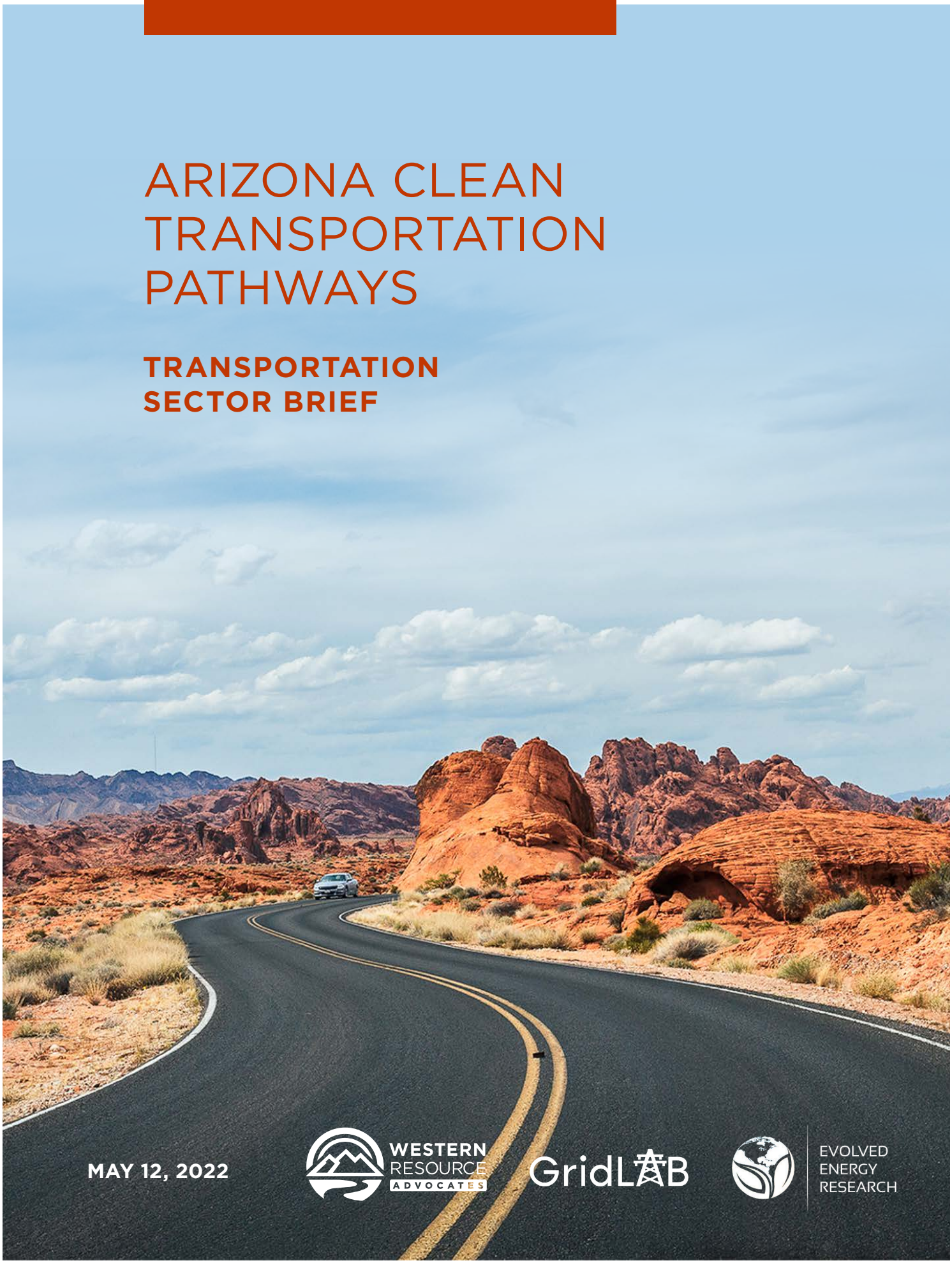
ARIZONA CLEAN TRANSPORTATION PATHWAYS

TRANSPORTATION SECTOR BRIEF



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WESTERN RESOURCE ADVOCATES

GridLAB

EVOLVED ENERGY RESEARCH

INTRODUCTION

As of early 2022, Arizona still lacks significant binding clean energy goals or transportation decarbonization measures. Western Resource Advocates (WRA) commissioned GridLab and Evolved Energy Research for a joint study to investigate the impacts of transportation electrification in Arizona. This study analyzes various pathways to decarbonizing Arizona's economy by 2050 to meet emission reduction goals set out by the International Panel on Climate Change (IPCC),[1] with a particular focus on the relative costs of different decarbonization strategies in Arizona's transportation sector. In this transportation sector brief, we also recommend policies that utilities and state and local decision makers can develop to help Arizona realize the economic and climate benefits that our study results outline.

In our analysis, six scenarios were developed, each looking at a specific set of assumptions and sensitivities about potential policies to enable the transition away from internal combustion engines (ICE). The **Clean