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BATTERIES 1

ELECTRIC JETLINERS: NOT ANYTIME SOON

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The world's first practical battery, Gustave Planté's lead-acid cell, was introduced in 1859, and you can see its modern versions under the hoods of internal combustion vehicles. During more than 160 years of its existence the cell's volumetric energy density (measured in watthours per liter, Wh/L) has improved from about 80 Wh/L. The nickel-cadmium battery (invented by Waldemar Jungner in 1899) now has a maximum energy density of about 150 Wh/L. Lithium-ion batteries, available in commercial products since 1991, are today's best performers. When Panasonic's widely used 2170 battery was released in 2009 it had a volumetric density of 675 Wh/L, now it is deployed in electric cars with a density of 730 Wh/L, in 2020 the company promised to boost it to about 850 Wh/L by 2025, and it eventually aims at 1,000 Wh/L.

News of new energy density records that are approaching, or even surpassing 1,000 Wh/L appear regularly -- but they are all based on laboratory tests and prototypes, not on commercial products. But let us assume that 1,500 Wh/L, having an energy-dense twice as high as today's best commercial option, will be with us shortly. What would it mean beyond having more electric vehicles able to travel longer distance without recharging? Could such batteries power intercontinental flight? Could they propel a large container ship bringing Japanese manufactures from Nagoya to Los Angeles? Could they cover, even for a few hours, a significant share of the power supply for such a large utility as the Tokyo Electric Power Company? First, a look at the prospect of commercial battery-powered flying.

Modern jetliners are fueled by kerosene and the fuel's volumetric energy density is about 9,800 Wh/L. A Boeing 787-10 taking off from Haneda airport for an intercontinental flight can carry up to 101 tons of kerosene, nearly 40% of its maximum take-off weight of 245 tons. Even if equipped with 1,000 Wh/L batteries, and even if we assume that the efficiency of electric drive would be twice as high as for a gas turbine (resulting in energy density equivalent to 2,000 Wh/L), battery mass alone would be twice of today's maximum take-off weight. Moreover, kerosene-fueled jetliners become lighter (hence less costly to fly) as they approach their distant goal, battery-powered planes would have to carry the same mass all along. Obviously, all electric jetliners are not coming anytime soon: kerosene, or a substitute biojet fuel derived from crop or waste feedstocks, will remain the only realistic options for a long time to come. Next time we will look at how ready today's best batteries are to provide large-scale storage for major electricity-generating companies.

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