



ARIZONA  
TRANSPORTATION  
DECARBONIZATION  
ANALYSIS

ELECTRICITY  
SECTOR BRIEF

NOVEMBER 2022



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),<sup>1</sup> with a particular focus on the relative costs of different decarbonization strategies in Arizona's transportation sector. In this electricity 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 this 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). In the first scenario, **No Transportation Action**, no additional action is taken beyond a 2050, 100% economy-wide emissions reduction target, and both the electric power and transportation sectors maintain their current trends and trajectories. This scenario assumed that the Arizona Corporation Commission's proposed Arizona Energy Rules, which required 100% clean electricity by 2070, had passed. Additionally, in our transportation modeling scenarios, it was found that the **Clean Car and Truck** scenario produced the best, most cost effective outcomes for Arizona. This scenario requires 100% of light duty vehicle sales to be electric by 2035, and sets similar goals for medium- and heavy-duty vehicles by 2040.

This policy brief focuses on two of the additional scenarios, **2040 Clean Energy Standard (CES)** and **2040 CES + Clean Gas**. The **No Transportation Action** scenario is used to compare and contrast the outcomes of both. The additional scenarios implement the policies in the **Clean Car and Truck** scenario, with additional restrictions for electric power decarbonization.

---

<sup>1</sup> 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.





# ELECTRICITY SECTOR SCENARIOS

**2040 CES:** This scenario assumes the power sector achieves a clean energy standard (CES) of 100% carbon-free retail sales in Arizona by 2040. This scenario allows for synthetic fuels to be created in Arizona and shipped to other states, in part due to Arizona's strong, inexpensive solar resources.

**2040 CES + Clean Gas:** This scenario is similar to the **2040 CES** scenario, but restricts pipeline gas to only clean alternatives.

These **CES** scenarios demonstrate the ability for Arizona to achieve ambitious, clean transportation targets while simultaneously pursuing a rapid decarbonization of the electric power sector. Both scenarios require an accelerated deployment of clean energy resources.





# ELECTRICITY SECTOR EMISSIONS

Each scenario modeled in this study meets binding, economy-wide emissions constraints based on a 2016-2018 baseline. In these scenarios, economy-wide greenhouse gas emissions targets are 40% below baseline by 2030, and 100% by 2050. Our analysis shows that for Arizona to meet economy-wide net zero emissions targets, the state's electricity sector must rapidly decarbonize over the next decade by transitioning to clean energy resources.

The retirement of Arizona's coal fleet can account for 66% of these emissions reductions. Currently, Arizona generates roughly 20% of its electricity from coal. In this analysis, all scenarios include the elimination of the coal fleet by 2040 (based on the planned retirements of Arizona's coal generators). The two scenarios highlighted in this brief, **2040 CES** and **2040 CES + Clean Gas**, evaluate the impact of an accelerated Clean Energy Standard (CES), which would achieve 80% clean electricity by 2030 and 100% clean electricity by 2040.

In both **CES** scenarios, electric sector emissions fall approximately 60% by 2035. This analysis assumes all existing coal generation remains online until its scheduled retirement date, which results in nearly 3 GW of coal in 2030 and 600 MW of coal in 2035 still in operation. To meet economy-wide GHG targets, other generation resources and sectors of the economy must reduce emissions in lieu of ramping down coal generation. An accelerated coal retirement may lower costs and ease the transition to zero-carbon resources.

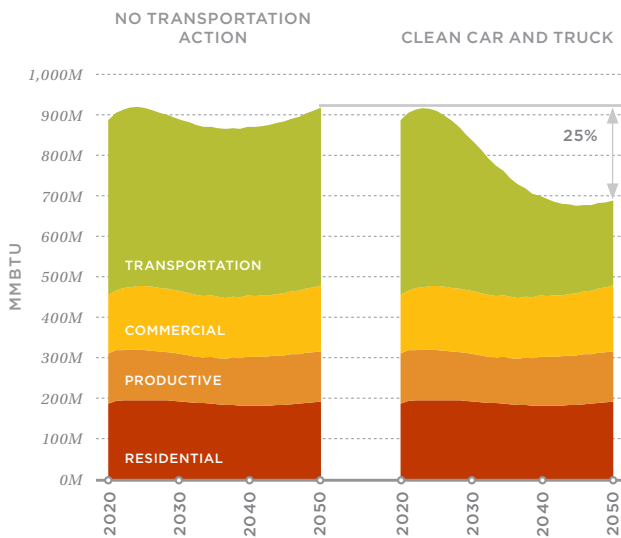
In scenarios with aggressive electric vehicle adoption, such as the **Clean Car and Truck** and **Max Adoption** scenarios, emissions fall rapidly from the transportation sector. These emissions reductions are captured in both of the electricity sector scenarios. Retail sales of electricity are served with 100% clean electricity in the **2040 CES** scenario, though Arizona would have room to export gas out of state to areas without clean energy standards. The most significant emissions reductions, however, are in the **2040 CES + Clean Gas** scenario, which analyzes a more stringent clean electricity standard. While **2040 CES** evaluates the impact of accelerated clean electricity standards, **2040 CES + Clean Gas** also adds a requirement that all pipeline fuels be decarbonized by 2040. This reduces emissions even further than the **Clean Car and Truck** and **2040 CES** scenarios.

