NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Alternative Fuels, Fuel Efficient Vehicles and Funding our Highways

Committee for a Study of the Future Interstate Highway System

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National Renewable Energy Laboratory

Photo by Dennis Schroeder, NREL 17613

NREL at a Glance

- Only U.S. National Laboratory dedicated to renewable energy and energy efficiency research
- Established in 1979 as Solar Energy Research Institute
- About 2,400 employees with world-class facilities
- Owned by the Department of Energy, operated by the Alliance for Sustainable Energy

Transportation and Energy Policies are Not Aligned

CAFE is projected to provide economic benefit of between $372 and $507 billion by 2025

Source: NHTSA, 2011

Fuel tax revenues are projected to decrease by $57 billion by 2022 due to CAFE.*

Source: Congressional Budget Office, 2012 (Dinan and Austin)

Transportation Funding is at an Impasse

Transportation fundamentals are changing and current funding paradigms are being challenged

- Infrastructure is deteriorating and current funding mechanisms are largely insufficient; federal government has relied on supplemental payment from general fund since 2008

Infrastructure Funding Reform

Modified Management of Transportation System

Alternative fuels introduce increased complexity

- Multiple fuels with varying energy contents, delivery methods, and taxation schemes present challenges towards balancing parity and promotion
- Potential approaches pursued include:

Annual Fees

Energy-Based Taxation

VMT

Carbon Tax

States/Provinces Are Implementing New Funding Mechanisms

VMT

Oregon is conducting a pilot that allows for up to 5,000 drivers of certain types of light-duty vehicles to participate in a program that will pay $0.015/mile in lieu of the $0.30/gallon state gasoline tax

%

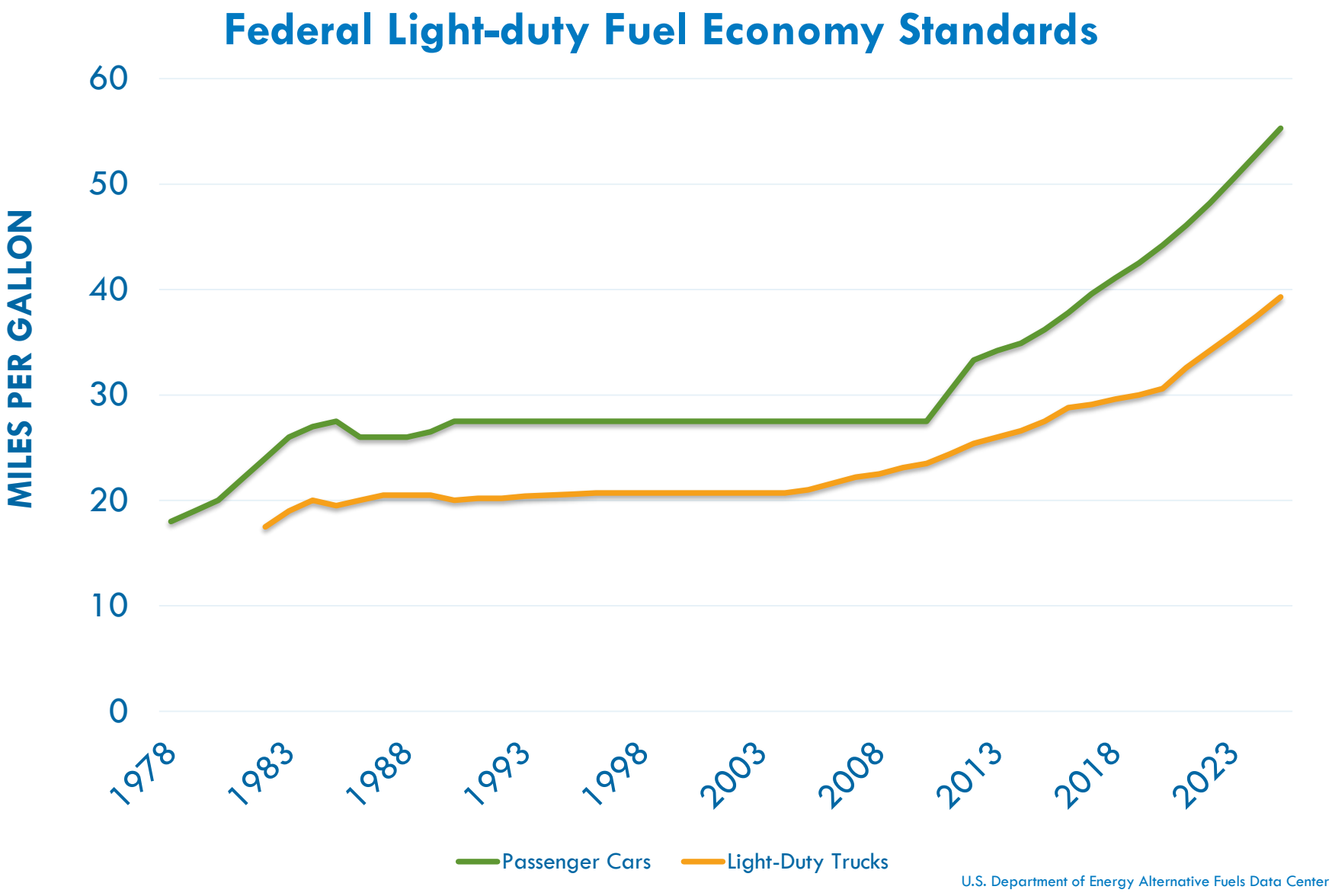
Virginia eliminated its $0.175/gallon motor fuels tax in favor of a 3.5% sales tax on gasoline and a 6% sales tax on diesel fuel. The tax is adjusted twice annually.

