National Consumer Energy Resources Roadmap

Powering Decarbonised Homes and Communities

energy and climate change ministerial council

Australian Government

The Department of Climate Change, Energy, the Environment and Water prepared this report on behalf of energy and climate change ministers from Australian, state and territory governments.

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Acknowledgement of Country

We acknowledge the Traditional Owners of Country throughout Australia and recognise their continuing connection to land, waters and culture. We pay our respects to their Elders past and present.

Contents

1 Introduction

Consumer energy resources (CER) are consumers' resources that generate or store electricity as well as flexible loads that can alter demand in response to external signals. CER includes rooftop solar, batteries, electric vehicle chargers and controlled loads such as water heaters and air conditioners.[1]

1.1 Purpose

Australian consumers are driving one of the fastest transformations of electricity systems in the world through record breaking investment in consumer energy resources (CER).

This is being accelerated by Australia's national commitment to net zero emissions by 2050, with each jurisdiction having interim emissions and renewable energy targets to meet that deadline. The Australian Government has made a national commitment to a 43% reduction on 2005-level emissions by 2030, with 82% of on-grid electricity supplied from renewable sources.

Integrating CER into the electricity grid is a critical part of a renewable superpower economy where consumers can access clean, affordable and secure energy.

The National CER Roadmap envisages a future where:

Consumer Energy Resources are an integral part of Australia's secure, affordable and sustainable future electricity systems, delivering benefits and equitable outcomes to all consumers through efficient use which smooths the transition, rewards participation and lowers emissions.

All Australians should be able to harness the full benefits of rooftop solar batteries and electric vehicle (EV) growth. In line with this, the outcomes the Roadmap seeks are:

- Benefits delivered to all consumers, regardless of whether they can invest in CER
- Economic opportunities for consumers are maximised
- The energy system is reliable and secure in the face of significant transformation
- Australia's energy system is sustainable, future-ready and world leading

Effective integration and management of CER like rooftop solar, household batteries and electric vehicles could unlock billions of dollars in savings to the energy system that could be passed on to consumers. This is why the Commonwealth and states and territories are taking action to move forward with a nationally consistent approach that allows Australians to harness the full potential of new and emerging household and business CER. The CER Roadmap does not seek to duplicate

[1] See Glossary for full definition.

reforms underway within Australia's energy market, but rather focuses on optimising opportunities that complement other reforms and which benefit from a consistent national coordinated response.

Reforms progressed under the CER Roadmap will support consumers to:

- increase exports from rooftop solar systems to the grid
- benefit from new opportunities like vehicle-to-grid
- get paid for participating in programs that benefit the electricity system
- manage energy use to save on bills and pay back CER investments faster
- safely participate in the energy market

Projects delivered under the CER Roadmap will also benefit the community by helping to make the energy transformation quicker and cheaper, reducing the need for new large-scale generation, storage and transmission, and lowering wholesale electricity prices and network costs.

1.2 National approach

Under the National Energy Transformation Partnership (NETP), Australian governments are working together to maximise economic opportunities from the clean energy transformation, ensure reliable and affordable electricity, and deliver the greatest benefits for Australian households, businesses and communities.

At the November 2023 Energy and Climate Change Ministerial Council (ECMC) meeting, Ministers recognised the need for a national CER roadmap to promote better coordination and optimisation of CER, which will put downward pressure on bills and overall system costs, reduce emissions and broaden access to CER across communities. They agreed to the creation of a CER Taskforce to fast track priority projects, beginning in early 2024, and in March 2024 agreed to an initial work plan that outlined early priorities.

The CER Roadmap and Implementation Plan have been subsequently developed by the interjurisdictional CER Working Group established under the NETP, building on the work of jurisdictions, the former Energy Security Board and market bodies. They provide strategic direction and highlight priority reforms and sequencing considerations to achieve the vision and outcomes.

The CER Roadmap sets national reform priorities to build national consistency and support a harmonised approach to unleashing the full potential of CER. By focussing on national reforms, it will enable CER uptake to be as efficient and effective as possible, with benefits spread more fairly, including where jurisdictions choose to provide subsidies to accelerate investment.

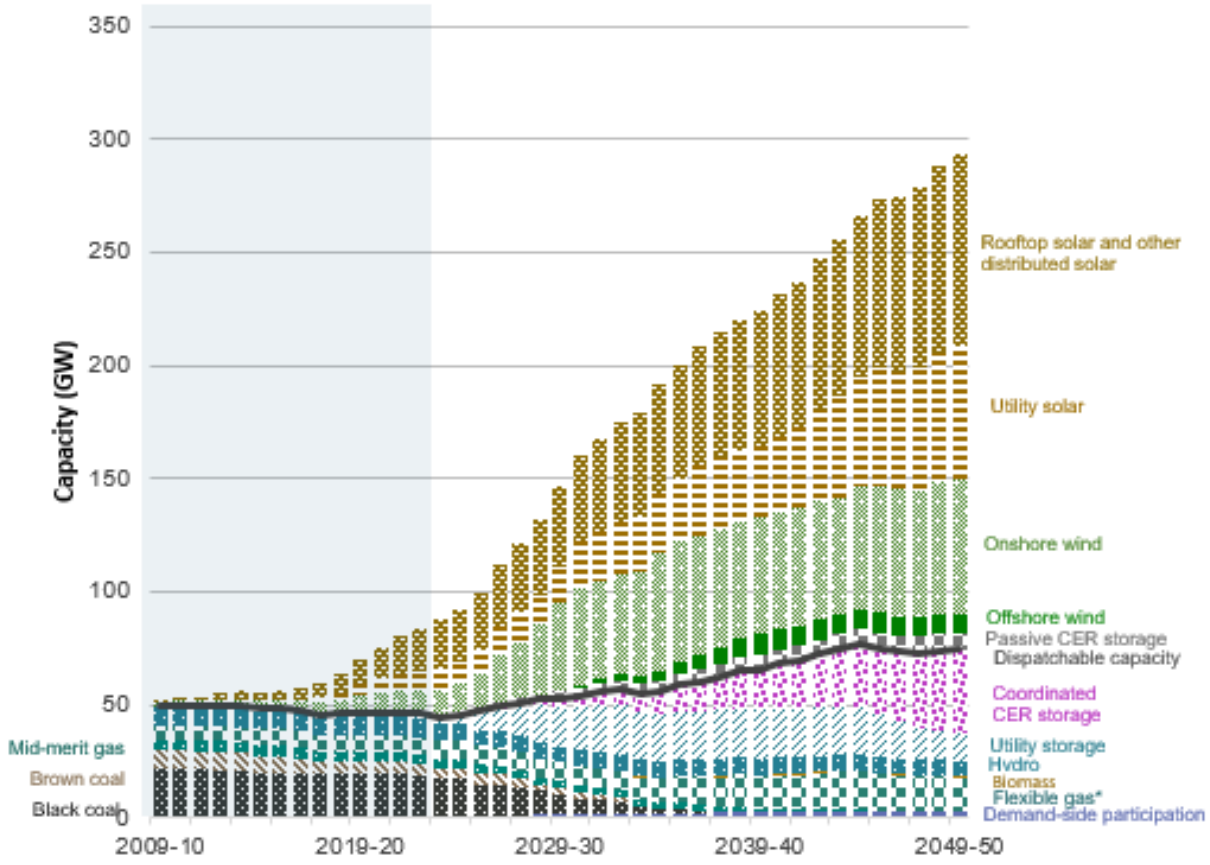
When planning reforms, consideration will be given to the regulatory and market environments of each jurisdiction, noting differences between jurisdictions that participate in the National Electricity Market and those with alternative systems.

Progress against outcomes will be reviewed with an updated Implementation Plan considered by ECMC on an annual basis. An in-depth review of the Roadmap will occur in 2027.

