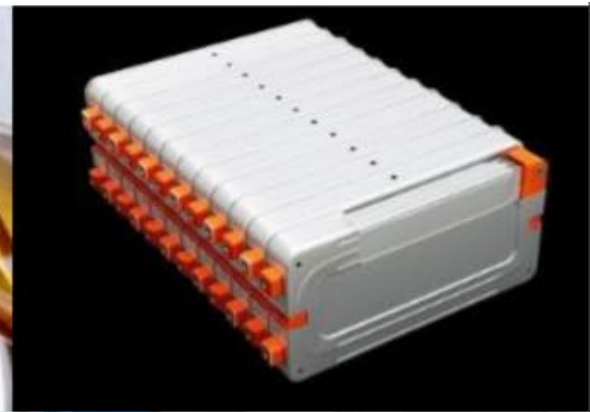


# Electric Vehicles: Opportunities and Challenges

MARK SMITH

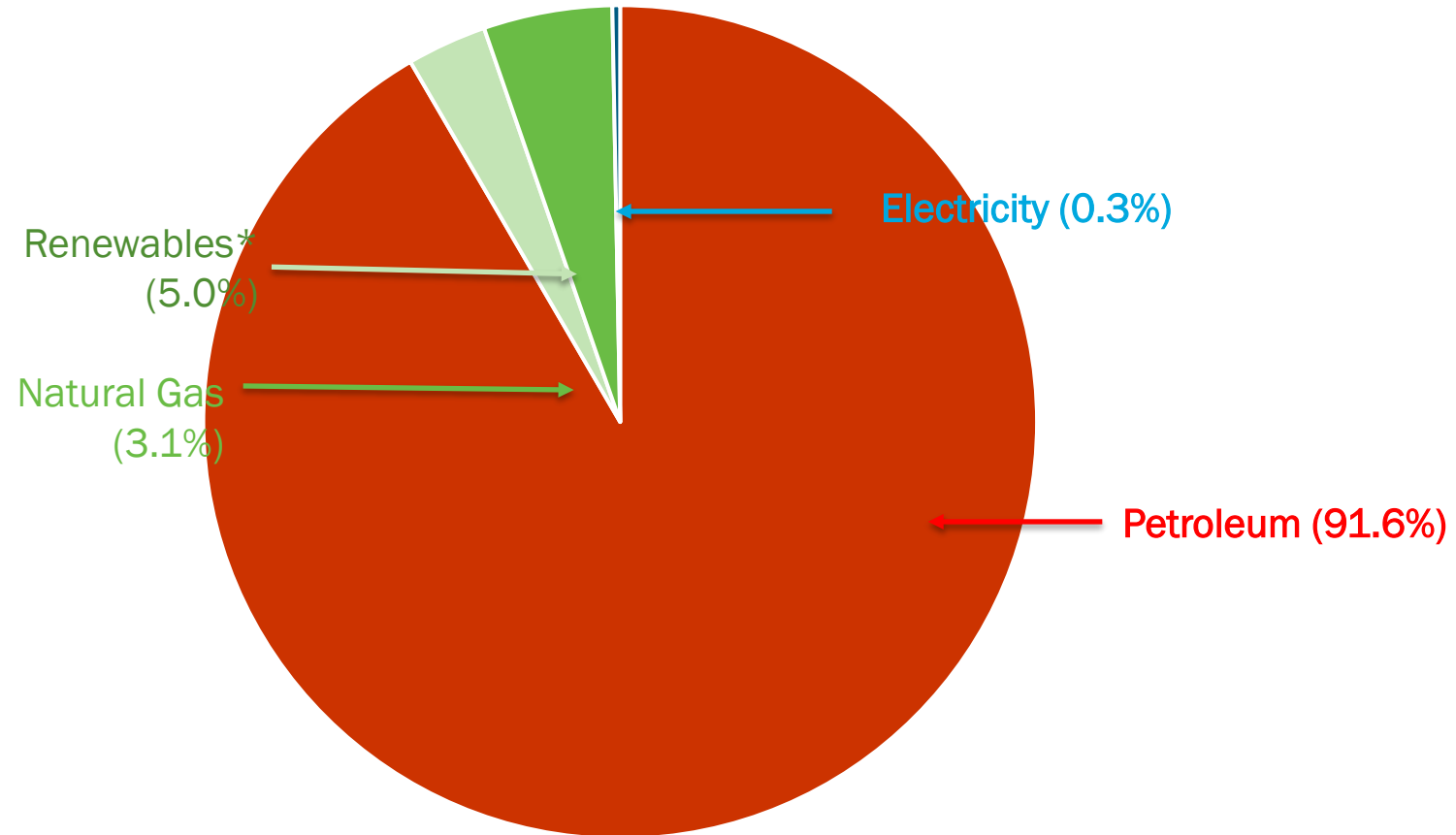
Program Manager, Vehicle Technologies Office

