This event will be recorded



Engineering Roadmap to 100% Renewables

Stakeholder Webinar

3 February 2023





We acknowledge the Traditional Owners of country throughout Australia and recognise their continuing connection to land, waters and culture.

We pay respect to their Elders past, present and emerging.

Purpose and interaction



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- Please ask questions using Slido.
- Join the Slido chat via another tab or window directly through https://app.sli.do/event/x2VkwyT80 nFPkcwmoiMYRu









Background context and Roadmap structure

Q+A Break #1



An overview of the engineering and operational readiness steps to prepare for 100% renewables

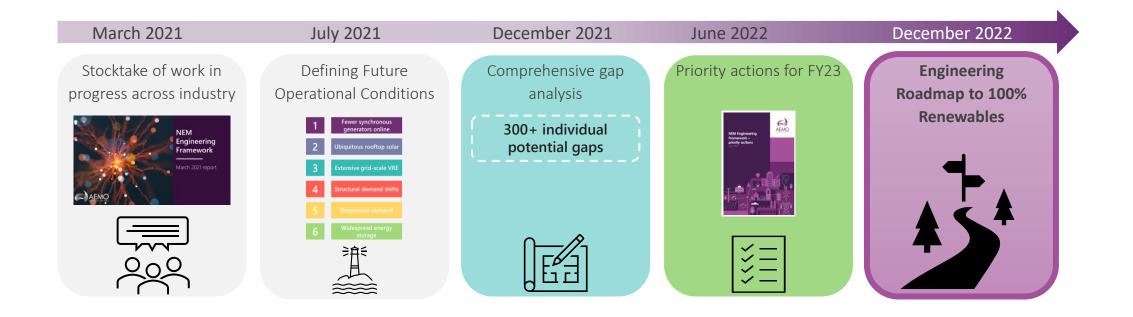
Q+A Break #2



Next steps and how to stay involved







Utilisation of renewable resource potential





Renewable availability Potential market dispatch outcome Coal Gas Hydro Battery Wind Solar Distributed PV Total demand

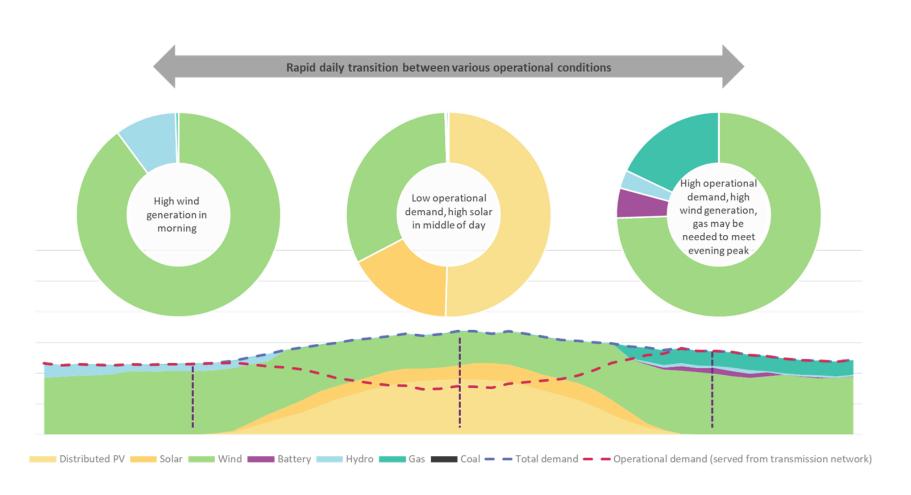
Day with viable 100% renewable penetration



- It may not be possible to dispatch the market at 100% renewable penetration the first time that 100% renewable resource potential.
- Operating a secure and reliable system under these conditions will require sufficient reserve margins and sources of essential system services, at the time of 100% renewable operation and during the surrounding periods.
- Economic bidding behaviour from market participants may further influence whether renewable resource potential is dispatched.



Rapid daily changes in generation mix



- Multiple generation mixes likely
- Rapid daily transitions
- System will be a hybrid of synchronous generation, IBR, synchronous condensers, dominated by different technologies at different times of each day.







