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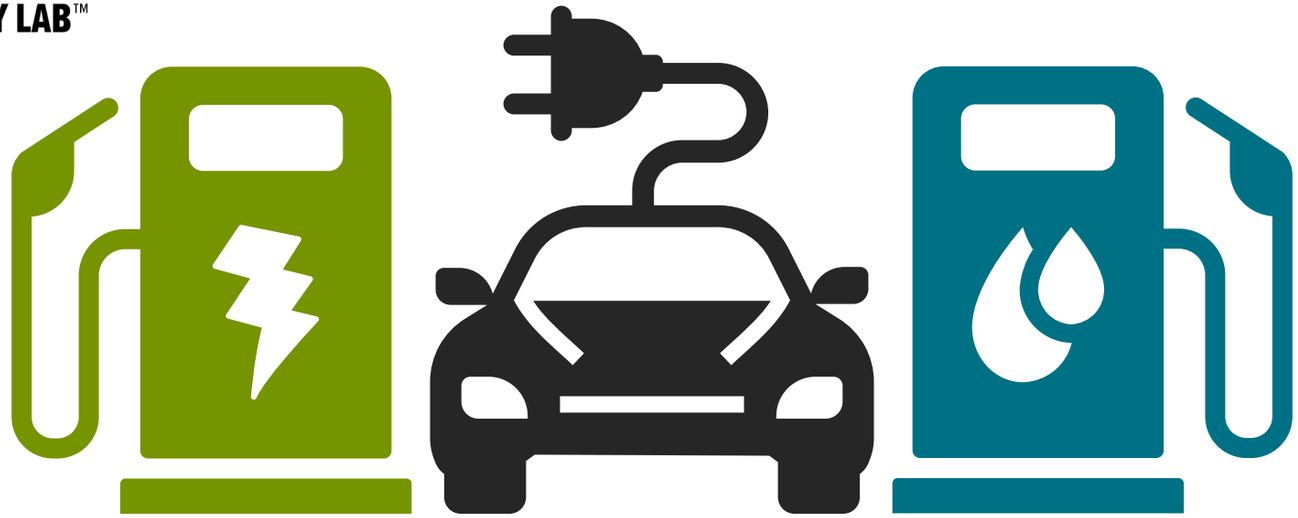


THE EV TRANSITION: IMPLICATIONS FOR THE US GAS STATION & CONVENIENCE STORE INDUSTRY

www.DynamicsLab.org
Researching the Risks and Opportunities of the Global Sustainability Transition
Bulletin No. 20220303

CONTENTS

GLOSSARY OF TERMS

EV
ELECTRIC VEHICLE

UST
UNDERGROUND STORAGE TANK (FOR PETROLEUM FUELS)

RFS
RENEWABLE FUEL STANDARD

EPA
U.S. ENVIRONMENTAL PROTECTION AGENCY

LDV
LIGHT DUTY VEHICLE

LUST
LEAKING UNDERGROUND STORAGE TANK

IC
INTERNAL COMBUSTION

DCFC
DIRECT CURRENT FAST CHARGE

INTRODUCTION

As greenhouse gas emissions are a growing global concern, an increasing portion of U.S. drivers are seeking electric vehicles (EVs). U.S. sales continue to rise steadily from 17,763 EVs in 2011 to 1,015,040 EVs by 2021 [17]. Simultaneously, the U.S. Gas Station/ Convenience Store Industry made $532.9 in sales revenue, employed 960,300 and totaled 150,2274 establishments in 2020 [3,37].

Until 2050, the U.S. will experience an infrastructural transition away from common fueling methods towards widespread accessible EV charging. This report will explore elements of the transition such as legacy industry statistics and trends, environmental threats such as CO2 emissions and leaking underground storage tanks (USTs), EV charging business models and related policy needs.

FAST FACTS

The Dynamic Sustainability Lab™

If all US passenger cars were EV, their emissions would drop by **90%**, however with ambitious 2030 EV fleet projections, CO2 emissions will reduce by only **14.4%** [20,21].

Currently **123,920** charging ports exist across the US [30].

9.6 million ports are the estimated need to support the US EV fleet by 2030.

In 2020 the US accounted for **15%** of global CO2 emissions, and **29%** of all US CO2 was produced by the transportation sector as of 2019 [38].

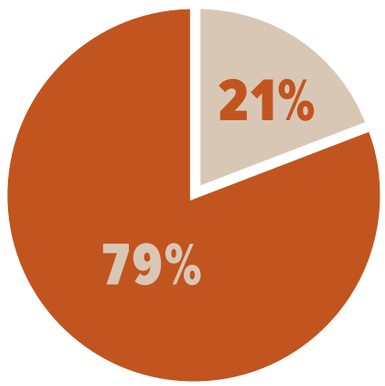
There are **542,000** operating USTs in the US as of 2021 according to the EPA [33].

Petroleum sales at retail and convenience stores accounted for 75% of revenue but realized a 2.7% profit margin in 2020 [37].

DISRUPTIVE TECHNOLOGIES AND LEGACY INDUSTRIES

In modern history we have witnessed that disruptive technologies can substantially impact legacy industries. Notable recent examples include how the digital transformation has altered industries including legacy video industry, mail, retail and communications. The question in play is how the transition to EVs will alter the convenience store industry.

INDUSTRY AT-A-GLANCE



As of 2021, 79% of convenience locations provide fuel, and 80% of U.S. fuel sales occur at a convenience store [7].

CONVENIENCE STORES WITH FUEL

CONVENIENCE STORES WITHOUT FUEL

150,274

TOTAL ESTABLISHMENTS

There are an estimated **145,000 – 150,000** fueling pumps in the U.S.

The number of fueling pumps in the U.S. has recently plateaued as customers seek locations with more pumps, wider in-store selection, and stations with fewer pumps close.

NAICS: 4471

All fuel retailers (further divided by type of retail).

6,494

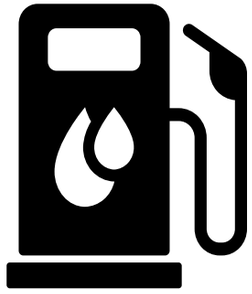
HYPERMARKETS are big box stores and wholesalers such as Walmart and Costco, several of which offer fueling [7].

121,538

CONVENIENCE STORES by far are the dominant fueling retailer [7].

3,000-8,000

SERVICE STATIONS were the dominant fuel retailer in the U.S. until the 1970's, when high-tech diagnostic equipment increased expenses and led service stations to focus on maintenance and repairs. An estimated 3,000-8,000 service stations sell fuel in the U.S. today [7].



15,638

FUELING KIOSKS are similar to convenience stores but have a smaller in-store selection [7].

INDUSTRY AT-A-GLANCE

Table 1: US gas station/convenience store employment and wages by type in 2020 [6].

occupation	employment	median annual wage
Automotive Service Technicians & Mechanics	13, 540	$37,840
Cashiers	611,800	$23,650
Food Preparation & Service	39,140	$23,090
First-line Supervisors & Managers of Retail Workers	89,180	$36,220
Food Preparation Workers	17,090	$23,620
Service Station Attendants	19,350	$24,740
OVERALL	**960,300**	**$24,195**

INDUSTRY TIMELINE

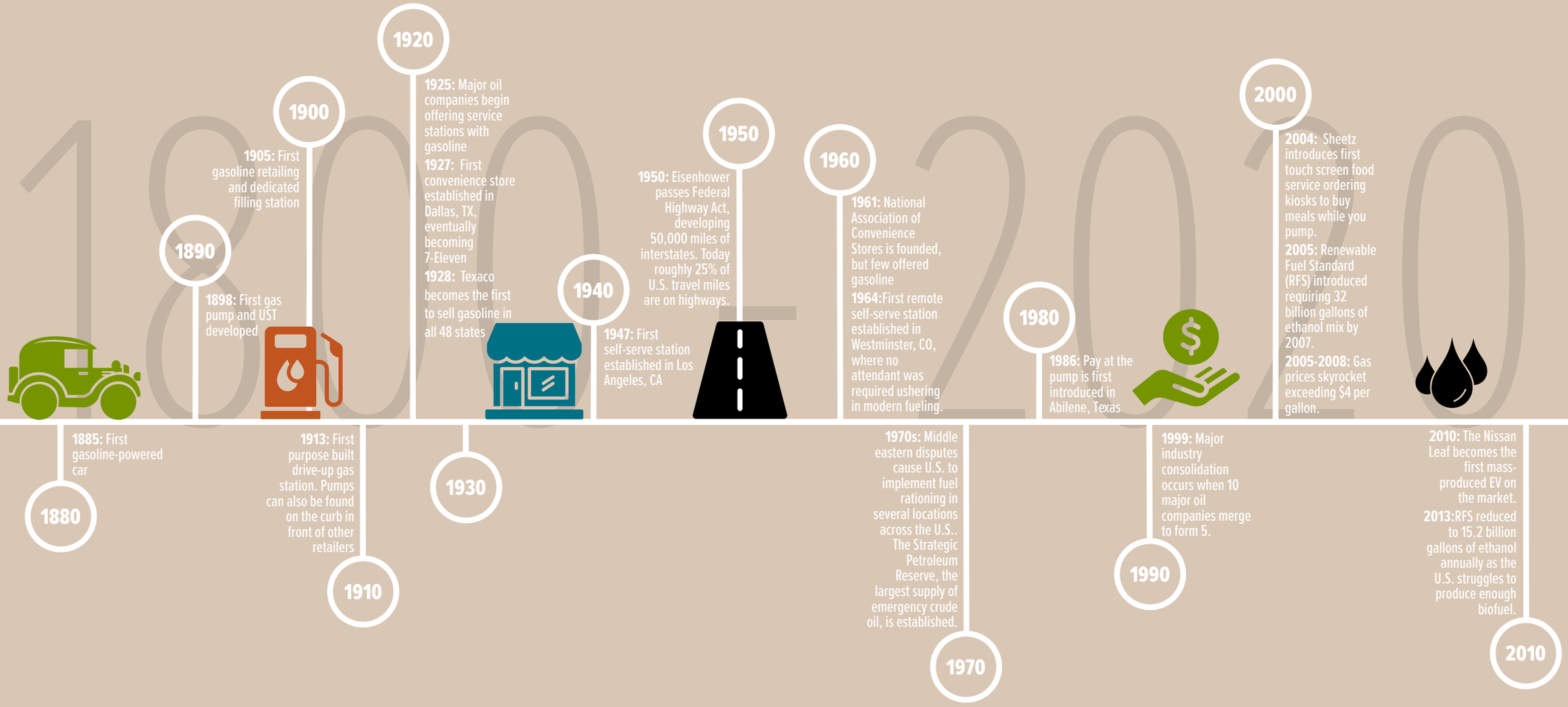


Figure 1: U.S. industry timeline from 1800-2020 [8,9].

