BLUEGREEN ALLIANCE

TECH@RISK

The Domestic Innovation, Technology Deployment, Manufacturing, and Jobs at Risk in Stepping Away from Global Leadership on Clean Cars

BLUEGREEN ALLIANCE

The BlueGreen Alliance **unites America's largest labor unions and its most influential environmental organizations** to solve today's environmental challenges in ways that create and maintain quality jobs and build a stronger, fairer economy.

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EXECUTIVE SUMMARY

Policy matters.

Between 2007 and 2016, the United States' commitment to a new generation of fuel economy improvement and greenhouse gas (GHG) emissions reduction in the massive passenger vehicle sector helped transform manufacturing in America. Automakers didn't just rebuild from a recession, they rebuilt to produce vehicles that were far cleaner, more efficient, and more globally competitive, while simultaneously maintaining the performance, safety, and design innovation that customers demand. Doing so spurred more rapid retooling of automaker facilities and required enhanced purchase of advanced technology from thousands of suppliers. In past research and reports the BlueGreen Alliance has identified the suppliers of this technology across the nation.

The threat appears particularly acute for those that make the most advanced technologies and materials, but a rollback threatens jobs and investment across the industry. These immediate impacts understate the longer-term impact of losing the competitive technology edge to other nations. Stepping back from leadership on efficiency and emissions reductions in the global vehicle sector means both U.S. jobs lost making the advanced engines, transmissions, components, and materials that consumers count on to deliver fuel savings in popular SUVs, cars, and trucks today, and jobs and business opportunities lost in building the domestic supply chain in emerging and electric vehicle technology for today and tomorrow. **Our analysis finds between 89,000 and 202,000 of tomorrow's jobs would be lost or foregone as a result of the rollback.**

Since 2017, however, the administration has proposed—and is expected shortly to finalize—standards that dramatically reduce requirements for continued efficiency improvements in passenger cars, SUVs, and trucks and undermine states' ability to spur additional demand for advanced vehicles. The administration's own analysis of their proposal finds that halting the advance of standards at 2020 levels would cut demand for advanced clean and efficient automotive technology, components, and materials by approximately $30 billion a year and result in 60,000 fewer jobs in the auto industry.

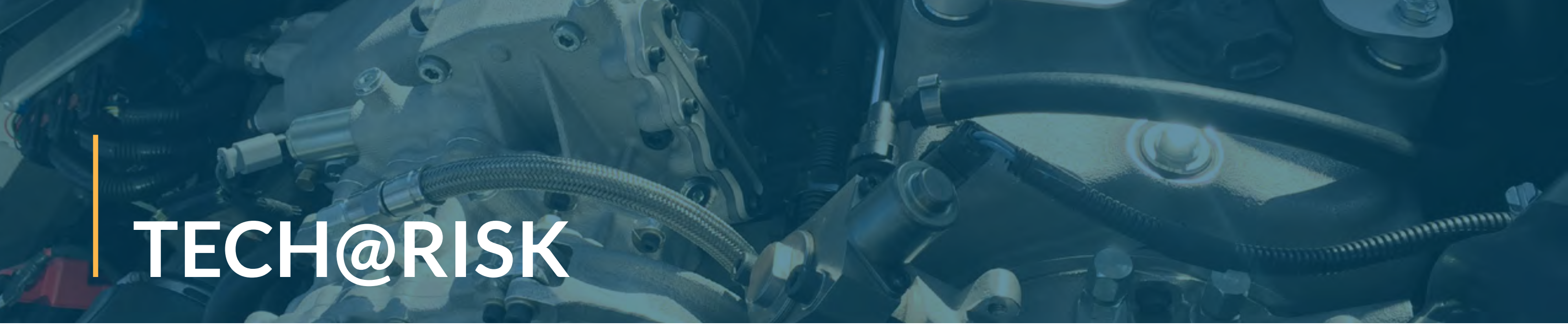
> **Our analysis vividly illustrates that—regardless of the modeling approach used—flatlining the standards in 2020 significantly slows adoption of advanced technologies in almost every vehicle subsystem and cuts demand for products made by hundreds of manufacturers and hundreds of thousands of workers all across the country.**

In this report, we unpack these topline statistics and look in detail at the impact of less stringent standards on demand for clean vehicle technologies and the companies that build them. We look both at today's vehicle technology manufacturing jobs that may be impacted if standards are weakened, and estimate the impact on future jobs and job growth in the industry. Our analysis vividly illustrates that—regardless of the modeling approach used—flatlining the standards in 2020 dramatically slows adoption of advanced technologies in almost every vehicle subsystem and cuts demand for products made by hundreds of manufacturers and hundreds of thousands of workers all across the country.

At a time when nations worldwide are moving aggressively to capture the jobs and economic benefits of rapidly changing vehicle technology, the U.S. too must use all the tools at its disposal to lead in technology innovation, investment, manufacturing, and good job creation.

To secure jobs and manufacturing growth in the highly competitive global automotive industry the U.S. will need to complement strong vehicle standards with smart trade, tax, and manufacturing policies. But making policy decisions now that actively disincentivize innovation and investment in advanced vehicle technology in America—such as choosing to rollback industry leading clean vehicle standards—puts the United States at a profound disadvantage and will cost manufacturing and jobs today and tomorrow.

It is not yet too late to take a smarter path.



I. INTRODUCTION: A HISTORY OF BUILDING CLEANER VEHICLES AND AMERICAN JOBS

In 2007, the passage of a major bipartisan energy bill—the Energy Independence and Security Act of 2007 (EISA)—set in motion a new generation of fuel economy rulemaking, and was the first significant forward movement on vehicle efficiency in the United States since the 1970's oil crisis. In accordance with EISA, federal rulemakings in 2010 and 2012 put in place a schedule for fuel economy improvement through 2025 and codified a groundbreaking approach, often referred to as the "One National Program," under which the U.S. Environmental Protection Agency (EPA), U.S. Department of Transportation (DOT), and the California Air Resources Board (which had also set standards for 2009-2016), develop and promulgate coordinated standards across their separate regulatory obligations.[1] This process was designed to ensure long-term certainty, consistency, and clarity for the industry. It enabled automakers and suppliers to develop and build a single fleet that meets federal vehicle fuel economy and GHG rules—and state vehicle emission standards—at once. Under these policies, the nation has seen a decade of dramatic improvement in vehicle efficiency, emissions reductions, and oil and consumer cost savings.[2]

In addition, the drafters of EISA also included explicit measures to help promote domestic manufacturing of cleaner and more fuel-efficient vehicles and technology. They recognized that a new generation of stronger standards would spur a new generation of innovation and investment in both technology and manufacturing, but that—given a simultaneous crisis in U.S. manufacturing—there was no guarantee that these investments would be made in the United States. Workers in the automotive sector continue to be impacted by incentives embedded in trade policy, for example, that have encouraged offshoring and other declines in manufacturing over the past several decades. Recent reinvestment in the United States to meet leading standards and build a new generation of more fuel-efficient vehicles has demonstrated progress in the opposite direction.

A strong, certain, and globally leading regulatory framework has ensured the market certainty needed for long-term investment in advanced vehicle technology manufacturing in the United States. This framework—alongside loan and tax support to facilitate manufacturing investments—has underpinned a revival in domestic automotive innovation and a significant recovery in automotive manufacturing and jobs. The industry's profitability and competitiveness globally have also been transformed.[3] As of 2018, jobs brought back in motor vehicle and parts manufacturing accounted for more than 35 percent of all net manufacturing sector jobs restored since the recession.[4] The auto industry has added more than 730,000 direct jobs since mid-2009, nearly 340,000 of these in manufacturing. This represents 54 percent growth since the recession low point in 2009.[5]

However, the challenges to U.S. leadership in vehicle technology and manufacturing are by no means over. China and the European Union (EU) have set ambitious goals to meet even stronger fuel economy and GHG standards over the next decade. China and others have demonstrated their commitment to pursuing global technology leadership.[6] Degradation of standards here in the United States would create a disadvantage for U.S. companies in a rapidly advancing global marketplace. Unfortunately, exactly at this time of economic challenge, the administration has proposed to step away from policy leadership. This puts American competitiveness, manufacturing, and jobs at risk.

Over the past decade the industry has invested towards an anticipated strong, increasing vehicle GHG and fuel economy trajectory through 2025. This report looks in detail at the potential impacts of a rollback on the advanced automotive supply chain.

In the sections that follow, we briefly review the mechanics of how clean vehicle standards work to increase jobs and the footprint of the clean vehicle manufacturing supply chain in the United States today. Using two different approaches to predicting how automakers would achieve the previously promulgated 2025 fuel economy and GHG goals, we then analyze and discuss the impacts of a rollback on demand for specific technologies, and how that would affect the companies and workers who make them.

II. VEHICLE STANDARDS, MANUFACTURING, AND JOBS TODAY

Since 2010, there have been numerous studies predicting the impact of increasing fuel economy and GHG standards on jobs and manufacturing. These economic models consistently find that the standards are expected to increase jobs through two mechanisms. First, when consumers and businesses drive more fuel-efficient vehicles, they save significant fuel and money, which they spend throughout the economy. This boost in consumer spending increases jobs throughout the economy.

Second, the standards spur investment in new and added innovative technology within the auto industry. Added or enhanced technology on every vehicle means added labor hours—and thus more jobs—to develop and build that technology. Whether standards increase U.S. manufacturing jobs a little or a lot depends on the extent to which those investments in technology and manufacturing are made in the United States. In either case, job growth is still significant—especially within the industry.[7]

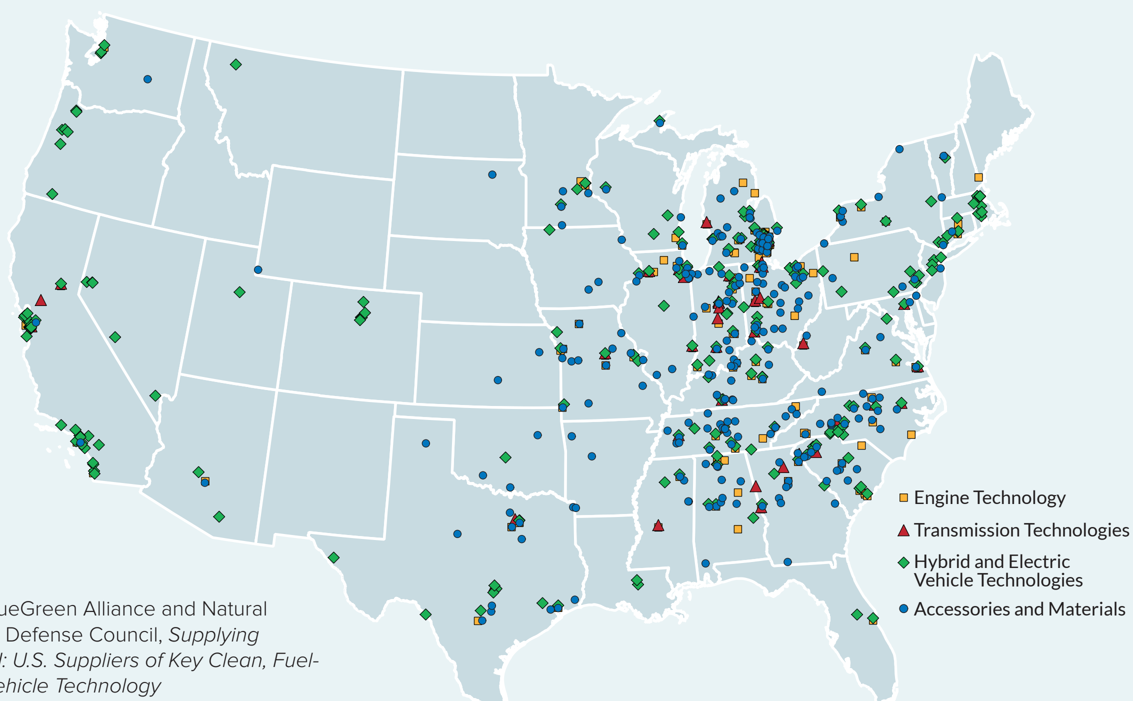
The most recent study of this nature looking just at the latest round of standards from 2017-2025 found the existing standards would create 100,000 more jobs in 2025 and 250,000 more jobs in 2035 throughout the economy.[8]

Real-World Deployment

In addition, since 2011, a number of researchers have tracked the real-world deployment and manufacturing of clean vehicle technology, and have seen the innovation, investment, manufacturing, and job growth predicted in economic models play out across the industry.