July 28, 2021



# Transportation Energy Consumption (2019)

Petroleum Dominates Transportation Fuel Use

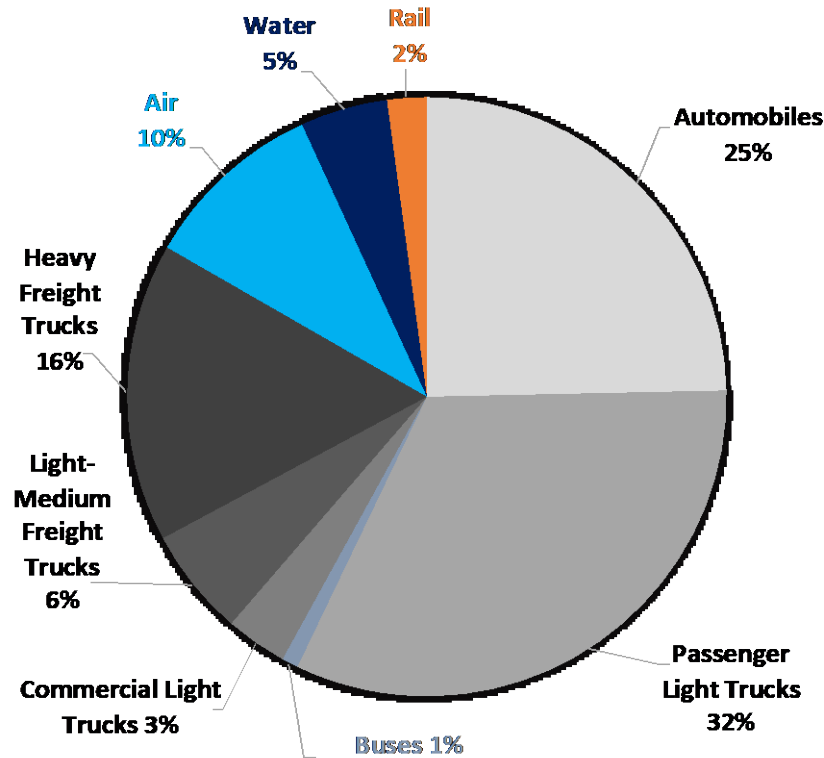


Source: Transportation Energy Data Book, edition 37 (January 2019), Table 2.03  
\*Renewables include hydro-electric, geothermal, wind, solar, and bio-mass energy.



## Mission: Decarbonize transportation across all modes

### 2019 U.S. Transportation Energy Use (26.8 Quads)



Source: EIA AEO

- Net-zero by 2050 requires dramatic energy efficiency and emissions improvements in vehicle and the overall transportation system
- 100% clean electricity and dramatic technology cost reductions enable deep transportation decarbonization
- On-Road Vehicles (Light, Medium, Heavy) account for 83% of energy use, and can be electrified leveraging cheap and abundant clean electricity
- Long Haul freight movement and Air, Marine, Rail likely require Hydrogen and Biofuels



ON-ROAD  
Light-, Medium-, Heavy  
Duty Vehicles



Batteries &  
Electrification



Materials  
Technology



Mobility  
Systems



Demonstration and Deployment



Air, Marine, Rail



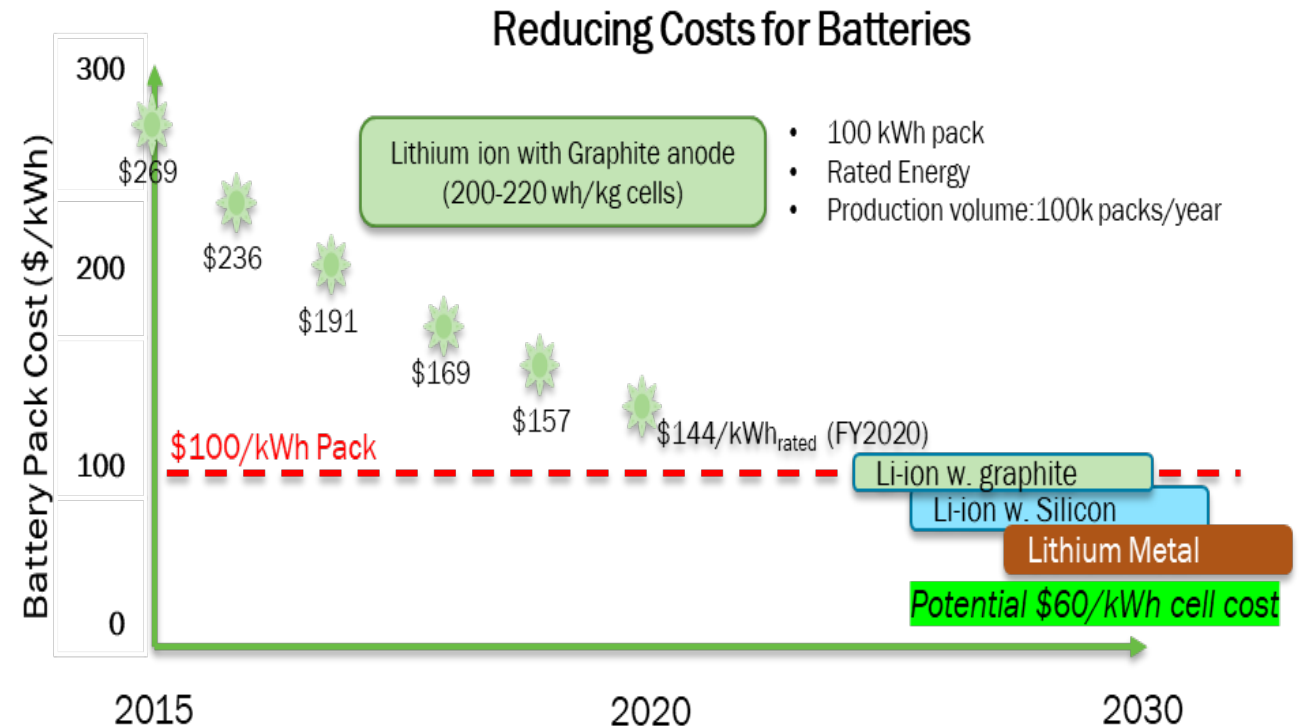
Some R&D for On/Off-  
Road MD/HD Vehicles

# Electric Vehicle Battery R&D

BY 2025, reduce the cost of EV battery packs to less than \$100/kWh, and increase range to 300 miles, and decrease charge time to 15 minutes or less.

