**Australian Power Institute and Energy Networks Australia Innovation Initiative**

**Update: December 2018**

**SUMMARY:**

Industry driven innovation projects/initiatives which the Australian Power Institute (API) facilitated and Energy Networks Australia (ENA) funded with other industry partners will total $5.33M over the next 2 years. The cash funding of these projects by Energy Networks Australia through member contributions will be only 20% of the total project costs due to the substantial leveraging that has been achieved: $5 of research/innovation work for every $1 of cash contribution.

The Australian Power Institute’s objective in its collaboration with Energy Networks Australia on the Innovation Initiative is to strengthen the skills of future STEM professional graduates working in the energy industry by enhancing the capability of university academics and their teaching curriculum. This is being achieved through academics working collaboratively with industry on industry driven “real world” research and innovation such as the projects outlined below. API is also well placed to assist with “knowledge sharing” to both industry and academia of the outcomes of all innovation and research in the energy industry to provide a sustainable supply of industry STEM professionals with contemporary skills.

As a follow up from the last API/Energy Networks Innovation Newsletters (June 2018), which provided an overview of the partnership between Energy Networks Australia and the Australian Power Institute (API) to drive and facilitate innovation for the industry, a number of achievements have been progressed by the partnerships Innovation Steering Group and Project Teams. Updated details of the achievements to date are outlined below.

1. **NETWORK SENSING PROJECT**

The overarching objective of the Network Sensing Project is to provide Network Service Providers (NSPs) with a structured evaluation of investment options into measurement and data acquisition schemes to support efficient and secure operation and maintenance of their networks in the future – grouped as Network Optimisation Functions. A fundamental building block of future Network Optimisation Functions will be to gain the required (electrical) visibility of the network and the network operational state to allow informed decisions, irrespective of whether these decisions are to be made manually or automatically. This will impact areas ranging from network planning to real time orchestration of Distributed Energy Resources (DER). Gaining this visibility has the potential to come a high financial cost and there are many diverse ways to gain it. There are legacy systems that also need to be considered.

While the project is being undertaken on behalf of all Energy Networks Australia members and the outcome is being shared throughout, a group of members have come forward to directly participate in the project work, to provide their unique perspective and to ensure the project aligns with their specific needs. The members that are directly participating are AusGrid, ElectraNet, Western Power and Energy Queensland. This group is being supported by the University of Queensland, which is contributing the academic perspective, as well as experience in conducting structured studies and research projects.

Although the project timeline extends to December 2019, there is a sense of urgency in providing Energy Networks Australia members with useful insights into the investment alternatives and their
respective advantages and disadvantages as soon as possible. To achieve this, the project team has reviewed a range of different Network Optimisation Functions that are believed to be required by NSPs in the future and has prioritised functions around the areas of:

- Hosting Capacity Assessment,
- Grid Performance and Efficiency,
- Improved Network Planning and
- Increasing Customer Choice and Participation.

The next phase of the project will focus on establishing the interdependencies between available measurements and other forms of data on the one hand and visibility and accuracy of estimates of the required operational parameters on the other hand. These analyses will be carried out using generic, representative network models on which different measurement and data analytics techniques will be performed to assess the achievable level of visibility and accuracy. This will provide Energy Networks Australia members with an initial guide to evaluate their legacy systems and possible amendments to it against their own known data requirements. Once these interdependencies have been established, the following phase of the project will focus on the impact of limited visibility and accuracy on the performance of the prioritised Network Optimisation Functions. This will be done around questions like “How much safety margin is required to allow for the limited accuracy to which operational parameters are known?” A question that network planners and operators are currently being faced with every day.

While this information will allow network operators to assess additional data acquisition as part of their planning processes, the final part of the project will focus on how improved visibility and accuracy, e.g. through a possible reduction in safety margins, can benefit customers by enabling a greater range of choices and increased participation in the transition towards the more decentralised, inclusive and coordinated green energy network of the future.

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2. **MANAGEMENT OF VOLTAGES IN LV NETWORKS**

As the world is progressing towards ‘greener’ energy, more renewable energy resources are installed, particularly in distribution networks. Either encouraged by various ethical reasons or the government incentives, proliferation of solar photovoltaic (PV) systems in low voltage (LV) distribution networks can be seen as the impact of this progress.

While desirable, the rapid increase of PV penetration in LV networks brings about new voltage issues that have not been foreseen years ago when the electricity distribution networks were designed to accommodate unidirectional power flow. The rise of PV penetration is the prime cause of voltage rise issues and reverse power flow in LV networks, not to mention voltage excursions related to intermittent nature of the solar PV generation resulting in challenges associated with management of voltages in LV networks.

Traditionally, LV networks are not explicitly modelled in the similar manner as that of high voltage (HV) and medium voltage (MV) networks for a number of reasons – they are vastly different, with variable loads, inherent unbalance, different designs/constructions and inadequate data capture, to name a few. In short, modelling a ‘typical’ LV network that can broadly reflect all the LV networks accurately is an extreme challenge. However, this needs to be done to study the impact of solar PV penetration on LV networks and plan appropriate voltage management strategies.

