Supplying Ingenuity

U.S. Suppliers of Clean, Fuel-Efficient Vehicle Technologies

August 2011

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Cover photos:

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EXECUTIVE SUMMARY

Emerging from recent economic turmoil, the United States automotive industry is again profitable. Consumers are demanding cars and light trucks that go farther on a gallon of fuel, and the industry is meeting those demands by adding technologies that improve fuel economy and cut carbon pollution.

Vehicle efficiency and emissions reductions are being further encouraged by the first significant improvements in fuel economy standards for both cars and light trucks in more than two decades, and the first-ever carbon pollution standards, covering model years 2012 to 2016. Additional improvements in the standards currently being developed by the Obama Administration will have a dramatic impact on the future direction and competitiveness of the U.S. automotive industry and the economic growth of the United States as a whole. Moreover, strong standards can save consumers money at the pump.

U.S. suppliers of clean, fuel-efficient vehicle technologies can play a key role in the expansion of U.S.-based vehicle manufacturing that can lead to job gains.

THE AUTOMOTIVE INDUSTRY IS KEY TO ECONOMIC GROWTH

A successful domestic automotive industry is critical for preserving and growing U.S. jobs. Today, the automotive industry directly employs nearly 700,000 U.S. workers. More than 427,000 of those jobs are at automotive suppliers—companies that design, engineer, and manufacture the parts that are eventually assembled into cars and light trucks.

This study assesses the supply chain for clean and efficient vehicle technologies and identifies more than 300 companies that are located in 43 states and the District of Columbia. These clean and efficient vehicle component suppliers are responsible for employing 150,000 workers directly and for employing hundreds of thousands of others indirectly (see Table 1). These companies develop and supply the critical components for advanced internal combustion engines and vehicles, hybrid powertrains, plug-in electric vehicles, and create the electric vehicle charging infrastructure (see Figures 1 and 2).

Table 1: Top 15 States Currently Employing the Highest Number of Autoworkers in Clean, Efficient Technologies

State	Facilities	Employment
Michigan	97	38,067
Ohio	28	13,753
Indiana	30	11,819
Kentucky	6	9,775
Pennsylvania	13	8,662
Texas	22	8,558
Alabama	13	8,285
California	79	7,422
South Carolina	16	6,934
North Carolina	19	5,928
Tennessee	11	5,393
New York	16	5,339
Illinois	23	4,715
Virginia	11	2,373
Arizona	4	1,765
Other States	116	12,380
Total	**504**	**151,168**

Figure 1: United States Suppliers of Low-Emission, Fuel-Efficient Vehicle Technologies (Number of Supplier Facilities by State)

