

JEMENA ELECTRIC

ENERGY REFERENCE MEETING 3 PREPARATION MATERIAL





“Jemena”
is an Aboriginal word
that means “to hear,
to listen and to think”



Acknowledgement of Country

Jemena acknowledges the Traditional Owners of the land on which we operate and recognises their continuing connection to land, waters and culture. We pay our respects to their Elders past, present and emerging.

Artwork is by Chern'ee Sutton a contemporary Indigenous artist from the Kalkadoon people from the Mount Isa area in Queensland.

Contents

Abbreviations.....	v
1. Grid Stability.....	vi
1.1 The background.....	vi
1.2 Trends of Maximum and Minimum Demands and Their Implications.....	vi
1.3 Essential System Services	ix
1.4 Actions to Address Minimum Demand (Peak Export) and Maximum Demand (Peak Demand)	xii
1.5 Grid Stability and Flexibility.....	xiv
1.6 Voltage and power quality management	xvi
1.7 Demand Management	xviii
1.8 Coordination Tariffs	2

Abbreviations

Advanced Distribution Management System	ADMS
Advanced Metering Infrastructure	AMI
Application Programming Interface	API
Australian Energy Market Commission	AEMC
Australian Energy Market Operator	AEMO
Australian Energy Regulator	AER
Consumer Energy Resources	CER
Demand response	DR
Distributed Energy Resource Management System	LV-DERMS
Distributed PV	DPV
Distributed solar photovoltaic	DPV
Distribution Network Service Providers	DNSP
Dynamic Voltage Management	DVM
Electric Vehicle	EV
Energy Reference Group	ERG
Essential Services Commission Victoria	ESCV
Essential System Services	ESS
Fault Location isolation and Service Restoration	FLISR
Frequency Control Ancillary Services	FCAS
Guarantee Service Level	GSL
Information and Communication Technology	ICT
Inverter-Based Resources	IBR
Jemena Electricity Networks	JEN
Major Event Days	MED
Minimum System Load	MSL
Momentary Average Interruption Frequency Index	MAIFI
National Electricity Market	NEM
National Electricity Objective	NEO
National Electricity Rules	NER
Outage Management System	OMS
Photovoltaic	PV
Powerline Bushfire Safety Taskforce	PBST
Probability of exceedance	POE
Rapid Earth Fault Current Limiter	REFCL
Regulatory Information Notices	RINs
Reliability and Emergency Reserve Trader	RERT
Solar Soak	SS
System Average Interruption Duration Index	SAIDI
System Average Interruption Frequency Index	SAIFI
Under Frequency Load Shedding	UFLS
Values of Customer Reliability	VCR
Variable Renewable Energy	VRE
Victorian Department of Energy, Environment, and Climate Action	DEECA
Volt-VAR control	VVC

1. Grid Stability

1.1 The background

Today, approximately 30% of detached homes in the Australian National Electricity Market (NEM)—the wholesale electricity market for eastern Australian states and territories—have rooftop photovoltaic (PV) electricity generation with a combined generating capacity of 15GW. This is forecast to rise to 65% with 69GW of combined generation capacity by 2050, according to the 2022 forecasts prepared by the Australian Energy Market Operator (AEMO) under its “Step Change” scenario.¹ This represents 93TWh of electricity generation annually, enough to meet nearly one-fifth of the total underlying demand in the NEM.

For Victoria, the picture is not dissimilar to the national forecast. The total installed generation capacity (as of July 2023) is 19.6 gigawatts (GW), made up of 8.1 GW of large-scale renewable generation (wind, solar, storage and hydro), 7.4 GW of large-scale conventional thermal generation (coal and gas), and approximately 4.1 GW of Consumer Energy Resources (CER); mainly distributed PV. These energy sources are known as Variable Renewable Energy (VRE).

If left uncoordinated, this fleet of grid-connected electricity generation (and storage resources) would pose a significant risk to power system security due to its impact on operational forecasting accuracy and real-time system operations. Conversely, if properly coordinated, these resources would serve as valuable enablers in the transition of the electricity system to a lower cost and zero emissions in the future. Such coordination involves making these resources more visible, price-responsive, and dispatchable in the electricity market and providing flexible services to the local electricity networks. Compounding the challenge—apart from electricity exports—are de-carbonisation initiatives such as transport and gas electrification, which will add to the import challenges and the increasing divergence between maximum and minimum demands.

