The impact of electric vehicles on climate change

Will the adoption of EVs accelerate fast enough for the U.S. to achieve a net-zero economy by 2050?

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Executive summary

The stage is set for significant electric vehicle (EV) growth in the coming decades, but even the most optimistic scenarios bring dramatic plot twists.

The Biden administration has **set a goal** for the U.S. economy to achieve net-zero greenhouse gas (GHG) emissions by 2050. Achieving that goal will require a nationwide transition to EVs and clean energy.

Within this report, the ICF Climate Center offers insights grounded in data-driven projections of likely EV adoption scenarios. This report identifies ways for federal, state, and local leaders and utilities to incorporate EVs as a strategy to achieve GHG emissions reduction targets and prioritize equity while maintaining power reliability.

Using ICF's CO_2Sight platform, we present integrated scenarios for the nation and two groups of states—those with existing targets and plans to drive EV and clean energy adoption and those that do not have public EV commitments. Our analysis reveals four critical impacts for consideration by public sector and utility leaders at all levels.

1. **The U.S. is not currently on track to achieve a net-zero transportation sector by 2050.** Existing state-level EV policies would only lead to a 27% decline in 2050 on-road transportation GHG emissions compared to 2020.

2. **Ambitious nationwide EV adoption would significantly reduce on-road transportation GHG emissions,** but an electric grid powered primarily by clean energy is required to get closer to net-zero emissions.

   A national transition to 100% EV sales could reduce GHG emissions from on-road transportation by 67% by 2050 compared to 2020. The same level of EV adoption could reduce emissions by up to 82% if those EVs were charged from an electric grid powered primarily by clean energy.

3. **Rapid EV adoption could impact electric grid reliability.** EV charging needs could add 2,000 TWh to annual energy demand in 2050, a 40% increase from Business-as-Usual projections. Depending on when EVs charge, they could add up to 450 GW to nationwide peak demand by 2050. Managed charging can help mitigate the peak impact by shifting charging to off-peak hours or aligning with periods of excess renewable generation.

4. **EV adoption is on track to progress at different rates regionally.** Only about a third of U.S. states have aggressive EV goals but achieving a net-zero transportation sector by 2050 will require aggressive EV adoption in all states.

The future of EVs across the country

While EV adoption is surging, reaching many goals set by automakers and policymakers will require extensive changes that go far beyond just the vehicles on the road. The transformation will be felt across auto-manufacturing facilities and processes, the type and location of infrastructure used to fuel our vehicles, and power generation, transmission, and distribution systems.

EV market growth

EVs are poised to play a leading role in on-road transportation in the coming decades. Across the U.S., EV sales more than doubled in 2021 compared to 2020, surpassing half a million despite supply chain issues related to the COVID-19 pandemic. EVs now account for 4.5% of U.S. car sales. In sheer numbers, LDV EV adoption will outpace MDV and HDV adoption due to greater availability of purchase options. Many types of MDV and HDVs don't even have EV models available yet, but that's beginning to change as battery costs fall and demand from fleets increases.

Key terms

Internal combustion engine (ICE) vehicles: ICE vehicles burn fossil fuels within an engine to power the vehicle and are a source of carbon monoxide, nitrogen oxides, hydrocarbons, and particulate matter, depending on the type of fuel.

Zero-emission vehicles (ZEVs): ZEVs are cars, trucks, and buses that emit no CO_2 through their tailpipe. Examples include EVs and hydrogen fuel-cell vehicles, among others.

Electric vehicles (EVs): EVs are a type of ZEV powered by electricity. This report focuses exclusively on on-road battery electric vehicles (as opposed to hybrid EVs) and does not include other ZEVs.

Light-duty vehicles (LDVs): Passenger cars and pick-up trucks are LDVs. They account for 96% of vehicles and 68% of CO_2 emissions on the road today.

Medium-duty vehicles (MDVs): Box trucks and shuttle buses are examples of MDVs.

Heavy-duty vehicles (HDVs): HDVs are the heaviest vehicles on the road. They include buses and tractor trailers and typically have diesel engines. MDVs and HDVs make up just 4% of vehicles on the road but account for 32% of on-road CO_2 emissions.

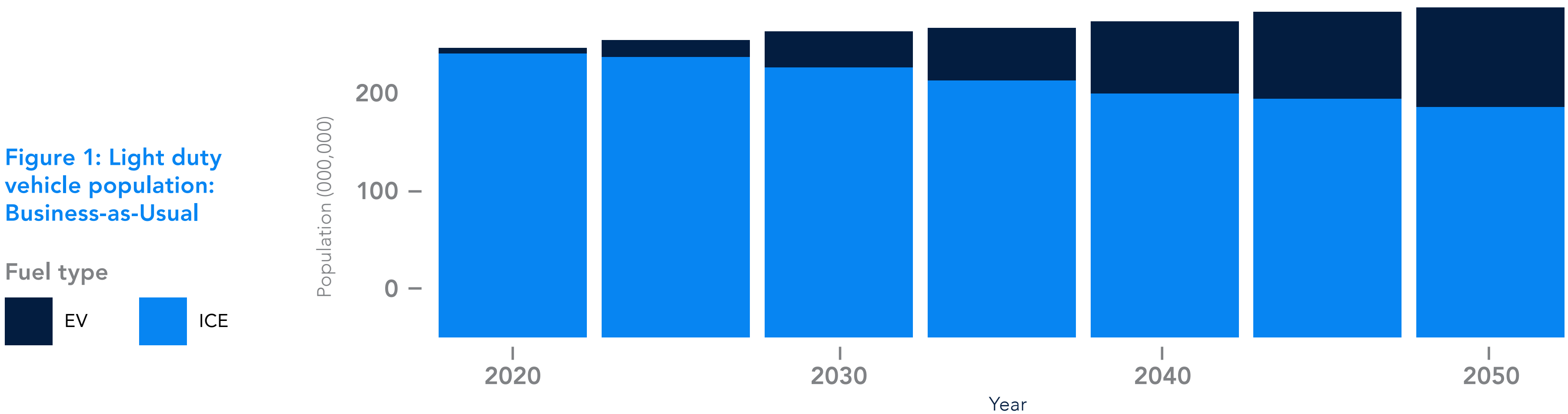
Clean electricity grid: In this report, a clean grid is defined as a net-zero power sector in which GHGs going into the atmosphere from the power sector are balanced by removal out of the atmosphere.

Demand response: Programs that encourage customers to reduce energy during critical periods of peak demand, including through paid incentives.

Time-of-use (TOU) rates: Electricity prices that vary throughout the day based on the cost of supplying electricity. For example, rates would decrease late at night because electricity consumption is usually low at that time.

The EV market at the national level appears, at a minimum, to be headed to 22% of LDV sales by 2050, according to the National Renewable Energy Laboratory's reference case estimate. There are about 275 million registered vehicles in the United States today and the baseline population growth assumes an increase to about 310 million vehicles on the road by 2050. This Business-as-Usual projection would result in electric cars comprising about 30% of the on-road LDV population in 2050.

Figure 1: Light duty vehicle population: Business-as-Usual



Automakers and policymakers have more ambitious goals. The "Big Three" U.S. automakers—Ford, General Motors, and Chrysler parent Stellantis—jointly announced they expect 40%-50% of their new sales in the U.S. to be electric models by 2030, while EV-only automakers like Tesla continue to grow in popularity. The Biden Administration has set a goal for 50% of all new vehicle sales in the U.S. to be ZEVs by 2030 as part of a broader target for the U.S. economy to achieve net-zero GHG emissions by 2050.

The Nationwide EV Policy scenario envisions the potential for LDVs and MDV/HDV sales to be 100% electric by 2035 and 2050, respectively. Under this aggressive EV adoption scenario, EVs could grow from less than 3 million vehicles on the road today to 265 million by 2050, or 86% of all vehicles in 2050.

Understanding EV scenarios[1]

This analysis presents six different scenarios of EV adoption that leverage ICF's CO_2Sight data. The scenarios model increasingly aggressive decarbonization policies at both the state and national level for the on-road transportation and electric power sectors.

The "Business-as-Usual" scenario models current state-level ZEV and clean electricity policy targets. For states without ZEV sales targets, EV adoption follows the National Renewable Energy Laboratory Reference Case projection, which reaches LDV ZEV sales of 22% by 2050.