Today, the United States is a global leader in engineering and manufacturing advanced vehicle technologies. Strong long-term fuel economy and GHG standards have spurred innovation and job growth and strengthened the manufacturing sector as a whole. Domestic motor vehicle and parts manufacturing is the nation's largest manufacturing sector, directly employing 1 million workers today[9], with employment at auto suppliers up 19 percent since 2012.[10] In 2017, a BlueGreen Alliance and NRDC study found 288,000 American workers—in 1,200 factories and engineering facilities in 48 states—building the specific technologies that improve vehicle fuel efficiency.[11] These facilities are producing some of the world's most innovative automotive technologies for an ever more competitive global marketplace.

Figure 1: Suppliers Of Fuel-Efficient Vehicle Technology – More Than 1200 Facilities Nationwide



Source: BlueGreen Alliance and Natural Resources Defense Council, *Supplying Ingenuity II: U.S. Suppliers of Key Clean, Fuel-Efficient Vehicle Technology*

Similarly, the *2018 U.S. Energy and Employment Report*, which directly surveys automotive industry employers, found that 23 percent of automotive suppliers stated that 100 percent of their revenue came from technology that improves fuel efficiency.[12] This is 6 percent higher than the previous year's report.[13]

The current standards have created market certainty necessary for both automakers and suppliers to feel confident in longer-term investments in emerging technologies. Many suppliers have already planned for, and invested in, production and development of technologies designed for automakers to meet the standards through 2025.[14]

Photo Courtesy of Ford Motor Co.

Anchoring the growth of the supplier industry, U.S. automakers have also invested robustly over the past decade, both in added vehicle technology and in their facilities directly. Looking just at assembly plants, and automaker-owned engine, transmission, and stamping facilities, a 2018 BlueGreen Alliance report found that automakers have invested $76 billion in facilities across the country, completing 258 investments at 100 factories since 2008, with a further 42 investments at 37 facilities promised or underway through 2020.[15] Similarly, according to the Center for Automotive Research, between 2009 and 2017 automakers announced $119.5 billion in investments in North America. Two-thirds of that investment—$87.6 billion—has been or is planned to be invested in the United States.[16] While a portion of this investment is business as usual, much represents added or enhanced investment to meet globally leading standards.

III. PROPOSED ROLLBACK THREATENS INDUSTRY GAINS

In August of 2018, the EPA and the National Highway Traffic Safety Administration (NHTSA) released a notice of proposed rulemaking (NPRM) to significantly relax the car and truck efficiency and emission standards. In the proposed rule—entitled "The Safer Affordable Fuel-Efficient Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks"—the agencies put forward varying options for the rollback of the current standards, with the preferred option freezing the standards at 2020 levels.

In the NPRM, **the agencies own analysis shows the new rule would result in billions less annually in technology investment and, as a result, approximately 50,000 to 60,000 fewer American manufacturing jobs.**[17] Figures 2a and 2b show the agencies' analysis of the impacts of the rollback (of both the NHTSA–administered fuel economy standards, and the EPA-administered vehicle GHG standards, respectively) on technology spending and labor hours in every year.

Unfortunately, these estimates significantly underestimate the likely negative impacts of the proposed rule on jobs and the economy. They do not include any jobs lost elsewhere in the economy as consumers lose gas savings, nor do they reflect the other harms to U.S. competitiveness and jobs should lagging standards and uncertainty drive innovation and investment abroad.

In addition, the proposal threatens to dissolve the partnership between the federal and state agencies, throwing coordination, certainty, and U.S. technology leadership under the One National Program into disarray.

NHTSA's jobs analysis uses a similar approach to that used by economic modelers looking at direct impacts to the industry. The agencies project significantly lower spending on technology and translate that into reduced industry revenues. They then associate a number of jobs at automakers and suppliers with every dollar of revenue.

A number of studies have been undertaken confirming the direction of these results. The Motor & Equipment Manufacturers Association (MEMA) contracted with IHS Markit to model the impacts of a regulatory rollback and found, "the agencies' preferred alternative 1 of zero percent increases year-on-year through 2026 would result in a loss of 67,000 direct automotive industry jobs" with a "full impact" of "500,000 direct, indirect, and induced jobs by 2025, in comparison to the employment levels supported by the augural standards."[18] Similarly, in September 2018, Synapse released an analysis that found the proposed—much weaker—rule would support 60,000 fewer job-years in 2025, and more than 125,000 fewer jobs years in 2035. The Synapse models also indicate that flat lining of the standards in 2020 will reduce GDP and eliminate many of the anticipated economic benefits generated under the augural standards.[19]

In the following sections, we review the effect of the rollback in more detail and examine the specific impacts of weakening the standards on technology deployment, manufacturing, and employment in the United States. We compare the technologies that would have been deployed by automakers under the current standards if implemented through 2025 in contrast with their deployment under the agencies' proposed rule that would halt required fuel economy and GHG improvement in 2020. We then connect these technologies with the American manufacturing facilities that build them.

Figure 2A: Rollback of Fuel Economy Standards: Agency Estimate of Impacts on Technology Cost and Labor Hours

	Spending on Technology (Technology Costs) and Beyond MY 2016 (in billions)				Domestic Labor Hours (1000s of Job-Years)			
	Standards		Change		Standards		Change	
	Baseline (Under current "augural"[20] standands through 2025)	Proposed (Under "preferred option" freezing standards in 2020)	Difference in $B	Percentage change in technology spending	Baseline (Current "augural" standrads)	Proposed (Preferred option)	Difference in job-years	Percentage change in domestic labor hours
2017	$4 Billion	$2 Billion	–$2 Billion	-41%	1170 (1,170,000)	1170	0	0%
2018	11	5	-6	-53%	1210	1200	-10 (-10,000)	-1%
2019	16	7	-10	-58%	1240	1220	-20	-1%
2020	25	10	-15	-59%	1260	1240	-30	-2%
2021	35	11	-24	-68%	1290	1240	-50	-4%
2022	40	12	-28	-70%	1300	1250	-50	-4%
2023	43	12	-30	-71%	1310	1250	-60	-4%
2024	44	12	-32	-72%	1310	1250	-50	-4%
2025	46	12	-34	-73%	1310	1250	-50	-4%
2026	48	13	-35	-73%	1310	1260	-60	-4%
2027	47	13	-34	-73%	1310	1260	-50	-4%
2028	47	13	-34	-72%	1320	1260	-60	-4%
2029	46	13	-33	-72%	1320	1260	-60	-4%
2030	45	13	-33	-72%	1320	1270	-60	-4%
Cumulative undiscounted reduction in technology spending 2017-2030			**-350**	**Billion**	**Industry supports 50–60,000 fewer jobs starting in 2021**			

Adapted from NPRM Table VII-5, Federal Register page 43265

Figure 2B: Rollback of Vehicle GHG Standards: Agency Estimate of Impacts on Technology Cost and Labor Hours

Spending on Technology (Technology Costs) Beyond MY 2016 (in billions)				
	Standards		Change	
	Baseline (Under existing standards thru 2025)	Proposed (Under "preferred option" freezing standards in 2020)	Difference in $B	Percent change in technology spending
2017	3	2	-1	-48%
2018	9	4	-6	-61%
2019	15	5	-10	-64%
2020	21	7	-14	-68%
2021	30	8	-21	-71%
2022	34	9	-25	-74%
2023	38	9	-29	-76%
2024	40	9	-31	-78%
2025	42	9	-33	-79%
2026	46	9	-37	-80%
2027	48	9	-39	-81%
2028	50	9	-40	-81%
2029	50	9	-41	-82%
2030	50	9	-40	-81%
Cumulative undiscounted reduction in technology spending 2017-2030			**-367**	**Billion**

Domestic Labor Hours (1000s of Job-Years)			
Standards		Change	
Baseline (Existing standards)	Proposed (Preferred option)	Difference in job-years	Percent change in domestic labor hours
1170	1170	0	0%
1210	1200	-10	-1%
1230	1220	-20	-1%
1260	1230	-20	-2%
1280	1240	-40	-3%
1290	1240	-40	-3%
1290	1250	-50	-4%
1290	1250	-50	-4%
1300	1250	-50	-4%
1310	1250	-50	-4%
1310	1260	-60	-4%
1320	1260	-60	-5%
1320	1260	-60	-5%
1330	1260	-60	-5%
Industry supports 50 - 60,000 fewer jobs starting in 2021			

Adapted from NPRM Table VII-26, Federal Register page 43291

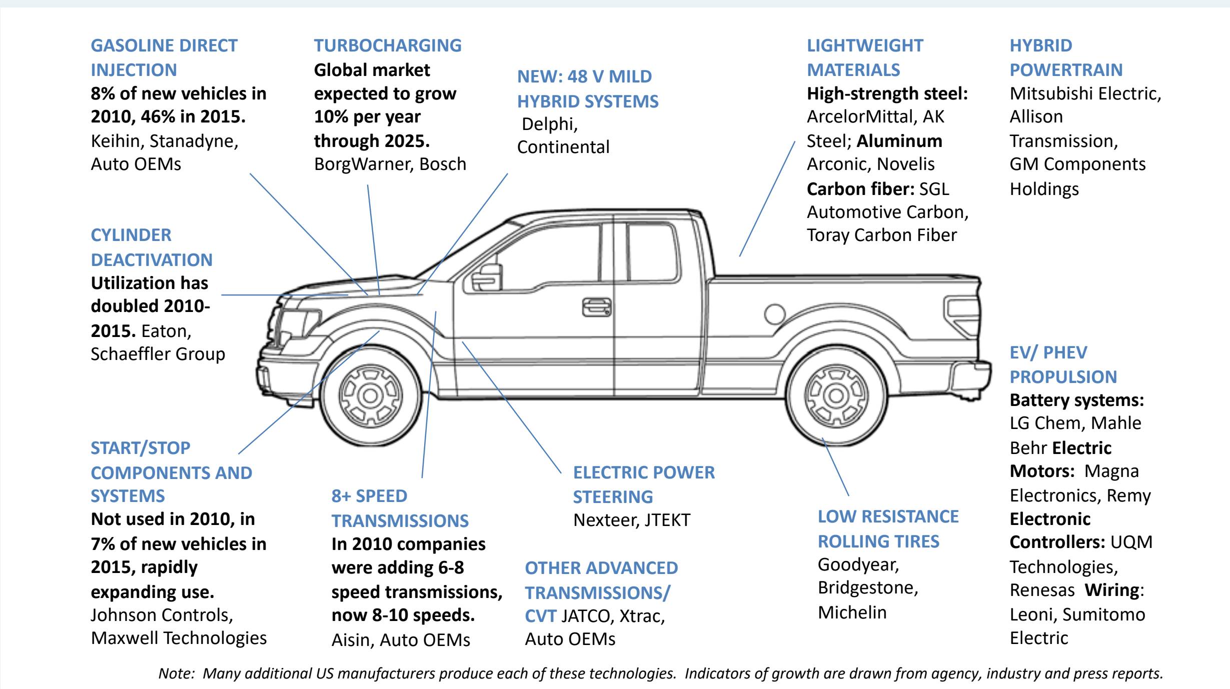
IV. THE IMPACT OF A ROLLBACK ON TECHNOLOGY DEPLOYMENT, MANUFACTURING, AND JOBS

Achieving higher fuel economy and cutting GHG emissions requires innovation across a variety of vehicle systems. In fact, there are many possible ways for different automakers that make different types of cars, SUVs, and trucks to meet any given fuel economy target.