Given the aforementioned considerations, this project aims to develop a flexible modelling tool for LV networks using the network data readily available with the associated distribution network
service providers (DNSPs). With minimal time and efforts, different LV networks can be modelled with the addition of multiple, unbalanced solar PV systems at any customer connection point. With this, the current and future generation by solar PV units in different types of LV networks can be correctly modelled and their effects on voltages in the networks can be examined. In addition, the outcome of different voltage management strategies can be studied.

Funded by the Energy Networks Australia, this 18-month project is led by the University of Wollongong along with the industry partners from different parts of Australia, including Energy Queensland, Jemena, SA Power Networks and United Energy. Almost 5 months into the commencement of the project, the proposed modelling/network building tool is still in the developmental phase. Currently, it is able to model/build 3-phase, 3-wire LV networks, with solar PV units at various locations, for conducting power system studies using the OpenDSS software platform.

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3. CONDUCTOR CONDITION MONITORING

Energy Networks Australia member utilities have almost 800,000 circuit kilometres of overhead conductor in service, valued at several billion dollars. Many of this critical infrastructure is ageing with some already reaching 70 years. Current conductor condition monitoring practices are mainly visual inspections and conductor replacement is usually driven by the frequency of conductor failures. Reliable and cost-effective methods to assess the likelihood of a conductor failure have not yet been developed.

This project investigates how to effectively monitor and assess the condition of overhead conductor for an improved asset management of conductors in Australian distribution networks. The objectives are:

- Review of conductor failure modes, degradation mechanisms, and ageing parameters, which are primarily responsible in influencing conductor degradation; and current Australian industry practices to test, operate, inspect, and asset manage overhead distribution conductors.
- Define the criteria for quantifying conductor condition and its end-of-life, and subsequently determine the probability of conductor failure and estimate its remaining useful life.
- Identify the core areas of research and development for improving condition assessment of conductors in Australian DNSPs’ networks.
- Survey state-of-the-art conductor condition monitoring techniques (e.g. smart sensor and other advanced tested and validated techniques in overseas) that could be used to monitor distribution conductor condition without having to de-energise the distribution network. Assess the practicality and economics of applying these techniques and evaluate their suitability for Australian networks.

This 18-month project has started on June 20, 2018. A “one team” approach is adopted requiring a close collaboration between industry and the university. The following work has been undertaken to date:

- Reviewed existing literature on conductor failure mechanisms and condition monitoring;
- Surveyed industry current practices on conductor asset management;
- Identified the possible challenges of extracting useful information from the data available with industry partners;
- Analysed several conductor failure datasets;
- Developed a software tool to estimate percentage loss of tensile strength of copper and aluminium conductors under elevated temperature levels; and identified several areas
need immediate attentions of research and development including sensor-based condition monitoring.

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4. **QUANTIFYING EXTREME BUSHFIRE CONSEQUENCES**

Australia’s electricity network operators and peak industry body Energy Networks Australia is working with researchers from the Bushfire and Natural Hazards CRC to mitigate against the economic impacts of catastrophic bushfires caused by powerlines.

The Quantifying catastrophic bushfire consequence project, led by A/Prof Trent Penman at the University of Melbourne, will identify a standardised method for accurately assessing the potential costs of a bushfire by combining fire simulations with economic and decision analyses.

“This collaboration will help expand the role that the CRC has as a trusted advisor in natural hazards research and contribute to empowering key infrastructure providers to continue to invest in mitigation across Australia,” CRC CEO Dr Richard Thornton said.

The research team, which also includes Dr Veronique Florec, University of Western Australia, and Kate Parkins and Brett Cirulis, University of Melbourne, will develop and implement the method to quantify the costs of a catastrophic bushfire.

Phoenix Rapidfire will be used to model the fire, which will help the team estimate tangible losses after a bushfire and measure those impacts against the economics of intangible loss.

Six of the 18 electricity network operators across Australia are providing valuable datasets and engineering expertise. The group of six organisations, together with Energy Networks Australia will represent and engage with other networks to ensure a truly national representation.

The project showcases the commitment that electricity networks have in increasing the resilience of the power grid during catastrophic and cascading natural events.

“Electricity network operators take pride in being part of their community and this important research will give them a valuable insight into where infrastructure investment is most needed to protect and promote community value in areas vulnerable to bushfire,” Energy Networks Australia CEO Andrew Dillon said.

The project is a pivotal step for the Bushfire and Natural Hazards CRC, as it extends its research expertise of fifteen years into the electricity sector. Whilst the project is in its initial phase, so far, the fire simulation methodology has been confirmed and four case studies regions have been selected to conduct the simulations within New South Wales, Victoria, South Australia and Tasmania. A range of physical assets to be factored into the simulations have also been considered in each case study area and utilisation planning is commencing to ensure that insights from the research can be of most benefit to Energy Networks Australia and its members.

The Bushfire and Natural Hazards CRC draws together Australasia’s peak emergency services authorities and researchers with scientific expertise to gather and promote research across a range of natural hazards.

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