MAJOR INDUSTRY PLAYERS

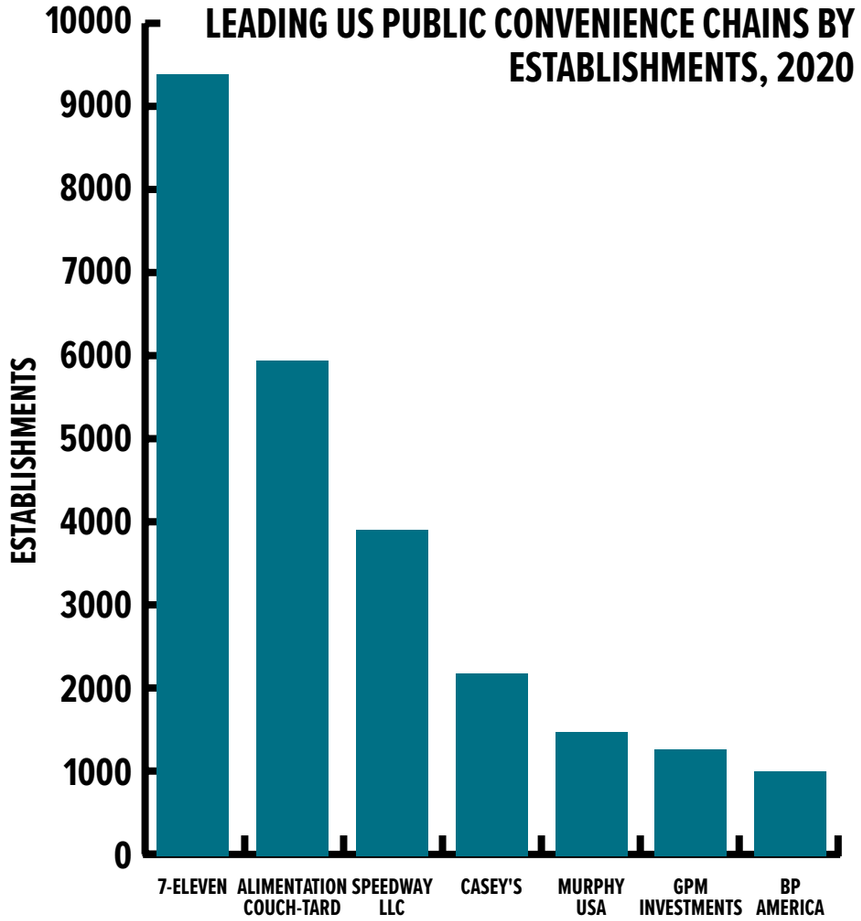
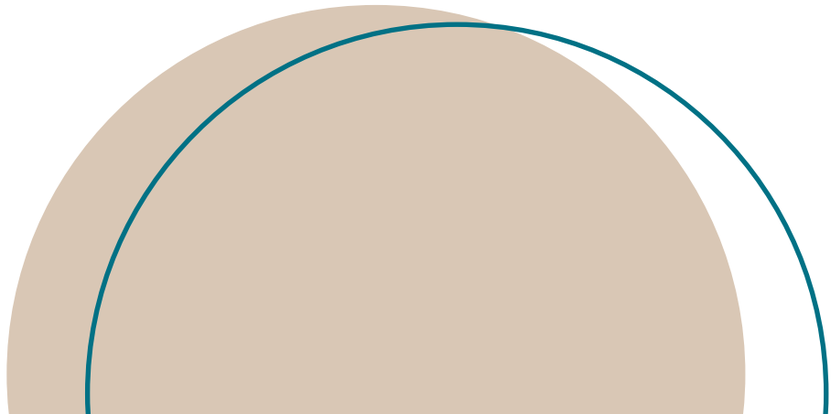


Figure 1: Leading public convenience store chains by establishments in the U.S., 2020 [14].



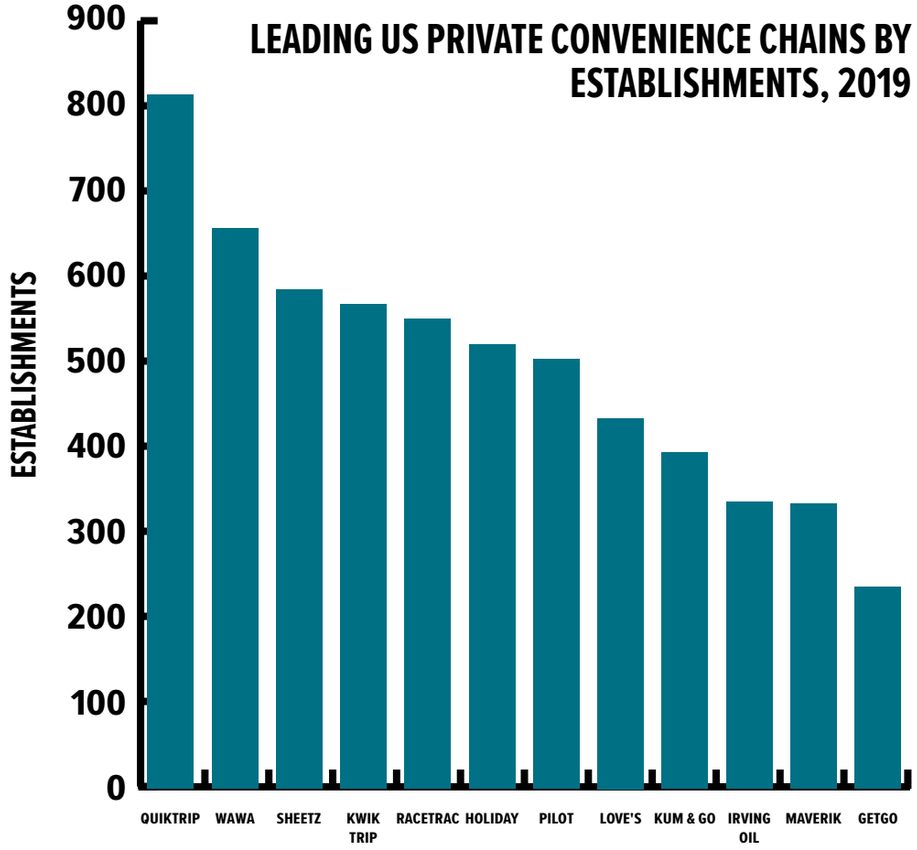


Figure 2: Leading private convenience store chains by establishments in the U.S., 2019 [14].

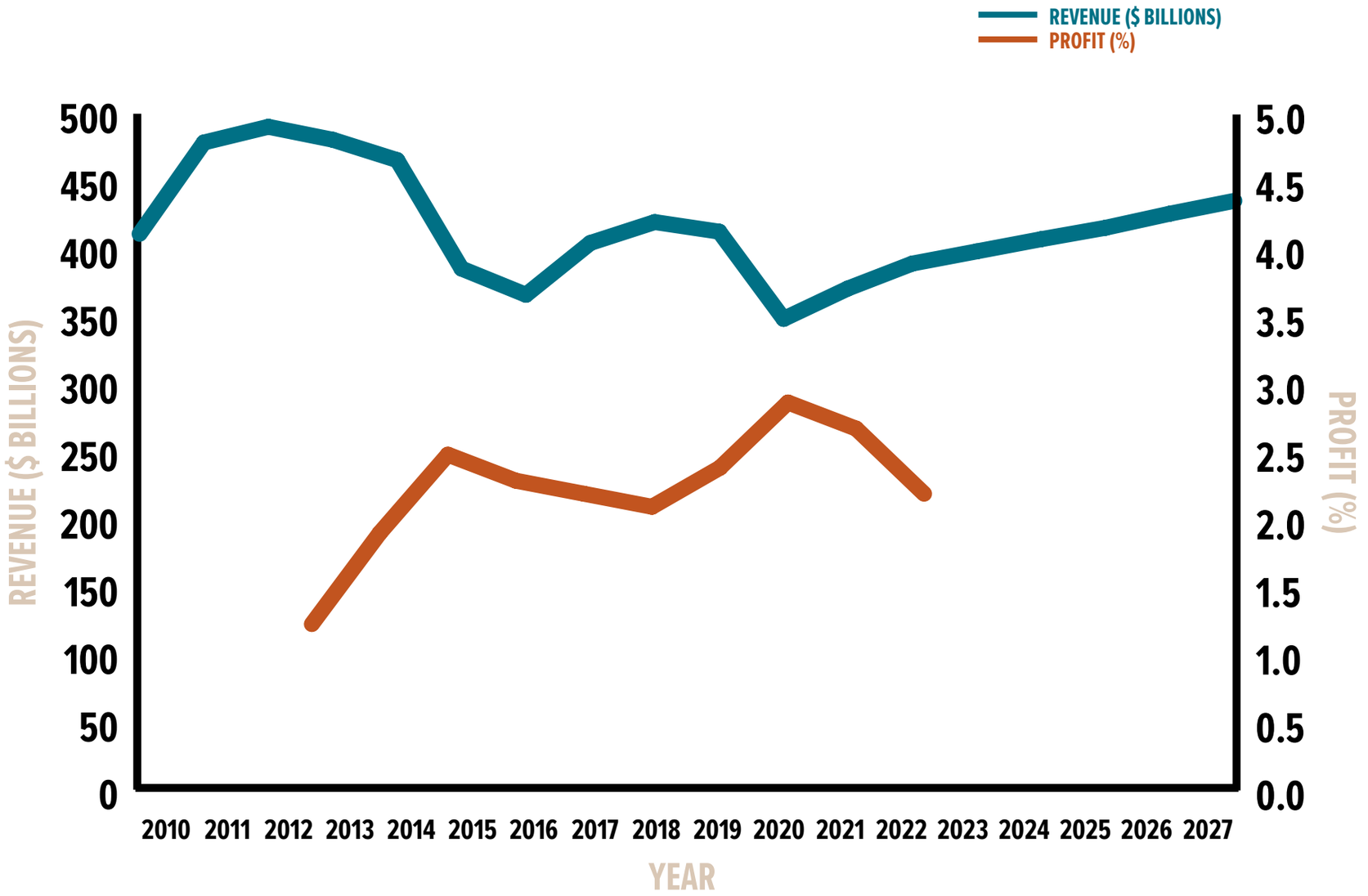


Figure 3: Gas station/convenience store revenue and profit by year; all data following 2020 are projections [37].

