



OKLAHOMA Transportation

**Oklahoma Transportation Cabinet
report to the
Hydrogen Production, Transportation and
Infrastructure Task Force**

November 2021

Prepared by Terri Angier and Cody Boyd
200 N.E. 21st St.
Oklahoma City, OK 73105

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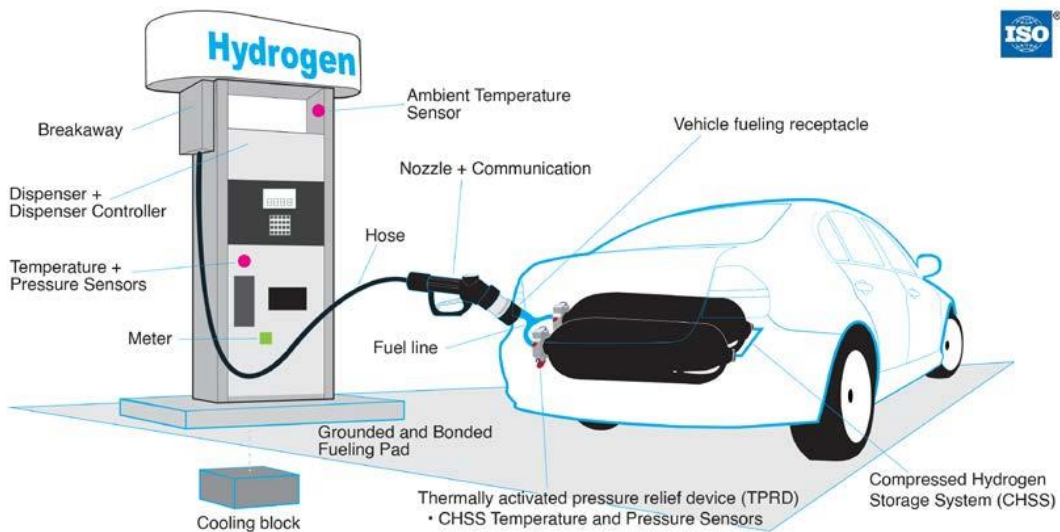
Section I: Introduction

In 2021, Senate Bill 1021¹ created the Hydrogen Production, Transportation and Infrastructure Task Force to research, gather feedback from stakeholders and produce a comprehensive report on the potential for Oklahoma to become a Top Ten State in the production and/or marketing of hydrogen as a fuel source. The task force was set to begin on July 1, 2021 and sunset on Dec. 31, 2021, with its report due to the governor and legislative leadership by Dec. 1, 2021.

The legislation included the Oklahoma Secretary of Transportation or a designee as a member of the task force, along with the Oklahoma Secretary of Energy and Environment, Oklahoma Secretary of Commerce, and representatives from the Oklahoma Senate, Oklahoma House of Representatives, Oklahoma Corporation Commission, Oklahoma Water Resources Board and Oklahoma Center for Science and Technology. The task force is co-chaired by Oklahoma Secretary of Energy and Environment Ken Wagner, Sen. Kim David and state Rep. Mark McBride.

The Secretary of Transportation’s designee – Interagency Liaison Terri Angier – representing the interests of the Oklahoma Department of Transportation, Oklahoma Turnpike Authority and Oklahoma Aeronautics Commission – serves as co-chair of the Subcommittee on Transportation, Storage and Distribution along with Oklahoma Corporation Commission Public Utility Division Director Brandy Wreath.

This segment of the report will primarily cover potential commercial freight transportation of hydrogen by roadway, rail, waterway and air, along with information on identified alternative fuel corridors on Oklahoma’s highway system for possible integration of hydrogen as a fuel source for vehicles. A companion piece by OCC will detail other distribution and transportation issues including use of pipelines.



*Diagram of a hydrogen fuel pump
(California Governor’s Office of Business and Economic Development, 2020)*

Section II: Agency Responsibilities and Jurisdiction



OKLAHOMA
Transportation

Transportation Cabinet Agencies

The **Oklahoma Department of Transportation (ODOT)** has jurisdiction over the planning, construction, maintenance and operation of roads and bridges on the state's highway system, which includes state highways, U.S. highways and interstates. The agency also administers state and federal funding for local road projects, public transit programs and rail crossing safety improvements, along with providing support to Oklahoma's port operators on the McClellan-Kerr Arkansas River Navigation System and maintaining state-owned railroads through lease agreements with rail operators. Additionally, ODOT collects data on traffic and freight movement across all modes of transportation.

The **Oklahoma Turnpike Authority (OTA)** has jurisdiction over planning, construction, maintenance and operation of the state's tolled highways on the turnpike system.

The **Oklahoma Aeronautics Commission (OAC)** administers state and federal funding for airport improvements at the state's 108 public use airports and promotes development of the aerospace industry.

The three agencies in the Transportation Cabinet have interests and missions focused on the safety of the traveling public and the protection, preservation and efficient operation of the state's transportation infrastructure system. While many regulations are based on feedback, information and recommendations from the Transportation Cabinet agencies, they are not regulatory or law enforcement agencies. The safe movement of freight on the state's transportation system is facilitated through the safety oversight and regulatory duties of several state and federal agencies that work in close partnership with the Transportation Cabinet.

The next section includes a list of state and federal partner agencies and a summary of their roles in the realm of transportation of materials like hydrogen.

Partner Agencies

The **Oklahoma Corporation Commission (OCC)** has numerous administrative and enforcement responsibilities relating to intrastate and interstate motor carriers and commercial motor vehicles, including vehicle registration, tax and fee compliance and permits for hazardous materials. Additionally, the regulation of oil and gas storage and pipelines falls under the jurisdiction of OCC.

The **Oklahoma Department of Public Safety (DPS)** enforces size and weight restrictions for commercial vehicles and issues permits for transportation of oversize and overweight loads and/or loads carrying hazardous materials, in close collaboration with ODOT.



The **U.S. Department of Transportation's Federal Motor Carrier Safety Administration (FMCSA)** has federal jurisdiction over commercial trucks and is the primary regulator of truck traffic.

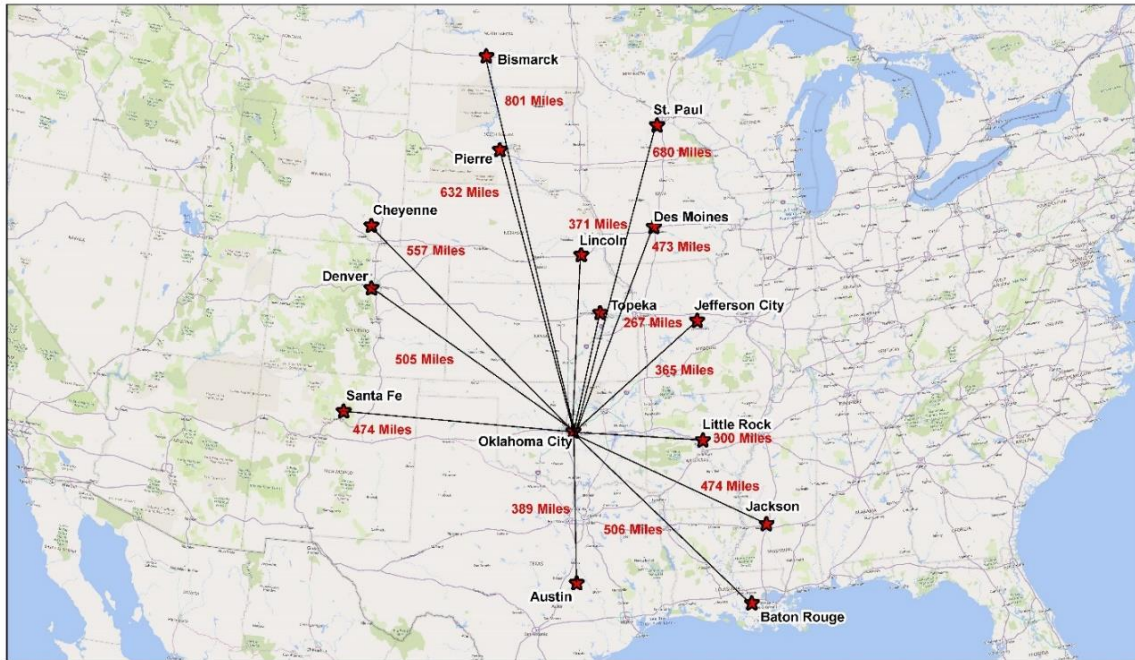
The **Federal Highway Administration (FHWA)**, under USDOT, sets standards and policy and administers federal funding for improvements to roads and bridges, including interstates, highways, city streets and county roads. FHWA also designates alternative fuel corridors, which will be discussed in Section V.

The **Federal Railroad Administration (FRA)**, under USDOT, is the primary federal agency with regulatory authority over railroads and rail traffic.

The **U.S. Army Corps of Engineers (USACE)** is responsible for maintenance of water routes like the McClellan-Kerr Arkansas River Navigation System (MKARNS) and the **U.S. Coast Guard (USCG)**, part of the U.S. Department of Homeland Security, has regulatory authority over waterborne traffic on navigable waterways. The **Maritime Administration (MARAD)** within USDOT also provides technical support to help support waterway infrastructure and the operation of ports and waterways.

The **Federal Aviation Administration (FAA)**, also under USDOT, has federal regulatory authority over aircraft, air traffic and airports.

Section III: Freight Transportation in Oklahoma



Distance to/from Oklahoma City

Legend

★ State Capitals



Overview

Oklahoma’s central location in the continental United States and the confluence of major interstate routes make the state a major link in the nation’s network of trade and commerce and serves as a natural hub for interstate truck traffic.

According to the 2018-2022 Oklahoma State Freight Transportation Plan (which was developed in 2017 using official data from 2015), 817 million tons of freight are transported in Oklahoma annually, with 512 million tons moving through the state with an origin and destination outside of Oklahoma.² Through traffic accounts for 63% of total freight tonnage and 83% of total freight value in Oklahoma. The freight plan can be found online at <https://oklahoma.gov/odot/programs-and-projects/transportation-programs/odot-freight-transportation-plan.html>.

With 79 million tons of inbound traffic versus 100 million tons of outbound traffic, Oklahoma is a net exporter state. 90% of all freight traffic in Oklahoma is domestic, as defined by the U.S. Department of Commerce as produced



within the nation's borders.

In general, most freight transported through Oklahoma is being moved from Texas northeast toward the Great Lakes area and the northeastern seaboard, or from California and the western United States to the east coast and northeastern seaboard.

Coal and nonmetallic minerals (i.e. limestone, granite, stone, sand, gravel, potash, phosphate and other fertilizer miners) represent the largest volumes of commodities transported by total tonnage. Chemical products (i.e. unrefined petroleum such as crude oil and natural gas) are the largest commodity by total value, according to the freight plan. Transportation of hydrogen falls into this category.



Freight traffic by mode of transportation (ODOT, 2017)

In 2015, 473 million tons of freight were transported by truck, 338 million tons were transported by rail and 6 million tons were transported by waterway. Air traffic represents a relatively small amount of the total freight movement in Oklahoma but fills a niche by providing business travelers access to more remote areas of the state.

Highway Transportation

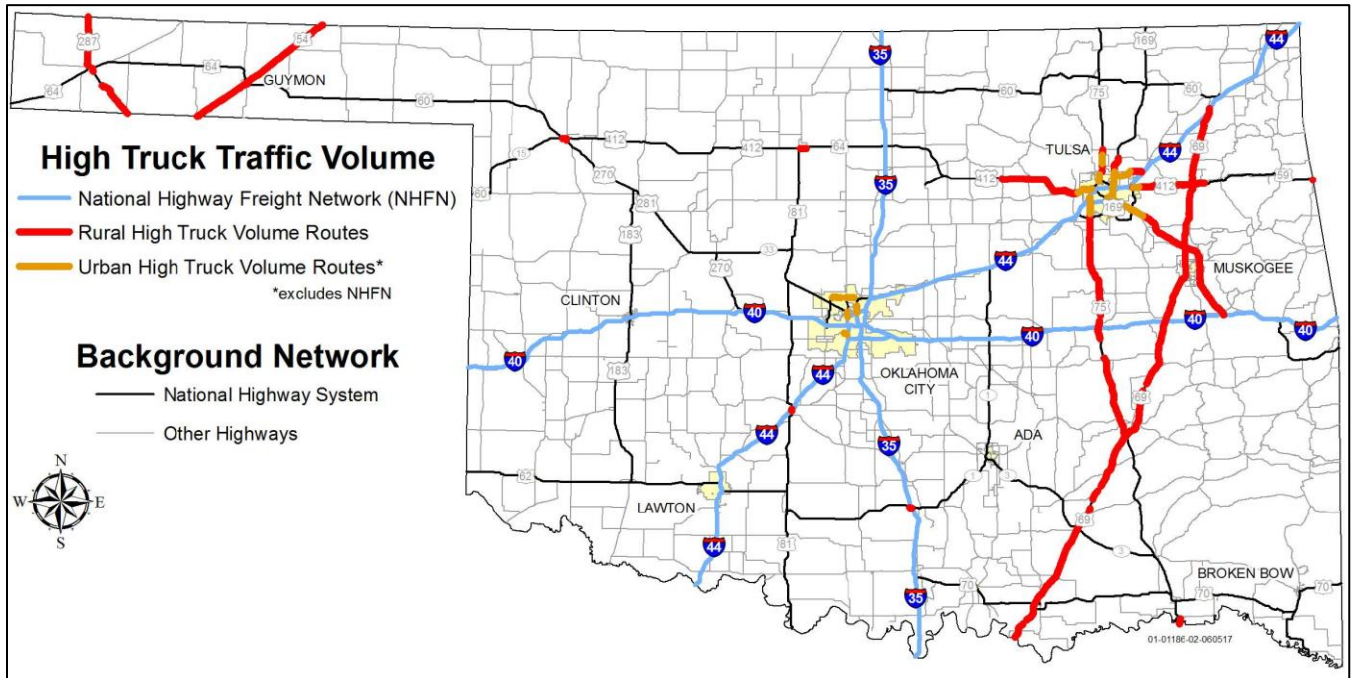
Oklahoma's major highway corridors make the state an important link in the region and nation's network of trade and commerce, especially for interstate commercial truck traffic. Oklahoma's highway system includes more than 30,000 lane miles or more than 12,000 centerline miles of interstates, U.S. highways and state highways maintained by the Oklahoma Department of Transportation and nearly 625 centerline miles of tolled interstates and highways maintained by the Oklahoma Turnpike Authority. The highway system is the 17th largest in the nation by centerline miles, ahead of states like Florida and just behind California.³

Major cross-country interstate routes like I-35, I-40 and I-44 facilitate transportation of freight from coast to coast and from Texas and Mexico north to the Great Lakes states and the

northeastern seaboard.

