PROJECTS FOR WHICH DMIA APPROVAL IS SOUGHT

Projects for which approval is sought under the Demand Management Innovation Allowance (DMIA) for the 2020 – 2025 Regulatory Period include the projects outlined in Table 1 below with a total of $462k incurred in the 2021-22 Regulatory year.

The projects for 2021/2022 are categorised into 3 key streams of work:

- **Smart hot water** – there's approximately 900MW of electric hot water installed in South Australia, a significant resource if it can be managed in ways that not only reduce peak demand but utilise their significant energy storage potential to improve DER hosting capacity and provide additional services. Projects in this stream aim to trial innovative approaches to activate this capability.
- **Advanced planning** – planning for distribution networks is becoming increasingly more complex as DER continues to connect to the network. The long-term impacts of DER integration need to be considered, while also considering the potential of DER to provide network services and alternatives to network investment, requiring a much more sophisticated and integrated planning approach. Projects in this stream aim to develop more innovative methods and tools for network planning, including optimising efficient outcomes across both network and non-network solutions.
- **Voltage control** – as the distributed energy transition continues at rapid pace, distribution networks must now increasingly support significant levels of reverse power flow from distributed energy resources. This is placing significant pressure on the ability of networks to accommodate a much greater 'dynamic range' while maintaining voltage within quality of supply limits. Projects in this stream aim to develop more effective and efficient approaches to voltage management in high DER energy systems.

DMIA Innovation Stream	Project	Expenditure 2021/22
1. Smart hot water	1.1 Smart hot water trial	$3,481
2. Advanced planning	2.1 Low voltage planning	$78,763
	2.2 Advanced network modelling	$347,965
3. Voltage control	3.1 Closed Loop Voltage Control trial	$0
	3.2 LV regulation trial	$31,864
	Total	**$462,073**

Table 1 DMIA projects 2021/2022

1 Smart hot water

1.1 Rheem Smart Hot Water Control

1.1.1 Nature and scope of the project

South Australia has around 900MW of hot water load which could provide an immediate and cost-effective opportunity to increase network and system-wide hosting capacity for solar PV.

The Rheem VPP Project seeks to prove that smart electric hot water storage systems can also provide aggregated demand response within a Virtual Power Plant (VPP) and deliver potential wholesale and Frequency Control Ancillary Services (FCAS) value to participating customers, supporting stabilisation efforts on the South Australian grid and enabling load shifting to soak up energy from solar during the day.

The project seeks to demonstrate active control over 2,400 residential hot water systems, 200 air conditioning control load adapters and 200 pool pump control load adapters within South Australia. The roll out starts from Q2 2019 and run field trials until Q2 2023.

1.1.2 Aims and expectations

- Test the practical application and customer benefits of smart hot water control in a real-world environment, and determine how this can be optimised with other controllable loads in the home and other distributed energy resources such as battery storage;
- Demonstrate the value of new time-of-use tariffs which have an off-peak component during the middle of the day; and
- Use the smart hot water systems as a test-bed to develop a plan for a subsequent internal project to reprogram legacy customer off peak controlled load (OPCL) meters with daytime hot water switching times (~150MW to 270MW opportunity).

1.1.3 Implementation of the project

Implementation is governed by Rheem, as project lead, alongside funding partners ARENA and SA Government. SA Power Networks is providing an in-kind contribution of $250k towards the project. Implementation is split across 5 key milestones:

Milestone	Date	SAPN tasks / deliverables
1	1-Feb-21	Summary of tariffs Preliminary integration with API (registration as a minimum)
2	31-Mar-21	Evidence of VPP test plan, developed in conjunction with CET, Project Retailers, SA Power Networks and AEMO, complete. Evidence that OPCL settings have been reprogrammed for all Devices installed to date in non-solar homes to shift load to daytime.
3	15-Jul-22	Evidence that OPCL settings have been programmed to shift load to the daytime (SAPN supporting)
4	15-Jul-23	Evidence of the total number of customers and Devices enrolled in the VPP, achieving aggregate load capacity to deliver a minimum of 1 MW FCAS response Evidence that all Devices installed are integrated with the SAPN API and are operating as a VPP
5	15-May-24	Static heating profile trials complete Final report and learnings