US INDUSTRY BUSINESS METRICS

An American transition to electric vehicles will have implications for the Gas Station/Convenience Store industry, which in 2020 employed 869,000 people with $19.8 billion in total wages, and $368.7 billion in revenue in the United States. Petroleum fuel accounts for 75% of industry revenue, yet due to the volatility of crude oil prices retailers realize only a 2.7% profit margin [37].

ENVIRONMENTAL FACTORS

The two leading environmental legacy implications for the Gas Station/Convenience Store industry are petroleum product leaking from USTs and CO2 emissions associated with gasoline demand. 63,000 UST releases impacting soil, air and groundwater remain unaddressed, and transportation accounts for 29% of U.S. emissions as of 2020 [31].

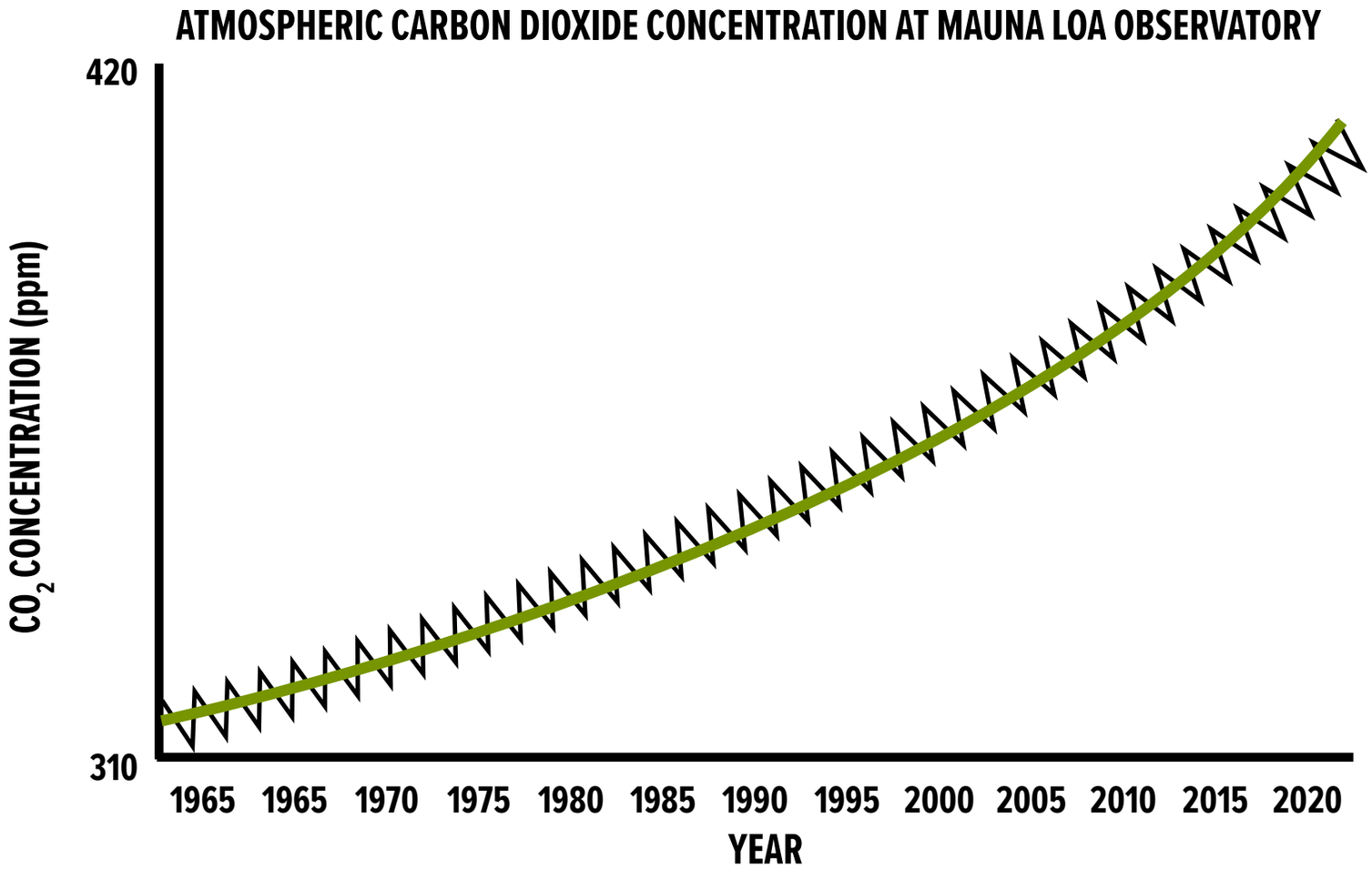


Figure 4: Atmospheric CO2 concentration over time, commonly known as the Keeling Curve [11].

ENVIRONMENTAL FACTORS

CONCEPTUAL SITE MODEL

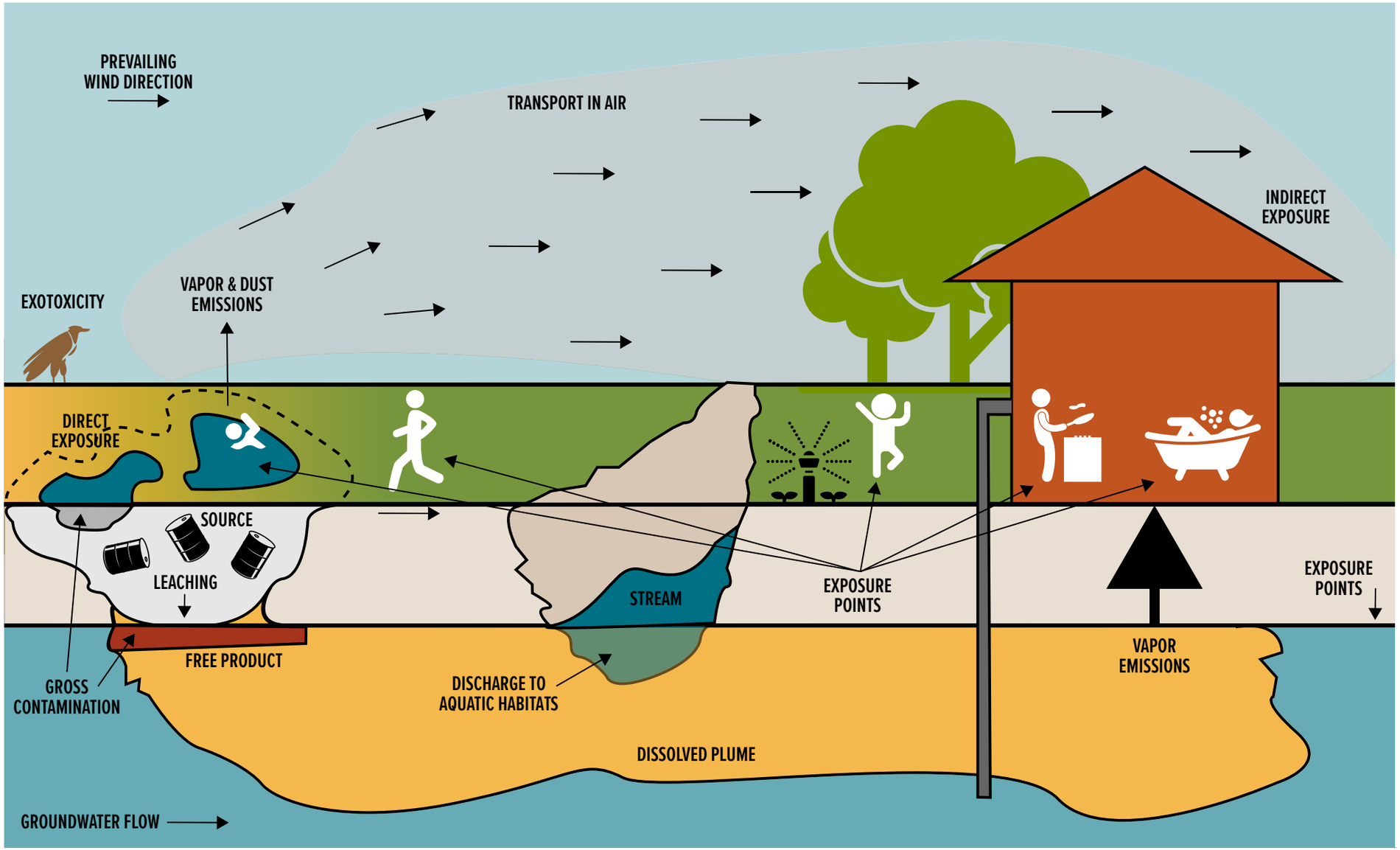
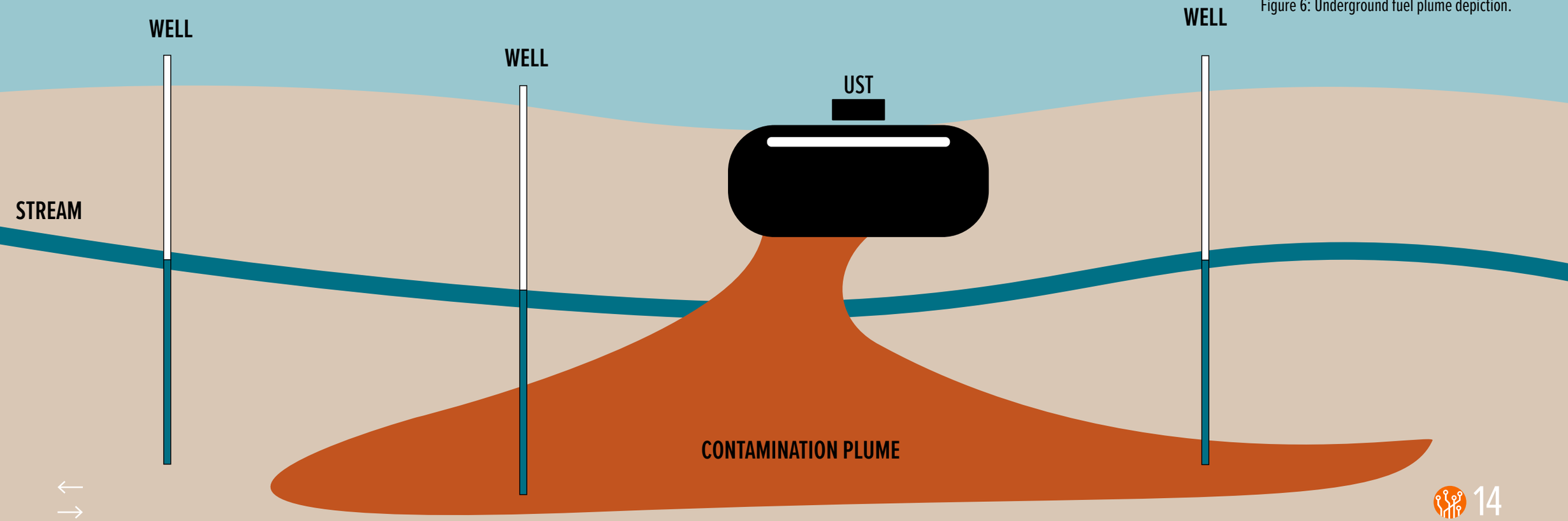


Figure 5: Conceptual model of Leaking UST impact [10].

