Candidate Essay: Renewable Resources and Energy Systems Integration Impacts on Standard Adoption

International electrotechnical standards play a crucial role in shaping the future of energy systems and decarbonization efforts globally. As countries, organizations, and industries strive to achieve net-zero carbon emissions by 2050, the focus of international electrotechnical standards should consider renewable energy, hybrid power plants, and integrated energy systems.

The European Union, China, and the Unites States (U.S.), and 90 other countries have committed to achieving net-zero carbon emissions by 2050, with countless companies, states, regions, and organizations also committing to decarbonize. To achieve decarbonization at the scale and pace required to meet these targets, future energy systems will need renewable energy to serve 100% of the existing direct electricity demand, support additional electrification, and decarbonize the wider economy across diverse geo-political landscapes and cultures. Inter-regional transmission is limited in many countries and is prohibitively expensive and time-intensive to build. Even ambitious plans like the North Sea Wind Power Hub [1], aimed at facilitating international transmission, are not expected to be completed until after 2030. Hybrid power plants that combine generation, storage, and end uses on-site to maximize efficiency of energy use have the potential to avoid stranded assets and maximize the use of existing interconnections, as well as contribute to decarbonization across sectors (including transportation, industry, agriculture, and building energy use). Tomorrow’s electrotechnical standards and conformity assessment community has a massive opportunity to facilitate the safe, efficient development of these hybrid power plants and integrated energy systems.

While hybrid power plants are not a new concept, their application is increasing and expanding, driven not only by decarbonization goals, but also by transmission constraints, market competition, and ancillary grid services benefits.[[1]](#footnote-1) Developers face lengthy interconnection queues and escalating upfront costs despite the falling costs for battery, solar, and wind technologies. Paired with recent increases in market competition (which will continue as renewable energy generation penetration increases), wherein power purchase agreements have sharply declined in price, this has made project financing increasingly difficult, and has increased the impact of resource uncertainty risk [2]. These drivers incentivize hybrid plant developers to leverage the complementarity of disparate generation resources and the flexibility to dispatch energy at times when the grid needs it most (at times of high demand, low generation). This helps mitigate some project financing risk and provides an attractive alternate “hedge” to in this new low-cost climate by reducing overall resource uncertainty, optimizing dispatch for capture prices, and adding grid services revenue in select markets. Hybrid power plants also provide an opportunity to share building and infrastructure costs, capture otherwise clipped energy, and take advantage of available federal incentives.

Developers are increasingly exploring the integration of hybrid power plants with end uses beyond electricity. This approach enables reliable profit from offtake agreements and eliminates the need for extensive transmission infrastructure. Power-to-X concepts, such as hydrogen production, provide flexibility and support the decarbonization of hard-to-abate industries (such as ammonia, steel, heavy transport, shipping, and cement/concrete) and provide opportunity for efficiency increases and risk reduction. For instance, design and operation of a hydrogen-producing hybrid power plant with a steel fabrication facility can reduce the risk to people, planet, and profit by minimizing hydrogen compression and storage, which can be difficult, expensive, and hazardous. Furthermore, offshore deployment of these integrated energy systems capitalizes on the vast renewable energy sources available, including offshore wind, marine hydrokinetic, and floating solar photovoltaic technologies, that can deliver the scale and flexibility necessary to transform the energy sector and achieve enhanced cost and performance efficiencies while addressing other key challenges like carbon capture, clean water, and food production. However, offshore projects require inter-regional and international coordination, and (because of their complexity and inaccessibility) are only feasible with advanced technologies such as digitalization, cybersecurity, and automation to optimize performance and reduce risk.

To adequately support the integration of these complex and multi-disciplinary systems, the standards and conformity assessment community faces several challenges. Technology standards must be rapidly adapted to changing market and technical contexts (even conventional technologies are being designed, operated, and applied in new ways). Coordination across technical experts in disparate disciplines and committees is essential to account for integrated systems. Moreover, effectively incorporating cross-cutting standards (such as those for cybersecurity, artificial intelligence, data, and digital technologies, as well as those that pertain to the safe, equitable, and just application of technologies) are needed.

This requires broad transparency, communication, and accessibility across the body of standards and conformity assessments that exist and are in-progress so that members can effectively collaborate to develop cross-references and consistency across documents. Furthermore, leadership engagement is vital to ensure effective coordination. The electrotechnical standard community is uniquely positioned to provide guidance and clarity to a vast, emerging industry need that currently lacks standardization and conformity. These advancements are crucial for achieving global decarbonization targets, addressing transmission constraints, and capitalizing on the potential of integrated energy systems.

References:

[1] North Sea Wind Power Hub Programme, “Hubs and spokes–viable beyond theory: sharing of feasibility results,” *Technical Report*, url: https://northseawindpowerhub.eu/knowledge/hubs-and-spokes-viable-beyond-theory.

[2] J. Fields et al., “Wind Plant Performance Prediction (WP3) Benchmark Introduction,” *NREL Technical Report*, 2019,NREL/PR-5000-74347, url: https://www.nrel.gov/docs/fy19osti/74347.pdf.

[3] W. Gorman, et al., "Motivations and Options for Deploying Hybrid Generator-Plus-Battery Projects within the Bulk Power System," *The Electricity Journal*, 33 (5), pp. 106739, 2020, doi: <https://doi.org/10.1016/j.tej.2020.106739>.

1. In the U.S., pre-Inflation Reduction Act interconnection queues showed a quarter of all proposed solar projects are combined with batteries, with 4% of wind projects also proposed as hybrids. In California, almost 2/3 of solar projects are proposed as hybrids [3]. [↑](#footnote-ref-1)