Commercial Truck Traffic

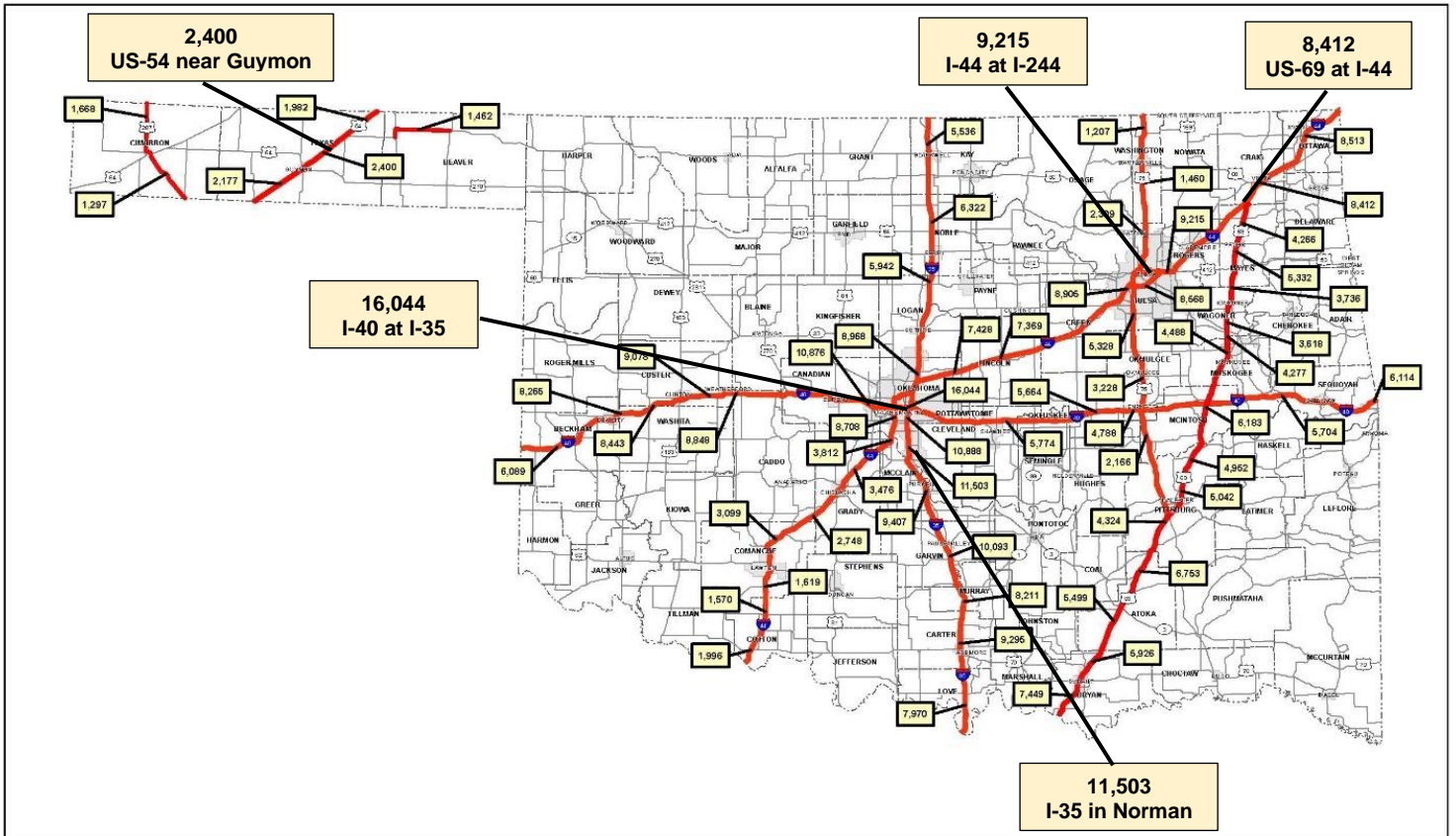
Major routes for freight traffic include Oklahoma's interstates – I-35, I-44, I-40, I-240, I-235, I-244 and I-444 (Inner Dispersal Loop in Tulsa) – which are part of the National Highway Freight Network. Urban High Truck Traffic Volume routes include several major non-interstate turnpikes including the John Kilpatrick Turnpike (proposed future I-240) in Oklahoma County and freeways like US-64/SH-51/Broken Arrow Expressway in Tulsa County.



High commercial truck traffic volume corridors in Oklahoma (ODOT, 2017)

Rural High Truck Traffic Volume routes include:

- US-69 from the Texas state line near Colbert to I-44/Will Rogers Turnpike at Big Cabin
- US-75 between the Kansas state line and I-40 in Henryetta
- SH-375/Indian Nation Turnpike between I-40 in Henryetta and US-69 in McAlester
- SH-351/Muskogee Turnpike between Broken Arrow and I-40
- US-412 between Tulsa and US-69
- US-412/Cimarron Turnpike between Tulsa and Hallett
- The junction of US-412 and US-270 in Woodward
- The junction of US-412 and US-81 in Enid
- US-81 in Chickasha
- US-54 between the Texas state line and the Kansas state line in the Panhandle
- US-287 between the Texas state line and the Colorado state line in the Panhandle



Truck AADT Locations

Legend
 — Highest Truck AADT
 — Highways
 — Urban Areas
 — Counties



Average Annual Daily Traffic volumes for commercial trucks on major Oklahoma highway routes (ODOT, 2021)

The largest volumes of truck traffic in Oklahoma are found along the I-35, I-40 and I-44 corridors.⁴ More than 16,000 trucks pass through the junction of I-35 and I-40 in downtown Oklahoma City each day, the highest count in the state. Truck traffic volumes in excess of 10,000 per day are observed on I-35 between Oklahoma City and Pauls Valley and on I-40 between Oklahoma City and Yukon. The largest truck traffic volumes in eastern Oklahoma include 9,000 on I-44 in Tulsa; 7,500 on US-69 near Durant and 8,500 between the US-69 and I-44/Will Rogers Turnpike junction in Big Cabin and Miami. Some of the highest percentages of truck traffic are found on rural highways like US-69

Commercial truck traffic as a percentage of total traffic volumes in Oklahoma range from 30% on I-35 to 40% on US-69 to 50% on rural segments of I-40. The highest truck traffic percentages in the state are found on the short segments of US-287 and US-54 through the Oklahoma Panhandle between Texas and Colorado.

Passenger Vehicle Traffic

The highest total traffic volumes in the state are found in the Oklahoma City metro area where interstate traffic and daily commuter traffic crisscross. Nearly 170,000 vehicles travel I-44 just north of I-40 each day, the highest average daily traffic count site in Oklahoma. The highest average traffic counts in the Tulsa metro area are found on US-169 near SH-51/Broken Arrow Expressway, which carries nearly 130,000 vehicles per day.

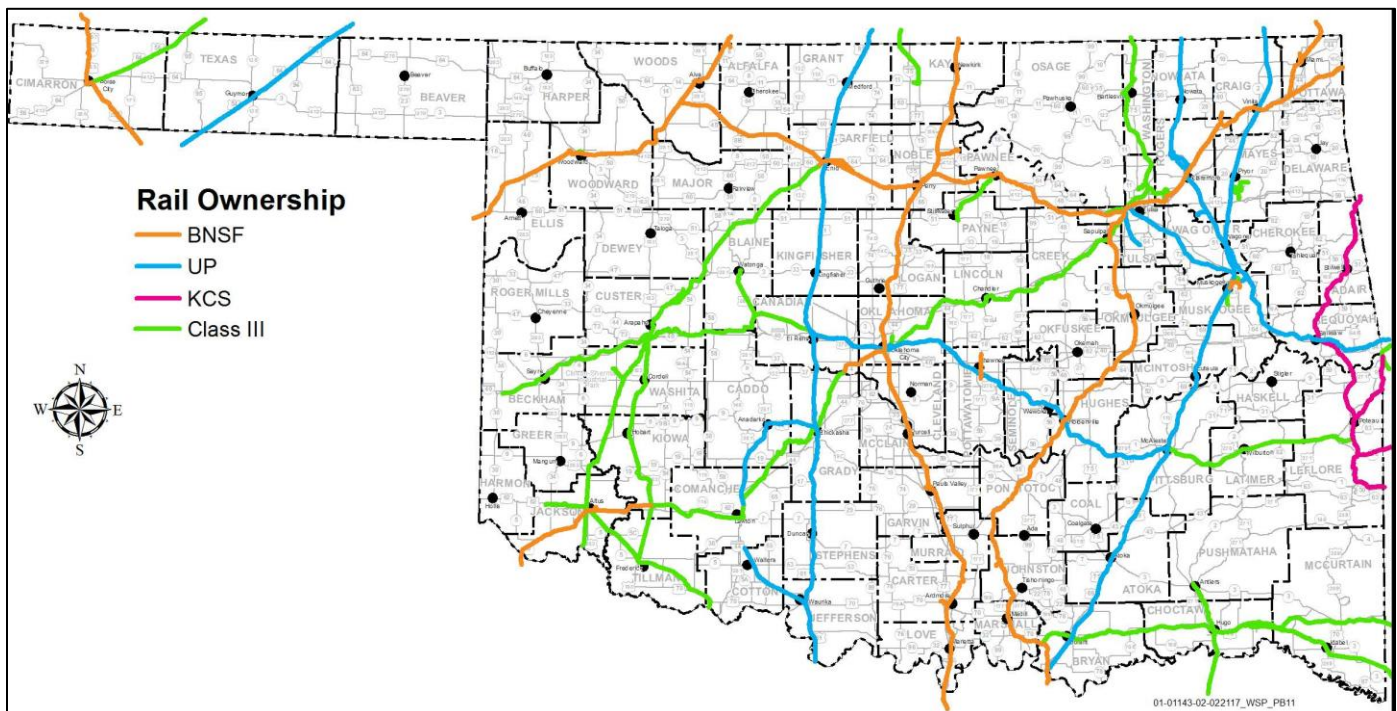
Future Outlook

Every five years, ODOT produces an update to the State Freight Transportation Plan, which analyzes current conditions and forecasts future growth and issues in the movement of freight.

Total average daily traffic volumes are expected to increase by 2% annually, nationwide. Commercial truck traffic is expected to increase by 3% annually, according to the ODOT freight plan.

Rail Transportation

Oklahoma has 1,987 miles of railroad currently in operation by Class I operators – BNSF Railway, Union Pacific Railroad and Kansas City Southern – as well as 1,132 miles of railroads used by Class III short-line operators. The State of Oklahoma, through ODOT, owns and maintains 152 miles of railroad, of which 126 miles are operated through lease agreements with short-line operators.⁵



Oklahoma's system of railroads (ODOT, 2017)

High volume freight rail routes in Oklahoma include:

- North-south: BNSF Railway along the I-35 and US-77 corridor between Kansas, Oklahoma City and Texas
- East-west: BNSF along the US-412/US-64 corridor between Tulsa and the Woodward/Alva area in northwestern Oklahoma
- North-south: Union Pacific Railroad between I-40 near Checotah, Tulsa and Kansas
- North-south: Union Pacific along US-54 between Texas and Kansas and BNSF along US-287 between and Texas and Colorado in the Panhandle

Oklahoma has 40 transload terminals, which are facilities that transfer non-container freight from one mode of transport to another. Products at transload terminals include open stockpiles of minerals and chemical products stored in tanks.

