Auxiliary Power Units:

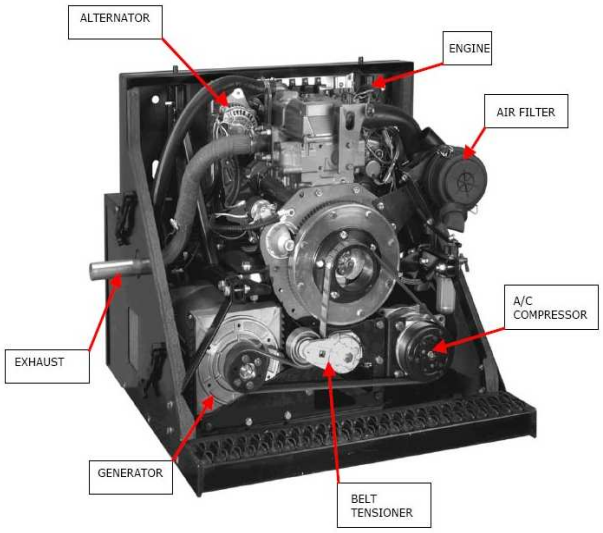
Carbon Emissions Reductions Through an Idling Reduction Truck Technology

Executive Summary

The auxiliary power unit (APU) is a technology that offers long-haul truck drivers power-consuming amenities during driving breaks while eliminating the need to idle a tractor engine. This technology could reduce 11 million tons of carbon dioxide in the U.S. each year. The market penetration for APUs in the U.S. is only 5%. Thus, APUs have great potential to reduce future carbon emissions and are included as one of the U.S. Environmental Protection Agency's five SmartWay Transport Partnership strategies. In addition to environmental benefits, current APUs on average save approximately 8% in fuel costs each year, according to the EPA. High upfront costs (approximately $7,000-$9,000 per unit) limit APU penetration. To assist with the expansion of idle reduction technologies, the EPA has partnered with the Small Business Administration to set up attractive loan packages for trucking companies that implement SmartWay strategies such as the use of APUs.

Expanded production of APUs would create economic opportunity at all stages of the value chain by increasing purchases from material and component suppliers, many of which are U.S.-based. A secondary economic impact of expanded APU production and sales would be increased demand for APU installation and service providers in all 50 states. Additional value chain opportunities will likely come in when APU technology is integrated into tractor manufacturing and becomes a component rather than an aftermarket product. This development will significantly change the current distribution of APUs, which are sold by retailers to end users. By contrast, APU manufacturers will become component suppliers to tractor manufacturers. These significant value chain changes would likely realign the supply of jobs along the value chain more towards manufacturing and service work and away from retail and installation jobs. It is possible that vertical integration could reduce the cost barriers of adding APUs as an aftermarket product. Thus, these changes could lead to positive U.S. job implications if they result in more widespread use of auxiliary power units on tractors which would require increased production and a greater need for service and repair work.

Figure 1. Auxiliary Power Unit



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Overview

There are six major types of idling reduction technologies including cab and block heaters, automatic engine start-stop controls, battery-powered air conditioning systems, on-and-off truck electrification, and auxiliary power units. While not the most commonly used idling reduction technology, APUs enable truck drivers to access the full range of cabin comforts (e.g., heating, air conditioning, electricity for personal devices such as televisions and cooking devices) without restricting where the truck must stop. Other idle reduction technologies either dictate conditions for stop locations or provide a lesser menu of amenities.

The current market penetration rate for APU technologies is estimated at approximately 5% of long-haul tractors (Bubbosh, 2008). Fuel operated heaters, which provide heat to the cabin when the engine is off, are more common with a penetration rate of approximately 25%. Fuel operated heaters do not offer the full range of cabin comforts provided by an APU but their penetration rate is higher because of the lower up-front costs. The low penetration of APUs indicates untapped manufacturing and sales potential for this market but also illustrates the difficulty in convincing fleet owners and independent truck owner- operators to purchase and install APUs. Some barriers include the high initial costs and lack of awareness of true idling costs. Theses may be overcome by rising fuel prices. Other barriers include loss of payload for trucks due to APU weight, a 12% federal excise tax, and APU system durability concerns (Bubbosh, 2008) (Lutsey, Brodrick, Sperling, & Dwyer, 2003).