2 Australia's changing energy system

2.1 Rapid adoption of CER

One third of Australia's households have installed rooftop solar. Total capacity of rooftop solar across Australia amounts to 22.6 GW as of May 2024 (Australian Energy Council 2024), a more than seven-fold increase from the 3 GW of rooftop solar capacity that had been installed across Australia in May 2014 (Clean Energy Regulator 2024). Total installed rooftop solar and other distributed solar capacity in the National Electricity Market (NEM) is required to reach more than 36 GW by 2029-30 under AEMO's 2024 ISP Step Change Scenario (Figure 1). Collectively, rooftop solar is the second largest source of renewable electricity generation in Australia (behind wind energy generation), and the fourth largest source of electricity generation, making up approximately 11.2 per cent of the country's installed capacity for power supply (Clean Energy Council 2023). The installed capacity of rooftop solar combined is greater than the single largest generator in the NEM (AEMO 2024; Origin 2024).



Notes: 1. Flexible gas includes gas-powered generation and potential hydrogen capacity. 2. "CER storage" means consumer energy resources such as batteries and electric vehicles. 3. Projections for "Rooftop solar and other distributed solar" and "CER storage" are forecast based on unit costs, consumer trends and assumptions about payments received to participate in the electricity market.

Figure 1: Capacity, NEM GW 2009-10 to 2049-50, Step Change Scenario (AEMO 2024)

Since 2014, close to 100,000 small-scale solar photovoltaic (PV) systems with a battery have been installed across Australia. This has grown from just under 700 solar and battery systems installed across Australia as at year end 2014 (Clean Energy Regulator 2024).[2] Total installed capacity for small-scale batteries is 1 GW across the NEM and under AEMO's 2024 ISP Step Change scenario is required to increase to 6.6 GW in 2029-30 (AEMO 2024).

Australia's electric vehicle fleet (including battery electric and plug-in hybrid vehicle types) has grown from just over 300 in 2011 to over 180,000 as of December 2023 (Electric Vehicle Council 2021; Electric Vehicle Council 2022; Jafari 2022; Electric Vehicle Council 2023).[3] By 2030 it is projected that 1.5 million EVs will be on Australian roads (Electric Vehicle Council 2022). Alongside this, technology advances are increasingly enabling household appliances to become 'smarter', providing flexibility to shift use to when it best suits the household and grid.

AEMO's 2024 ISP Step Change Scenario shows potential for the capacity of coordinated CER storage to rise from today's 0.2 GW to 3.7 GW in 2029-30, and then 37 GW in 2049-50 – making up 66% of the NEM's energy storage nameplate capacity (AEMO 2024).[4] Passive CER storage (not part of a Virtual Power Plant) could increase to approximately 2.8 GW in 2029-2030 and approximately 6.8 GW in 2049-50 under the same scenario (AEMO 2024).

The centralised energy system of the past where power flowed one way from supply-side to demand-side (see Figure 2) is transforming to a future grid that will be more decentralised, accommodating two-way power flows (see Figure 3). As more CER are deployed involving a greater number of players in energy markets, the lines between demand-side and supply-side are increasingly blurred, creating a more complex system, but one with greater opportunities and potential for lower costs for consumers.

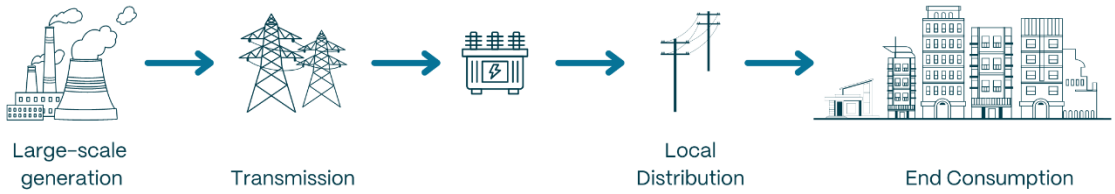


Figure 2: Legacy grid (Energy Catalyst 2024)

[2] This is based on voluntarily disclosed data for batteries that were installed at the same time as the solar PV system.

[3] DCCEEW estimate calculated based on 2022 EV circulation figures as baseline, subtracting sales figures each year back to 2011. 2022 EV circulation figures from Electric Vehicle Council Blog post from 7 February 2023. 2021 EV sales figures from Electric Vehicle Council, *State of Electric Vehicles 2022* report. EV sales figures each year from 2011 to 2020 taken from Electric Vehicle Council *State of Electric Vehicles 2021* report.

[4] Note this is a scenario supporting Net Zero and the 82% target – but is not an "expected outcome" without supporting policy interventions.

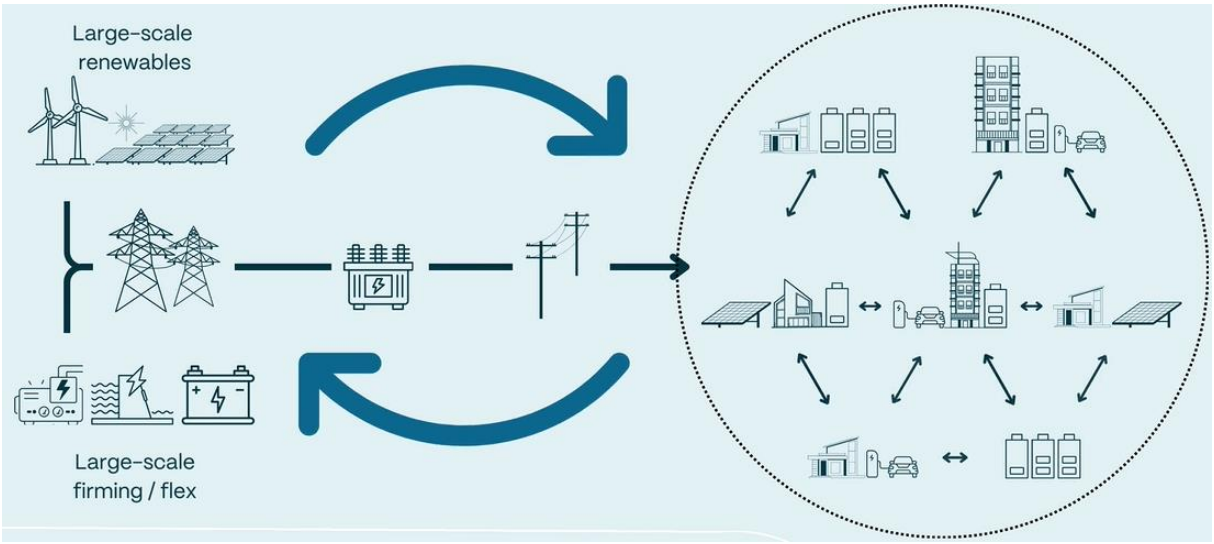


Figure *3: Transforming Power Systems (Energy Catalyst 2024)*

2.2 Unleashing the full potential of CER

Well-integrated CER present an opportunity to support a least cost and faster energy transition, system reliability, and to reduce consumers' energy bills.

Consumers can benefit from high CER integration as it can help manage minimum demand and reduce peak demand, provide essential system services, and reduce the need for costly network upgrades, grid scale generation and storage investments. Balanced regulation of new energy technologies and services can facilitate this engagement by ensuring adequate consumer protections are in place. This can help people trust that the control of CER by third parties – necessary to coordinate technologies and realise possible benefits – is safe, in their interest, and does not require them to become energy experts.

The benefits that can be realised through well-integrated CER are:

Lower bills – By investing in rooftop solar and battery storage, owners can save money on their retail bills. In addition, because solar energy is cheap to produce and abundant during the day, rooftop solar lowers daytime wholesale energy prices. If well-coordinated, CER can also lower network costs, which make up a significant proportion of all consumer bills, benefiting people who do not own CER.