UNDERGROUND STORAGE TANKS

According to the The U.S. Environmental Protection Agency (EPA) as of 2021, there are approximately 542,000 underground storage tanks (USTs) nationwide, the vast majority of which contain petroleum fueling products [33]. The average gas station will have three to four 10,000-gallon USTs underneath the concrete, one each for regular unleaded, mid-grade, premium and perhaps diesel. Depending on local soil properties and the leaking substance, the contaminants will spread vertically and laterally with decreasing concentration to form a plume as depicted in Figure 6. Contaminants impact soil and air quality, but the greatest concern is groundwater contamination as over 102 million Americans, or about one third of Americans, utilize groundwater as their main drinking water source [39].

Figure 6: Underground fuel plume depiction.



UST TIMELINE

1980 — 2020

1983
National attention rises for gasoline contaminated drinking water.

1985
1985 - 1990: 49,691 UST releases were reported. Influx of reports increased until 1995 when reporting began to gradually decline.

1986
Congress formed the LUST Trust Fund and Financial Responsibility for UST owners.

1988
EPA published UST Regulations.

1993
National Work Group on Leak Detection Evaluations is formed to ensure UST equipment is effective in preventing and detecting releases. By this date, all USTs installed before 1988 must implement federally approved leak detection methods.

1998
All existing USTs were required to be replaced or upgraded to prevent releases.

2005
EPA UST Regulations are updated with additional prevention requirements and expanded eligible uses of the LUST Trust Fund. The EPA also increased biofuel blends in gasoline, thus requiring further UST upgrades.

2009
$200 million from the LUST Trust Fund was allocated to states for UST release remediation efforts, benefitting over 7,300 sites by 2013.

2011
EPA compiled UST release and backlog data to enhance remediation efforts.

2015
UST Regulations are updated emphasizing proper UST operation and maintenance.

2019
Industry UST partners developed practices and standards to help detect and prevent releases.

Figure 7: UST timeline from 1980-2020 [13].

LEGACY UST RELEASES AND LUST TRUST FUND

Since 1965 there have been at least 562,000 documented UST releases, with 63,000 remaining open, or unaddressed. In a study including ten states (CA, FL, Il, MI, NJ, NY, NC, PA, SC, and TX) with the most releases (64% of all documented releases), 78% of releases contaminated groundwater [23]. Overtime, contaminants continue to leach through soil and can infiltrate groundwater in locations which were originally unaffected. 55% of spills in the national backlog are at least 10 years old increasing contamination and remediation cost [23].

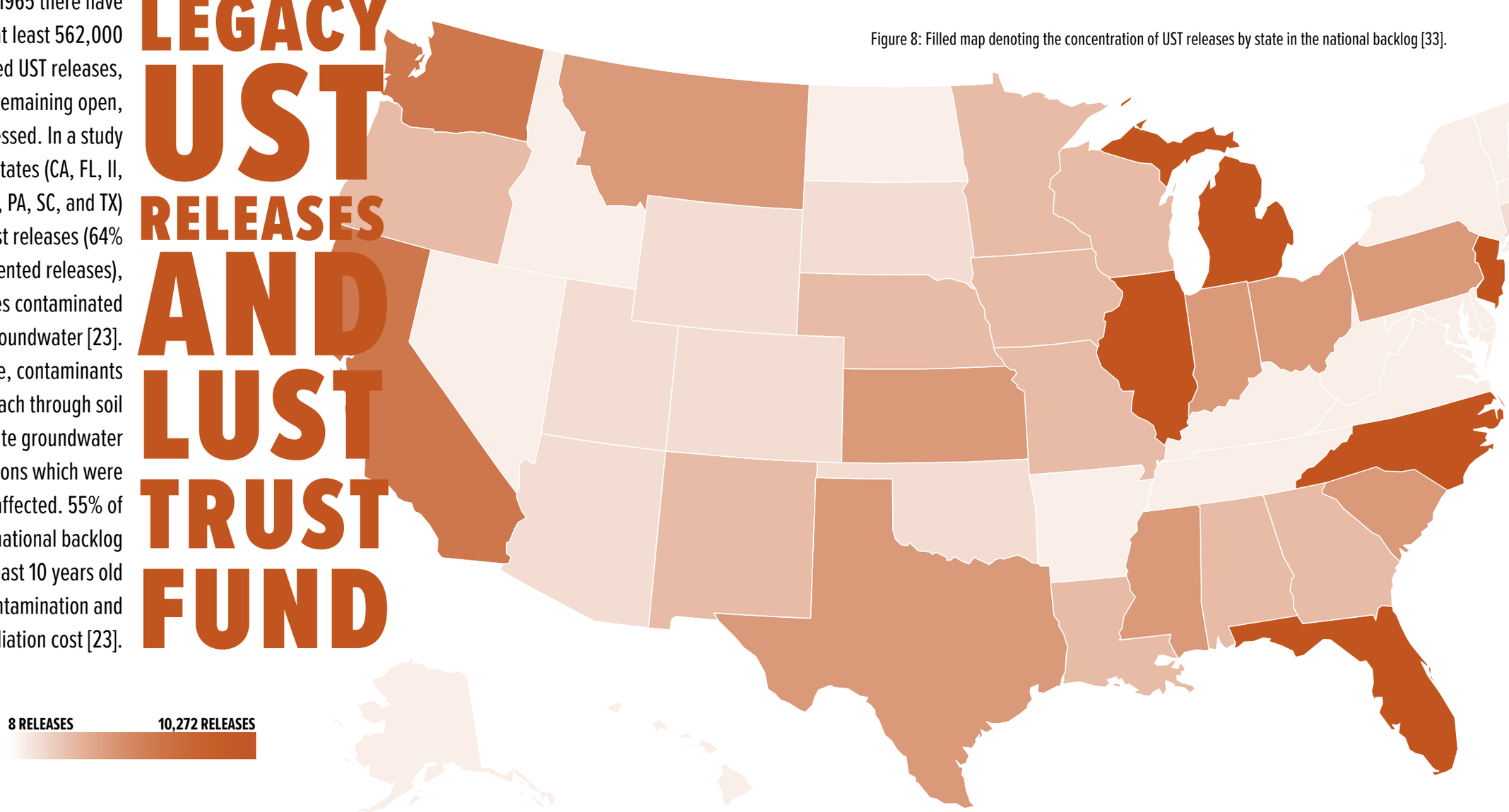


Figure 8: Filled map denoting the concentration of UST releases by state in the national backlog [33].

STATE LUST TRUST FUND VALUE & ABILITY

$0.01/gallon of fuel from the national fuel tax directed to the national legacy UST release trust fund (LUST Trust Fund), and each individual state's gas tax and UST fee contributes to their respective trust fund. Each state's trust fund receives revenue from a unique combination of petroleum tax per gallon and an annual fee for operating each UST. In Figure 9, Available Balance is calculated by the difference between each approximate current balance and the amount already allocated for remediation projects. Of the ten states with the most backlog spills (see Figure 8), many also have among the highest available balance.

*Maryland, Oregon and West Virginia did not make their current balances public.

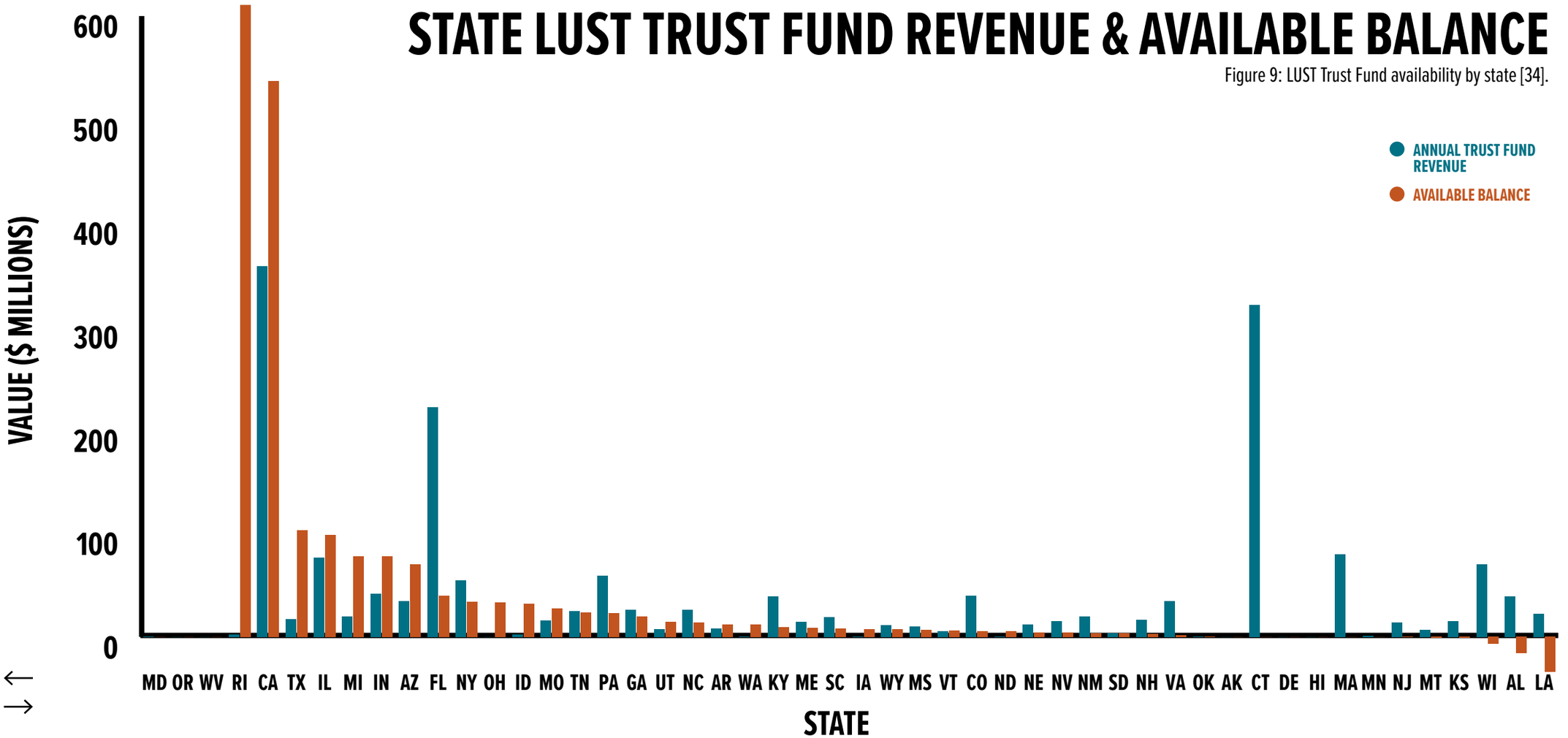


Figure 9: LUST Trust Fund availability by state [34].