1.1.4 Implementation costs

Milestone	Indicative date	Cumulative in-kind contribution
1	1 February 2021	$50,491
2	31 March 2021	$60,779

3	15 July 2022	N/A
4	15 July 2023	N/A
5	31 May 2024	$250,039

Project costs for the Regulatory year 2021/22 were $3,481. Milestone 3, 4 & 5 have been deferred due to supply chain constraints and slower than anticipated customer recruitment. Material spend in the 2022/23 regulatory year is subject to resolution of the abovementioned issues.

1.1.5 Identifiable benefits

Shifting a hot water system's electrical load to use solar PV in the middle of the day (at times of otherwise low demand) has potential to minimise the impacts of the solar PV 'duck curve'. It will also help to:

- enhance customer in-house energy optimisation
- alleviate power quality issues such as voltage rise
- increase the network hosting capacity of distributed energy resources
- improve utilisation of the distribution network
- reduce the need for expensive augmentation of the distribution network

While battery VPP projects are an active area of research across a number of jurisdictions, this project specifically explores the potential for hot water storage systems to become smart and actively participate in the provision of energy market services in VPPs whilst also maximising the DER hosting capacity of the electricity system. Lessons learned from this project will inform the industry on the future potential of smart hot water across Australia.

2 Advanced planning

2.1 Low Voltage Planning

2.1.1 Nature and scope of the project

SA Power Networks procures various levels of power quality measurements from residential smart meters and power quality monitoring devices installed throughout the state. The need for additional monitoring data has been driven by DER Enablement spend in the 2020-25 regulatory period.

Historically augmentation expenditure on low voltage networks was driven by customer enquiries, with very little forecasting and planning. This project aims to develop tools and processes that leverage new diverse data sources and hosting capacity models to increase SA Power Networks' ability to strategically plan the low voltage network. This project will establish a health index for each LV area within the distribution network which will be used to rank performance of LV areas and guide targeted remediation work to proactively manage low voltage networks and prioritise augmentation spend.

2.1.2 Aims and expectations

- Understand the minimum data inputs and network information required to categorise a suitable health index and performance of the associated LV network.
- Develop innovative measures to model the entire LV network with limited visibility
- Identify relevant performance metrics and establish a risk quantification based on health index.
- Establish cost benefit calculations based on risk and performance metrics against costs of various solutions in order to best guide investment decisions.

2.1.3 Implementation of the project

The project will be phased over the 2021/22 and 2022/23 Regulatory years delivering benefits in each phase of the project. Implementation is split across 3 key milestones:

Milestone	Target Date	SAPN tasks / deliverables
1	1st January 2022	- Establish initial Health Index calculation tool + initial procedures for its utilisation
2	1st December 2022	- Develop integration of health index calculation tool with data sources to calculate Health Index for all LV areas.
3	30th June 2023	- Expand health index and performance scoring into a risk quantification tool to enable risk based cost benefit assessment.

2.1.4 Implementation costs

Milestone	Indicative date	Cost
1	1 January 2022	$50,000
2	1 July 2022	$20,000
3	31 December 2022	$80,000

Project costs for the Regulatory year 2021/2022 were $78,763.