1.2 Trends of Maximum and Minimum Demands and Their Implications

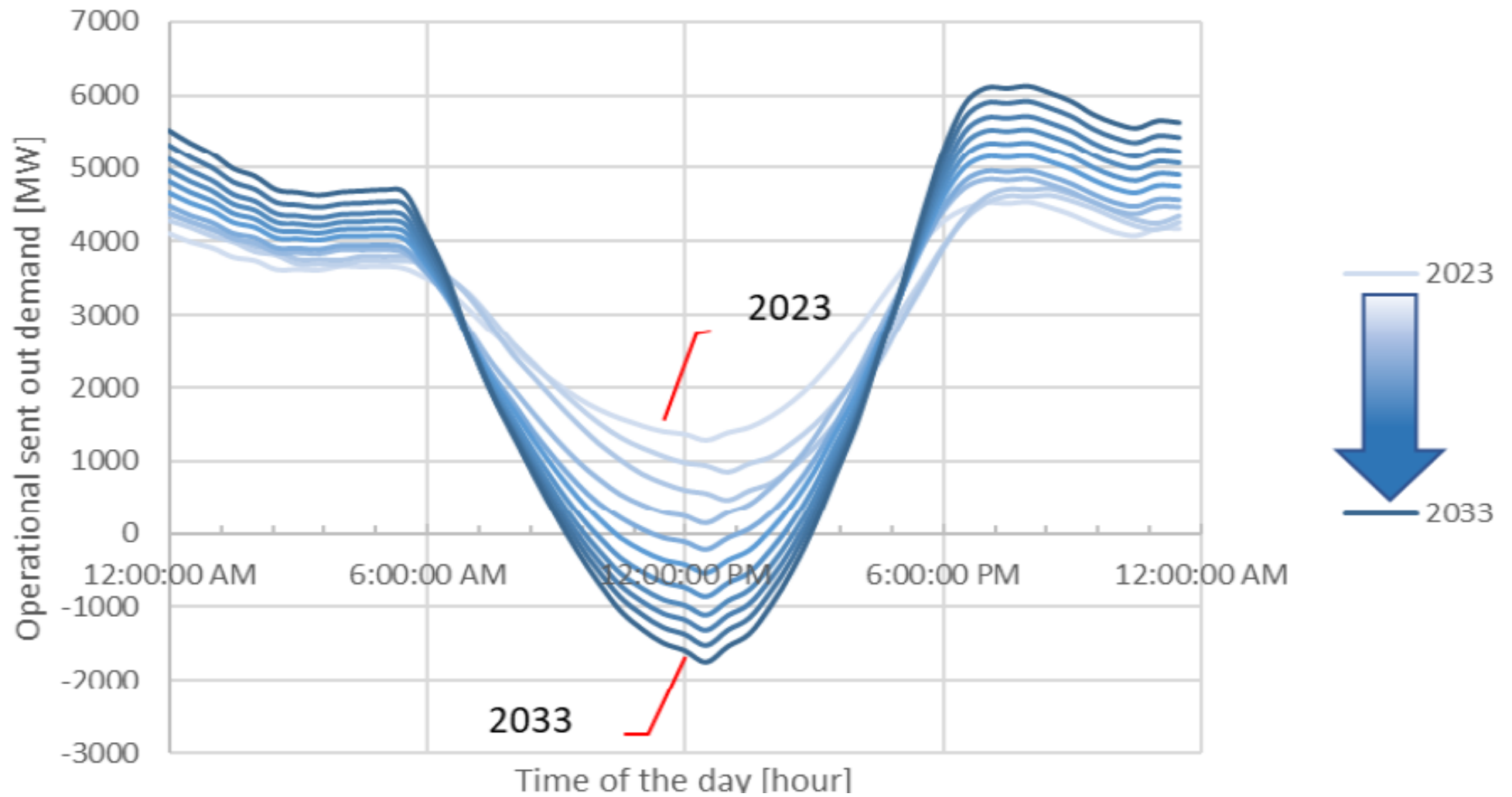
From AEMO’s recent Victorian Annual Planning Report 2023, Victoria recorded its all-time lowest minimum operational demand of 2,195 MW on 18 December 2022. This was 138 MW lower than the previous record set last year and the fourth consecutive year that the record has been broken, with distributed PV meeting 55% of Victoria’s underlying demand.

It is forecast that Victoria’s levels of minimum grid demand will continue to decline, requiring additional market-based solutions (like coordinated storage and electric vehicle (EV) charging, scheduled loads such as pumping load, and demand response) to support system security at these times.

Perhaps it is noteworthy that the above minimum demand record in Victoria has recently been broken. On 12th November 2023, the Victorian minimum demand dropped to 1724.66MW at 10:45, a drop of 470MW or 21% from the 2022 record. This indicates that minimum demand is decreasing faster than anticipated and highlights the urgent need for actions to address the security risks that this trend brings.

¹ National Greenhouse and Energy Reporting Act 2007 (NGER Act)

Figure 1 – Forecast Victorian daily load profile on minimum demand day (2023 -33) under the 'Step Change Scenario'3



Diminishing minimum demand raises the risk of system/grid stability in two areas:

- Supply-Demand Balance – An oversupply of Distributed PV (DPV)⁵ generation that cannot be controlled can cause the power system to collapse due to supply-demand imbalance, and
- Under Frequency Load Shedding (UFLS) – A stable electricity frequency is imperative in transporting electricity to customers in the Australian alternating current system, and for the correct operation of many electrical appliances. To ensure the frequency is maintained around the 50Hz range, AEMO deploys several tools, including load shedding in extreme circumstances. However, the existing load-shedding control scheme, triggered upon a loss of generation event, will become ineffective when the load blocks are “diluted” by the presence of DPV and can cause widespread segments of the power system to collapse.

In Australia, the state of South Australia (SA) is the first large-scale power system in the world to approach zero net operational energy demand – even for very short periods – due to high proportions of demand being met by DPV. AEMO has published a technical report that focuses on the current operational challenges arising from the rapid increase of DPV in South Australia and the resultant impact on minimum demand, which⁶ indicates what is likely to happen in Victoria as DPV continues to increase. In May 2023, AEMO also published its ‘Victoria: UFLS load assessment update’ report outlining the emerging issues and recommendation of actions for Victoria⁷.

Prompted by the SA experiences, AEMO and the Victorian Department of Energy, Environment, and Climate Action (DEECA) have been working with Victorian Distribution Network Service Providers (DNSPs) to develop measures to address the risks posed by declining minimum demand.

In Figure 1 we note that while minimum demand is decreasing, peak demand is increasing due to EV charging loads and other de-carbonisation initiatives such as gas substitution and greater electrification. If Jemena continues to build distribution infrastructure to cater for the increasing peak demand—while minimum demand is decreasing—the infrastructure will become increasingly underutilised and require replacement more frequently.

