

Grid-forming Technology Access Standards

OEM Kickoff Workshop
04 December 2024





We acknowledge the Traditional Custodians of the land, seas and waters across Australia. We honour the wisdom of Aboriginal and Torres Strait Islander Elders past and present and embrace future generations.

We acknowledge that, wherever we work, we do so on Aboriginal and Torres Strait Islander lands. We pay respect to the world's oldest continuing culture and First Nations peoples' deep and continuing connection to Country, and hope that our work can benefit both people and Country.

'Journey of unity: AEMO's Reconciliation Path' by Lani Balzan

AEMO Group is proud to have launched its first Reconciliation Action Plan in May 2024. 'Journey of unity: AEMO's Reconciliation Path' was created by Wiradjuri artist Lani Balzan to visually narrate our ongoing journey towards reconciliation – a collaborative endeavour that honours First Nations cultures, fosters mutual understanding, and paves the way for a brighter, more inclusive future.

Read our
RAP



The Competition and Consumer Act 2010

- The Act prohibits anti-competitive and restrictive trade practices.
- Specific prohibitions include:
 - Sharing of information in relation to prices and the mechanisms for setting of prices;
 - Agreements not to deal with a particular business or class of business;
 - Collective negotiations that have an anti-competitive effect;
 - Attempts to influence competitors or supplier or customer behaviour in an anti-competitive behaviour;
- Anti-competitive agreements do not need to be in writing. An understanding or arrangement to take or refrain from taking a course of action may be prohibited.
- All participants and representatives must take care not to do anything which may result in a breach of the Act. A breach may lead to financial or criminal penalties for individuals, or the organisation they represent.
- The above explanation of the Act is not intended to be exhaustive, and legal advice should be sought if uncertain about the obligations imposed by the Act.

Agenda

1. Introduction and workshop objectives
2. Overview of AEMO's Access Standards Review (ASR)
3. Learnings to date
4. Technical considerations
5. Next steps



1. Introduction and workshop objectives

Introduction and workshop objectives

- In 2023, AEMO concluded its 5-year Access Standard Review as per obligation NER 5.2.6A(a). Focussing initial recommendations for grid-forming connections on amending relevant technical requirements to ensure they do not inadvertently hinder the connection of the technology.
- This project continues the work to create detailed technical requirements to provide an overall better impact in the National Electricity Market (NEM).

Workshop objectives

- Introduce the review of Grid-Forming Technology
- Discuss key learnings to date
- Outline the proposed approach
- Seek stakeholder feedback

2. Overview of AEMO's Access Standards Review (ASR)

AEMO Access Standards Review

2022

AEMO started its 5-year Access Standard Review

The consensus from Industry was that grid-forming technology was not quite at a point of **maturity** that AEMO could consider a Rule change, so instead a **Voluntary Specification** was drafted (finalized May 2023).

2023

AEMO concluded its 5-year Access Standard Review.

The Final Report focused **initial recommendations** for GFM connections on amending relevant technical requirements to ensure they do not **inadvertently hinder the connection of GFM technology** (released Dec 2023)