Car and Truck** scenario, in which 100% of light-duty vehicle sales are electric by 2035, 100% of medium-duty vehicle sales are electric by 2040, and heavy-duty vehicle sales are 100% electric or hydrogen fuel-cell by 2040, represents the least-cost pathway for Arizona to decarbonize transportation. Three other unique demand-side scenarios are considered, including: **No Transportation Action**, **Maximum Feasible Adoption**, and **Delayed Action**. Two additional scenarios evaluate the impact of Arizona meeting an accelerated Clean Energy Standard. Each of these scenarios evaluates the broad impacts of differing levels of electric vehicle (EV) adoption. Our analysis found that **failing to take steps to achieve rapid transportation electrification will cost Arizona consumers $13.7 billion in additional annual energy spending in 2050** by stranding them with high future costs, compared with the Clean Car and Truck scenario that outlines a quick transition to EVs.

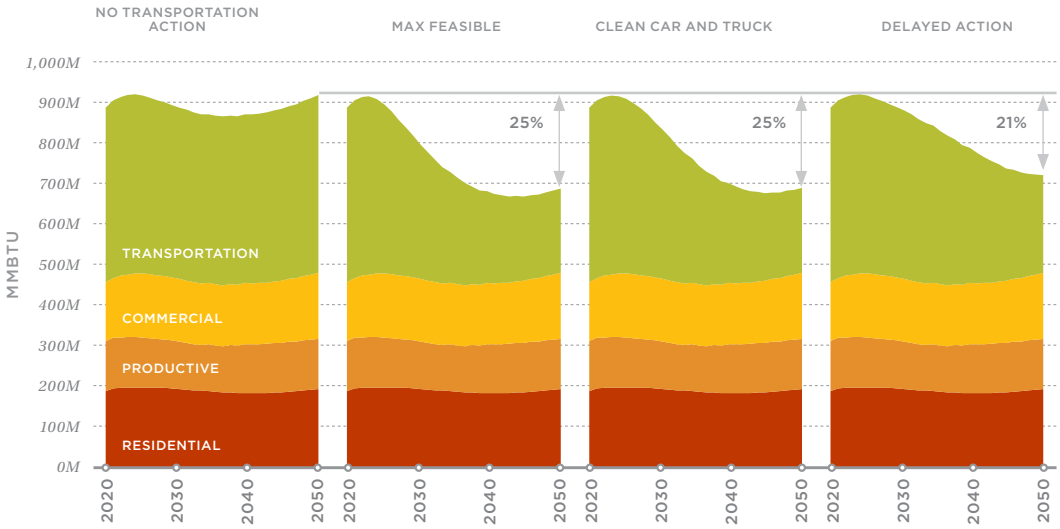
1 In 2018, the IPCC published a report on the implications of limiting global average temperature rise to 1.5°C above pre-industrial levels, establishing 1.5°C as a common target threshold in many emissions reduction goals in the United States.