Other challenges are created by the increase in renewable generation and the accelerated retirement of fossil-fuel-based generation. Most renewable generation systems are connected to the power system using inverters. Unlike fossil-fuel generation, these Inverter-Based Resources (IBR) raise the need for new sources of system security services – such as reactive power capability, inertia and system strength services. The providers of these new system security services may come from several sectors, DNSPs included. Markets for these services are in their infancy, and there may be a lack of providers in the early stages of the energy transition, putting the electricity system at further risk.

1.3 Essential System Services

Essential System Services (ESS) are critical technical services provided to the NEM to help keep the electricity network safe, reliable and secure. They include services such as:

- Services to manage Minimum System Load (MSL) risks when electricity demand levels in the grid reach critically low levels;
- Services to manage Under-Frequency Load (UFL) risks should there be a sudden drop in system frequency due to an imbalance between electricity generation and load demand;
- Operating reserve market services proposed through a rule change request to the AEMC8 and Reliability and Emergency Reserve Trader (RERT) services to help respond to unexpected changes in supply and demand with reserve capacity;
- System restart services to restore and recover the power system after there has been a complete or partial blackout, shutdown or large-scale disturbance;
- Frequency Control Ancillary Services (FCAS) to actively manage and stabilise the power system's frequency continuously and
- System strength services, including inertia.

Historically, many of these services, such as frequency response and inertia, have been provided as an inherent by-product of thermal electricity generation (including coal-fired and gas-fired generation). However, through the energy transition, many thermal generation plants are being retired as new VRE generation resources, such as solar and wind farms, are introduced. Some VRE resources do not inherently provide ESS as a by-product of electricity generation. If ESS is supplied by other means, a lack of capacity to provide ESS may pose challenges for maintaining a stable electricity grid. Furthermore, some risks managed through ESS provision are exacerbating at this stage of the energy transition. This includes MSL risks, partly emerging due to the uptake of CER and increased excess electricity exports at times of minimum system demand.

The provision of ESS needs to be carefully managed through the energy transition, with some forms of ESS being provided by NEM market participants, including utility-scale batteries, large energy users and some forms of generation. The costs of these services being provided are passed through by AEMO to NEM participants and electricity customers. However, electricity distribution businesses, including Jemena, also have the capacity, capabilities and expertise to deliver some types of ESS. Examples of these capabilities are shown in Figure 2 below.

Figure 2: Example of ESS capabilities and services electricity distribution businesses can provide

Capabilities that could be used	ESS that could be provided	Benefits for the system	Potential implementation
 SCADA and smart inverter control	Services to manage minimum system load (Victoria's Emergency Backstop Mechanism)	Temporary curtailment of distributed solar PV as a last resort to maintain system stability and security when there is critically low load	Classification of these services through this distribution determination
 Smart meter control	Services to manage under-frequency load	Disconnection of under-frequency loads as a last resort if there is a sudden drop in system frequency due to an imbalance between supply and demand	
 Voltage management e.g. using dynamic voltage management system (DVMS)	Operating reserve market services, Reliability and Emergency Reserve Trade services, system restart services	Management of voltage such as through a DVMS to provide reserve supply to meet system demand in exceptional or emergency situations	- Classification of these services through this distribution determination - NER rule change, or ring-fencing waiver - Voltage management regulations may also need updating
 Batteries, potentially DVMS	Frequency Control Ancillary Services	Management of the system's frequency levels on a continuous basis by adjusting charge and discharge rates of batteries and potentially voltage settings	
 Synchronous condensers if developed and installed	System strength services, inertia	Management of synchronous condensers to generate or absorb reactive power and adjust conditions in the energy system to maintain stability	- Classification of these services through this distribution determination - NER rule change, or ring-fencing waiver - Investment in new network assets

In late 2022, the Australian Energy Regulator (AER) granted a class waiver under the **Electricity Distribution Ring-fencing Guideline** to allow electricity distribution businesses to contract with AEMO to provide RERT services via voltage management through April 2025. This increased the number of possible RERT service providers, reducing the risk of insufficient services and lowering costs from providing these services.

Electricity distribution businesses could provide a range of other types of ESS using existing assets, capabilities and expertise. In particular:

- Electricity distribution businesses can provide services to manage MSL risks through the use of supervisory control and data acquisition (SCADA) technology and smart inverter control. Through Victoria's Emergency Backstop Mechanism reform, the Victorian Government is introducing requirements for new and replacement solar photovoltaic generation systems to be capable of having their electricity generation remotely curtailed by Victorian electricity distribution businesses to manage MSL risks.¹⁰ This means that Jemena and other Victorian distribution businesses will be required to provide services to manage MSL risks if directed by AEMO.
- Electricity distribution businesses are also capable of providing services to manage UFL risks using smart meter control technology.

There may be many advantages to Jemena providing ESS. These include our existing capabilities, our ability to provide ESS at scale using the range of assets across our network and by seeking a generation or demand response from a large number of customers, and therefore, the relatively low cost of our potential provision of ESS. These benefits may flow through to customers through reduced costs of ESS provision.

In the future with additional investment and capability-building, Jemena and other distribution businesses may also provide FCAS, using batteries and potentially a dynamic voltage management system, and system strength services including inertia using synchronous condensers. Currently, electricity distribution businesses are prevented from providing these services due to ring-fencing restrictions, and the only way they can be provided is through waivers. These waivers do not provide investor certainty, thereby discouraging electricity distribution businesses from investing in these services; investors making long-term investment decisions require more certainty than that afforded in a ring-fencing waiver. This means customers do not receive the full benefit of the services electricity distribution businesses could provide.

