Attachment A

Advisory Note for relevant topics.

The following notes are provided for each of the major topics. While CSIRO considers this guidance as useful for EOI submissions, potential respondents may submit against alternative topic areas within a Topic.

Your submission will be considered along with all others. CSIRO would suggest respondents spend some time offering an explanation why an alternate path should be considered.

Topic 1: Inverter-Based Resources (IBRs)

The CSIRO research roadmap for Topic 1 produced in 2021[1], outlines major research tasks for understanding performance requirements for IBR as they displace synchronous generation.

Work has progressed on the most critical tasks, starting with Stage 2 in 2022. The current Stage 5 research is focused on large-signal stability analysis and stability of multi-IBR systems, sensitivity analysis of grid forming inverters and controller design and tuning guidelines for grid forming inverters.

AEMO has now published five Statements of Need for *Transitional Services*[2] to trial new technologies for the management of power system security in a low- or zero- emissions power system.

Although Topic 1 has focussed in the past on large scale IBRs in the bulk power supply system, proposals that focus on small scale IBR in the distribution network will be considered where the work will alleviate constraints on renewable generation uptake. Based on the ongoing research, as well as industry developments since inception of the Roadmap, CSIRO emphasise the following list of tasks for future stages in Topic 1:

High Priority

- Continue investigation of grid-forming technology beyond virtual synchronous generators, considering other control schemes to outperform existing methods, and analyse and quantify the ability of grid-forming inverters to meet power system requirements. In particular,
    - the ability of IBRs to provide system strength sufficient to support the correct operation of conventional or advanced protection devices, including
        - investigating the role of grid forming inverters supported by grid following inverters in the provision of local system strength.
        - consideration of grid following behaviour under fault conditions by inverters that operate in grid forming mode under normal conditions.
        - management of unbalanced faults.
        - broad technical and economic comparisons among: oversizing IBR fault-current capacity, enhancing protection relay capability, or novel IBR behaviour to facilitate fault identification other than via traditional current or impedance characteristics.
    - understanding theoretical technical constraints and cost trade-offs of IBR performance requirements such as grid formation, virtual inertia provision, protection quality system strength provision, fault ride through, system strength requirements for reliable Phase Locked Loop operation, and restart support.
- Understanding the relationship between technical performance requirements on individual GFL and GFM IBR and power system aggregate stability and security

[1] https://www.csiro.au/-/media/EF/Files/GPST-Roadmap/Topic-1-Inverter-design-Final-Report-with-alt-text-2.pdf

[2] https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/transition-planning/transitional-services---type-2-services

behaviour. Identify gaps in existing approaches that are limited to simulation studies and small signal analysis, and possible practical solution approaches.

- Modelling and Grid Integration of Inverter-Based Loads (IBLs)
    - Assess simplified aggregate models compared to more detailed representations
    - Assess relevance of diversity in inverter behavioural responses
    - Validation and benchmarking of IBL models
    - Assess system wide impact and mitigating solutions, potential interaction with IBR and synchronous machines
    - Improving visibility
    - Provision of essential system services required to support renewable generation, such as frequency control ancillary services, inertia related services, voltage support and support of protection quality system strength.
- Research (literature review assessing, simulations of, and laboratory demonstrations of, technology close to implementation) that will support practical outcomes in the implementation of AEMO's *Type 2 Transition Services* field trials, via the development and assessment of field trial design options mostly likely to cost effectively demonstrate capability to remove technical constraints on renewable power in
    - Provision of protection quality system strength from IBR (highest priority)
    - System restart from IBR
    - Power system operation with zero synchronous generation
- Prevention, restarting and recovering stability from IT or control and communications events which disrupt operation. For example, cyber interruption, degraded communication, DER orchestration failure, and IT/OT interaction failures.
- Development of technical standards for grid forming inverters including defining technical requirements for system restart, both as a restart source and for restart support. Include consideration of cyber-resilience such as some degree of manual operation for critical assets to avoid having to retrofit these critical functions.