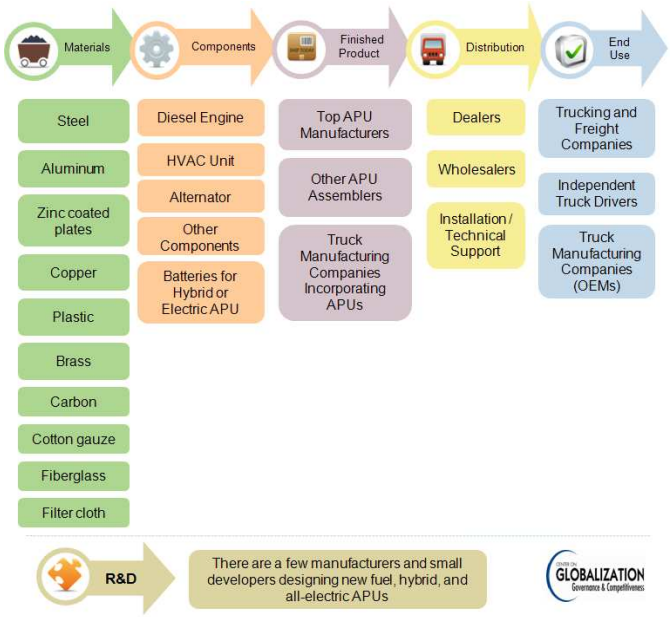
Auxiliary Power Unit Value Chain Analysis

The auxiliary power unit has more than 43 components and the value chain incorporates 5 stages: materials, components, finished product, distribution (including installation and technical support), and end use. (See Figure 2.) Many of the companies involved across the APU value chain are located in the United States. Expanded production of APUs would create economic opportunity at all stages of the value chain.

Materials

The major raw materials used in APU component manufacturing are aluminum, copper, plastic, steel, zinc, brass, and fiberglass. Other raw materials include cotton gauze, carbon, and filter cloth. The United States is the world's largest producer of plastic and brass (United Nations Industrial Development Organization, 2007) (NBMmetals.com, 2007) and the top U.S. producing companies are Dow Chemical Company and E.I. du Pont De Nemours & Company (plastics), and National Bronze & Metals and Allied Brass (brass) (Hoover's Inc., 2008b) (Hoover's Inc., 2008c) (NBMmetals.com, 2007). The United States also supplies a significant portion of the other raw materials with the exception of zinc. The major producers for iron ore and steel are Cleveland Cliffs and U.S. Steel (Cleveland Cliffs, 2008) (U.S. Steel, 2008) and the major producers of aluminum are Alcoa, Inc and A.M. Castle (Hoover's Inc., 2008a). The market strength of and proximity between suppliers of raw materials and U.S. components and APU manufacturers is an opportunity to strengthen domestic job opportunities within the value chain.

Figure 2. Simplified Auxiliary Power Unit Value Chain



Components

Diesel auxiliary power units are comprised of three major components: the alternator, the engine (usually a 2- or 3-cylinder), and the heating, ventilating, and air conditioning (HVAC) system. The main components of the alternator include the bearings, brushes, housing, rectifier, regulator, rotor, and stator. The main components of the diesel engine include the integrated rotor, stator generator block, and bearings, and cylinder. The main HVAC system components include the HVAC compressor, refrigerant, evaporator, and condenser. The major suppliers of engines and HVAC systems are listed in Table 1. Many of the APU engines are manufactured outside the United States but company interviews indicate that a significant proportion of other component manufacturing and assembly is completed in the United States.