To promote more efficient outcomes for the long-term interests of customers, we proposed to the AER the classification of ESS into two distinct categories:

- A category of ESS (mandatory ESS) that we provide as directed by AEMO under rules and regulations as Standard Control Service (SCS). These services include interruption or curtailment of generation of embedded generating units connected to the distribution system at AEMO's direction to manage MSL risks as will be required under Victoria's Emergency Backstop Mechanism and interruption or disconnection of supply at premises at AEMO's direction to manage UFL risks.
- A separately classified ESS (non-mandatory ESS) that AEMO can contract Jemena to provide as SCS. These services could include RERT services, FCAS, inertia and other system security services.

We consider classifying services into these two distinct categories is essential to reflect the different circumstances in which these services are provided – whether as directed by AEMO or as contracted by AEMO on request. Should the services be classified as SCS, this would mean our costs for

providing ESS would be shared across our customer base, reflecting the benefits shared by our customers from ESS.

We consider it essential to ensure that appropriate incentives and mechanisms are in place to share the value from the provision of ESS with our customers. To complement the provision of ESS, we propose a new Market Sharing Incentive Scheme (MSIS) to incentivise the provision of ESS and share value with our customers.

Considerations for the Energy Reference Group:

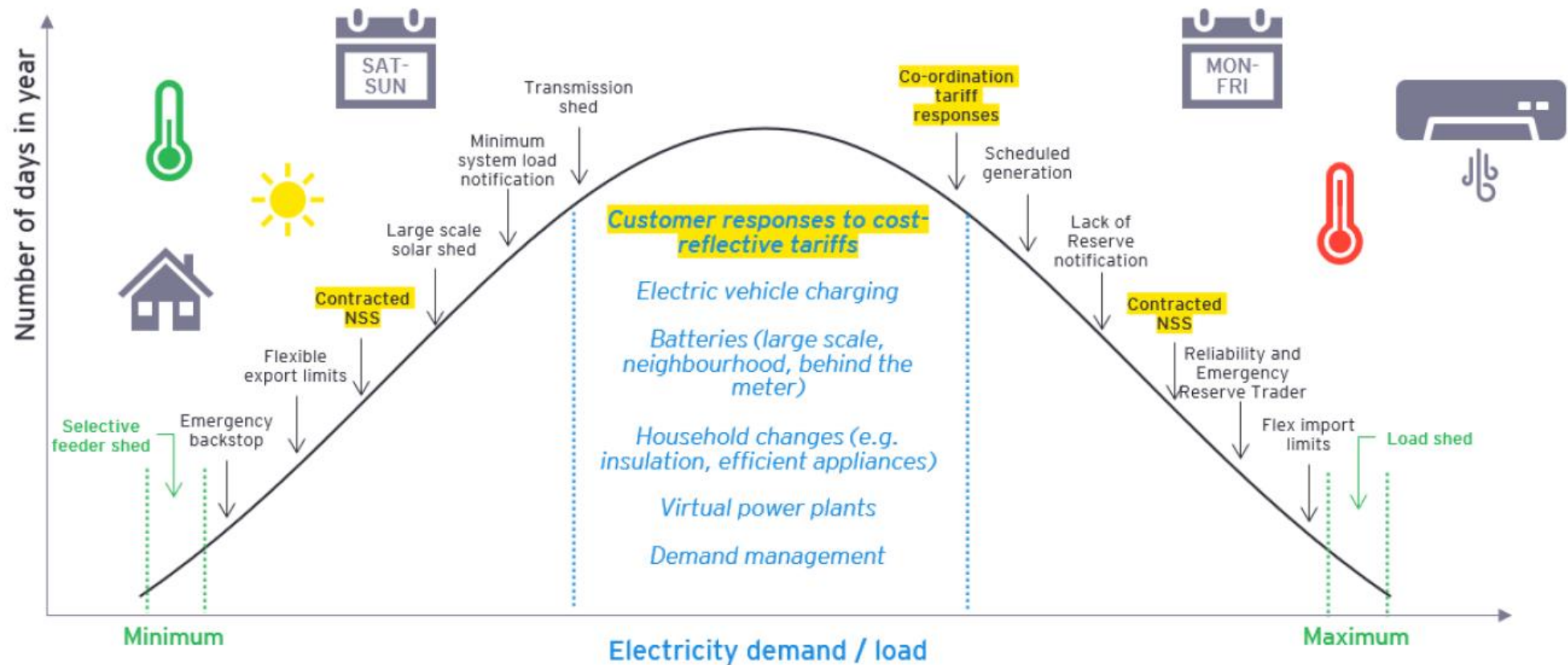
Do you think Jemena has a role in providing non-mandatory Essential System Services (ESS)?

What do you think is the appropriate framework to incentivise Jemena to provide non-mandatory ESS to ensure the derived benefits are shared with its customers?

1.4 Actions to Address Minimum Demand (Peak Export) and Maximum Demand (Peak Demand)

A myriad of options can address the challenges of minimum demand (peak export) and maximum demand (peak demand). The best set of options are the ones that deal with the challenges in a holistic fashion, that is, not treating peak export and peak demand as separate issues to resolve. Figure 3 highlights a range of options under consideration against the expected durations when those options are called upon. The figure shows mechanisms such as emergency backstop for DPV (to address peak generation challenge) and load shedding (to manage peak demand challenge), which should only be relied upon very infrequently—that is, as a last resort—because of their impact on customers. The Victorian DNSPs should also focus on developing customer and market-friendly options that are expected to be used frequently.