Medium Priority

- Continued development for publicly releasable wide-area model that is more reflective of the NEM transmission network for studies (model above 33 kV).
- Research that will support the implementation of AEMO's *Type 2 Transition Services* field trials in system restart under conditions of high capacity of distributed IBR
- Laboratory hardware demonstration of novel IBR control methods where this is required to encourage deployment of technology that alleviates constraints on the uptake of renewable generation.
- Interaction mitigation and oscillation damping in high IBR penetration power systems.
- Consideration of how the future provision of any existing and anticipated restart services should be incentivised and maintained, either through technical standards and/or market mechanisms. Explore different market structures that may more efficiently and effectively provide restart services. What incentives are required to encourage connection of grid forming inverters including additional incentives for those that are black start capable?
- Assess adequacy of simulation modelling given complexity of power systems, and explore use of data driven approaches and artificial intelligence machine learning methods

<u>Topic 2:</u> Power Systems Stability

The future direction of Topic 2 is undergoing review by CSIRO and there is no call for expressions of interest on this topic on the Stage 6 proposal time line.

<u>Topic 3:</u> Control Rooms of the Future

This work is to develop new technologies and approaches for enhanced real-time visibility and analysis for decision making in power system operator control rooms. The work should have clear and demonstrable benefits to control rooms (of the System and Market Operator, Transmission Operators, and/or Distribution Operators) including their systems, processes, and human operators. Research proposals should explicitly state for what system scale of control room they are applicable. Where relevant, bidders are advised to strongly link their expected research to the tools, processes, and outcomes for Operations Technologies (OT).

Applied research that serves the priority OT applications below are welcomed, including (but not limited to) recent advances in generative AI, human computer interfaces, physics-informed neural networks, data governance/stewardship techniques, and human-AI collaboration. However, they must be firmly grounded in use-cases for control rooms and have benefits within the 1-year time frame.

Identified areas include:

High Priority

- Continue to build on current work, improving alarm management, visualisation and fatigue management, and other improvements coming out of Topics 3 and all other topics impacting directly on Real-time Operations and Control Room interfaces.
- Increase the focus on machine learning for managing data in the control room and producing task-specific outputs.
- Determine what visualisation capabilities are needed to enable operators to effectively and efficiently interpret relevant information and make operational.
- Identify how operational forecasting capabilities can be improved to manage a VRE-dominated grid, and what tools are needed to manage short-term resource adequacy.
- Investigate what short-term planning and control room tools are necessary to manage an energy grid with a high penetration of BESS including coordinated CER storage.

Medium Priority

1. Comprehensive assessment of data processing and interpretation requirements of the key future control room capabilities to manage high penetration of IBR listed below, and hence requirements for operator capability, major computational hardware, software, communications systems, metering and sensing hardware, and externally supplied data streams, in order of priority in terms of removing constraints to the uptake of renewable energy generation.
    a. **Data Driven Topology Estimation**
    b. **Alarm Management Process improvement**
    c. **Outage Management and Reporting**: Automated logging systems and integration with other tools; Network Outage Scheduler (NOS) enhancements with risk assessments and forecasting.
    d. **Frequency Management and Control, Ramping, and Inertia**: Ramping assessment tools; Distributed Energy Resources (DER) demand control architecture and implementation.

   e. **Electricity Market Management System (EMMS)**: General improvements for NEM2025 and WEM market reforms.
   f. **Foundation for Resilience, including Protection, Control, Blackstart, and Restoration**: Special Protection Scheme (SPS) and protection wide area coordination tools; Blackstart and Restoration tools using Variable Renewable Energy (VRE) and DERs.
   g. **Voltage and Reactive Power Management**: Voltage reactive power management tool with look ahead capability.
   h. **System Strength and Electro Magnetic Transient (EMT)**: Study automation tools and Real Time Simulations (RTS)
   i. **Dynamic Security Assessment (DSA) and Constraints**: Prediction tools for Transient, Voltage, Frequency, and Small Signal stabilities.
   j. **EMS SCADA and System Monitoring**: Continued enhancement and integration of Energy Management Systems (EMS) and Wide Area Monitoring Systems (WAMS)
   k. **Compliance Monitoring**: Systems for generation demand, DER, model validation and compliance monitoring.
   l. **Operational Forecasting**: Integration of operational forecasting tools with general OT tools
   m. **Operational Data and Models**: Governance and management system for operational and modelling data; Network Model Management (NMM) framework to service operations, markets, planning and connections.
2. Cybersecure solutions for both sharing of relevant monitoring data and protecting the integrity of command and control capability.
3. Improving Control Room decision making process
4. Development of open-source software

Future work in this area should

- be based on an integration-first architecture (one model, many views)
- pilot 1–2 high-value use cases (event detection through to decision aids)
- embed new ways of working in control room operations – agile, feedback loops, measurable workload impacts.

Acceleration will come from a shared data fabric and infrastructure platform that supports access to all relevant information, not only for operational production control room software, but also for rapid, ad hoc, analysis to support the control rooms.

