

Application of 5G Technology to Smart Grids

As the energy sector shifts towards more decentralized and renewable sources, advanced communication technologies are essential. 5G offers significant enhancements in bandwidth, connectivity, and reliability, which are crucial for the efficient operation of modern smart grids. Working Group D2.55 has produced Technical Brochure (TB) 996 which explores the integration of 5G technology within smart grids, highlighting its potential to transform energy distribution and management. The Australian members of the WG were V Tan and L Shao.

As electricity systems become increasingly distributed and incorporate growing levels of renewable energy and distributed energy resources (DERs), advanced communications are required to support real-time monitoring, protection, automation and control functions. TB 996 identifies several smart grid applications that can benefit from 5G capabilities, including distribution automation, differential protection, supervisory control and data acquisition (SCADA), phasor measurement units (PMUs), advanced metering infrastructure, precise load control, energy storage management, transmission line monitoring and drone-based asset inspection. These use cases leverage 5G features such as ultra-reliable low-latency communications (URLLC), massive machine-type communications (mMTC), network slicing and edge computing.

The report highlights that 5G can support time-critical smart grid applications that have traditionally relied on dedicated communications infrastructure, including fibre-based networks in some deployments. In particular, it notes that 5G-enabled distribution network differential protection can reduce fault isolation times from several minutes to tens of milliseconds, reducing both the duration and extent of customer outages.

A further finding is the importance of private 5G networks, network slicing and edge computing in providing secure, isolated and deterministic communications for mission-critical utility operations. These capabilities allow communications resources to be tailored to the differing requirements of protection systems, operational technology (OT), field workforce applications and large-scale sensor networks.

The report also identifies several challenges that must be addressed to realise the full benefits of 5G-enabled smart grids. These include infrastructure costs, coverage limitations in difficult terrain or remote locations, device power consumption, integration with existing utility systems, and the need to manage cybersecurity risks associated with increasingly virtualised and cloud-based network architectures.

Implications for Australia

These findings are particularly relevant as Australia transitions towards a more decentralised energy system characterised by high levels of rooftop solar, battery storage,

electric vehicles and increasing renewable energy generation. The use cases identified in TB 996 closely align with emerging Australian requirements for DER orchestration, distribution automation, grid visibility, remote asset monitoring and network resilience.

The report's emphasis on distributed energy management, energy storage integration and precise load control is especially relevant as utilities seek to maintain grid stability while managing increasing renewable penetration and bidirectional power flows across distribution networks.

A notable Australian challenge is spectrum availability for utility broadband networks. While TB 996 highlights the benefits of private 5G networks, Australia currently lacks readily available low-band private broadband spectrum such as 450 MHz, which is increasingly used internationally to support utility communications due to its cost-effective wide-area coverage characteristics. This may constrain deployment of utility-owned private 5G networks across remote and regional areas, increasing reliance on public mobile networks, fibre, microwave and emerging 3GPP non-terrestrial network (NTN) connectivity.

Overall, TB 996 concludes that 5G has the potential to become a foundational communications platform for future smart grids, supporting greater automation, resilience, operational efficiency and renewable energy integration across increasingly complex electricity networks.