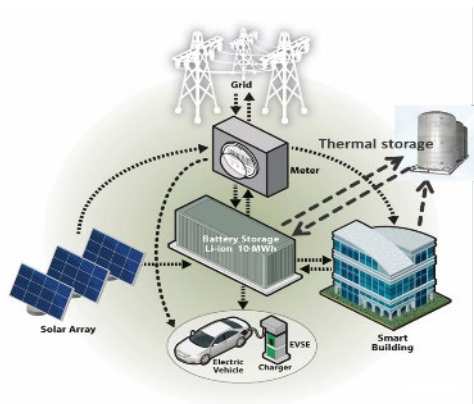
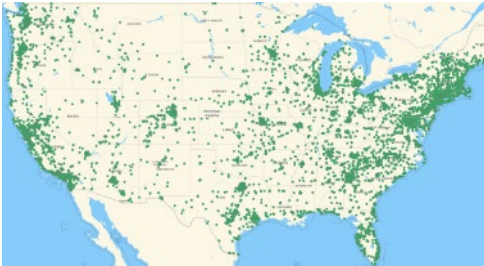
## Developing multiple pathways to reduce costs and reduce material needs

- Next generation lithium ion
  - higher capacity Cathodes (*no cobalt/no nickel*)
  - silicon-based anodes (*no or low graphite*)
- Lithium metal batteries including solid-state & lithium-sulfur (*no cobalt/no nickel, no graphite*)
- Establish profitable lithium battery recycling ecosystem





# Accelerate Nationwide Adoption and Deployment of EVs and Infrastructure



- ❑ Significantly expand EV community partner demonstration activities
- ❑ Demonstrate innovative charging/ infrastructure technology for various types of EV owners. Improve equitable access to the benefits of electrified transportation,
- ❑ Support Administration's goal to deploy 500,000 charging stations across the Nation.
- ❑ Demonstrate innovations to enhance community resilience (especially underserved communities) to physical hazards using distributed solar, energy storage, EVs, and other DERs (joint EERE-OE effort).
- ❑ Support education and workforce training.

# Technology Integration Program (TI)

**Provide objective/unbiased data and real-world lessons learned that inform future research needs and support local decision-making**



**Clean Cities  
Coalitions**



**Information  
and Tools**



**Technical  
Assistance**



**Training,  
Outreach,  
Partnerships**



**Financial  
Assistance**



**Regulatory Activities /  
State and Alt Fuel  
Provider Fleets**



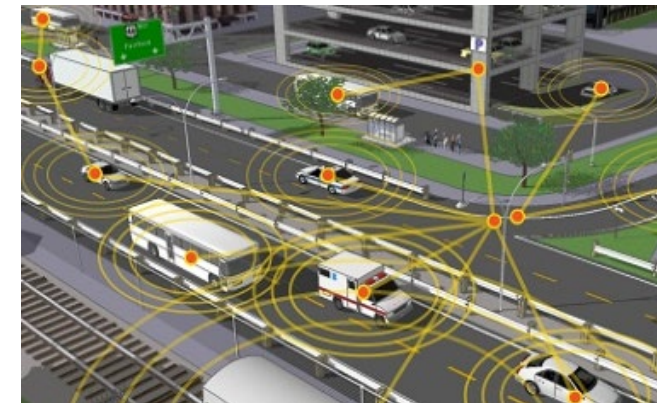
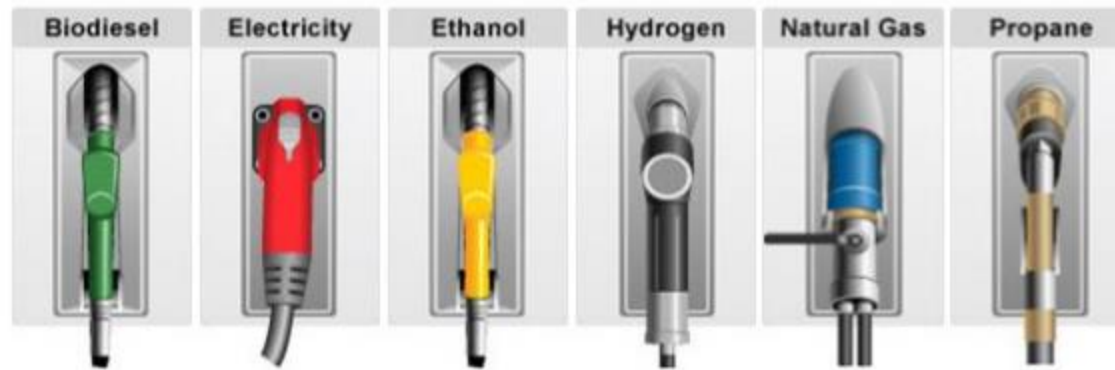
**Advanced Vehicle  
Technology  
Competitions**

# Technology Integration Focus Areas

## Light, medium and heavy-duty vehicles



## Alternative Fuel Infrastructure



## Energy Efficient Mobility Systems and Technologies



# Alternative Fuels Data Center (AFDC)

afdc.energy.gov

U.S. DEPARTMENT OF **ENERGY** | Energy Efficiency & Renewable Energy

EERE Home | Programs & Offices | Consumer Information

## Alternative Fuels Data Center

Search the AFDC  [SEARCH](#)

[FUELS & VEHICLES](#) [CONSERVE FUEL](#) [LOCATE STATIONS](#) [LAWS & INCENTIVES](#) [Maps & Data](#) [Case Studies](#) [Publications](#) [Tools](#) [About](#) [Home](#)

[EERE](#) » [AFDC](#) [Printable Version](#)

### Fuels & Vehicles

Biodiesel Electricity Ethanol Hydrogen Natural Gas Propane



**Would a battery electric bus be cost effective for your transit fleet?**  
Check out a new financial analysis tool to find out.

### The Information Source for Alternative Fuels and Advanced Vehicles

The Alternative Fuels Data Center (AFDC) provides information, data, and tools to help fleets and other transportation decision makers find ways to reach their energy and economic goals through the use of alternative and renewable fuels, advanced vehicles, and other fuel-saving measures.