The "Moderate State Policies" scenario layers in the ZEV sales targets that 15 states and Washington, D.C., recently agreed to work toward when they signed the Memorandum of Understanding (MOU) on Zero-Emission Medium- and Heavy-Duty Vehicles. Most ZEV targets to-date have focused on LDVs, but this MOU sets a goal of 30% ZEV sales for MDVs and HDVs by 2030 and 100% by 2050. All the MOU signatories also have clean energy policies in place, half of which are targets for a 100% clean electricity grid. As such, the MOU signatories are used as a proxy for a future where state-level action continues to dominate without any significant policies at the national level to decarbonize the transportation and power sectors.

The "Expanded State Policies" scenario assumes the MOU signatories adopt a similarly aggressive policy for LDV electrification, reaching a 100% sales target by 2050. State EV and clean electricity policies remain unchanged from today for non-MOU signatory states.

The "Nationwide EV Policy" scenario includes an aggressive national ZEV sales mandate across all categories: 100% sales by 2035 for LDVs and 100% sales by 2050 for MDVs and HDVs. State clean electricity policies remain unchanged from today.

The "Nationwide EV + 2035 Energy Policies" scenario mimics the Nationwide EV Policy scenario but adds a national clean electricity policy for a net-zero power sector by 2035, which is aligned with the Biden administration's goal.

The "Nationwide EV + 2050 Energy Policies" scenario mirrors the Nationwide EV Policy scenario but adds a national clean electricity policy for a net-zero power sector by 2050.

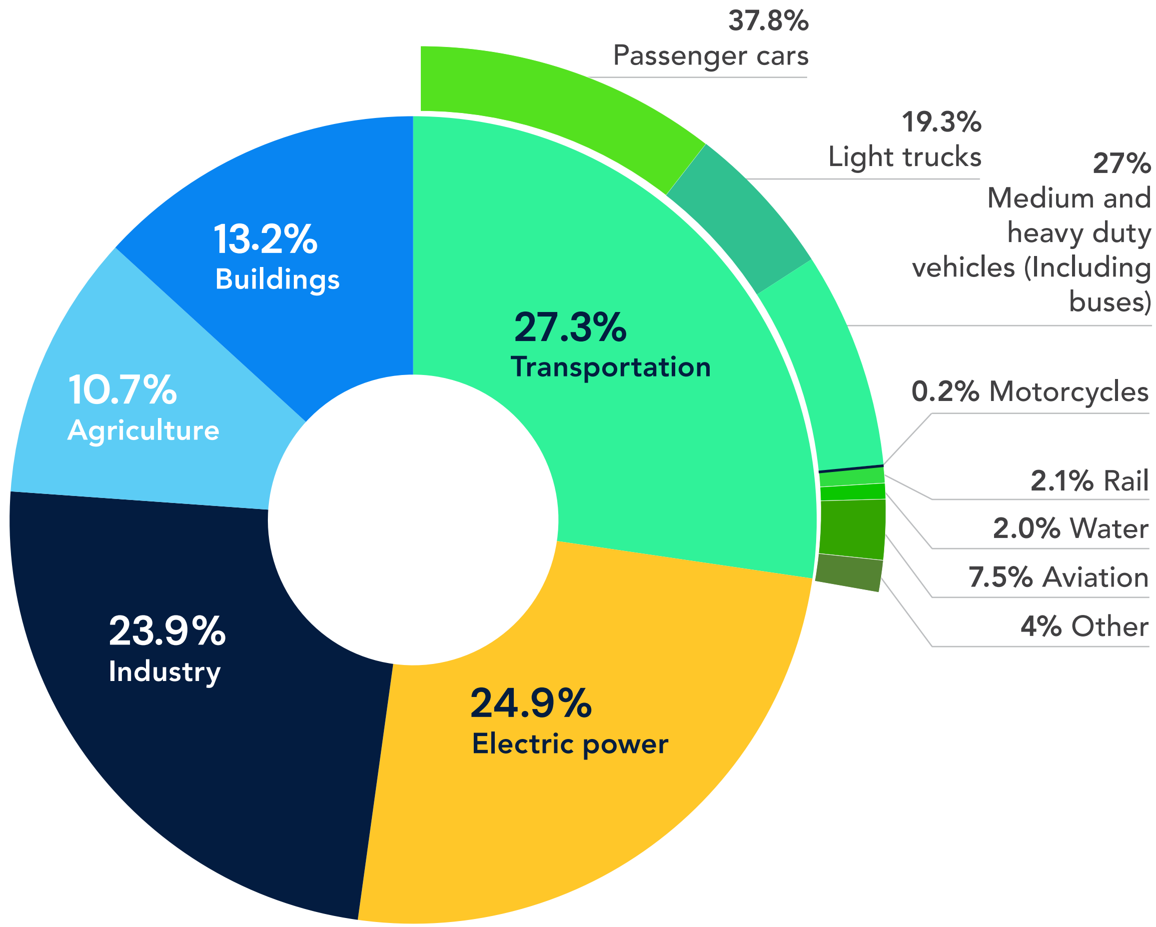
[1] All national fleet and activity data for the baseline scenario projection is based on data in US EPA's MOVES3 model. The default MOVES3 fleet is modeled for the 48 continental US states plus the District of Columbia, with results at a national scale. The baseline fleet uses MOVES' default values of VMT, vehicle age distribution, and population by MOVES vehicle types, which are combined into the reported vehicle types of light-duty and medium/heavy-duty. ICF's CO_2Sight fleet turnover modeling varied the level of EV adoption only; total population and VMT remain the same in each scenario. Emission calculations for the embedded CO_2e in EV charging were calculated with emission factors from an integrated CO_2Sight power sector modeling scenario. The scenarios were modeled in IPM and included the impact of EV charging on energy and peak for each scenario. This study uses Battery Electric Vehicles (BEVs) as a marker for zero emission technologies, as we anticipate the market for most ZEVs will be addressed through EVs. Also, for simplicity, it substitutes EVs for traditional vehicles (internal combustion engine vehicles) on a one-to-one basis. A clean electricity grid is defined as a net-zero power sector. Carbon capture and sequestration is allowed under this definition, although it only removes 90% of carbon emissions from natural gas generators. Other eligible resources include wind, solar, hydro, and nuclear, among others. The analysis for this report was completed in March 2022, just prior to Nevada Governor Steve Sisolak announcing he had signed the MOU on Zero-Emission Medium- and Heavy-Duty Vehicles, bringing the total number of continental US states that have signed the MOU to 16 and the District of Columbia.

Greenhouse gas emissions changes

The transportation sector is the largest contributor of GHG emissions in the United States, and on-road vehicles produce the majority of those emissions.

Figure 2: 2020 U.S. GHG inventory

Figure 2: Shows the breakdown of 2020 U.S. GHG Emissions by sector, with transportation representing the largest share of emissions. Within the transportation sector, on-road vehicles comprise the vast majority of emissions and are a primary focus for the sector's decarboinzation efforts. (Environmental Protection Agency).



At any level, the impact of EV adoption on GHG emissions from the transportation sector is dramatic, as illustrated by Figure 3. Even in the Business-as-Usual scenario, GHG emissions decline 27% by 2050 from 2020. In the Moderate State Policies scenario, emissions fall 31% in 2050 compared to 2020. The aggressive EV adoption in the Nationwide EV Policy scenario reduces emissions 67% by 2050 from 2020.

U.S. GHG Inventory gross emissions; does not include U.S. Territories. In 2020 transportation emissions significantly decreased as a result of the COVID-19 pandemic. It is expected transportation emissions, and the share of transportation emissions will likely increase in the near-term.

Charging EVs with clean electricity is critical to GHG reduction–without that piece, total transportation sector emission reductions by 2050 are limited to 67% for on-road vehicles compared to 2020. Clean electricity minimizes the emissions impact of charging and could result in an 80%-82% decline in GHG emissions (figure 3).