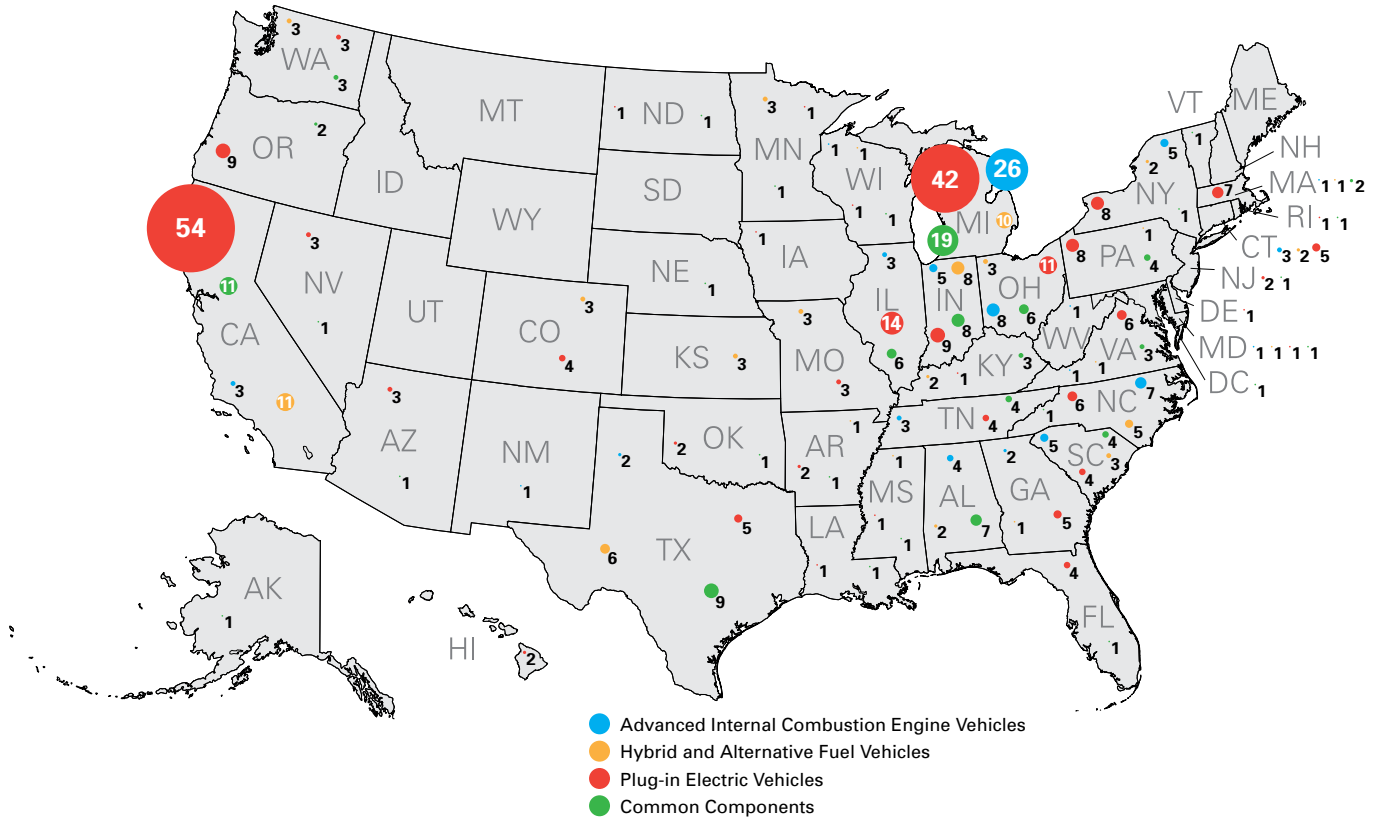
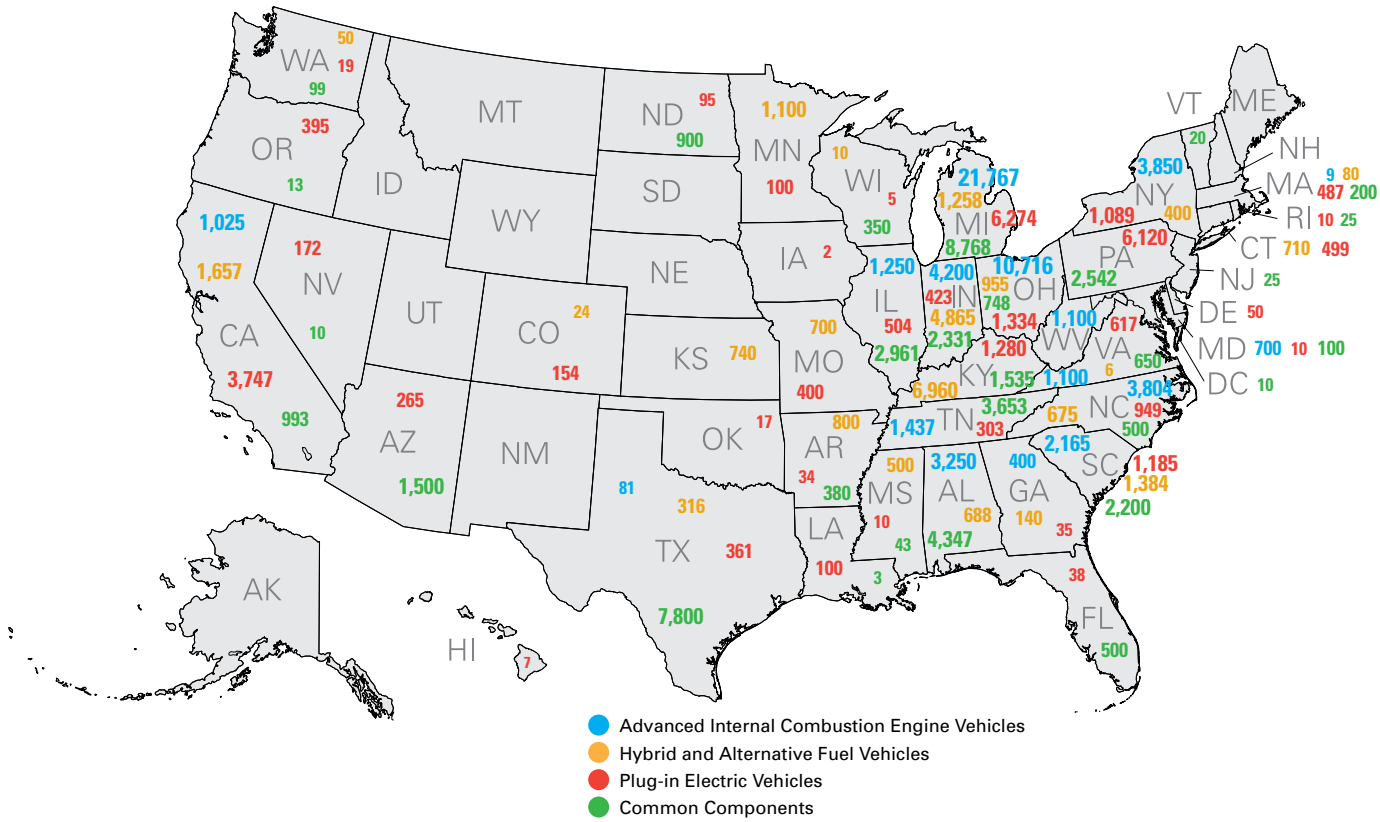