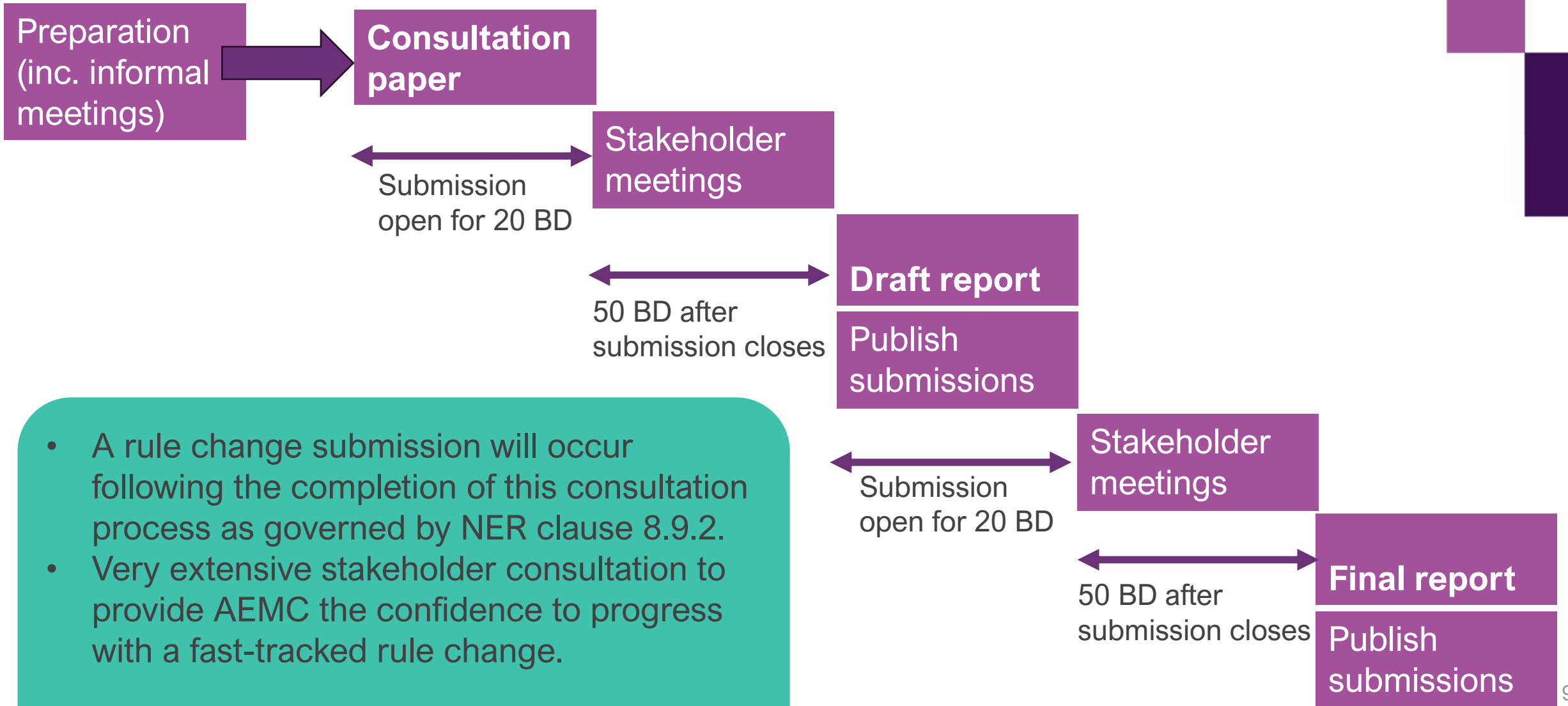
2024

AEMO submitted two Rule change requests

AEMO acknowledged the importance of further work to develop **core requirements** to support the connection of GFM technology, however this requires a **prudent level of validation and testing**, which AEMO could not achieve during the Review timeframe

The purpose of this work is to develop detailed technical requirements suitable for a Rule change proposal submission to the AEMC.

The Consultation Process



- A rule change submission will occur following the completion of this consultation process as governed by NER clause 8.9.2.
- Very extensive stakeholder consultation to provide AEMC the confidence to progress with a fast-tracked rule change.