The diagram below (Figure 3) provides an example of the kinds of technologies that could be used by a manufacturer of pickup trucks, for example, to improve fuel economy and cut emissions. To achieve different levels of emissions reduction, a manufacturer might choose to use just one or several of the technologies. And different manufacturers might use different groups of technologies to achieve the same result. For example, between 2010 and 2016, Ford chose to utilize a more efficient engine design and a much lighter aluminum body to achieve fuel economy improvements in the F150 pickup. At the same time, GM chose more modest lightweighting, and added mild hybrid assist to the advanced engine in its Silverado pickup[21]. For both automakers the innovations enabled the company to meet fuel economy targets and provide improvements to vehicle performance. Over the past decade, we've seen how strong and smartly structured standards have encouraged innovation across all types of vehicles and across a wide range of technologies.

In order to calculate the impact of a rollback on individual technologies, we utilize the same computer models that the agencies use to assess the feasibility and cost of proposed vehicle standards. These models simulate the entire fleet of new vehicles in America and predict the lowest cost technological pathways for every automaker (given their particular mix of vehicles) to achieve compliance with fuel economy and GHG standards in every year. When the estimates for every vehicle are rolled together, the model provides an estimate of how much of each fuel efficiency-related technology is used throughout the fleet. The model allows us to see the difference between technologies

Figure 3: Examples of Vehicle Components That Improve Fuel-Efficiency and Cut Emissions



Source: BlueGreen Alliance and Natural Resources Defense Council, *Supplying Ingenuity II: U.S. Suppliers of Key Clean, Fuel-Efficient Vehicle Technology* that would be used to meet the current standards that continue to increase thru 2025 and by contrast how much more or less technology would be used in the case of the agencies' preferred alternative in which standards stop increasing in 2020.

Different Models Tell Different Stories

The models that the agencies use to create a picture of the automotive sector rely on extensive industry data that automakers report, and decades of research by the agencies, technical experts, and others about advanced technology innovation, deployment, and costs in the sector. At the same time, however, the models can reflect very different assumptions about how the technology will be deployed. NHTSA uses the "CAFE Compliance and Effects Model", known as the "Volpe Model," to estimate the outcomes of changes to the rule. NHTSA's 2018 Volpe modeling for the NPRM has been criticized by many experts for changes to approach relative to previous modeling done by NHTSA and EPA to support the 2016 Technical Assessment Report and the previous midterm review of the standards.

In order to look at manufacturing and jobs impacts under both approaches we compare the results from two different runs of the Volpe model—the one used by NHTSA in the current NPRM, and one that utilizes assumptions that more closely simulate those used by the agencies in 2016 for the joint draft technical assessment report (TAR).[22, 23] Major differences between the models include the inclusion or exclusion of state Zero-Emission Vehicle requirements, assessments of the complexity and availability of cylinder deactivation and transmissions, differences in assumptions around the cost and effectiveness of these same technologies, assumptions around whether automakers will increase or decrease the performance of vehicles, and the use of different baseline vehicle fleets.

In both cases we look at what technology would be deployed under the existing or "augural" standards as compared to a rollback scenario where required fuel economy improvements halt in 2020. We then compare those results with our data on the manufacturing facilities across America that build these technologies.

In reality, each automaker chooses how they will comply with standards. They could choose either of these pathways or still others that were not modeled by the agencies. But in either approach, we find a rollback means much less technology deployed.

What We Found

The Volpe model tracks technologies critical to fuel economy improvement in major technology categories. Not all technologies' use increases as standards rise, some less advanced technologies (e.g. 6-speed automatic transmissions) would be replaced by newer technology (e.g. 8- and 10- speed transmissions) and thus decline. In the case of a rollback, investments in these less advanced technologies continue, while investment in the new technology is reduced or halted. Overall, however, in line with industry findings of far lower technology spending, we find significant growth foregone. A rollback means much less technology deployed and less future demand for the companies that build them.

The charts in the following sections show what percentage of the vehicle fleet would use key technologies under each deployment model if standards increase through 2026, versus if they are flatlined in 2020. The charts show impact on key technologies in each major vehicle system, the companies which make those technologies in our data, and their location nationwide.

Our analysis vividly shows that regardless of the modeling approach used, flatlining the standards in 2020 significantly slows adoption of advanced technologies in almost every vehicle subsystem, and cuts demand for products made by hundreds of manufacturers and hundreds of thousands of workers all across the country.

Today, approximately 326,000 Americans work nationwide in the facilities that manufacture the technologies we review in this report. But these companies and facilities are not uniform. Many of these companies have already invested in R&D and plant and equipment and have hired or plan to hire new staff to meet the demand for new technology anticipated under the existing and augural standards. Others had planned to invest or expand in the near future. Some will face stranded spending or assets should there be major changes to the existing and augural standards, while others may not see expected growth. Some of the companies in our data make just one or a few of these technologies, and whether demand increases or decreases for specific technologies is likely to have profound effects. Others make multiple technologies, including some that may increase while others decline.

In our analysis we associate each technology, and the degree to which it is anticipated to increase or decline, with the manufacturing facilities that make those technologies and an estimate of their exposure to changes in demand for fuel efficiency related technologies.

> **Our analysis vividly illustrates that—regardless of the modeling approach used—flatlining the standards in 2020 significantly slows adoption of advanced technologies in almost every vehicle subsystem and cuts demand for products made by hundreds of manufacturers and hundreds of thousands of workers all across the country.**

Figure 4: Estimated Impacts of Fuel Economy Standards and Rollback by Type of Vehicle Technology

	Number of Companies Potentially Impacted	Number Of U.S. Manufacturing Facilities Potentially Impacted	Employment At These Facilities Today	Projected Future Job Growth Under Existing Standards	Number Of Future U.S. Vehicle Technology Manufacturing Jobs Lost Or Foregone Under Weaker Standards
Engines and engine components	42	97	149,000	+16,000 to +71,000	-16,000 to -71,000
Transmission technology[24]	16	32	25,000	0 to -1000	0 to +1000
Hybrid and electric technology	170	213	69,000	+26,000 to +91,000	-26,000 to -91,000
Accessories and mass reduction	85	235	83,000	+41,000 to +48,000	-41,000 to -48,000
TOTAL			**326,000**	**+89,000 to +202,000**	**-89,000 to -202,000**

When we calculate the impact of changes in demand for the specific technologies identified on the share of workers at each type of company likely to be highly vulnerable to technology shift, **we find between 89,000 and 202,000 of tomorrow's jobs lost or foregone as a result of the rollback.**

A summary of our results by major vehicle technology type are found in Figure 4, above.

Again, these jobs estimates only reflect the nearest-term impacts of loss of future investment in advanced vehicle technology due to relaxing vehicle standards. They do not include impacts that might result from changes to the competitiveness of the industry, or to location of production overall, as technology changes globally.

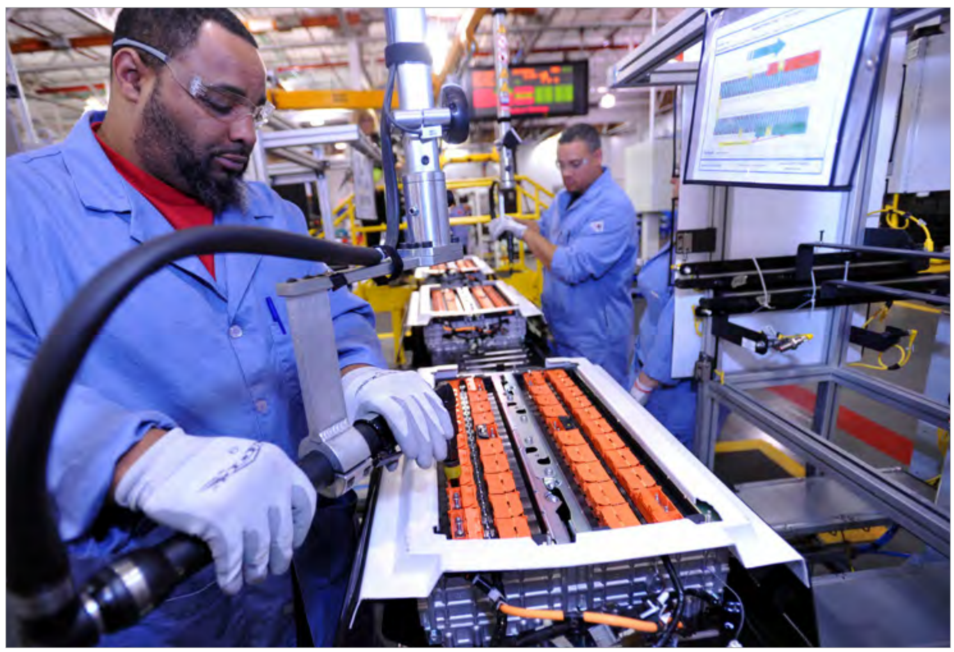


Photo Courtesy of Ford Motor Co.

Detailed Results

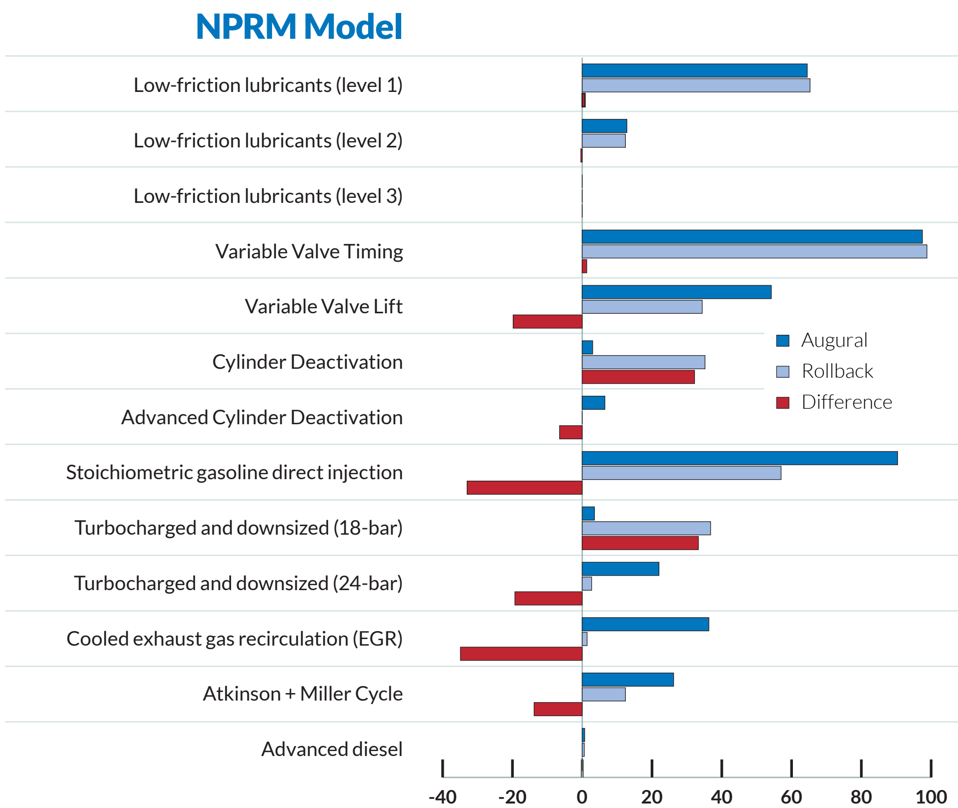
Figures 5–8 on the pages that follow show the impact of changes to the existing/augural standard on major vehicle subsystems and technology.