Enhanced coordinated flexibility – Virtual Power Plants (VPPs) that help coordinate CER can provide additional flexibility to meet grid needs and enhance cost savings (Rocky Mountain Institute 2024). For example, owners can participate in demand flexibility initiatives to shift energy consumption to when it suits them as well as when it suits the grid. Consumers could also be paid for contributing to grid and network requirements through participation in VPPs.

Reduced grid-scale investment – Optimised use of CER can reduce the need for large-scale generation and storage capacity, as well as minimise the need for curtailment and network augmentation. This optimisation can result in lower costs and bills for all consumers, including those who do not own CER. For example, AEMO's 2024 ISP shows that without effective coordination of consumer batteries, around $4.1 billion of additional grid-scale investment would be needed under the Step Change Scenario to 2050, increasing the costs that are reflected in consumer bills.

Overall, recent analysis by the Institute for Energy Economics and Financial Analysis (2024) indicates that CER (across the full range of possible sources) has the potential to deliver a combined economic benefit for Australia of more than $19 billion by 2040 (inclusive of $11 billion in avoided network costs and $8 billion in reduced generation and storage costs) if well integrated. Clean Energy Council (2024) modelling found that not meeting CER forecasts, under AEMO's draft 2024 ISP Step Change Scenario, risks losing $22 billion in savings for Australian taxpayers. Further, the Institute for Sustainable Futures and RACE for 2030 (2023) projected that employment in the clean energy sector will grow from 19,000 in 2023 to a peak of 81,000 in 2049, driven in part by increased CER uptake.

2.3 Challenges

While CER offers benefits and opportunities for consumers, there are challenges that remain to unlock its full potential. The projects under the Roadmap Implementation Plan seek to respond to existing and emerging challenges and will be reviewed annually. These challenges include:

System stability – CER can play an integral role if the system, network, and market operators have sufficient visibility of two-way power flows and can predict how it is going to be managed in a way that is coordinated with the rest of the system.

Device performance – CER devices need to operate in a consistent manner when connected to the grid, such that they do not cause any unintended harm to the rest of the system.

Voltage management in distribution network – Effective CER integration requires careful management of two-way power flows to avoid pushing voltage beyond safe limits, which can damage and shorten the life of electrical appliances, including CER. Voltage management issues reduce the network's capacity to manage CER and increase CER constraints, but effective CER coordination can contribute to better voltage management.

Minimum system load – Growing CER generation during the day is off-setting consumer demand leading to lower operational minimum system load. Reduced grid-scale generation when CER generation is at its highest can make the provision of system services, such as frequency control, system strength, and voltage management more challenging.

Peak demand – When the system is already experiencing periods of high demand, additional demand from CER, such as EV charging after work during the early evening peak, could increase the costs of maintaining a reliable system, including additional dispatchable capacity and increased network capacity (TasNetworks 2023).

Consumer access and equity – Careful development of regulation and programs is required to ensure that the deployment and use of CER allows the distribution of benefits to all energy consumers, avoids costs to those who are unable to invest in CER, and ensures access, particularly for people vulnerable to or experiencing hardship.

Cyber security – Malicious actions against CER have the potential to cause harm and concerns about security could slow the adoption of CER. Governments, industry, academia and other stakeholders are progressing work aimed at securing the CER ecosystem.

3 Roadmap vision, outcomes & principles

National Consumer Energy Resources Roadmap

Vision

Consumer Energy Resources are an integral part of Australia's secure, affordable and sustainable future electricity systems, delivering benefits and equitable outcomes to all consumers through efficient use which smooths the transition, rewards participation and lower emissions.

Outcomes

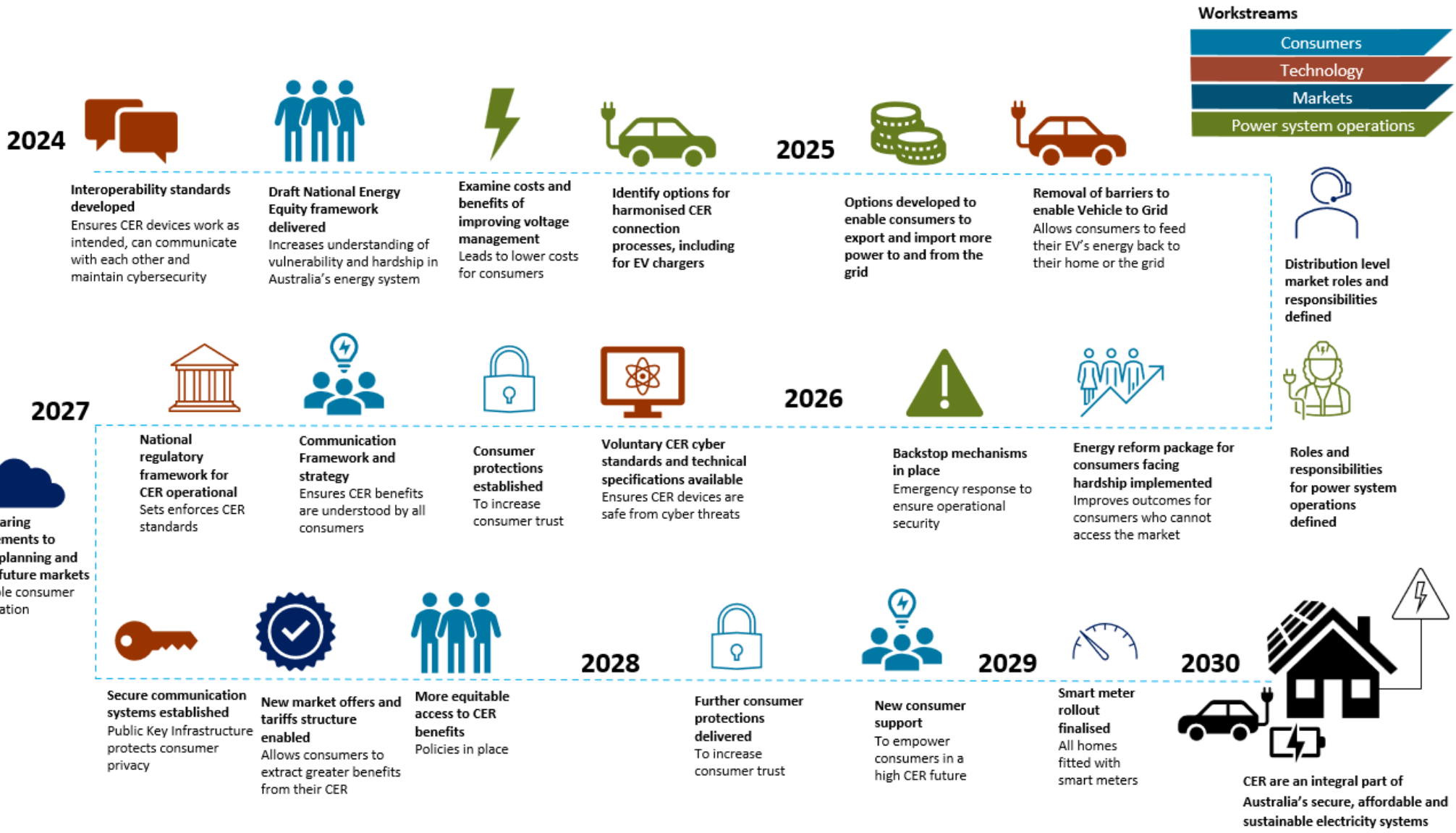
- Benefits for all consumers
- Maximise economic opportunities
- Reliable and secure systems
- Sustainable, future-ready and world-leading