ENERGY DEMAND

Transportation is the most significant contributor to energy demand in Arizona.[2] Meeting final energy demand requires building the requisite infrastructure, including increasingly clean electricity generation, as well as a variety of liquid fuels. Importantly, transitioning to predominantly electric vehicles reduces final energy demand, due to the increased efficiency of electric vehicles and other electric end-uses. Both the **Clean Car and Truck** and **Maximum Feasible Adoption** scenario reduce final energy demand by 25% in 2050, compared to **No Transportation Action** (Figure 1). While electricity use is increasing significantly, the improved efficiency of electric vehicles over ICE vehicles results in less total energy demand (Figure 2). In contrast, the **Delayed Action** scenario, which delays EV sales and thus leaves a higher number of ICE vehicles on the road by 2050, only reduces final energy demand by 21% relative to **No Transportation Action**.

FIGURE 1.

Final Energy Demand by Sector

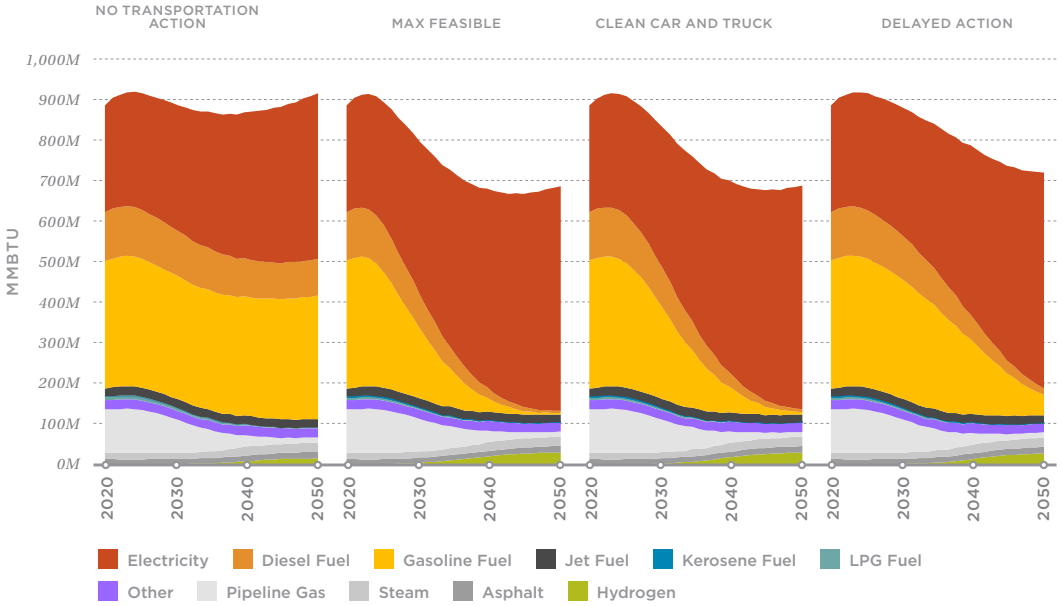


In all scenarios, the electricity sector grows to meet rising energy demands. However, scenarios with higher electric vehicle and appliance adoption result in a larger electricity system. The electricity sector grows by 110% in both the **Maximum Feasible Adoption** and **Clean Car and Truck** scenarios relative to 2021 levels (Figure 2). The increase is only 55% in the **No Transportation Action** scenario.

2 Among the sectors of the Arizona economy, transportation consumes the most energy (https://www.eia.gov/state/seds/)

FIGURE 2.

Final Energy Demand by Fuel



ACCELERATING ELECTRIC CARS AND TRUCKS

The **Clean Car and Truck** scenario modeled in this analysis represents the least-cost pathway for Arizona to decarbonize both the transportation sector and the economy as a whole. This scenario investigates vehicle transition policy commensurate with vehicle sales targets for light-,medium-, and heavy-duty vehicles that have recently been analyzed, proposed, or enacted by states or major auto manufacturers.[3] In this scenario, light-duty electric vehicles reach 100% of vehicle sales by 2035, and 100% of medium-duty and heavy-duty short-haul vehicle sales are electric by 2040. Finally, 50% of heavy-duty long-haul sales are electric by 2040, and 50% are hydrogen fuel-cell.