Figure 3: Transportation sector total national GHG emissions

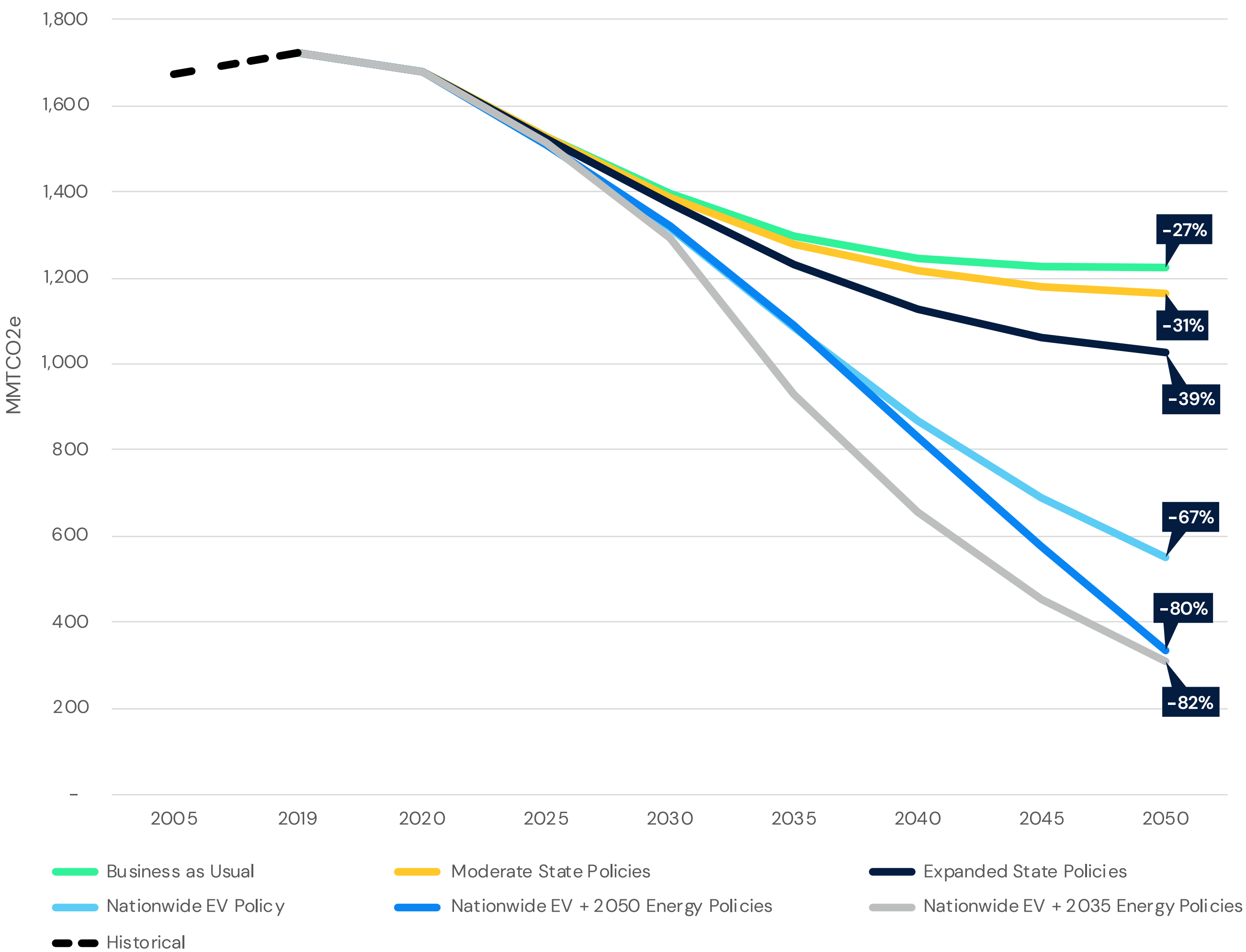


Figure 3 shows 2020-2050 projections of national on-road transportation sector GHG emissions in the six modeled scenarios. The emissions shown cover all fuel types for ICE vehicles as well as EVs. Power sector GHG emission-factor projections were used to determine the implied emissions from vehicle charging.

Why focus on EVs?

This report paints a national and regional picture for EV adoption and related electricity and emissions impacts in the coming decades, relying on data and insights from ICF's strategic decarbonization planning platform CO_2Sight. EVs are a proven technology and represent the highest percentage of ZEVs on the road today.

EVs are distinct from other ZEVs such as hydrogen fuel-cell vehicles, which are an earlier-stage technology and therefore not considered in this report. Other modes of transportation, from trains to airplanes, are also excluded from this report because on-road vehicles account for the highest level of GHG emissions in the transportation sector – 84%. Put another way, rapid and widespread EV adoption is essential to achieving national GHG emission reduction goals.

Figure 4: Percentage change in 2050 emissions compared to Business-as-Usual

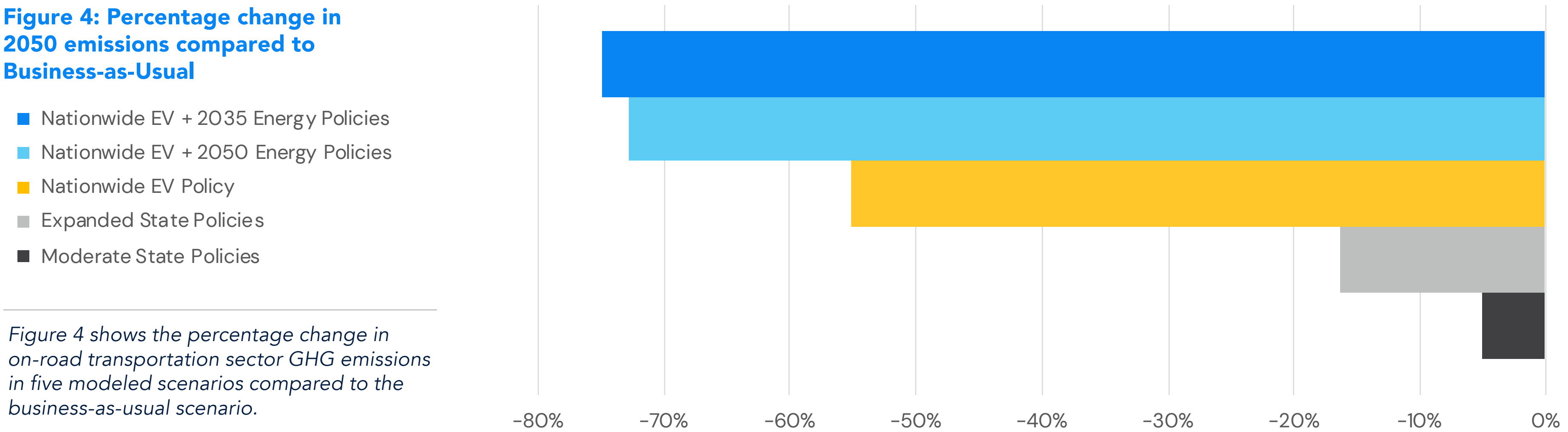


Figure 4 shows the percentage change in on-road transportation sector GHG emissions in five modeled scenarios compared to the business-as-usual scenario.

Even without a national clean electricity supply, increasing the share of EVs on the road results in overall GHG emission reductions. For example, transportation GHG emissions in the Nationwide EV Policy scenario are 55% lower in 2050 relative to the Business-as-Usual scenario (Figure 4), but emissions from electricity generation are 22% higher due to the increased demand from EV charging (Figure 5). This power sector emissions increase is due to additional generation from resources such as natural gas to meet EV charging demand. Combined, the two sectors realize an overall reduction of 20% by 2050 relative to Business-as-Usual. That reduction could reach nearly 70% if national clean electricity is realized.

The Nationwide EV scenario combined with a clean electricity supply shows how a decarbonized power sector could help further reduce overall emissions. Combined emissions from the power and transportation sectors are 57%-66% lower in 2050 with a clean electricity grid, compared to a scenario with the same level of EV adoption but without a national clean electricity supply (Figure 5).