Detailed, engineering-focussed roadmap



AEMO's view of the **technical**, **engineering**, **and operational actions** required to **operate the NEM at 100% instantaneous renewables** for the first time



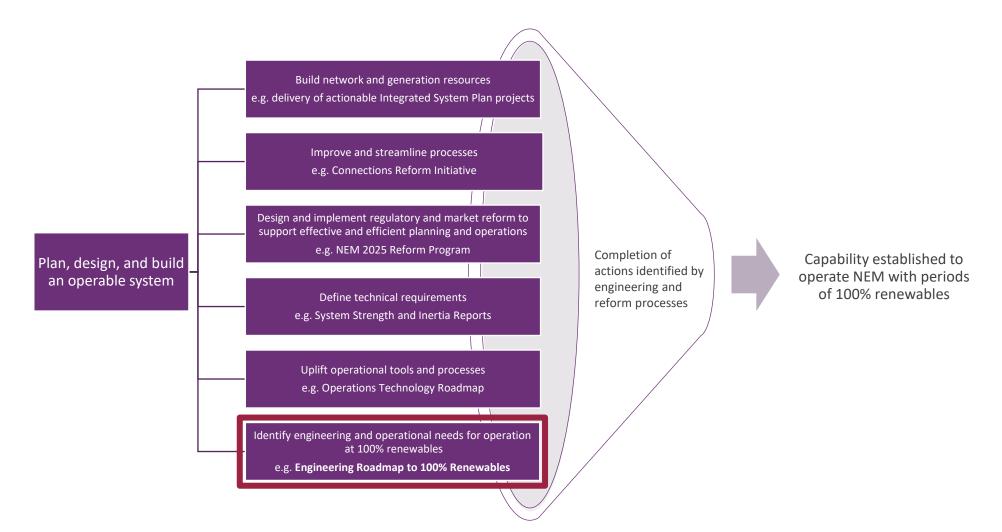
Technical base to **inform industry prioritisation of steps** necessary to transition through key milestones on the way to 100% renewables



Provide confidence around underway actions and highlight areas requiring further attention







Roadmap structure



- Frequency & inertia
 Transient & oscillatory stability
 System strength & converter driven stability
 Voltage control
 System restoration

System operability Monitoring & situational awareness Operational processes Power system modelling

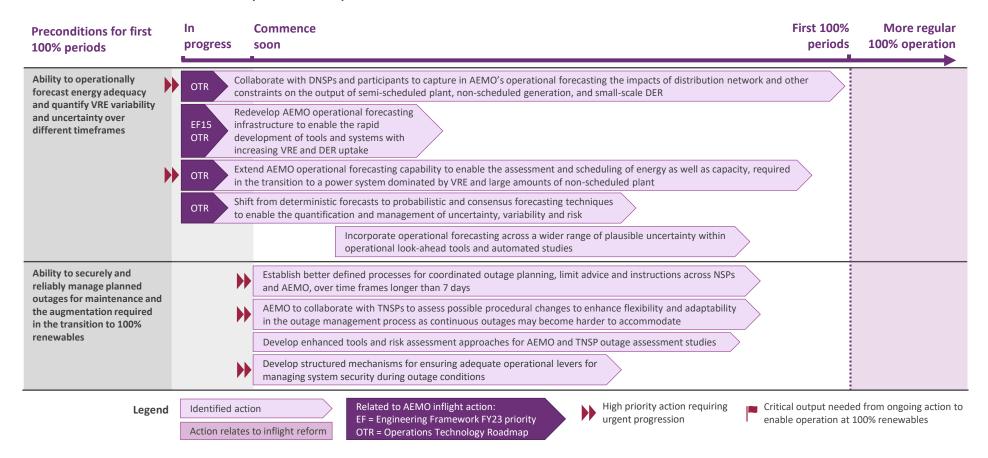
Resource adequacy & capability • Structural demand shifts • Transmission

- Utility-scale variable renewable energy (VRE)
- Distributed energy resources (DER)



Roadmap example: Operational processes

What the transition to 100% renewable operation will require





Q+A Break

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Key messages



Deployment of **system** strength solutions, to deliver equivalent capability of up to 40 synchronous condensers, including the use

> of advanced inverter technologies [2022 System Strength/Inertia assessment]

