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TRANSMISSION 1

FROM DC TO AC TO DC

Prof. Vaclav Smil

Distinguished Professor Emeritus, University of Manitoba

Increasing reliance on renewable electricity generation means, almost inevitably, increasing reliance on long-distance electricity transmission. Load centers (areas of the highest electricity demand) rarely coincide with the regions of the highest insolation (solar radiation received on the ground) or with the areas experiencing steady and fairly strong winds. The best way to lower transmission losses over large distances is to work with higher voltages: the combination of lower current and higher voltage makes it possible to use lighter-weight conductors (made of aluminum with a steel core) and also to save material and reduce the cost of steel tower construction. High voltages (HV) are between 115-230 kilovolts (kW), extra-high voltages (EHV) between 345 and 765 kV; anything above that level is an ultra-high voltage (UHV). Moreover, high base-load demand (the minimum level of supply during a 24-hour period) of large cities and industrial areas and their peak loads that can be easily twice the base load require transmission links of sufficient capacity, with many of them now measured in gigawatts (GW, billions of watts).

After 140 years of development (first electricity was transmitted over a short distance from a New York power plant in 1882), these demands face no technical obstacles. The first coal-fired stations sent out their electricity as direct current (DC) at low voltages, alternating current (AC) became dominant during the 1890s, and typical transmission voltages rose from just 4.6 kilovolts (kV) in 1895 to 500 kV AC in the early 1960s. Development of large hydro stations located far away from load centers brought the resurgence of DC to minimize long-distance transmission losses, and these DC links went from 500 kV DC in 1970 (Pacific Northwest) to 600 kV DC by 1984 (from Itaipu, at that time the world's largest dam in Brazil). The record is now held by China, with a 1,100-kV DC link between Xinjiang and Anhui completed in 2019.

China has used these UHV links to construct a national grid, something that the US has never managed to do. And while Europe is much more interconnected than North America, it, too, has fallen behind in building new transmission lines that are needed to enable, and to optimize, long-distance transfers from sunny and windy regions to the continent's major load centers. Clearly, such projects do not pose any technical challenges and the lack of financing cannot be the decisive factor in economies that have recently used trillions of dollars and euros for all kinds of subsidies. Why then are the world's richest economies falling behind?

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