Figure 5: Cumulative change in transportation emissions by 2050 compared to Business-as-Usual

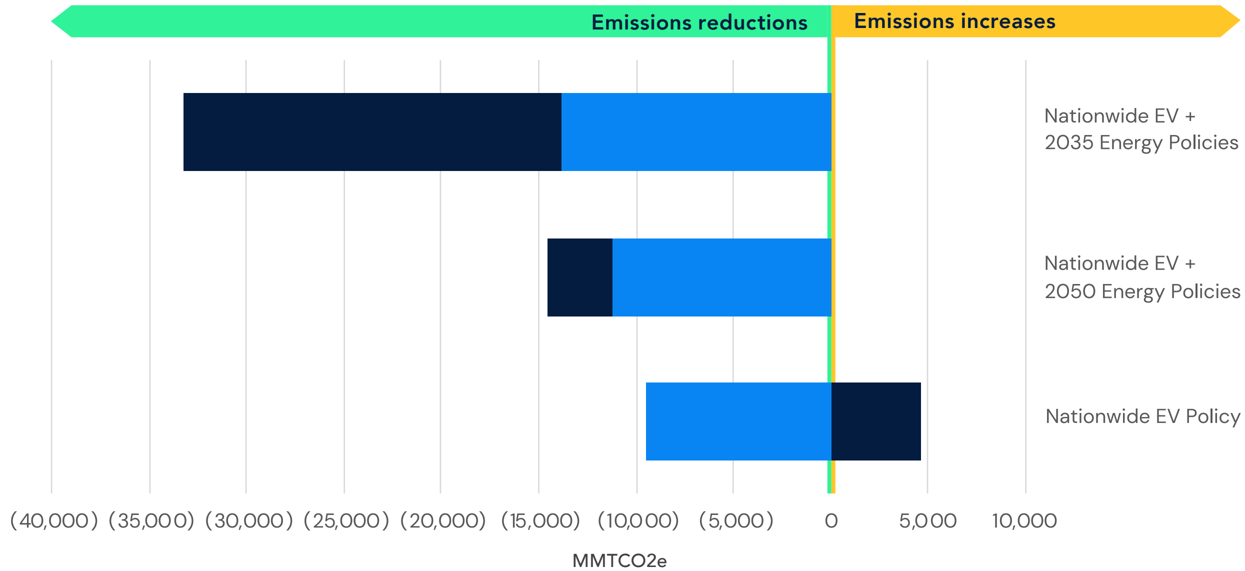


Figure 5 shows that increasing EV adoption shifts some of the GHG emissions from on-road vehicles to the power sector that continues to burn fossil fuels. Deep reductions in GHG emission are only possible with both high EV adoption and a grid powered primarily by clean energy.

Figure 6: National load impact: incremental transportation electricity demand compared to Business-as-Usual

Electric grid impacts

In the Nationwide EV Policy scenario, national electricity demand increases 40% by 2050 compared to the Business-as-Usual scenario, adding about 2,000 TWh of load from EV charging. Even the Moderate State Policies and Expanded State Policies scenarios result in electricity demand increasing 13% and 17%, respectively, from the Business-as-Usual scenario by 2050.

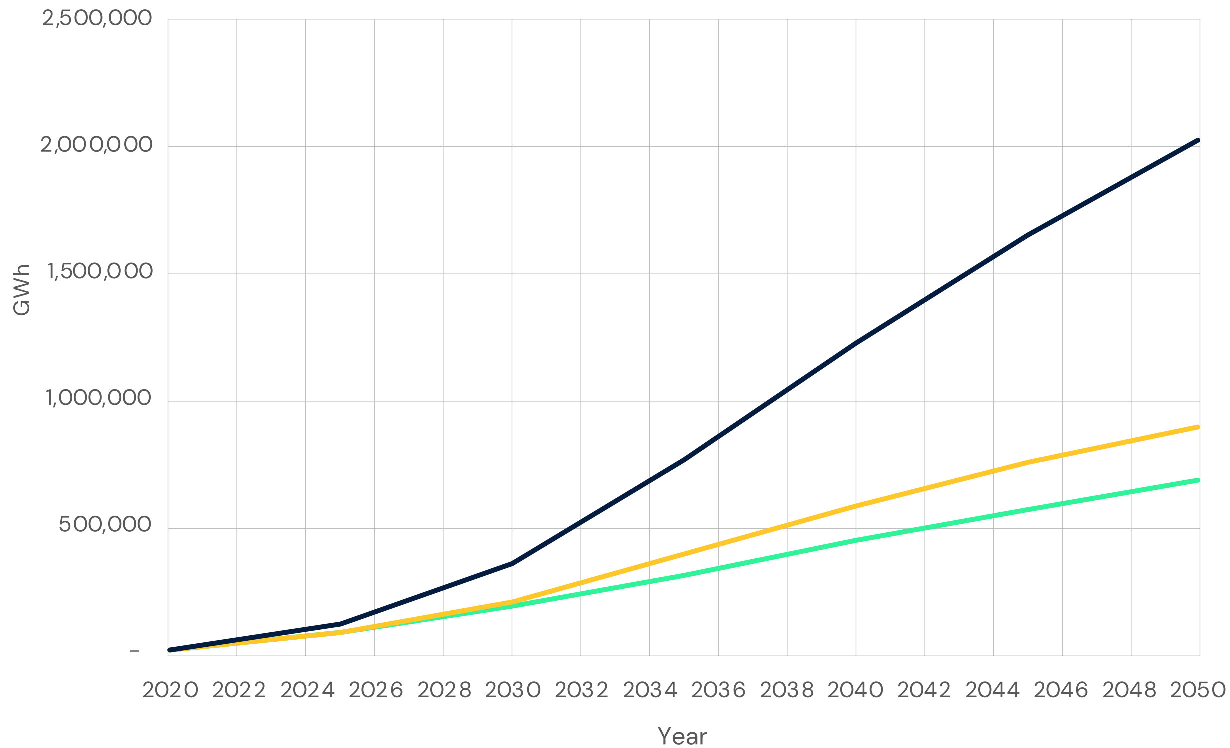


Figure 6 shows the incremental impact on national annual electricity demand from EV charging.

The amount of electrification—and when it impacts the grid—will have significant implications for utility reliability planning and grid infrastructure development. This peak hour impact is especially critical for EV charging behavior, which if unmanaged could add nearly 450 GW per hour to peak demand in the late afternoon, at the same time electric demand already peaks today with relatively few EVs on the road (Figure 7).

Unless managed, EV charging could strain the grid to the point of compromising power reliability for customers. The goal of managed charging is to mitigate these peak impacts such that EV charging occurs during periods of low demand and, preferably, high renewable generation. The definition of managed charging will change over time based on when non-emitting resources are available and when the system peak is occurring, which will shift due to electrification in the transportation and building sectors. Managed charging can also be used to minimize the use of emitting resources to meet demand.

In areas with significant solar resources, for example, EVs can be used to store excess power. EVs can also reduce charging levels in the evening when solar resources go offline to combat the phenomenon known as the duck curve: a discrepancy in timing between peak demand and high renewable supply periods, resulting in reliance on fossil-fuel emitting resources to meet the sharp increase in demand for grid power when solar becomes unavailable.

Managing the new and varied peaks due to EV charging and other end-use sector electrification will be difficult, but load flexibility strategies can play a key role in helping to provide reliable power. For example, co-locating batteries with EV chargers can help mitigate not only their impact on grid demand, but also defer transmission and distribution upgrades that may have been required for a constrained area of the grid.

EVs can also act as distributed energy generation resources by discharging electricity from their batteries to the grid (or a building) during times of peak demand. Vehicle-to-grid (V2G) is not an accessible feature in all EVs today, but there is potential for V2G to both enhance grid reliability and provide resilience by powering a local community shelter or residential home during an outage.

CO_2Sight is ICF's strategic planning platform for decarbonization and energy. Backed by ICF's 1,000+ climate and energy experts, CO_2Sight leverages publicly available, vetted data or client data for hundreds of clean energy and climate action strategies, policies, and regulations.

1 million+ ready-to-access decarbonization pathways

5 integrated energy demand and supply sectors

50 states

1 streamlined interface and platform

20+ decarbonization strategy selections

6 census regions

>3,000 counties and cities

Figure 7 illustrates the electric load impact of two EV charging profiles for the National EV Policy scenario: 100% unmanaged charging and 50% managed charging. The incremental impact from EVs on peak demand at 7 p.m. (a time of high overall system demand) is roughly 230 GW in 2050 at a 50% managed charging level, but this could increase to nearly 450 GW with a completely unmanaged charging system. In a system with high penetration of solar energy, unmanaged charging could heighten the potential for rising demand to meet or exceed falling supply at peak periods.