# ELECTRICITY GENERATION AND DEMAND

Arizona must significantly accelerate its clean electricity generation if it is to successfully meet growing energy demands. If no action is taken to electrify the transportation fleet, final energy demand will remain largely stagnant. However, in scenarios in which the sector transitions to electric vehicles, total energy demand decreases by 25% in 2050. As highly efficient electric vehicles and electric end-use appliances, such as heat pumps, replace traditional, fossil fuel powered end-uses, the electricity sector increases significantly. By 2050, the electricity sector will increase by 110% relative to 2021 levels as electricity displaces fossil fuels as the primary energy source in the economy. Due to the efficiency of such electric end-uses, electricity needs increase, but total energy demand decreases. This difference in final energy accounts for a substantial portion of the cost savings in these **CES** scenarios. In effect, Arizona must develop 4.5 times today’s generating capacity to meet nearly 2.3 times today’s load, including exports to the rest of the West and new electric loads that help create clean fuels.

**FIGURE 1.**

*Final Energy Demand by Sector*



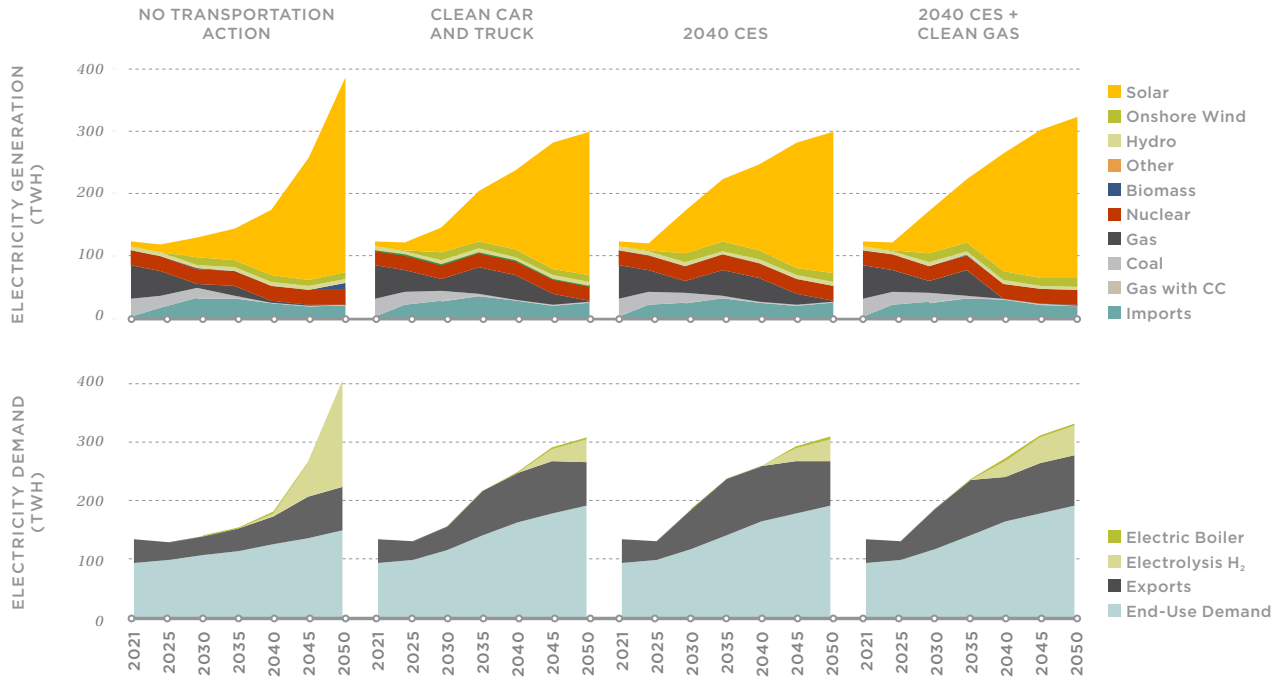
Without action on transportation electrification or electricity decarbonization, Arizonans will be burdened with greater energy needs in order to meet long-term emissions reductions targets. The **No Transport Action** scenario, for example, has the highest energy and clean fuel demands, resulting in the largest electricity and hydrogen sectors. Alternatively, scenarios that rapidly electrify transportation and simultaneously ramp up clean energy generation are lower cost.