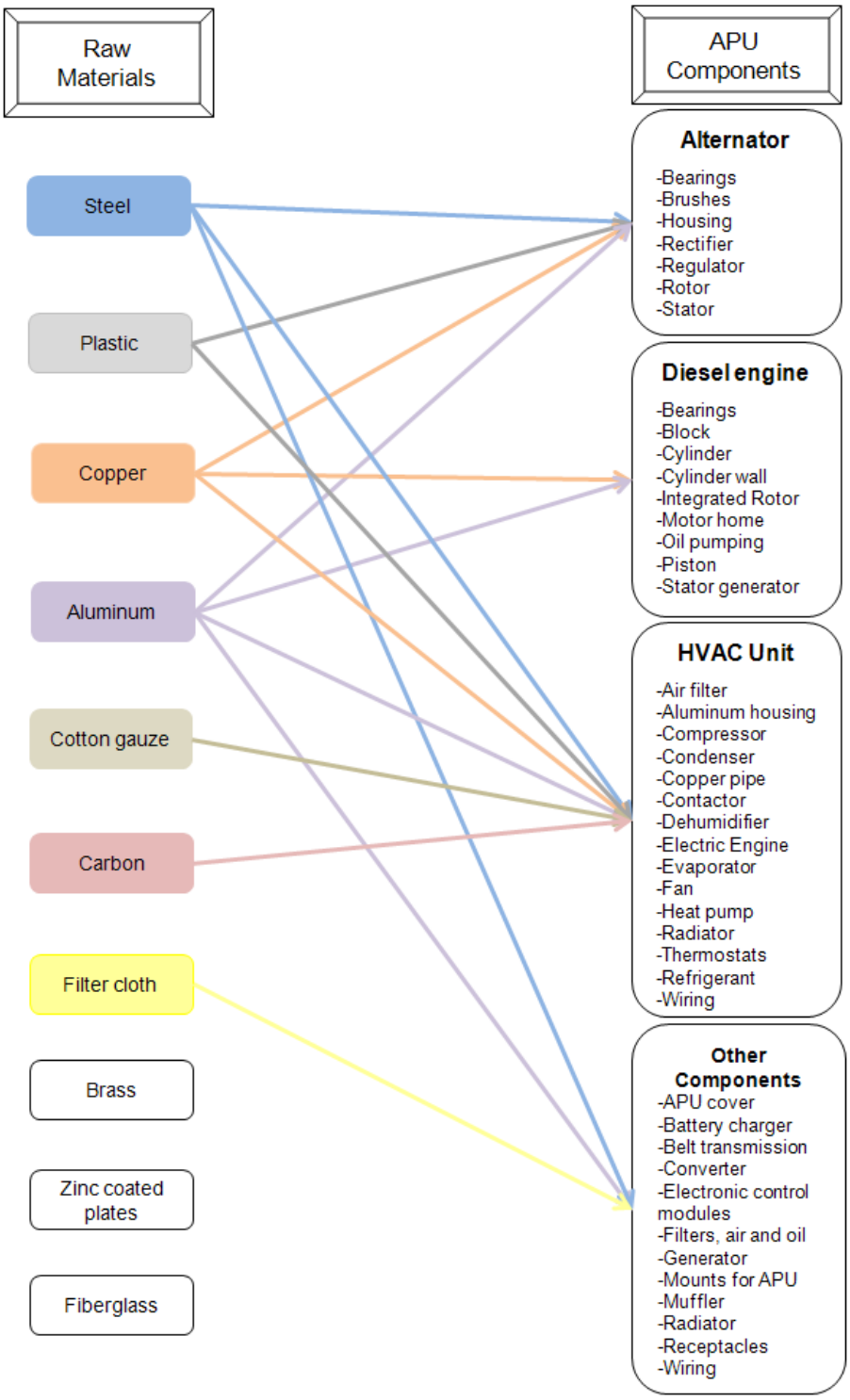
Relatively new to the market are hybrid and electric APUs, for which batteries and an inverted charger are important components in the value chain. The components of an all-electric APU are the HVAC system, batteries, the alternator, and an inverted charger.

Table 1. Top Suppliers of APU Engines and Heating, Ventilating, and Air Conditioning (HVAC) Systems

APU Component(s) Manufactured	Manufacturer	Location
Engine	Isuzu	Japan
Engine	Kubota	Japan, U.S. presence in IL
Engine	Perkins	Japan & Griffin, GA
Engine	Yanmar	Japan
Engine & HVAC system	Caterpillar	Illinois
Engine & HVAC system	Cummins	Indiana
HVAC system	Dometic Environmental Corp.	Virginia
HVAC system	Mobile Thermosystems	Canada
HVAC system	ThermoKing	Minnesota

Source: Center on Globalization, Governance & Competitiveness. Information from company annual reports, individual interviews, and company websites.

Figure 2. Auxiliary Power Unit Materials and Corresponding Components



Source: CGGC based on information from company annual reports, individual interviews, and company websites.