Why your participation is important

Determine the range of possible performances among different GFM types, makes and control strategies

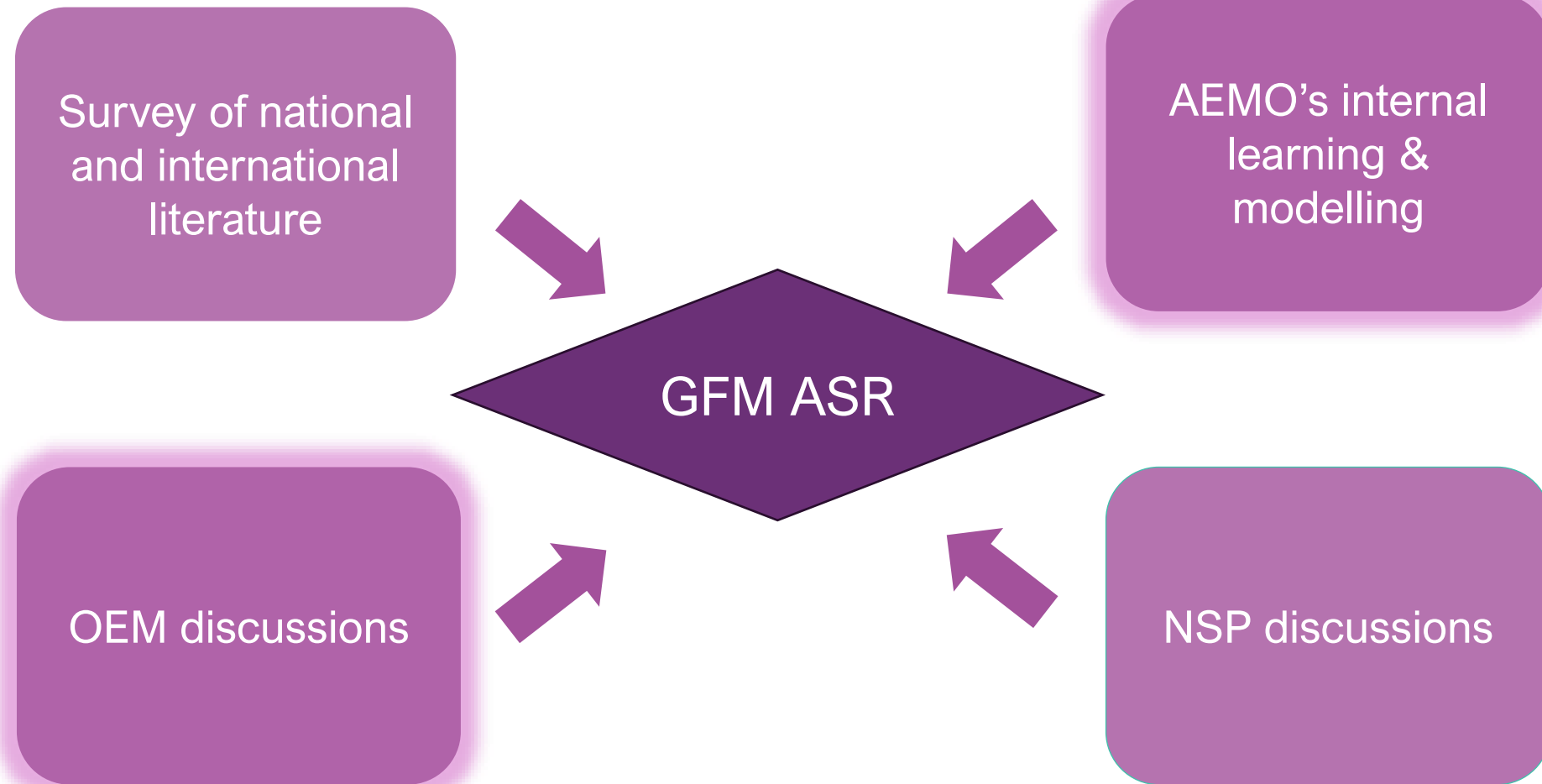
Understand both the capabilities and limitations of GFM technology

Understand the implications of Access Standards on a plant's utilisation, lifetime or performance

Learn from OEM experiences and reflect in its rule change submission

Compare equipment capabilities and limitations against network needs and limitations

