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When high-temperature superconductivity was discovered in the 1980s, commercial applications in the electric power sector were estimated to take 20 to 30 years. A combination of private capital and government grants funded the development of the first generation (1G) high-temperature superconductor (HTS) tapes for power grid applications. By 1995, the first prototype HTS line design, including joints, terminations, and cryogenic cooling, was complete. Soon after, the first complete cable and system was installed and tested. By 2001, the world's first grid connected HTS system was staged for demonstration though the project was never energized.

Work on HTS power lines accelerated, prompted in part by continued public and private investments as well as advances in the superconducting tapes used to carry current. Over the next several years, HTS demonstration projects were set up internationally. In April 2008, the world's first transmission voltage HTS power cable was commissioned in Long Island, New York. The 138 kV cable ran 600 meters with a power carrying capacity of 574 MVA and a current of 2,400 Amps. The project used 155 kilometers of 1G wire in Phase 1. A project in Columbus, Ohio, demonstrated a 3-phase, 13.2 kV line that ran 200 meters. In Albany, New York, a 350 meter 3-phase, 34.5 kV cable of 1G wire was installed.

Both the Long Island and Albany projects included a second phase that demonstrated the first use of second generation of superconducting tapes (2G). When they were first produced in 2003, 2G tapes were projected to lower the cost of HTS wire to 2 to 5 times less than the cost of 1G wire. They had greater flexibility, enabled higher carrying capacities, and could be manufactured more easily in longer lengths. All the demonstration projects were technical successes and fully grid compatible. They all had protection and control just like a conventional cable, and the 'superconductivity' was invisible to the control room.

By 2006, tape costs were still high and refrigeration was still a major cost element. The shift from low-temperature superconductors (LTS) to HTS had triggered a ten-fold decrease in cooling costs but more cost reductions were still needed. Despite significant advances in HTS tapes, performance would need to double or triple to reduce losses sufficiently and subsequently decrease cryogenic costs. Eight years later, when the Coalition for the Commercial Application for Superconductors identified four fundamental challenges for superconductors, refrigeration was second on the list after cost. By then superconductors were confined to niche applications on the grid's low voltage distribution systems – high voltage, long distance transmission applications were still out of reach unless better HTS material was discovered or better cooling.

While most researchers and superconductor experts were looking at the limitations to superconductor applications for transmission as a problem presented by cooling systems linked to underground lines and the HTS materials, in 2011, a small but important body of work emerged that took a different approach. Instead of looking for better tapes and more efficient mechanical refrigeration systems, researchers Steve Ashworth and David Reagor looked at a different way to cool the existing HTS tapes.

They decided to explore a new method of cooling that would address the barriers that the large cooling stations presented to the long-distance deployment of superconductors. Instead of chasing more efficient refrigeration or looking for better conductors to ease the thermal load, they chose to use the coolant itself – liquid nitrogen – as part of the solution. To keep the nitrogen and the tapes they cooled at 77K, Ashworth and Reagor designed and tested an open-loop cooling system that evaporates a small portion of the liquid nitrogen. Allowing a small amount of liquid nitrogen to change from a liquid to a gas, the system used the latent heat of vaporization to provide twenty times the cooling power of the sensible cooling used in the closed-loop cooling methods of all of the earlier HTS applications.

Ashworth and Reagor's proposed approach could potentially overcome many of the challenges posed by the earlier closed-loop cooling methods. First, the need for large, complex cooling stations and infrastructure with multiple moving parts and a dependence on a reliable local power supply was removed. Second, the passive, open-loop cooling system was more energy-efficient than even the very best closed-loop refrigeration systems. Third, the new approach eliminated the "hot spots" that formed and constrained the amount of power a long HTS line could carry. And fourth, the approach eliminated temperature "jump" points at terminations and splices where there is no separate liquid circulation system.

Beyond mitigating challenges that had been encountered in earlier HTS transmission projects, the evaporative cooling approach could also open new doors for superconductor applications on the power grid. Instead of being limited to short distances and primarily distribution-level applications, this new evaporative cooling technique has the potential to enable cost effective, reliable HTS transmission lines at higher voltages and power levels over distances of 100 kilometers between cooling stations. A short distance, proof-of-concept overhead line was constructed at a U.S. government research lab in 2010. However, further development of the concept was largely discontinued roughly a decade ago as the funding was cut in part due to the perception that practical applications remained somewhat far off in the future.

Today, efforts are underway to commercialize and deploy the open-loop cooling system concept for HTS lines. This work involves significant testing and development of the components and overall system of an HTS transmission line using an open-loop distributed evaporative cooling system that can be deployed at any voltage level in overhead, underground, and on-ground grid installations.