CO_2

In 2008, British Columbia instituted a carbon tax that is levied in proportion to equivalent tons of carbon dioxide emitted by a given fuel

Photo by Warren Gretz, NREL 10640

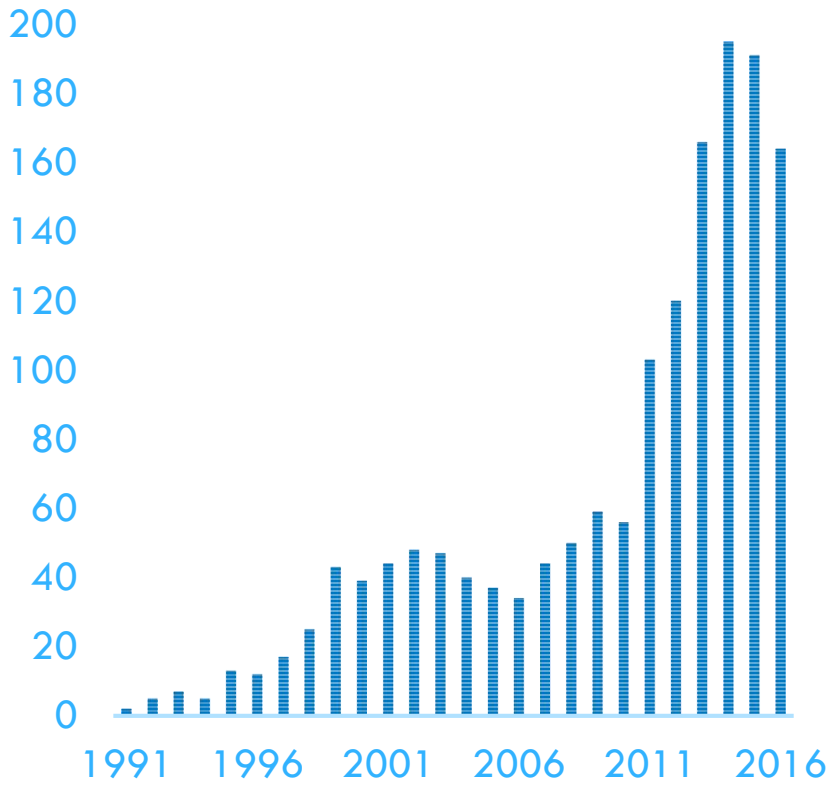
Vehicles Are Becoming Increasingly Fuel Efficient



U.S. Department of Energy Alternative Fuels Data Center

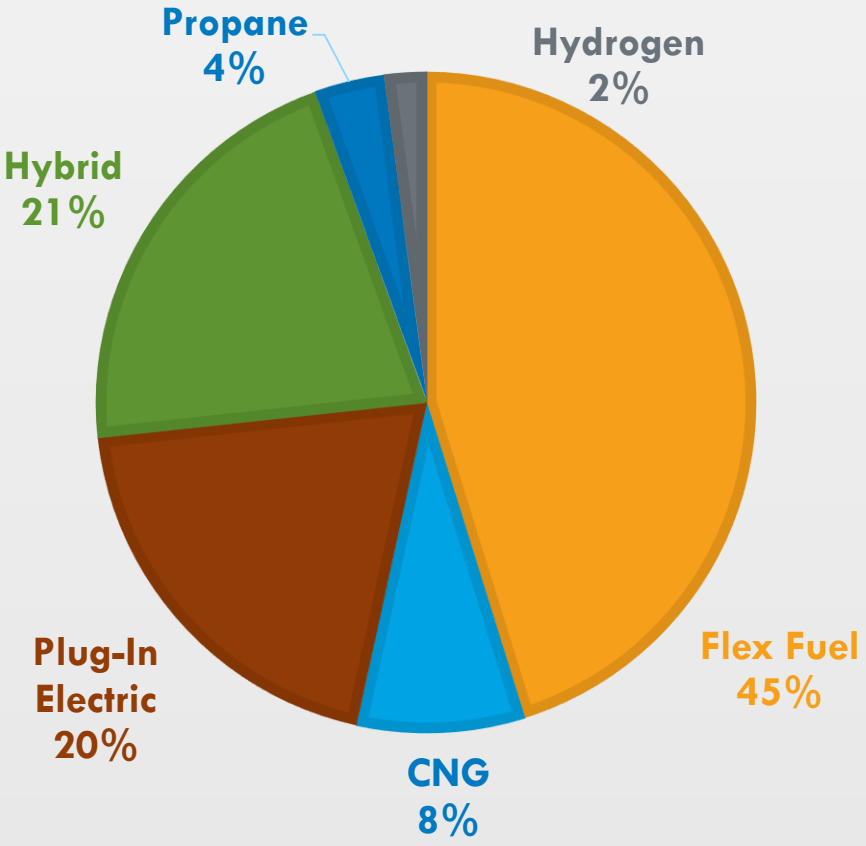
The Market for Alternative Fuels Is Increasing