Light-duty vehicles (LDV) comprise the largest vehicle-class share. Electric vehicle sales ramp up as the sales requirement increases. However, ICE vehicles are not retired until the end of their useful life, so the stock of electric vehicles on the road does not dominate until later in the analysis period (Table 1). In 2030, when sales of light-duty electric vehicles reach approximately 85%, there will be 1.4 million EVs on the road. Five years later, when sales reach 100%, there will be 3.2 million electric vehicles. Fifteen years later, as the ICE vehicle fleet is almost entirely retired, 6.4 million electric light-duty vehicles will be on the road. This contrasts with the **No Transportation Action** scenario, in which electric vehicle sales only reach 14% by 2050, based on conservative assumptions from the Annual Energy Outlook (AEO).[4] In this scenario, only 703,000 electric light-duty vehicles will be on the road by 2050.

In the **Clean Car and Truck** scenario, light-duty EV sales ramp up considerably in the late 2020s. Between 2027 and 2032, light-duty EV sales climb from 46% to over 95% of total vehicle sales, a short five-year window in which the state may deploy nearly 1.5 million EVs. This deployment highlights the need to begin planning and installing critical EV infrastructure now, including chargers and grid upgrades. According to our analysis, by 2050, Arizona will need to install more than 150,000 DC fast chargers, 2 million workplace chargers (level 1 and 2), 5.7 million home chargers (level 1 and 2), and 70,000 public chargers (level 1 and 2).[5]

3 According to Bloomberg New Energy Finance, sales of combustion engine vehicles must stop around 2035 in order to bring transportation sector emissions to net-zero by 2050. Numerous U.S. states plan to or have signaled intent to achieve 100% electric vehicle sales by 2035. Automaker GM plans to achieve 100% electric vehicle sales by 2035.

4 https://www.eia.gov/outlooks/archive/aeo21/

5 Approximated using charger to vehicle ratios from the NREL Electrification Futures Study (https://www.nrel.gov/docs/fy18osti/70485.pdf)

TABLE 1.

Light-Duty Vehicle Sales and Stock, Clean Car and Truck and No Transportation Action Scenarios

		CLEAN CAR AND TRUCK			NO TRANSPORTATION ACTION	
		% EV SALES	STOCK		% EV SALES	STOCK
Light-Duty Vehicles	**2030**	85%	1,430,000	**2030**	6%	183,000
	2035	100%	3,280,000	**2035**	8%	291,000
	2040	100%	4,920,000	**2040**	10%	421,000
	2050	100%	6,430,000	**2050**	14%	702,000

A similar story exists in the **Clean Car and Truck** scenario for medium-duty vehicles (MDV), which comprise a much smaller segment of vehicles that includes local delivery vans and speciality vehicles (Table 2). Between 2020 and 2035, when sales of electric medium-duty vehicles reaches approximately 91%, the model adds nearly 62,000 electric vehicles to the road. In 2040, sales of EVs reach 100% and there will be approximately 124,000 medium-duty EVs on the road. Ten years later, that number rises to 264,000, when nearly all ICE vehicles are phased out.

TABLE 2.

Medium-Duty Vehicle Sales and Stock, Clean Car and Truck and No Transportation Action Scenarios

		CLEAN CAR AND TRUCK			NO TRANSPORTATION ACTION	
		% EV SALES	STOCK		% EV SALES	STOCK
Medium-Duty Vehicles	**2030**	43%	15,000	**2030**	0.2%	200
	2035	91%	61,000	**2035**	0.3%	320
	2040	100%	124,000	**2040**	0.3%	470
	2050	100%	264,000	**2050**	0.4%	870

We disaggregate the vehicle stocks of certain heavy-duty truck (HDT) classes, as these classes have unique travel and design specifications that may lend themselves well to different vehicle technologies, depending on future technological developments. Shares of short-haul vehicles reach 100% electric by 2040 (Table 3).