Figure 2: Employment by U.S. Fuel-Efficient Vehicle Technology Suppliers (Number of Supplier Employment by State)



Suppliers and automaker component operations are on the front lines of innovation, producing new fuel-saving and low-emission technologies that add new content to vehicles on the assembly line. By growing the production of these new technologies—including advanced internal combustion engine components, turbochargers, improved transmissions, lightweight structures, electric traction motors, electronic controllers, advanced battery materials, traction batteries, and smart charging systems—suppliers can maintain existing jobs and create new ones.

Improved vehicle fuel economy and pollution performance standards provide the certainty necessary to foster automotive supplier and automaker investment in fuel-saving technologies. Standards that are more similar to those in Europe and Asia will allow automakers and their suppliers to leverage the efficiency of global platforms and powertrains that add scale and reduce costs, leading to lower prices and higher profits.

Further, with ongoing innovation and higher volumes of fuel-saving components that are required to meet U.S. standards, domestic manufacture of these fuel-saving technologies becomes more likely. The recently adopted standards requiring that vehicle model years 2012 to 2016 reach 34.1 miles per gallon provide near-term direction.

The Obama Administration is now developing standards for model years 2017 to 2025 that will have a major impact on long-term investment decisions and, therefore, on innovation and jobs. The 2010 report, "Driving Growth: How Clean Cars and Climate Policy Can Create Jobs," published jointly by the UAW, the Center for American Progress, and the Natural Resources Defense Council[1] showed that up to 150,000 new domestic jobs could be created in the automotive sector if the industry followed a sustained path of improving new vehicle fuel economy and continuing support through complementary polices such as the EISA Section 136 retooling loans.

Strong standards will do the most to cut our nation's oil dependence and carbon pollution, improve our security, and keep billions of dollars in our economy annually instead of sending it overseas for oil. Strong standards will put automotive engineers and production workers on the job, supplying ingenuity for cleaner, more fuel-efficient vehicles.

I. ECONOMIC OPPORTUNITY THROUGH EFFICIENT VEHICLES: THE ROLE OF SUPPLIERS

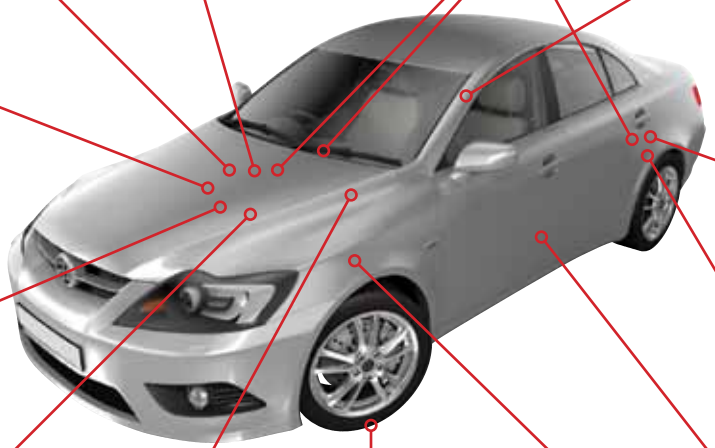
The value and capabilities of a car are determined by the sum of its integrated parts. Automakers assemble the various parts to make the cars that we know by their auto company brand and model names. Lesser known to the average consumer are the thousands of companies that produce the components—the auto suppliers.

A single vehicle model typically has components built by companies across the United States and around the globe—and includes both traditional components and innovative ones that deliver improved fuel economy or performance. Figure 3 shows many of the components of a hybrid car and the U.S. suppliers of those components.

According to statistics from the first five months of 2011, the automobile industry in the United States[2] directly employs an average of 694,000 workers. But even after beginning to recover from the 2009 crisis, auto employment is only half what it was in early 2000. This one-sector collapse predates the financial crisis, caused by the loss of market share by domestic firms and increased imports, and the relocation of production and engineering jobs overseas. The motor vehicle parts sector—identified by North American Industry Classification System (NAICS) code 3363 and by far the largest sector of the industry, employing 427,000 (61 percent) of all motor vehicle industry workers—lost nearly half its jobs since 2000.

