



# Aspen Global Change Institute Energy Project

## September 2017 Quarterly Research Review

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### Planes, Ships, and Trucks: Decarbonizing Long Distance Transport

Electric tractor trailers have been making headlines lately, and rightfully so. Heavy duty and long-distance transport have long posed a significant challenge to those seeking to decarbonize the transportation sector: Aviation, shipping, and heavy-duty road transport (i.e. trucking) collectively account for over 12% of all global anthropogenic emissions, and those emissions are still growing (both in terms of annual emissions and overall percentage). While electric cars are being continually refined and multiplying on the roads, the question of heavy duty ground transport has proven more elusive. Researchers have been exploring the most promising low carbon technologies for semi-trucks, including direct electrification via batteries, overhead power lines, as well as hydrogen and other renewable energy carrier fuels. Some of these technologies are not far off, but many of them (especially those, like direct electrification, with the greatest potential to mitigate greenhouse gases), will require substantial infrastructure investments before they can become mainstreamed (Gnann, et al. 2017).

But this obstacle is not holding back manufacturers. Tesla has been teasing audiences all year with rumors about its forthcoming electric semi-truck, which will reportedly boast a range of 200-300 miles (a formal reveal is slated for later this month). Likewise, truck maker Cummins just announced the release of its AEOS – a Class 7 “urban hauler” tractor cab, with a 140-kilowatt-hour (kWh) battery and range of 100 miles, for sale starting in 2019. While in some ways a big gamble, manufacturers also have much to gain by disrupting the current tractor-trailer market with billions in revenue available even with 10% market share of new semi-truck purchases.



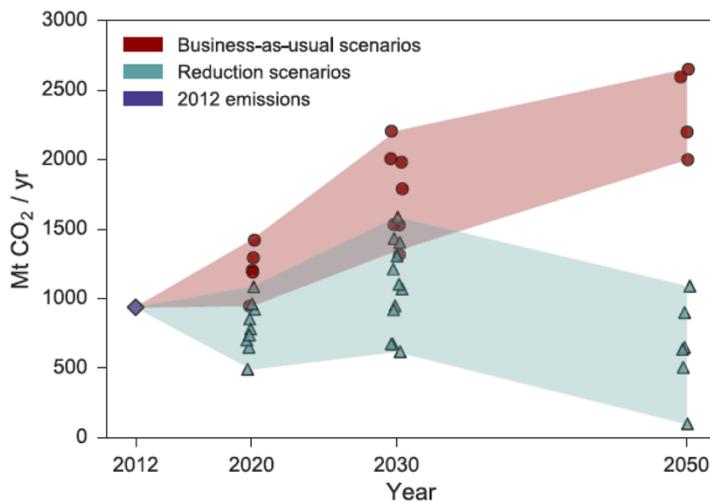
Photo credit: Tesla

Heavy-duty ground transport only accounts for one piece of the long-distance transport puzzle, however. While exciting advances seem to be on the horizon for trucking, air travel and long-

distance shipping will require “herculean efforts” to decarbonize (Rockstrom, et al. 2017). Decarbonizing these parts of the transportation sector through renewable fuels, electrification, and transitioning shorter range air traffic to rail will require elevated public and private research investment, as well as political will.

Just as biofuels have been explored for ground transport, they are also being considered for aviation. Due to the high energy needed to power jets, alternative fuels have been seen as the most promising avenue to lower the emissions associated with air travel (as opposed to electrification with batteries). High energy and non-edible crops like algae, camelina, and jatropha are all being experimented with to make jet fuel, either as direct biofuel, or as bio-synthetic paraffinic kerosene. To date, progress has been made in developing these fuels as additives to fuel jet fuel blends, but they have not reached a point where they can altogether replace jet fuel (Yilmaz and Atmanli 2017). The promise of alternative jet fuels ultimately lies in if fuel quality can improve, while keeping costs down and maintaining sustainable feedstocks, conversion technologies, and co-product allocation. Versions of these biofuels can be used in both aviation and ground transport (Yilmaz and Atmanli 2017, de Jong, et al. 2017). Additionally, design, operations, infrastructure, socio-economic and policy measures will also be key factors in decreasing aviation emissions (Singh, et al. 2017).

Similar factors will also play a critical role in ensuring a decarbonization pathway for long distance shipping. Shipping accounts for 3.5% of global emissions, and is forecast to increase by an additional 150-250% by 2050 if unmitigated; whereas to follow the targets of staying below 2°C warming set out in the Paris Agreement, collective international shipping emissions need to decrease by 85% by 2050 (Bouman, et al. 2017). This high target may seem impossible based on



the current low levels of adoption of emissions-reducing measures in the shipping industry (Rehmatulla, et al. 2017). Careful review, however, illustrates that through a combination of measures and technologies, reduction in emissions by 75% and higher is possible by 2050 with current technologies.