Figure 3 – Potential actions to address peak export and peak demand events



Considerations for the Energy Reference Group:

Would you like us to restrict DPV exporting to our network to zero at all times of the year when there is a network limitation, with no additional investment?

Would you like us to invest in new incremental tools and systems to allow DPV export at different times of the year?

Would you like us to invest in new incremental tools and systems to and introduce export tariffs with rewards and penalties to allow customers with solar to export at different times of the year?

Would you like us to build out the electricity distribution network to meet the peak demand required from EVs and other electric home appliances?

Instead of building out the network, would you like us to consider investment in providing flexible import or control of your EV charging to reduce the peak demand increase?

What about an EV tariff where we would charge higher amounts during peak demand times and lower network charge(s) at other times?

1.5 Grid Stability and Flexibility

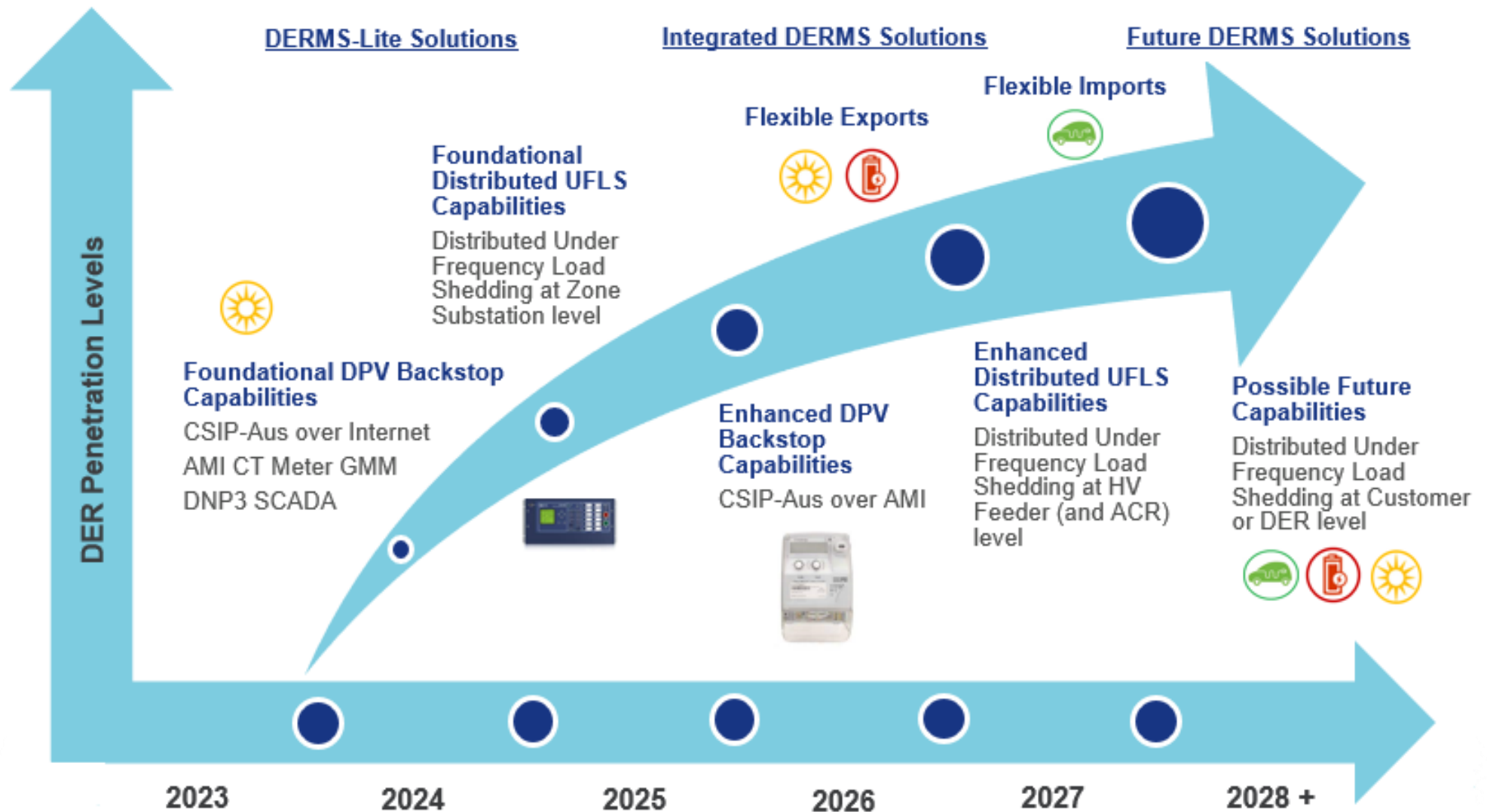
Jemena proposes to develop a DPV Backstop Capability and a Distributed Under-frequency Load Shedding (Distributed UFLS) Scheme as two distinct grid stability applications to strategically respond to the challenges and opportunities associated with increasing numbers of Distributed Energy Resources (DER) and their related influences on power system security and network operating limits.

The applications will be developed on a new and staged Distributed Energy Resource Management System (LV-DERMS) platform to achieve near real-time optimised control of DER active power operating envelopes for the delivery of grid stability and flexible export and import services using Dynamic Operating Envelopes (DOE), facilitated by a CSIP-AUS utility server.