Topic 4: System Planning

The need for expansion of our electrical transmission and distribution networks has been raised by network companies, the system operator, and energy producers, across Australia. In outlining the many changes that are occurring in our electrical network from decarbonisation to decentralisation, from electrification and digitisation, and to a transition to asynchronous generation, the 2021 Topic 4 Research Roadmap identified that substantial research is required to define the planning frameworks that will lay the foundation for low carbon and energy system planning. The research roadmap outlined the need for research across five cohesive programs including open-source tools and datasets, new decision-making metrics, modelling of power system operation and distributed energy systems, and long-term uncertainty for the system planning.

The roadmap can be accessed: https://www.csiro.au/-/media/EF/Files/GPST-Roadmap/Topic-4-Planning-Final-report_with-AltText.docx

Previous stages of Topic 4 research have developed a range of tools and methodologies, including probabilistic decision-making frameworks and security-constrained planning approaches for assessing network security and resilience, as well as evaluating the contributions of hydrogen pipeline network and distributed energy systems to transmission networks.

Previous stage research reports can be accessed: https://www.csiro.au/en/research/technology-space/energy/Electricity-transition/AR-PST

Some of this work has reached a relatively mature stage, while other components remain in early development. This creates strong opportunities for future research to deliver practical, scalable, and implementable solutions that can directly support planning functions within transmission or distribution network service providers, or within AEMO.

High Priority

- Planning for energy management with high penetration of battery energy storage systems (BESSs) in conditions such as minimum system load (MSL), lack of reserve (LOR).
- Planning that anticipates the coordination of storage from consumer energy resources (CERs).
- Time-sequential modelling beyond ISP-style capacity expansion modelling.
- New planning models and metrics for resource adequacy, scarcity, reliability and resilience considering load forecast, CERs and BESSs.
- Modelling, forecasting, and management of large loads, including bidirectional loads, such as data centres (higher priority), and electrolyser/fuel-cells (lower priority).
- Planning models extending beyond energy and capacity, capturing system security.
- Integrated Transmission and & Distribution planning.
    - Incorporating impacts of markets and CER coordination on distribution requirements
    - Incorporating flexible demand options
- Working with power system or network planners to implement modern planning methods within their business practices.

Future work in this area should continue to prioritise open-source practical, scalable, and implementable research outcomes that support AEMO planning teams and network service providers. Highest priority will be given to work that enables planners to confidently develop plans that enables renewable generation to be deployed at least net cost.

Consideration of probabilistic resource adequacy and demand flexibility could be included as part of Topic 4 if there is also a planning application focus, otherwise such analysis may be better placed within Topic 6.

Topic 5:

The research area covered by Topic 5 (System restoration and black start) in Stages 1-5 are now included within Topic 1: (Inverter Based Resources) and Topic 6: Power Systems Security

<u>Topic 6:</u> Power Systems Security

Power system security entails the coordinated dynamical management of the electrical power system to deliver power to customers despite credible uncontrollable contingencies such as unavoidable loss of power system elements.[3] It includes aspects such as

- the coordinated balancing of generated supply with instantaneous demand,
- maintenance of network voltages,
- the correct operation of protection equipment,
- restoration and restart from system black conditions, and
- cybersecurity.

More recently system strength and inertia have been introduced as essential system services that are required to ensure the National Electricity Market operates securely and reliably. AEMO has developed an annually updated *Transition Plan for System Security*[4] which outlines high priority system security constraints that must be managed to enable a high renewables power system. AEMO has also published five Statements of Need for *Transitional Services*[5] to trial new technologies for the management of power system security in a low- or zero- emissions power system.

Previous Stage 4 research[6] conducted a review of an earlier Topic 6 Research Roadmap published in 2021[7], as well as creating a catalogue of all anticipated future system services and system functionalities to support these has been developed to guide future research.

It is recognised that power system security is relevant not only to the bulk power system and market operator, but also to transmission and distribution network operators. All have a need for the secure operation of the parts of the power system they are responsible for operating. All have an opportunity for indirectly facilitating the security of operations outside their areas of direct existing responsibility. This Topic has a very broad scope, and consequently would be considered a particularly good candidate for the support of more than one research proposal. Essential enablers of system security in the future may include integrated transmission-distribution security, grid-forming inverter capabilities, and the coordination of BESS, DER, and flexible loads. Technical assessment of these individual capabilities could be considered within this topic. However, comparison among a broad suite of options with an application focus on holistic planning may be better placed within Topic 4.For future stages of the system services research, research that would address open matters and provide practical and useable outcomes to the operation of the Australian power system to enhance the contribution of renewable generation. This could include the following.

