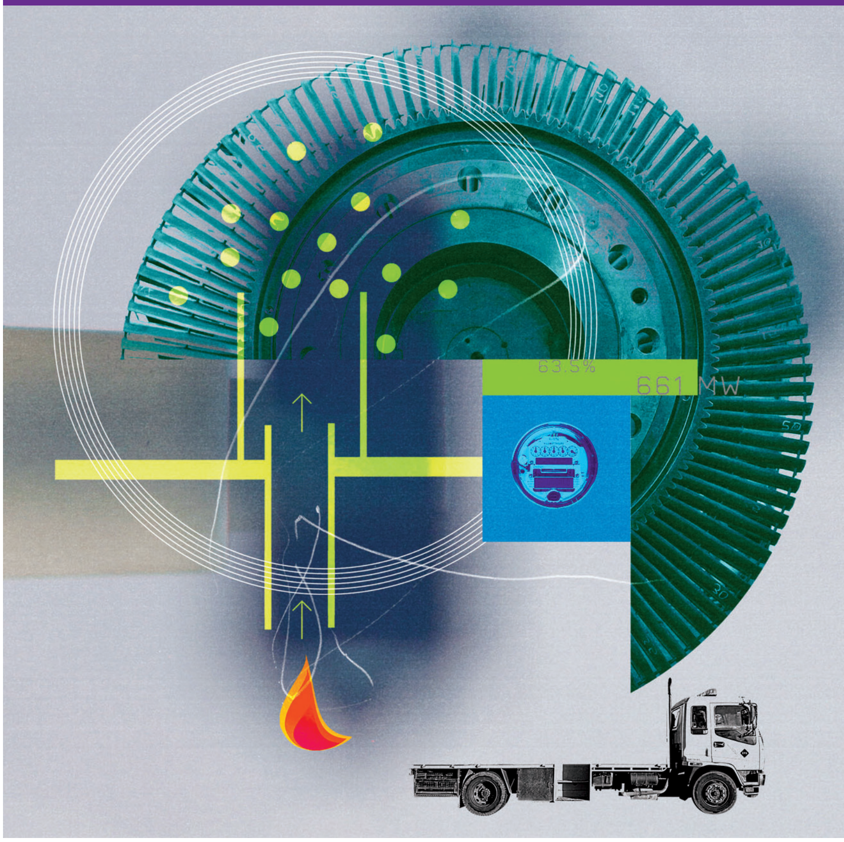

ILLUSTRATION BY Stuart Bradford

SUPEREFFICIENT GAS TURBINES

EIGHTY YEARS AGO, the world's first industrial gas turbine began to generate electricity in a municipal power station in Neuchâtel, Switzerland. The machine, installed by Brown Boveri, vented the exhaust without making use of its heat, and the turbine's compressor consumed nearly three-quarters of the generated power. That resulted in an efficiency of just 17 percent, or about 4 MW. • The disruption of World War II and the economic difficulties that followed made the Neuchâtel turbine a pioneering exception until 1949, when Westinghouse and General Electric introduced their first low-capacity designs. There was no rush to install them, as the generation market was dominated by large coal-fired plants. By 1960 the most powerful gas turbine reached 20 MW, still an order of magnitude smaller than the output of most steam turbo generators. • In November 1965, the great power blackout in the U.S. Northeast changed many minds: Gas turbines could operate at full load within minutes. But rising oil and gas prices and a slowing demand for electricity prevented any rapid expansion of the new technology. • The shift came only during the late 1980s. By 1990 almost half of all new installed U.S. capacity was in gas turbines of increasing power, reliability, and efficiency. But even efficiencies in excess of 40 percent–matching today's best steam turbo generators–produce exhaust gases of about 600 °C, hot enough to generate steam in an attached steam turbine. These combined-cycle gas turbines (CCGTs) arrived during the late 1960s, and their best efficiencies now top 60 percent. No other prime mover is less wasteful.

Gas turbines are now much more powerful. Siemens now offers a CCGT for utility generation rated at 593 MW, nearly 40 times as powerful as the Neuchâtel machine and operating at 63 percent efficiency. GE's 9HA delivers 571 MW in simple-cycle generation and 661 MW (63.5 percent efficiency) by CCGT.

Their near-instant availability makes gas turbines the ideal suppliers of peak power and the best backups for new intermittent wind and solar generation. In the United States they are now by far the most affordable choice for new generating capacities. The levelized cost of electricity–a measure of the lifetime cost of an energy project–for new generation entering service in 2023 is forecast to be about US $60 per megawatt-hour for coal-fired steam turbo generators with partial carbon capture, $48/MWh for solar photovoltaics, and $40/MWh for onshore wind–but less than $30/MWh for conventional gas turbines and less than $10/MWh for CCGTs.

Gas turbines are also used for the combined production of electricity and heat, which is required in many industries and is used to energize central heating systems in many large European cities. These turbines have even been used to heat and light extensive Dutch greenhouses, which additionally benefit from their use of the generated carbon dioxide to speed up the growth of vegetables. Gas turbines also run compressors in many industrial enterprises and in the pumping stations of long-distance pipelines. The verdict is clear: No other combustion machines combine so many advantages as do modern gas turbines. They're compact, easy to transport and install, relatively silent, affordable, and efficient, offering nearly instant-on power and able to operate without water cooling. All this makes them the unrivaled stationary prime mover.

And their longevity? The Neuchâtel turbine was decommissioned in 2002, after 63 years of operation–not due to any failure in the machine but because of a damaged generator. ■

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