By developing the capabilities to determine and transmit network dynamic import and export limits to each customer connection point using industry-standard data communication protocol, the capabilities can be used more frequently, for example, for DER market facilitation (when the market becomes available) and for flexibility services/network support services.

The proposed strategic roadmap for developing JEN's Grid Stability and Flexible Services capability to meet the identified needs for the next ten years is illustrated in Figure 4.

Figure 4 – Grid Stability and Flexible Services Capability Roadmap



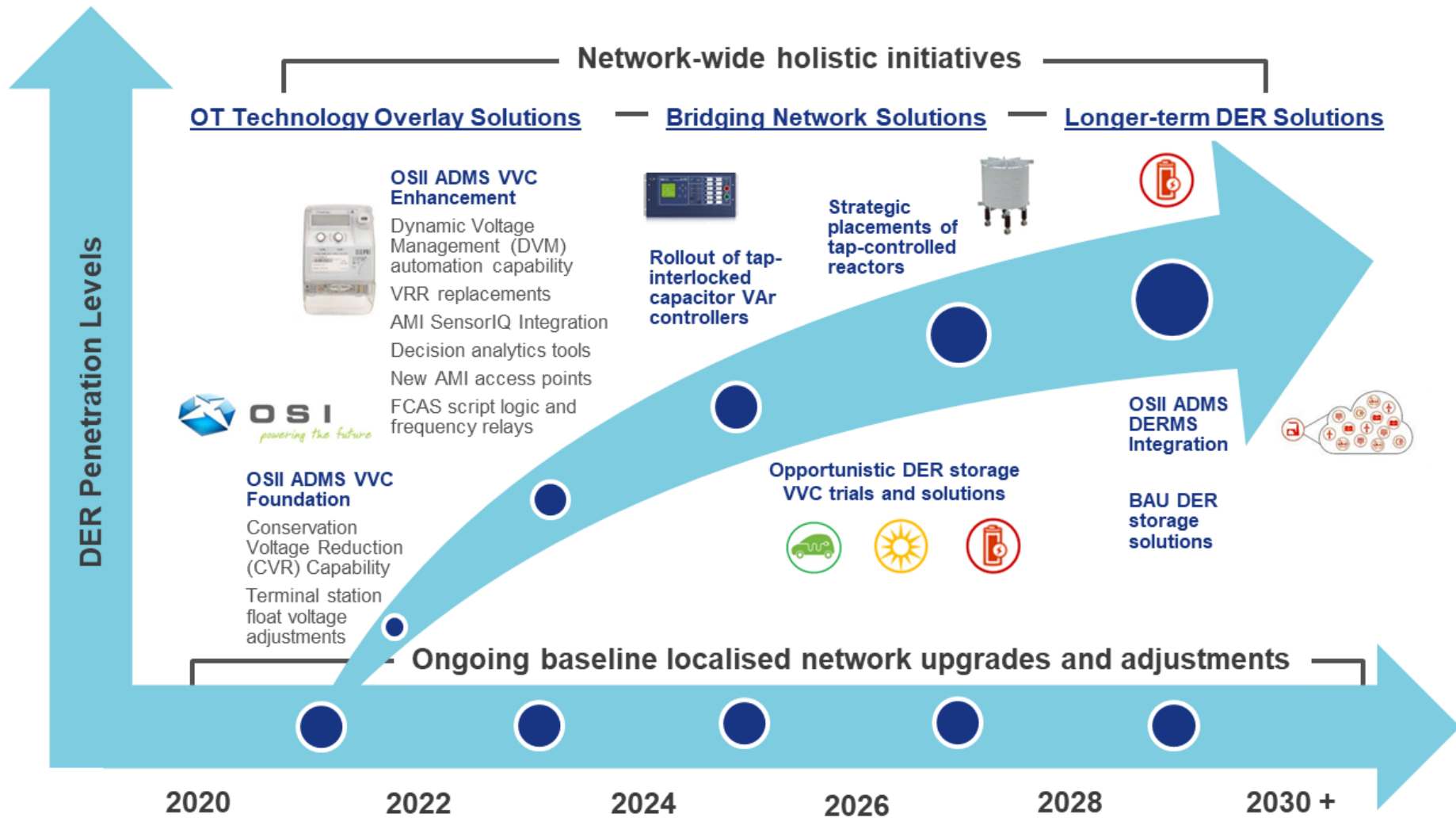
1.6 Voltage and power quality management

Voltage rise occurs when CER exports power back to the electricity grid while voltage drop occurs when CER consume power. This has led to a wider range of voltage variation that is not within the design parameters of DNSP's conventional voltage control scheme. Jemena is considering developing a Volt-VAr control program to respond strategically to the challenges and opportunities associated with increasing numbers of DER and their related influences on network voltage, demand, and power factors.

The applications could be developed on a new and staged Dynamic Voltage Management (DVM) system platform to achieve near real-time optimised control of network voltage and reactive power flow for the delivery of compliant voltages and reduced DER curtailment. It will utilise the Volt-VAr control (VVC) capability of Jemena's Advanced Distribution Management System (ADMS) and Jemena's Advanced Metering Infrastructure (AMI).

The possible strategic roadmap for developing Jemena's Volt-VAr Control and Quality of Supply to meet the identified needs for the next ten years is illustrated in Figure 5.

Figure 5 – Volt-VAR Control and Quality of Supply Roadmap



1.7 Demand Management

The growth in maximum demand across Jemena's network is increasing, with the total underlying network 50% probability of exceedance (POE) maximum demand forecast to grow at an average rate of 3.76% per annum over the next five years (between 2023-24 to 2028-29). More recent reviews demonstrate that sharper increases are expected in future years as de-carbonisation initiatives start to take effect.