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[3] Where system security is supported by well-defined, quantifiable, capabilities attributable to specific responsible entities, these capabilities are commonly described in the Australian power system context as “essential system services”.
[4] https://www.aemo.com.au/energy-systems/major-publications/transition-plan-for-system-security-tpss
[5] https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/transition-planning/transitional-services---type-2-services
[6] https://www.csiro.au/-/media/EF/Files/GPST-Roadmap/Stage-4-Final/AR-PST-Stage-4-Topic-6-pdf.pdf
[7] https://www.csiro.au/-/media/EF/Files/GPST-Roadmap/Topic-6-Services-Final-Report-with-alt-text.pdf

High Priority

- Research that will support implementation, or accelerate achievement of objectives, the *AEMO Transition Plan for System Security* with a focus on practical outcomes such as the development or application of assessment and design tools, laboratory demonstrations and field trials in
    - alleviating need for, and minimising technical trade-offs and economic costs of meeting, system strength requirements
        - For example, a shift in focus towards developing more robust system strength metrics, and how protection quality fault current is maintained with few or no synchronous generators.
    - alleviating need for, and minimising technical trade-offs and economic costs of meeting, minimum bulk power system load requirements
        - For example, give an account of how minimum demand requirements might be expressed more fundamentally in terms of essential services as a derived operability constraint.
    - alleviating need for, and minimising technical trade-offs and economic costs of meeting, system inertia requirements
- Research (literature review assessing, simulations of, and laboratory demonstrations of, technology close to implementation) that will support practical outcomes through the implementation of AEMO's *Type 2 Transition Services* field trials, such as via the development and assessment of field trial design options mostly likely to cost effectively demonstrate capability to remove technical constraints on renewable power in
    - Provision of protection quality system strength from IBR (highest priority)
    - Solutions to managing minimum system load (highest priority)
    - System restart under conditions of high capacity of distributed PV
    - System restart from IBR
    - Power system operation with zero synchronous generation
- System Restart research priorities
    - Optimal location of IBR based system restart black start capable plant
    - Laboratory demonstrations of plausible IBR based system restart pathways including testing of commercial protection hardware
    - System restart under conditions of high capacity of distributed PV
- Future proofing Underfrequency Load Shedding in the South West Interconnected System under High Penetrations of Transmission and Distribution Inverter Based Resources
    - Characterise emerging frequency stability risks in high IBR SWIS scenarios. Assess the performance of the current UFLS scheme under projected operating conditions. Develop updated UFLS design principles that are technology neutral, scalable, and compatible with IBR dominated grids. Propose a future ready UFLS framework including adaptive, dynamic, or inverter coordinated mechanisms. Provide regulatory recommendations.
- Management of energy in grids with high penetration of battery energy storage systems (BESS)
    - Review fundamental assumptions for assessing power system reliability under conditions of high proportions of variability and storage-based technology,

including large scale storage, distribution and utility scale system, and consumer energy resources storage behind the meter.
  - Consider options for alternative metric and methods for assessment of power system reliability that quantify an optimal mix of different technologies (e.g. ideal proportions of firm, variable, and storage-limited capacity)
  - Consider changes to dispatch optimisation and/or market incentives to improve resilience and response to periods of high variability or high-stress events.

Medium Priority

1. Cybersecurity threat assessment and remediation option identification for both large scale and small scale power system elements, particularly during vulnerable system restart conditions. Prevention, restarting and recovering stability from IT or control and communications events which disrupt operation. For example, cyber interruption, degraded communication, DER orchestration failure, and IT/OT interaction failures.
2. Assessment of requirements for system strength in distribution networks
3. Consideration of how the future provision of any existing and anticipated system services should be incentivised and maintained, either through technical standards, or wholesale, distribution, and/or retail market mechanisms. Explore different market structures that may more efficiently and effectively provide services.
   - Identify which essential services are quantifiable at whole of system scale such that contributions of individual plant can be accurately attributed.
4. System Restart
   - Laboratory demonstrations showing how best Renewable Energy Zones (REZs) can be used as System Restart Ancillary Service (SRAS) sources and investigating typical times for self-start.
   - Estimate the aggregate reliability of the SRAS source when the wind and solar farms are the black-starters.
   - Investigate the possibility of using hybrid GFM BESS and IBRs as reliable SRAS sources from a technical perspective.
5. Load modelling and coordination and provision of services from loads, including aggregated models of small loads, pumped hydro etc. What framework for modelling the power system is required to enable this to be evaluated?
6. Real-world trials other than contributing directly to the *Transitional Services* field trials, or a roadmap to real-world trials including laboratory demonstrations, with industry partners to demonstrate provision of services from newer technologies
7. Expansion and further refinement of the developed wide-area EMT model to consider additional scenarios and ensure its fitness-for-purpose for evaluation of a wider set of system needs / potential system services.
8. With reference to the *Transition Plan for System Security*.
   - Enhance the catalogue of essential system services from Stage 4, including characterising in terms of fundamental power system security objectives, and estimating the time frames over which they might no longer be provided by identifying consequences of inadequacy and assessing their significance,
   - Development of tools and models for quantifying the system inertia requirements and remediations in case of variations in the future 100% renewable operation scenario of least/no synchronous generating units, more emerging technology, and innovations that enable IBR to provide sought-after system services, demand