For heavy-duty long haul trucks, we assume a 50-50 split between electric vehicle sales and fuel-cell vehicle sales by 2040, understanding that future technical and policy decisions may favor one technology over the other (Table 4). For short-haul trucks, electric vehicle sales reach 44% by 2030, adding approximately 5,600 new EVs. By 2040, when electric sales reach 100%, there will be 41,000 electric vehicles on the road. That number increases to 66,000 just 10 years later.

TABLE 3.

Heavy-Duty Short Haul Truck Sales and Stock, Clean Car and Truck and No Transportation Action Scenarios

		CLEAN CAR AND TRUCK			NO TRANSPORTATION ACTION	
		% EV SALES	STOCK		% EV SALES	STOCK
Heavy-Duty Short Haul	**2030**	44%	5,600	**2030**	0.2%	70
	2035	91%	21,000	**2035**	0.2%	100
	2040	100%	41,000	**2040**	0.3%	140
	2050	100%	66,000	**2050**	0.4%	220

In long-haul trucks, electric sales reach 21% by 2030, adding approximately 1,400 new electric trucks to the vehicle stock. In 2040, electric truck sales reach 50% and 10,600 electric trucks are on the road. In 2050, that number rises to 17,000. There is commensurate growth in fuel-cell vehicles, with sales reaching 15% and 1,200 fuel-cell vehicles added. In 2040, when fuel-cell vehicle sales reach 50%, about 10,000 fuel-cell vehicles will be on the road. That number climbs to nearly 17,000 long-haul fuel-cell trucks by 2050, as nearly all ICE vehicles are retired (Figure 3).

FIGURE 3.

Heavy-Duty Vehicle Sales

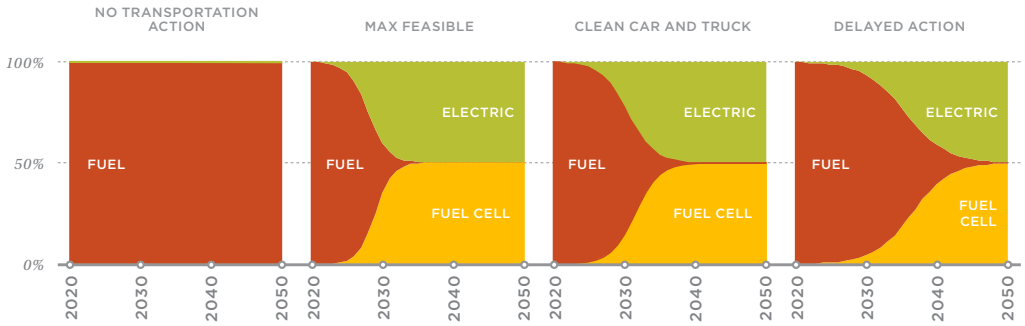


TABLE 4.

Heavy-Duty Long Haul Truck Sales and Stock, Clean Car and Truck and No Transportation Action Scenarios