APU Manufacturing

The majority of auxiliary power unit manufacturing companies focus on assembly rather than component innovation, and they outsource the manufacturing of parts as indicated above. ThermoKing is the leading manufacturer of APUs with more than 50% of APU sales. (Kampf, 2008) Other market leaders include Rigmaster Power (15%-20% market share), Black Rock Systems (10%), and Teleflex which sells its APU through Carrier Transicold retailers. A number of other companies offer APUs. However, they have limited market share and there is significant movement into and out of the APU market by these firms. A more inclusive list of APU manufacturing companies and their headquarter cities and states are listed in Table 2.

The APU manufacturing companies have a broad geographic distribution across the United States. (See Map 2.) The majority are small companies with less than 100 employees. The smallest firms have limited distribution networks and operate in local markets selling and installing the APUs on location. By contrast, the big companies have multi-state distribution, installation, and service networks. Three of the most common APUs on the market are the TriPac™ (Thermo King Co.), the RigMaster Power (RigMaster Power, Inc), and the Black Rock® (Black Rock Systems). (Landstar System Inc., 2008) (Bosch, 2008)

Table 2. Auxiliary Power Unit Manufacturers, 2007

Company	APU Name	Office Headquarters Location
Aura Systems, Inc.	AuraGen ICS hybrid	El Sagundo, CA
Auxiliary Power Dynamics, LLC	Willis Auxiliary Power System	Sparks, NV
Black Rock Systems, LLC*	Black Rock®; Black Rock Evolution™	Reno, NV
Comfort Master	Comfort Master	Whittier, CA
Cummins	ComfortGuard System	Minneapolis, MN
Daimler Trucks North America LLC	NITE anti-idling system; RestSmart™ system	Portland, OR
Double Eagle Industries	GenPac™	Shipshewana, IN
Enertek Corporation	Gen-A-Sys™	Beaverton, OR
Florida Manufacturing Group	IdleBuster	Odessa, FL
Flying J Inc.	Cab Comfort System	Ogden, UT
Kohler Power Systems (Mobile Div.)	Kohler 3APU; Kohler 7APU	Kohler, WI
Pony Pack, Inc	Pony Pack®	Albuquerque, NM
Rigmaster Power Inc*	RigMaster Power	Olathe, KS
SCS/Frigette Corporation	Alliance APU	Fort Worth, TX
Star Class, Inc.	Gen-Star	New Castle, PA
Teleflex Power Systems*	ComfortPro™	Canada
Temco Metal Products*	Idle Solutions APU®	Clackamas, OR
Thermo King Company*	TriPac™	Bloomington, MN
Tridako Energy Systems	PowerCube™	Alliance, NE

Source: Center on Globalization, Governance & Competitiveness. Information from company annual reports, individual interviews, and company websites. *Indicates top APU manufacturing companies

Some heavy-duty truck manufacturers also play a role in manufacturing idling reduction technologies like APUs. For example, Daimler Trucks North America owns Alliance Parts which manufactures the Alliance APU. The Alliance APU is installed in the Daimler Trucks and also commercialized in the market. Navistar installs Maxxpower APUs in some of its trucks and Mack Trucks Inc is another company installing APU technology. Investing in idling reduction technologies at the level of truck manufacturing indicates recognition of the demand for idling reduction by fleet and independent truck owners. In fact, this demand appears to be increasing and the future of APU technology appears to be going in the direction of vertical integration with factory-installation of APUs becoming more common than an after-market sales.

Map 2. Geographic Distribution of U.S. Companies Manufacturing Auxiliary Power Units and Corresponding Engine and HVAC System Components

INSERT UPDATED MAP FROM GARY T

Source: Center on Globalization, Governance & Competitiveness. Information from company annual reports, individual interviews, and company websites.

Distribution

Over 2,300 companies across the country provide APU installation and maintenance services. Most of these vendors are dealers, service centers, and installation centers. These vendors are generally small businesses with fewer than 30 employees. The APU dealer/retail network is well distributed across the 50 states and the District of Columbia with a minimum of six in D.C. and a maximum of 129 in Texas. These actors in the value chain employ workers with mechanical skills. Greater APU use in long-haul trucks has the potential to increase the need for service jobs nationwide.