Even after recent losses, however, the auto and auto components industry remains the single-largest manufacturing employer in America, and is essential for ongoing economic strength due to the jobs it creates both directly and indirectly, the strong position of the industry with respect to technical innovation, and the link between the auto industry and a variety of other critical economic sectors. While overall economic growth has been modest over the past year as the country has emerged from recession, growth in the manufacturing sector has been robust,[3] helping to power the nation's economic recovery. The auto components sector has played a central role. As the industry continues to recover and production levels increase, the leadership provided by the auto industry will also grow.

Figure 3: Example U.S. Suppliers of Fuel-Efficient Vehicle Components



ENGINE DIRECT INJECTION
SUPPLIERS MANUFACTURING THIS COMPONENT:
Bosch, Continental, Siemens

ADVANCED ENGINE VALVE CONTROLS
SUPPLIERS MANUFACTURING THIS COMPONENT:
GM Components Holdings, Aisin, BorgWarner

ELECTRONIC CONTROLLERS
SUPPLIERS MANUFACTURING THIS COMPONENT:
Arens Controls, Denso, Keihin

HIGH STRENGTH STEEL
SUPPLIERS MANUFACTURING THIS COMPONENT:
AK Steel, Severstal, ArcelorMittal

EXHAUST GAS RECIRCULATION
SUPPLIERS MANUFACTURING THIS COMPONENT:
GM Components Holdings, Keihin, Metaldyne

CAPACITORS
SUPPLIERS MANUFACTURING THIS COMPONENT:
Hemlock Semiconductors, KEMET, Maxwell Technologies

START/STOP COMPONENTS AND SYSTEMS
SUPPLIERS MANUFACTURING THIS COMPONENT:
Denso, Bosch, Johnson Controls, Inc.

BATTERY SYSTEMS
SUPPLIERS MANUFACTURING THIS COMPONENT:
A123 Systems, Johnson Controls, Inc., GM Subsystems Manufacturing

TURBOCHARGERS
SUPPLIERS MANUFACTURING THIS COMPONENT:
Honeywell, BorgWarner, ABB

ELECTRIC POWER STEERING
SUPPLIERS MANUFACTURING THIS COMPONENT:
JTEKT, Nexteer, NTN

FUEL-EFFICIENT TIRES
SUPPLIERS MANUFACTURING THIS COMPONENT:
Michelin, Goodyear, Continental Tires

ADVANCED TRANSMISSIONS
SUPPLIERS MANUFACTURING THIS COMPONENT:
Ford, Chrysler, ZF

ELECTRIC-DRIVE WIRING SYSTEMS
SUPPLIERS MANUFACTURING THIS COMPONENT:
Lear, Yazaki, Sumitomo Electric

New Entrants to U.S. Vehicle Manufacturing

Figuring out which employees should be counted as part of motor vehicle employment and which should be counted as part of other industries is tricky in areas where disruptive technologies are being introduced. For example, automobile battery workers are part of the battery industry, which makes sense since the starter battery is a mature commodity product that is a minor component of the vehicle. The major automakers stopped designing and producing these products a long time ago.

On the other hand, the battery packs for electrified vehicles are the critical element of a revolution in vehicle propulsion, a new and pivotal sector within the motor vehicle industry. As a result, the auto manufacturers are relying on supplier expertise and increasing their in-house capacity in this critical product area.

As an example, General Motors is building a plant near Baltimore to produce electric traction motors for hybrid and plug-in electric vehicles. The employees will be counted as motor vehicle industry workers. If the same motors were produced by Siemens or General Electric, the employment might be counted in NAICS 335312, motors and generators.

The Bureau of Labor Statistics supplier classifications are linked to the main business line of the employer, which is appropriate for conventional vehicle technologies that have dominated the market for decades. The emergence of hybrid and plug-in electric vehicles has brought new sectors to the industry and results in new entrants that provide sophisticated electronics, traction motors, batteries and battery packs, networked electric vehicle charging points, and dozens of other components.

As noted above, some automakers are choosing to engineer and produce these components in-house, figuring that these products are core competencies to be mastered for a competitive advantage. These cutting-edge technologies—in most cases for electrification, but also to refine combustion processes—are creating opportunities in the vast auto supplier industry for new entrants with new ideas, which provides the basis for a green-based revival of the domestic auto industry.

JOB GROWTH DEPENDS ON TECHNOLOGY INNOVATION

Growth in the U.S. automotive sector jobs depends, as it always has, on continued innovation to keep demand high for U.S.-made vehicles and parts. High and volatile global oil prices are driving consumers to purchase cars and trucks that go farther on a gallon of gasoline or diesel. Further, new vehicle fuel economy and emissions standards in the United States and globally, intended to clean the air and reduce dangerous dependence on oil, are setting the benchmark and providing regulatory certainty for investments in improved technology. U.S. automotive suppliers are responding with new innovations that enable cleaner, more efficient vehicles, including advanced internal combustion engine components, turbochargers, improved transmissions, lightweight structures, electric traction motors, electronic controllers, advanced battery materials and traction batteries, and smart charging systems. The suppliers of fuel-efficient technologies needed to meet current demand and improve future vehicle fuel economy and emissions standards are widespread in the United States, with operations in 43 states and the District of Columbia (see Figures 1 and 2).