When we calculate the impact of changes in demand for the specific technologies identified on the share of workers at each type of company likely to be highly vulnerable to technology shift, we find between 89,000 and 202,000 of tomorrow's jobs lost or foregone as a result of the rollback.

Engine Technology

As shown in Figure 5a, very few engine technologies in any modeling scenario are required to be deployed uniformly across the fleet, indicating that manufacturers have a diverse assortment of powertrain options to meet any future standards. However, it is clear when comparing the 2020 and 2025 modeling results that there is a dramatic drop-off in investment in more expensive and complex technologies. For example, 24-bar turbocharged-downsized (TDS) engines see a 20-30 percent penetration when meeting the 2025 standards, but that drops below 10 percent when the standards are held at 2020 levels, with that leading to more penetration of the less advanced 18-bar TDS engines. There is also a dramatic drop in stoichiometric gasoline direct injection, from near ubiquity when meeting the 2025 standards (80-90 percent) to levels barely above the current fleet penetration if standards are held at 2020 levels (see Figure 9).

Figure 5a: Engine Technology Deployment in the New Vehicle Fleet in 2032 Under Existing/Augural Standards That Increase Through 2025, and Under the Agencies' "Preferred Option" Freezing Standards at 2020 Levels



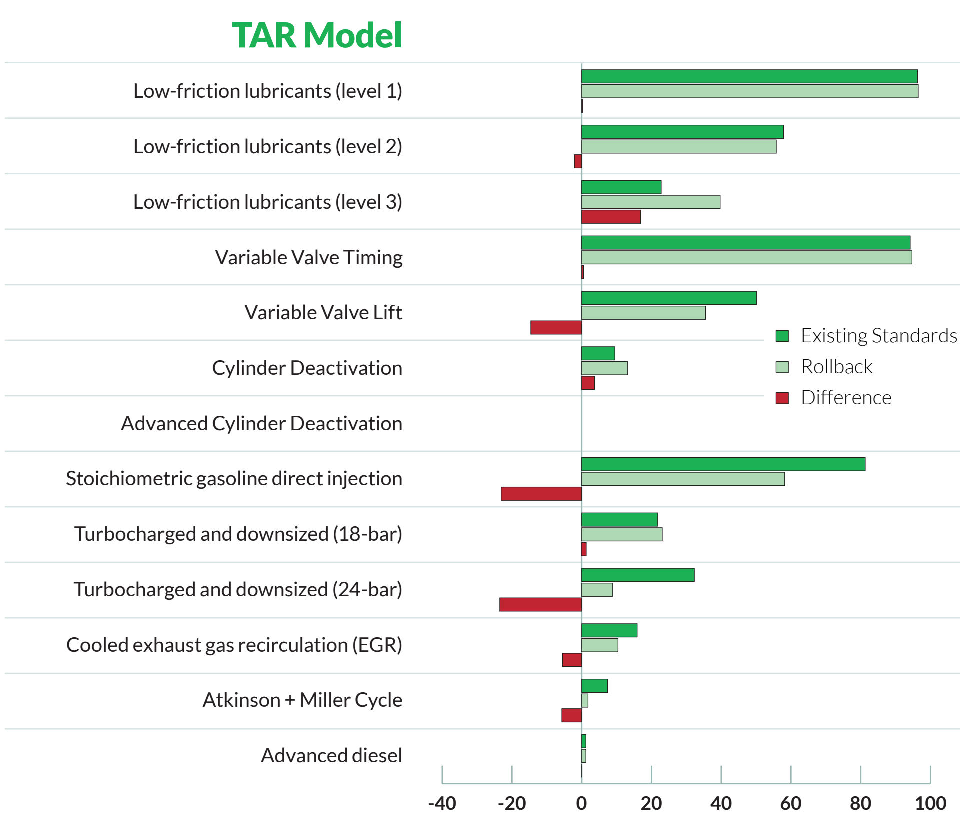
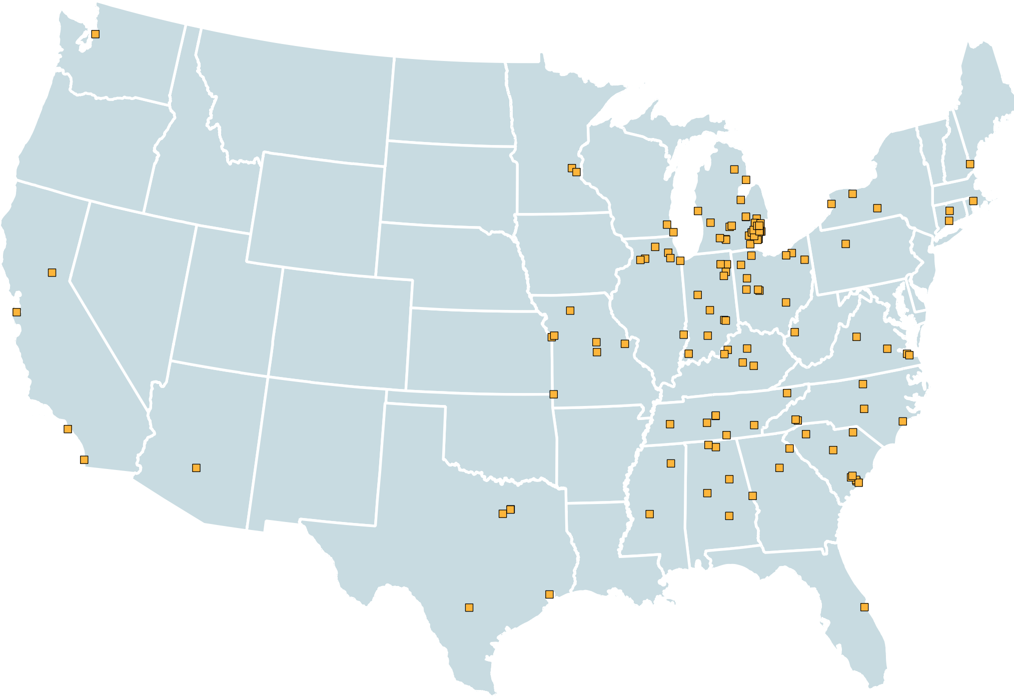


Figure 5b: Selected Companies Manufacturing Engines and Engine Technologies in the U.S. and Their Location



Our data shows 42 companies manufacturing advanced engine technology at 97 locations in the United States.

These facilities employ approximately 149,000 American workers.

Our analysis suggests that 16,000 to 71,000 future jobs in this sector could be lost or foregone should the nation move away from the ongoing fuel economy and GHG increases in the existing/augural standards.

Achates Power
American Axle & Manufacturing
Autocam Corporation
BMW Manufacturing Co
Borg Warner
Borg Warner Morse TEC
Bosch
Continental Automotive
ContiTech Thermopol
Cooper Standard
Cummins Turbo Technologies
Dana Incorporated
Delphi Technologies
Denso Manufacturing
Eaton
EFI Automotive
FCA (Fiat Chrysler Automobiles) US LLC
Ford Motor Company
General Motors
Hitachi Automotive Systems Americas, Inc.
Honda of America Manufacturing
Honeywell Transportation Systems
Hyundai Motor Manufacturing
Keihin
Kia Motors
Magneti Marelli USA
Modine Manufacturing
Nissan North America
Praxair Surface Technologies
PurePower Technologies
Ricardo
Rotomaster
Schaeffler Group USA
Senior Flexonics
Stanadyne
Subaru
TE Connectivity
TI Automotive
Toyota Motor Manufacturing
Tula Technology
Valeo
Volvo Car: U.S. Operations

The companies listed here may also manufacture other advanced clean or fuel-efficient technologies. In addition, our dataset is not comprehensive. It is likely that additional companies and facilities manufacture these technologies in the United States.

This analysis is an estimate of the impact of regulatory changes on sub-sectors of the industry. It does not predict impacts on any specific company or location.

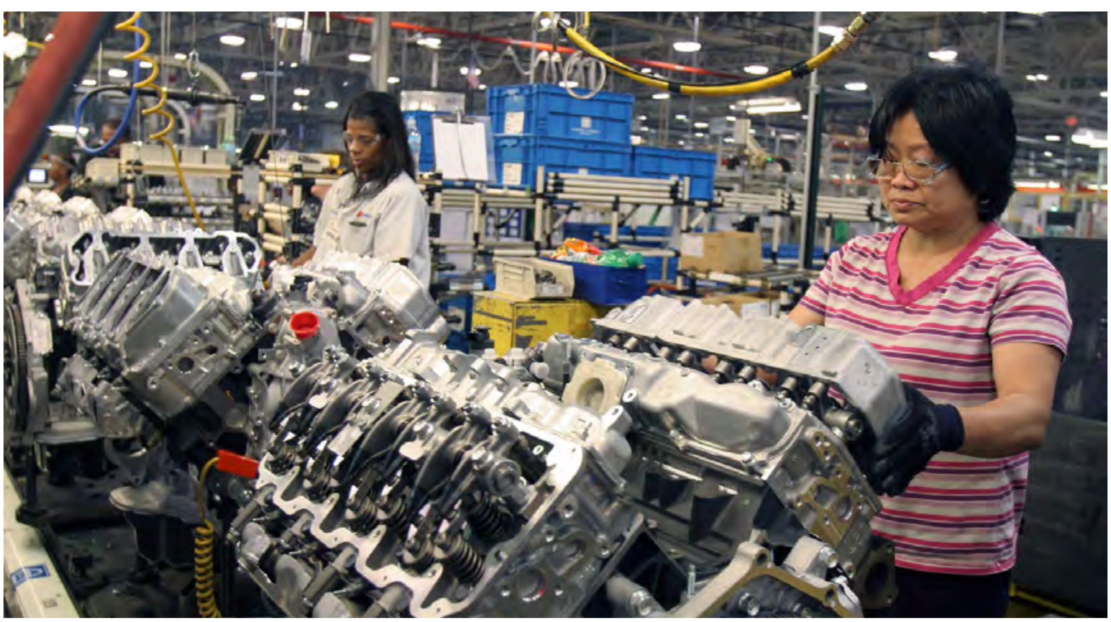


Photo Courtesy GM by Skip Peterson for DMAX

Transmission Technologies

As was the case for engines, Figure 6a shows that there is a broad array of transmission technologies that can be deployed to meet future vehicle standards. And again, what is observed is that a reduced standard results in greater penetration of lower-tech solutions and less deployment of more advanced technologies. This is most pronounced in the TAR modeling runs, which shows less than 10 percent penetration of the most common transmission seen today, a 6-speed automatic, while freezing standards at 2020 levels would see a fleet retaining more than 40 percent adoption, similar to today's levels. This also holds true when comparing continuously variable transmissions, which have seen growth over the past decade in response to strong standards. These trends are less pronounced in the NPRM results due to the pathway approach of the NPRM Volpe model that leads the fleet to adopt transmission technologies with less consideration of individual cost or effectiveness.[25]

Overall, shifts in the stringency of the standards result in shifts amongst transmission technologies often manufactured by the same companies, and thus in only modest impacts on employment. Under strong standards we would expect to see increased labor hours as companies deploy more advanced transmissions with greater content, and deploy more types of transmissions. Our methodology does not allow us to make this granular a distinction amongst transmission technologies, however. If it did, we might expect to see modest losses rather than gains under a rollback in this technology category.