Figure 7: National average daily load impact patterns in 2050: Nationwide EV Policy Scenario

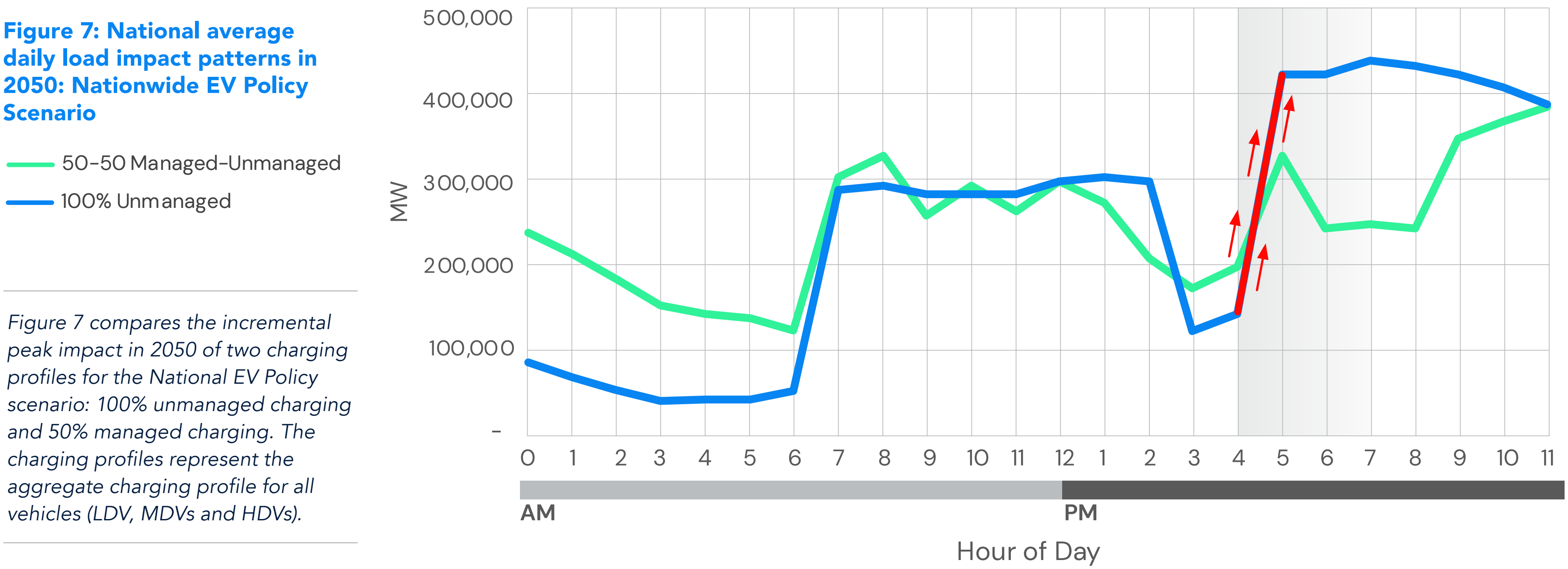


Figure 7 compares the incremental peak impact in 2050 of two charging profiles for the National EV Policy scenario: 100% unmanaged charging and 50% managed charging. The charging profiles represent the aggregate charging profile for all vehicles (LDV, MDVs and HDVs).

The added demand from EVs could also increase the use of emitting resources while the power sector transitions to reliable sources of clean energy. Meeting EV demand in the Nationwide EV Policy scenario with a clean electricity supply will require the development of about 1,000 GW of renewable energy generating capacity.

This report presents two national clean electricity scenarios with varying target years of 2035 and 2050. The main difference is that if a 2035 grid policy is established, there will only be 13 years to hit the target, rather than three decades. That has significant implications for the policy and regulatory landscape, mobilization of capital, siting and permitting, construction, and many other variables.

For example, the necessary transmission infrastructure development to support 1,000 GW of renewable deployment can take decades of financing, planning, and permitting. The technologies that may be needed (e.g., carbon capture, green hydrogen) are years away from being deployed at a large scale. As such, fully and reliably decarbonizing the grid by 2035 is a massive undertaking. Doing the same by 2050 is no easy task but provides more time to plan for overcoming current technological constraints, flexibility to adopt and develop new technologies, and offers more lead times for project development, which can take years.

Utilities, generation developers, fleet managers, regulators, and policymakers would have to work together across sectors to ensure that the grid can handle the influx of demand. This coordination would need to go beyond traditional grid planning, especially when it comes to managing the increased peak demand when customers charge their vehicles.

Equity and environmental justice progress

Increasing the number of EVs on the road can also result in significant air quality and health benefits, particularly for disadvantaged communities. These communities are disproportionally affected by the pollution emitted by ICE vehicles. Cities and highway-adjacent communities, which are often impacted by low air quality due to the volume of tailpipe emissions, will have significantly less air pollution as the nation transitions to EVs and clean energy.

The transition to electric school buses, in particular, will provide health benefits to children in these communities. Sixty percent of low-income students rely on school buses, while only 45% of higher income students rely on them. Of all the school buses in operation in the U.S., more than 90% are powered by diesel, adding to the pollutants and air quality impacts in disadvantaged communities.

These types of air quality and health benefits were assessed in a recent report by the American Lung Association (ALA), developed in partnership with ICF:

> A national shift to 100% sales of zero-emission passenger vehicles (by 2035) and medium- and heavy-duty trucks (by 2040), coupled with renewable electricity would generate over $1.2 trillion in public health benefits between 2020 and 2050. These benefits would take the form of avoiding up to 110,000 premature deaths, along with nearly 3 million asthma attacks and over 13 million workdays lost.

The ALA report used its own methodology to come to these conclusions, but scenarios analyzed were similar to the scenarios presented here (i.e., high EV sales and low or no carbon power). The ALA findings illustrate the same point as this report: EVs can deliver significant health and economic well-being benefits for Americans, especially disadvantaged communities, by reducing harmful emissions.

The chicken-and-egg challenge of EV equity

Despite the potential benefits to disadvantaged communities, there is a real risk that these benefits won't be realized without a concerted effort and investment. EV ownership today is much greater among higher-income households and in higher income communities. Even though fueling and maintenance costs for LDVs often make EVs less expensive than ICE vehicles over the lifetime of ownership, the upfront cost of EVs can be higher than ICE vehicles, making them unattainable for lower-income households. This is also true for school and transit buses in low-income districts, further limiting access to EVs in disadvantaged communities.

Cost is not the only limiting factor for equitable EV deployment. Ready access to charging infrastructure in disadvantaged communities will be a key part of the solution. President Biden has set a goal for 500,000 EV charging stations to be installed by 2030. In November 2021, Congress supported the effort to address cost barriers and significantly advance charger deployment by passing the Bipartisan Infrastructure Law, which includes $7.5 billion to support EV charging equipment and $5 billion to replace existing school buses with clean and zero-emissions models.