LUST TRUST FUND FUEL TAX

In 1919 the first motor fuel tax was introduced in Oregon to fund developing roads. Today, most states tax gasoline including, but not limited to, environmental taxes, excise taxes and special taxes. Many states use part of this revenue to fund their respective LUST Trust Fund. The federal excise taxes on gasoline and diesel are 18.4 and 24.4 cents respectively [2], 1 cent of which is allocated to the national LUST Trust Fund [35]. Figure 9 depicts each state's LUST Trust Fund tax allocation.

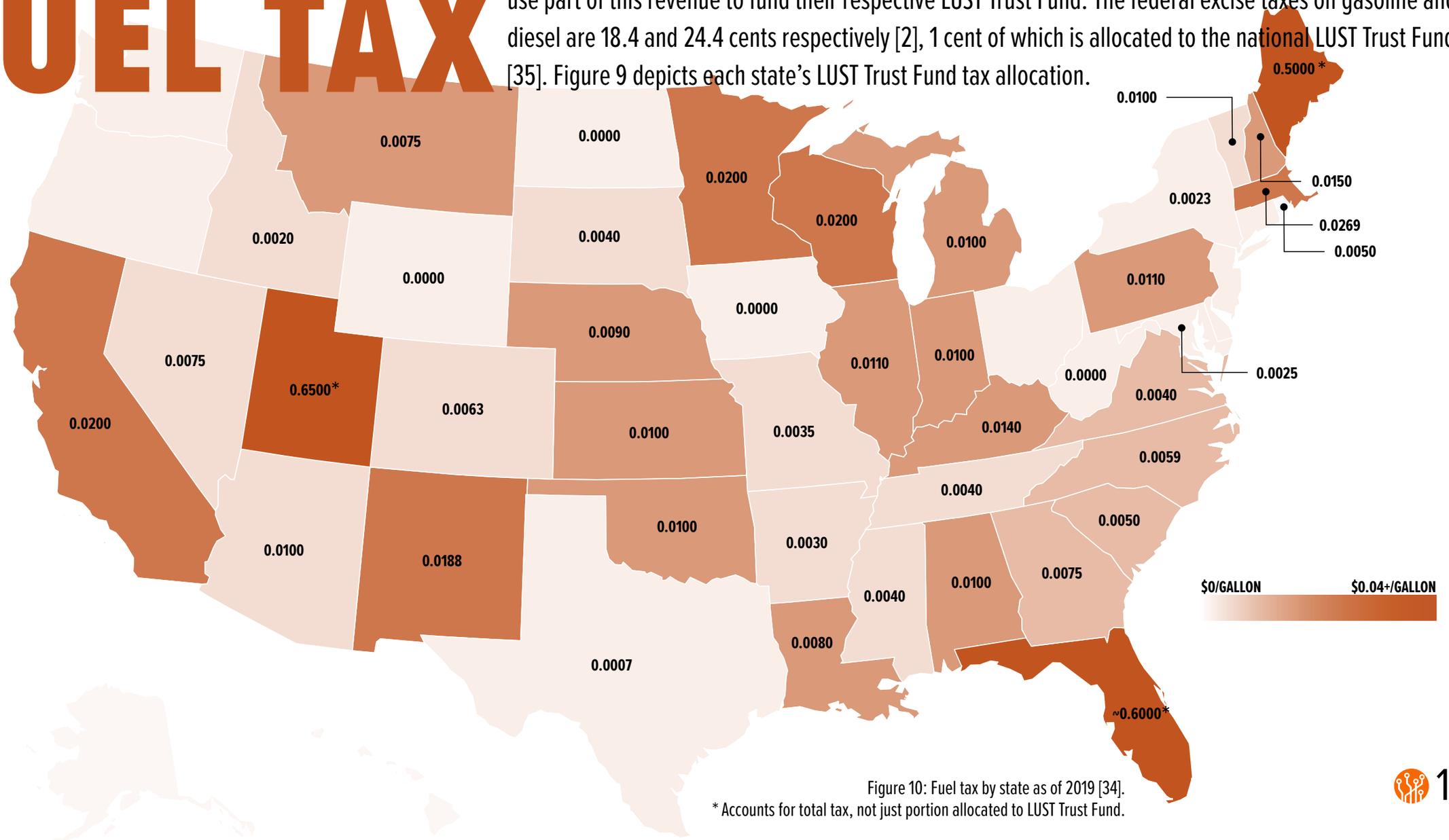


Figure 10: Fuel tax by state as of 2019 [34].
* Accounts for total tax, not just portion allocated to LUST Trust Fund.

EV FLEET PROJECTIONS

The body of registered passenger cars is referred to as the passenger fleet. As of 2021 the U.S. passenger fleet is 0.4% EV. The high EV fleet size scenario is comparable to the economic transition BNEF scenario seen in figures 18 and 19. Assuming consumer trends follow the DOE medium projections, as they have in preceding years, the economy is equipped to support the EV transition. However, this scenario will not meet 2050 Net-Zero goals.

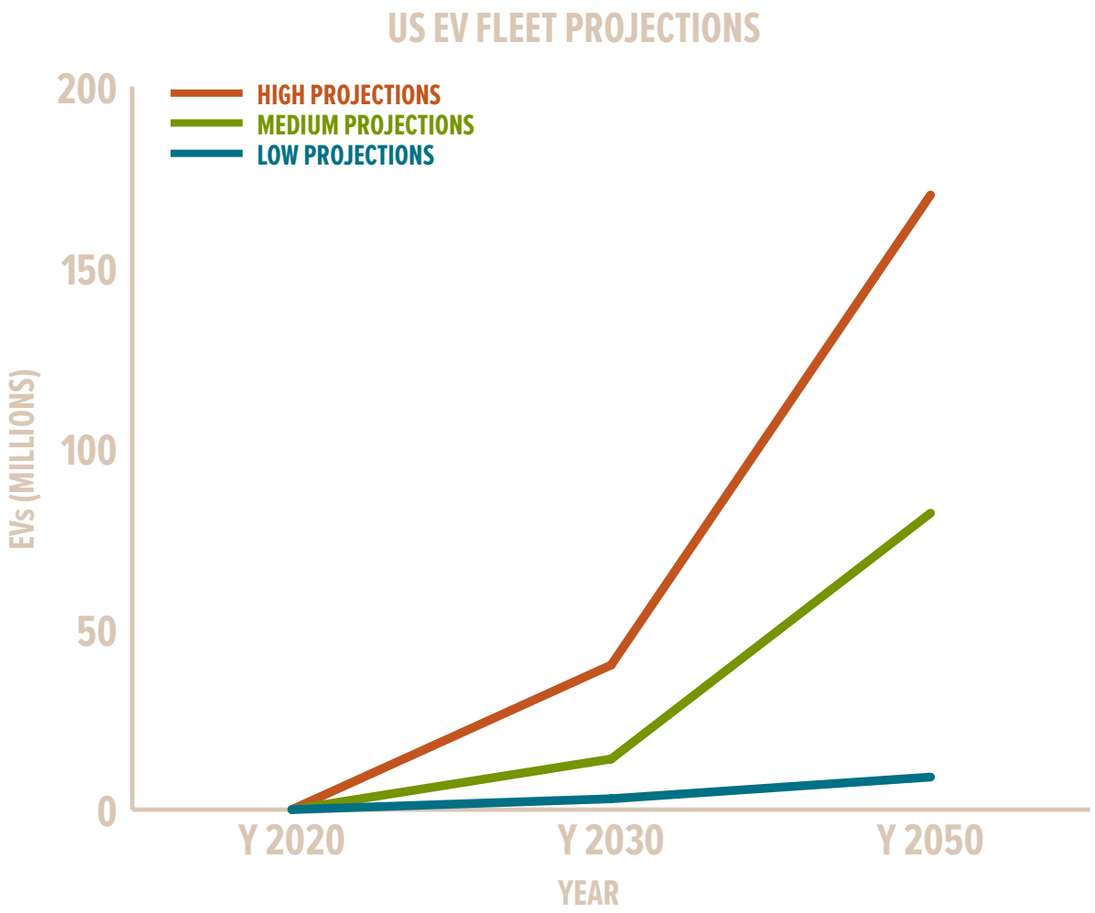


Figure 11: Low, medium and high projections for the number of EV's in the U.S. Light Duty Vehicle fleet by year [18].