Inertia, frequency response, FCAS, system strength, and voltage control requirements all completely met by VRE, storage and other non-fossil

and manage IBR the power system

Adequate emergency frequency control arrangements in place to manage non-credible contingency events

Ability to restart power system without fossil-fuelled generation having to have been online prior to system black

Transmission network expanded to enable renewable development, sharing across regions, and system Confidence that security

fuelled technologies

Processes to identify control interactions in

security System **Preconditions**

> resource Adequact and Capability

available to cover

variability of solar and wind

Basic level of controllability of DPV available to sufficient **flexible** sufficiently plant capacity is

manage bulk

energy supply

reliably manage planned managing outages to allow entry of Ability to securely and outages for maintenance and the augmentation

Establish coordinated approach to resilience planning, including new transmission and generation



Sufficient wide area visibility of power system performance, and control room tools for stability monitoring and risk assessment

> Ability to forecast and actively manage plausible VRE generation output variability and uncertainty

Processes to manage increased operational risk and uncertainty during initial operation in unchartered operational conditions

responsibilities and operational boundaries at the interfaces between distribution, a proportion of transmission and bulk power system operation

.....

required in the transition

to 100% renewables

operability

Uplift in operational capability

to securely and reliably manage increasingly complex operational conditions in the transition to 100% renewable operation [AEMO Operations Technology Roadmap]



Modernising the distribution network

and uplifting operational frameworks between AEMO,

Defined planning NSPs and aggregators

Establish effective emergency DPV shedding schemes, operational roles and procedures in each NEM region, before minimum system load challenges

emerge [EF Priority FY23 Action A11]





Progress delivery of **new** transmission infrastructure [2022 ISP Step Change]



Key messages: System Security





assessment]



Key messages: System Operability



resilience planning, including managing outages to allow entry of new transmission and generation



Ability to securely and reliably manage planned outages for maintenance and the augmentation required in the transition to 100% renewables

Sufficient wide area visibility of power system performance, and control room tools for stability monitoring and risk assessment

operability

Ability to forecast and actively manage plausible VRE generation output variability and uncertainty

Processes to manage increased operational risk and uncertainty during initial operation in unchartered operational conditions

Uplift in operational capability

to securely and reliably manage increasingly complex operational conditions in the transition to 100% renewable operation [AEMO Operations Technology Roadmap]

Key messages: Resource Adequacy and Capability





Progress delivery of **new** transmission infrastructure [2022 ISP Step Change]

resource Adequa and Capability Transmission

> network expanded to enable renewable development, sharing across regions, and system Confidence that sufficient **flexible** security plant capacity is available to cover variability of solar and wind

Basic level of controllability of DPV available to sufficiently manage bulk energy supply

Defined planning responsibilities and operational boundaries at the interfaces between distribution. a proportion of transmission and bulk power system operation

Modernising the distribution network and uplifting operational frameworks between AEMO, NSPs and aggregators



Establish effective emergency DPV shedding schemes, operational roles and procedures in each NEM

region, before minimum system load challenges emerge [EF Priority FY23 Action A11]



Evolving the power system operating envelope

Operate power

system in existing

operating envelope

Analyse and prepare Operate power system power system for new across intermediate operating envelope hold points Operate power system in new operating Analysis to assess new Operate power system at envelope operating envelope hold point Formalise operational processes for new operating envelope Ongoing monitoring of power system performance under new operating envelope Assess power system performance against Assess operational risk Develop operational expectations and and need to move to procedures and validate understanding hold points contingency plans and operating assumptions Assess next new operating envelope Develop operational processes, limits advice Revert to previous hold and constraints to point or existing operating envelope if manage new operating envelope or hold points required as required



Q+A

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Activities to June 2023

- Targeted engagement on request
- Ongoing delivery of FY23 Priority Actions
- Scoping of additional priorities for FY24
- Update on Priority Actions

How you can stay involved:

- Read the <u>Engineering Roadmap to 100%</u>
 Renewables
- Sign up for our mailing list
- Reach out to AEMO directly
- FutureEnergy@aemo.com.au







Background context and Roadmap structure



An overview of the engineering and operational readiness steps to prepare for 100% renewables



Next steps and how to stay involved





Please provide AEMO with feedback from today's webinar by responding to this pulse survey:

https://forms.office.com/r/YYVt95n6pG

Thank you!



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