### Information by State



### Information by Fleet Application

 Delivery Services  Refuse Collection  
 Public Transit  School Transportation

### Maps & Data

- U.S. Alternative Fueling Stations by Fuel Type
- U.S. Hybrid Electric Vehicle Sales by Model
- Light-Duty Alternative Fuel Vehicle Registrations

### Fuel Prices



### Tools

- Laws & Incentives
- Electricity Sources & Emissions
- Vehicle Cost Calculator
- Vehicle Search

### Station Locator



Download [iPhone app](#) or [Android app](#)

**Fuels & Vehicles**  
Biodiesel

**Conserve Fuel**  
Idle Reduction

**Locate Stations**  
Search by Location

**Laws & Incentives**  
Search

**Data & Tools**  
Widgets

**About**  
Newsletters



Public Stations

**Advanced Filters**

### A Corridor Measurement

47,468 results in

U.S. and Canada 

Enter location

Q

Electric

### Charger Types

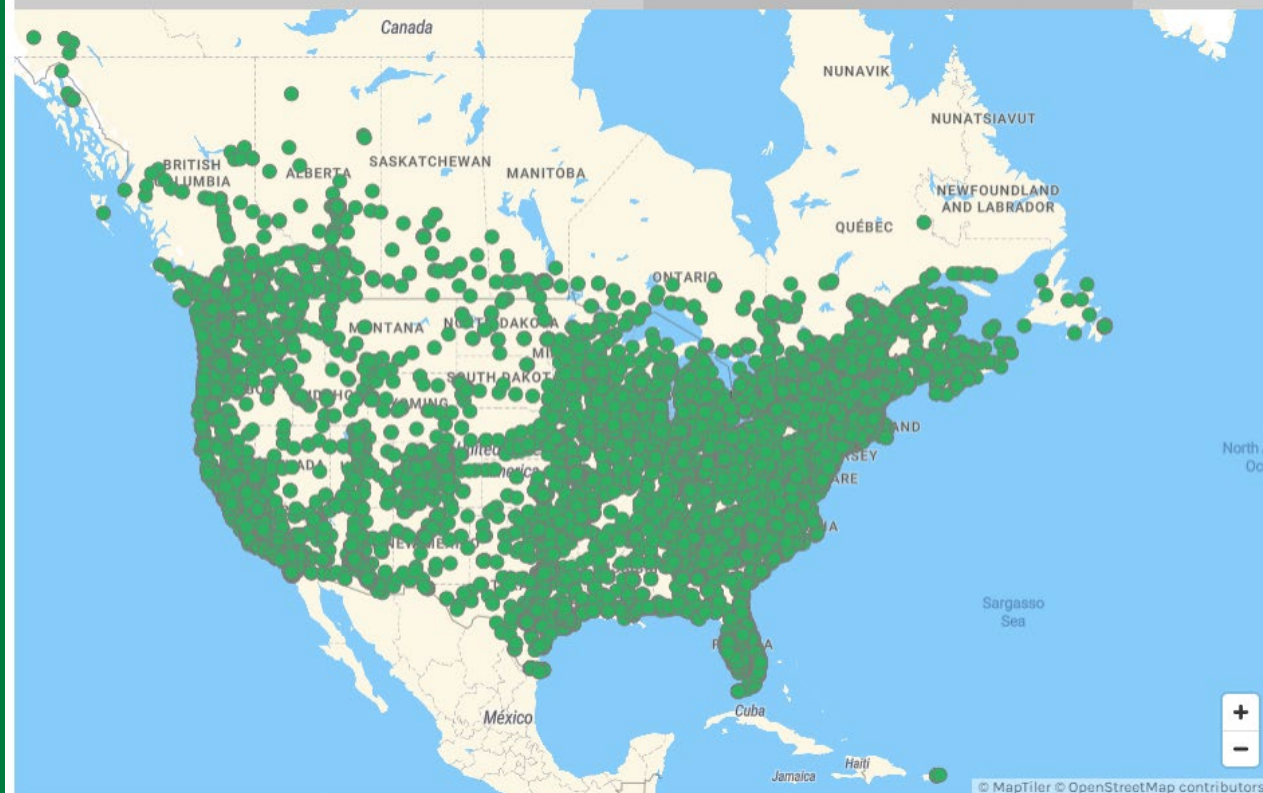
## Connectors

Map a

Level 2, DC Fa...

All 

Map a




 [Map Results](#)


45,160  
stations

115,386  
charging outlets

Filters chosen:

United States

 **Electric**

 **Access:** Public & private


 [Download Results](#)

 iPhone App  
for U.S. stations

 Android App  
for US stations Developer APIs

Embed Tool

[+ Submit New Station](#)

 About the Data



# Alternative Fueling Corridor Tool

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

[afdc.energy.gov/stations/#/corridors](https://afdc.energy.gov/stations/#/corridors)

## Alternative Fueling Station Locator

Find alternative fueling stations in the United States and Canada. For U.S. stations, see [data by state](#). For Canadian stations in French, see [Natural Resources Canada](#).

Public Stations

Advanced Filters

Corridor Measurement

Use this tool to measure the driving distance along Interstate Highways between stations that meet the criteria under the Federal Highway Administration's [Alternative Fuel Corridors Program](#). Explore more [resources for nominating corridors](#). Have a comment or a concern with this tool? [Please contact us](#).