levels, regulatory change, operational measures, and other emerging security issues in pre- and post-security events.
    - Development of tools and models for quantifying the system strength requirements and remediations in case of variations in the future 100% renewable operation scenario of least/no synchronous generating units, more emerging technology, and innovations that enable IBR to provide sought-after system services, demand levels, regulatory change, operational measures, and other emerging security issues in pre- and post-security events.
9. Investigating how DER and distributed flexible loads on the distribution grid can provide frequency balancing services to TSOs.
10. Probabilistic resource adequacy and demand flexibility could be included here, if there is more of a system security or individual resource assessment focus, or in Topic 4 if there is more of a planning application focus.
11. Assess the opportunities for system services to enhance power system resilience.
12. Develop ontology for language used to describe, and help build a common understanding of, services including system restart.

Topic 7

The research area covered by Topic 7 (Power System Architecture) in Stages 1-5 is not being supported under this research program for Stage 6.

Topics 8 & 9: Distributed Energy Resources

Australia leads the world in rooftop solar photovoltaic (PV) adoption, with more than 50% of households equipped with PV systems in three states. Batteries are increasingly being installed within distribution networks, by both customers and utilities, and electric vehicle charging is expected to represent a significant new load that will require planning and management. To maximise the utilisation of distribution network assets, Distribution Network Service Providers (DNSPs) in Australia have moved away from static export limits to flexible connection agreements known as Dynamic Operating Envelopes (DOEs). These DOEs manage bidirectional power flows against network constraints. They are inherently less conservative than static limits and help to ensure equitable distribution of the renewable energy export opportunity between both present and future DER enabled households.

Led by the need to interact with solar PV, both DNSPs and electricity retailers have seen a significant uplift in their capability to manage their assets, as well as their customer's assets in near-realtime. This has included efforts to roll out smart meters and integrate this data stream for network visibility, load and generation forecasting and DER dispatch limits. Utilities now use CSIP-Aus, an open, internet-based protocol to communicate limits to DER sites, typically without the need for additional control hardware. Aggregators have successfully given some DER wholesale price exposure and access to FCAS markets. This has given rise to the term prosumer, where the DER household is a participant in the energy system, rather than just its end user.

Topic 8: Distributed Energy Resources (Architecture & Utility Coordination) focuses on the components of DER that are in front of the meter. This includes how AEMO, DNSPs and retailers cooperate, how solutions like DOE, CSIP-Aus and load forecasting can be improved, and how we protect this architecture from vulnerabilities.

Topic 9: Distributed Energy Resources (Behind the Meter Cooperation & Individual device performance) focuses on the components of DER that are behind the meter. This includes how DER from different manufacturers can cooperate via open-protocols, and the potential uplift in services attainable from individual devices including smart loads, dynamic settings and unbalanced operation to meet upstream system needs.

While a distinction is made between Topics 8 and 9 it should not limit research that would consider factors and solutions on both sides. Where this is the case, a bid can be directed to either topic. This will not affect its consideration as there is no minimum or maximum number of bids that can be included in any topic.

Noting how both retailers and DNSPs have shifted from planning/operating with static models and data to actively managing portfolios of DER their participation in this workstream is essential. Researchers would ideally collaborate with an Australian utility or at the very least have a letter of support for the proposed topic.