Light-Duty Hybrid and Alternative Fuel Vehicle Models Available to Consumers



U.S. Department of Energy Alternative Fuels Data Center

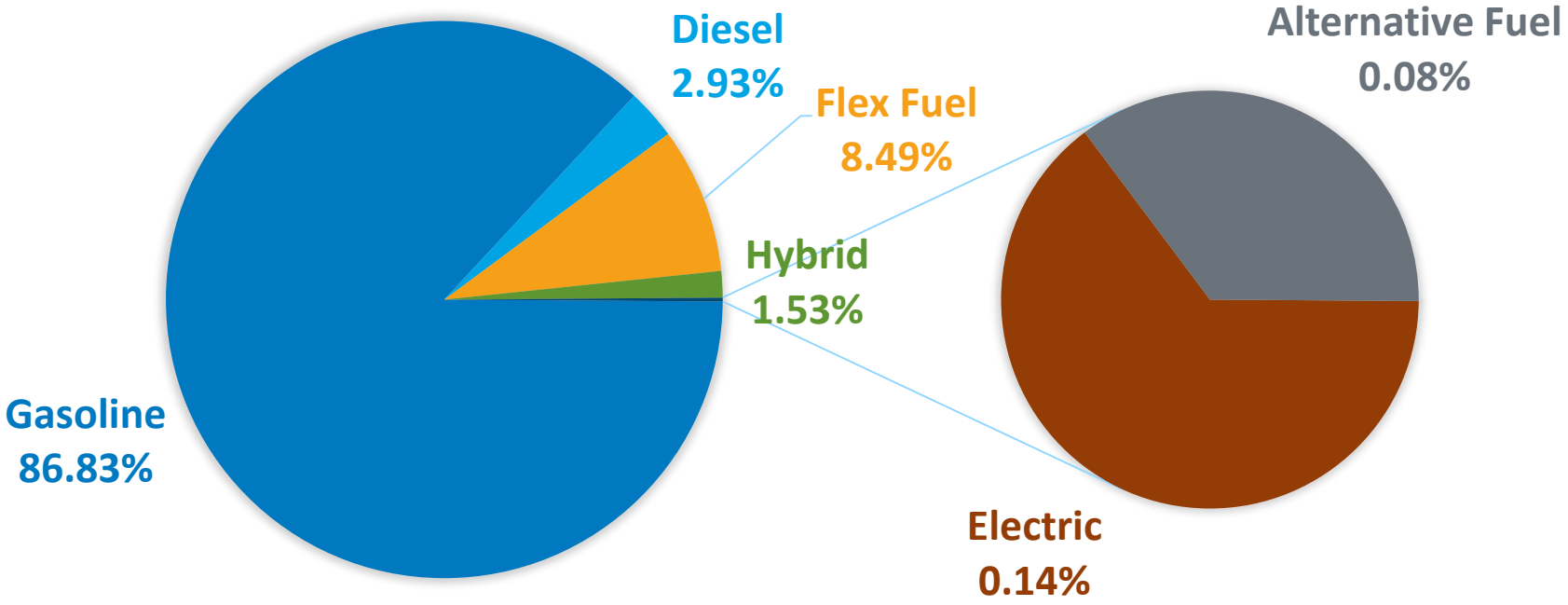
Available Light-Duty Hybrid and Alternative Fuel Vehicles by Fuel Type (MY16)



U.S. Department of Energy Alternative Fuels Data Center

But Still a Relatively Small Portion of the Fleet

AFV sales are increasing substantively on a year over year basis, but still make up a small portion of the overall fleet.