All states

Electric

50 miles between stations allowed

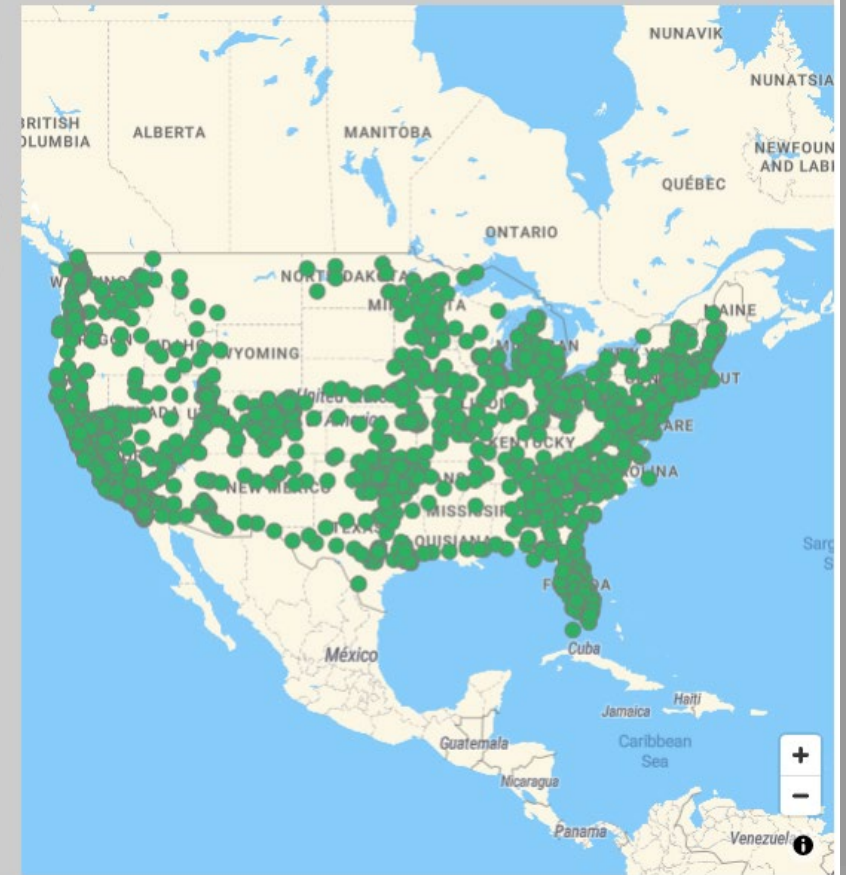
Starting Station

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

Ending Station

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

☐ Advanced Route Preferences



[fhwa.dot.gov/environment/alternative\\_fuel\\_corridors/](https://fhwa.dot.gov/environment/alternative_fuel_corridors/)



# Electricity Pages

Basics, benefits and considerations, stations, infrastructure development, vehicles, and more!

[afdc.energy.gov/fuels/electricity](https://afdc.energy.gov/fuels/electricity)

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Alternative Fuels Data Center

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LOCATE STATIONS

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Tools

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Home

EERE » AFDC » Fuels & Vehicles » Electricity

Printable Version

Electricity Basics

Benefits & Considerations


Stations

Vehicles

Laws & Incentives


## Electricity

Electricity can be used to power plug-in electric vehicles (PEVs), including both [all-electric vehicles](#), also called battery-electric vehicles, as well as [plug-in hybrid electric vehicles](#). These vehicles can charge their batteries by drawing electricity directly from the grid and other off-board electrical power sources. In contrast, [hybrid electric vehicles](#) are fueled with liquid fuels, like gasoline, but use small batteries to recapture energy otherwise lost during braking (ultimately boosting fuel economy). PHEVs can use off-board electricity for power, which classifies them as a PEV, but can also use liquid fuels and operate similar to a HEV if necessary. Using electricity to power vehicles can have significant energy security and emissions benefits.




**Basics** ▶

Find information about using electricity to power vehicles, including production and distribution, and research and development.




**Benefits and Considerations** ▶

Explore the benefits and considerations of using electricity to power vehicles.



**Stations** ▶

Locate electric charging stations in your area and learn about charging infrastructure for PEVs.




**Vehicles** ▶

Learn about hybrid and plug-in electric vehicles and how they work, and find information about vehicle availability, conversions, emissions, batteries, deployment, maintenance, and safety.

**Fuel Prices** ▶

Find electricity prices and trends.



Download the Alternative Fuel Price Report



# Charging Infrastructure Procurement & Installation

Link to EVTIP resources

[afdc.energy.gov/fuels/electricity\\_infrastructure\\_development](https://afdc.energy.gov/fuels/electricity_infrastructure_development)

## Electricity Basics

### Benefits & Considerations

### Stations

#### Locations

#### Infrastructure Development

#### - Procurement & Installation

#### - Operation & Maintenance

#### - Charging at Home

#### - Multi-Unit Dwelling Charging

#### - Charging in Public

#### - Workplace Charging

#### - Signage

### Vehicles

### Laws & Incentives

## Charging Infrastructure Procurement and Installation

A variety of options for plug-in electric vehicle (PEV) charging infrastructure exist, thereby creating a multifaceted infrastructure procurement process. In addition to typical infrastructure considerations like cost, regulations, safety, siting, and type of equipment, installing charging infrastructure can involve complex payment structures, data collection, ownership models, parking, and signage requirements. Some organizations may also need to issue a formal solicitation, such as a request for proposal (RFP). See the Infrastructure Development Checklist for important factors to consider when selecting and procuring charging infrastructure.

For examples of how other organizations have completed the charging infrastructure procurement process, see the following case studies.

- [Public Charging Procurement Case Study: Colorado Energy Office: EV Fast-Charging Corridor Grant Program](#)
- [Multi-Unit Dwelling Charging Procurement Case Study: Green Rock Apartments](#)

### Identify the Need


An initial action in the charging infrastructure procurement process is to identify potential users (i.e., plug-in electric vehicle (PEV) drivers). It is important to understand their expected charging needs based on travel patterns, PEV ownership, amount of time it may take to charge the vehicle battery, and the number and type of PEVs expected to be served at each location. This type of information can help better determine the number and type of charging infrastructure required for the project.

The [EVI-Pro Lite tool](#) can also provide an informed estimate of the quantity and type of charging infrastructure necessary to support regional adoption of electric vehicles by state or city/urban area.

### Cost Considerations

Another important consideration is to determine the cost associated with the required charging needs. This includes equipment, installation, and [operation and maintenance](#) (including electricity, demand charges, and any annual charging network fees).

#### Equipment

Equipment costs may vary based on factors such as application, location, [charging level](#), and type. Single connector [unit costs](#)  range from \$300 to \$1,500 for Level 1, \$400 to \$6,500 for Level 2, and \$10,000 to \$40,000 for DC fast charging. When choosing charging infrastructure,

### Infrastructure Development Checklist

- ✓ Determine project scope, budget, funding mechanism, and timeline using the following considerations
- ✓ Determine ideal project site, based on [existing infrastructure](#) and [infrastructure needs](#)
- ✓ Determine the number, type(s), and costs of [charging equipment](#) needed, typically:
  - [Workplaces](#) and [multi-unit dwellings](#) should consider Level 1 and Level 2 charging
  - [Public](#) charging hosts should consider Level 2 and DC fast charging
- ✓ Decide whether the stations will need to be networked, including if utilization data will be collected and if payment capabilities are necessary
- ✓ Determine if a formal solicitation is needed
- ✓ Choose a network and/or charging infrastructure manufacturer and provider
- ✓ Identify installation needs and costs, including upgrades to electrical wiring, and find a certified [electrical contractor](#)
- ✓ Obtain required permits
- ✓ Determine additional site needs, including signage and security
- ✓ Identify project partners, including electric utilities and [Clean Cities coalitions](#)
- ✓ Assess charging infrastructure maintenance and operation needs and costs

