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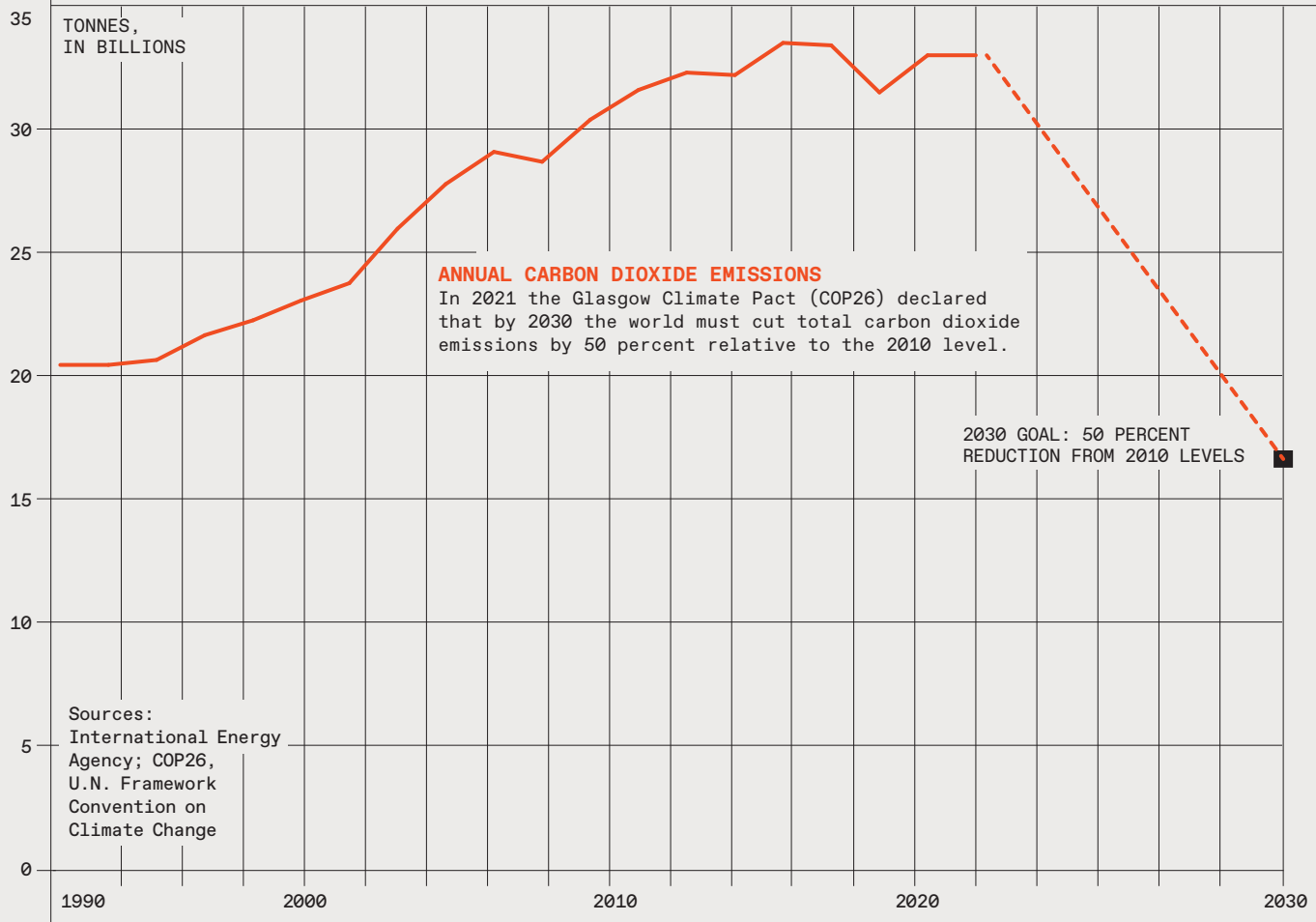

Decarbonization Algebra

The COP26 calls for impossibly steep cuts in carbon emissions

Three months ago the Glasgow Climate Pact (COP26) declared that by 2030 the world must cut total carbon dioxide emissions by 50 percent relative to the 2010 level, which was 30.4 billion tonnes. This would bring annual emissions to less than 20 billion tonnes, a level last seen more than 30 years ago.

What are the chances of that? Let's look at the arithmetic.

First, assume that all energy-consuming sectors share the cuts equally and that global energy demand stays constant (instead of increasing by 2 percent a year, as it did in the prepandemic decade). Today our best commercial batteries have energy densities of about 300 watt-hours per kilogram, less than 3 percent as much as kerosene; among some 25,000 planes in the global commercial fleet, there is not a single high-capacity electric or hydrogen-powered aircraft. A 50 percent cut in kerosene-fueled flying would mean that by 2030 we would have to build about 12,000 new airplanes with capacities of from 100 people (the Embraer 190) to 400 people (the Boeing 777-300ER), all powered by as-yet-nonexistent superbatteries or equally nonexistent hydrogen systems. That's what we'd need to fly