Waterway Transportation

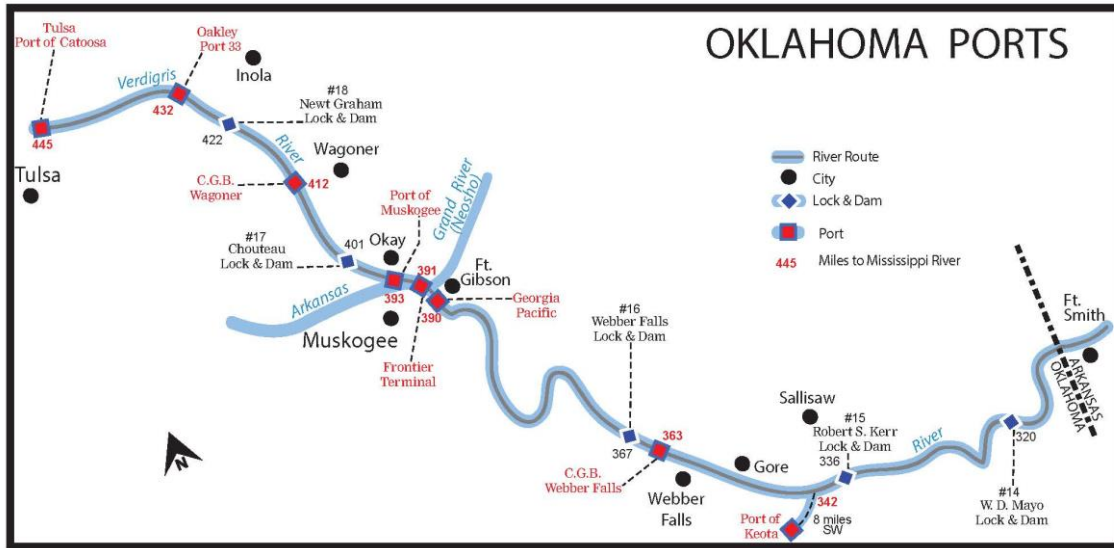
Opened in 1971, the 445-mile McClellan-Kerr Arkansas River Navigation System (MKARNS) in eastern Oklahoma extends from the Tulsa Port of Catoosa southeast through Arkansas to the Mississippi River and the Gulf of Mexico.⁶ The MKARNS links Oklahoma to a 12-state service area with various domestic ports on the U.S. inland waterways system and foreign ports by way of New Orleans and the Gulf Intracoastal Waterway. This system can be used as a viable tool in the U.S. for international hydrogen with some improvements to the MKARNS over time.



Marine Highway Routes in the United States. The MKARNS is designated M-40. (USDOT, 2021)

The MKARNS is designated Marine Highway 40 by the U.S. Department of Transportation and is the nation's most westerly inland freight water and provides an ice-free shipping channel year-round. The navigation system supports 11,000 jobs and provides a national and international outlet for Oklahoma and regional commodities and products.

Oklahoma has two public ports – the Tulsa Port of Catoosa and the Port of Muskogee – and other



private ports on the MKARNS, including Oakley’s Port 33 near Inola, C.G.B. Wagoner, Frontier Terminal and Georgia Pacific near Muskogee-Fort Gibson, C.G.B. Webbers Falls, and the Port of Keota. These ports process more than 6 million tons of cargo annually with a \$1.6 billion economic impact in Oklahoma.

Air Transportation

Oklahoma has 108 public use airports on the Oklahoma Airport System. Commercial passenger service is available at Will Rogers World Airport in Oklahoma City, Tulsa International Airport, Lawton-Fort Sill Regional Airport and Stillwater Regional Airport.⁷ Air freight is a relatively small percentage of all freight transported in Oklahoma; however, these airports address an important need of business travel to rural and remote areas.



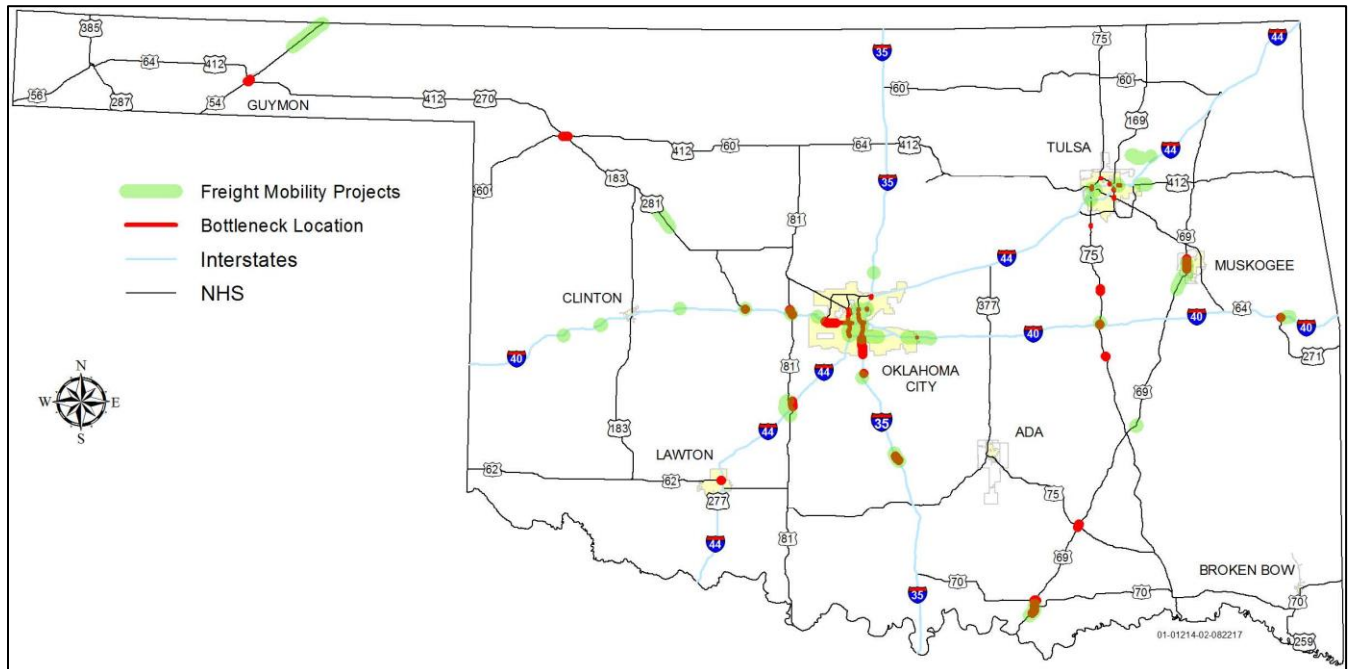
Public use airports in Oklahoma (OAC, 2021)

Section IV: Freight Transportation Opportunities and Issues

Highway Transportation

General Freight Issues

Through regular traffic analysis, feedback from the industry and updates to the state's freight plan, ODOT has identified several freight bottlenecks on the highway system to be targeted for continued investment to facilitate efficient transportation of goods in and through Oklahoma.



Freight bottlenecks are highlighted in red and freight mobility projects under construction or planned are highlighted in green (ODOT, 2017)

The following locations were identified as freight bottlenecks in the most recent update to the Oklahoma State Freight Transportation Plan:

- Major interstate junctions and interchanges in the Oklahoma City and Tulsa metro areas
- I-35 near Pauls Valley and Purcell
- I-35 and SH-7 near Davis
- I-40 in El Reno and near Sallisaw
- I-44 and US-62 in Lawton
- US-69 in Calera, Durant, Atoka and Muskogee
- US-75 between Tulsa and the junction of I-40 and SH-375/Indian Nation Turnpike in Henryetta
- US-81 in El Reno and Chickasha
- US-412 and US-270 in Woodward
- US-54 and US-412 in Guymon

Several highway and turnpike projects to address Oklahoma's major freight corridors and bottlenecks are currently under construction or scheduled in ODOT's FFY 2022-2029 Eight-Year Construction Work Plan and OTA's CY 2021-2025 Five-Year Capital Plan for future improvement. Many of these projects include construction performed in several phases over multiple years.

Under Construction as of Fall 2021:

- Upgrade of US-69/75 to a controlled-access freeway between Calera and Durant
- Upgrade of US-69 to a controlled-access freeway in McAlester
- I-235 and I-44 interchange reconstruction in Oklahoma City
- I-35 pavement reconstruction between Wayne and Pauls Valley
- I-44 and US-75 interchange and widening of I-44 to six lanes between the Arkansas River and Turner Turnpike in Tulsa
- I-44/Turner Turnpike widening to six lanes between Kellyville and Tulsa
- I-40 widening to six lanes between I-240 in Oklahoma City and US-177/US-270 in Shawnee
- US-270 widening to four lanes between Woodward and Seiling

Scheduled in ODOT's FFY 2022-2029 Eight-Year Construction Work Plan:⁸

- I-44 interchange upgrades at SH-152/Airport Rd. and I-240 in Oklahoma City
- I-44 widening to six lanes between I-240 in Oklahoma City and the H.E. Bailey Turnpike in Newcastle
- I-35 widening to six lanes from US-77/SH-66 in Edmond north to the Logan Co. line
- I-35 widening to six lanes between I-40 and I-44 in Oklahoma City
- I-35 and I-240 Crossroads interchange reconstruction in Oklahoma City
- I-35 widening to six lanes between Norman and Goldsby
- Right-of-way acquisition and utility relocation for future I-35 widening between Goldsby and Purcell
- I-35 widening to six lanes across the Red River to Thackerville
- I-40 widening to six lanes between Douglas Blvd. and I-240 near Tinker Air Force Base in Midwest City and Oklahoma City
- Right-of-way acquisition and utility relocation for future US-75 upgrades between Tulsa and Henryetta
- Construction of US-81 Bypass in Chickasha

Potential Future Interstate Designations

The Oklahoma Transportation Commission and the Oklahoma Turnpike Authority board recently approved a request for addition of the I-240 designation to the John Kilpatrick Turnpike, SH-152/Airport Rd., the Kickapoo Turnpike and a segment of I-44/Turner Turnpike to create a continuous 91-mile interstate loop around Oklahoma City.⁹ The designations are pending approval from the Federal Highway Administration and the American Association of State Highway and Transportation Officials.

Such designations will not change the tolling status or maintenance responsibilities of the above-mentioned roadways but will increase the national prominence of the loop and improve continuity as more drivers use Global Positioning Systems-based routing applications, which can have difficulty producing continuous, logical routes on unnumbered highways.

U.S. Sen. Jim Inhofe of Oklahoma, together with U.S. Sen. Tom Cotton and U.S. Sen. John Boozman of Arkansas, has proposed S. 1766 to designate US-412 between I-35 near Perry, Okla. and I-49 in Springdale, Ark. as a new interstate.¹⁰ US-412 is currently built to interstate standards along the Cherokee Turnpike between Locust Grove and Flint and along the Cimarron Turnpike between I-35 and Tulsa. Segments of US-412 between Catoosa and Locust Grove and between

Flint and the Arkansas state line would need to be improved to freeway standards to facilitate the interstate designation.

The Indian Nations Council of Governments (INCOG), the Tulsa area's Metropolitan Planning Organization, is leading this effort for the designation, which is also supported by the City of Tulsa, ODOT and other regional stakeholders. If successful, this designation would increase the prominence of the connection from northwestern Oklahoma to ports on the MKARNS to the growing Northwest Arkansas region. Additionally, an interstate designation would quality future construction projects along the corridor for more federal funding.

Pipeline Crossings of Highways

Public Right-of-Way

A myriad of public and private utilities cross Oklahoma highways, including fuel transmission, electrical, telecommunications, water and sewer lines. The vast majority of highway crossings are facilitated via an underground bore to pass underneath the roadway, while some select utilities pass over highways via a dedicated bridge or an attachment on a roadway bridge. **As per state law, only public utilities are permitted to be buried inside of public rights-of-way.** Private utilities, such as pipelines for transmission of petroleum products, may be buried parallel to highways, outside of public right-of-way, through a private easement.

Hydrogen pipelines could be placed parallel to highways, outside of public right-of-way and would be allowed to cross highways through ODOT's permitting process, detailed below.

Most volatile petroleum products have specific regulations, such as minimum easement width, depth, cathodic protection, signage and excavation restrictions that would prevent them from being located inside state right-of-way even if they were designated as public utilities. Not only is ODOT unable to place such restrictions on public rights-of-way, but the agency also cannot indemnify the facility owners from liability in the event of a pipeline failure. Highway rights-of-way regularly undergo maintenance and construction that includes excavation by heavy machinery, which is not conducive for buried high-pressure pipeline due to risks to the traveling public and to workers.

Pipeline Crossing Permits

While hydrogen pipelines would not be permitted to be located inside public right-of-way, crossings, they are a class of utility allowed to cross under highways through a permit that meets specific criteria outlined by ODOT based on U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration regulations.¹¹

Primarily, these regulations require such pipelines to be encased, sealed and vented in accordance with certain standards and buried at a minimum of 48 inches below subgrade and not less than 30 inches below the bottoms of ditches. Proper markers are required to be attached to vents and/or right-of-way fencing at intervals of no more than 1,000 ft. and be plainly visible to workers, first responders and the public.

Steel pipelines may be installed without encasement if the pipe material meets certain standards, employs anti-corrosion countermeasures, and is buried at least 48 inches below the flow line of drainage ditches or other drainage structures.