2.1.5 Identifiable benefits

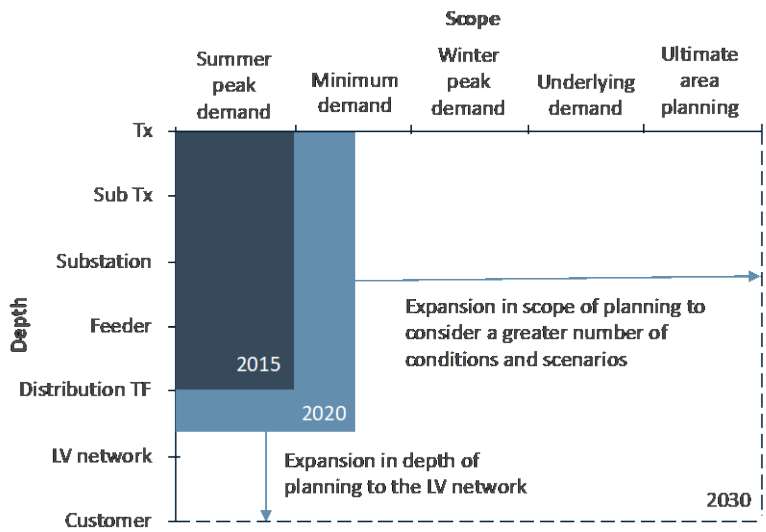
- alleviate power quality issues such as voltage rise
- increase the network hosting capacity of distributed energy resources
- improve overall asset optimisation and use in both households and the distribution network.
- improve customer experience and increase efficiency through proactively resolving network issues without requiring customers to make enquiries prior
- Minimising network augmentation through building a better and more holistic understanding of network constraints and determining the most efficient means to meet them

2.2 Advanced network modelling

2.2.1 Nature and scope of the project

SA Power Networks publishes a Distribution Annual Planning Report (DAPR) intended to assist non-network proponents in proposing alternative solutions to defer network upgrades and to inform interested parties. It also aims to guide new load and generation proponents to suitable parts of the network that would result in reduced network augmentation associated with any new connection. Stakeholders have commented that the information presented currently is not easily interpreted or sufficient to guide their decision making. This has resulted in large numbers of high-level connection enquiries as customers and proponents often consider several geographic locations before determining a suitable site.

Furthermore, to continue to plan our network effectively we will need to model the impact of new energy technologies and services, such as PV, VPPs and EVs, which not only introduce complex new constraints in peak demand, minimum demand, and the need to manage diverse power flows, but also significantly increase the necessary depth, breadth, and overall complexity of planning. We need to be able to plan for a broad range of scenarios to understand how best to target investments and identify efficient non-network opportunities.



The project scope includes establishing and enhancing data, tools and processes associated with SA Power Networks' digital network models, to enable advanced network constraint analysis. This will produce improved visualisation of hosting capacity via opportunity maps, provide more accurate identification and transparency of network constraint information, and enable the identification of the most efficient solutions to these constraints.

2.2.2 Aims and expectations

The project aims to provide advanced network planning tools and models that allow for accurate digital models of the Distribution Network suitable for planning purposes which can be used to identify the most efficient solutions to network constraints, including the assessment of non-network alternatives. The concept involves developing innovative techniques to model the HV network by automation and optimisation of the network build process. New advanced planning functionality and processes will then be developed to enable efficiency and quality improvements.

A key objective is to improve the transparency of network constraint information and visualisation of hosting capacity. The higher degree of accuracy within the models and the advanced planning functionality delivered by the modelling tool is expected to automate processes for constraint identification and facilitate efficient options analysis. This functionality will also enable the publication of hosting opportunity maps as part of the DAPR highlighting those areas with load and generation hosting constraints (thermal and voltage limits).

2.2.3 Implementation of the project

The project will be phased over the 2020/21, 2021/22 and 2022/23 Regulatory years delivering benefits in each phase of the project.

Phase 1 – HV model creation and automation of planning processes

- HV model automatic build (and update) from the GIS to Sincal modelling tool;
- Model validation and establishment of processes to ensure model accuracy;
- Functionality to simplify and improve the quality of Network Planning analysis;

- Functionality and process efficiency improvements for assessment of load and generation connections.

