Conference Summary: SAE COMVEC 2023

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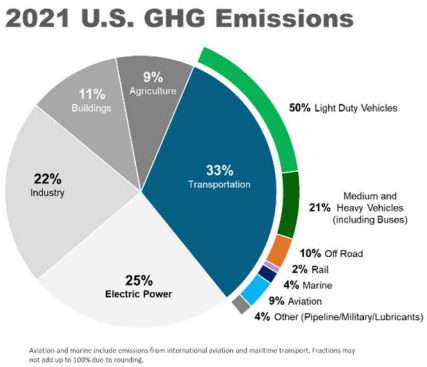
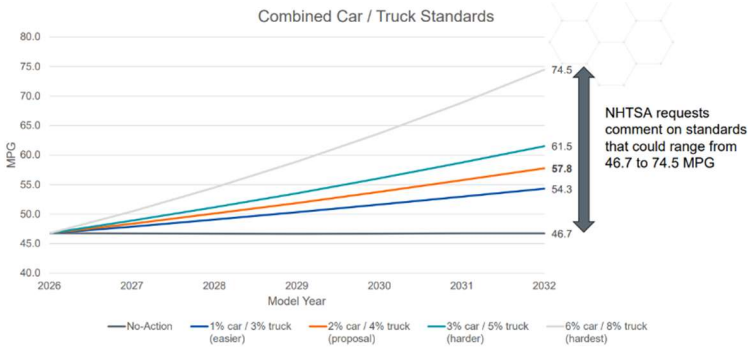
Eyes on the target



It's important to occasionally take a step back and re-visit the problem statement. The **U.S. Department of Energy** showed that transportation is currently the largest source of GHG emissions, accounting for about a third of the total anthropogenic emissions. Of this, medium and heavy-duty trucks and buses account for a fifth of the emissions (i.e., ~ 7% of the total anthropogenic emissions). The current national goal includes (1) 30% of new MHDV vehicle sales to be zero-emission by 2030 and 100% by 2040 and (2) 100% federal fleet procurement to be zero-emission by 2035. For the hard-to-electrify sectors – off-road, marine, rail, aviation – the emphasis is on renewable fuels and improving efficiency.



These are translating into tougher regulations for the industry. The **Alliance for Automotive Innovation** highlighted the various regulations being imposed through multiple regulatory agencies. The industry is gearing up to an all-electric future but we are still in the early stages, with battery electrics occupying only 7% of 1H 2023 sales. The latest proposal by NHTSA could require raising the combined car/truck fuel economy anywhere from 47 to 74 mpg.

The heavy-duty sector is also facing a tough regulatory landscape. **Navistar** provided a high-level summary, highlighting it as one of the most complex regulatory periods in the history of trucking. Upcoming regulations include the national heavy-duty low NOx standards, California's ZEV mandates and EPA's GHG standards, meeting all of which will require OEMs to perform a balancing act on allocating resources to various workstreams and products – all while infrastructure for ZEVs is in its infancy.

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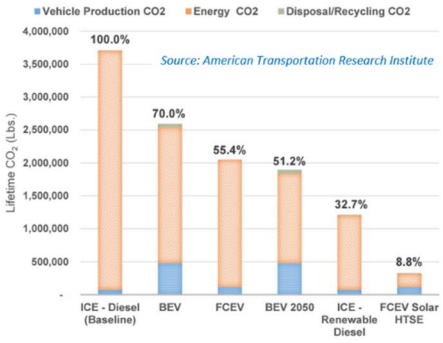
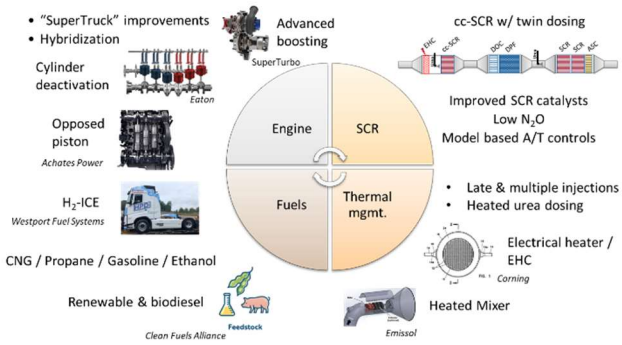
Technologies for GHG Reduction and Low NOx



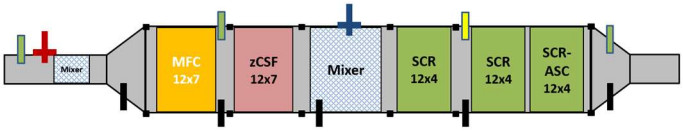
Cummins expressed the view that GHG Phase 3 will require engines with brake thermal efficiency exceeding 50%, and encourage the use of hybrid powertrains. Renewable fuels could play a role in decreasing well-to-wheel GHG today, but proper incentives must be put in place.

A variety of technologies are being pursued for transport decarbonization. **Corning** presented a summary comparing some of the alternatives and touched upon some of the challenges ahead. For instance, total cost of ownership parity for battery electric trucks is very sensitive to fuel and electricity costs, while green H_2 production and infrastructure is a significant bottleneck for hydrogen powered vehicles – also keeping in mind that other industries such as steel and fertilizers will first claim much of the green H_2.