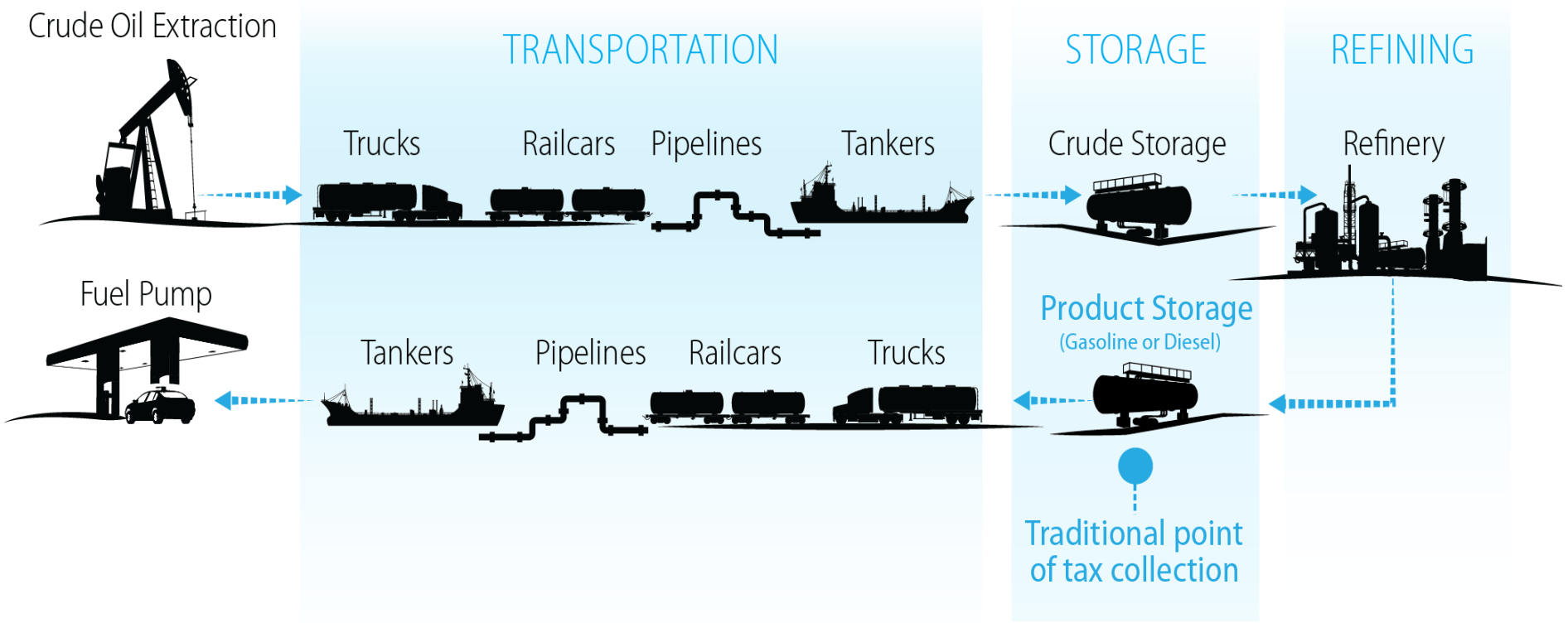


Approximate number of gasoline, diesel, hybrid, electric, and alternative fuel light-duty vehicles (Model years 1999-2015)

Source: IHS/Polk 2015

Collecting Motor Fuel Taxes Used to be Simple…

- Single, consistent point of enforcement
- Two major fuels (gasoline and diesel)
- International Fuel Tax Agreement for interstate transactions



New Fuels and Technologies Complicate Things

Photo by Pearson Fuels

Plug-in Hybrid Electric Vehicle
Series Hybrid Vehicle
Parallel Hybrid Vehicle
Series/Parallel Hybrid Vehicle
Mild Hybrid
Battery Electric vehicle
Hybrid Electric Vehicle
Fuel Cell Electric Vehicle

Gasoline Vehicle

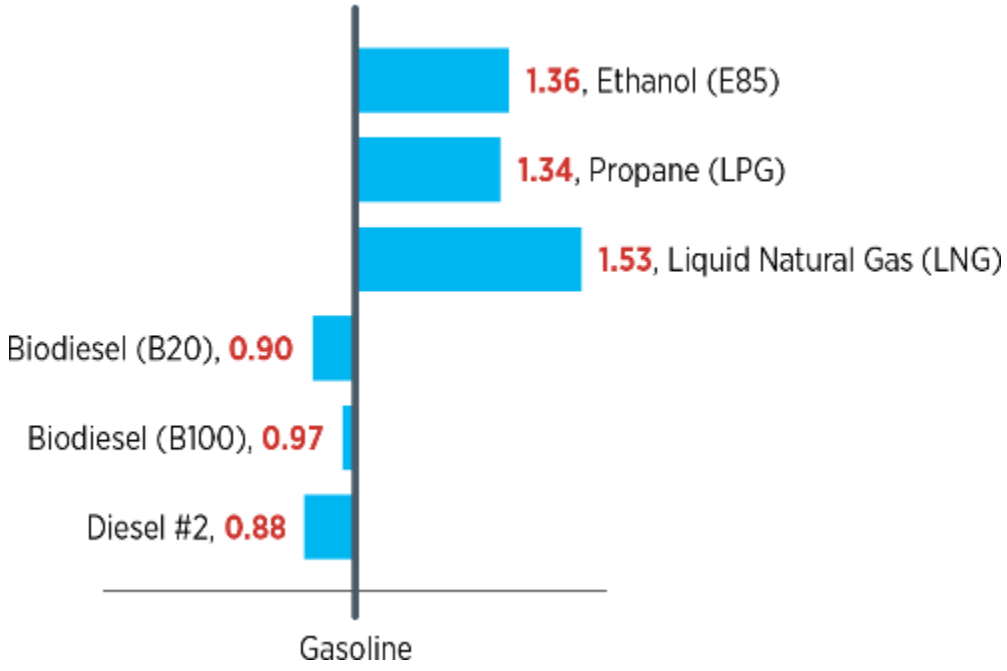
Diesel Vehicle

Fuel Cell Hybrid Vehicle
Bi-fuel Natural Gas Vehicle
Dedicated Natural Gas Vehicle
Dual-fuel Natural Gas Vehicle
Propane Vehicle
Flexible Fuel Vehicle
Extended Range Electric Vehicle
Neighborhood Electric Vehicle