Principles

- Ensure equitable access to benefits of new technology
- Fair system that prioritises consumer protection, including emerging energy products and services
- Reduce household and business bills and emissions, support power system security and reliability
- Integration with sectoral action plans
- Consistent and contemporary compliance, technical standards and enforcement
- Orchestrated management and implementation of CER and enabling infrastructure

Workstreams	National Reform Priorities
1 **Consumers**	**C.1** Extending consumer protections for CER
	C.2 More equitable access to benefits of CER
	C.3 CER information to empower consumers
2 **Technology**	**T.1** Nationally consistent standards, including electric vehicle to grid
	T.2 National regulatory framework for CER to enforce standards
	T.3 Establish secure communication systems for CER devices
3 **Markets**	**M.1** Enable new market offers and tariff structures to support CER uptake
	M.2 Data sharing arrangements to inform planning and enable future markets
	M.3 Redefine roles for market operations
4 **Power system operations**	**P.1** Enable consumers to export and import more power to and from the grid
	P.2 Faster, harmonised CER connection processes, including EV chargers
	P.3 Improve voltage management across distribution networks
	P.4 Incentivising distribution network investment in CER
	P.5 Redefine roles for power system operations

4 Roadmap on a page



5 Roadmap Implementation Plan

The Implementation Plan is structured around four workstreams (Consumers, Technology, the Market and Power System Operations) which reflect the interconnecting layers of the electricity system. National Reform Priorities are grouped within each workstream. The projects delivering the reforms are listed with their year of commencement and completion and key dependencies for the project. For each workstream, one table outlines the projects to be led by the CER Working Group and the CER Taskforce. A second table outlines important related national projects being delivered by other bodies.

Progress against outcomes will be reviewed and an updated Implementation Plan considered by ECMC on an annual basis. An in-depth review of the Roadmap will occur in 2027.

The Implementation Plan is not intended to capture all work being undertaken that is relevant to CER. Appendix A highlights aligned projects and initiatives being progressed by governments and market bodies.

5.1 Consumers

Consumers are the driving force behind the purchase and use of energy and energy technologies including CER. Projects in this workstream aim to ensure continued strong uptake of CER and emerging products such as VPPs by providing a safe and fair market for CER. Further it aims to ensure that the benefits of CER are shared with all consumers regardless of their ability to invest or engage with the market.

CER Working Group & CER Taskforce led projects

National Reform Priority	Project description	Lead	Start	Completion	Dependencies
C.1 Extending consumer protections for CER	1) Ensuring consumers will benefit from CER and new energy services by extending consumer protections to new service offerings where they are not already covered by existing electricity consumer protection laws.	CER Taskforce in collaboration with AER	In progress	2026	Defined roles and responsibilities of distribution network market participants – June 2025
	2) Further consumer protections delivered.	CER Taskforce	2026	2028	M.2
C.2 More equitable access to the benefits of CER	1) Development of options (2025) and implementation of selected options to deliver more equitable access to the benefits of CER for all consumers.	CER Taskforce	2024	2027	M.1, M.2 The National Energy Equity Framework
C.3 CER information to empower consumers	1) Communication framework and strategy to ensure CER participation is compelling and easily understood by all consumers.	CER Taskforce in collaboration with ECA	2024	2026	
	2) Consumer support to empower consumers in a high CER future.	CER Taskforce	2026	2028	M.2

Projects led by other bodies

National Reform Priority	Project description	Lead	Start	Completion	Dependencies
C.2 More equitable access to the benefits of CER	1) The National Energy Equity Framework – increase understanding of vulnerability and hardship in Australia's energy system as a foundation for a framework to ensure equity is a key consideration in government policy and reform work into the future.	Energy Transformation Enablers Working Group	In progress	2024	
	2) AER review of embedded networks guidelines – assessment of benefits and harms due to embedded networks, and assessment of the regulatory framework for further consideration by policy makers.	AER	In progress	2025	
Other	1) The Future Price Trends Report – 10-year outlook on consumer pricing, based on changes in energy costs.	AEMC	In progress	2024	
	2) Greater access to consumer data to inform impact on diverse consumer bills and optimise consumer policy.	AEMC DCCEEW	In progress	2025	

5.2 Technology

High uptake and use of CER will create new opportunities and challenges for system security and reliability. Projects in this workstream aim to optimise system operation in a future where CER is an integral part of Australia's electricity systems. Future-ready architecture, holistic technical standards, compliance and enforcement will all work together to achieve this outcome.

CER Working Group & CER Taskforce led projects

National Reform Priorities	Project description	Lead	Start	Completion	Dependencies
T.1 Nationally consistent standards, including electric vehicle to grid	1) Develop an initial set of technical standards for CER device interoperability and flexibility for consideration by Energy Ministers.	CER Taskforce supported by ARENA and the Distributed Energy Integration Program Steering Group	In progress	2024	
	2) Voluntary adoption of standards prior to the regulatory framework being implemented.	CER Working Group	TBC	TBC	
T.2 National regulatory framework for CER to set and enforce standards	1) Options agreed by Energy Ministers	CER Taskforce	In progress	2025	
	2) Draft legislation	CER Working Group	2025	2026	
	3) Regulator established	CER Working Group	2026	2026	
T.3 Establish secure communication systems for CER devices	1) Establish a national not-for-profit entity to manage Public Key Infrastructure (PKI) to operate and manage authentication of communications with CER for backstops.	CER Working Group Energy Security and Resilience Working Group ENA	2024	2025	T.1 ENA and Synergy's National PKI for Energy project

National Reform Priorities	Project description	Lead	Start	Completion	Dependencies
	2) Expand the national not-for-profit entity to manage PKI to operate and manage authentication of communications with CER for more energy services.	CER Taskforce	2025	2026	T.1
	3) Future work: Expand PKI secure communications to cover EV charging and virtual power plants.	CER Taskforce	2026	2027	T.1
Other	1) Jurisdictions review their own technical or regulatory frameworks and remove barriers for consumer adoption of vehicle-to-grid opportunities.	CER Working Group	2024	2025	

Projects led by other bodies

National Reform Priority	Project description	Lead	Start	Completion	Dependencies
T.1 Nationally consistent standards, including electric vehicle to grid	1) Update Australian Standard 4777 to remove barriers to electric vehicle to grid charging.	Standards Australia	In progress	2024	
	2) Define EVSE minimum technical standards for power system security (where appropriate).	AEMO	In progress	2027	National regulatory framework to set and enforce standards
	3) Review of minimum operating standards for government supported public electric vehicle charging infrastructure.	National Electric Vehicle (EV) Action Plan Implementation Group	2025	2025	
T.3 Establish secure communication systems for CER devices	1) Implementation of the *Roadmap for CER Cyber Security.* As part of this work proposals to adopt some international standards have been submitted to Standards Australia and proposals to develop technical specifications for CER cyber security that are specific to Australian technologies and markets are being developed.	Standards Australia Energy Security and Resilience Working Group	In progress	2026	T.2 or cyber security legislation
Other	1) Code of practice for the management of public charging infrastructure.	TBC	2025	TBC	
	2) Strategy to identify commercial pathways for vehicle-to-everything, building on ARENA's Driving the Nation program.	ARENA	2024	2025	

5.3 Markets

Electricity markets will need to adapt to a system high in CER uptake. Projects in this workstream are aimed at developing well-designed markets and incentives to optimise utilisation of CER and existing grid assets and reduce the need for system augmentation. In turn this will unlock significant value for market participants, including networks and consumers. Incentivising efficient investments in electricity markets provides an efficient way to accelerate emissions reductions.