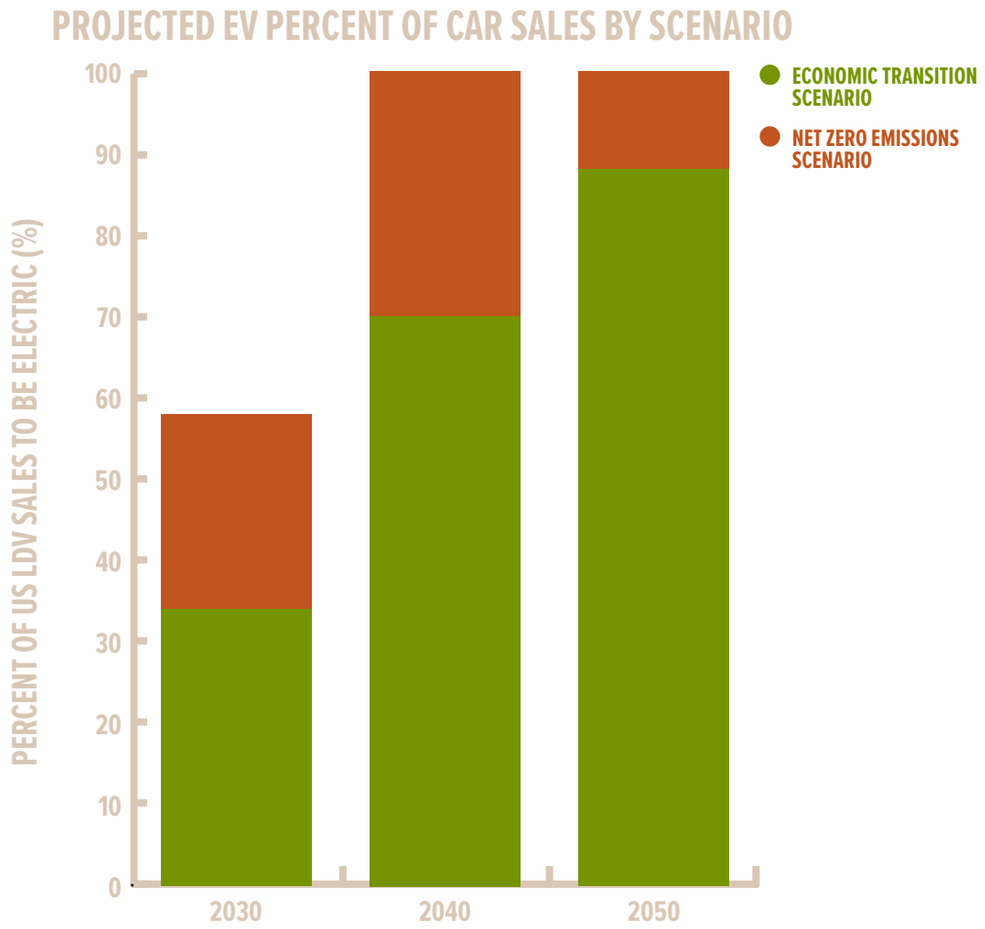
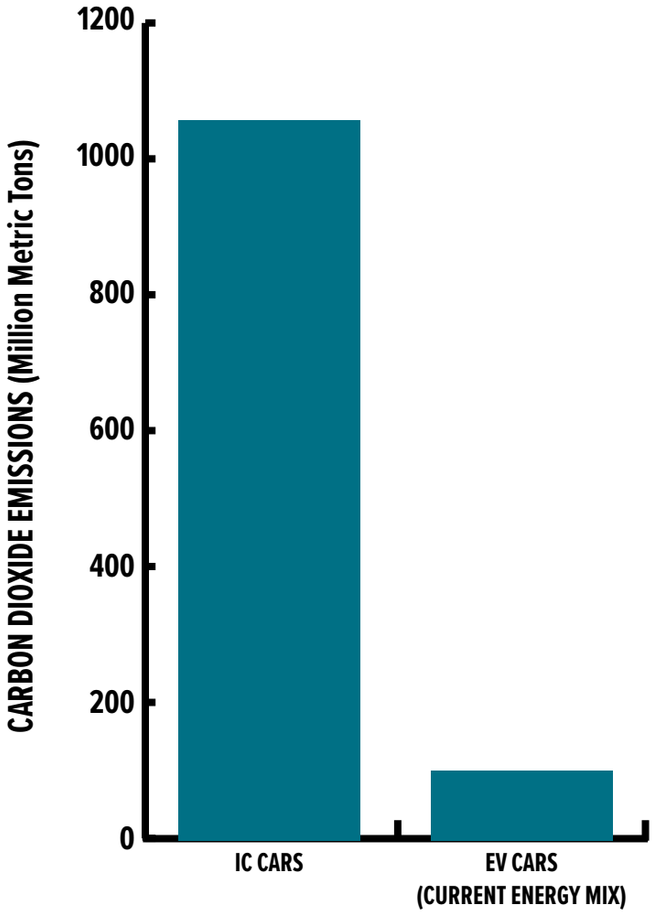


Figure 12: Percent of U.S. car sales to be electric in order to meet net zero emissions goals vs. economically sustainable transition goals [19].

TRANSITION TO CHARGING INFRASTRUCTURE

IMPACT ON CO_2 EMISSIONS

ANNUAL CO_2 EMISSIONS REDUCTION BY TRANSITIONING US PASSENGER VEHICLE FLEET TO EV



If the entire registered internal combustion (IC) passenger car fleet in America as of 2021 were EVs, we would see a 90% reduction in CO_2 emissions from passenger cars given the current US electricity mix.

Notably, this is referring only to the Transportation Phase of the Environmental Life Cycle Assessment and does not consider other phases such as extraction, manufacturing, etc.

Figure 13 projects 259 Million Light Duty Vehicles (LDVs) in the U.S. in 2030.

Figure 13: Annual CO_2 emissions from US registered IC passenger cars vs. annual CO_2 emissions to charge US registered vehicles if they were all electric [21].

2030 CO_2 EMISSIONS FROM IC CARS AND EV'S GIVEN PROJECTED EV FLEET SCENARIOS

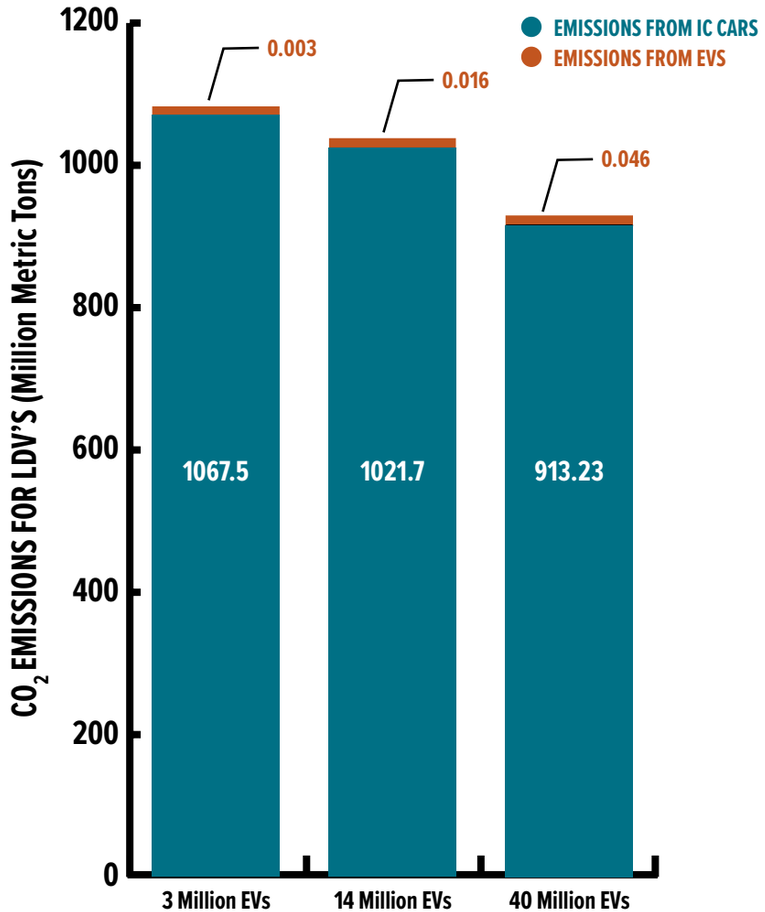


Figure 14: 2030 U.S. CO_2 Emissions from the U.S. DOE projected EV fleet scenarios [20].

EV CHARGING OVERVIEW

level 1

“top-off” charging

amperage: 12 - 16A

voltage: 120V (1 phase AC)

power load: 1.2 - 1.9kW

charging speed: 3 - 5 miles of Range per hour
over 24 hours for 300 miles of Range

practical locations: at home charging

level 2

opportunity charging

amperage: 16 - 48A

voltage: 208 - 240V (1 phase AC)

power load: 2.5 - 19.2kW

charging speed: 10 - 20 miles of Range per hour
5 - 9 hours for 300 miles of Range

practical locations: home, workplace, business-front

dc fast charging

opportunity & long-range charging

amperage: 60 - 200A

voltage: 208 - 480V (3 phase DC)

power load: 50 - 350kW

charging speed: commonly less than 1 hour for 300 miles of Range

practical locations: highway, business-front

Table 2: EV Charger Level Comparison [16,25,26]

ALTERNATIVE FUEL CORRIDOR

The US Federal Highway Administration logs all charging stations nationwide as part of their Alternative Fuel Corridor program. DCFC chargers are extremely important to EV owners for trips farther than the capacity of one full charge (roughly 300 miles in many EVs).

Each year the Federal Highway Administration accepts applications from state governments to fund alternative fueling along crucial interstates and local routes. The program also includes biofuels, compressed natural gas, liquified natural gas, hydrogen and propane fueling.