Despite the general growth in demand at the network level, there are areas within the network where maximum demand is forecast to grow well beyond the network average level. In contrast, other parts of the network are forecast to experience a decline in maximum demand.

The historical and forecast coincident peak demand growth is outlined in Figure 6.

For completeness we have also included the forecast minimum demand growth in Figure 7.

Figure 6 – Jemena’s historical and forecast coincident peak demand growth.

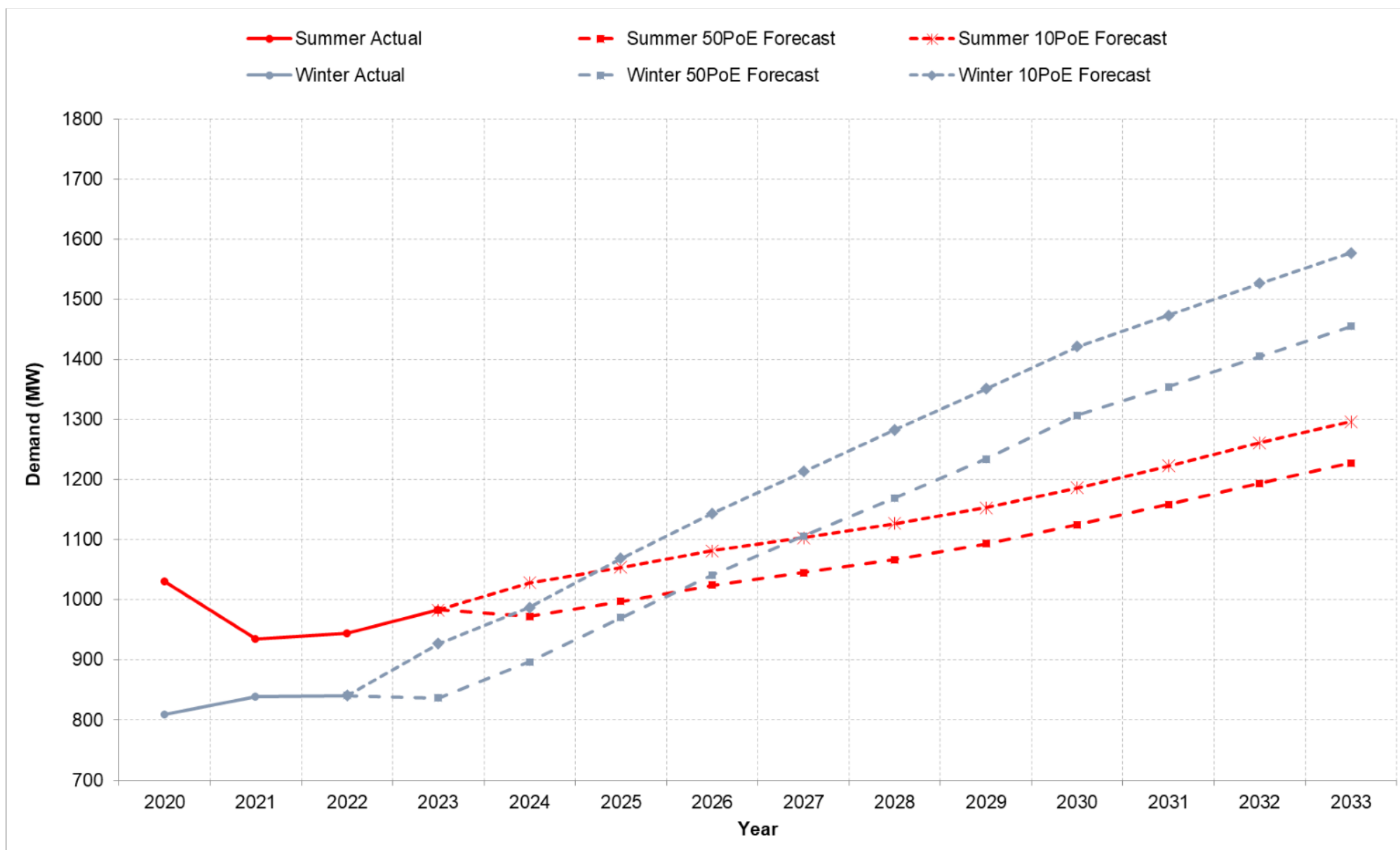
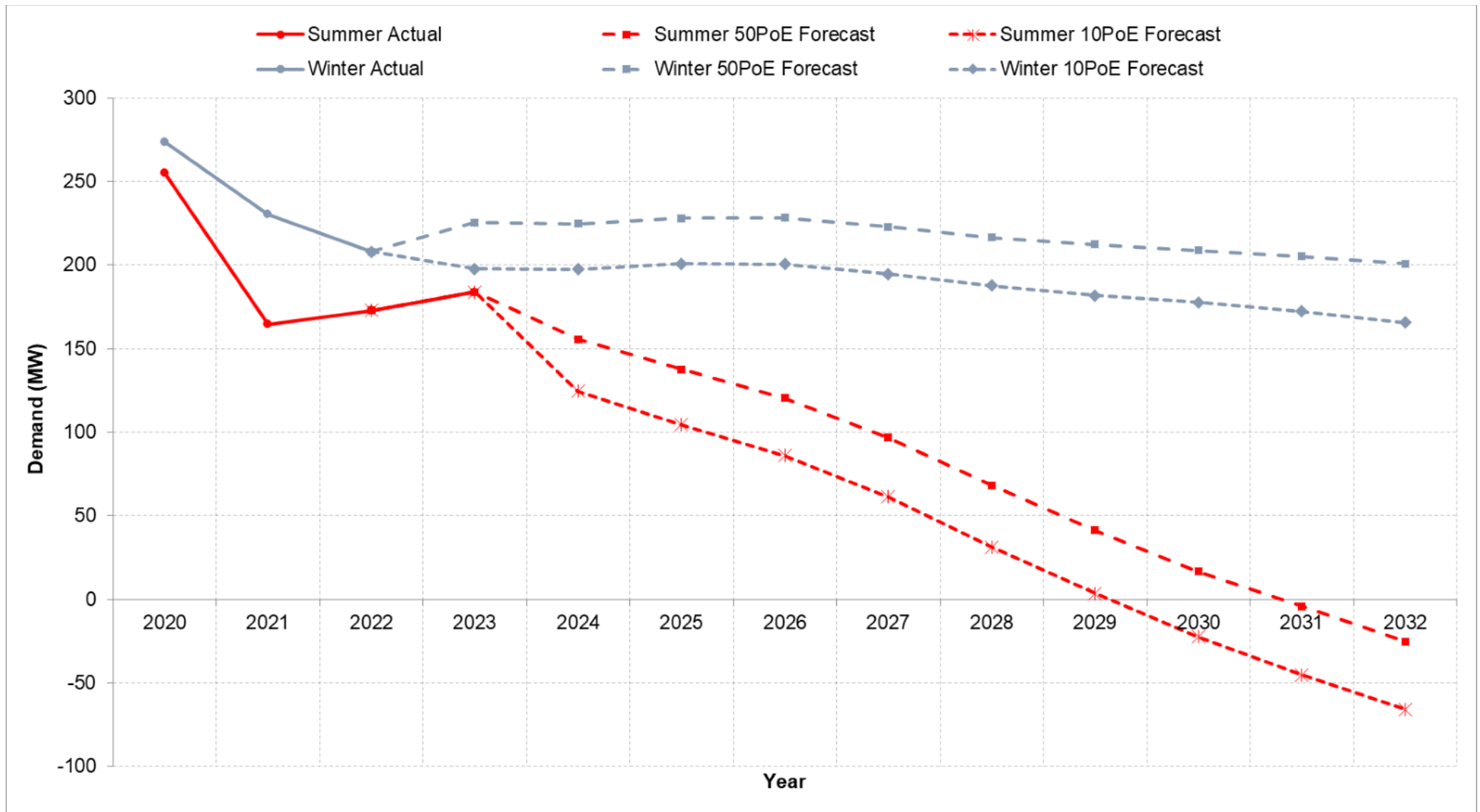