Requests for pipeline crossing permits on highways may be made by contacting the appropriate ODOT Field District office. Central office experts in ODOT's Right-of-Way and Utilities Division are available to assist with consultation and review. Requests for crossings of city streets or county roads must be made to the appropriate local officials.

Commercial Truck Transportation and Use as a Fuel Source

Current Market

According to feedback from the U.S. Department of Energy and National Renewable Energy Laboratory's Technical Response Service, there is not yet a comprehensive list of fuel cell electric (FCEV) trucks that are planned for production and domestic use. However, this market is rapidly evolving, and several vehicle manufacturing brands have made public commitments to enter hydrogen-powered trucks into the medium- and heavy-duty market. These entries into the consumer market therefore require an infrastructure of hydrogen supply including pipelines and fueling stations.

These announcements include:¹²

- Nikola
 - Tre FCEV, available 2023
 - Two FCEV, available 2024
- Toyota-Kenworth
 - T680 FCEV on demonstration
- Toyota-Hino
 - XL8 – revealed prototype August 31, 2021 at the Advanced Clean Transportation Expo
- Volvo- Daimler
 - Mercedes-Benz GenH2 Truck, available 2023
- Hyundai
 - Xceint Fuel Cell, available in Switzerland currently

Currently, Scania, a subsidiary of Volkswagen, has a fleet of FCEV garbage trucks in Sweden however they recently announced that they will be moving away from FCEV technology for trucks in favor of battery electric technology.

Additionally, Hyundai Xceint Fuel Cell trucks are available in Switzerland already and Hyundai is rolling out a large-scale demonstration project in California bringing more than 30 trucks to the road through the NorCAL ZERO project.

Feedback from Oklahoma Trucking Association

Input from the Oklahoma Trucking Association indicates that trucking companies and operators are very interested in and closely watching hydrogen as a fuel source for commercial trucks.

The following comments were received from Jim Newport of the Oklahoma Trucking Association on Sept. 15, 2021.

“To the Oklahoma Hydrogen Task Force (Hydrogen Production, Transportation, and Infrastructure Task Force in accordance with SB 1021)

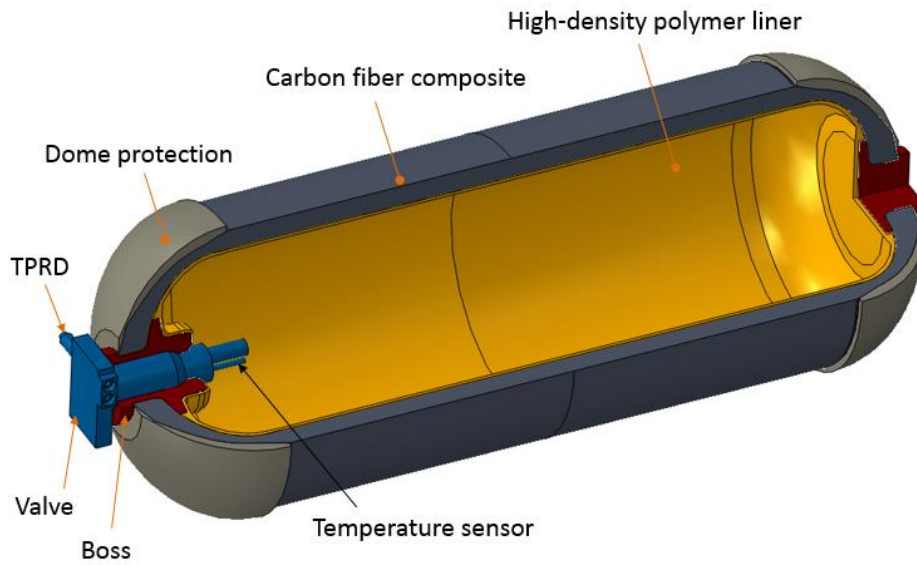
Commercial Motor Vehicles Initial Considerations - Oklahoma Hydrogen Task Force

Task Force Members- Besides the production and viability of large scale fully operational hydrogen fuel cell commercial motor vehicles, some early policy considerations may need to be explored. (Needless to say, Safety First is always implied.)

- **Production & Refueling Infrastructure.** Obviously, hydrogen fuel cell use cannot become a mainstream fuel alternative without being readily available.
- **Incentives.** This chicken and egg scenario is not dissimilar to what Oklahoma experienced with CNG and Electric vehicles. Rebates and/or tax deductions helped fast track the refueling infrastructure for both private fleets and public stations.
- **Weight Differentials.** Federal and State regulations determine the total amount a truck can weigh. Trucking is capital intensive and operates on thin margins. A truck’s revenue is often based on the amount of payload it can carry. The batteries used in Commercial Truck EV’s are extremely heavy. The Compressed Natural Gas (CNG) tanks mounted on a truck are very heavy. In both cases, these additional weights were exempted to allow an equal gross payload weight regardless of the truck’s fuel source. Without this consideration of weight parity, one fuel source could inadvertently become more attractive than another. A Hydrogen Fuel Cell capable truck may also be heavier than today’s conventional commercial vehicles and would likely need the same weight exempted consideration.
- **Equitable Fuel Taxation.** According to the American Transportation Research Institute (2020), commercial trucks paid 48% of all taxes owed by Oklahoma motorists despite trucks representing only 16% of vehicle miles traveled in the state. Because a fuel tax is a significant tax collected for road and bridge investment, a fair and equitable tax equivalent among all fuels should be a priority. Again, without this consideration, one fuel source could inadvertently become more attractive than another.”¹³

-Jim Newport, Chief Executive Officer
Oklahoma Trucking Association

The installation of hydrogen equipment to commercial trucks would add considerable weight to vehicles that operate primarily to carry as much freight as allowed to maximize efficiency. This issue has been explored with other alternative fuel vehicles, such as CNG-powered trucks, which are currently granted exemptions that allow them to exceed federal and state truck weight limits by 2,000 lbs. to account for the weight of the pressurized tank and other equipment, therefore serving as an incentive for alternative fuel use.



TPRD = Thermally Activated Pressure Relief Device

Credit: Process Modeling Group, Nuclear Engineering Division, Argonne National Laboratory (ANL)

Diagram provided by U.S. Department of Energy, 2021

The following additional comments were received from Jim Newport of the Oklahoma Trucking Association on Nov. 1, 2021.

“I have made mention of increased weight for zero/low emission vehicles before. I recently attended a national trucking convention. One of the committee meetings included a portion on Zero Emission Trucks (ZEV)s. **Hydrogen** powered trucks are now included in the conversation along with Electric and CNG. ZEV's increased weight and impact on bridge and pavement were discussed. I am sharing with the bullet points captured below.

Zero Emission Vehicle Weight Increase

- Current federal law allows vehicles powered primarily by batteries or natural gas to exceed gross and axle weight limits by 2,000 pounds.
- Manufacturers support two revisions:
 - Extend exemptions to all zero emission vehicles, including FCEV (i.e., hydrogen)
 - Increase weight increase to **7,000 pounds**
- Changes would allow parity with diesel/gas trucks, eliminating a competitive disadvantage; and prevent a reduction in vehicle capacity (added congestion)/productivity
- Infrastructure impacts
 - Higher gross and axle weights likely increase bridge and pavement cost
 - Those additional cost likely to be partially or fully offset by reduced number of miles traveled with increase weight allowance
 - FHWA study on impacts of 88,000 pound 5-axel trucks: \$400 million one-time bridge cost; 0.4%-0.7% increase in pavement cost

- Battery weight will likely come down, but we don't know when or by how much

Obviously at present, ZEV's weigh more than conventional diesel powered trucks. Without the collaborative support of weight increases from policy makers, ODOT and stakeholders, for hydrogen (fuel cell) trucks, a lack of parity will incentivize the continuation of diesel power and hinder the acceleration of hydrogen powered trucks."

-Jim Newport, Chief Executive Officer
Oklahoma Trucking Association

The following response to Mr. Newport's comments was made by Terri Angier on Nov. 2, 2021.

"Thank you Jim! I am encouraged to hear there is dialogue on this issue on a national level. I am certain that there will be a happy median for the industry that doesn't adversely impact the infrastructure investments including a conversation about spreading axle weight options. AASHTO (the national transportation association) has facilitated this a few times and familiar with the DOT's needs and capacities and will probably be involved again. We appreciate the additional information."

-Terri Angier
Interagency Liaison/PR Advisory
Office of Transportation Secretary Tim Gatz

The Transportation Cabinet is committed to working with the industry on reasonable weight accommodations for hydrogen vehicles while also safeguarding infrastructure from excessive loads that accelerate the deterioration of roads and bridges.

Rail Transportation

General Freight Issues

Since 2005, Oklahoma has had no intermodal rail terminals, which are facilities that can transfer containers from one mode of transport to another. The nearest intermodal facilities are located in Dallas, Kansas City and Memphis.

Railroad-related concerns and mobility issues can be attributed to several factors. Inadequate track and a rail yard's physical capacity can produce railroad bottlenecks, as can the crossing of two or more tracks. Rail bottlenecks in turn, impact rail velocity. Deficient structures such as bridges can introduce speed restrictions that affect freight mobility

These factors not only affect the mobility of rail freight but can also have an impact on highway traffic. Slow or stopped trains can interfere with motor vehicle traffic at grade crossings. Even fast-moving trains in high frequency railroad corridors can create bottlenecks for motor vehicles.

The Oklahoma State Freight Transportation Plan includes a list of 16 locations with railroad mobility issues, including limitations on standard 286,000 lb. freight cars, lack of capacity and missing connections; however, the rail network is extensive and can be improved to facilitate distribution of hydrogen in the state.

Feedback from Oklahoma Railroad Association

Feedback has been received from the railroad industry that indicates hydrogen is not currently being transported by rail, but that the industry is open to the market if customer demand materializes.

The following comments were received from Lori Peterson of the Oklahoma Railroad Association on Aug. 27, 2021.

“Thank you so much for including me in the meeting. I look forward to the next one. I do not have an official paper for the issue as it is new to our industry. I have contacted the Association of American Railroads (AAR), our national policy organization was provided the following information.

It is my understanding there is no liquid hydrogen transported by rail at the present time, but it is a commodity authorized by regulation. If tendered in a DOT approved tank car, the railroads would transport it. It is more hazardous than transporting LNG by tank car, but I have not heard anyone opposed to transporting it if offered. Since it is so cold when liquified, it takes a special tank car (like a thermos bottle – a tank within a tank) to transport it. Currently, there are very few of these cars. If transport by rail were considered, the shipper/customer would have to provide the cars. Also, since they are so specialized, they are more expensive than a traditional tank car. I understand an LNG tank car costs around \$750K, maybe less if a large order were processed. Canadian Pacific, one of AAR’s member railroads is planning to test a hydrogen powered locomotive. I have not heard any results. As I have more information, I will share it with you.

Thank you again. Please let me know if I can be of any assistance.”

-Lori A. Kromer Peterson, Executive Director
Oklahoma Railroad Association

Waterway Transportation

General Freight Issues

According to the U.S. Army Corps of Engineers Tulsa District, there is a backlog of maintenance projects on the MKARNS affecting freight transportation. Critical backlog projects to address infrastructure with an estimated 50% chance of failure within a 5-year period include deteriorated gate mechanisms at the Robert S. Kerr, Mayo, Webbers Falls and Graham locks and dams.

Additionally, the MKARNS has a 9 ft. controlling navigation depth, compared to a 12 ft. depth on most other inland waterways which allow heavier loads and larger barges. U.S. Congress

authorized a 12 ft. depth on the MKARNS in 2005, but no funding has been appropriated to USACE for the necessary dredging. Waterway industry stakeholders and port operators are actively seeking funds to remedy this deficiency.

Feedback from Ports and Waterway Freight Industry

Feedback has been received from Oklahoma's port operators that acknowledge the potential for hydrogen be a prosperous commodity, however, strong concerns regarding safety were expressed by all Port representatives. While the Ports feel certain that strict safety protocols and precautions exist, they implore hydrogen industry leaders to better educate ports and industrial locations about the real risks, issues, and challenges of producing and storing the gas, as well as what modern safeguards are in place to mitigate the risks.

A meeting was arranged with port operators to receive feedback and share information, the minute so which are included in the below comments from Thaddeus Babb of ODOT's Waterways Program on Oct. 4, 2021.

“On September 10, 2021, Terri Angier (ODOT Senior Staff), Cody Boyd (ODOT Communications) and Thaddeus Babb (ODOT Waterways) met with Oklahoma Port Directors, David Yarbrough (Tulsa Ports), Kimbra Scott (Port of Muskogee) and Josh Taylor (Oakley's Port 33) to discuss potential hydrogen production, storage and distribution by barge in Oklahoma. Andrew Ralston, Tulsa Ports Economic Development, and Dan Grisham, Tulsa Ports Deputy Director, and Scott Robinson with Port of Muskogee were also present during this discussion.

Overall, Oklahoma Ports agreed that hydrogen has the potential to be a prosperous commodity in our state, however, strong concerns regarding safety were expressed by all Port representatives. They explained that the common perception of hydrogen is that it is highly explosive and, therefore, the biggest concern amongst Ports and industries along the McClellan-Kerr Arkansas River Navigation System (MKARNS). While the Ports feel certain that strict safety protocols and precautions exist, they implore hydrogen industry leaders to educate ports and industrial locations about the real risks, issues, and challenges of producing and storing the gas, as well as, what modern safeguards are in place to mitigate the risks.