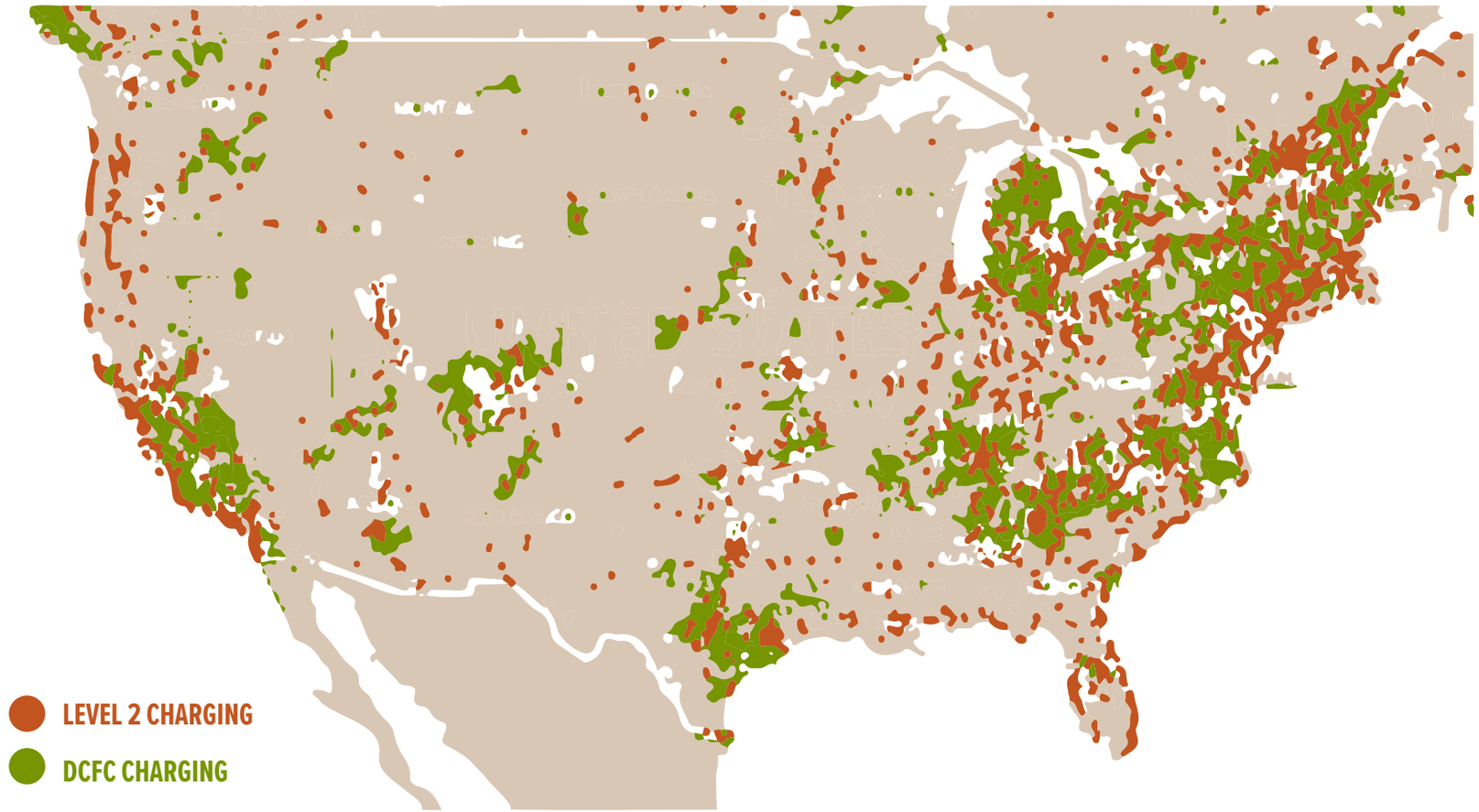


Figure 15: Public Level 2 and DCFC chargers across the US [30].

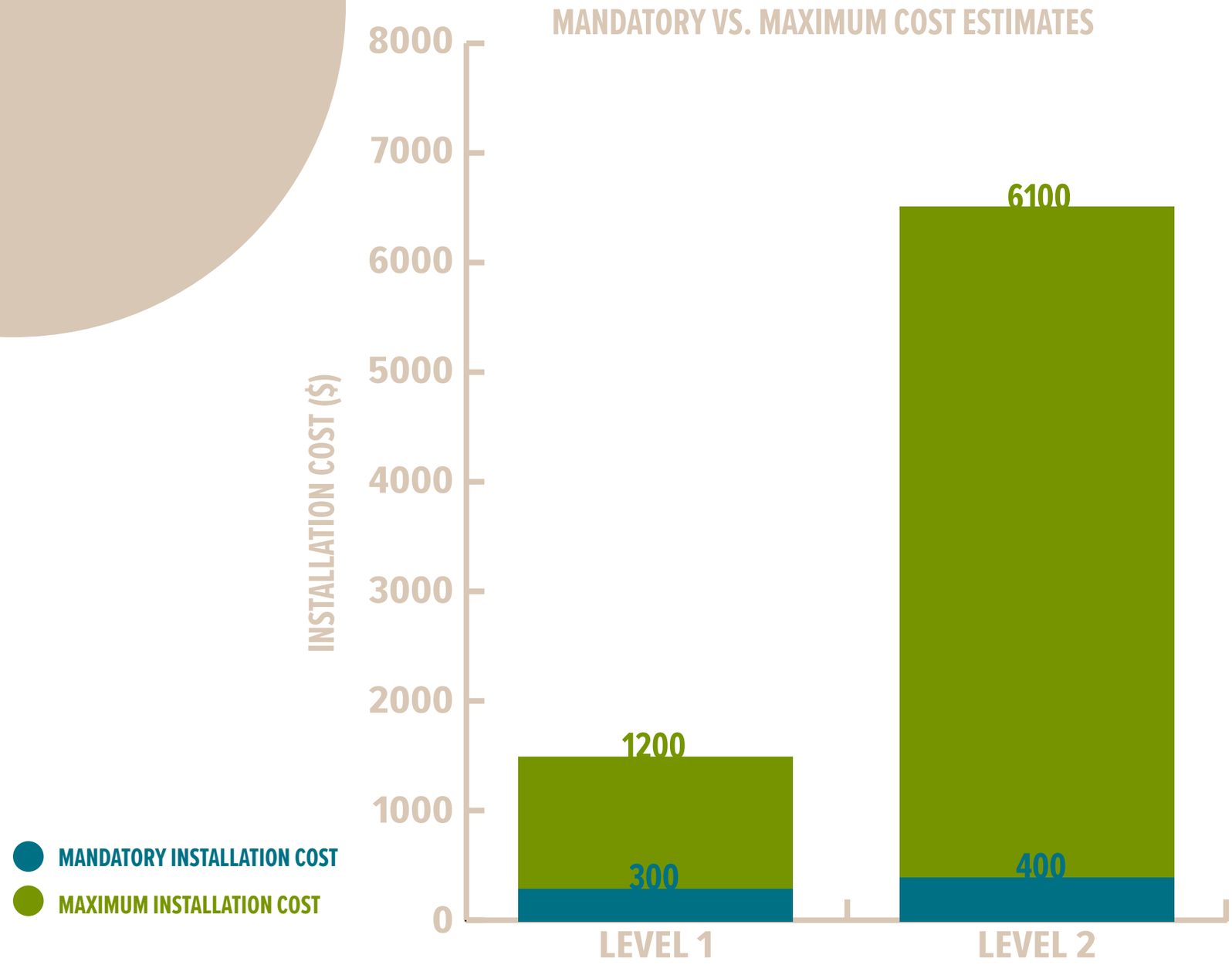


Figure 16: Mandatory estimated cost compared to the maximum estimated cost, including all optional amenities, for Level 1 and Level 2 charging station installation, as of 2015 [25].

CHARGING STATIONS & INSTALLATION COSTS

Faster charging means higher electrical capacity at the charging unit. Because utility upgrade and usage costs vary by location there is no set amount a charger may cost per electrical capacity. Contractor costs for installation also vary due to site geology and electrical availability variation as well as the independent contractors' given rates. Generally, installation costs increase (leading to the variability shown in Figure 16) due to:

- Pedestal mounting (~$1200)
- Trenching for electrical connection
- Including network connection
- Screen display

DCFC CHARGING & INSTALLATION

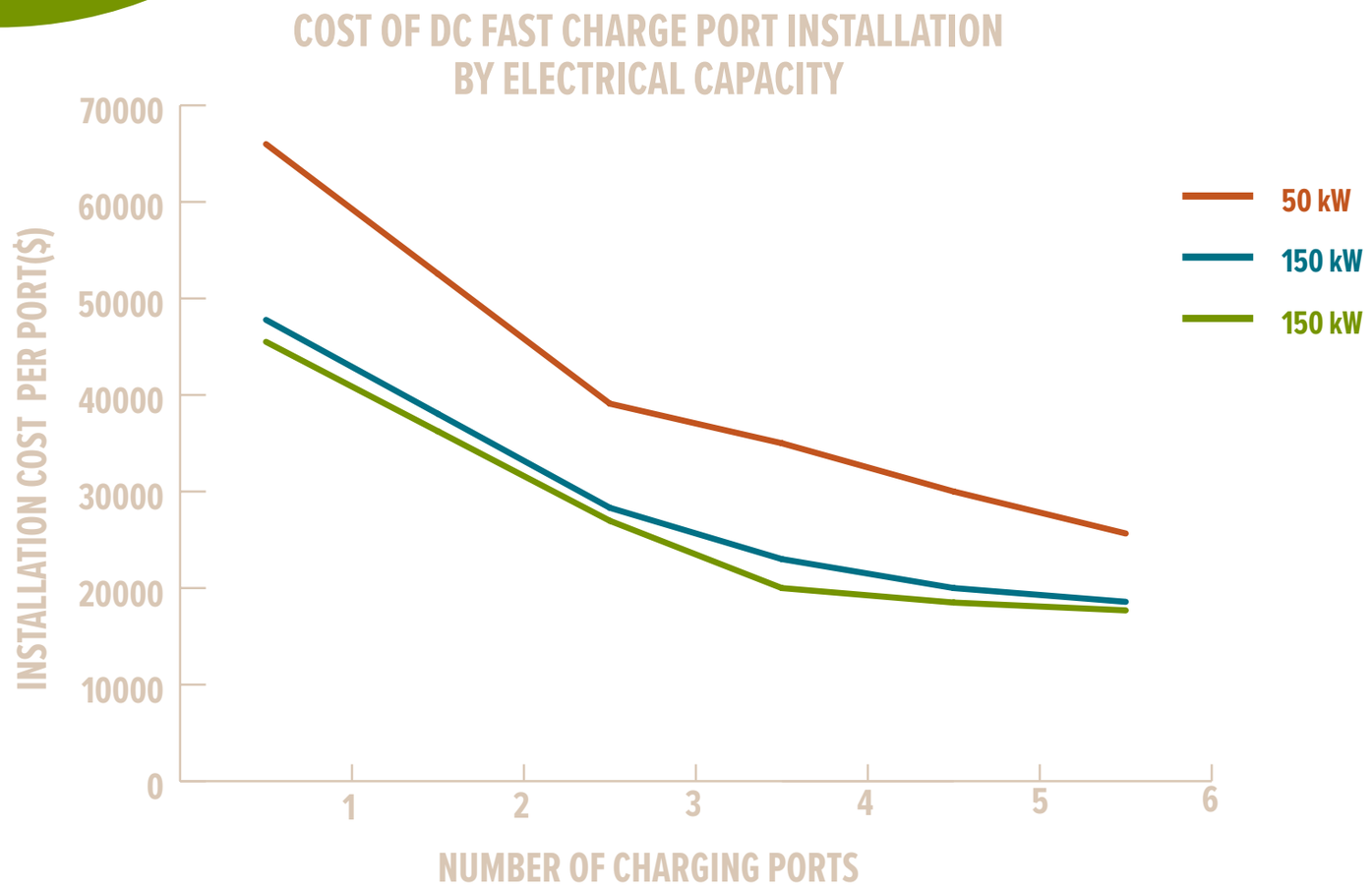


Figure 17: Installation cost estimate for DCFC charging port by number of ports and electrical capacity [26].