# Highlight: Electricity Handbooks

- Fleet Managers
- Workplace Charging Hosts
- Public Charging Hosts
- Consumers

*[afdc.energy.gov/publications/](https://afdc.energy.gov/publications/)*

U.S. DEPARTMENT OF  
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Renewable Energy

## Plug-In Electric Vehicle Handbook for Fleet Managers



U.S. DEPARTMENT OF  
**ENERGY** | Energy Efficiency &  
Renewable Energy

## Plug-In Electric Vehicle Handbook for Workplace Charging Hosts



U.S. DEPARTMENT OF  
**ENERGY** | Energy Efficiency &  
Renewable Energy

## Plug-In Electric Vehicle Handbook for Consumers



U.S. DEPARTMENT OF  
**ENERGY** | Energy Efficiency &  
Renewable Energy

## Plug-In Electric Vehicle Handbook for Public Charging Station Hosts



# Fuel Economy

FuelEconomy.gov

U.S. DEPARTMENT OF  
**ENERGY**

Office of ENERGY EFFICIENCY  
& RENEWABLE ENERGY

United States  
Environmental Protection  
Agency

[www.fueleconomy.gov](http://www.fueleconomy.gov)  
the official U.S. government source for fuel economy information

Mobile Español Site Map Links FAQ Videos

[Find a Car](#) [Save Money & Fuel](#) [Benefits](#) [My MPG](#) [Advanced Cars & Fuels](#) [About EPA Ratings](#) [More](#)



## 2020 Fuel Economy Estimates Now Available!

Includes plug-in hybrid and electric vehicles  
Fuel economy leaders for each vehicle class  
More vehicles added weekly

### Find & Compare Cars



- Compare Side-by-Side
- Power Search
- Find-a-Car App

### My MPG



- Calculate or Share Your MPG
- Estimates from Drivers Like You
- Enter Your MPG at the Pump

### Save Money



- Gas Mileage Tips
- Fuel Cost Calculator
- Find the Cheapest Gas

### Hybrids & Electrics



- Hybrids
- Plug-in Hybrids
- All-Electric Vehicles

### Calculators and Other Tools

- Fuel Savings Calculator
- Trip Calculator

### New on fueleconomy.gov...

- 2020 Fuel Economy Guide
- 2020 Fuel Economy Data

### Quick Picks

- Find a Car App for Apple and Android

### Related Links

- VW, Bentley, Audi and Porsche MPG Estimates Revised



# Training, Outreach & Partnerships

- Propane Education & Research Council
- NGVAmerica
- National Biodiesel Board
- Renewable Fuels Association
- California Fuel Cell Partnership
- NTEA



## Clean Cities University Workforce Development (Intern) Program





# Technical & Problem Solving Assistance



## Technical Response Service

- **First-level** resource for stakeholders, consumers, and others
- Research and response to general inquiries
- Help with challenging questions
- Education for legislators and government officials.