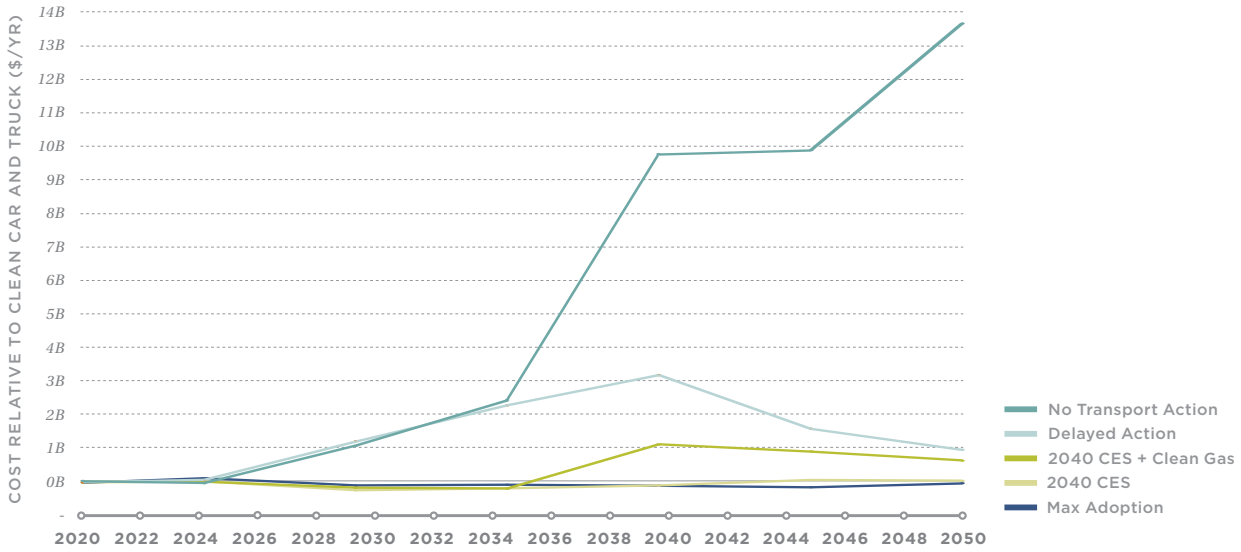
		CLEAN CAR AND TRUCK				NO TRANSPORTATION ACTION			
		% EV		% FUEL-CELL		% EV		% FUEL-CELL	
		SALES	STOCK	SALES	STOCK	SALES	STOCK	SALES	STOCK
Heavy-Duty Long Haul	**2030**	22%	1,400	15%	820	0.2%	30	0.1%	20
	2035	46%	5,500	44%	4,500	0.2%	50	0.1%	30
	2040	50%	10,600	50%	9,700	0.3%	70	0.2%	40
	2050	50%	17,000	50%	16,000	0.4%	110	0.2%	60

ELECTRIFYING RAPIDLY

Failure to electrify the transportation fleet in Arizona has significant long-term downsides and may result in costly infrastructure investments in order to meet future carbon emissions reduction goals. The **Clean Car and Truck** scenario represents the least-cost pathway for Arizona to decarbonize its transportation fleet (Figure 4). The scale and speed of this transition will depend on a variety of factors, including policy initiatives, legislative targets, and investment.

FIGURE 4.

Net Cost Comparison Relative to Clean Car and Truck Scenario



Relative to the **Clean Car and Truck** scenario, taking no action on aggressive transportation electrification strands consumers with high future costs. In the **No Transportation Action** scenario, final energy end use is considerably higher, which means consumers will end up paying for additional liquid fuels to support inefficient end uses, many of which must come from clean sources by 2050 to reach net zero emissions. This corresponds to an additional $13.7 billion in annual energy spending in 2050 compared to the **Clean Car and Truck** scenario. In contrast, moving far more aggressively on vehicle electrification may have different implications for meeting future energy demand. The **Maximum Feasible Adoption** scenario, in which 100% electric vehicle sales are accelerated by five years for each vehicle class, has a minimal total cost increase relative to the **Clean Car and Truck** scenario. Savings on fossil liquid fuels are offset by increased demand-side investments, as the cost of electric vehicles has not yet reached parity with ICE vehicles in all vehicle classes.