	IC Engine (Ref.)	Improved ICE	Low C Fuels	BEV	H_2 Fuel Cell	H_2 ICE
GHG Reduction	Ref.	+	++	++	++	++
Fueling Infrastructure	Ref.	o	o	--	---	---
Refueling Time	Ref.	o	o	--	o	o
Range	Ref.	o	o	--	o	o
NOx/PM emissions	Ref.	++	o	+++	+++	++ PM only
TCO	Ref.	+	---	++/-- (*)	++/-- (*)	--
Critical materials	Cat. only	o	-	-	-	o
Existing fleet	Ref.	Yes	Yes	No	No	No

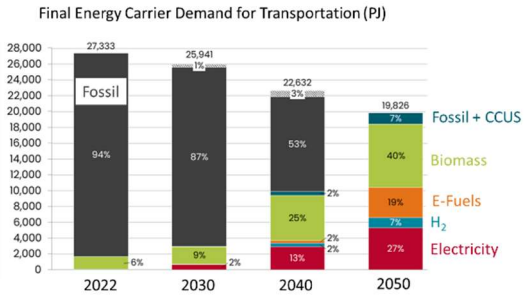


GHG reduction is only one part of the problem. For meeting Low NOx standards, there are also various technologies being developed, and another panel discussion covered these. **Corning** provided a summary of preferred after-treatment architectures. The use of close-coupled SCR catalysts, possibly electrically heated catalysts and higher filtration filters were shown as leading candidates. For Europe, the particle number regulations may require the use of a second filter.



Work continues at **Southwest Research Institute** on exploring system architectures to achieve low NOx using the Cummins X15 engine. Recent work exploring the use of biodiesel at higher blends showed that NOx emissions increased when using B50 primarily due to a decrease in exhaust temperature. Engine calibration could help but will require detection of fuel change. SWRI is also working on low NOx evaluation for the upcoming off-road standards in California. An after-treatment system has been downselected and is being aged to 8,000 hrs.

Renewable and Low Carbon Fuels



Biofuels and synthetic fuels will continue to fuel a significant portion of transportation, according to a study presented by **Aramco** and done with **FEV Consulting**. Good news is that a shift to improved better fuel efficiency and electrification is predicted to result in a 27% reduction in energy demand for transportation by 2050. While a quarter of that energy will be delivered via electricity, 40% will be delivered via biofuels and 19% via synthetic fuels. The other talks in the panel discussed other low carbon pathways for transport decarbonization.

MAN is pursuing battery electric propulsion as the prime path for trucks and buses. Still, H2 ICE is being pursued as a pathway for meeting near-term GHG reductions while also meeting NOx standards in Europe. An update was provided on the predevelopment status of their H_2 ICE truck. It will require 58 kg H2 stored at 700 bar to cover 600 km, and use 90% components from the base diesel.

Ballard Power Systems argued that H_2 fuel cell technology is the most suitable for long-haul transport. Modeling results were shown which suggest that fuel cell trucks will reach parity with BEVs by 2026 and with diesels by the end of this decade. Whether fuel cells or H_2-ICE, these solutions will require availability of H_2. **Air Products** gave an update on the work being done to increase H_2 production (from the ~ 70M tons being produced annually today). By 2027, H_2 capacity added will be able to fuel 60,000 additional trucks per day.

AMOGY is working on ammonia-powered propulsion, but with a novel technology for on-board conversion of NH_3 to H_2, which in turn is used in a fuel cell to generate electricity. Tech demo has been done for a drone, 100 kW off-road tractor, 300 kW Class 8 truck, and planned for a 1,000-kW tugboat by the end of this year.

Electrification / ZEV

The critical bottleneck for electrification is infrastructure. Most panelists highlighted the need for a wel-thought out plan to get the charging strategy right, summarized by a pithy comment – “electric trucks are not toothbrushes”. The need for planning is especially greater and more complex for larger fleets. **Walmart** gave their approach on achieving their target of zero emissions across global operations by 2040. A significant portion of the initial effort should be dedicated to analysis, which includes various aspects of electrification such as network planning, developing infrastructure partnerships, internal total-cost-of-ownership studies, and maintenance strategies. These steps are integrated with testing of vehicles, site selection and initial vehicle deployment and testing, before moving to a broader and larger-scale deployment. Also important is to consider long-term fuel availability, in this case renewable energy and H_2 (RNG was also included as a low carbon pathway).

A framework for planning electrification of fleets was presented by the Electric Power Research Institute (EPRI). Initial work is critical – for fleets on identifying the charging requirements based on number and type of trucks, travel patterns, charging rates, etc. and for utilities who must plan the grid at the system level, taking into account overall activity in a given region, based on traffic density, dwell time, charging times, etc. It is important to recognize that utilities cannot add capacity without an explicit demand, so this requires a tighter integration with fleets on future planning.

Further Reading

See also an excellent summary of the conference by DieselNet as complementary reading.