The Garwin-Matisoo Vision After 45 Years
- Electric Power Via Superconducting Cables: Economic and Environment Issues -

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100 years ago this past month [1], Gilles Holst and Gerrit Flim successfully designed and conducted an experiment in Kamerlingh Onnes' laboratory in Leiden that revealed perfect conductivity slightly below the boiling temperature of helium in a pure sample of elemental mercury. Almost immediately dreams emerged of the lossless transmission of electric power throughout the burgeoning electricity enterprise on the American continent and in Europe. However, it was quickly found that these early "superconductors," mostly elemental metals, lost this property under conditions of impractically low transport currents and magnetic fields. It was not until reaching the decades from 1930 through 1950 that a family of metallic alloys, so-called "intermetallics," also known today as "type II" superconductors, were found that could conduct currents of over a thousand amperes/cm^2 and withstand magnetic fields on the order of 1-2 tesla.

These developments encouraged revisiting the potential of superconductivity for transmission of electricity, perhaps the most thorough being the 1966 study, "Superconducting Lines for the Transmission of Electrical Power over Great Distances," by Richard Garwin and Juri Matisoo [2]. The scale of their proposal was truly enormous – 100 GW (+/- 100 kV at 500 kA direct current) over a distance of 1000 km, carried by Nb_3Sn wire, the entire length refrigerated by liquid helium, the electricity itself being generated by large, remotely located nuclear and/or coal "farms." The G-M model continues to serve as the general blueprint today for similar projects that would now employ high temperature superconducting cables. We will revisit their concept in the context of this new materials technology and explore its potential for today's emerging energy economy, one which would stress centralized and remote non-eco-invasive and low-cost generation (natural gas and nuclear, as opposed to land-area-intensive solar and wind farms) of electricity and its delivery for consumption at large population centers [3] [4] [5] [6] [7] [8].

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[2] R. L. Garwin and J. Matisoo, "Superconducting Lines for the Transmission of Electrical Power over Great Distances," Proc. IEEE **55**, 538 (1967).
[3] Paul Michael Grant, "Extreme energy makeover," Physics World, October 2009, p. 1.
[4] P. M. Grant, C. Starr and T. J. Overbye, "A Power Grid for the Hydrogen Economy," Scientific American, July 2006, p. 78.
[5] Paul Michael Grant, "…Garwin-Matisoo Revisited Forty Years Later," IEEE Trans. Appl. Supercond. **17**, 1641 (2007).
[6] P. Grant and S. Eckroad, "The Hydrogen-Electric SuperGrid: Two Scenarios – SuperSuburb and SuperTie," EPRI Report 1013204, March 2006.
[7] W. V. Hassenzahl, S. Eckroad, P. M. Grant, B. Gregory, S. Nilsson, "A High-Power Superconducting Cable," IEEE Trans. Appl. Supercond. **19**, 1756 (2009).
[8] P. M. Grant, "Superconductivity in Power Applications," ICEC-ICMC Conference Proceedings, Wroclaw, Poland, 2010 (to be published).