CER Working Group & CER Taskforce led projects

National Reform Priority	Project description	Lead	Start	Completion	Dependencies
M.1 Enable new market offers and tariff structures to extract greater benefits from CER	1) Develop options to facilitate new market offers and tariff structures to extract greater benefits from CER. This needs to support equitable outcomes for consumers while providing new incentives for uptake and coordination of CER. This will include consideration of how to drive small customer participation in market mechanisms to maximise consumer participation in demand-side and dispatchable markets. Findings from the AEMC Electricity pricing for a consumer-driven future review will be taken into account.	CER Taskforce AEMC	2025	2027	AEMC Review of electricity pricing for a consumer-driven future C.2 More equitable access to the benefits of CER AEMC Final Determination for Unlocking CER benefits through flexible trading AEMC Integrating Price Responsive Resources rule change T.1, T.2, T.3, M.2, M.3, P.5

National Reform Priority	Project description	Lead	Start	Completion	Dependencies
M.2 Data sharing arrangements to inform planning and enable future markets	1) Establish data access rights, metrics and processes for collection and sharing of CER and relevant network data to be used for effective investment decisions and compliance with CER standards and utilisation in the market.	CER Taskforce AEMO	In progress	2026	AER Network visibility and over voltage projects ISP review – Rule changes to support AEMO access to network and demand data CSIRO Network Metrics work T.2, M.3, P.5
	2) Establish arrangements necessary for operational CER data including flexible operating envelopes, network management and reliability and market exchange. This includes defining and implementing a CER data exchange to enable markets and services that incentivise consumer participation in CER coordination. CER Operational data, including that of EV and EVSE, will be captured for use to better manage local networks and the energy system as a whole.	CER Taskforce AEMO	2025	2027	Phased implementation informed by current and future ARENA programs, trials and projects AEMC Unlocking CER Benefits Through Flexible Trading rule change P.5
	3) Consider CER data requirements for consumers including for consumer protections and switching to obtain best CER services Ensuring CER consumer data is shared in an appropriate form to benefit consumers and the operation of the energy system. Consideration will be given to how private	CER Taskforce	TBC	TBC	Consumer Data Right – coverage of CER data M.3, P.5 AEMC Unlocking Benefits Through Flexible Trading rule change AER Network Visibility project – end 2024

National Reform Priority	Project description	Lead	Start	Completion	Dependencies
	data is shared as the future market design is developed.				AEMC Billing Transparency Project recommendations 2024 on management of consumer data.
	4) Develop future trend reporting of the effects of CER on retail markets. Extension of current AER roles in retail market performance monitoring and reporting and wholesale market performance monitoring and reporting.	CER Taskforce	2024	2025	
M.3 Redefine roles for market operations	1) Define the roles and responsibilities of distribution level market operation and drive alignment of incentives between market participants for CER integration.	CER Taskforce AEMC	In progress	2025	P.5 Building on AEMO 100% Renewables Roadmap and current and future ARENA programs, trials and projects.
	2) Define the role of DNSPs to achieve equitable two-way market operations, including in owning/operating community batteries and kerbside EV chargers, and other distributed resources.	CER Taskforce	2025	2026	P.5 Building on AEMO 100% Renewables Roadmap and current and future ARENA programs, trials and projects.
	3) Future work: Implementation of new roles and responsibilities. This may require legislative changes.	CER Taskforce	TBC	TBC	

Projects led by other bodies

National Reform Priority	Project description	Lead	Start	Completion	Dependencies
M.1 Enable new market offers and tariff structures to extract greater benefits from CER	1) AEMC Review (Electricity pricing for consumer-driven future) considers retail and network pricing to align the incentives for network-level market participants, including consumers.	AEMC	In progress	2025	
	2) Unlocking CER through Flexible Trading Determination – improve flexibility and trading of CER to unlock value for consumers and to facilitate better integration of flexible CER into the power system.	AEMC	In progress	2024	
	3) Develop a pathway to deliver network visibility to the market (critical information that could support CER planning decisions and manage network-related risks).	AER	In progress	2024 – TBC	
	4) Scheduled Lite/ Integrating Price Responsive Resources rule change. Will enable aggregated CER to participate in energy forecasting and dispatch.	AEMC	In progress	2024	

National Reform Priority	Project description	Lead	Start	Completion	Dependencies
M.2 Data sharing arrangements to inform planning and enable future markets	1) Increasing the pace of smart meter rollouts to enable consumers to benefit from participation in time of use markets through amendments to the National Electricity Rules (NER) and National Energy Retail Rules (NERR).	AEMC	In progress	2024 – NER and NERR amended	
	2) Standing data for Electric Vehicle Supply Equipment is captured to support energy system demand management.	CERWG AEMO	In progress	2027	T.2
	3) ARENA market integration projects including the CER Data Exchange, Project Converge, Project EDGE and Project Symphony.	ARENA	In progress	2025	
	4) AER Network Visibility project - The project seeks to optimise the benefits of CER and network assets for all customers by providing market and policy stakeholders with the critical information they need to make CER planning decisions and to manage network-related risks.	AER	In progress	2024	

5.4 Power system operations

The electricity system will need to adapt to high CER uptake. Projects in this workstream aim to enable secure and optimised system operation of the distribution network, helped by the adoption of nationally consistent standards and processes.

CER Working Group & CER Taskforce led projects

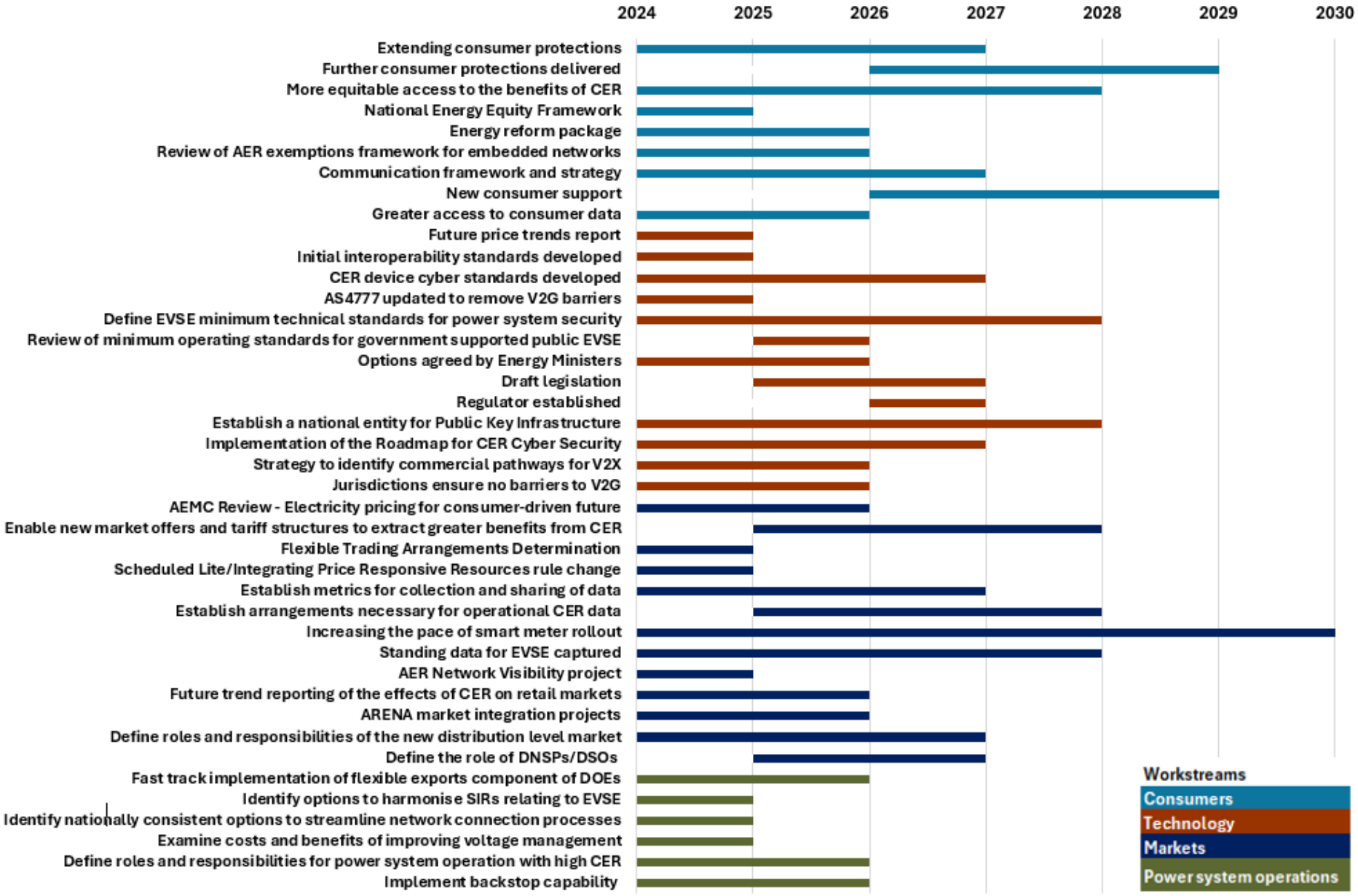
National Reform Priorities	Project description	Lead	Start	Completion	Dependencies
P.1 Enable consumers to export and import more power to and from the grid	1) Fast track implementation of flexible exports component of dynamic operating envelopes (DOEs) by network operators to enable increased CER flexibility, third party participation and maximise benefits to the system and customers. This project will build on the work of AER, ARENA and network projects (including Project EDGE and Symphony).	CER Working Group	In progress	2025	T.1, T.3 - Implementation of PKI and interoperability standards.
	2) Future work: Full implementation of dynamic operating envelopes that addresses dynamic imports.	CER Working Group	TBC	TBC	Work will commence after the initial work is completed for Flexible Export Limits.
P.2 Faster, harmonised CER connection processes, including for EV chargers	1) Identify options to harmonise Service and Installation Rules (SIR) relating to EVSE installations for consideration by the CERWG.	CER Working Group ENA	In progress	2024	ENA project on harmonisation of EV connections and SIRs
	2) Identify nationally consistent options to streamline network connection processes for CER, including EV charging equipment.	CER Working Group	In progress	2024	