In the **Clean Car and Truck** demand scenario, which is reflected in both the **2040 CES** and **2040 CES + Clean Gas** scenarios, electricity sector investments in 2050 will amount to over four times today's generating capacity while serving two times the load. In the **2040 CES** scenario, the state will need to add 74 GW of new solar, 4 GW of new wind, and 34 GW of new battery storage by 2050 to meet future energy demands. For the **2040 CES + Gas** scenario, which requires additional renewables or alternative fuels to replace pipeline fossil gas, that need rises to 40 GW of new battery storage and 85 GW of new solar. At the same time, Arizona becomes a major energy exporter to support rising energy demand throughout the Western U.S. By 2050, transmission capacity to California will increase by 6 GW. The model constrained this transmission intertie at a maximum of 6 GW of new capacity, suggesting that additional transmission capacity is likely cost-effective.

The **2040 CES** and **2040 CES + Clean Gas** scenarios look at the impact of an accelerated clean energy standard, requiring Arizona to achieve 80% clean electricity by 2030 and 100% clean electricity by 2040. The clean gas scenario requires that any remaining gas generation is met by zero-carbon gas. These scenarios require an even faster deployment of solar and storage in the 2030s, in order to meet accelerated clean energy targets. In **2040 CES**, installed capacity of battery storage in Arizona will reach 3.7 GW by 2030, 11.5 GW by 2035, and 20.8 GW by 2040. Installed capacity of solar reaches 23.6 GW by 2030, 35.8 GW by 2035, and 50 GW by 2040. Similar magnitudes of solar and storage are deployed in **2040 CES + Clean Gas**.

**FIGURE 2.**

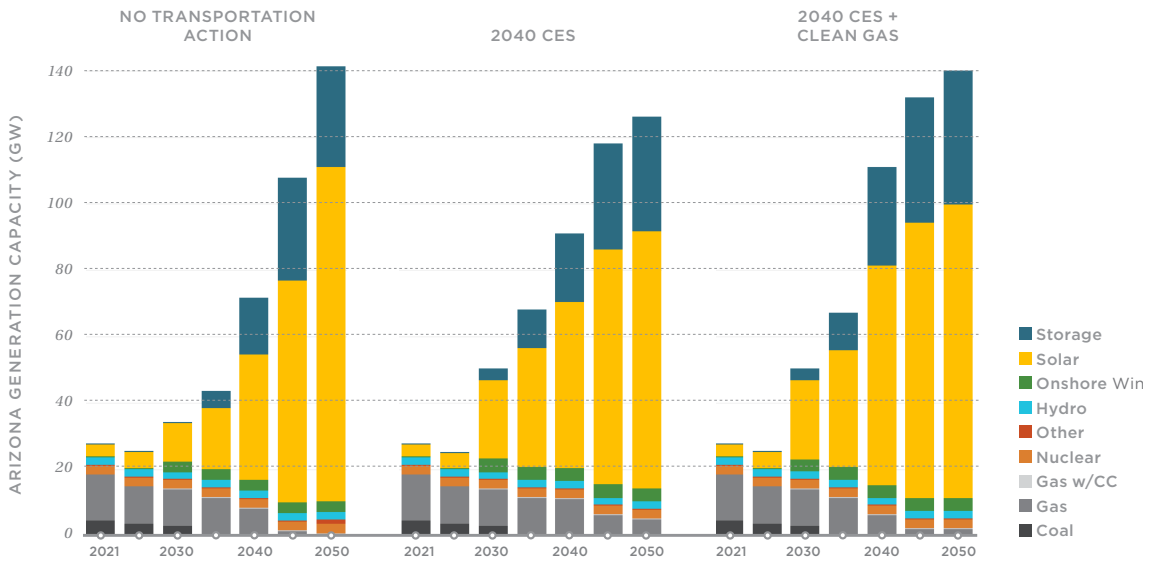
*Electricity Generation (top) and Demand (bottom)*



Regardless of which pathway Arizona heads down, the long-term emissions reductions targets require a substantial investment in clean energy resources. The rapid adoption of electric vehicles and other highly-efficient electric end-uses makes this transition far easier, reducing the aggressive expansion of solar energy resources in the **No Transportation Action** scenario. This scenario would install nearly 100 GW of solar by 2050, compared to approximately 80 GW in other decarbonization scenarios, due to the clean fuel requirements of transportation and other sectors. Failure to rapidly electrify vehicles means that future fossil fuel needs, such as liquid fuels to power internal combustion engines, will need to be met with expensive replacement fuels such as synthetic and bio-fuels.

