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# Advances to the Restoration and Protection of Wind-Dominant Power Systems

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## Abstract

The restoration of wind-dominant power systems is an emerging problem in power engineering. To study these processes, power engineers have been challenged to employ electromagnetic transient (EMT) simulations. This talk addresses these hurdles by developing EMT control models to: (i) reliably supply grid-forming inverters using both Type 4 wind turbines and batteries, (ii) stably interconnect wind power plants into a grid under recovery, and (iii) autonomously make adaptive restoration decisions if transmission faults occur during restoration. In this vein, another emerging challenge is to reliably detect, remove, locate, and classify faults given the limited fault-current capability of converter-based generation. To tackle this problem, this talk also introduces a time-domain protection approach that leverages the classical Bergeron model for ac transmission lines. Low- and high-impedance asymmetrical faults are detected by ascertaining their absence and located by solving a one-variable non-convex optimization problem. In this presentation, power converters are steered by a reliable grid-forming control strategy that employs two-axis anti-windup proportional-integral regulators that bound control commands and integrators within an origin-centered circle. These advances are significant to reliably restore wind-dominant grids and timely remove transmission faults that can jeopardize their recovery. They are also important to address the recommendations of the North American Electric Reliability Corporation in the sense of employing EMT simulations to study restoration and developing new relaying techniques for converter-based systems. This presentation is based upon work funded by the U.S. Department of Energy, Office of Basic Energy Sciences, award No. DE-SC0021410.

## Biography

Hugo earned his Ph.D. in Electrical and Computer Engineering from Purdue University in 2016. He joined the Department of Electrical and Computer Engineering at Iowa State University (ISU) in 2019 where he is a Harpole-Pentair Assistant Professor. Previously, he was a Postdoctoral Researcher at the National Renewable Energy Laboratory in Golden, CO from 2017 to 2019. He was also a supervisor of electrical maintenance in thermal power plants of CELEC EP Termopichincha in Ecuador from 2007 to 2009.

Hugo was the recipient of a Fulbright scholarship from 2009 to 2011, the Best paper award of the IEEE Transactions on Energy Conversion for 2013–2014, and the IEEE Power & Energy Society Prize paper award for 2015. Hugo's research and teaching interests lie at the intersection of electric machinery, power systems, control systems, power electronics, protections, and computational analysis of complex systems. At ISU, Hugo is affiliated with the Electric Power & Energy Systems group and the Electric Power Research Center. Hugo serves as an Associate Editor of IET Generation, Transmission & Distribution since 2020.

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