Figure 6a: Transmission Technology Deployment in the New Vehicle Fleet in 2032 Under Existing/Augural Standards That Increase Through 2025, and Under the Agencies' "Preferred Option" Freezing Standards at 2020 Levels

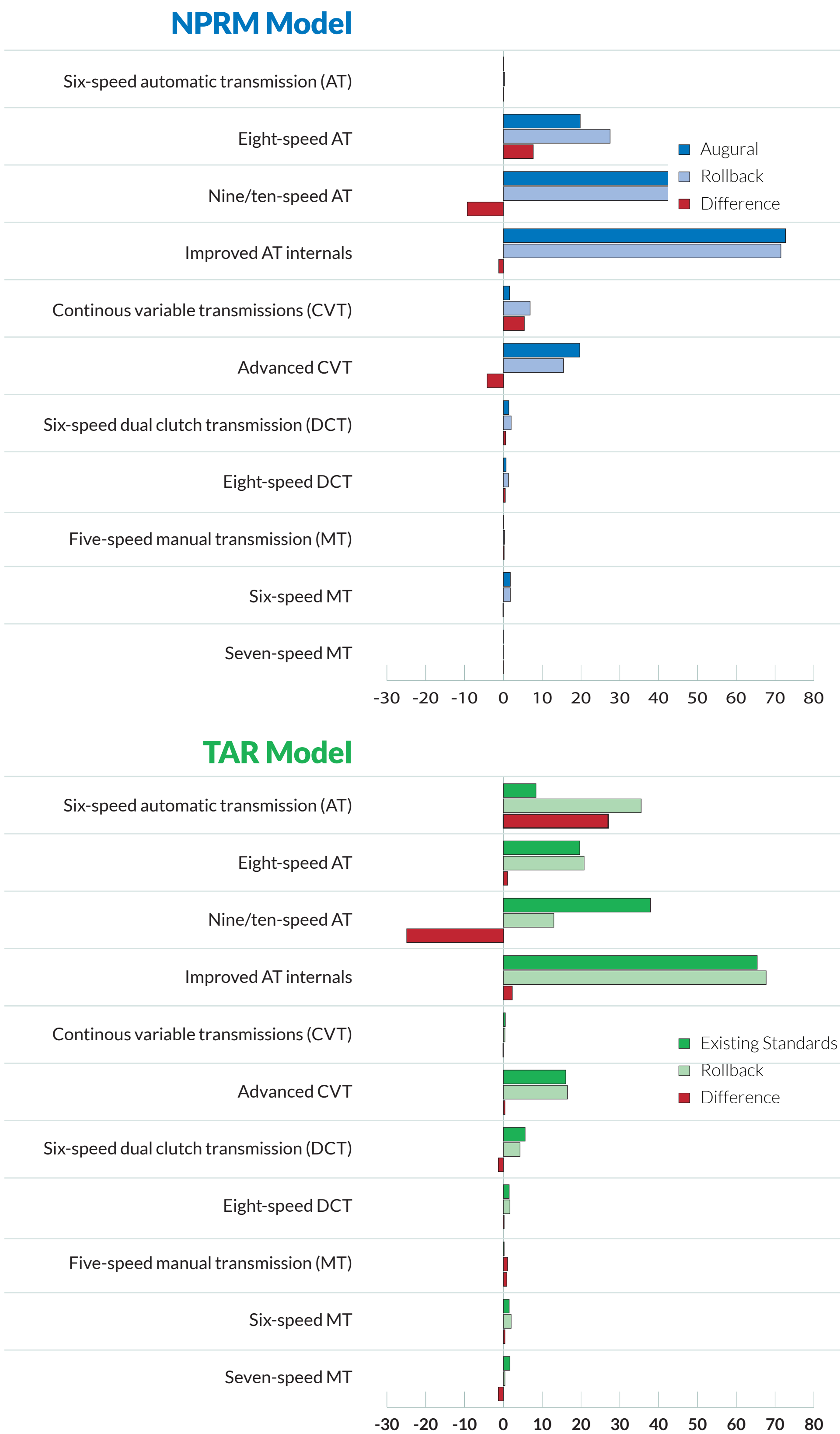
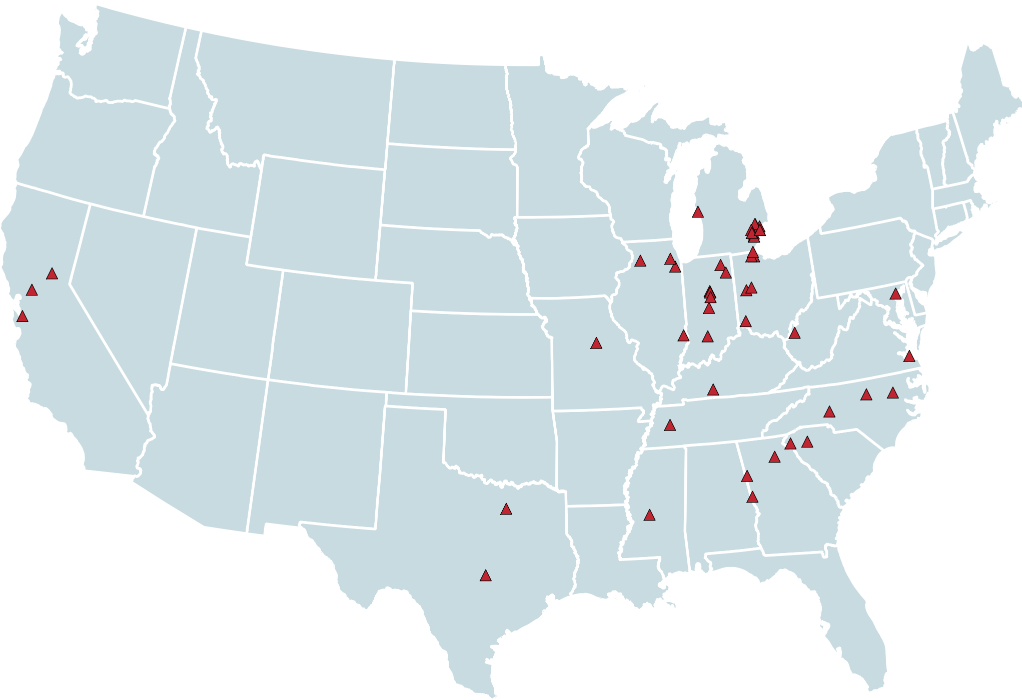


Figure 6b: Selected Companies Manufacturing Transmissions and Transmission Technologies in the U.S. and Their Location



Our data shows 16 companies are manufacturing transmission technology at 32 locations in the United States.

These facilities employ approximately 25,000 American workers.

Our analysis suggests that the sector could gain 0 to 1,000 jobs should the nation move away from the ongoing fuel economy and GHG increases in the existing/augural standards.

Aisin World Corporation of America

Borg Warner

Dana Incorporated

Efficient Drivetrains

Fallbrook Technologies, Inc

FCA (Fiat Chrysler Automobiles) US LLC

Ford Motor Company

General Motors

Hilite International

Honda of America Manufacturing

Hyundai Powertech

Keihin Carolina System Technology (KCST)

NHK of America Suspension Components (NASCO)

Tremec

Xtrac

ZF

The companies listed here may also manufacture other advanced clean or fuel-efficient technologies. In addition, our dataset is not comprehensive. It is likely that additional companies and facilities manufacture these technologies in the United States.

This analysis is an estimate of the impact of regulatory changes on sub-sectors of the industry. It does not predict impacts on any specific company or location.

Photo by: Sam VarnHagen/Ford Motor Co.

Hybrid and Electric Vehicle Technologies

The electrified powertrains technologies identified in Figure 7a tend to be more costly compared to other technology options, and as a consequence are likely to be one of the last to be chosen, according to the model's "effective cost" algorithm. Therefore, these technologies are some of the most susceptible to changes in the stringency of the program, which is borne out in the modeling results in Figure 7a. This is especially pronounced in the NPRM results, for which the modeling assumes more than half the vehicle fleet will need to adopt strong or mild hybridization in response to the current standards. In contrast, under a freeze at 2020 levels, virtually no mild or strong hybridization would be required, and levels of start-stop would barely budge above today's levels. However, given the rapid reduction in battery costs over the past five years, these technologies are expected to become increasingly affordable. While the TAR model does not predict that automakers would utilize nearly as high levels of hybridization to meet the standards, stepping away from standards that drive investment in these advanced technologies would, in either case, represent a major step backward in the technologies expected to be critical to the future of the industry beyond 2025.

Figure 7a: Hybrid and Electric Vehicle Technology Deployment in the New Vehicle Fleet in 2032 Under Existing/Augural Standards That Increase Through 2025, and Under the Agencies' "Preferred Option" Freezing Standards at 2020 Levels