National Reform Priorities	Project description	Lead	Start	Completion	Dependencies
	3) Future work: Implementation of harmonised service and installation rules and streamlined CER connection processes.	CER Working Group	TBC	TBC	
P.3 Improve voltage management across distribution networks	1) Examine costs and benefits of improving voltage management across distribution networks to lower costs for consumers.	CER Taskforce	2024	2024	AER network visibility and over voltage projects.
	2) Future work: Consideration of costs and benefits to determine best approach for consumers, to improve network voltage management.	CER Working Group	2024	TBC	
P.4 Incentivising distribution network investment in CER	1) Pathways identified to further incentivise distribution network investment frameworks to efficiently utilise CER and optimise network assets.	CER Taskforce	2025	TBC	M.3, P.5 AER Distributed energy resources integration expenditure guidance note, export services performance reporting and export services incentive scheme for Networks.
	2) Future work: The investment process for network operators will be examined for the different pathways identified.	CER Working Group	TBC	TBC	
P.5 Redefine roles for power system operations	1) Define the roles and responsibilities of power system operation with high CER and drive alignment of incentives between industry actors for CER integration for agreement by Energy Ministers.	CER Taskforce	In progress	2025	M.3

Projects led by other bodies

National Reform Priorities	Project description	Lead	Start	Completion	Dependencies
P.5 Redefine roles for power system operations	1) Iterative updates to the AEMO Engineering Roadmap to 100% Renewables and related transitional plans.	AEMO working with all of industry	In progress	TBC	
Other	1) Implement backstop capability that is robust and reliable in each jurisdiction to provide an emergency response improving operational security for all consumers.	Jurisdictions and AEMO	In progress	2025	

5.5 High level timeline



Glossary[4]

Term	Definition
AEMC	Australian Energy Market Commission. The AEMC is the government body that develops the rules by which Australian energy markets must operate.
AER	Australian Energy Regulator. The AER is the regulatory body that monitors performance and compliance with the rules governing energy markets in Australia.
ARENA	Australian Renewable Energy Agency. The Australian Government agency that provides financial assistance to accelerate pre-commercial innovation in renewable energy, energy efficiency and electrification technologies and projects.
Asynchronous	Asynchronous refers to the type of electrical generation whose voltage waveform is not synchronised with the rotation of the generator. The output frequency of an asynchronous generator is slightly (usually about 2 or 3%) lower than the frequency formula of synchronous generation.
Bidirectional charging	Charging of an electrical device (such as a battery or electric vehicle) that goes two ways: drawing electricity from the grid to charge the EV's battery and supplying electricity to the grid or to other electrical loads.
Consumer Energy Resources (CER)	A diverse range of small to medium scale energy resources that are located behind the meter at residential, commercial and industrial premises and are owned or operated by the customer. These resources generate or store electricity and includes flexible loads that can alter demand in response to external signals. CER includes technologies such as rooftop solar small scale battery including community battery storage systems, inverters, bi-directional energy resources including electric vehicle supply equipment.
Controlled loads	Specific electrical appliances, such as hot water systems which have electricity supplied to them during off-peak hours via a dedicated circuit, at a lower cost. The operation of these circuits is normally controlled via the meter by Distribution Network Service Providers (DNSPs).
Demand-side	Refers to the consumer side of the energy system, the other side being the 'supply side'. Consumers can reduce their energy demand by changing consumption patterns.
Dispatchable	When a particular energy resource can be relied upon to 'follow a target' issued by the market or system operator, Distribution System Operator (DSO) and/or Aggregator and/or adhere to a pre-agreed dispatch schedule at some time in the future. This may also be referred to as the firmness of response of the particular energy resource.
Distributed Energy Resources (DER)	A diverse range of small to medium scale energy resources that are directly connected to the distribution system. Examples of distributed energy resources that can be installed include roof top solar, small-scale wind generators and battery storage.
Distribution	The system of poles and wires which transport electricity to your home or business from the transmission network.
Distribution Network Service Provider (DNSP)	The company that owns and operates the distribution network (poles and wires) that supplies electricity to your home or business.
Distribution System Operator (DSO)	An entity responsible for the planning, operation and optimisation of a distribution system with high levels of Distributed Energy Resource or Consumer Energy Resources (DER/CER), electric vehicles (EV) and other flexible resources. Depending on the DSO model implemented, this may include functions such as implementing advanced, scenario-based modelling of DER/CER and EV uptake and operation, bidirectional power flows and Distribution System operations.