DCFC chargers require their own designated circuit thus these are more expensive, but more useful and efficient. Once the electrical infrastructure exists to support one charging port the cost to install additional ports in the same location decreases by thousands of dollars as shown in Figure 16.

Electrical circuits cannot exceed 2.5 megawatts of power (or 2,500,000 kW) limiting the number of charging ports per location to 50 at 50 kW, 20 at 150 kW and 10 at 350 kW. However, a 50 kW port can provide a full charge in about 2 hours while a 350 kW port can do so in 20 minutes [25,26] .

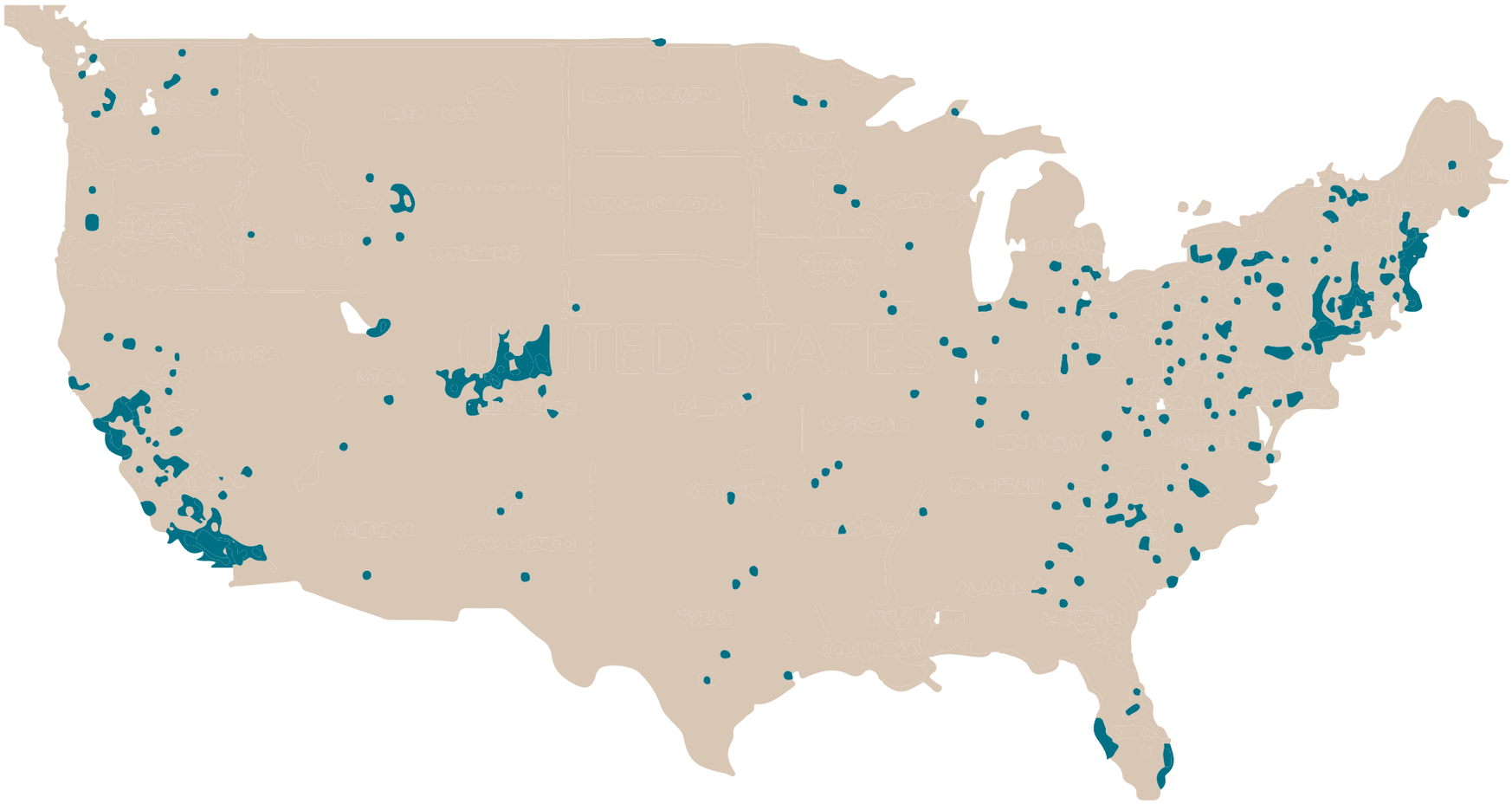


Figure 18: Installation cost estimate for DCFC charging port by number of ports and electrical capacity [26].

GOVERNMENT-OWNED CHARGING

Of 51,255 total Level 2 and DCFC charging stations across the US, only 1,166 are government owned, 942 of which are owned by local governments. Figure 17 emphasizes that local governments in densely populated and metropolitan areas can prioritize funding EV charger installation while rural governments cannot. Retailer, workplace and at home charging is essential for rural Americans to own EVs.

RETAIL BASED CHARGING INSIGHTS

Hosting EV charging stations provides many benefits to retailers such as attracting customers and employees and improving branding. However, retailers with varying profiles based on customer dwell times, average customer spending per minute dwell time and average purchase value will find maximized charging profits by employing different customer charging regimes. All retailers should consider:

1

IN STORE PURCHASING HAS THE LARGEST IMPACT ON CHARGING PORT NET PRESENT VALUE (NPV). ON AVERAGE ONLY **8%** OF NPV RESULTS DIRECTLY FROM PORT PROFITS.

2

INITIAL PORT UTILIZATION IMPACTS NVP IN SUBSEQUENT YEARS.

2X INCREASE IN INITIAL USE LEADS TO **20% INCREASE IN NPV.**

3

CHARGER OWNERSHIP:

RETAILER OWNED & OPERATED CHARGING: HIGHER GROSS PROFIT

THIRD-PARTY OWNED - RETAILER OPERATED: LOWER VOLATILITY/ STABLE PROFIT

4

RETAILERS WITH **LOW AVERAGE PURCHASE VALUE** (UNDER $25) SHOULD FOCUS ON STATION TURNOVER **IMPLEMENTING A PROFIT CENTER CHARGING SCHEME** (E.G. $0.25-$0.5/kW HOUR) TO MAXIMIZE CHARGER NPV.

5

RETAILERS WANTING TO **MAXIMIZE CUSTOMER DWELL TIME** (E.G. GROCERS) ASSUMING AVERAGE PURCHASE VALUE PER MINUTE DWELL TIME SHOULD IMPLEMENT **FREE CHARGE FOR THE DESIRED STORE DWELL TIME** TO MAXIMIZE STORE SPENDING AND THUS CHARGER NPV.

INSIGHTS FOR THE FUTURE OF CONVENIENCE STORES

Food sales are a growing proportion of gas station/convenience store sales in recent years. Younger demographics rely on convenience stores more than their older counterparts especially as companies like Wawa, QuickChek and Buc-ee's are offering healthier options and expanding made-to-order prepared foods selection. In 2019 Forbes called Wawa "A direct competitive threat to the restaurant space" as customers are beginning to opt for these stores over fast food.

56%
of Americans purchase 1+ meals/month from a convenience store, 2019
[28]

43%
of millennials buy more food from convenience stores than 3 years ago, 2020
[29]

25%
of Americans 30-44 years old purchase a convenience store meal 5+ times/month, 2020
[29]

2-3%
of food expenditures of people living in food deserts occur at convenience stores, 2021
[41]

POLICY NEEDS

1 Expand charging infrastructure subsidies and incentives across industries with incentives such as the California Electrical Vehicle Infrastructure Project [22].

2 As the EPA LUST Trust Fund addresses existent environmental damage from gas stations, tax funds should be continuously collected to address any foreseeable EV charging associated environmental damages [35].

3 Cement zero-emissions targets in policy for LDVs such as those for medium to heavy duty vehicles (e.g. California's Advanced Clean Truck Regulation and the Netherlands' zero-emission commercial vehicle zones) [40].

4 Prioritize DCFC charging within the Federal Highway Administration's Alternative Fuel Corridor program and other programs targeting U.S. interstate and state routes.

5 Require public charging infrastructure in apartment and other residential parking lots. For example, as of 2022 the EU's Energy Performance in Buildings Directive requires new construction to include electrical line capacity for chargers, and for Member States to set a requirement for chargers in non-residential parking lots with over 20 spots. [41].

CONCLUSION

A transition from the legacy fueling industry and infrastructure to EV charging is beginning across the U.S.. Charging technology and current charging build out are both on pace with consumer demand for EVs, and a shrinking portion of consumers continue to view charging availability as a barrier to owning an EV. Growth will need to expedite in the coming 3 decades and cannot exclude the legacy convenience store industry which employs 960,300. By implementing appropriate retailer charging models and overcoming legal barriers to reselling electricity in some states, the convenience store industry can continue to be competitive in the future without fuel sales.

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SUSTAINABLE FUELS & THE AVIATION SECTOR

BULLETIN NO. 20220101

The transition to Sustainable Aviation Fuels (SAF) has the potential to significantly benefit both the domestic economy and environment. SAF can reduce the risks of the Electric Vehicle Transition which is expected to have significant implications for the production and demand of sustainable/renewable fuels such as Ethanol of renewable diesel.

https://www.dynamicslab.org/sustainable-aviation-fuels-technical-bul

CRITICAL MINERALS & THE EV TRANSITION

BULLETIN NO. 20220102

The production of a typical lithium-ion battery requires five minerals dubbed “critical minerals” by the USGS - lithium, cobalt, manganese, nickel, and graphite. These critical minerals each face potentially significant supply chain bottlenecks and disruptions, such as: inadequate supply, dominance by select countries in production and refining, an oligopoly of producers, and more. Additionally, the extraction of critical minerals includes environmental and socio-political impacts that must be addressed for a sustainable and just EV transition.

https://www.dynamicslab.org/critical-minerals-ev

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MISSION STATEMENT

Provide support to public and private organizations on the risks, unintended consequences, and opportunities of the global sustainability transition

PRIMARY TRANSITION AREAS OF FOCUS

Technology Transitions – Energy Transitions – Biobased Transitions Economy

COMPONENTS OF THE TRANSITION

Supply Chains – Green Finance – Critical Minerals – ESG – National Security

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