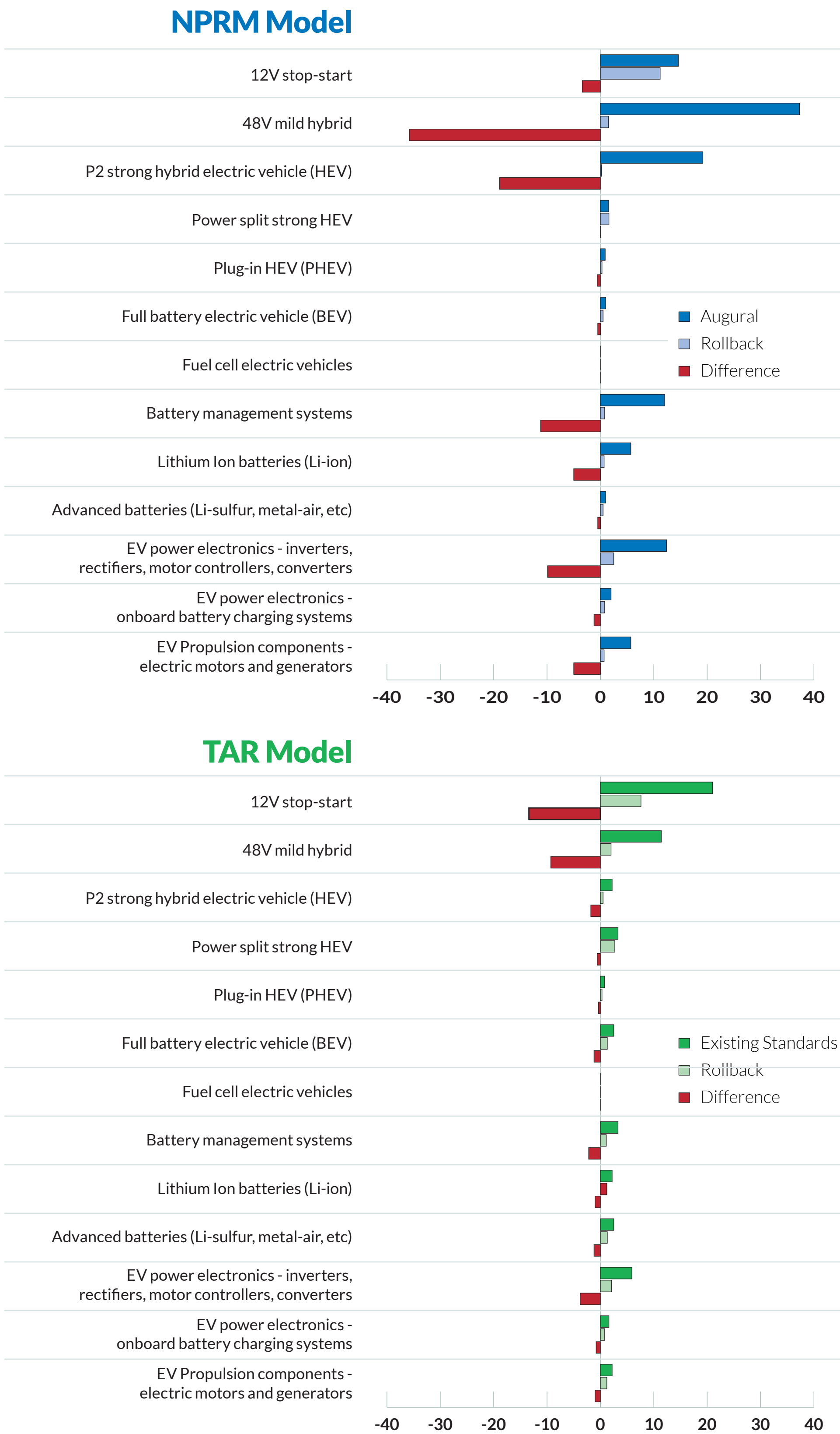
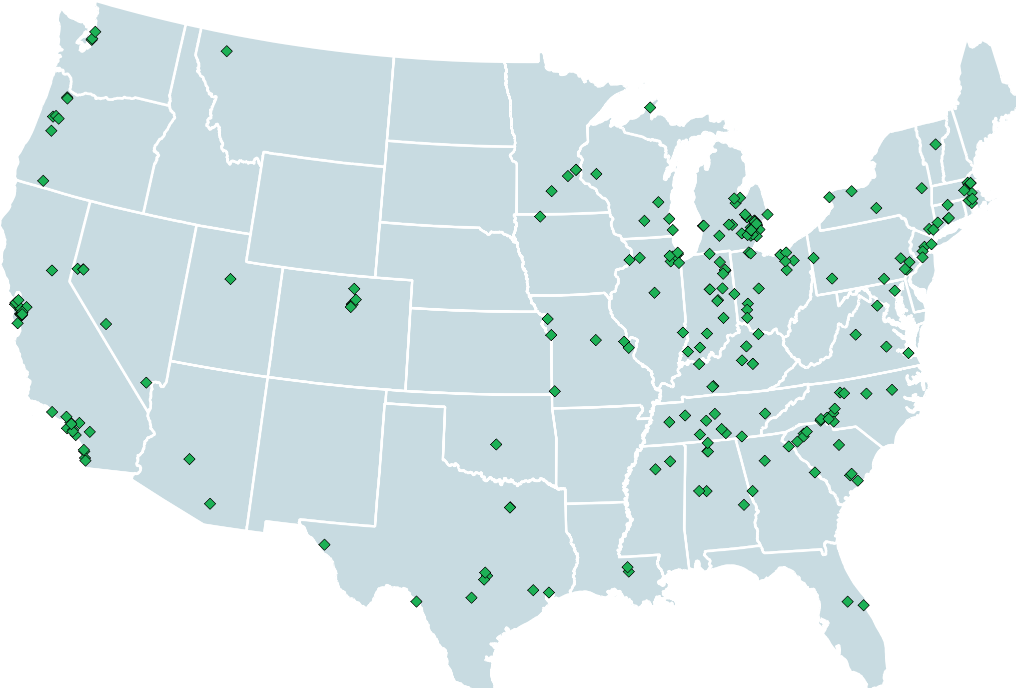


Figure 7b: Selected Companies Manufacturing Hybrid and Electric Technologies in the U.S. and Their Location



Our data shows 170 companies manufacturing hybrid and electric vehicle technology at 213 locations in the United States.

These facilities employ approximately 69,000 American workers.

Our analysis suggests that 26,000 to 91,000 future jobs in this sector could be lost or foregone should the nation move away from the ongoing fuel economy and GHG increases in the existing/augural standards.

3M Corporation
A123 Systems
AC Propulsion
ACTIA US
ADVICS Manufacturing
Airbiquity
Albemarle
AllCell Technologies
Alta Motors
Altair Nanotechnologies
ALTe
American Lithium Energy Corporation
Amprius
Analog Devices
Andromeda Interfaces
Applied Nanotech
Arcimoto
Ardica Technologies
Atomized Products Group
Axion Power International
BASF
BASF Catalysts
BASF Toda America
Bender
Bettergy
Borg Warner
Bosch
Brammo
Cadenza Innovation
Café Electric
Caleb Technology Corporation
California Lithium Battery
CAMX Power
Celgard
Chargetek
Chasm Advanced Materials
Continental Automotive
CoorsTek Fluorochemicals
Coulometrics
Coveris Advanced Coatings
Curtis Instruments
Daikin
Dana Incorporated
Daramic
Delco Remy
Delphi Technologies
DENSO
Dexmet Corporation
Dreamweaver International
DuPont
EaglePicher Technologies
East Penn Manufacturing
Eaton Cooper Bussman
Elegus Technologies
EnerG2
Enevate
Entek
Evans Capacitor Company
Federal-Mogul Systems Protection
Ford Motor Company
Forge Nano
Freudenberg NOK
Fujitsu Electronics America
G&S Titanium
General Motors
GeneSiC Semiconductor
Gentherm
GKN Driveline
Glatfelter
Gotion
Green Gears
GS Yuasa
Hemlock Semiconductor Group
Henkel Electronics Materials
Hitachi Automotive Systems Americas
Hollingsworth and Vose
Honda of America Manufacturing
II VI Marlow
Inmatech
Innova EV
Johnson Controls
Johnson Matthey Fuel Cells
K2 Energy Solutions
Karma Automotive
KEMET Corporation
Kimball Electronics Group
Kongsberg Automotive
LG Chem Michigan
Linde Group
Livent Corporation
Lucid Motors
Magna Electronics
MAHLE Behr
Mainstream Engineering
Materion Tech Materials
Maxim Integrated Products
MaxPower
Maxwell Technologies
Mercedes-Benz US International (MBUSI)
Midtronics
Mitsubishi Electric
Myers Motors
NEI Corporation
NetGain Motors
Nissan North America
Nitto Automotive
NOHMs Technologies
Novarials
Nuvera Fuel Cells
NXP Semiconductor
Oak-Mitsui
Optodot
Panasonic
Paraclete Energy
Pellion Technologies
Pi Innovo
Planar Energy
Plug Power
Polaris Industries
PolyPlus Battery Company
Powerex
Prayon
Prieto Battery
Primet Precision
Proton Onsite
Pyrotek
QuantumScape
RAPA LP
Renesas Electronics Corporation
Rinehart Motion Systems
Rivian Automotive
Robert Bosch Battery Systems LLC
Romeo Systems
Sakti3
Samsung SDI
SBE Electronics
Seeo
Sendyne Corporation
Sensata Technologies
Sevcon
Showa Denko Carbon
Silatronix
SiNode Systems
Sion Power Corporation
Solid Power
SolidEnergy Systems
Soltex
Solvay
Soulbrain
Sumitomo Electric
TE Connectivity
Tesla Motors
Texas Mineral Resources Corporation
Texmac
TIC Automotive Systems
Toray Fluorofibers
TreadStone Technologies
Umicore Autocat USA
UQM Technologies
VIA Motors International
Voltronix
Wells Vehicle Electronics
Wildcat Discovery Technologies
Wolfspeed
XALT Energy
XG Sciences
ZAF Energy Systems
Zero Motorcycles
ZF
ZincFive

The companies listed here may also manufacture other advanced clean or fuel-efficient technologies. In addition, our dataset is not comprehensive. It is likely that additional companies and facilities manufacture these technologies in the United States.

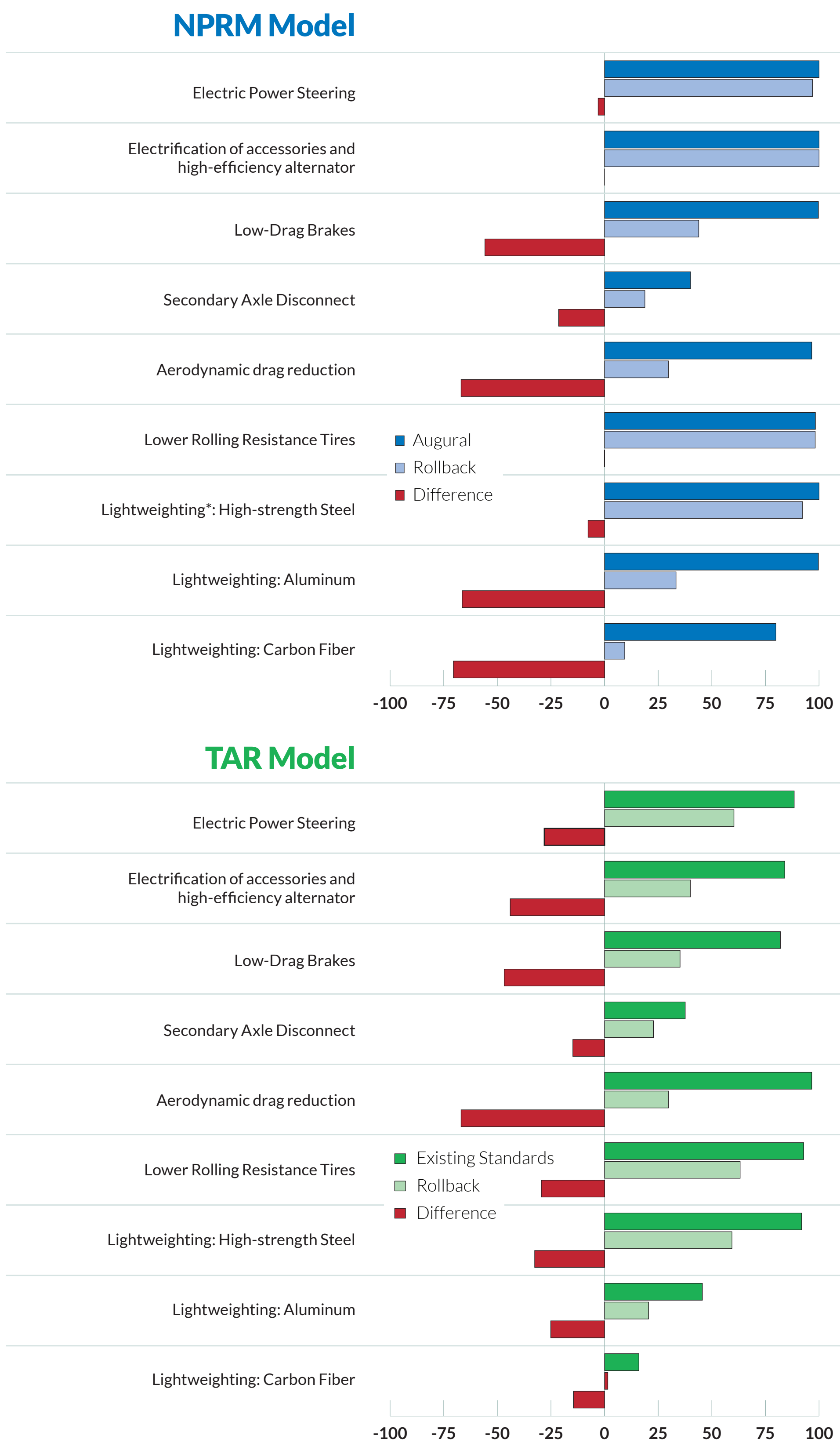
This analysis is an estimate of the impact of regulatory changes on sub-sectors of the industry. It does not predict impacts on any specific company or location.

