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Alternatives to Rare Earth Permanent Magnets for Energy Harvesting Applications[1] HELENA KHAZDOZIAN, RAVI HADIMANI, DAVID JILES, Department of Electrical and Computer Engineering, Iowa State University
— Direct-drive permanent magnet generators (DDPMGs) offer increased reliability and efficiency over the more commonly used geared doubly-fed induction generator, yet are only employed in less than 1 percent of utility scale wind turbines in the U.S. One major barrier to increased deployment of DDPMGs in the U.S. wind industry is NdFeB permanent magnets (PMs), which contain critical rare earth elements Nd and Dy. To allow for the use of rare earth free PMs, the magnetic loading, defined as the average magnetic flux density over the rotor surface, must be maintained. Halbach cylinders are employed in 3.5kW Halbach PMGs (HPMGs) of varying slot-to-pole ratio to concentrate the magnetic flux output by a lower energy density PM over the rotor surface. We found that for high pole and slot number, the increase in magnetic loading is sufficient to allow for the use of strontium iron oxide hard ferrite PMs and achieved rated performance. Joule losses in the stator windings were found to increase for the hard ferrite PMs due to increased inductance in the stator windings. However, for scaling of the HPMG designs to 3MW, rated performance and high efficiency were achieved, demonstrating the potential for elimination for rare earth PMs in commercial scale wind turbines.

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