Our database of facilities that supply low-emission, fuel-efficient components includes those owned and operated by major automakers such as General Motors, Ford, Chrysler, Toyota, Nissan, and Honda, which are commonly referred to as the original equipment manufacturers (OEMs). Each location may house one or more activities, including manufacturing; research and development; infrastructure installation and maintenance; and management, and may also produce one or more of the products listed in Table 2. The employment estimates presented in Tables 2 and 3 (following) are conservative because they exclude planned, but not yet completed, facility expansions and jobs that are primarily focused on more conventional technologies (many of which will be developing into the more advanced technologies as these products become the norm rather than the exception).

Table 2: Product Category Legend and Summary

Icon	Technology Class	Products	Facilities	Employment	Employment Share	Employment Share by Technology Class
	Advanced Internal Combustion Engine Vehicles	Gasoline engines and components specifically oriented towards fuel savings	54	35,376	23%	38%
		Diesel engines and components[a]	8	2,895	2%	
		High speed (6+), continuously variable and dual clutch transmissions	20	18,583	12%	
	Hybrid and Alternative Fuel Vehicles	Hybrid powertrain components and vehicle assembly	27	11,872	8%	16%
		Hybrid and plug-in electric bus and truck component manufacturing and vehicle assembly	37	10,470	7%	
		Fuel cell, propane, and natural gas propulsion systems	13	1,477	1%	
	Plug-in Electric Vehicles	Batteries, battery materials	119	15,181	10%	18%
		Plug-in electric vehicle components such as traction motors and battery cooling systems, vehicle assembly	53	6,609	4%	
		Specialty 3-wheel electric and neighborhood electric vehicle production	10	329	<1%	
		Infrastructure for public, home, and workplace charging stations and battery swap stations[b]	53	5,170	3%	
	Common Components	High-strength, low-weight structural replacements to existing materials, including advanced steels, aluminum, plastics, and carbon fiber as well as component raw materials such as lithium and rare earth metal extraction	23	5,522	4%	29%
		Emissions controls, aerodynamics, cooling systems	13	8,414	6%	
		Start/stop systems, motors, sensors, controls, inverters, electronic power controllers, capacitors, wiring, electric power steering	74	29,270	19%	
Total			**504**	**151,168**	**100%***	**100%***

NOTES:

* Employment share and employment share per technology class do not add to 100% using table percentage values due to rounding.

[a] Large diesel engines used in full-size pickups are not included, although they are also being improved to generate better fuel economy and reduced emissions.

[b] Infrastructure employment does not include potentially thousands of jobs created to install and maintain individual charging stations.

An interactive on-line version of the maps in Figures 1 and 2 is available at http://www.nrdc.org/transportation/autosuppliers/

Table 3 below summarizes current employment for suppliers of fuel-efficient technologies by state. States are listed according to employment levels, in descending order.

Table 3: Current Employment at Suppliers of Clean, Efficient Automotive Technologies

State	Facilities	Employment	Advanced Internal Combustion Engine Vehicles	Hybrid and Alternative Fuel Vehicles	Plug-in Electric Vehicles	Common Components
Michigan	97	38,067	21,767	1,258	6,274	8,768
Ohio	28	13,753	10,716	955	1,334	748
Indiana	30	11,819	4,200	4,865	423	2,331
Kentucky	6	9,775	N/A	6,960	1,280	1,535
Pennsylvania	13	8,662	N/A	N/A	6,120	2,542
Texas	22	8,558	81	316	361	7,800
Alabama	13	8,285	3,250	688	N/A	4,347
California	79	7,422	1,025	1,657	3,747	993
South Carolina	16	6,934	2,165	1,185	1,384	2,200
North Carolina	19	5,928	3,804	675	949	500
Tennessee	11	5,393	1,437	N/A	303	3,653
New York	16	5,339	3,850	400	1,089	N/A
Illinois	23	4,715	1,250	N/A	504	2,961
Virginia	11	2,373	1,100	6	617	650
Arizona	4	1,765	N/A	N/A	265	1,500
Arkansas	4	1,214	N/A	800	34	380
Connecticut	10	1,209	N/A	710	499	N/A
Minnesota	5	1,200	N/A	1,100	100	N/A
Missouri	6	1,100	N/A	700	400	N/A
West Virginia	1	1,100	1,100	N/A	N/A	N/A
North Dakota	2	995	N/A	N/A	95	900
Maryland	4	810	700	N/A	10	100
Massachusetts	11	776	9	80	487	200
Kansas	3	740	N/A	740	N/A	N/A
Georgia	8	575	400	140	35	N/A
Mississippi	3	553	N/A	500	10	43
Florida	5	538	N/A	N/A	38	500
Oregon	11	408	N/A	N/A	395	13
Wisconsin	4	365	N/A	10	5	350
Nevada	4	182	N/A	N/A	172	10
Colorado	7	178	N/A	24	154	N/A
Washington	9	168	N/A	50	19	99
Louisiana	2	103	N/A	N/A	100	3
Delaware	1	50	N/A	N/A	50	N/A
Rhode Island	2	35	N/A	N/A	10	25
New Jersey	3	25	N/A	N/A	N/A	25