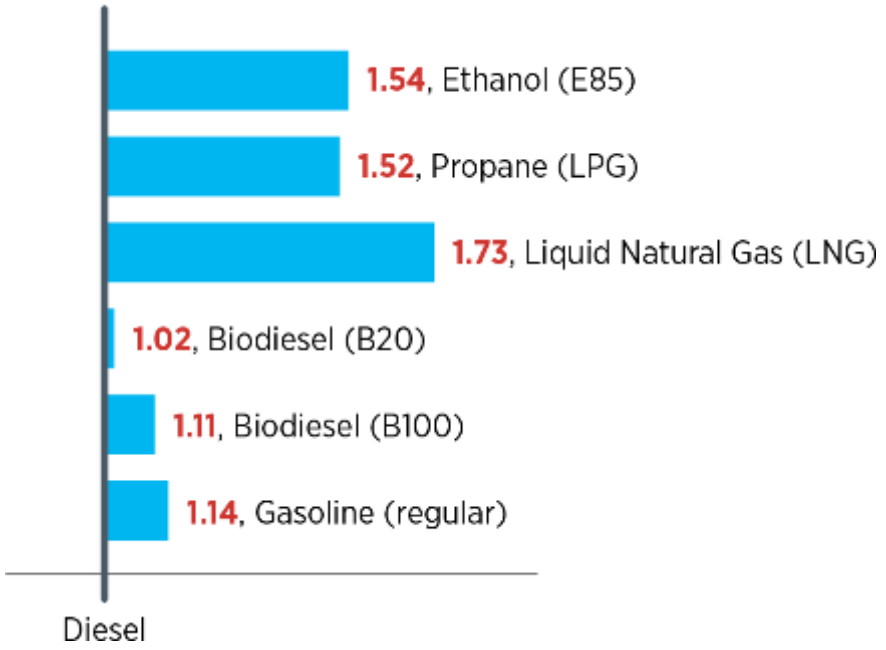
Fuel Taxes are Traditionally Based on Volume

Current System of Taxation Does Not Accommodate Variation Among Alternative Fuels

Gallons of Fuel Needed to Produce the Energy Equivalent of a Gallon of Gasoline



Gallons of Fuel Needed to Produce the Energy Equivalent of a Gallon of Diesel



Please note that these values are averages and are subject to regional and seasonal variation.

Source: U.S. Department of Energy Alternative Fuels Data Center

Energy Content-Based Taxation

Recent Legislation Seeks to Tax Alternative Fuels Based on Energy Content

Consideration of for Energy Content Based Fuel Taxes

- Establishing a baseline
- Fuel blending and vehicle conversion
- Introduction of non-traditional "fuels" such as electricity
- Funding impacts

Utilizing Decals and Fees for Alternative Fuels

Decals/annual fees being used in 17 states as a mechanism for compliance, convenience, and incentive

- Recover revenues from non-traditional fueling options (home fueling, behind the fence, etc.)
- Facilitate private fleet use of alternative fuels
- Incentivize the use of alternative fuels, especially for vehicles/fleets with relatively high fuel consumption