Term	Definition
ENA	Energy Networks Australia. ENA is the peak body representing Australia's electricity transmission and distribution and gas distribution networks.
Energy Market Aggregator	An Entity that brings together and orchestrates a fleet of energy resources, including Distributed Energy Resources (DER/CER), for the purpose of providing one or more Electric Products to different Tiers/Layers of the Power System.
EVSE	Electric vehicle supply equipment. Refers to the devices that provide electric power to the electric vehicle and use that to recharge the vehicle's batteries.
Firming capacity	A specific volume of electricity that is available to back up the output of a generator that has intermittent characteristics for a committed duration of time.
Interoperability	The capability of two or more Systems, Components or Applications to share, transfer, and readily use Energy, Power, information and services securely and effectively with little or no inconvenience to the user. Interoperability is underpinned by Connectivity, which is inherently related to Structure and Systems Architecture.
Inverter	A device which converts direct current (DC) electricity to alternating current (AC) electricity.
Market participant	Refers to the people or businesses that take part in the electricity and gas markets operated by the Australian Energy Market Operator (AEMO), the biggest of which is the National Electricity Market (NEM).
National Electricity Market (NEM)	The NEM is a wholesale spot market for electricity, covering the wholesale electricity generation across five interconnected regions (Queensland, New South Wales (including the Australian Capital Territory), Victoria, South Australia, and Tasmania), transported via 40,000 km of transmission lines and cables to large industrial energy users and to local electricity distributors in each region, which deliver it to homes and businesses.
Network monitoring devices	Equipment such as sensors, meters, and other specialised measuring equipment that network operators use to help manage electricity networks.
Network operators	Entities who run and manage electric power transmission or distribution systems.
NEVAPIG	National Electric Vehicle (EV) Action Plan Implementation Group. This is a sub-group of the Decarbonisation Working Group, a group of officials working under the direction of Australian, state and territory ministers working to deliver the National EV Action Plan under the National Electric Vehicle Strategy.
Orchestrated management	The coordination of dispatchable energy resources, including but not limited to Consumer Energy Resources or Distributed Energy Resources (DER/CER), in a manner that moderates negative system impacts and may include facilitating the provision of electricity to various market participants under a commercial arrangement.
Supply-side	Refers to the generation and delivery side of the energy system, the other side being the 'demand side'.
Synchronous	Synchronous refers to the type of electrical generation whose voltage waveform is synchronised with the rotation of the generator. Each peak of the sinusoidal (that is, corresponding with the sine trigonometric function) waveform corresponds to a physical position of the rotor. The output frequency of a synchronous generator is exactly determined by the formula f = RPM x p / 120 where f is the frequency (Hz), RPM is the rotor speed (revolutions per minute) and p is the number of poles formed by the stator windings (stator windings are vital components within electric motors, serving as the heart of the stationary section of the motor).
Transmission	The system of towers, wires, cables, and other infrastructure which connects large electricity generators to each other and the distribution network.
Variable Renewable Energy (VRE)	A generic term for intermittent forms of electricity generation powered from renewable resources which are inherently variable, such as wind and solar energy.

Term	Definition
Vehicle-to-grid (V2G)	A system that allows an electric vehicle (EV) to supply electricity to the electricity grid and/or manage its own charging in response to grid operating conditions, typically in exchange for some form of incentive.
Virtual power plant (VPP)	A network of batteries (or sometimes customer loads or electric vehicles), controlled to operate in a coordinated way.
Wholesale Electricity Market (WEM)	The WEM supplies electricity to the south-west of Western Australia via the South West Interconnected System (SWIS). The WEM is not connected to the NEM and operates under different regulatory arrangements.

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Appendix

Appendix A: Alignment with other work

The national CER roadmap is intended to align with relevant Australian Government initiatives, including net zero sector plans.

Areas of alignment between the roadmap and concurrent and previous work by the Australian Government, state and territory governments, and energy market bodies is listed below.

A.1 Australian Government

Body of work	Timing	Main areas of alignment
National Electric Vehicle Strategy	Published April 2023 Refers to 2025 and 2030 targets	Standards, data sharing, support CER uptake (in this case, EVs) consumer information
National Battery Strategy (under development)	Issues Paper released February 2023, Community Batteries Funding Round 1 recipients announced. April 2023	Management of CER at end of life
ARENA Distributed Energy Integration Program	The DEIP commenced in 2018 and the Interoperability Steering Committee (ISC) is the ongoing workstream in this program.	Roles and responsibilities, CER integration, standards for CER cybersecurity
National Energy Performance Strategy	Published April 2024. The strategy establishes the framework for energy performance action in the context of energy transformation including 82% renewables by 2030.	Small consumer CER measurement, data framework

Body of work	Timing	Main areas of alignment
Electricity Network Transformation Roadmap (ENA and CSIRO)	Final Report published April 2017 – Implementation strategy to 2027 with predicted customer outcomes by 2027 and by 2050.	Coordination of CER, CER data visibility: Establish future DNSP-level market management, low voltage network visibility
First Nations Clean Energy Strategy (under development)	Regional consultation from March 2023 to early 2024 First draft expected May 2024	Lowering costs for consumers, equitable access to benefits
2023-2030 Australian Cyber Security Strategy and Action Plan	Launched November 2023 Delivery by 2030	Standards for CER cybersecurity
Roadmap for CER cybersecurity (Standards Australia and DCCEEW)	Published June 2024	Standards for CER cybersecurity
National Circular Economy Framework	Delivery by end of 2024	Management of CER at end of life
Product stewardship scheme to recycle solar panels at end of life	In progress Delivery by December 2026	Management of CER at end of life

A.2 State and territory governments

Body of work	Timing	Main areas of alignment
ACT Integrated Energy Plan	2024-2030	Investing in utility-scale batteries, renewable electricity generation and electric vehicle infrastructure.
NSW Electricity Infrastructure Roadmap	Investment and delivery targets by 2030.	Reliability and lowering costs for consumers
NSW Electric Vehicle Strategy	EV stamp duty removal by 2027, 2026 and 2030 government EV fleet targets	Standards, vehicle-to-grid
NSW Net Zero Plan	Stage 1: 2020 – 2030 – 35% emissions reduction by 2030	EV charging, consumer information
NSW Consumer Energy Strategy (working title, under development)	Mid-year 2024	CER equity, coordination of CER, standards, consumer protections, education, VPPs, tariff structures (DOEs), V2G, data sharing, market operator roles
SA Electric Vehicle Action Plan	EV charging infrastructure by November 2025 – Other targets by 2025, 2030, and 2040.	Standards, data exchange platform
SA Distributed Energy Transition Roadmap 2020-2025	Investment and delivery targets and outcomes by 2030.	voltage management, VPPs, coordination of CER, data exchange platform
WA Energy Transformation Strategy	First stage 2019-2021, Stage 2 2021-2025	Regulatory framework, network security and reliability, efficient investment

Body of work	Timing	Main areas of alignment
WA Electric Vehicle (EV) Strategy	Published Nov 2020, EV sales targets by 2025-26	EV charging, standards, consumer information, interoperability
WA Distributed Energy Resources (DER) Roadmap	Roadmap published 2019, progress reports in April 2021, April 2022. Roadmap lists work items and goals each year to 2025. The Third update to the WA DER roadmap is set to be published in 2024.	Roles and responsibilities, distribution network visibility, standards, coordination of CER, customer protection and engagement
WA Electric Vehicles Action Plan (EVAP)	Published in 2021. EVAP lists work items and goals each year to 2024.	EV grid integration, standards, connection processes, distribution network visibility, coordination of CER (in this case, EVs), consumer protection and engagement
TAS Distributed Energy Resource Register	Ongoing – TAS DER Register compulsory from Dec 2020.	VPPs, data exchange platform, coordination of CER
NT Electric Vehicle Strategy and Implementation Plan	Underway - Strategy and Implementation Plan covers period 2021-2026	EV charging, standards, consumer information
Harnessing Victoria's Distributed Energy Resources (DER)	Published in 2022.	Vision, key objectives and targets for DER integration, consumer protections, and increased uptake of rooftop solar and greater export opportunities.
Victoria Zero Emission Vehicle Roadmap	Various charging station and fleet targets by 2023, 2024, 2025 and 2030.	Management of CER at end of life, EV charging, standards

Body of work	Timing	Main areas of alignment
Queensland Zero Emission Vehicle Strategy 2022-2032 **Action plan 2022-2024**	First part – Zero Emission Vehicle Action Plan 2022–2024. Fleet targets for 2026, 2030 and 2036.	Tariffs, EV charging
Queensland Energy and Jobs Plan	First launched in September 2022, update released November 2023 Investment, and renewable energy capacity and percentage targets to 2030 and 2035	Smart meters, connections, roles and responsibilities, EV charging coordination of CER, standards, network access