Phase 2 – Advanced Network Planning and automation capabilities

- Functionality to facilitate the efficient analysis of investment options including augmentation deferral through demand management and non-network solutions associated with load connections and long-term network development;
- Functionality to analyse the future wide area effects of DER, BESS and EVs;
- Hosting capacity analysis for both generation and load on the HV network;
- Publication of Hosting Capacity Opportunity maps.

Phase 3 –LV Model creation trial

- Trial of LV model automatic import of LV GIS model to Sincal;
- The purpose of the trial is to
  - Inform DER management trials
  - Inform more efficient deployment of voltage control solutions
  - Understand LV hosting capacity
  - Enable improved LV planning including Quality of Supply analysis and proactive planning

2.2.4 Implementation costs

The expected implementation costs are outlined in the table below.

Project Phase	**Cost**	**Regulatory Year(s)**
Phase 1 – HV model creation and automation of planning processes	$282,445 $100,000	2020/2021 2021/2022
Phase 2 – Advanced Network Planning and automation capabilities	$200,000 $200,000*	2021/2022 2022/2023
Phase 3 –LV Model creation trial	$50,000	2021/2022

*Estimates, subject to more detailed scoping.

Project costs for the Regulatory year 2021/2022 were $347,965.

2.2.5 Identifiable benefits

The project is expected to deliver significant benefits for customers and non-network solution providers including:

- Visualisation of hosting capacity (load and generation) via opportunity maps will facilitate greater network utilisation and reduction in augmentation.
- Greater transparency of network constraint information leading to greater awareness of network capability and opportunity for greater utilisation.
- Improved identification of network constraints that can be resolved or deferred by demand management including non-network service solutions.

- More efficient targeting of network investment.
- Greater stakeholder access to network information is expected to reduce the number of speculative load and connection enquires that connection proponents need to make.
- Innovative advanced planning functionality to analyse the future network needs of DER, BESS and EVs and ensure this is incorporated into forward planning.
- Facilitating engagement with third party non-network solution providers

Whilst modelling tools have been implemented in other jurisdictions, the modelling tools and techniques developed in this project are new approaches to model build and visualizations. Benefits are expected to be realised for customers, non-network solution providers and internally within SA Power Networks.

3 Voltage control

3.1 Closed Loop Voltage Control trial

3.1.1 Nature and scope of the project

Develop models and algorithms to perform closed loop voltage control in a limited-visibility environment, and test this capability in a field trial from March 2020 to March 2021 at a selected metropolitan substation.

In order to develop and validate these models and algorithms, data streams for 1085 smart meters in the trial area will be procured from smart meter providers, and an additional 10 distribution transformer monitoring units will be deployed in the trial area. The algorithms will be implemented in the Future Grid COMPASS platform, which will consume all available data sources. Once proven, the approach will be tested on other substations for fit and accuracy.

3.1.2 Aims and expectations

In the South Australian metropolitan distribution network, the lowest level of the network at which voltages can be controlled is the zone substation. This project aims to establish advanced voltage control techniques on SA Power Networks' distribution network to optimise network voltage by automatically controlling the substation voltage setpoint in response to real-time network state to:

- Increase DER hosting capacity;
- Provide demand response services; and
- Maintain or improve customer power quality.

3.1.3 Implementation of the project

The project has been staged over four distinct project milestones:

Milestone 1 – Technology Deployment (November 2019)

- Project plan completed
- Draft research plan completed
- Knowledge sharing plan completed
- Future grid COMPASS platform
- Initial integrations (smart meters & visualisation)

- Voltage control algorithm v0.1

Milestone 2 – System launch in advisory mode (April 2020)

- Final research plan
- Digital hosting capacity model v1
- Voltage control algorithm v1
- Additional integrations (TF monitors, SCADA)
- System operational for ad-hoc field tests

Milestone 3 – System launch and extended trials (November 2020)

- System operating for extended time periods
- Refined DHCM and control algorithms

Milestone 4 – Project Close (June 2021)

- Further refined DHCM and control algorithms
- Validation of models against other substations
- Knowledge sharing activities completed
- Findings from field trial published
- Final report to SA Government

3.1.4 Implementation costs

Actual implementation costs incurred are outlined in the table below.