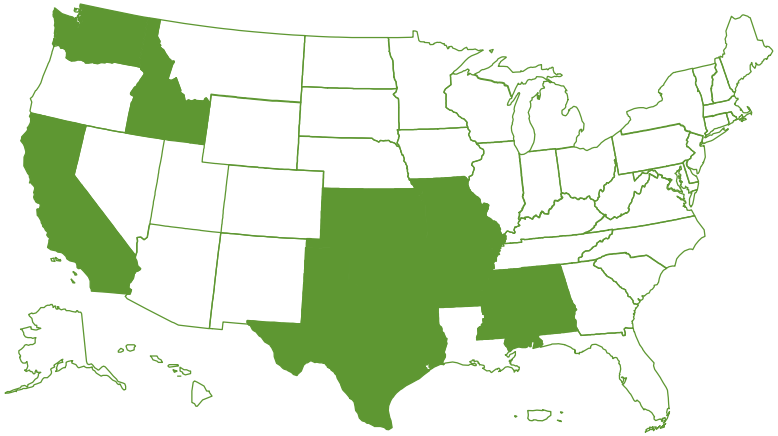
Photo by Pat Corkery, NREL 18175

Considerations for Implementation/Administration

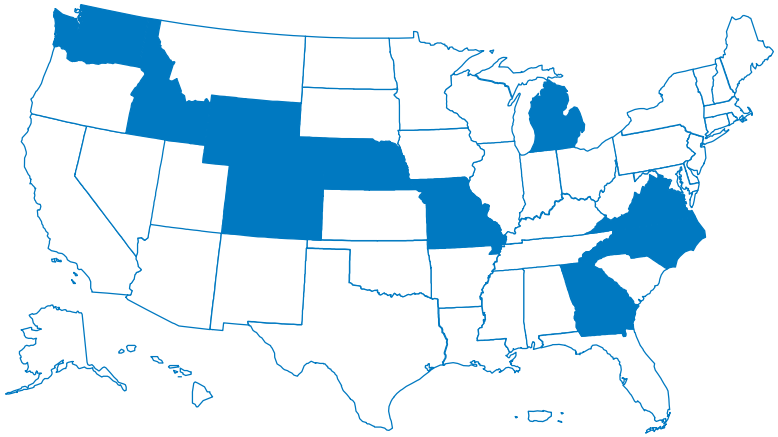
- Fair and efficient taxation
- Taxation in commercial transactions
- Parity with electric and bi-fuel vehicles
- Enforcement

States with Annual AFV Fees

Nationally, annual fees are generally being phased out for CNG/LNG/LPG and established for EVs



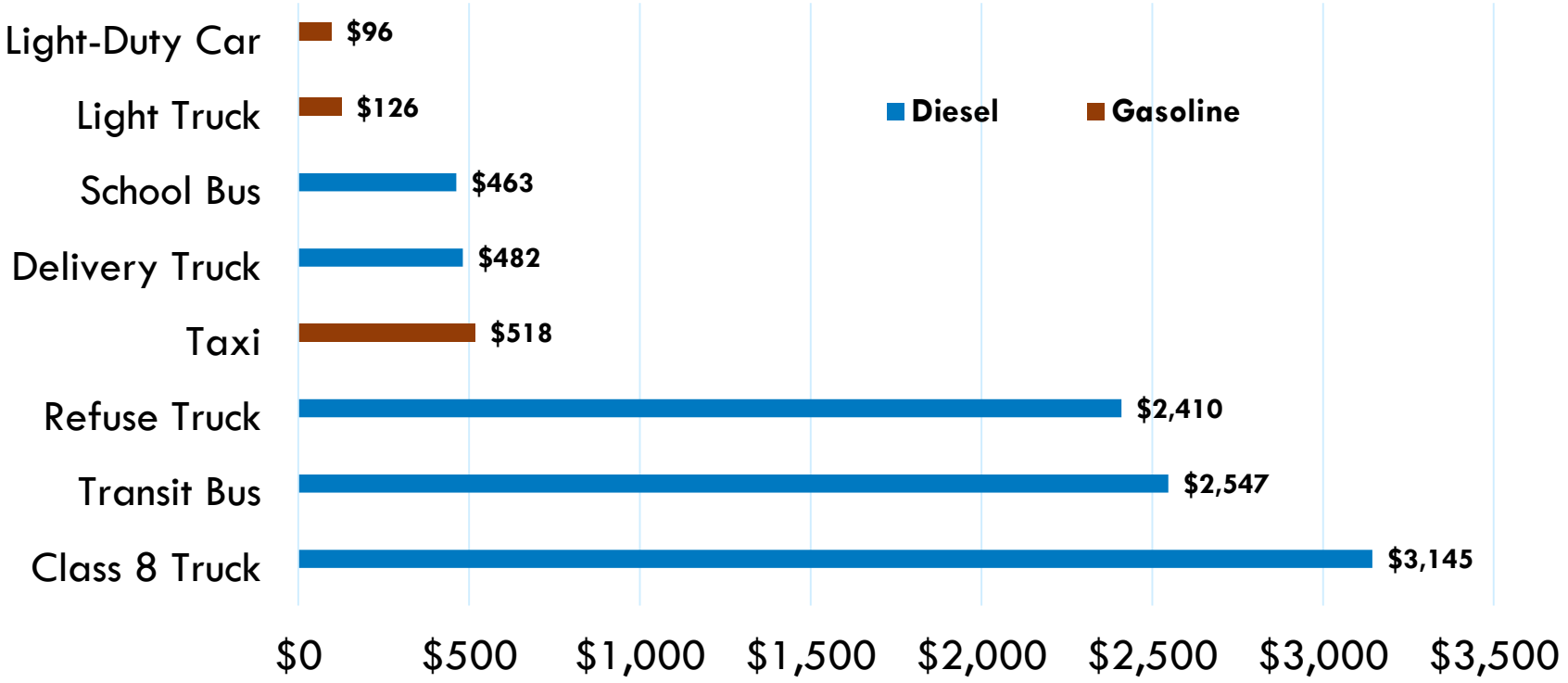
States with an annual fee or decal for CNG, LNG, and/or LPG



