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Cool coils

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MATERIALS that conduct electricity without losing any of it are the stuff that electricity companies dream of. In fact, they are far from being a pipe dream. All metals, as a Dutch physicist, Heike Kamerlingh Onnes, discovered in 1911, are capable of “superconducting”. But there is a small inconvenience. They do so only when refrigerated to a few Kelvin (K), just above absolute zero (-273°C), the coldest temperature possible. In practice it is therefore cheaper to let conductors waste some electricity than to keep them so cold.

Hence the excitement a decade ago when Karl Müller and Georg Bednorz of IBM's Zurich research laboratories discovered a superconductor that worked at 35K, a discovery that was soon followed by those of even better superconductors. These materials have been put to some good uses, particularly in small electronic devices. But the goal of piping electricity around countries without wasting any (in Britain nearly a tenth of the power in power lines turns into useless heat) has remained much harder to attain. Last month, however, the Swiss gave the cause of superconducting another fillip. On March 12th Geneva's electric utility, SIG, inaugurated three squat, inconspicuous tanks, each about 2m (7feet) tall and 1m wide. Together they make up the first electrical transformer in commercial operation to use superconducting wires.

The devices, built by ABB Asea Brown Boveri, a Swiss-Swedish conglomerate, convert electricity from the high voltage of the Swiss national grid down to a usable level for SIG's headquarters. They contain 6km (4 miles) of wire, wound into coils and dipped into liquid nitrogen (at a temperature of 77K) to keep it cold enough (although it retains its superconducting powers all the way up to a balmy 110K).

The challenge is in fabricating the wires. All the high-temperature superconductors (HTS) so far discovered are ceramics, made by baking a mixture of metals in an oven and letting them cool gradually to form a complicated atomic structure that permits superconductivity. American Superconductor, the firm that made the flexible wire for ABB out of this intrinsically hard and brittle substance (and in which Electricité de France, also a partner on the project with SIG and ABB, this week bought a $10m minority shareholding), does so by packing the raw material into hollow silver tubes, which are drawn into fine rods. Multiple rods are grouped within another metal jacket which is then drawn and baked to convert the raw material to the ceramic form and the rod into a wire. The wire is then flattened into a ribbon, 2 1/2mm wide and 1/4mm thick, that comprises the transformer coils.

It is not a perfect superconductor. Some power is lost in the silver, and the wires suffer so-called “hysteresis” losses from carrying alternating current. But these losses can be reduced, and ABB says that the transformer already wastes only about one-fifth as much power as conventional ones. An HTS transformer has other advantages too. HTS wires can carry more electric current than the usual kind, so a transformer made with them is more compact, and therefore easier to transport and set up, than a conventional transformer. And whereas conventional devices have their wires cooled and insulated by mineral oils that have a nasty habit of leaking or catching fire when things go wrong, the liquid nitrogen in which HTS coils are bathed is far safer; if it escapes, it just boils off into the air.

True, the transformer is a “commercial operation” in only a limited sense. The $5m project was partly paid for by the Swiss Federal Office of Energy Management, among other agencies, and the plan is to take the thing apart after a year and assess how well it has worked. But it may help Switzerland to become known not just as the place where high-temperature superconductors were born, but where they came of age.

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