Topic 8/9 of the research program encourages researchers to investigate all the challenges and opportunities which relate to DER and its relationship to the power system. Some examples include:

Topic 8

- Advanced DOE – How we can make DOE more fair/equitable, enable greater transfer of distributed renewable energy, extract additional services from DER to support the power system and use this solution for better management of distribution networks. Could DOE be used to tune inverter settings or control other network assets (switches, taps etc.) to facilitate greater transfer of renewable energy?
- Advanced DOE - What metrics could be used to evaluate the performance of different DOE solutions and how should these be weighted? Is greater effort needed to understand inverter settings and factor these in DOE calculations? Can DOEs evaluate compliant behaviour against standards? Can they report on the capacity factor achieved in a network in terms of improvement and avoided/delayed upgrades?
- Interoperability between DER sites and Australian utilities – Building on the framework of CSIP-Aus what are the next steps in innovation? How can CSIP-Aus be used to communicate with additional DER types, for dynamic pricing? For dynamic inverter settings? How can this protocol be upgraded to be more robust and cybersecure? Should CSIP-Aus integrate with the Power System Data Communication Standards?
- DER Storage coordination and forecasting - Develop, expand, and refine forecasts of coordinated CER, including for non-storage coordinated CER, considering verification and controllability.
- Influence of DER on system level planning – How can we improve models and data flows as they relate to DER? What telemetry is needed for advanced DOE, forecasting, LV visibility and other operational functions? What improvements are needed to help AEMO and others as DER penetration increases and new DER populations like EVSE and home batteries become more prevalent?
- Overcoming institutional challenges – Which functions should sit with retailers/aggregators, DNSPs and AEMO? How can we improve operational coordination and data/telemetry exchange between these parties, including constraints? Are there conflicting demands/objectives that need to be managed, particularly in terms of events and contingencies??
- DER Price Responsiveness - To what extent should DER be pushed towards market participation and/or price responsiveness? How can aggregators provide visibility of scheduled and price-responsive DER for centralised forecasting and other operations?
- DER & System Strength – What are the requirements for system strength in distribution networks? for both backup protection (minimum MVA and duration) and PLL synchronisation? What upgrades to AEMO modelling are needed in terms of understanding the aggregate response of EVs and other IBR to disturbances, particularly as system strength reduces and at different stages in the 50 Hz wave?
- DER architecture vulnerability - Prevention, restarting and recovering from IT or control and communications events which disrupt DER orchestration. For example, cyber interruption, degraded communication, and IT/OT interaction failures. How should cybersecurity threats be managed, for example enforced isolation and disconnection?

Topic 9

- Interoperability between DER devices – What protocols are needed for DER from different vendors to cooperate in the best interest of customers and the power system? What tests, certification/accreditation is needed to ensure interoperability? What physical ports are required? What minimum functions should be possible using open protocols and how should testing/accreditation be managed?
- Interoperability between DER devices - What is needed to achieve smart control and integration of V1G EVSE and V2G chargers? Should the smart meter be considered part of the DER ecosystem and how readily could it be integrated to provide function and services behind the meter? What steps are needed to coordinate behind the meter storage with wholesale market participation/ outcomes?
- Advanced services provided by DER – Should power quality response modes and low voltage ride-through capabilities be required of inverter-based loads as well as inverter-based generators? Could DER provide greater services in terms of voltage regulation, phase balance and other distribution level challenges? For example, deliberately operating three phase DER unbalanced to achieve better balance upstream. How does this compare with networks attaining such services from statcoms, inverters or solid-state transformers?
- Advanced services provided by DER - Are current power quality metrics fit for purpose in the context of modern appliances as we shift from motors to power electronics? Should more DER provide frequency response and support with minimum system demand and system restart events? For example, could certain non-essential loads be configured to drop out in a manner graded with UFLS? Have we adequately looked at the opportunity in commercial loads that lack wholesale price exposure?
- DER & System Strength – GFM inverters are often credited as having characteristics which are beneficial to grid strength and stability and yet we don't permit DER capable of operating grid-forming to do so while its grid connected? What would be needed to enable this capability and how valuable would it be to the power system? Is the situation similar with distribution scale batteries? Should this be explored for V2G EVSE? What is the disturbance behaviour of lesser studied DER, such as larger inverters and EVSE? What changes to standards may be needed to certify operation in weak system conditions?
- Retail electricity products – Do modern day electricity tariffs extract the ideal behaviour from DER? Do they enable fair remuneration for all the value DER can provide? Is it still sensible to bundle all the value to energy, or would a shift to capacity billing provide better outcomes? What is needed for customers to embrace a shift away from flat tariffs? Can smart loads be tariffed separately and would this empower ToU pricing for the more dispatchable residential loads?