States with an annual fee on electric vehicles

Vehicle Fees Across Vehicles Types

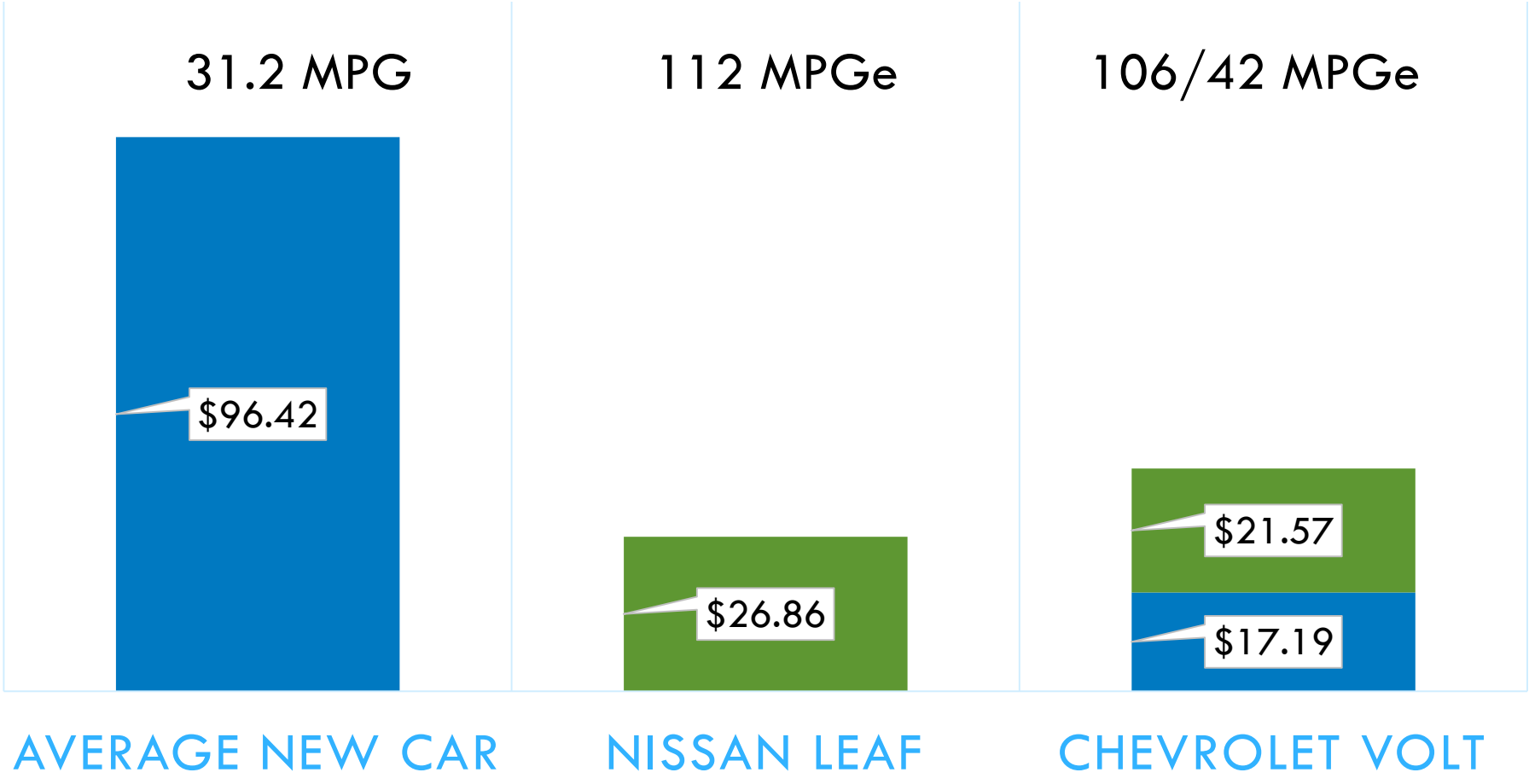
- Flat-fee decals effectively provide a subsidy to heavy fuel users and a penalty on light-duty vehicle drivers
- Burden of compliance is often not clear resulting in possible situations of double taxation or no taxation



Average Federal Fuel Tax Revenue for Various Vehicle Classes

[1] Average mileage values are derived from **Federal Highway Administration** Table VM-1 **American Public Transit Association's Public Transportation Fact Book** Tables 8, 16, and 21

How Much Revenue Are EVs Displacing?



Estimate of Annual Federal Fuel Taxes Paid by an Average Conventional Vehicle, Nissan Leaf EV, and Chevrolet Volt PHEV if Electricity Were Taxed as a Motor Fuel

Tax assumed to be $0.18 per gallon of gasoline
Average annual vehicle mileage assumed to be 16,349 miles based on average fuel consumption from FHWA
Average new car fuel economy from mpge for Nissan Leaf and Chevrolet Volt from U.S. Environmental protection agency fuel economy guide

Relevant and Recent Legislation

U.S. Congress (2015)

Legislation was passed to equalize the federal excise tax on LNG with that of diesel and LPG and CNG with that of gasoline (H.R. 3236)

Colorado (2013)

HB1110 phased out decal for CNG/LNG/LPG and phased in energy-content based fuel taxation. Assessed $50 annual fee on EVs - $25 of which goes to transportation infrastructure, $25 of which goes to EV charging infrastructure

Mississippi (2015)

HB1590 defined a diesel gallon equivalent for the purpose of taxation of LNG

New Mexico (2014)

HB30 removed the decal and established an energy equivalent tax for CNG, LNG, and LPG