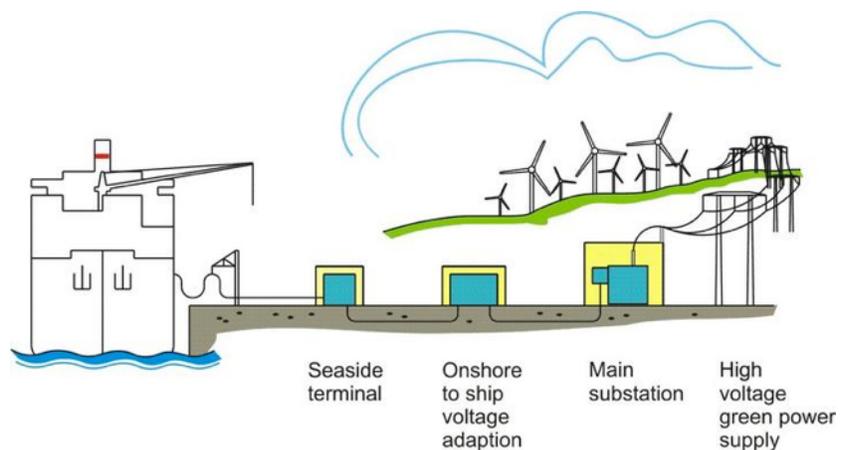
No single solution will be sufficient to meet decarbonization goals for the highly heterogeneous shipping industry (Walsh, et al. 2017; Bouman, et al; 2017,

Gritsenko 2017). Some of the greatest opportunities for emissions reduction include improvements in vessel size, hull shape, ballast water reduction, hull coating, hybrid power propulsion, propulsion efficiency devices, speed optimization, and weather routing (Bouman, et al. 2017). Many of these measures are already being implemented, but not at sufficient scales to

significantly decrease shipping emissions (Rehmatulla, et al. 2017). If implemented at scale, however, these measures alone could account for 55% reduction in shipping emissions. When alternative fuels like biofuels are then added to the portfolio, the target of 85% emissions reduction becomes feasible, assuming carbon-neutral feedstock sourcing (Bouman. et al. 2017).

Policies, regulations, and legislation that address the demand, technology, and operations of shipping will be paramount to ensuring the adoption of these and other advances (Walsh, et al. 2017). For instance speed optimization, which often includes speed reduction, creates a major opportunity for emissions reductions – an efficiency improvement that may not find traction without legislative backing short of another global economic recession as in 2008 or an oil crisis as in the 1970s when ships self-elected to reduce speeds for the sake of cost savings (Styhre, et al. 2017). Increasing analysis is underway to examine what governance structures would be most effective in promoting shipping industry emissions reductions – analysis that is additionally critical because shipping was excluded from the COP21 conversations that led to the Paris Agreement. Gritsenko (2017) makes the case for a polycentric approach to maritime governance which allows for multiple regimes and solutions, regulated and enforced through contractual and cooperative agreements, which could appropriately accommodate the dynamism of the global shipping sector. This kind of governance structure also fosters the kinds of steps already being taken on local and regional scales, and within the private sector. What has yet to be seen, though, is whether this disaggregated approach to shipping governance will carry sufficient accountability to motivate the kind of rapid decarbonization that experts say is critical to achieving a future climate with less than 2°C warming.

On local scales, authorities worldwide are taking steps to reduce emissions in ports. In 2008, 55 port cities voluntarily adopted the World Ports Climate Declaration, which is dedicated to reducing emissions through examination of port operations, inland shipping (logistics chains), and alternative renewable energy and fuels (Fenton 2017). So far, this network of port cities has shown a great deal of variability in adoption of emissions-saving measures. Opportunities like onshore power supply were adopted by some with much success to reduce the amount of idling in port. Additional opportunities include measures such as reduced speed in fairway channels, reduced turnaround time for ships at berth (time at berth accounts for half of port emissions), and portside availability of alternative and renewable fuels (Styhre, et al. 2017).



Likewise, within the private sector, mixed reviews exist on the effectiveness of self-regulation. Reducing emissions has the clear co-benefit of reducing fuel costs, which are the industry’s single

largest cost, accounting for 25-50% of overall costs (Scott, et al. 2017). However, some key barriers complicate this seemingly simple win-win scenario. First off, data collection on fuel efficiency is minimal, with ships often getting one reading a day on fuel consumption. Without information on the efficiency (or lack thereof) of specific operating conditions, and with funds for efficiency retrofits so limited, resistance often arises to making such retrofits. Nevertheless, private standards for improved efficiency and emissions reductions have been increasing, and those within the industry have been quick to tout generic claims of the success of these standards. What impact those have had on greenhouse gas emissions is in reality unclear, due to lack of data transparency and reliability within the industry.

In summary, heavy-duty and long-distance transport – whether by semi-truck, aviation, or shipping – is in the early phases of a potentially significant market shift towards a lower carbon future. The technology, and certainly the governance, driving that shift is still in development, but nevertheless gaining in momentum. Whether momentum will gather at a sufficient pace to help meet a 2°C goal, will ultimately depend on effective policies, legislation, market signals, and implementation.

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