e-News for power industry leaders
Edition 43 – May 2026

Energy Sectors Integration and Impact on Power Grids

As the world transitions to a low carbon economy, Technical Brochure (TB) 973 prepared by Working Group (WG) C1.47, examines Energy Sector Integration (ESI), current practices and opportunities to advance the coordinated planning and operation of energy systems, including electricity, gas, heating and cooling, transport, and emerging hydrogen systems.

23 members from 14 different countries contributed to WG C1.47, with Australian C1 Convener, Christian Schaeffer representing Australia.

The global push to limit climate change to 1.5 °C, as set out in the Paris Agreement, is accelerating the transformation of energy systems worldwide. While renewable electricity is expanding rapidly, decarbonisation cannot be achieved by the power sector alone. TB 973 presents how ESI can be a critical enabler of a resilient, efficient and low-carbon energy future.

Historically, energy sectors were planned and operated in isolation. This siloed approach is increasingly incompatible with high shares of variable renewable energy. ESI addresses this challenge by coupling sectors through technologies such as power-to-gas, power-to-heat, electric vehicles, gas-fired generation, and combined heat and power. These links allow energy to be converted, stored, and shifted across sectors, improving overall system flexibility and efficiency while reducing emissions.

TB973 identifies three primary drivers for energy sector integration. First, it supports carbon reduction by enabling renewable electricity to displace fossil fuels in transport, heating, and industry. Second, it enhances system reliability and resilience by creating multiple energy supply pathways and allowing partial system operation during disturbances. Third, it improves economic efficiency by reducing infrastructure duplication and making better use of existing assets, particularly in systems with intermittent renewable generation.

From a power grid perspective, ESI has profound implications for both planning and operation. Electrification of transport and heating is expected to significantly increase electricity demand, while flexible loads such as heat pumps, electric vehicles and electrolysers, introduce new opportunities for demand response. Integrated systems can absorb surplus renewable generation, reduce curtailment, and defer costly transmission reinforcements. However, they also introduce greater complexity, interdependencies between infrastructures, and the risk of cascading failures if not carefully managed.

Energy conversion technologies for energy sector integration are presented, such as *Power-to-X* (including power-to-gas, power-to-heat, power-to-cooling, and power-to-transport) and *Gas-to-X* (including gas-to-power, gas-to-heat, combined cooling heat and power plants, and combined heat and power plants).

To address the requirements for more advanced planning, the brochure reviews modelling approaches based on energy hubs and interconnected energy networks, which allow planners and operators to analyse multi-energy interactions consistently. A range of specialised software tools in active use are assessed, including EnergyPLAN, PLEXOS, Calliope, and Artelys Crystal Super Grid, each supporting different aspects of integrated planning, operation, and market analysis.

Finally, international case studies including from China, Italy, the United Kingdom, the United States, and Australia demonstrate that well-designed energy sector integration can improve flexibility, manage uncertainty, lower operating costs, and facilitate higher renewable penetration. These examples also underline the importance of aligning market structures, regulatory frameworks, and data governance with integrated system objectives.

Overall, WG C1.47, TB 973, concludes that Energy Sector Integration will be a foundational element of future power system development. Successfully realising its benefits will require coordinated technical standards, advanced modelling tools, supportive market design, and close collaboration across traditionally separate energy sectors.

The TB is free for members and €240 for non-members.