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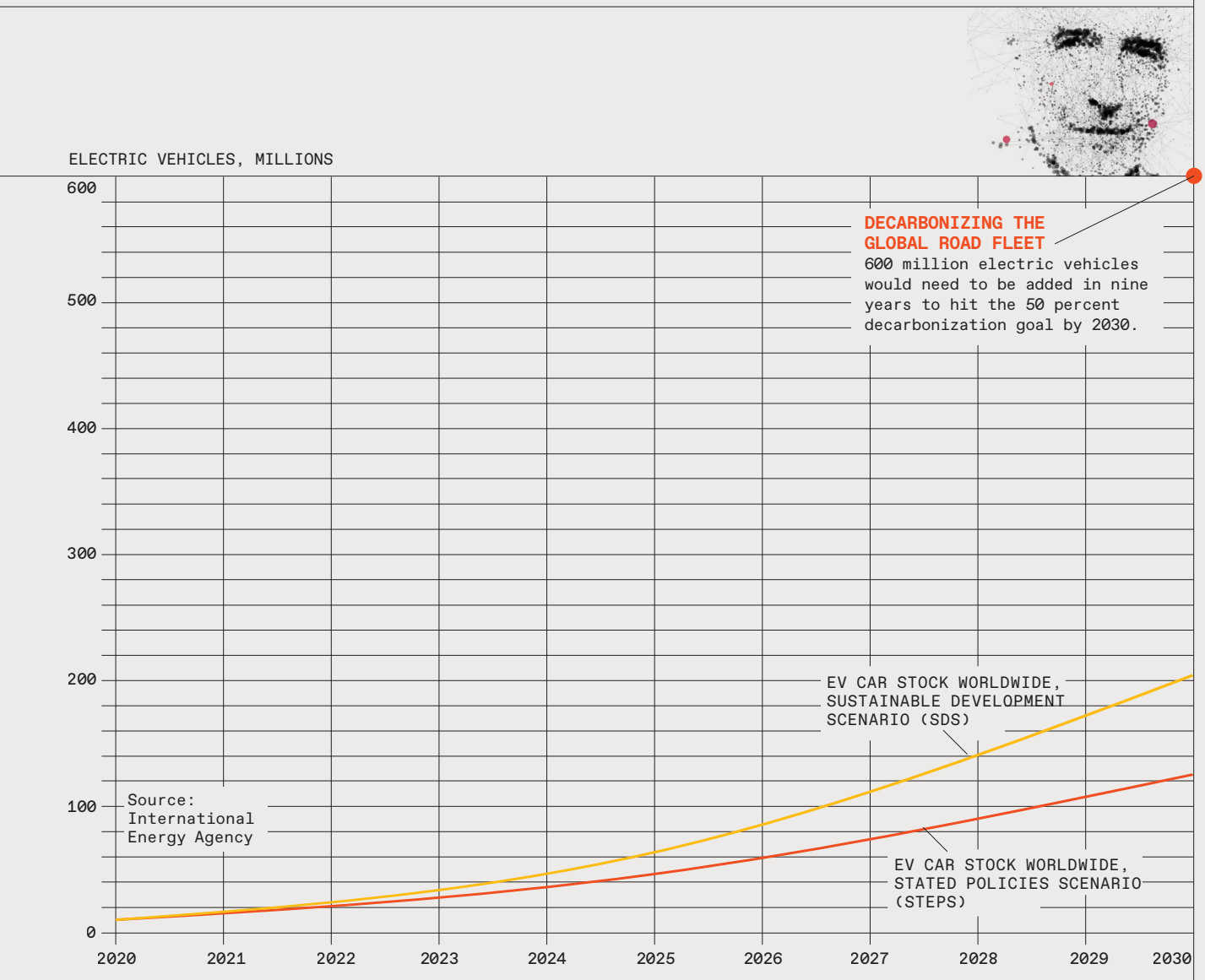

about 2.2 billion passengers a year, for a total of about 4.3 trillion carbon-free passenger-kilometers. What are the chances of that?

In 2019 the world produced 1.28 billion tonnes of pig (cast) iron in blast furnaces fueled with coke made from metallurgical coal. That pig iron was charged into basic oxygen furnaces to make about 72 percent of the world's steel (the rest comes mostly from electric arc furnaces melting scrap metal). Today there is not a single commercial steel-making plant that reduces iron ores by hydrogen. Moreover, nearly all hydrogen is now produced by the reforming of natural gas, and zero-carbon iron would require mass-scale electrolysis of water powered by renewable energies, something we still haven't got. A 50 percent cut of today's carbon dependence would mean that by 2030 we would have to smelt more than 640 million tonnes of iron—more than the annual output of all of the blast furnaces outside China—by using green hydrogen instead of coke. What are the chances of that?

Decarbonizing the global fleet of cars by 50 percent in nine years would require that we manufacture 66 million EVs a year, nearly as much as the total global production of all cars in 2019.

In 2021 there were some 1.4 billion motor vehicles on the road, of which no more than 1 percent were electric. Even if the global road fleet were to stop growing, decarbonizing 50 percent of it by 2030 would require that we manufacture about 600 million new electric passenger vehicles in nine years—that's about 66 million a year, more than the total global production of all cars in 2019. In addition, the electricity to run those cars would have to come from zero-carbon sources. What are the chances of that?

To set goals that correspond to available technical capabilities while taking into account reasonable advances in the production and adoption of non-carbon energy sources, we must start with grade-school algebra. What are the chances of that? ■

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