A.3 NEM market bodies

Body of work	Timing	Main areas of alignment
AEMO NEM DER work program	Standards and connections work – update report published December 2023 – ongoing DER Demonstrations – Project EDGE Final Report published Oct 2023, VPP Final Design published Jan 2021, Demand Response RERT Trial Year 3 Report published Oct 2023 – ongoing Markets and Framework – ongoing – covers Post 2025 Market Design and Open Energy Networks Operations Data and visibility – ongoing	Tariffs to support CER uptake, standards, EV charging

Body of work	Timing	Main areas of alignment
AER Review of Consumer Protections for future energy services	Final advice published November 2023. Feeds into CER Roadmap consumer protections for future energy services project.	Consumer protections
Review of the regulatory framework for metering services (AEMC)	Review completed August 2023 Final Report recommends a target of universal uptake of smart meters by 2030 in NEM jurisdictions.	Smart meters, lowering costs for consumers and networks
Consumer Energy Resources Strategy (AER)	Strategy published April 2023 - feeds into CER Roadmap and reform of the NECF.	Standards, consumer protections
Energy Security Board (ESB) Consumer Energy Resources and the Transformation of the NEM	Report published November 2023 – feeds into CER Roadmap and concurrent market body and jurisdictional work.	Standards, consumer protections, Public Key Infrastructure, new market roles and responsibilities

Appendix B: Alternative text for images and graphs

B.1 Figure 1: Capacity, NEM GW 2009-10 to 2049-50, Step Change Scenario (AEMO 2024)

Figure 1 is a graph of the historical, current and projected future capacity (in gigawatts) of different energy generation and storage types in the National Electricity Market. This graph is taken directly from page 11 of AEMO's 2024 Integrated System Plan (ISP), which shows projections under the ISP's Step Change scenario. The chart data is available at: https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2024-integrated-system-plan-isp. Refer to the 'Figure 2' tab of the Excel spreadsheet '2024 ISP chart data' under 'Supporting materials'.

B.2 3 Roadmap vision, outcomes & priorities alternative text

Vision – Consumer Energy Resources are an integral part of Australia's secure, affordable and sustainable future electricity systems, delivering benefits and equitable outcomes to all consumers through efficient use which smooths the transition, rewards participation and lower emissions.

Outcomes – Benefits for all consumers, Maximise economic opportunities, Reliable and secure systems, and Sustainable, future-ready and world-leading.

Principles – Ensure equitable access to benefits of new technology, fair system that prioritises consumer protection, including emerging energy products and services, reduce household and business bills and emissions, support power system security and reliability, integration with sectoral action plans, consistent and contemporary compliance, technical standards and enforcement, orchestrated management and implementation of CER and enabling infrastructure.

Workstream	National Reform Priorities
Consumers	C.1 Extending consumer protections for CER C.2 More equitable access to benefits of CER C.3 CER information to empower consumer

Workstream	National Reform Priorities
Technology	T. 1 Nationally consistent standards, including electric vehicle to grid T. 2 Nationally regulatory framework for CER to enforce standards T.3 Establish secure communication systems for CER devices
Markets	M.1 Enable new market offers and tariff structures to support CER uptake M.2 Data sharing arrangements to inform planning and enable future markets M. 3 Redefine role for market operations
Power systems operations	P.1 Enable consumers to export and import more power to and from the grid P.2 Faster, harmonised CER connection processes, including EV chargers P.3 Improve voltage management across distribution networks P. 4 Incentivising distribution network investment in CER P. 5 Redefine roles for power system operations

B.3 5.5 High level timeline alternative text

Reform Priority	Project	Timeline
C.1 Extending consumer protections for CER	Extending consumer protections	Start 2024 complete 2026
C.1 Extending consumer protections for CER	Further consumer protections delivered	Start 2026 complete 2028
C.2 More equitable access to the benefits of CER	More equitable access to the benefits of CER	Start 2024 complete 2027
C.2 More equitable access to the benefits of CER	National Energy Equity Framework	Start 2024 complete 2024
C.2 More equitable access to the benefits of CER	Energy reform package	Start 2024 complete 2025
C.2 More equitable access to the benefits of CER	Review of AER exemptions framework for embedded networks	Start 2024 complete 2025
C.3 CER information to empower consumers	Communication framework and strategy	Start 2024 complete 2026
C. Other	New consumer support	Start 2026 complete 2028
C. Other	Future price trends report	Start 2024 complete 2024
T.1 Nationally consistent standards, including electric vehicle to grid	Initial interoperability standards developed	Start 2024 complete 2024

Reform Priority	Project	Timeline
T.1 Nationally consistent standards, including electric vehicle to grid	CER device cyber standards developed	Start 2024 complete 2026
T.1 Nationally consistent standards, including electric vehicle to grid	AS4777 updated to remove V2G barriers	Start 2024 complete 2024
T.1 Nationally consistent standards, including electric vehicle to grid	Define EVSE minimum technical standards for power system security	Start 2024 complete 2027
T.1 Nationally consistent standards, including electric vehicle to grid	Review of minimum operating standards for government support public EVSE	Start 2025 complete 2025
T.2 National regulatory framework for CER to set and enforce standards	Options agreed by Energy Ministers	Start 2024 complete 2025
T.2 National regulatory framework for CER to set and enforce standards	Draft legislation	Start 2025 complete 2026
T.2 National regulatory framework for CER to set and enforce standards	Regulator established	Start 2026 complete 2026
T.3 Establish secure communication systems for CER devices	Establish a national entity for Public Key Infrastructure	Start 2024 complete 2027
T. Other	Jurisdictions to ensure no barriers to vehicle to grid	Start 2024 complete 2025

Reform Priority	Project	Timeline
M.1 Enable new market offers and tariff structures to extract greater benefits from CER	Enable new market offers and tariff structures to extract greater benefits from CER	Start 2025 complete 2027
M.1 Enable new market offers and tariff structures to extract greater benefits from CER	Flexible Trading Arrangements Determination	Start 2024 complete 2024
M.1 Enable new market offers and tariff structures to extract greater benefits from CER	Scheduled Lite/integrating Price Responsive Resources rule change	Start 2024 complete 2024
M.2 Data sharing arrangements to inform planning and enable future markets	Establish metrics for collection and sharing of data	Start 2025 complete 2026
M.2 Data sharing arrangements to inform planning and enable future markets	Establish arrangements necessary for operational CER data	Start 2025 complete 2027
M.2 Data sharing arrangements to inform planning and enable future markets	Increasing the pace of smart meter rollout	Start 2024 complete 2030s
M.2 Data sharing arrangements to inform planning and enable future markets	Standing data for EVSE captured	Start 2024 complete 2027
M.2 Data sharing arrangements to inform planning and enable future markets	AER Network Visibility project	Start 2024 complete 2024

Reform Priority	Project	Timeline
M.2 Data sharing arrangements to inform planning and enable future markets	ARENA data exchange projects	Start 2024 complete 2025
M.3 Redefine roles for market operations	Define roles and responsibilities of the new distribution level market	Start 2024 complete 2026
M.3 Redefine roles for market operations	Define the role of DNSPs/DSOs	Start 2025 complete 2026
P.2 Faster, harmonised CER connection processes, including for EV chargers	Identify harmonised SIRs relating to EVSE	Start 2024 complete 2024
P.3 Improve voltage management across distribution networks	Examine costs and benefits of improving voltage management	Start 2024 complete 2024
P.5 Redefine roles for power system operations	Define roles and responsibilities for power system operating with high CER	Start 2024 complete 2025
P. Other	Implement backstop capability	Start 2024 complete 2025