The Tulsa Port of Catoosa has one industry now that produces and maintains pressurized tank trailers and storage and as part of their services, they have petitioned the port multiple times for permission to place outdoor storage tanks of hydrogen. Additionally, a past opportunity involved a welding gas supplier who wanted to produce hydrogen at a location to dispense to the public. The Port, however, was not in favor of allowing it in the Port (in large quantities) until the company provided a safety plan that demonstrated area of impact. CF Industries, located at the Tulsa Port of Catoosa is the closest thing we have to an existing hydrogen production and shipping operation with their anhydrous ammonia production and transportation. Their “blue ammonia” expansion in Donaldsonville, LA has already proven their interest in exploring the market more. Our ports all agree that ammonia would be the safest and easiest path forward because it already exists on our waterway and rail line. Gray ammonia was identified as the most cost efficient, showing to be ten times less expensive than others.

The MKARNS waterway links Oklahoma to a 12-state service area with various domestic ports on the U.S. inland waterways system and foreign ports by way of New Orleans and the Gulf Intracoastal Waterway. Transporting by barge is the most economical, safe and environmentally friendly way of shipping bulk and oversized cargo, therefore, the transport of hydrogen products seems like a logical next step towards sustainable growth on the MKARNS. It is the position of ODOT Waterways, that the production, distribution and export of hydrogen products via the MKARNS would open doors to new business opportunities and economic growth. Furthermore, Oklahoma Ports and industries along the waterways will likely embrace the addition of this commodity if their concerns regarding safety are appropriately addressed.”

-Thaddeus Babb, Waterways Program Manager
Oklahoma Department of Transportation

Oklahoma’s ports and the MKARNS are an underutilized resource and provide the state with an incredible connection to international markets. The Oklahoma Department of Transportation is heavily involved in promotion of waterborne transportation of freight and coordination of transportation projects that will enhance the ability of the state’s ports and the MKARNS to recruit more industries to the area.

Air Transportation

General Freight Issues

Airport access is affected by several of the truck bottlenecks identified earlier, including the I-44 and I-240 interchange near the Will Rogers World Airport in Oklahoma City, the I-44 and I-244 interchange near the Tulsa International Airport and at I-44 and US-62 near the Lawton-Fort Sill Regional Airport.

Feedback from Oklahoma Aeronautics Commission

Feedback has been received from the Oklahoma Aeronautics Commission that indicates hydrogen is not being transported by air and is unlikely to anytime in the near future with current technology. There is a developing market for alternative fuel sources for aircraft, especially Unmanned Aerial Systems, that includes hydrogen fuel cells. Safety education in this area will be a key recommendation of this subcommittee to the task force.

The following comments were received from Grayson Ardies of the Oklahoma Aeronautics Commission on Sept. 28, 2021.

“Please see below for some data and information on hydrogen power in air transportation:

The current market for hydrogen power in aviation is at the tip of the sword in terms of technology and testing. Many in the industry believe it will be a long flight path forward to get FAA and the general public to not only certify the technology but get the population as a whole buy off on widespread use of hydrogen fuel aircraft. Timeframes such as 2040 and 2050 have been tossed around as dates for widespread use of hydrogen, and even then, the question as to what vehicles it will be used in at that time period are in

question. One of the big issues is that even if the technology is fully capable of being used as a fuel for aircraft, will the public buy in to this new fuel technology or will visions of the Hindenburg come to mind and keep people from wanting to fly these aircraft similar to what occurred after the 737max issues.

All of that being said, the potential for hydrogen is very good for aviation. Hydrogen powered aircraft development is following in very similar footsteps to battery powered aircraft, and interestingly enough, are running into the some of the same challenges. And that is one of the biggest challenges for aircraft, weight and power density of the fuel being utilized. For aircraft, density of the power providing substance (whether battery, hydrogen, or traditional fuel) is paramount compared to surface vehicles. There is a finite amount of lift each aircraft can make based upon the engine power and aeronautical characteristics of the aircraft. Each pound brought on board the aircraft to account for fuel is a pound of people, baggage, or equipment that has to be left off.

The current testing and development market is taking existing aircraft, mostly smaller general aviation style or smaller commuter airline type aircraft and retrofitting these aircraft to be powered by hydrogen or a combination of hydrogen and battery powered. For example, a company in California is taking a Dash 8 (50+ seat commuter airline aircraft) and retrofitting it to be powered by hydrogen. Unfortunately, as discussed above, they're having to take approximately 16 seats out of this aircraft in order to accommodate the addition fuel storage needs. Hydrogen fuel has about 1/4 of the fuel density of traditional Jet A and therefore it requires significantly more storage capacity. The other thing to consider is that the storage tanks that hydrogen fuel is stored in have to be stronger than traditional fuel tanks given the potential nature of hydrogen fuel. Other companies are working on hydrogen and battery powered aircraft which they hope to have airworthy and ready for testing in the next several years. Once the hydrogen fuel powered aircraft have been able to prove their concepts the industry expects new aircraft designs to start incorporating hydrogen power as a main source as opposed to converting existing aircraft over from traditional fuel to hydrogen fuel.

Another potential area that hydrogen power could make inroads into is the UAS (unmanned aircraft systems) and AAM (advanced air mobility) sector which is rapidly expanding. A lot of these aircraft won't have people on board and therefore won't have to necessarily overcome the public perception point of hydrogen fuel. This could be an advantageous area of aviation for hydrogen fuel to take advantage of and developers of these new aircraft and their hydrogen fuel partners are looking to take advantage of this.

At the end of the day, hydrogen power is an important component in the overall air transportation strategy to have fuel sources that are more environmentally friendly. Most aviation forecasters believe that battery powered aircraft will make up the short haul and small aircraft market (generally speaking 400 miles or less and 10 passengers or less) for the next couple of decades or until battery density technology improves significantly. Hydrogen powered aircraft can also step into this short haul market but have the ability to increase the range and passenger carrying capacity beyond what battery powered aircraft can provide. It is expected that in the next 20-30 years hydrogen powered aircraft could find a role in the 100 passenger or less market that serves destinations of 800-900 miles. Nothing will be able to replace the power providing

capability that traditional fuel has had for the last 70 years. That said, hydrogen fuel development will attempt to bring the overall industry forward and provide an alternative source of fuel for commercial airlines and general aviation users alike. Another area not routinely considered for hydrogen fuel is ground support vehicles and equipment. It is possible, likely probable that these types of support vehicles will see adoption of hydrogen fuel long before the routine adoption of the fuel in aircraft given the reduced barriers to entry in terms of certification and public acceptance. I think it's safe to say that hydrogen fuel along with its alternative fuel partner, battery power, will play a role in the aviation market for years to come as the testing, development, and certification of new technology is presented to the industry.

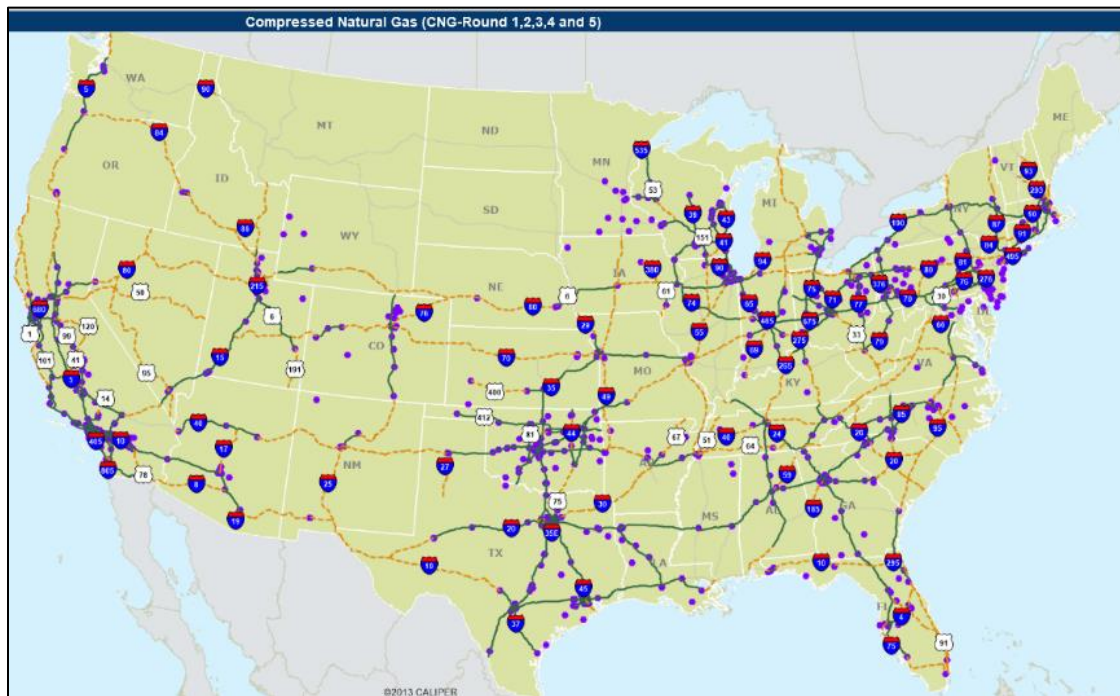
Hopefully that will satisfy what you need for the report. If you need more or anyone has questions, we would certainly be glad to answer them or provide additional information.”

-Grayson Ardies, State Director of Aeronautics
Oklahoma Aeronautics Commission

Section V: Identified Transportation Corridors

Existing Alternative Fueling Infrastructure

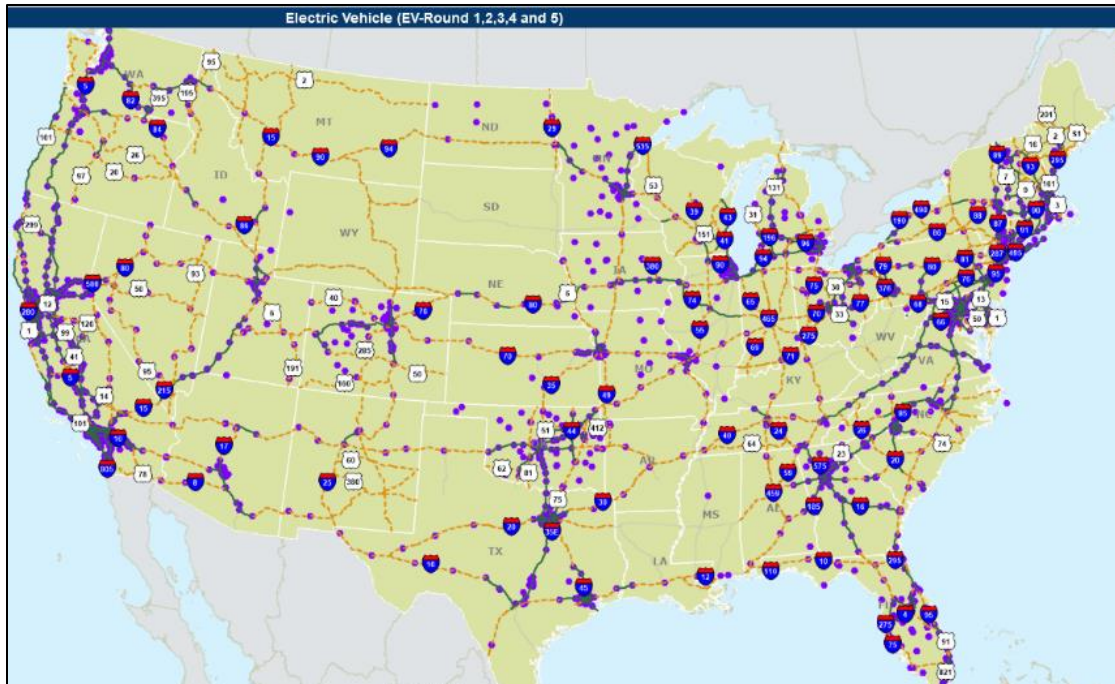
The Fixing America’s Surface Transportation (FAST) Act of 2015 requires designation of alternative fuel corridors for electric, hydrogen, propane and natural gas vehicles by the Federal Highway Administration.¹⁴ Corridors designated as “Ready” currently have the fueling or charging infrastructure in operation in accordance with FHWA standards. Pending corridors have fueling or charging stations spaced farther apart or have stations that are not yet in operation, but only proposed.



Designated CNG-Ready (solid lines) and CNG-Pending (dashed lines) corridors in the continental U.S. (USDOT, 2021)

CNG

Oklahoma is a national leader in the production and use of natural gas products and features nearly 100 Compressed Natural Gas (CNG) fueling stations open to the public. The Federal Highway Administration has designated CNG-Ready corridors that include all Oklahoma interstates and significant segments of US-412, US-81, US-69 and SH-351/Muskogee Turnpike. Segments of US-69, US-75 and SH-51 are currently designated as CNG-Pending.