Photo by National Park Service, NREL 5690

Thank You

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Learn more at
www.nrel.gov/transportation

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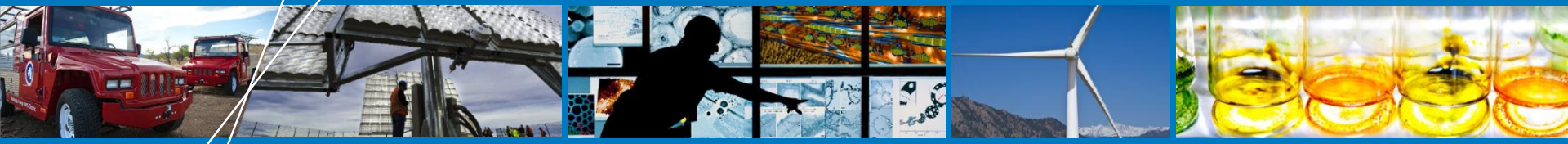

Backup Slides and Supporting Information

Energy Content of Various Alternative Fuels

	Gasoline/E10	Low Sulfur Diesel	Biodiesel	Propane (LPG)	Compressed Natural Gas (CNG)	Liquefied Natural Gas (LNG)	Ethanol/E100	Methanol	Hydrogen	Electricity
Gasoline Gallon Equivalent [4]	97% - 100%	1 gallon of diesel has 113% of the energy of one gallon of gasoline.	B100 has 103% of the energy in one gallon of gasoline or 93% of the energy of one gallon of diesel. B20 has 109% of the energy of one gallon of gasoline or 99% of the energy of one gallon of diesel.	1 gallon of propane has 73% of the energy of one gallon of gasoline.	5.66 pounds or 123.57 cu ft. of CNG has 100% of the energy of one gallon of gasoline. [2][5](q) 6.38 pounds or 139.30 cu ft. of CNG has 100% of the energy content of one gallon of diesel [2][5](q)	5.38 pounds of LNG has 100% of one gallon of gasoline and 6.06 pounds of LNG has 100% of the energy of one gallon of diesel (r)	1 gallon of E85 has 73% to 83% of the energy of one gallon of gasoline (variation due to ethanol content in E85). 1 gallon of E10 has 96.7% if the energy of one gallon of gasoline. [3]	1 gallon of methanol has 49% of the energy of one gallon of gasoline.	1 kg or 2.198 lbs. of H2 has 100% of the energy of one gallon of gasoline.	33.70 kWh has 100% of the energy of one gallon of gasoline.
Energy Content (Lower heating value)	112,114 - 116,090 Btu/gal (g)	128,488 Btu/gal (g)	119,550 Btu/gal for B100 (g)	84,250 Btu/gal	20,160 Btu/lb	21,240 Btu/lb	76,330 Btu/gal for E100 (g)	57,250 Btu/gal (g)	51,585 Btu/lb	3,414 Btu/kWh
Energy Content (Higher heating value)	120,388 - 124,340 Btu/gal (g)	138,490 Btu/gal (g)	127,960 Btu/gal for B100 (g)	91,420 Btu/gal	22,453Btu/lb	23,726 Btu/lb	84,530 Btu/gal for E100 (g)	65,200 Btu/gal (g)	61,013 Btu/lb	3,414 Btu/kWh

See: http://www.afdc.energy.gov/fuels/fuel_comparison_chart.pdf for additional details and notes

Federal Motor Fuel Excise Tax Rates (IRS Form 720)

Fuel	Tax Rate Per Gallon (cents)
Gasoline	18.4
Ethanol/Methanol	18.4
Diesel and Kerosene	24.4
Biodiesel	24.4
Liquefied Petroleum Gas (Propane, butane, pentane, or mixtures of these gases)	18.3
Liquefied Natural Gas	24.3
Compressed Natural Gas (including biogas)	18.3
P-series Fuels	18.4
Liquefied Hydrogen	18.4
Any liquid fuel derived from coal through the Fischer-Tropsch process	24.4
Ethanol produced from natural gas	11.4
Methanol produced from natural gas	9.25
Other Fuels	18.4

International Fuel Tax Agreement

The International Fuel Tax Agreement (IFTA) was enacted in 1991 to address some of these disparities and simplify state-level transactions. It currently includes the 48 contiguous states in the United States and 10 Canadian provinces as parties to the agreement. Vehicles that operate in multiple states and meet one of the following conditions qualify for an IFTA license:

- Two axles and a gross vehicle weight (or registered gross weight) exceeding 26,000 pounds
- Three or more axles, regardless of weight
- Used in combination, and the gross vehicle weight of the combination is more than 26,000 pounds.

Carriers in participating jurisdictions are required to obtain an IFTA license; alternately, carriers can in some cases obtain trip permits if interstate travel occurs infrequently. Fuel taxes are reported on a quarterly basis through IFTA and allow for a carrier to report taxable miles, gallons of fuel, and taxes paid in order to reconcile discrepancies across states. Its important to note that while IFTA is a coordinating entity, its functions are purely administrative and do not influence state rates.