*TechnicalResponse@icf.com, 800-254-6735*

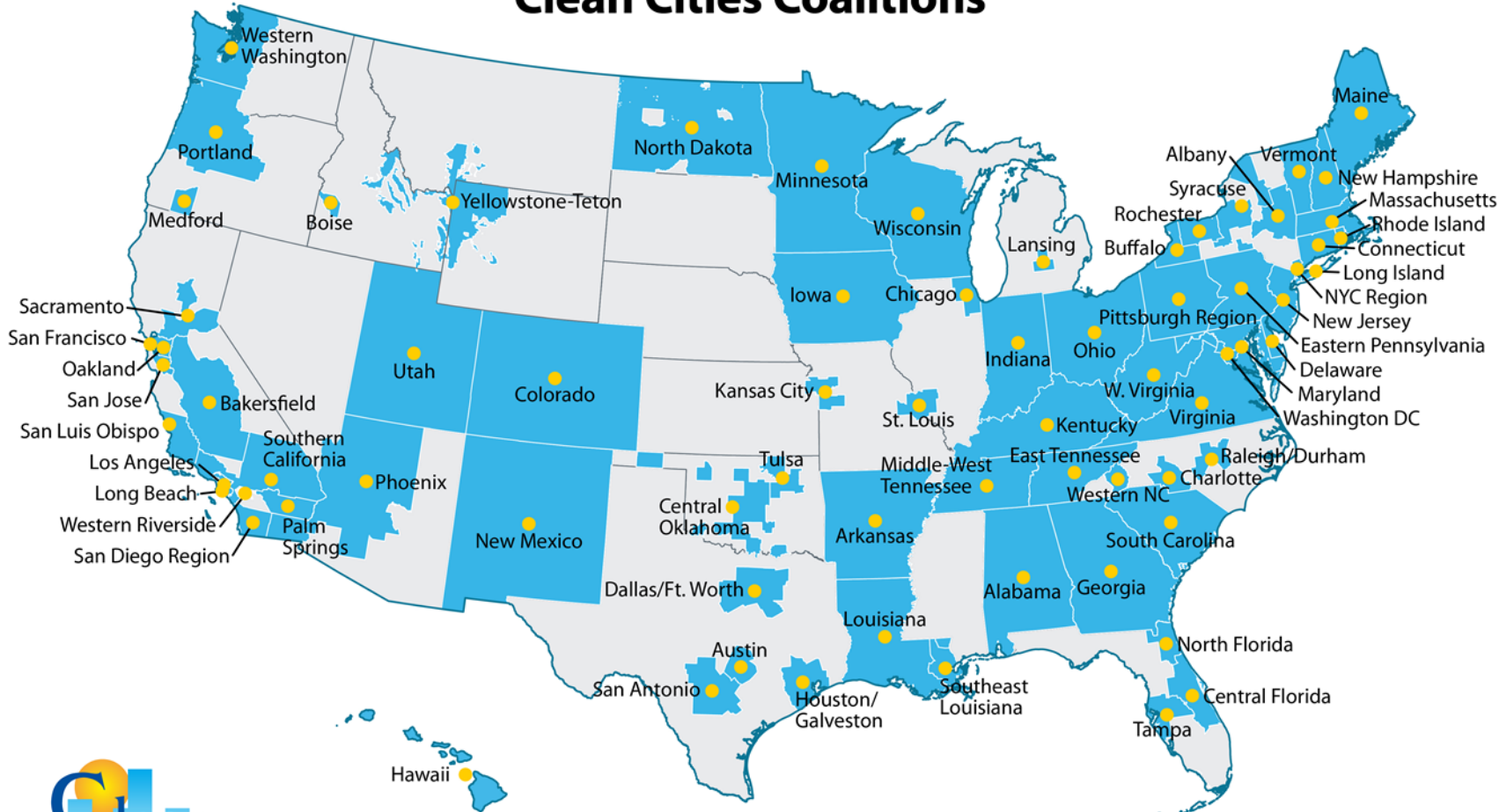


## Tiger Teams

- **Second-level** resource for coordinators, stakeholders, and others
- Expert technical problem-solving to overcome obstacles
- Assistance on barriers that challenge local resources
- Help at any point in the project/product life cycle (concept, development, execution, operation/maintenance, closure)

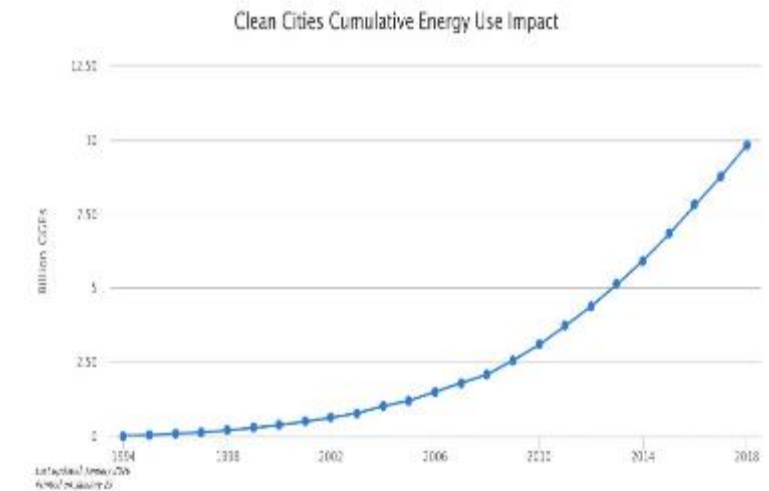
# More than 75 Clean Cities coalitions with thousands of stakeholders, representing ~80% of U.S. population

## Clean Cities Coalitions



## Clean City Coalition Results

- Since 1993, the cumulative energy impact of Clean Cities coalition activities has surpassed 9.8 billion GGEs through alternative fuel use, fuel economy improvements, idle-reduction measures, and other strategies
- In 2019, nearly 1 million of the AFVs in operation were a result of Clean Cities coalition efforts.



U.S. Department of Energy

# VT0 Technology Integration Competitive Project Funding

VT0 has funded over 600 Technology Integration projects and distributed nearly \$500 million since 1993