Alternatively, slowing the transition to electric vehicles will have costly impacts. In order to meet future decarbonization targets, the state would need to invest heavily in a significantly larger energy system, which is necessary to meet both increased electricity demand as well as increased demand for liquid fuels to fuel the large number of ICE vehicles still on the road. In the **Delayed Action** scenario, 100% electric vehicle sales targets are delayed by 15 years, such that all-electric sales are not reached until 2050. Due to stock turnover dynamics, such a delay leaves a significant number of ICE vehicles on the road at a period when emissions must reach net-zero. This delay has significant cost impacts, adding an additional .55% of GDP spending to Arizona's economy in 2040, or $3 billion per year in additional spending, relative to the **Clean Car and Truck** scenario. Taking no action at all adds 1.9% of GDP spending to Arizona's economy in 2050, or an additional $13.7 billion in annual spending.

CONCLUSION

Rapid decarbonization of the transportation fleet in Arizona is cost-effective and necessary to meet international climate targets. However, the costs and benefits of this transition must be carefully evaluated. Moving aggressively on vehicle electrification has clear benefits for Arizona consumers through increased efficiency, decreasing fossil fuel use, and less overall spending on energy. Vehicle electrification cannot happen in isolation. A robust electrification strategy will also require commensurate infrastructure planning, including a coordinated rollout of charging infrastructure and careful electricity grid planning to prepare for increased electricity demand.

The **Clean Car and Truck** scenario, in which 100% of light-duty vehicle sales are electric by 2035, 100% of medium-duty vehicle sales are electric by 2040, and heavy-duty vehicle sales are 100% electric or hydrogen fuel-cell by 2040, represents the least-cost pathway for Arizona to decarbonize transportation. In order to achieve this least cost pathway to decarbonization of the transportation sector, Arizona should take the following steps to accelerate the adoption of zero-emission cars and trucks:

- Policymakers should ensure robust support for low-income consumers, renters, and other consumer classes who may not have equal access to affordable electric vehicles and vehicle charging infrastructure.
- Utilities should take advantage of upcoming requirements to file Transportation Electrification Implementation Plans (TEIPs) and subsequent filings, by:
    - Planning for charging infrastructure and load growth, to ensure they are prepared for increased demand expected from widespread electrification.
    - Adopting smart rate designs at the commercial level, which make EV charging economically beneficial while ensuring EV-charging load is being pushed into off-peak hours.
    - Expanding the availability of charging infrastructure. Fast charging along highway corridors is critical, but just as important is expanding the availability of charging at apartment complexes, universities, workplaces, airports, and any other places that will make the ownership of an EV easier. Influx of federal funding will target increasing availability of highway fast chargers, but entities like electric utilities will be essential in increasing the availability of chargers for renters, fleets, and everyday EV drivers who need more public places to charge their vehicles. The TEIP filings will be an excellent opportunity to make progress on increasing EV charging availability.

- Providing incentives to install level 2 home charging and commensurate electrical upgrades, upon the condition that those receiving an incentive agree to participate on a time-of-use rate or a managed charging program. Level 2 chargers scheduled to charge during off-peak periods are the best solutions to ensure EVs are providing benefits to the electric system.
- Encouraging electric utilities to bring forward innovative financing models to increase the availability of EV charging for individual customers, apartment complex owners, fleet operators, and other entities.
- Directing a dedicated portion of any funding for EV infrastructure to low-income individuals and communities, as well as increased incentive levels for customers who qualify as low-income.

• State and municipal departments should require full electrification of their fleet vehicles. Light-duty vehicles should be converted first, and longer-term commitments to electrify medium- and heavy-duty vehicle fleets should also be made.

• State decision makers should develop policies to lower upfront purchasing costs of electric vehicles by providing incentives or tax credits. All purchasing incentives are important in making EVs more accessible, and if budgets are limited, priority should be given to incentives for low-income individuals and/or for medium- and heavy-duty vehicles.

• Make EVs more widely available for purchase by adopting the Zero Emission Vehicle standard for light-duty vehicles and the Advanced Clean Trucks rule for medium- and heavy-duty vehicles.

• Create state-level programs to incentivize the development of EV charging.

• Increase customer education and awareness campaigns that can teach Arizonans about the logistics of owning an EV and the benefits they provide.

• Remove other hindrances to EV ownership like onerous EV fees.