Table 3: Current Employment at Suppliers of Clean, Efficient Automotive Technologies						
State	**Facilities**	**Employment**	**Advanced Internal Combustion Engine Vehicles**	**Hybrid and Alternative Fuel Vehicles**	**Plug-in Electric Vehicles**	**Common Components**
Vermont	1	20	N/A	N/A	N/A	20
Oklahoma	3	17	N/A	N/A	17	N/A
District of Columbia	1	10	N/A	N/A	N/A	10
Hawaii	2	7	N/A	N/A	7	N/A
Iowa	1	2	N/A	N/A	2	N/A
Alaska	1	N/A	N/A	N/A	N/A	N/A
Idaho	0	N/A	N/A	N/A	N/A	N/A
Maine	0	N/A	N/A	N/A	N/A	N/A
Montana	0	N/A	N/A	N/A	N/A	N/A
Nebraska	1	N/A	N/A	N/A	N/A	N/A
New Hampshire	0	N/A	N/A	N/A	N/A	N/A
New Mexico	1	N/A	N/A	N/A	N/A	N/A
South Dakota	0	N/A	N/A	N/A	N/A	N/A
Utah	0	N/A	N/A	N/A	N/A	N/A
Wyoming	0	N/A	N/A	N/A	N/A	N/A
Total	**504**	**151,168**	**56,854**	**23,819**	**27,289**	**43,206**

NOTE:
In cases where facilities are located in the state, 'N/A' indicates that an estimate of employment was not available. If there are no facilities in the state, 'N/A' reflects zero employment.

Supplier Profile: Nexteer Automotive

Nexteer Automotive is a Saginaw, Michigan-based supplier of steering and drivetrain components that is a world leader in the engineering and production of a key fuel-saving technology, electric power steering (EPS).

EPS saves fuel by eliminating the parasitic loss caused by the continuous driving of a hydraulic pump to maintain pressure to assist the driver in turning the vehicle. Instead, electric power steering uses an electric motor to assist the driver, which only draws power from the battery when needed, and in the amount needed.

The Environmental Protection Agency (EPA) estimates that EPS can reduce total fuel consumption by 1 to 2 percent. Nexteer estimates that its EPS systems can reduce tailpipe emissions by up to 10 grams per mile in certain vehicles.

Electric power steering is also a necessary enabler for all vehicle hybrid and electrification technologies, since it provides power steering when the gas engine is off, or in the case of a full electric vehicle, not there at all. It is also a necessary addition when start-stop technology is added to a vehicle with an internal combustion engine.

Nexteer produced its first EPS unit in 1999, and earlier this year reached a production milestone of 15 million units. EPS sales accounted for 30% of Nexteer's sales in 2010, and the company predicts that will grow to 50% by 2015.

Nexteer employs 8,300 individuals in 20 manufacturing sites and six engineering centers around the world. Its world headquarters, main engineering center, and largest production facility are in Saginaw, the historic home of Nexteer, which has been in operation for more than 100 years. Nexteer began as the Saginaw Division of General Motors, and became an affiliate of Beijing-based PCM in 2010.

The Saginaw site employs nearly 2,500 UAW-represented hourly workers and more than 1,200 engineering and technical employees. Nexteer's leading technology portfolio in the EPS business gives the Saginaw site a solid foundation for opportunities to grow as tougher tailpipe emissions standards encourage the faster adoption of technologies that reduce climate change pollution and cut oil use.

Supplier Profile: BorgWarner Morse TEC, Ithaca, NY

BorgWarner's Morse TEC facility in Ithaca, New York, employs more than 1,400 people involved in the research, design and manufacturing of engine timing and drivetrain chain systems for light and medium-duty vehicles.

Notably, Morse TEC makes BorgWarner's unique cam torque actuated (CTA™) variable cam timing system (VCT), which won a 2009 Automotive News PACE Award and was a finalist for this same award in 2011.

VCT systems improve fuel economy, engine performance, and emissions by optimizing the opening and closing of intake and exhaust valves as the engine runs. Being able to continually adjust the air or exhaust gases in the combustion chamber to match engine operating conditions avoids the tradeoffs between fuel economy, horsepower and torque, and pollution that exist with fixed valve operation as vehicle speed or load changes.

VCT systems affect valve timing by changing the angular position of the camshaft relative to the crankshaft. Unlike traditional cam phasing methods, which typically use engine oil pressure to phase the camshaft, BorgWarner's technology utilizes the existing torsional energy in the valve train similar to a hydraulic ratchet.