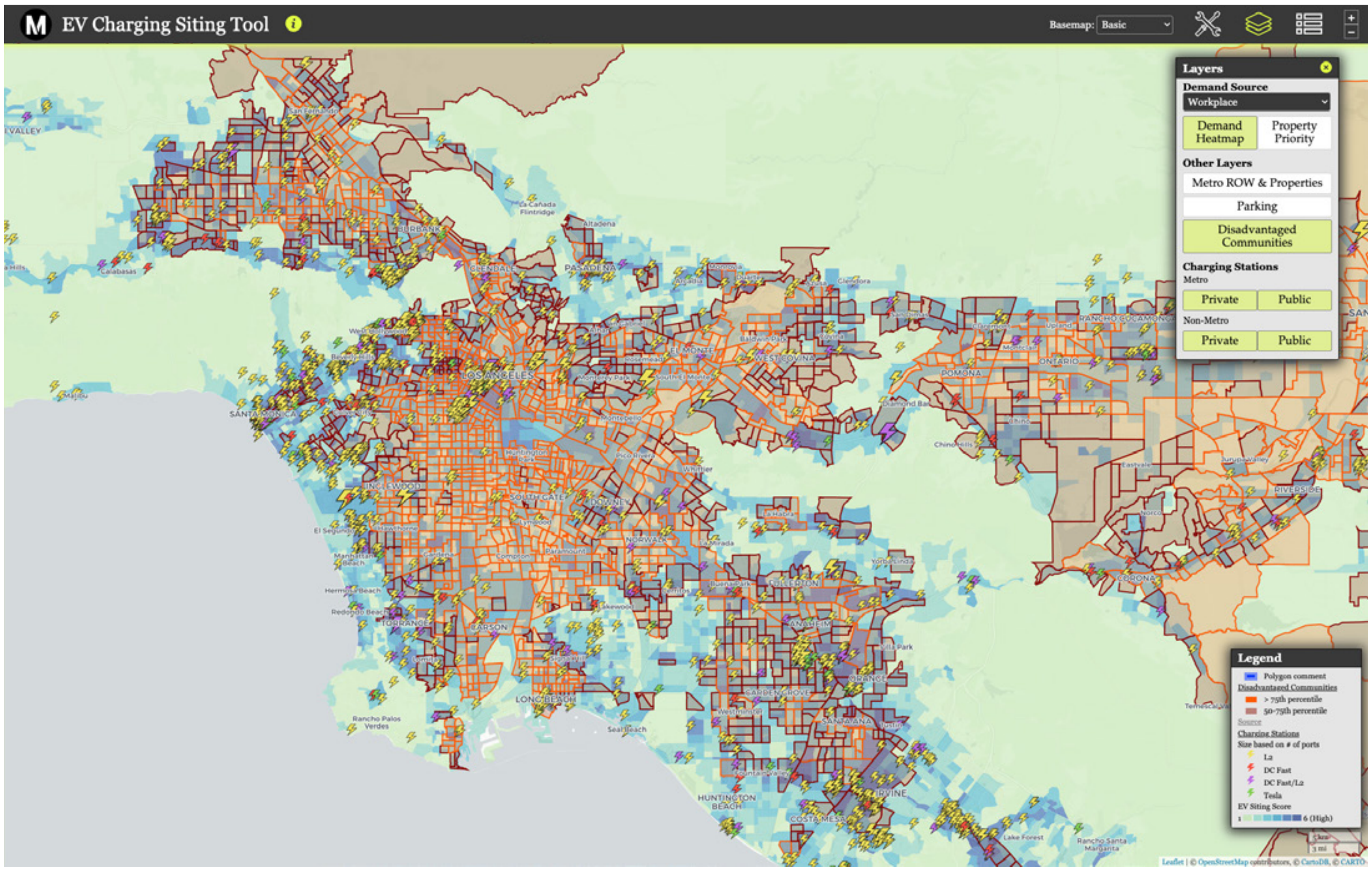
The new Joint Office of Energy and Transportation is overseeing the allocation of the charging equipment funding and the U.S. Environmental Protection Agency is allocating the bus funding through the Clean School Bus Program. Because disadvantaged communities have been the most impacted by air pollution from vehicles due to high-traffic highways built in and around them, the joint office is working with stakeholder groups to ensure funds are invested in neighborhoods that would benefit the most from emissions-free vehicles. The EPA is also looking to prioritize the replacement of buses for high-need school districts, tribal schools, and rural and low-income areas.

Federal government efforts around EV charging equity come at a critical time. In recent years, costs and the lack of EV charging are contributing factors to lower levels of EV ownership in disadvantaged communities. The analytics required to unpack these problems and solutions go beyond the scenario modeling presented in this report and require a more granular look at the unique context and characteristics of communities. ICF's work with the Los Angeles County Metropolitan Transportation Authority (Metro) illustrates this point.

ICF created an interactive EV charging demand map of the Los Angeles metropolitan region to help prioritize and site EV charging infrastructure. For the most part, the location of EV charging stations aligns with the areas where high demand for chargers is likely in the coming years. This sounds reasonable; EV chargers should exist in proximity to EVs. However, current projections for EV ownership and charger demand shouldn't be the only determining factors when deciding on the location and quantity of charging stations to install. Large charging deserts stretch across disadvantaged communities.

Figure 8: LA County Metro interactive EV charging demand map

Figure 8 captures an image from the interactive EV charging demand map of the Los Angeles metropolitan region, which was developed to help prioritize the placement of EV chargers.



While demand for EV charging may be limited in those communities now, demand for transportation isn't. Additionally, the lack of public and private charging stations may discourage EV adoption in disadvantaged communities and limit the achievement of climate goals.

The chicken-and-egg challenge of placing chargers in disadvantaged communities with low demand is not unique to Los Angeles—nor is it the only equity challenge surrounding EVs. To be sure, addressing these challenges will require significant investments. Federal, state, and local leaders across the country will need to consider the complex challenge of unlocking EV access in disadvantaged communities, and how to pay for them, as they pursue their ambitious EV adoption goals.

It's a noteworthy sign that the federal government, state agencies, and utilities are increasingly prioritizing equity.

Guided by the federal government's Justice40 Initiative, hundreds of federal programs representing billions in annual investment are being created and transformed to maximize benefits to disadvantaged communities. Only $2.2 billion of $38.5 billion in U.S. Department of Energy spending in 2021 was aligned with Justice40 priorities. With the department's budget rising to $62 billion in 2022, 40% of spending would mean an increase to $25 billion. That sum indicates significant program funding to support equitable access to EVs. However, the devil will be in the details of local-level program design and implementation.

U.S. states are on different paths

EV adoption will advance at different rates regionally and from community to community. In the Business-as-Usual scenario, it will mean 100% sales of zero-emission buses and other medium- and heavy-duty vehicles by 2050 in 15 states and Washington, D.C. that signed the MOU. It's very likely those states would drive toward 100% electric LDVs, as well, which is reflected in the Expanded State Policies scenario.

Figure 9: MOU and non-MOU states

- Signed the MOU and have a clean power plan in place
- Signed the MOU but don't have a clean power plan in place
- Not signed the MOU and have a clean power plan in place
- Not signed the MOU and do not have clean power plans in place

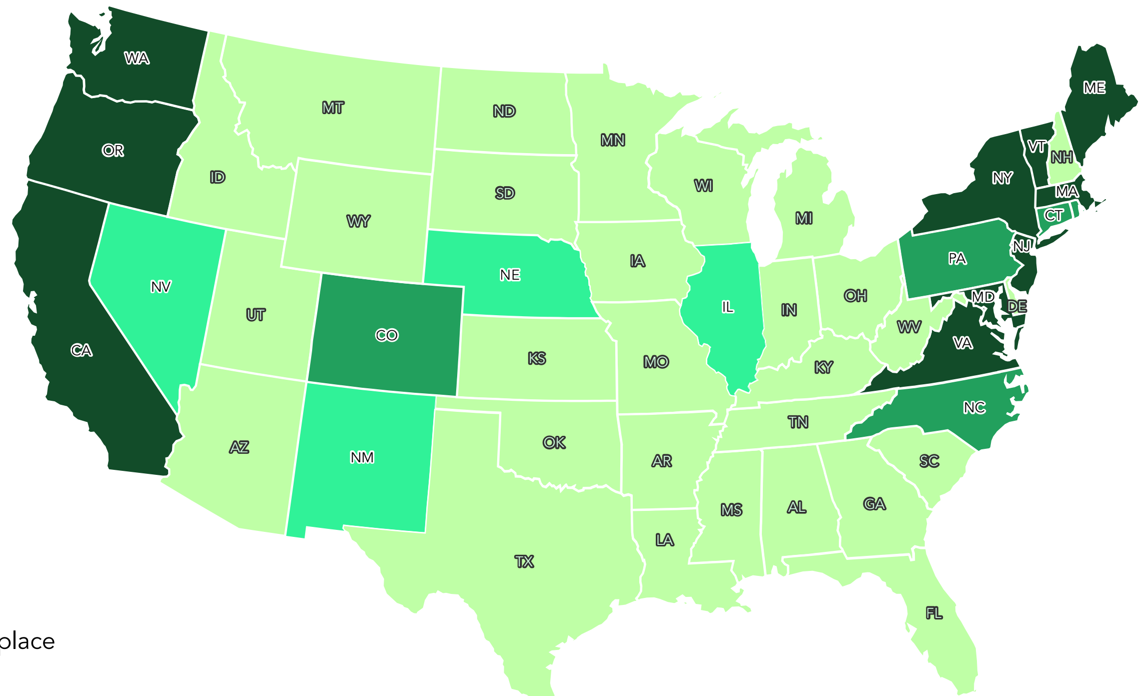


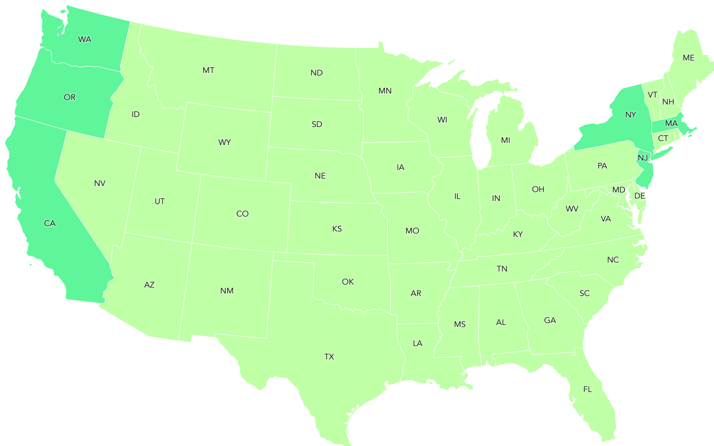
Figure 9 shows the states that have signed the MOU. (The analysis for this report was completed in March 2022, just prior to Nevada Governor Steve Sisolak announcing he had signed the MOU.)