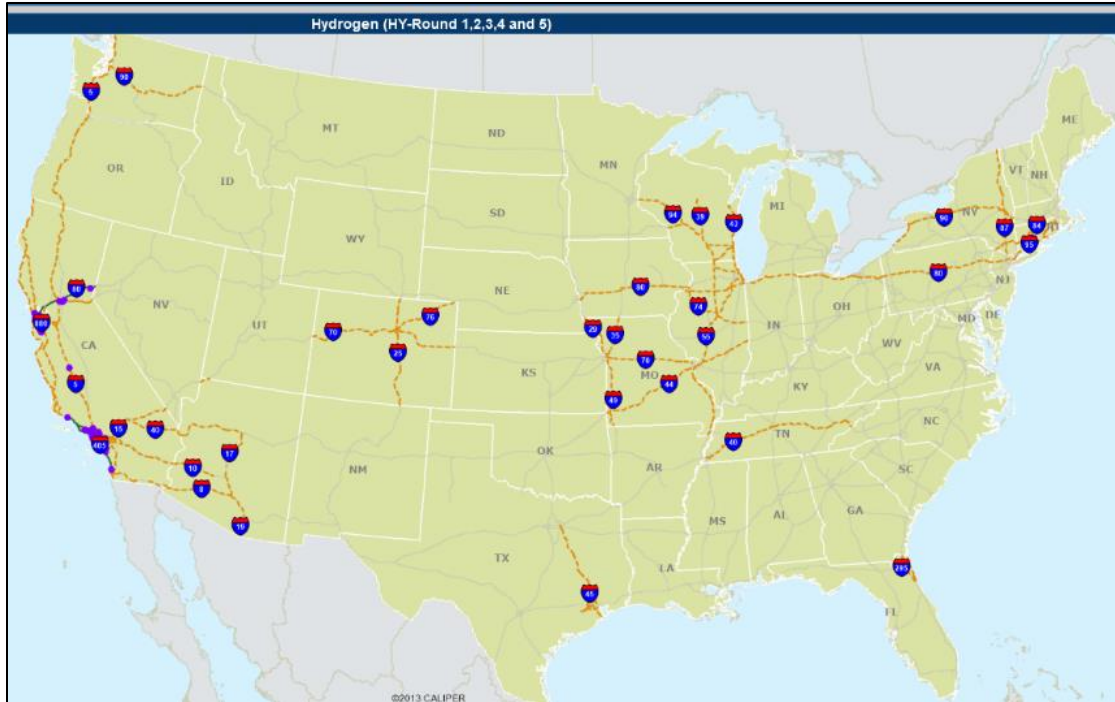


*EV-Ready (solid lines) and EV-Pending (dashed lines) in the continental U.S.
(USDOT, 2021)*

Electric Vehicles

There are 157 fast charging Electric Vehicle (EV) stations and 112 slow charging EV stations in Oklahoma. With charging infrastructure in place, FHWA-designated EV-Ready corridors include much of I-35, I-40, I-44, US-75 and SH-51. Major highways including US-81, US-62, US-69 and US-412 are designated EV-Pending.

Currently, more than 4,000 EVs are registered with the Oklahoma Tax Commission, including 2,200 Battery Electric Vehicles and 2,000 Plug-in Hybrid Vehicles. ¹⁵



Designated Hydrogen-Ready (solid lines) and Hydrogen-Pending (dashed lines) corridors in the continental U.S. (USDOT, 2021)

Hydrogen

The only Hydrogen-Ready corridors in the United States are located in California, specifically in Southern California and the San Francisco Bay area. Official data from the U.S. Department of Energy’s Alternative Fuels Data Center (AFDC) indicates that there are 48 public hydrogen stations located in California and one in Hawaii.¹⁶ AFDC also notes other North American stations are located in British Columbia, Ontario and Quebec.

Love’s Travel Stops and Country Stores, of Oklahoma, estimates that about 15 public stations are planned along the East Coast and notes that other private hydrogen fueling stations have been built for use by commercial and public transit fleets in the United States.

Hydrogen-Pending routes have been designated in nearly 20 states, including Colorado, Missouri and Texas; which indicates that stations are planned in these areas.

There are currently no public hydrogen fueling stations or known hydrogen-powered vehicles operating on public roads in Oklahoma. It is known that businesses such as Amazon are using hydrogen-powered equipment manufactured by Plug Power for industrial use. This includes powering forklifts with hydrogen through on-site fueling stations for warehouse operations.

Hydrogen Fuel Corridor Recommendations

For a corridor to be designated Hydrogen-Ready, public hydrogen fueling stations in operation must be spaced no more than 100 miles apart along a highway and must be within five miles of the highway.

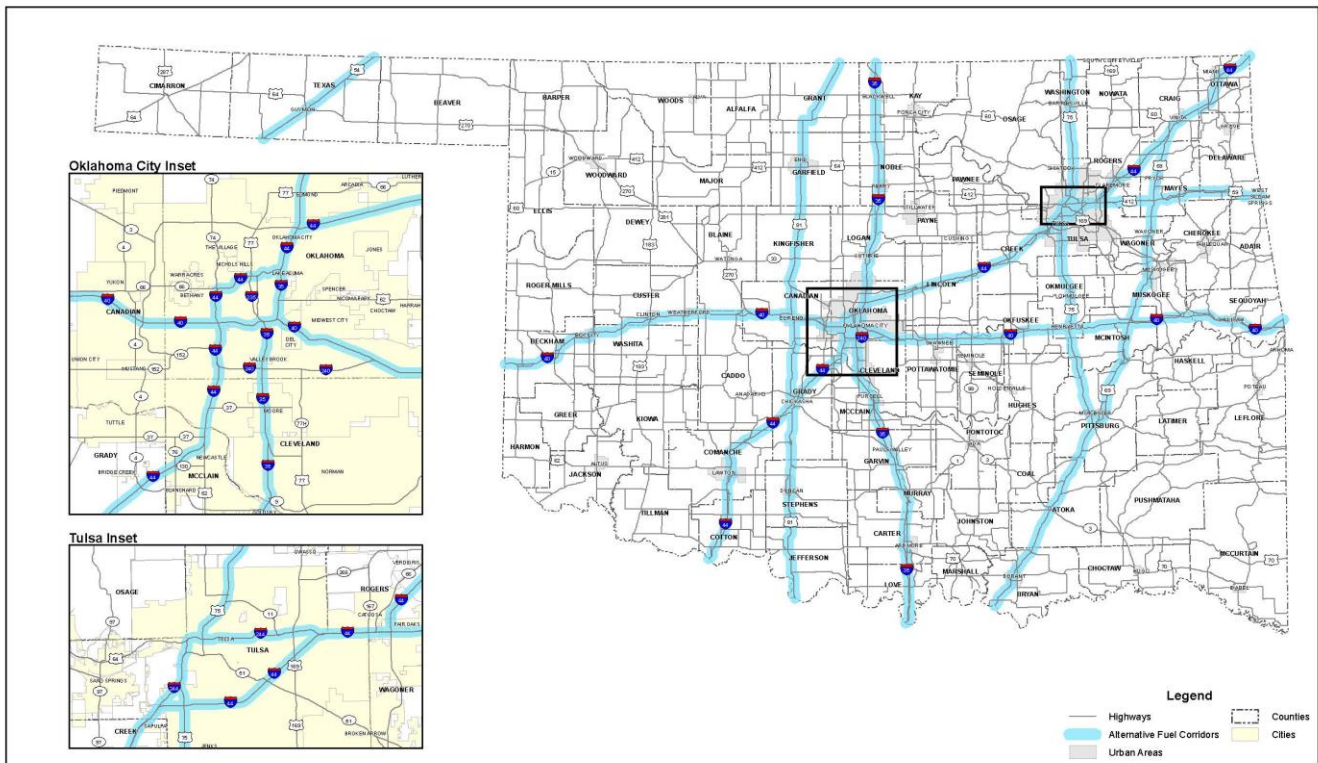
Hydrogen-Pending corridors may have hydrogen fueling stations in operation more than 100 miles apart or have stations planned but not yet constructed.

Oklahoma’s rich alternative fuel production and corridor development places the state in a favorable position for hydrogen production and corridor application. The state’s central location adds emphasis to its viability for such corridors due to the amount of commercial traffic. The following Oklahoma highway corridors with high traffic volumes, especially commercial truck traffic, and interstate connection to major cities and hubs are identified as candidates for future application to FHWA to be designated as hydrogen corridors.

Phase I Pending Corridors

Round 1 fuel station proposed locations highlighted in **Blue**

Round 2 fuel station proposed locations highlighted in **Green**



Hydrogen Fuel Pending Corridors – Phase I

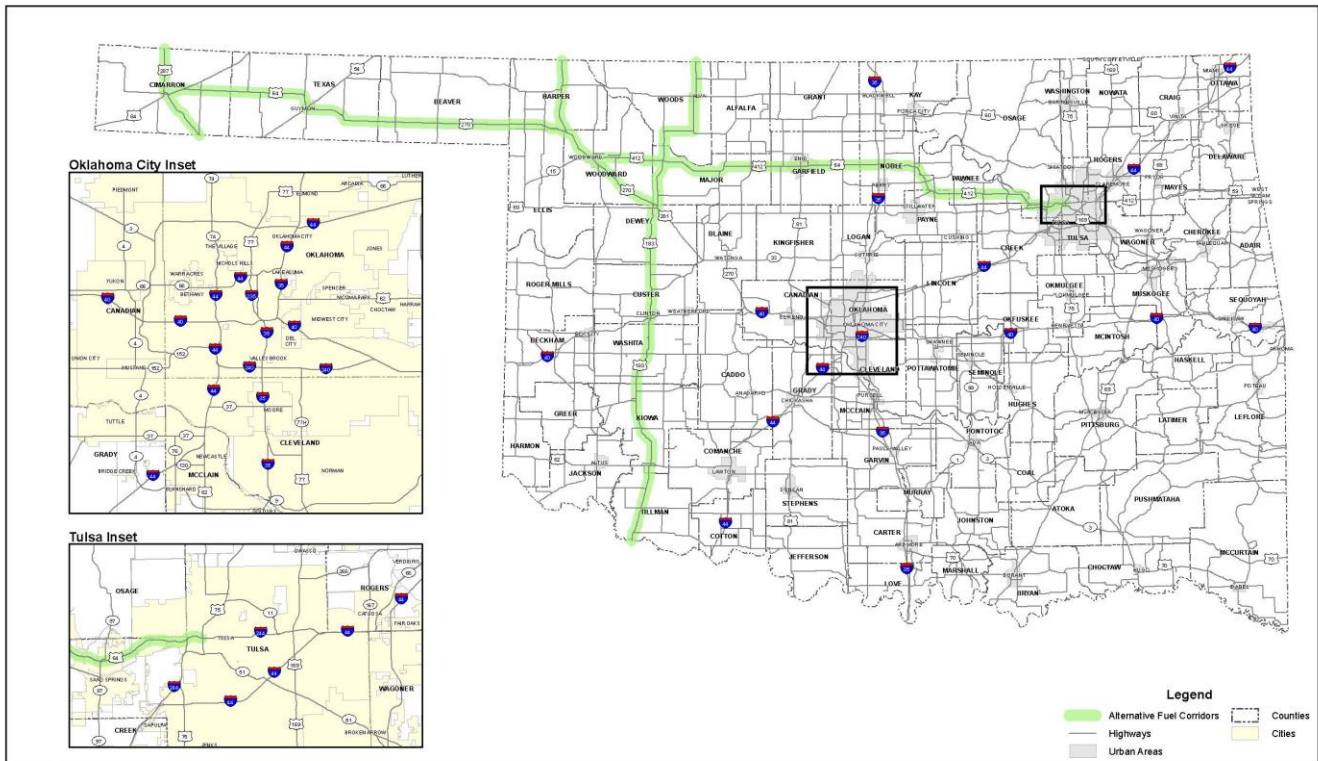


- I-35: 236 miles from Texas state line to Kansas state line
 - Thackerville (1 mile)
 - Ardmore (29 miles)

- Pauls Valley (74 miles)
 - Purcell (92 miles)
 - Oklahoma City (128 miles)
 - Guthrie (161 miles)
 - Perry (194 miles)
 - Tonkawa (222 miles)
- I-40: 331 miles from Texas to Arkansas
 - Erick (3 miles)
 - Elk City (40 miles)
 - Weatherford (75 miles)
 - El Reno (120 miles)
 - Oklahoma City (148 miles)
 - Shawnee (188 miles)
 - Okemah (228 miles)
 - Henryetta (249 miles)
 - Checotah (278 miles)
 - Webbers Falls (302 miles)
 - Sallisaw (323 miles)
- I-44: 328 miles from Texas to Missouri
 - Lawton (38 miles)
 - Chickasha (87 miles)
 - Oklahoma City (130 miles)
 - Stroud (188 miles)
 - Tulsa (238 miles)
 - Claremore (268 miles)
 - Big Cabin (301 miles)
 - Miami (337 miles)
- US-69: 254 miles from Texas to Kansas
 - Durant (20 miles)
 - Atoka (53 miles)
 - McAlester (98 miles)
 - Muskogee (162 miles)
 - Pryor (203 miles)
 - Big Cabin (220 miles)
- US-75/SH-375/Indian Nation Turnpike: 154 miles from McAlester, Okla. to Kansas
 - McAlester (1 mile)
 - Henryetta (36 miles)
 - Okmulgee (55 miles)
 - Tulsa (94 miles)
 - Bartlesville (139 miles)
- US-81: 226 miles from Texas to Kansas
 - Terral (1 mile)