The EPA and National Highway Traffic Safety Administration (NHTSA) highlight variable cam timing systems as a key technology for improving engine efficiency to meet both light duty car and truck standards and the soon-to-be finalized medium and heavy truck standards. The agencies count on VCT to cut fuel consumption 2 to 3 percent.

BorgWarner's VCT system is used to improve fuel economy and performance in vehicles such as the Ford Fusion, Mercury Milan, Mustang GT and Super Duty truck, which have engines that range from from 2.5 to 6.2 liters.

Headquartered in Auburn Hills, Michigan, BorgWarner is a global automotive technology company making engine, transmission, and all-wheel drive systems that allow automakers to meet current and future fuel economy and emission standards.

The Morse TEC facility is part of BorgWarner's global engine group, which includes eight plants and technical facilities in the United States. Its engine group makes engine timing, boosting and ignition systems, cooling systems, and controls. BorgWarner also operates seven other plants and technical centers in the United States as part of its Drivetrain group, which makes clutching technology, transmission control and torque management systems—including electric drive transmissions necessary for the emerging electric vehicle market.

II. METHODOLOGY

The suppliers detailed in Figure 2 provide technologies that contribute to improved vehicle fuel efficiency and lower carbon pollution. The technologies produced by the suppliers are expected to be deployed to meet improved fuel economy and greenhouse gas emissions performance standards for model years 2017 to 2025, as described in a joint analysis by the EPA, NHTSA, and California Air Resources Board. The report is titled "Interim Joint Technical Assessment Report: Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2017-2025".[4] Also included are suppliers of fuel-efficient technologies for transit buses and medium-duty trucks. The full list of technologies provided by the suppliers noted in Figure 2 is included in Appendix A of this report.

A supplier database was developed by automotive experts at Baum and Associates using a range of primary sources, including:

- A list of recipients of grants from federal government programs, including those funded by the American Recovery and Reinvestment Act of 2009 and the Advanced Research Projects Agency-Energy (ARPA-E)
- Baum and Associates North American Automotive Production Forecast
- Baum and Associates U.S. Electric Vehicles Sales Forecast
- Databases of automotive supplier facilities and other manufacturers
- Internet research

Research also included press reports of current industry developments and information gathered through direct contact with companies.

Employment data summarized in Tables 2 and 3 estimate the number of employees at each facility. To the extent possible, employment levels are specific to the fuel-efficient technologies produced at a facility. In a number of cases, reasonable (conservative) estimates were made when such figures were not available. In some cases, companies that are included have a wide range of customers (automotive and otherwise), and estimates specific to the automotive industry in general and the technologies in particular have been made.

It should be noted that as these technologies are developed further and volumes increase (due in large part to improving standards for fuel economy and emissions), there will be notable increases in employment and for that matter more companies than those that are currently in the database.

III. POLICY IMPLICATIONS

The National Program for fuel economy and greenhouse gas emissions standards for cars and light trucks will significantly impact the future adoption rates of the included technologies. Currently, three government agencies—the NHTSA, the EPA, and the California Air Resources Board—are working together to develop standards for new vehicles for model years 2017 to 2025.

Strong standards will provide needed certainty for suppliers that increased investments in innovative, fuel-saving technologies will pay off. While today's high oil prices may fuel current demand for clean, efficient vehicles, businesses face significantly higher risks if they rely solely on the volatile oil market to plan for the future. The suppliers featured in Figures 1 and 2 have the potential to grow and create jobs in states across the country. Strong standards through 2025 provide a clear signal that demand will grow for continued innovation and investment in production of new parts that improve vehicle fuel efficiency.

Recent testimony by the International Union, United Automobile, Aerospace & Agricultural Implement Workers of America (UAW) makes it clear that improved standards for carbon pollution, which also encourage technologies that cut fuel consumption, will drive job growth:

> *"The simple equation for understanding how this job creation occurs is that the new technology required to meet tailpipe emissions standards represents additional content on each vehicle, and bringing that additional content to market requires more engineers, more managers, and more construction and production workers."*
> - Barbara Somson, Legislative Director, UAW, in testimony before the Senate Committee on Environment and Public Works, March 17, 2011.

The suppliers noted in this report supply a range of technologies, but the recent emergence of new hybrid and plug-in electric-drive technologies provides a good example of the growth potential for U.S. suppliers. The initial introduction of U.S.-assembled hybrid vehicles, including the Ford Escape hybrid SUV in 2004, used Japanese-built drivetrains. Ford's dependence on Toyota affiliate Aisin for hybrid systems will fade as Ford completes plans to produce its own hybrid components and battery packs in the United States, in factories retooled using funds from the American Recovery and Reinvestment Act and the Advanced Technology Vehicle Manufacturers program.