The governors of almost every state in the group signed on to a letter asking the president to phase out all gas-fueled LDVs by 2035 and MDVs and HDVs by 2045. MOU states currently represent 37% of the vehicle population, according to EPA MOVES data, and their EV penetration grows to 18%-32% of on-road vehicles by 2050 in the Moderate State Policies and Expanded State Policies scenarios, respectively. Turning to non-MOU states, both the Moderate and Expanded State Policies scenarios assume that only 1% of MDV and HDV sales per year through 2050 would be electric models and only 22% of LDV sales by 2050 would be electric. By 2050, EVs would only comprise 12% of on-road vehicles in non-MOU states.

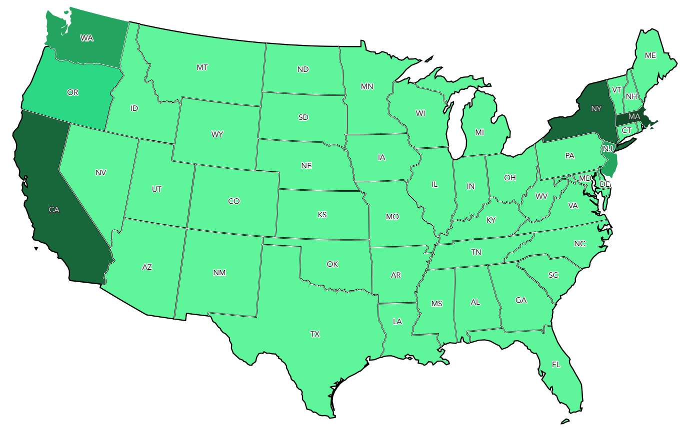
Figure 10: Vehicle population by state

- <10%
- 10-25%
- 25-35%
- 35-50%
- 50-75%
- >75%

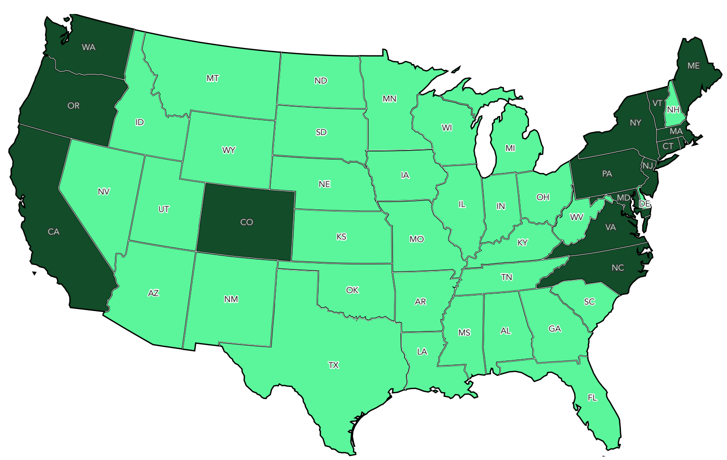
Source: ICF



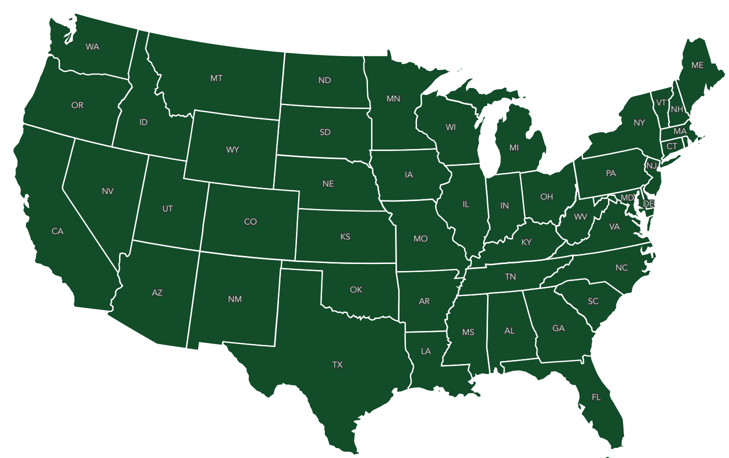
2030 Business-as-Usual EV population
EV penetration (% of the vehicle population that is electric)



2050 Business-as-Usual EV population
EV penetration (% of the vehicle population that is electric)



2050 Expanded State Policies EV population
EV penetration (% of the vehicle population that is electric)



2050 Nationwide EV Policy EV population
EV penetration (% of the vehicle population that is electric)

Figure 10 shows the percent of the vehicle population that is electric in 2030 and 2050 in the Business-as-Usual scenario and in 2050 under difference EV adoption scenarios.

It's worth noting that other factors from innovation to personal preferences could also influence EV adoption across the country.

GHG emission changes

EVs have the potential to drastically reduce economy-wide GHG emissions. However, the impact of charging will vary based on the state's electric grid mix. As discussed earlier in this report, unless the grid is largely or fully decarbonized, EV adoption could challenge states and utilities to meet their emissions-reduction aspirations for the industry.

In the MOU states, transportation GHG emissions in 2050 could fall by 18%-57% compared to the baseline in the Moderate and Expanded State Policies scenarios, respectively. However, power-sector emissions will increase 2%-15% in those same scenarios due to the EV charging impact. Despite many MOU states also having clean grid policies, they are not all aggressive enough to fully decarbonize the power supply and mitigate the emissions increase in the power sector.

Figure 11: Change in national GHG emissions in 2050 compared to Business-as-Usual

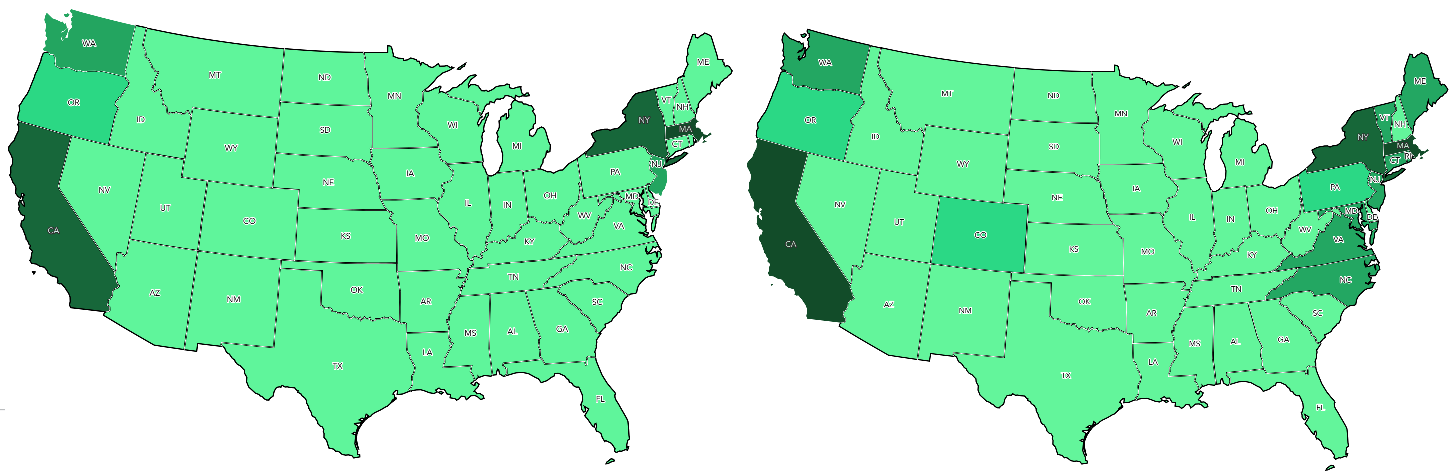
	Power Sector		Transportation Sector	
	Moderate State Policies	Expanded State Policies	Moderate State Policies	Expanded State Policies
MOU	**2%**	**15%**	**-18%**	**-57%**
Non-MOU	**0%**	**5%**	**0%**	**0%**

The forecast for minimal power sector emissions reductions under existing clean energy and EV policies would make it unlikely the economy could achieve President Biden's goal to reduce U.S. economy-wide GHG emissions by 50%-52% from 2005 levels by 2030.