Project Phase	**Incurred Cost**	**Regulatory Year(s)**
Stage 1 & 2 – Technology deployment and system launch	$673,694	2019/2020
Phase 3 & 4 – Extended trials and knowledge sharing activities	$14,323	2020/2021

3.1.5 Identifiable benefits

The project has delivered significant benefits including:

- Increased understanding of customer experience and voltage fluctuations, and how they are influenced by operations of upstream equipment.
- Methods to model and understand the performance of low voltage networks where visibility and data can be lacking.
- Estimated potential of advanced voltage regulation methodologies for increasing DER hosting capacity and enabling demand response.
- Pioneer new voltage control solutions that have the potential to avoid significant network augmentation within the low voltage network.
- Developed new integration solutions between third party applications and traditional operational technology systems.

While closed loop voltage control has been implemented in other jurisdictions with near universal low voltage network visibility (Victoria), this project pioneered new approaches to predict the state of network and determine appropriate substation control actions in a limited visibility environment. Lessons learned from this project will inform the application of advanced voltage control in other jurisdictions with low penetration of smart meters.

3.2 LV regulation trial

3.2.1 Nature and scope of the project

SA Power Networks has many Low voltage areas throughout the Adelaide hills or otherwise that consist of long overhead conductors supplying few customers in difficult to access locations. Increases in modern customer demand and introduction of distributed energy resources results in voltage constraints requiring costly augmentation works that benefit very few customers.

The scope of this project is to undertake trials of innovative new types of equipment that can be used as viable alternatives to efficiently address voltage constraints in the LV network and defer significant network augmentation. Equipment types being trialled currently include Statcoms and 11/0.4kV OLTC distribution transformers.

3.2.2 Aims and expectations

- Installation of new equipment in trial locations in conjunction with ongoing power quality monitoring to measure network performance pre and post installation.
- Cost benefit assessment to determine performance of device relative to the deferred augmentation costs and inform feasibility of ongoing utilisation.

3.2.3 Implementation of the project

2020/21 – market research and procurement; (complete)

- Review of available devices on the market and procurement;
- Development of network design & settings specifications;
- Installation of device (Statcom).

2021/22 – Installation & performance monitoring – Part 1

- Ongoing performance monitoring
- Cost benefit analysis and comparisons.

2022/23 – Installation & performance monitoring – Part 2

- Installation of device (11/0.4kV OLTC distribution transformer)
- Alterations to device (Statcom)
- Cost benefit analysis and comparisons.

3.2.4 Implementation costs

Project costs for the Regulatory year 2021/2022 were $31,864.
Implementation costs for the 2022/23 period are forecast at $70,000.

3.2.5 Identifiable benefits

Implementation of this project is expected to deliver reductions to required capital expenditure through deferral of augmentation by up to the serviceable life of the new technology. Additional benefits to customers include:

- Alleviate power quality issues such as voltage rise

- Increase the network hosting capacity of distributed energy resources

4 Costs not recoverable

Costs for the DMIA projects described above:

a. are not recoverable under any other jurisdictional incentive scheme,
b. are not recoverable under any other State or Commonwealth government scheme, and
c. are not included in the forecast capital or operating expenditure approved in the AER's distribution determination for the regulatory control period under which the scheme applies, or under any other incentive scheme in that determination.

5 Calculation of DMIA

The total amount of the DMIA spent in the 2021 -2022 Regulatory Control Period was $462k. This amount equates to the total spend against the projects for which approval is sought under the DMIA as detailed in this report. The costs associated with these DM trials have been separately captured at the individual project level in SAP, SA Power Networks' integrated business management system. The expenditures incurred against these trials for each year of the Regulatory Control Period have been reported in Table 7.11.2 of SA Power Networks' Annual Reporting RIN Response and subject to independent external audit in accordance with the RIN requirements.