End Use

The final stage of the value chain refers to consumers of APU technologies including freight companies, independent truck drivers, and truck manufacturing companies. There are approximately 41,000 general freight trucking companies in the United States. Approximately 5% are large companies with more than 100 drivers, 37% have between four and 100 drivers, and 60% have fewer than four workers (U.S. Bureau of Labor Statistics, 2008b). Larger companies who own the tractors and trailers may be more likely to both see the value of and have the financial resources to install idling reduction technologies (Plunkett Research Online, 2008a). There also are approximately 330,000 tractor truck owner-operators throughout the United States (Truck Info Net, 2008). Many of these individuals would like to have an APU for cost savings but are resistant to the high upfront capital costs. Trucking companies are less likely to install APUs on trucks greater than thre years old so the potential market for APUs is generally limited to Class A sleeper cabs less than four years old.

Total revenues for the truck transportation sector were $219 billion in 2006 and expenses exceeded $201 billion (Plunkett Research Online, 2008a). Therefore, the industry's relatively small profit margin of 8% in 2006 makes it a prime candidate for idling reduction technologies that reduce fuel and maintenance costs (Plunkett Research Online, 2008b). Furthermore, the US Department of Labor predicts the truck transportation sector will grow total revenues by 11.1% by 2016, generating 160,000 new jobs (U.S. Bureau of Labor Statistics, 2008a). Such growth indicates potential for greater demand for APUs and other idling reduction technologies that will help reduce long-haul truck fuel needs.

Case Study

In 2005, Wal-Mart introduced a goal of doubling the efficiency of its trucking fleet by 2015. Wal-Mart has the second largest private fleet in the nation. Increasing fleet efficiency to this level will prevent 26 billion pounds of carbon dioxide emissions (Addison, 2007). One of Wal-Mart's first steps towards this goal was to purchase

and install 7,000 APUs in its long-haul trucks to eliminate the need to idle the main engine for driver comfort during federally mandated rest periods or sleeping. The company has estimated APUs save $25 million in annual fuel costs, a figure that has likely increased with rising global oil prices in 2007 and 2008. (Addison, 2007). Furthermore, Wal-Mart's 2007 model truck has not only APUs but other improvements such as trailer side skirts, super single tires, an aerodynamic tractor package, and a tag axle (Green Car Congress, 2005). Wal-Mart estimated these changes will save the company $52 million per year in fuel costs. For the future, the company is also evaluating various hybrid technologies, such as those by Peterbilt and Eaton, for a new class-8 heavy-duty vehicle (Addison, 2007).

Illustrative Example

As more fleet owners recognize the unique opportunity to simultaneously reduce costs and present a more sustainable company image, the market for APUs could expand significantly. Specific APU technology improvements such as widespread development of hybrid APUs, more efficient battery-powered APUs, and further research and development of solid oxide fuel cell APUs may play an important role in increasing the technology's appeal.

Enertek Solutions, Inc is one of the newest and most promising examples of this new wave of APU technology. In March 2008 Enertek introduced the InfiniGen, an all-electric APU. The APU has no engine because it runs on nickel-metal hydride rechargeable batteries. The batteries are high-powered and make the APU lighter than previous diesel and battery-powered models. Furthermore, the system recharges while the truck engine is running and it also can be plugged into shore power. The InfiniGen requires only 6 hours to install (compared to 36 hours for diesel APUs) and the total cost including installation is $7,000. Enertek Solutions has already sold 1,000 InfiniGen APUs to Carrier Transicold (subsidiary of Teleflex Power Systems) and is in discussions with several companies in Europe including Paccar and DAF Motors (Baumann, 2008).