**Living Labs for  
Energy Efficient  
Transportation**



**AFV Adoption  
Through  
Partnerships**



**AFV Safety  
Training**



**Rural New  
Mobility  
Solutions**



**EV Community  
Partner Projects**

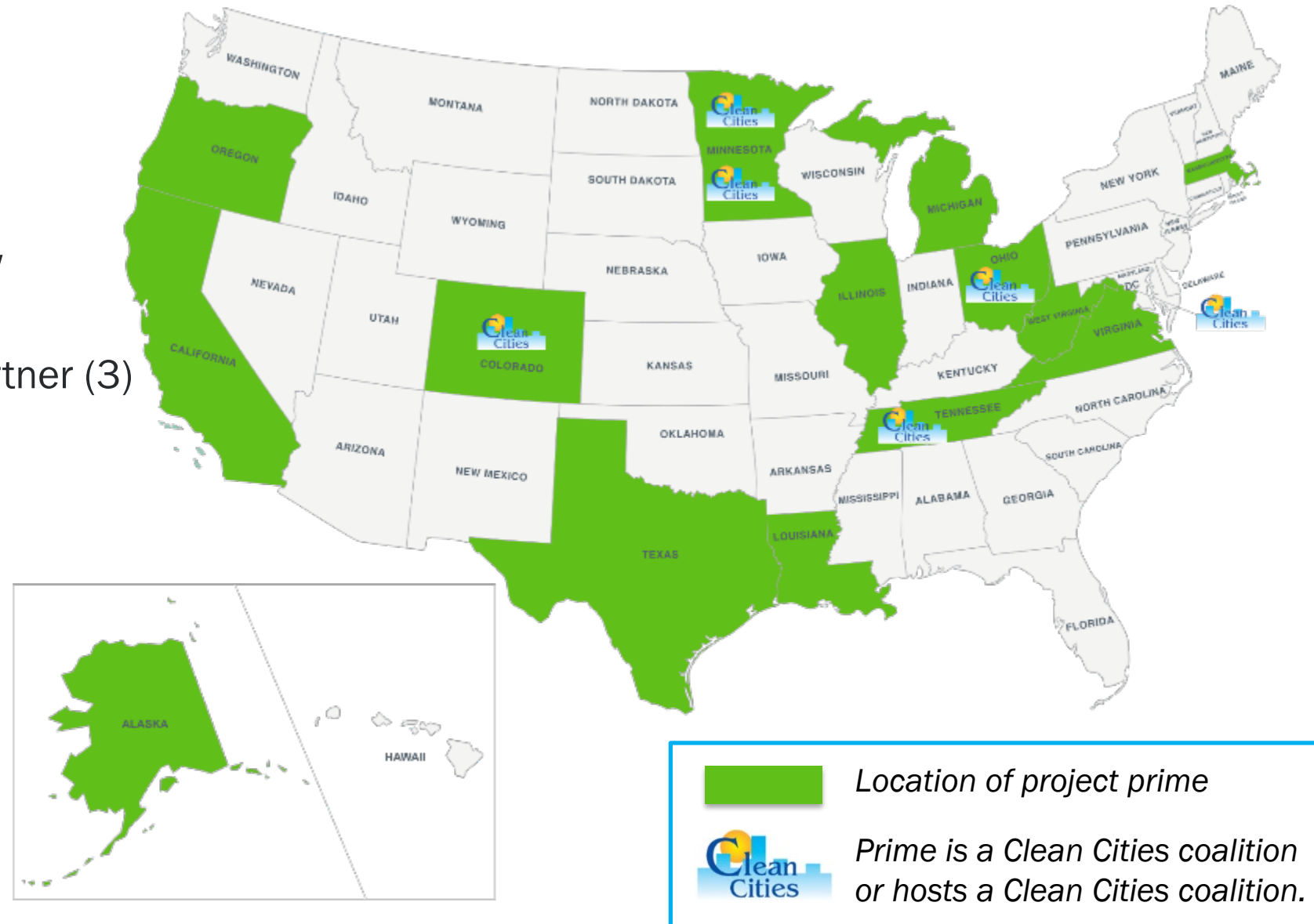


**AFV Data  
Collection  
and Analysis**

# FY20 TI Awards: \$37M for 18 Projects

## Topic Areas and # of Projects

- Gaseous Fuels Technology Demonstration (2)
- Alt. Fuel Proof-of-Concept in New Communities and Fleets (8)
- EV and Charging Community Partner (3)
- TI Open Topic Projects (5)





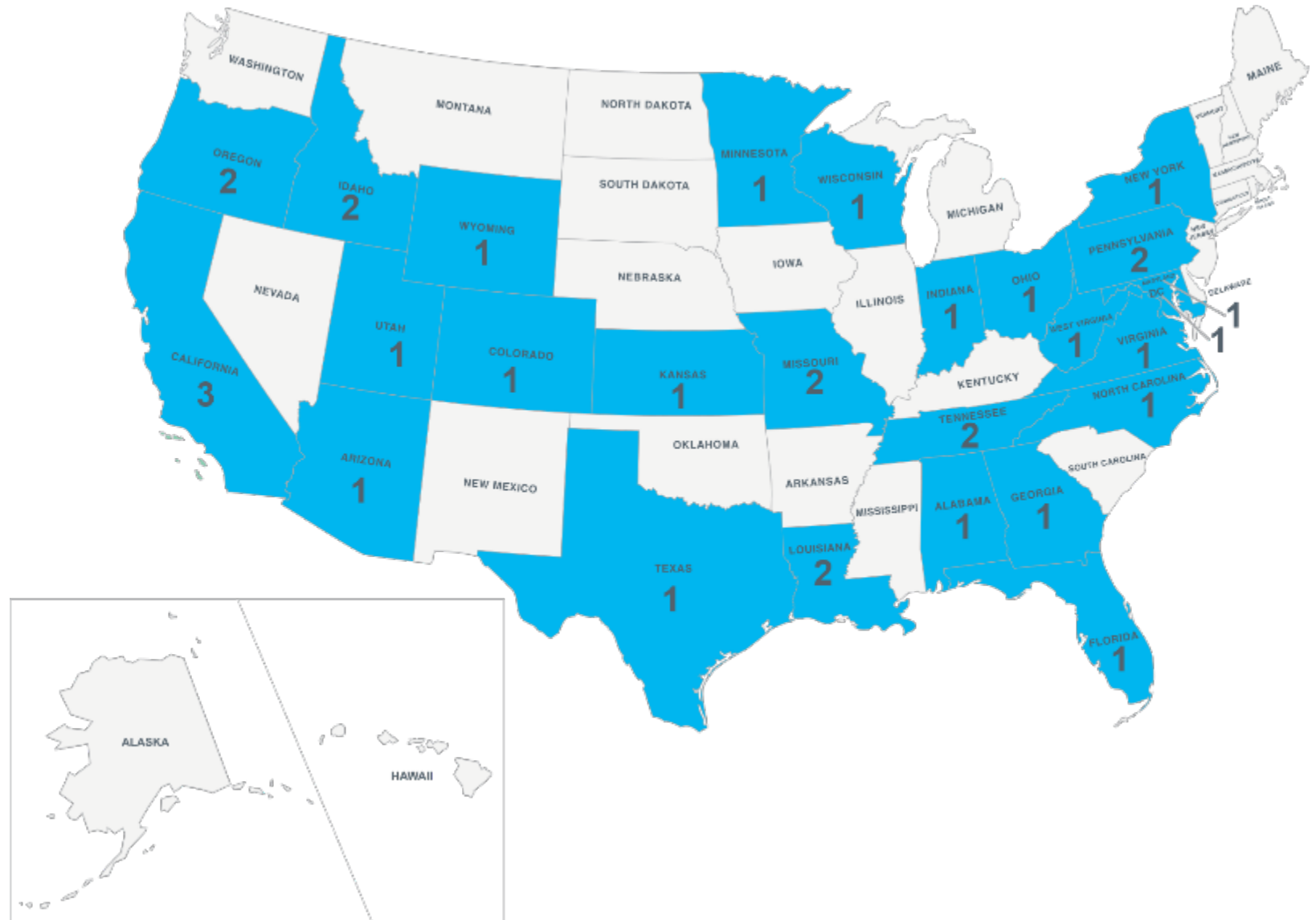
# Clean Cities Coalitions Involved in FY20 TI Awards



U. S. Department of Energy

Clean Cities coalitions will play a key role in the success of these awards.

- 32 Clean Cities Coalitions involved in projects\*
- Representing 26 States



*\*Based on pre-negotiated project information. Project partners may change.*



# THANK YOU

**Mark Smith,**  
**Program Manager, Technology Integration**  
[Mark.smith@ee.doe.gov](mailto:Mark.smith@ee.doe.gov)

afdc.energy.gov  
cleancities.energy.gov  
fueleconomy.energy.gov