With more domestic hybrid and plug-electric vehicles in the domestic production pipeline,[5] U.S. suppliers of motors, batteries, electronics, and electric charging support equipment are entering the market. Just two years ago, the scale of U.S.-based advanced propulsion battery manufacturing was considered insignificant in comparison to global capacity.[6] By 2012, the Obama Administration expects U.S. factories to hold 20 percent of world production capacity. In 2010, U.S. patents awarded for hybrid and electric vehicle technologies reached an all-time high, jumping 60 percent from the year before. General Motors (GM), Toyota and Ford held the first, second, and third spots, respectively, for the most new patents in 2010. Largely due to the investments in the auto sector, Michigan is the home of the most U.S. clean energy patents granted from 2002 to 2010.[7]

The technologies highlighted in this report span a broad range, from advanced conventional gas engines to pure electric vehicles. In the years before 2020, most fuel-efficiency improvements will come from improved engine and vehicle systems, including bridging technologies such as stop-start. After 2020, the stringency of the standard, along with the nature of the California Zero Emissions Vehicle requirement, will determine the rate of demand increase for vehicles with higher degrees of electrification technology. In most scenarios, hybrid and electric-drive component suppliers thrive under strong standards, but the industry will also maintain strong demand for traditional components used in these vehicles.

In addition, U.S. standards that are similar to those in Europe and Asia can be viewed as an important benefit for the global automotive industry. In the past, U.S.-based manufacturers often introduced products unique to the North American market while also producing other products for global sale. While these products have often been profitable, the global industry (including U.S.-based manufacturers) will benefit from reduced development costs and economies of scale enabled by converging regulatory requirements, increasing the importance of global platforms.

IV. CONCLUSIONS

Developing and producing technologies that cut fuel consumption and pollution in cars and trucks represents an important opportunity to maintain and create domestic jobs. Suppliers to the automotive industry are critical for innovation and employment. Today, suppliers make up 61 percent of all automobile jobs. More than 150,000 workers engineer and produce the innovative technologies that make new vehicles cleaner and more efficient, saving drivers money at the pump.

This report identifies more than 300 supplier companies, operating in 43 states and the District of Columbia, that develop and/or produce the technologies that enable cleaner, more fuel-efficient, advanced internal combustion engines and vehicles, hybrid powertrains, plug-in electric vehicles, and electric vehicle charging infrastructure.

Employment at these supplier facilities will grow as more fuel-saving technologies are added to the vehicle fleet. But the industry needs to be assured that their investment in new technologies will be rewarded so they can adapt to demand for clean and fuel-efficient models.

Strong standards for fuel economy and carbon pollution for model years 2017 to 2025 will inform the need for continued innovation, especially in hybrid and plug-in electric-drive technologies, where U.S.-based manufacturing is just starting to gain a foothold. Strong standards will be the most effective way to cut our nation's oil dependence and carbon pollution, improve our security, and keep billions of dollars in our economy annually instead of sending it overseas to purchase oil. Strong standards will also put automotive engineers and production workers on the job, supplying ingenuity for cleaner, more fuel-efficient vehicles.

APPENDIX A

Below is a list of technologies that improve fuel efficiency and reduce carbon pollution produced by suppliers mapped for this report.

Product Category	Products
Advanced Gasoline Internal Combustion Engines and Components	Engine assembly, camless valve actuation, cylinder deactivation, exhaust treatment, gasoline direct injection, turbochargers, variable valve lift, variable valve timing
Alternative fuel systems	Fuel cells, propane and natural gas propulsion components
Batteries	Materials, separators, cells, and packs for traction and start-stop system batteries
Diesel Engine Vehicles	Engines, turbochargers, injectors, electronic fuel pumps, and after-treatment systems
Electronics	Electronic braking, electronic compressors, electronic control modules, electronic controls/ controllers, capacitors, charging systems, electronic motors, electric power steering, high efficiency alternators, inverters, power splitters, sensors, start/stop systems, starter/ generator, wiring systems, including specialized wiring harnesses
Hybrids	Hybrid-specific powertrain components, fuel tanks, low energy lighting, vehicle assembly
Infrastructure	Battery-swapping stations, home charging stations, public charging stations, battery materials recycling
Materials	Aluminum, carbon fiber, high strength steel, lithium mining, magnesium, rare earth metals mining
Non Powertrain	Aerodynamic improvements, cooling systems, exhaust gas recirculation systems, electric water pumps, emissions control enabling clean diesels, gasoline direction injection
Plug-in Electric Vehicles	Battery cooling systems, vehicle assembly, vehicle conversion, specialty (3-wheel and low-speed electric) vehicle assembly
Transmission	Six or more speed transmission, automated manual transmission, continuously variable transmissions, dual clutch transmission
Truck (Class 4+) and bus hybrid components and assembly	Hybrid truck and bus component and vehicle assembly

ENDNOTES

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