**FIGURE 3.**

*Total Generating Capacity, No Transportation Action, 2040 CES, and 2040 CES + Clean Gas*





# COSTS

Rapid decarbonization of the electricity sector is key to reaching net zero in an economic manner. The 25% decrease in overall energy demand saves Arizona approximately \$13.7 billion annually in 2050 relative to **No Transportation Action**. Overall, decarbonization costs across all scenarios relative to **No Transportation Action** are similar and modest.

While the **2040 CES + Clean Gas** scenario leads to the fastest economy-wide decarbonization, it also increases costs to Arizona by approximately \$1 billion annually over the **2040 CES** scenario. However, this is still far below the cost of the **No Transportation Action** scenario. Both **CES** scenarios drive earlier renewable deployments, but the **2040 CES** scenario still remains cost-competitive throughout 2050. In 2050, as a percentage of state GDP, the costs to reach net-zero emissions in the **2040 CES** scenario are less than 0.1%.

While the **2040 CES** scenario has no impact on cost, the **2040 CES + Clean Gas** scenario adds approximately \$1 billion in cost between 2040 and 2050 while significantly decreasing emissions, well below the 2040 policy cap.



# CONCLUSION

The electricity sector will require significant investment, clean energy targets, and policy reform to ensure that the grid is capable of meeting rising electric demands. Arizona should take the following steps to both accelerate the deployment of zero-emission cars and trucks and prepare the electricity sector for increasing electric demands:

- Binding clean energy standards are critical to ensure that Arizona can meet long term decarbonization targets. The legislature and the Arizona Corporation Commission (ACC) should establish regulatory clean energy standards that target 100% clean electricity by 2040 – or sooner.
  - Our analysis suggests that 66% of economy-wide emissions reductions come from the retirement of Arizona’s coal fleet. The ACC should establish retirement plans for the existing coal by 2040 and explore opportunities to accelerate retirement prior to this date.
- A dramatic expansion of the state’s solar capacity is critical to meeting future power needs. Utilizing the best solar resource in the nation<sup>2</sup>, Arizona will need to develop nearly 75 GW of solar by 2050 across most scenarios.
  - The rigorous pace and the challenges that come with scaling up the electricity sector will require early coordination and planning.
  - Adopt new comprehensive All-Source Request for Proposal and Integrated Resource Plan rules that have been proposed at the Arizona Corporation Commission, which include<sup>3</sup>:
    - Requirements for a three step process for resource acquisition, which includes requests for information, integrated resource planning, and all-source requests for proposals.
    - Prioritizing new clean energy resources near communities impacted by coal plant closures.
    - Robust annual reporting requirements.
    - Oversight of all-source requests for proposal by an independent monitor.
- The strengthening of the transmission system between Arizona and surrounding states allows the West access to low-cost and diverse renewable resources and increases the size of the export market opportunity for Arizona.
  - The state legislature and the ACC should direct utilities to plan for transmission expansion, including through proactive modeling, permitting and planning.

---

2 <https://www.eia.gov/state/analysis.php?sid=AZ>

3 <https://docket.images.azcc.gov/E000018244.pdf?i=1652466416922>

- The ACC should direct utilities to explore opportunities to upgrade existing transmission infrastructure and utilize existing interconnects to increase transmission activity.
- A Western Regional Transmission Organization (RTO) that automates and coordinates electricity flow across Western states would facilitate greater access to low-cost and diverse clean resources while maintaining grid reliability. To advance an RTO and ensure Arizona can access the associated benefits:
  1. The ACC and regional planners should collaborate with AZ utilities to plan for interregional transmission expansion.
  2. The ACC should direct utilities to explore and evaluate future market and grid expansion possibilities to reflect a changing resource mix and increased electrification.
  3. The ACC should invest in internal resources to monitor and engage in regional market expansion initiatives.
- An ambitious expansion of new electrified end-uses, including electric cars and trucks, requires that utilities are prepared for new electric demands. The ACC should direct utilities to prepare for new loads through advanced forecasting, and explore opportunities to mitigate peak demand issues, including through time-of-use charging rates, load shifting, and other opportunities to prepare for new electric loads.





# ADDITIONAL CONSIDERATIONS

This analysis was completed before the passage of the Inflation Reduction Act (IRA). The incentives, rebates, and industrial policy outlined in that legislation would likely make decarbonization more cost-effective. In addition, after the conclusion of the modeling portion of this work, the Infrastructure Investment and Jobs Act (IIJA) was passed by the U.S. Congress. These two pieces of legislation have the potential to have profound impact on these results and reduce the costs of decarbonizing both the transportation sector and electric power sector dramatically.