- Waurika (21 miles)
 - Duncan (46 miles)
 - Chickasha (86 miles)
 - El Reno (121 miles)
 - Kingfisher (145 miles)
 - Enid (184 miles)
 - Pond Creek (207 miles)
 - Renfrow (227 miles)
- US-412: 88 miles from Arkansas state line to Tulsa
 - West Siloam Springs (1 miles)
 - Chouteau (45 miles)
 - Catoosa (72 miles)
 - Tulsa (88 miles)
 - US-54: 60 miles from Texas to Kansas
 - Guymon (22 miles)

Note: If hydrogen fueling stations are available in Texas or Kansas within 100 miles of this area, US-54 can still qualify as an Oklahoma hydrogen corridor



Phase II Pending Corridors

All proposed fuel station locations included in Round 2, highlighted in **Green**

- US-412: 420 miles from Tulsa to New Mexico
 - Tulsa (88 mile)
 - Morrison (150 miles)
 - Enid (206 miles)
 - Woodward (293 miles)
 - Elmwood (362 miles)
 - Guymon (419 miles)
 - Boise City (481 miles)

- US-183/US-281: 219 miles from Texas to Kansas via Seiling-Woodward-Buffalo; 213 miles via Seiling-Waynoka-Alva
 - Frederick (13 miles)
 - Snyder (30 miles)
 - Hobart (60 miles)
 - Cordell (80 miles)
 - Clinton (96 miles)
 - Seiling (142 miles)
 - Woodward (via US-183) (176 miles)
 - Buffalo (via US-183) (211 miles)
 - Waynoka (via US-281) (173 miles)
 - Alva (via US-281) (200 miles)
 -

- US-287: 41 miles from Texas to Colorado
 - Boise City (25 miles)

It's critical to recognize that surface transportation facilities are the first step in accommodating a hydrogen industry while a network of pipelines is being identified for use or construction. Additionally, these infrastructures will continue to serve as "last-mile" delivery means for public travel and industrial applications.

Section VI: Regulatory and Safety Issues

Highway

Truck Size and Weight Issues

A network of federal and state laws governs size and weight regulations for commercial trucks, which are enforced by the U.S. Department of Transportation's Federal Motor Carrier Safety Administration (FMCSA) at the federal level and the Oklahoma Department of Public Safety (DPS) at the state level. Carriers seeking to transport an oversize or overweight (OS/OW) load that exceeds these regulations either within or through Oklahoma are required to obtain a permit and specific route from DPS.¹⁷ Other DPS requirements, such as the use of escort vehicles and warning placards, may also apply.

Federal law allows loads of up to 80,000 lbs. Gross Vehicle Weight (GVW) on the interstate system. It's important to note that the maximum GVW originally set in 1956 Federal-Aid Highway Act that created the interstate network had a lower weight of 73,000 lbs., which was then increased in 1974 after much of the system had been constructed.¹⁸

All Oklahoma highways are open to legally loaded trucks (80,000 lbs. GVW on interstates and 90,000 GVW on non-interstate highway routes); however, certain routes may be restricted, and bridges may be load posted with specific weight limits.¹⁹ The Oklahoma Department of Transportation has input into the designated weight limits based on infrastructure capabilities and long-term health.

As of November 2021, there are 15 load posted bridges on the highway system that are not capable of supporting a legally loaded truck. Most of these bridges are on rural state highways over dams and spillways owned by the U.S. Army Corps of Engineers or Grand River Dam Authority and/or are currently undergoing reconstruction or major rehabilitation to remove the load restriction.²⁰ There are about 3,400 bridges maintained by cities and counties not on the highway system that are load posted and unable to support a legally loaded truck.

A provision in the Fixing America's Surface Transportation (FAST) Act of 2015 allows vehicles with engines fueled primarily by natural gas to exceed GVW limits set in 23 U.S.C 127 by an amount that is equal to the difference between the weight of the vehicle attributable to the natural gas tank and fueling system carried by that vehicle and the weight of a comparable diesel tank and fueling system. A similar provision was made in Oklahoma law in 2016 to mirror the federal exemption for natural gas-powered vehicles. The result is that vehicles powered by compressed or liquefied natural gas may exceed state GVW limits by up to 2,000 lbs. on public roadways – both interstate and non-interstate routes. These statutes are specific to natural gas and would have to be amended to extend the weight exemptions to hydrogen-powered trucks. However, since the precedent has been set, it appears to be easier to follow that pattern for exempting the weight of hydrogen tanks and systems.

No federal regulations exist for truck heights, but Oklahoma imposes a legal height of 14 ft. for trucks on the highway and turnpike systems and 13.5 ft. on local roads. Trucks with taller loads

are required to obtain a permit and an approved route from DPS to avoid bridge clearance issues.²¹

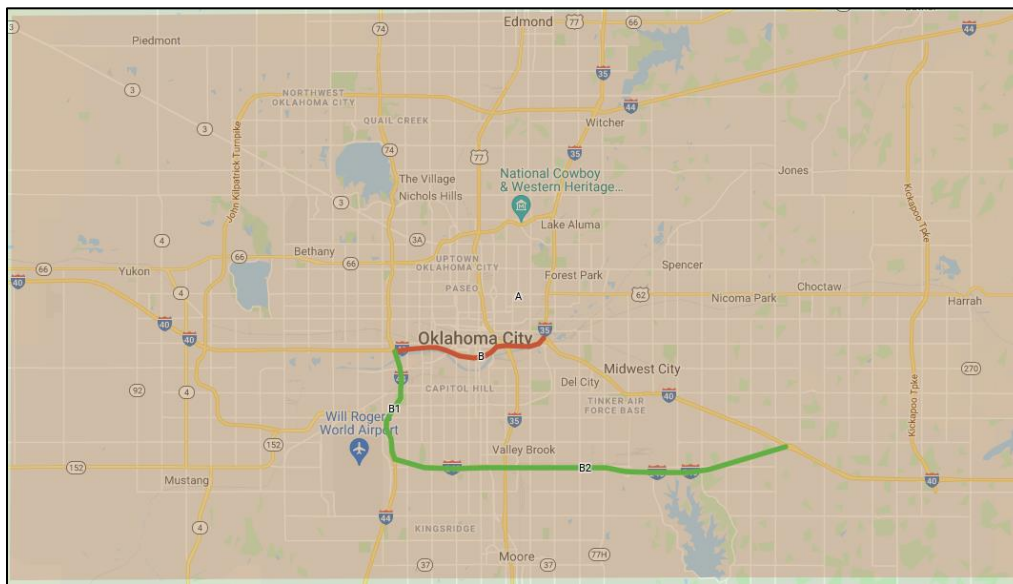
The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 imposed a national freeze on routes that are allowed to carry Longer Combination Vehicles (LCVs), which are tractor-trailer combinations greater than 60 ft. in length. Oklahoma is one of the few states that permitted LCVs prior to this change and was grandfathered by ISTEA. Trucks with double 29 ft. trailers may use any route on the National Highway System in Oklahoma, including interstates. Doubles with trailers that exceed 29 ft. in length are limited to interstate highways and 45 individual Oklahoma highway segments, which are listed in Title 23 of the Code of Federal Regulations, Part 658, Appendix C. According to Oklahoma law, no combination of trucks and trailers operating on public roads may exceed a total 70 ft.

Hazardous Materials Routes

Motor carriers transporting hazardous materials, including hydrogen, are subject to state and federal regulations for permitting and routing of truck loads.

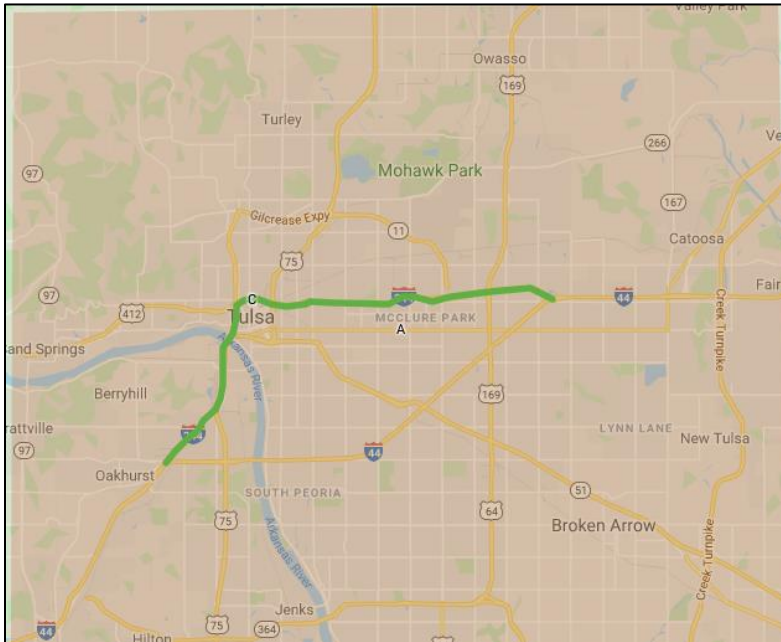
The FMCSA maintains the National Hazardous Materials Route Registry (NHMRR), which includes Hazmat route designated at the request of states.²² The NHMRR designations for Oklahoma were made in 1997 and include the following details:

- All shipments of hazardous materials should remain on interstate routes as much as possible while avoiding the centers of large metropolitan areas during times of the day when congested and also avoiding construction zones if they are able.
- Specific route requirements in Oklahoma City and Tulsa (see below)



Oklahoma City

I-40 between I-44 and I-35 in downtown Oklahoma City is banned from Hazmat transportation. I-44 and I-240 are designated as the bypass route for this section of I-40. (USDOT, 2021)



Tulsa

I-244 (west and north legs of the Inner Dispersal Loop) should be used for Hazmat transportation through downtown Tulsa. (USDOT, 2021)

As far as additional safety concerns for commercial truck transportation, it is important to note that US-69 in eastern Oklahoma is used extensively by the U.S. Department of Defense for transportation of explosive materials to and from the McAlester Army Ammunition Plant in Pittsburg County in southeastern Oklahoma.

Transportation of Hazardous Materials by Truck

Federal and state regulations exist for commercial trucks and the drivers operating them in the transportation of hazardous materials. A Commercial Driver License (CDL) issued by DPS with the following endorsements may be required to transport materials like hydrogen:²³

- “H” Endorsement: Hazardous Materials
- “N” Endorsement: Tank Vehicle
- “X” Endorsement: Combination of Hazardous Materials and Tank Vehicle

Additionally, a background check through the Transportation Security Administration (TSA) is required for the issuance of an Oklahoma CDL.

As per The Oklahoma Motor Carrier Safety and Hazardous Materials Transportation Act, drivers and/or workers involved in an accident or incident during the transportation, loading or unloading of hazardous materials must immediately notify DPS, which will produce a report that is sent to USDOT.²⁴ Those involved in an accident or incident may also be required to notify USDOT as well.

The USDOT Pipeline and Hazardous Material Safety Administration (PHMSA) sets and enforces national standards for the storage and transportation of hazardous materials. Title 49 of the Code of Federal Regulations, Parts 171, 172, 177, 178 and 180 detail these requirements as they pertain to the transportation of hydrogen and similar materials on public roadways.²⁵

The FMCSA sets national standards for licensing and testing of truck drivers and the permitting of hazardous loads. Title 49 of the Code of Federal Regulations, Parts 356, 389 and 397 detail these as they pertain to the transportation of hydrogen and similar materials.²⁶

Rail Hazmat Requirements

The Oklahoma Railroad Association (ORA) provided comments and information from the Association of American Railroads (AAR) about rail transportation of hydrogen, including safety issues and concerns.

Due to the cold storage of hydrogen in liquified form, a special insulated tank car is required to transport hydrogen by rail, and very few of these railroad scars are in operation nationwide. ORA and AAR note that the tank cars currently used to transport liquefied natural gas, which would be similar to what would be required for hydrogen, are more expensive than traditional tank cars and are currently estimated at around \$750,000 each.

Title 49 of the Code of Federal Regulations, Part 174 details PHMSA requirements as they pertain to the transportation of hazardous materials by rail.²⁷

Waterway Hazmat Requirements

As mentioned earlier, Oklahoma's port operators expressed strong concerns regarding safety of hydrogen transport and storage, given that the common perception of hydrogen is that it is highly explosive. While the Ports feel certain that strict safety protocols and precautions exist, they implore hydrogen industry leaders to educate ports and industrial locations about the real risks, issues and challenges associated with production and storage of the gas, as well as the modern safeguards that are in place to mitigate the risks.

The Tulsa Port of Catoosa has several industries now that produce and maintain pressurized tank trailers and storage as part of their services and have petitioned the port multiple times for permission to place outdoor storage tanks of hydrogen. Additionally, a past opportunity involved a welding gas supplier who wanted to produce hydrogen at a location to dispense to the public. The Port, however, was not in favor of allowing it (in large quantities) until the company provided a safety plan that demonstrated the area of impact.