Accessories and Materials

Technologies that reduce vehicle and accessory load are at the other end of the spectrum from electrification. Many of these represent some of the most cost-effective means to improve efficiency and are strongly adopted under all scenarios. However, the most advanced technologies in this space could see large reductions in deployment as a result of a freeze at 2020 levels, including next-generation materials development for lightweighting and rolling resistance reduction, as well as advanced aerodynamics.

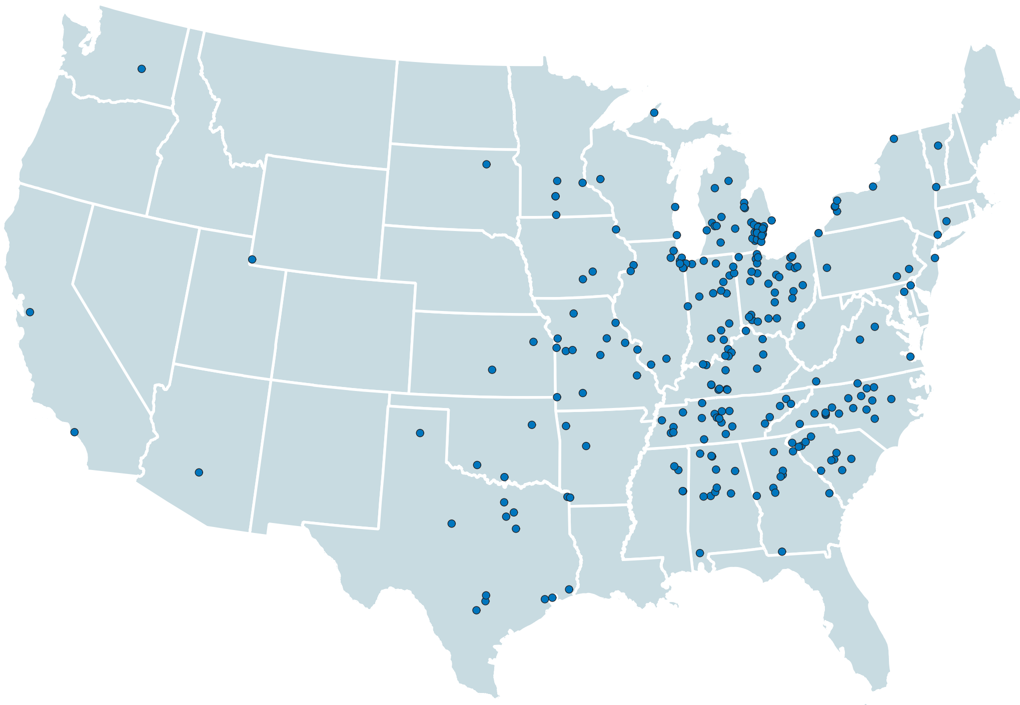
It is important to note that the Volpe model does not project usage of specific lightweight materials, but rather the share of vehicles achieving increasing levels of mass reduction—up to 20 percent mass reduction of the vehicle body. We have assumed that increasingly high levels of lightweighting require the use—at least in part—of high strength lightweight steel, aluminum, and carbon fiber, respectively, in line with National Academy of Sciences assumptions with respect to effectiveness and cost.[26] This data does not project the exact share or intensity of use of different materials within what are now and will continue to be multi-material vehicles.

Figure 8a: Accessory and Materials Technology Deployment in the New Vehicle Fleet in 2032 Under Existing/Augural Standards That Increase Through 2025, and Under the Agencies' "Preferred Option" Freezing Standards at 2020 Levels



*See discussion at left on allocation of lightweight materials to mass reduction categories.

Figure 8b: Selected Companies Manufacturing Efficient Accessories and Mass-Reduction Technologies in the U.S. and Their Location



Our data shows 85 companies manufacturing fuel-efficient accessories and advanced materials at 235 locations in the United States.

These facilities employ approximately 83,000 American workers.

Our analysis suggests that 41,000 to 48,000 future jobs in this sector could be lost or foregone should the nation move away from the ongoing fuel economy and GHG increases in the existing/augural standards.

3M Corporation
A. Schulman
Accuride Corporation
ADVICS Manufacturing
Aisin Drivetrain
AK Steel
Akebono Brake Corporation
Alcoa
Aleris Rolled Products
American Axle and Manufacturing
American Showa
American Synthetic Rubber Company
ArcelorMittal
Arconic
Associated Fuel Pump Systems Corporation
Benteler Automotive
Bodine Aluminum - Toyota
Borg Warner
Bosch
Bowling Green Metalforming, a Magna company
Bridgestone Americas
Buehler Motor
Constellium
Continental
Continental Structural Plastics, Inc.
Continental Tire
Cooper Tire and Rubber Company
Corvac Composites
Covestro
Cytec Carbon Fibers
Dana Incorporated
DENSO
Dicastal North America
Eberspaecher
Electric Fan Engineering
Faurecia
Ford Motor Company
General Motors
GKN Driveline
Goodyear Tires
Hino Motors (Commercial truck division of Toyota)
Hitachi
Hitachi Metals America
JTEKT North America
Kyosan DENSO Manufacturing
Lear Corporation
Materia
Michelin North America
Modine Manufacturing
Nemak
Neuman Aluminum Impact Extrusioin
New Process Steel
Nexteer
Novelis
NSK Steering Systems America
Oliver Rubber Company
Plasan Carbon Composites
Posco Americas
Pro-Tec Coating
SGL Group
Sika Corporation
Solvay
Spartan Light Metal Products
SRG Global
Stahl Specialty
Steel Dynamics
Sumitomo Rubber USA
Superior Essex
Superior Graphite
Superior Industries
TE Connectivity
ThermoAnalytics
Topre America
Toray Carbon Fibers
Toyota Boshoko Tennessee
Truelove & Maclean (T&M)
U.S. Steel Corporation
Valeo
Von Roll U.S.A.
Wescast
Windings
Worthington Industries
ZF Chassis Systems
ZF TRW North America

The companies listed here may also manufacture other advanced clean or fuel-efficient technologies. In addition, our dataset is not comprehensive. It is likely that additional companies and facilities manufacture these technologies in the United States.

This analysis is an estimate of the impact of regulatory changes on sub-sectors of the industry. It does not predict impacts on any specific company or location.

V. NEGATIVE IMPACT ON DOMESTIC INNOVATION AND U.S. COMPETITIVENESS IN KEY EMERGING TECHNOLOGIES

Our analysis, discussed above, shows direct negative impacts of a rollback on investment and jobs across vehicle systems. Looking at individual technologies more closely, however, our data suggests several additional ways in which a rollback could threaten the strength of the U.S. automotive sector.

The two models whose outputs we review are estimates that predict *future* deployment of technology. Meanwhile, the U.S. EPA's *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends 1975-2017* Report (known as the annual "Trends Report") as well as the technical record for the rulemaking, document the *actual* past adoption of these technologies under the standards to date. Looking across both sets of data, we can see the broader role standards (and the rollback) play in innovation.

In Figure 9 we show the actual and predicted deployment of four important fuel economy and emissions reducing technologies between 2010 and 2025. What we see are three consistent themes:

- Even well known and available technologies—such as turbocharging, which has been used to improve performance for decades—are not widely deployed to improve fuel economy in the absence of increasing standards. And even when those technologies become fairly widely deployed (turbocharging is now used in more than 25 percent of vehicles to achieve both efficiency and performance gains) cutting standards results in sharp slowdowns in further deployment.
- Under the existing standards, automakers and suppliers have developed, manufactured, and adopted new and advanced technologies at a steady rate and would be projected to continue to do so should standards continue along the current trajectory.
- A rollback would result in a clear reduction in the pace of technology development and deployment across diverse technologies, but with particularly extreme impacts on the newest and most advanced technologies just entering the market.

Looking at advanced conventional technology, all these analyses show that there is still extensive opportunity to deploy conventional technologies within the fleet, and that a rollback would stop that trajectory far short of full deployment. For more advanced technologies, a rollback could mean the difference between developing robust domestic manufacturing capacity in the United States and ceding that investment elsewhere.

We also note that this data does not show technologies for which there is near zero deployment today, but which under strong standards were expected to grow. These emerging technologies include important enablers of increased hybrid and electric vehicle deployment—such as 48-volt power electronics—but also highly innovative conventional engine technologies, such as an opposed piston gasoline engine currently being demonstrated delivering over 35mpg in a pickup truck.[27]

Furthermore, while meeting existing standards through 2025 does not require high levels of hybrid or electric vehicle penetration, the proposal to dramatically lower 2025 targets—plus failing to set higher targets through 2030 and proposing to limit states' authority to set zero emission vehicle targets—sends a signal that the United States will not be a major player in the electric vehicle market. It discourages investments in technologies like battery cell production, which will be essential to ensuring we capture the jobs and manufacturing benefits of global shifts in vehicle technology over the next decade.

Countries around the world are racing to capture the economic benefits of producing the next generation of cleaner and more efficient vehicle technology. Stepping away from standards that provide the certainty that manufacturers need to invest in and build leading technology in the United States puts the auto sector—and particularly domestic employment in the sector—in jeopardy, in the short, medium, and long term. It is essential that the United States maintains and increases its capability to produce these technologies domestically, and that fuel economy, GHG emissions reduction, manufacturing, and trade policies all support that trajectory.