Figure 12: Transportation emission reductions by state

- < -75%
- -75% - 50%
- -50% - 35%
- -35% - 25%
- -25% - 10%
- >10%

Figure 12 shows emissions reduction by state in 2050 compared to 2020 under different clean energy scenarios.



2050 Business-as-Usual emission reductions

2050 Moderate State Policies emission reductions

Electric grid impacts

Increasing the number of EVs on the road will have significant impacts on the power grid. In the Moderate State Policies scenario, relative to 2020, electricity demand will increase in MOU states by 13%, or 193 TWh, by 2035 due to EV charging demand, and 31% by 2050. That's a high demand bar to meet compared to the 4%, or 121 TWh, increase in demand expected by 2035 across non-MOU states. Even by 2050, EV charging demand in non-MOU states would only be expected to push demand 5%, or 181 TWh, higher in this scenario.

The bottom line is that utilities, state regulators, and policymakers need to start modeling how various EV adoption rates and levels of managed charging will impact electricity demand and peak demand now. It's a "no regret" step that will provide the foresight necessary to design and implement the right plans that deliver the most cost-effective investments for a reliable grid.

Planning is local: CO_2Sight in action

New York City, the most populous city in America, faces a difficult challenge in pursuing its goal of becoming carbon neutral in less than 30 years.

ICF worked with the New York City Mayor's Office, Con Edison, and National Grid to develop a landmark decarbonization study to assess technologies and costs to achieve this goal under different conditions. "Pathways to Carbon Neutral NYC" outlines three paths to carbon neutrality with focuses on distinctly different potential futures for supplies of low-carbon fuels, energy efficiency, and electrification of building heating systems. One common element across all pathways analyzed is aggressive electrification of passenger vehicles.

Driving forward

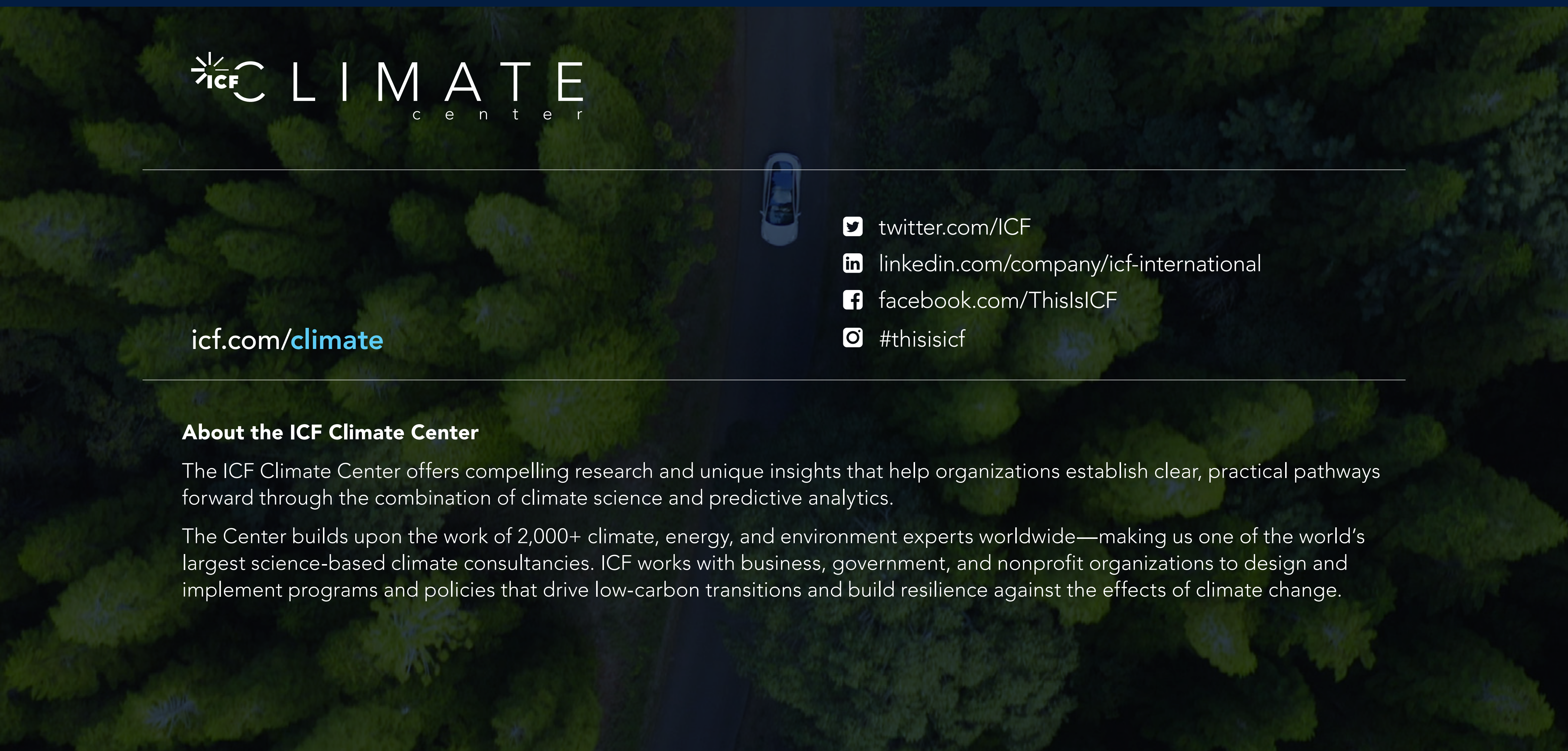
Here are four key insights for public sector and utility leaders seeking to accelerate EV adoption, reduce GHG emissions, maintain power reliability, and prioritize equity.

- **Advance EV adoption and charging infrastructure:** Whether it comes in the form of new information, programs, policies, or technology investments, actions from all parties will be needed to increase adoption and access to EVs, charging infrastructure, and clean energy. Careful planning, such as the location of charging stations, is critical to support these actions.
- **Plan power-sector integration:** Utility leaders and state planners need to understand multiple EV adoption scenarios, such as those presented in this report, and identify which actions are needed to keep power-sector emissions falling in concert with decarbonization goals. Strong data and forecasting provide the insights needed to make climate action align with needs.
- **Prepare for electric grid impacts:** Utilities, along with state regulators, will need to provide solutions and technologies for new and clean sources of energy, new transmission infrastructure, and solutions for managing increased total and peak load in the coming decades. Moving beyond scenario analysis into detailed transmission and reliability planning will help facilitate a smooth transition for the grid.
- **Prioritize equity:** Reducing tailpipe emissions by switching to EVs will save lives by improving air quality, especially in neighborhoods near transit corridors or in dense city centers. In addition to expanding access to EVs and charging stations in disadvantaged communities, electrified public transportation options, especially buses, will deliver significant benefits.

  Prioritizing equity will require significant funding and more locationally specific analyses. Minimizing the cost of the transition to disadvantaged communities–both in terms of electricity rates and the upfront cost of an EV–should be a key consideration, as well as the location and access to charging infrastructures.

For federal, state, and local officials as well as utility planners who want to maximize the benefits of EVs, a crucial first step is to conduct a range of analyses around how EV adoption will support GHG targets and interact with a complex set of variables. This type of analysis requires planning tools that offer flexibility and deep insights toward the decarbonized future through proven analytics, such as those highlighted throughout this report and offered with ICF's CO_2Sight platform.

Contact us



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About the ICF Climate Center

The ICF Climate Center offers compelling research and unique insights that help organizations establish clear, practical pathways forward through the combination of climate science and predictive analytics.

The Center builds upon the work of 2,000+ climate, energy, and environment experts worldwide—making us one of the world's largest science-based climate consultancies. ICF works with business, government, and nonprofit organizations to design and implement programs and policies that drive low-carbon transitions and build resilience against the effects of climate change.