

Title: How to accelerate learning by real scale system testing in harsh environments? The role of climatic validation testing of energy transition technologies operating in demanding worldwide markets

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Abstract

The global energy transition necessitates efficient and reliable equipment for success. Validation testing of critical technologies, like (offshore) wind turbines, floating PV tech, hydrogen generators, and battery storage units, operating in extreme climates, is vital for performance and safety. This abstract highlights Belgium's unique large climatic test chamber as a crucial tool for testing prototype equipment in real-scale environments. The 10.6m x 7m x 8m chamber offers a temperature range from -60°C to +60°C, 95%RH humidity, infrared heat, and ice testing options, enabling developers, operators, and suppliers to test under extreme conditions.

Case studies over the past decade emphasize the significance of testing transformer systems in harsh environments. New bio-degradable dielectric fluids offer sustainability benefits but introduce challenges due to higher oil viscosity. One 15MVA offshore wind transformer case demonstrates successful cold testing, improving cold-start procedures and reducing waiting times. Transformer pump testing further highlights the necessity of component-level examination, considering factors like viscosity, motor peak currents, and material behaviour.

Additionally, the paper showcases the importance of validating hydrogen fuel cells for harsh environments. A notable test campaign prepared a vertical axis wind turbine for operations in Antarctica, verifying reliability and performance under extreme conditions, including severe icing and high windspeeds.

These case studies underscore the role of advanced test facilities, such as Sirris's large climatic chambers, in accelerating the learning process by providing valuable insights into equipment performance and robustness. Industry feedback reveals that aspects considered in failure mode and effect analysis (FMEA) would be time-consuming through simulation testing alone. Learning from real-scale testing shortens time to market.

As climate change intensifies, adopting such testing methodologies becomes indispensable for a successful energy transition, reducing risks and ensuring equipment reliability. Future investment in larger testing facilities for offshore wind turbines with a focus on cold start-up behaviour further enhances the transition's implementation.