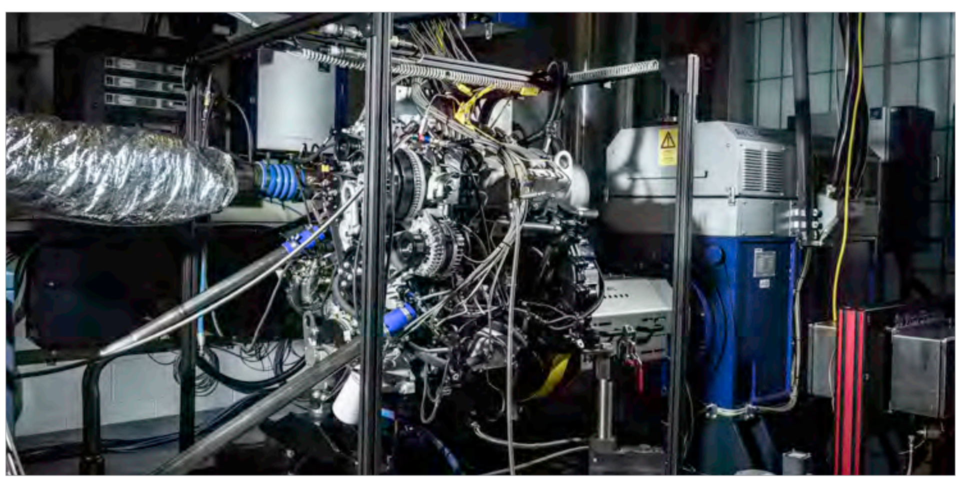
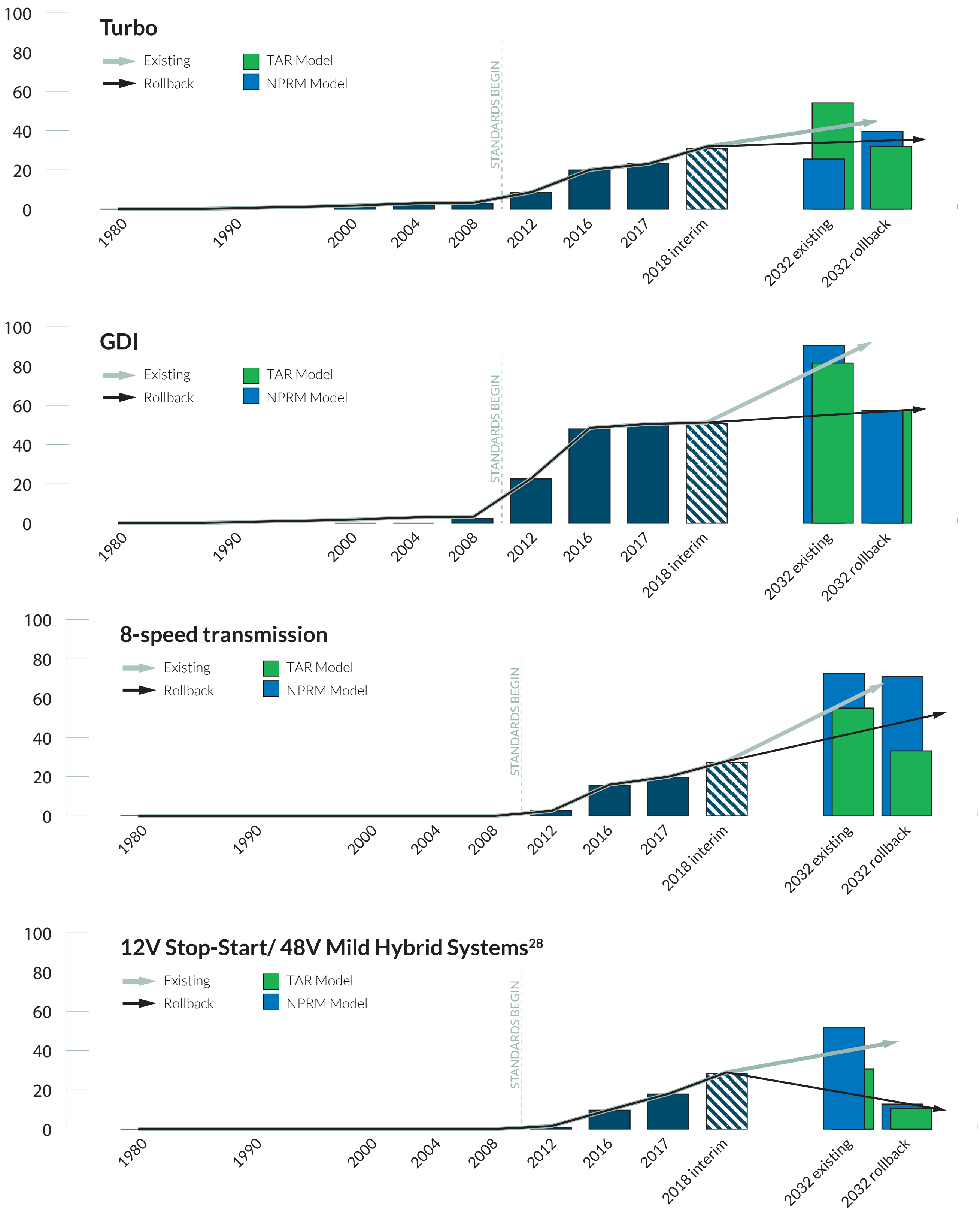


Photo Courtesy Achates Power

Figure 9 – Key Technologies Actual Deployment 1980-2017 and Projected Deployment Under Existing And Proposed Standards Through 2032



Source: Historic Data from 2018 EPA Automotive Trends Report.

VI. CONCLUSION

Rolling back our nation's fuel economy and GHG standards discourages important investments in the next generation of key vehicle technologies in America. Our research modeled two different approaches to technology deployment to meet the standards, and combined those findings with data on the domestic manufacturing facilities that produce these technologies. We consistently found that flat-lining the standards in 2020 greatly slows adoption of advanced technologies made by hundreds of manufacturers and hundreds of thousands of workers across the country.

Our analysis clearly indicates that stepping away from strong standards could have a significant detrimental impact on hundreds of domestic automotive parts suppliers in the short term. Moreover, a roll back of the standards discourages important investments in the next generation of clean and advanced vehicle technologies.

The analysis shows that strong, long-term standards provide a critical framework to help ensure that advanced vehicles and technology are developed and built in the United States. Moreover, the future of the American automotive industry depends on our ongoing leadership, innovation, and competitiveness in a global marketplace. Stepping away from these standards discourages the rapid adoption of advanced technologies and puts at risk American manufacturing growth, competitiveness, and domestic jobs.

APPENDIX A: METHODOLOGY

Over the past year, both the agencies, and independent economic researchers have developed estimates of auto sector jobs impacts of weakening the standards.

Whether through an economic model such as IMPLAN/REMI—or by using industry rules of thumb connecting revenues and employment—these studies translate reduced technology spending into reduced labor hours and jobs industry wide.

In order to give a picture of the dynamics below the industry level, the BlueGreen Alliance intentionally chose a different approach. We calculated the changes in demand for specific technologies as predicted by agency models, and then estimated the impact of those market changes on the companies known to manufacture those technologies across the United States.

Our approach necessarily entails a number of simplifying assumptions. We do not purport to predict the actual impact of a rollback on any specific company or facility. Instead, our results should be viewed as a directional estimate of the impact on important segments of the automotive sector, and as a more detailed picture of the dynamics that lead to the industry wide impacts on jobs and manufacturing that others have also assessed.

It is worth noting that almost all studies—including our own—find broadly similar negative impacts on direct auto sector employment.

To identify the companies manufacturing the technologies considered in clean vehicle rulemaking we drew manufacturing facilities from the BlueGreen Alliance's "U.S. automotive manufacturing" dataset. This larger dataset includes manufacturing locations of automotive assemblers, suppliers, subcomponent, and materials suppliers and includes data on the technology manufactured, its place in the supply chain, plant location, and a variety of other data. It also includes estimates of employment by facility and estimates of "advanced technology employment"—or the share of employment related to technologies or systems that improve fuel economy. This dataset—and the employment data in particular is proprietary, but the companies, locations, and technologies can be explored online at: https://www.bgafoundation.org/programs/visualizing-the-clean-economy-autos/

To be included in the analysis for this report, companies had to manufacture at least in part for the light-duty vehicle sector and manufacture vehicles or technology in the categories considered by the agencies in the rulemaking.

To estimate the share of employment at a facility potentially at highest risk of being impacted by changes to the standards facilities' "advanced tech employment" (already only a portion of most facilities' employment) was further discounted by an estimate of the degree to which the company supplies the light-duty sector, and its exposure to changes in demand for a single type of product. This discounting is significant. It results in a total that is just under 20 percent of full employment today at those facilities.

To create our estimate of future jobs or growth foregone, we calculate the change in out-year (2032) fleetwide deployment of the technology or technologies manufactured by each facility relative to current deployment both under existing standards that continue to increase through 2025 versus those that stop increasing in 2020. We view percentage fleetwide deployment as a proxy for industry demand. We then multiply each facility's vulnerable employment by the relative change in demand as a result of rollback of the standards.

To calculate fleet-wide technology-by-technology deployment, we carried out two runs of the Volpe Model utilized by NHTSA to set the standards. In the results we call the "NPRM" case, our model and our deployment data are identical to the agency's analysis in the NPRM. In our "TAR" case we run the Volpe model utilizing assumptions that more closely replicate analysis done in the Technical Assessment Report used for the 2016 Midterm Evaluation of the standards.

ENDNOTES

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2 Union of Concerned Scientists (UCS), *Fuel Economy and Emissions Standards for Cars and Trucks, Model Years 2017 to 2025*, June 2016. Available online: https://www.ucsusa.org/sites/default/files/attach/2016/06/Fuel-Economy-Standards-2017-2025-summary.pdf.

3 Natural Resources Defense Council (NRDC) and the BlueGreen Alliance, *Supplying Ingenuity II: U.S. Suppliers of Key Clean, Fuel-Efficient Vehicle Technologies*, June 2017. Available online: https://www.bluegreenalliance.org/wp-content/uploads/2017/05/Supplying-Ingenuity-vFINAL-low-res.pdf.

4 All employment data in this section is from the U.S. Bureau of Labor Statistics. Available online: https://www.bls.gov/iag/tgs/iagauto.htm. Analysis and calculations by BlueGreen Alliance. Accessed October 25, 2018.

5 Ibid.

6 International Council on Clean Transportation (ICCT), 2017 *Global Update: Light-Duty Vehicle Greenhouse Gas and Fuel Economy Standards*, 2017. Available online: https://www.theicct.org/sites/default/files/publications/2017-Global-LDV-Standards-Update_ICCT-Report_23062017_vF.pdf; and Foreign Affairs, "Green Giant: Renewable Energy and Chinese Power," March/April 2018. Available online: https://www.foreignaffairs.com/articles/china/2018-02-13/green-giant.

7 Center for American Progress (CAP), United Autoworkers (UAW), and NRDC, *Driving Growth: How Clean Cars and Climate Policy Can Create Jobs*, March 2010. Available online: https://www.nrdc.org/sites/default/files/drivinggrowth.pdf.

8 Synapse Energy Economics, *Cleaner Cars and Job Creation: Macroeconomic Impacts of Federal and State Vehicle Standards*, March 2018. Available online: http://www.synapseenergy.com/sites/default/files/Cleaner-Cars-and%20Job-Creation-17-072.pdf.

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14 Statement of the MEMA before the U.S. Environmental Protection Agency (EPA) "RE: Request for Comment on Reconsideration of the Final Determination of the Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022–2025 Light-Duty Vehicles; Request for Comment on Model Year 2021 Greenhouse Gas Emissions Standards," September 6, 2017. Available online: https://www.mema.org/sites/default/files/resource/MEMA%20Testimony%20EPA%20MTE%20Sept%206%202017.pdf.

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20 Under the coordinated "National Program" EPA has promulgated standards through 2025, while NHTSA has promulgated standards through 2020 and projected standards through 2025 consistent with the longer term trajectory previously agreed with EPA. NHTSA's projected standards are referred to as "augural" standards.

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22 Union of Concerned Scientists, Comments of David W. Cooke concerning the draft technical assessment report for the mid-term evaluation of model year 2022-2025 light-duty vehicle greenhouse gas emissions and fuel economy standards, Docket ID# EPA-HQ-OAR-2015-0827-4016, 2016.

23 Throughout this report, outputs labeled as "NPRM" refer to the outputs of the Volpe model released with the recent NPRM, run in compliance with the current EPA standards and the proposed CO2 standards. Outputs labeled "TAR" refer to a modified version of the Volpe model released with the agencies' joint draft TAR—the model incorporates compliance with state Zero-Emission Vehicle standards as well as minor modifications to technology assumptions which align the modeled cost outputs of this modified Volpe model to align with EPA's OMEGA runs also incorporated in the TAR (see Cooke 2016).

24 As discussed in more detail in the transmission section below, shifts in the stringency of the standards results in shifts amongst transmission technologies often manufactured by the same companies, and thus in only modest impacts on employment (Figure 4). Our methodology does not allow us to reflect differences in the amount of content and labor hours in each type of transmission, which might negate or change the direction of these still modest jobs impacts.

25 Union of Concerned Scientists, Comments by David W. Cooke concerning the draft technical assessment report for the mid-term evaluation of model year 2022-2025 light-duty vehicle greenhouse gas emissions and fuel economy standards, Docket ID# EPA-HQ-OAR-2015-0827-4016, 2016.

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28 The EPA trends report does not yet track deployment of 48V systems. These systems have just begun being deployed in the U.S. fleet, and we have assumed negligible deployment in 2017 and 2018 model years.

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