Delivery date: June 15, 2022

BATTERIES 3

ELECTRIC CONTAINER SHIPS

Prof. Vaclav Smil

Distinguished Professor Emeritus, University of Manitoba

How many times you have read, during the interminable Covid months, about problems with supply chains. This collective name has many specific real-world incarnations, none more important than large container ships that bring Asian manufactures to other continents. If you are an American or a European, then most of the clothing you wear and just about every electronic gadget reached you packed in China into a large steel box, trucked to a port and sent across the oceans. But these mainstays of global trade are burning low-quality liquid fuel and rank among the top CO_2 emitters. Could they be soon electrified? After all, unlike jetliners where every bit of additional weight matters, their already large mass should be able to accommodate the added weight of batteries!

But the key problem here is the very mass of these large ships. They now carry containers of different size, but their capacity is still measured in terms of standard twenty-foot equivalent units (TEU), steel rectangular prisms that are 20 feet long and usually 8.5 feet high. Record-size ships now carry nearly

24,000 TEUs (*Ever ACE*, since July 2021 the current record holder can load 23,992 of them), and a vessel carrying 18,000 TEU is now unexceptional. What would it take to make it all-electric? These large ships now cruise deliberately at a slow speed of 16 knots (in order save fuel), and it takes them 31 days to reach Hamburg from Hong Kong, consuming (at 150 t/day) 4,650 tons of bunker fuel per journey. With fuel's energy content of 40 GJ/t that is equivalent to about 52 GWh but because large diesels engines powering the ship are about 50% efficient only half of that energy goes into propulsion. Assuming 90% motor efficiency, a battery-powered ship would need 29 GWh of electricity to complete the trip.

This means that when deploying today's best Li-ion cells (with gravimetric energy density of 270 Wh/kg) an 18,000-TEU ship would have to carry about 107,000 tons of batteries, or nearly half of its maximum cargo capacity, to travel from Asia to Europe. The conclusion is obvious: diesel engines for large oceangoing ships will not be abandoned anytime soon, and if they are to be decarbonized then the best way is to fuel them differently, either with biodiesel fuel derived from plants or with ammonia. The first option would require an enormous increase in biodiesel capacities: global shipping now needs more than 200 million tons of fuel a year. The second one has to wait for "green" ammonia, with hydrogen coming from the electrolysis of water, not from the reforming of natural gas.

(Disclaimer: The views and impressions in the columns are personal opinions of Prof. Smil and do not represent the opinions of ICEF.)