CF Industries, located at the Tulsa Port of Catoosa, is the closest thing Oklahoma currently has to an existing hydrogen production and shipping operation with their production and transportation of anhydrous ammonia (NH₃). BayoTech and Linde both have a strong presence at the Tulsa Port of Catoosa and are already in the hydrogen production or technology business. Both companies have offered to help with making Oklahoma a hydrogen-producing state.

Title 49 of the Code of Federal Regulations, Part 176 details PHMSA requirements as they pertain to transportation of hazardous materials by waterborne vessel.²⁸

The U.S. Coast Guard sets and enforces national standards for waterway transportation. Title 33 of the Code of Federal Regulations, Parts 154, 155 and 156 detail USCG regulations for prevention of pollution for vessels carrying hazardous materials.²⁹ Title 46 of the Code of Federal Regulations, Parts 38, 150, 151, 153 and 154 detail USCG regulations as they pertain to shipping of hydrogen and similar materials by water.³⁰

Air Hazmat Requirements

As mentioned previously, comments from the Oklahoma Aeronautics Commission indicate that hydrogen is not currently being transported by air and is unlikely to anytime in the near future without significant advances in technology and safety measures.

According to OAC, many in the industry believe it will be a very long path forward to get the Federal Aviation Administration to certify the technology and orient the public to be comfortable with widespread use of hydrogen fuel aircraft. Timeframes such as 2040 and 2050 have been tossed around as dates for widespread use of hydrogen in aircraft, and even then, there is considerable uncertainty as to what vehicles it will be used in at that time.

Title 49 of the Code of Federal Regulations, Part 175 details PHMSA requirements as they pertain to transportation of hazardous materials by aircraft.³¹

The Federal Aviation Administration sets and enforces national standards for aircraft, including design, operation and fueling. Title 14 of the Code of Federal Regulations, Parts 23, 25, 27, 29 and 33 deal with aircraft requirements for fuel sources, which includes hydrogen power.³²

Section VII: Recommendations, Timeline and Conclusion

Recommendations

Based on thorough research and available data, the Transportation Cabinet makes the following recommendations to capitalize on state resources in a strategic manner to help make Oklahoma a hydrogen producing state.

Research and Development (1-2 years)

- Create a research center at an Oklahoma college or university to research hydrogen transportation issues, including fuel stations, corridors, economic incentives, and storage technology, and to pursue federal grant funding opportunities.

Safety Education (1-2 years)

- Develop and implement a statewide hydrogen safety education campaign in conjunction with industry partners that focuses on dispelling myths, sharing knowledge from other states and countries, explaining storage requirements and technology and highlighting Hazmat procedures and tools already in place. This should be aimed at businesses and the public alike to help familiarize Oklahomans of the benefits of hydrogen and the related industry job creation in the communities.

Legislative and Regulatory Updates (2-3 years)

- Identify and support necessary updates to Oklahoma state statutes and administrative rules to remove any remaining barriers and prepare the way for a hydrogen program, including alternative fuel incentives applicability to hydrogen
- Support action on agreed-upon national standards for hydrogen fueling stations (i.e. 350 bar vs. 700 bar) or other variances that could create a barrier to a speedy implementation or additional unnecessary costs to fuel station operators or the industry.
- Support authorizing legislation for state incentives for addition of hydrogen fueling stations and subsequent application for designation of hydrogen corridors
- Support federal and state legislation to standardize reasonable truck weight exemptions for alternative fuel vehicles and extending these exemptions to hydrogen powered trucks, considering engineering recommendations for infrastructure.

Hydrogen Fueling Stations (2-5 years)

- Develop partnerships with commercial fueling station owners to add hydrogen to the footprint of their stations on major corridors.
- Fuel stations must be in place before corridors can apply for Federal Highway Administration designation as alternative fuel corridors.
- Incentives for fuel station build-outs must consider the cost differential in the more expensive hydrogen pumps vs. other alternate fuel pumps such as EV or CNG.
- Incentives should also require a longer time period before a hydrogen car can be resold by the first buyer. Early suggestions are no less than 2-3 year ownership. This will allow the hydrogen industry the longevity to become better established and dispel uncertainties in hydrogen vehicle ownership.

Alternative Fuel Corridor Designation

- Develop and seek Federal Highway Administration approval of Phase I Corridors (1-5 years) in partnership with substate planning districts
- Develop and seek FHWA approval of Phase II Corridors (5-10 years) in partnership with substate planning districts

Resource Development

- Use the below interactive GIS tool, which was developed as a living map to provide a platform for continued hydrogen research and planning programs across multiple agencies and organizations

Map

The Transportation Cabinet has produced an online interactive GIS application that is hosted on the Oklahoma Department of Transportation's website to accompany this report as a tool to identify existing and proposed infrastructure and natural resources relevant to the committee's work. Hubs are a critical component of identifying alternative fuel corridors and can easily be depicted on this map by turning on the various layers.

This is a living map that can have layers added or modified as work continues and serve as a great tool for planning purposes toward Oklahoma becoming a hydrogen producing state.

Hydrogen Application Project

<https://okdot.maps.arcgis.com/apps/webappviewer/index.html?id=0198757b53f84ee49dbbeb74374c31a8>

The map currently features nearly 40 layers, which are generally organized in the application in a way that groups like categories together. More layers will be added as the planning effort continues.

- Love's Travel Stops and Country Stores stations
- OnCue stations
- QuikTrip stations
- TA Travel Center stations
- Pilot stations
- Flying J stations
- Natural Gas Storage
- Natural Gas Well
- Electric Vehicle Charging Stations
- CNG Fueling Stations
- Natural Gas Processing Plants
- Biodiesel Plants
- Petroleum Refineries
- Power Plants
- Amtrak stations
- Intercity Bus Line stations
- Public Transit Operator Headquarters
- Public Transit Routes
- City Level Public Transit Systems

- County Level Public Transit Systems
- Enterprise Zones Tracts FY 2022
- Airports
- Ports
- On-System Bridge (By max truck weight)
- Proposed Hydrogen Fuel Station – Phase I
- Proposed Hydrogen Fuel Station – Phase II
- Hydrogen Fuel Pending Corridor – Phase I
- Hydrogen Fuel Pending Corridor – Phase II
- Railroads – Class I
- Railroads – Class II
- Truck Corridors – High Volume (Highest Average Annual Daily Traffic volumes)
- Truck Corridors – Additional (Specific selections)
- Interstates
- Highways (Non-interstate state highway, U.S. highway and turnpike)
- McClellan-Kerr Arkansas River Navigation System (MAKRNS)
- Lakes
- Rivers
- Groundwater Basins

Conclusion

Oklahoma has a strong transportation presence and can compete well on a national level due to its central location, expansive transportation network and recent infrastructure investments making it a viable hub for transportation and distribution of hydrogen in the United States. Oklahoma is also well-positioned with existing alternative fuel corridors, which have high volumes of commercial truck traffic and can work as a blueprint for future hydrogen corridors.

An extensive pipeline network is needed as the ultimate goal if Oklahoma is to become a major hydrogen producing state. This will allow Oklahoma to not only produce hydrogen for use in the state and the U.S. but also to export internationally. However, surface transportation by truck, rail and waterway will be a key component initially and also after pipelines are fully implemented for “last mile” delivery, etc. Oklahoma must also continue to develop modern rules and procedures to facilitate surface transportation of hydrogen in the near and long-term.

What’s most needed for Oklahoma to become a successful hydrogen production, distribution and transportation center is public-private partnerships that can bring about interest from hydrogen producers, pipeline owners and fuel station owners who will add hydrogen to their portfolios.

The Oklahoma Corporation Commission, as co-chair of the Subcommittee on Transportation, Storage and Distribution, will also have a companion piece to this report that will address many other pertinent issues with hydrogen, such as pipelines and carbon capture.

Section VII: Appendix and References

¹ Oklahoma Senate, Senate Bill 1021 (2021)

<http://www.oklegislature.gov/BillInfo.aspx?Bill=SB1021&Session=2100>

² Oklahoma Department of Transportation, “2018-2022 Oklahoma State Freight Transportation Plan” (2017)

<https://oklahoma.gov/odot/programs-and-projects/transportation-programs/odot-freight-transportation-plan.html>

³ Oklahoma Department of Transportation, “2020 Update on Bridges and Highways” (2020)

https://oklahoma.gov/content/dam/ok/en/odot/publications/21%20BH%20Publication_FINAL.pdf

⁴ ODOT Strategic Asset and Performance Management Division (2021)

⁵ ODOT Rail Programs/Multimodal Division (2021)

⁶ ODOT Waterways/Multimodal Division, “MKARNS marks 50th anniversary” (2021)

<https://oklahoma.gov/odot/programs-and-projects/waterways/mkarns-50th-anniversary.html>

⁷ Oklahoma Aeronautics Commission (2021)

⁸ Oklahoma Department of Transportation, “FFY 2022-2029 Eight-Year Construction Work Plan” (2021)

http://www.odot.org/cwp-8-year-plan/cwp_ffy2022-ffy2029/8_year_construction_work_plan.pdf

⁹ Oklahoma Department of Transportation, “August Commission Meeting Wrap-Up: Updated five-year plan for major county projects adopted; \$91 million in contracts awarded” (2021)

<https://oklahoma.gov/odot/citizen/newsroom/2021/august/august-commission-meeting-wrap-up--updated-five-year-plan-for-ma.html>

¹⁰ U.S. Senate, “Inhofe, Boozman, Cotton Introduce Bill to Designate U.S. Route 412 as Future Interstate” (2021)

<https://www.inhofe.senate.gov/newsroom/press-releases/inhofe-introduces-bill-to-designate-us-route-412-as-future-interstate>

¹¹ Oklahoma Department of Transportation, “ODOT Right-of-Way and Utilities Policy & Procedure Manual, OP-UT 6-5” (2021)

¹² U.S. Department of Energy email to Indian Nations Council of Governments (2021)

¹³ Oklahoma Trucking Association email to Oklahoma Department of Transportation (2021)

¹⁴ U.S. Department of Transportation, Federal Highway Administration, “Alternative Fuel Corridors” 2021

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

¹⁵ Indian Nations Council of Governments email to Oklahoma Department of Transportation (2021)

¹⁶ U.S. Department of Energy, Alternative Fuels Data Center, “Alternative Fuels and Advanced Vehicles” 2021

<https://afdc.energy.gov/fuels/>

¹⁷ Oklahoma Department of Public Safety, “Administrative Rules Subchapter 3 - Size and Weight Permit Load” (2021) <https://oklahoma.gov/dps/administrative-rules0/size-and-weight-permits/size-and-weight-permit-load.html>

¹⁸ U.S. Department of Transportation, “Report to Congress: Compilation of Existing State Truck Size and Weight Limit Laws – Appendix A: State Truck Size and Weight Laws” (2015) https://ops.fhwa.dot.gov/freight/policy/rpt_congress/truck_sw_laws/app_a.htm#ex49

¹⁹ 47 O.S. 14-109.3, “Weight Exemption for Natural Gas Vehicles” <https://www.oscn.net/applications/oscn/DeliverDocument.asp?CiteID=478647>

²⁰ ODOT Bridge Division (2021)

²¹ 47 O.S. 14-103, “Width, Height, and Lengthy of Vehicle and Load” <https://www.oscn.net/applications/oscn/DeliverDocument.asp?CiteID=436865>

²² U.S. Department of Transportation, Federal Motor Carrier Safety Administration. “National Hazardous Materials Route Registry” (2021) <https://www.fmcsa.dot.gov/regulations/hazardous-materials/national-hazardous-materials-route-registry-%E2%80%93-oklahoma>

²³ Oklahoma Department of Public Safety, “Commercial Driver License Endorsements or Restrictions” (2021) <https://oklahoma.gov/dps/obtain-an-oklahoma-commercial-driver-license/cdl-license-endorsements-or-restrictions.html>

²⁴ 47 O.S. 230, “Oklahoma Motor Carrier Safety and Hazardous Materials Transportation Act” <https://www.oscn.net/applications/oscn/DeliverDocument.asp?CiteID=82814>

²⁵ 49 CFR Subtitle B, Chapter I, “Pipeline and Hazardous Material Safety Administration, Department of Transportation” <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-I/subchapter-C>

²⁶ 49 CFR Subtitle B, Chapter III, “Federal Motor Carrier Safety Administration, Department of Transportation” <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-III>

²⁷ 49 CFR, Subtitle B, Chapter I, Subchapter C, Part 174, “Carriage by Rail” <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-I/subchapter-C/part-174>

²⁸ 49 CFR Subtitle B, Chapter I, Subchapter C, Part 176, “Carriage by Vessel” <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-I/subchapter-C/part-176?toc=1>

²⁹ 33 CFR Chapter I, Subchapter O, “Pollution” <https://www.ecfr.gov/current/title-33/chapter-I/subchapter-O>

³⁰ 46 CFR Chapter I, “Shipping” <https://www.ecfr.gov/current/title-46>

³¹ 49 CFR, Subtitle B, Chapter I, Subchapter C, Part 175, “Carriage By Aircraft” 2021 <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-I/subchapter-C/part-175>

³² 14 CFR Chapter I, “Federal Aviation Administration, Department of Transportation” <https://www.ecfr.gov/current/title-14/chapter-I>