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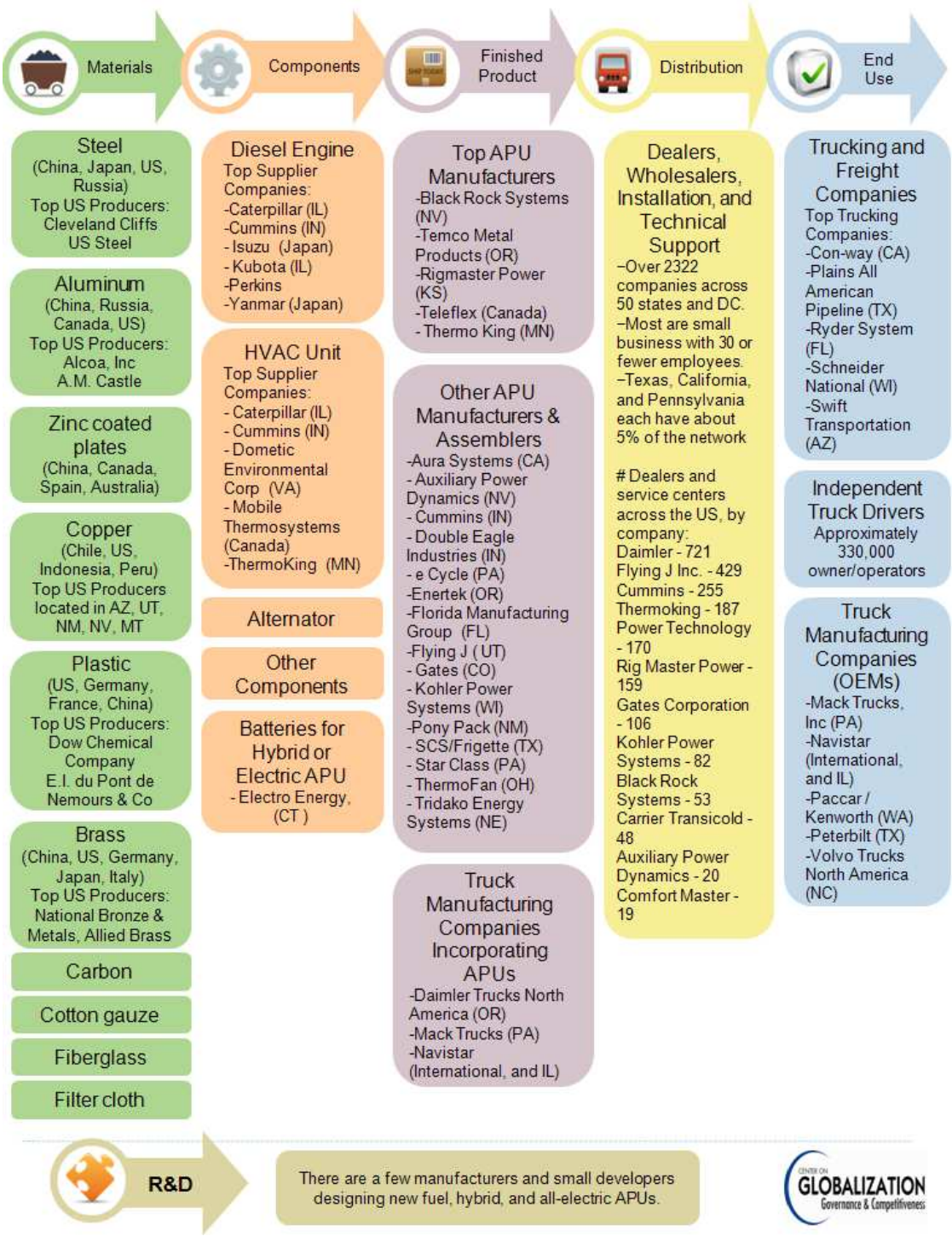
Other technological advances include efforts by BMW and Boeing to develop solid oxide fuel cell technologies that would allow for lighter and smaller engines. As this technology is refined and its cost structure is reduced, solid oxide fuel cells could be incorporated into long-haul truck APUs.

Conclusion

It appears likely that idling reduction technologies will soon be incorporated into truck engine manufacturing by original equipment manufacturers. Whether or not APUs or other types of idle reduction technologies are incorporated remains unclear although Daimler, Kenworth, and Peterbilt, among others, have adopted factory-installed APUs on some Class A sleeper cabs. Integrating idling reduction into long-haul truck manufacturing will have positive impacts on carbon reductions and may overcome some of the cost barriers associated with adding APUs or other idling reduction technologies as aftermarket add-ons. On the other hand, integration into truck manufacturing also may impact additional job opportunities at the manufacturing and installation stages of the value chain because this work may be subsumed by existing jobs. Nonetheless, there are clearly opportunities to reduce truck idling among existing long-haul trucks through expanding the available fuel-powered APUs and supporting opportunities to develop and manufacture new APU and other idling reduction technologies.

Furthermore, vertically integrating APUs as components in the tractor truck manufacturing system offers the potential to dramatically expand use of APUs. Such an expansion, in addition to the expected growth in the trucking industry, could have positive job implications at the material, component, and manufacturing stages of the value chain as well as increased demand for service and maintenance jobs.

Figure 4. Auxiliary Power Unit Value Chain



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