Figure 7 – Jemena’s historical and forecast minimum demand forecast.



Demand management aims to manage the electricity use profile on a network to minimise the cost of supplying customers while maintaining or improving customer options and service levels. The AER defines Demand Management¹³ as:

“any effort by a distributor to lower or shift the demand for standard control services, including agreements between distributors and consumers to switch off loads at certain times and the connection of small-scale 'embedded' generation reducing the demand for the power drawn from the distribution network”.

Jemena has reviewed its demand management program and is currently focusing on the following initiatives in the coming regulatory control period:

- Efficient connection of micro-embedded generators;
- Manage peak demand through demand response from customers;
- Exploring the use of DOE's to manage residential customer electric vehicle load and
- Explore using renewable embedded generation (including DPV) and energy storage for network peak demand support.

The following demand management initiative has just been completed in 2023: **Dynamic Electric Vehicle Charging Trial**

This trial investigated the impacts of EVs on the distribution network and consumer willingness for third party control to demonstrate how DNSPs can play a direct role in EV managed charging.

The trial was successful in developing, testing and implementing the capability to understand the charging behaviour of existing EV owners and the extent networks can manage their load to shift energy to periods of high renewable energy supply, reduce demand during periods of peak demand or low renewable energy supply and support network and wholesale constraints.

Solar Soak (SS) events were designed to encourage additional demand during times when the grid would have excess solar energy, such as during periods of high solar production and low demand. There were 5 SS events completed to investigate the increase in load on the grid and manage the impact of minimum demand while making better use of the available solar energy. Demand response (DR) events refer to the shifting or reducing of demand usually to support grid stability and security. As such, five DR events were initiated during the trial to understand the capability of participants to provide DR support and limit their EV charging during constrained periods.

- During the managed charging events, a DOE was sent to the EV charger to define the charge rate based on the current network conditions.
- Participants in the trial were mostly satisfied with the delivery of the events and the trial overall and were content with having their EV charging managed by another party and purchasing a smart EV charging themselves.

Any implementation of the lessons learnt will need to consider the applicability for mass market EV adoption given the small scale of the trial's cohort of participants which are likely to reflect highly engaged early adopters, those that are informed and aware of their charging behaviours and those that have other behind the meter technologies such as solar PV. Future EV owners may not be as engaged or technologically aware which may impact the effectiveness of managed charging via DR and SS events and may also impact the network differently to those within the trial.

1.8 Coordination Tariffs

Coordination tariffs refer to network tariffs that work alongside flexible resource signals to promote a level of firm response. An example is a dynamic price signal to encourage a response; if no response is detected, more onerous action, such as back-stop mechanisms or load control, will be taken. The range of coordination tariffs to promote—rather than direct—electricity usage is very broad and will be the subject of future discussions.

GridTalk.com.au