Methodology used for GFM ASR



Overarching considerations

GFM ASR

Recognising both the capabilities and limitations

Similarities and differences with conventional technologies

Considerations of different technology types, makes and controls

Accounting for the impact of network operating conditions

Potential need for trade-off among multiple access standards

Delineation with system services ensuring that an access standard will not become an unintended barrier for a system service

Out of scope

GFM ASR



Provision and quantification of system strength grid support

GFM model testing and validation

GFM modelling requirements

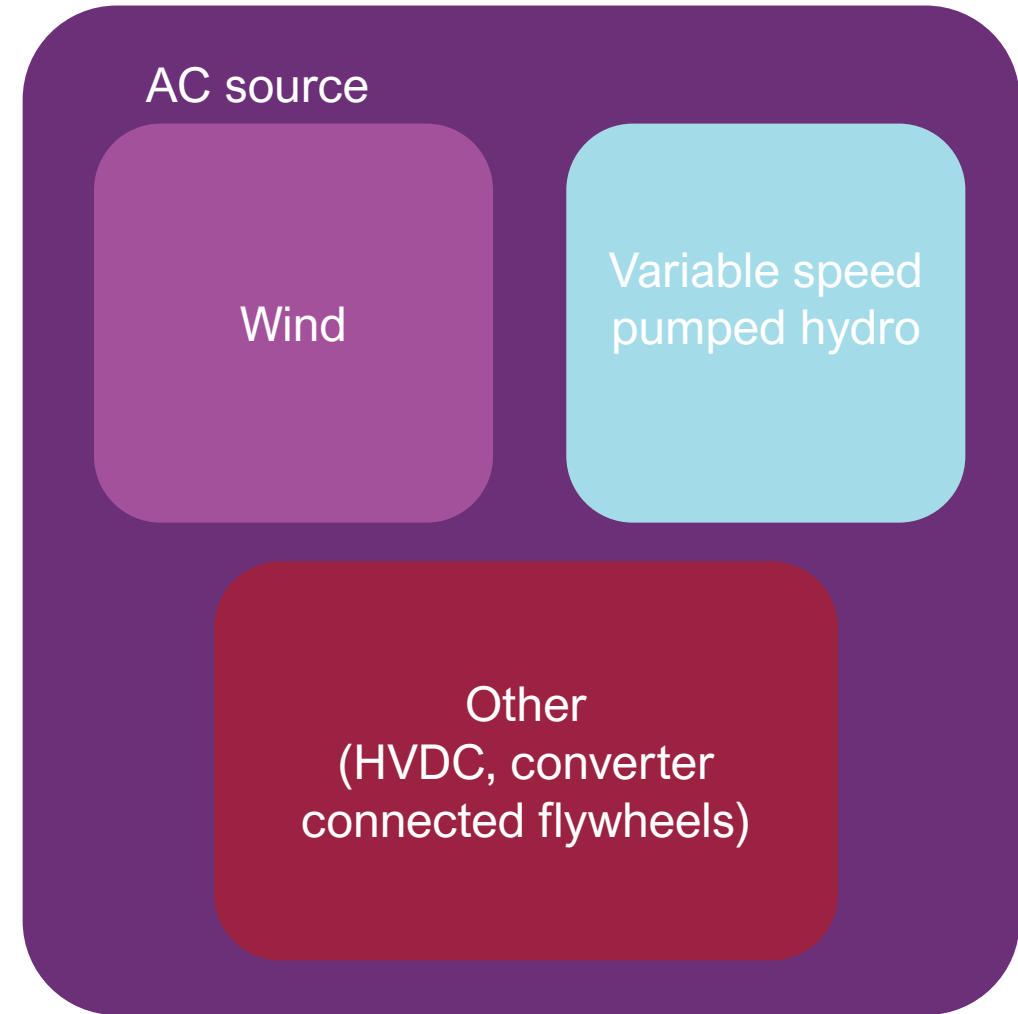
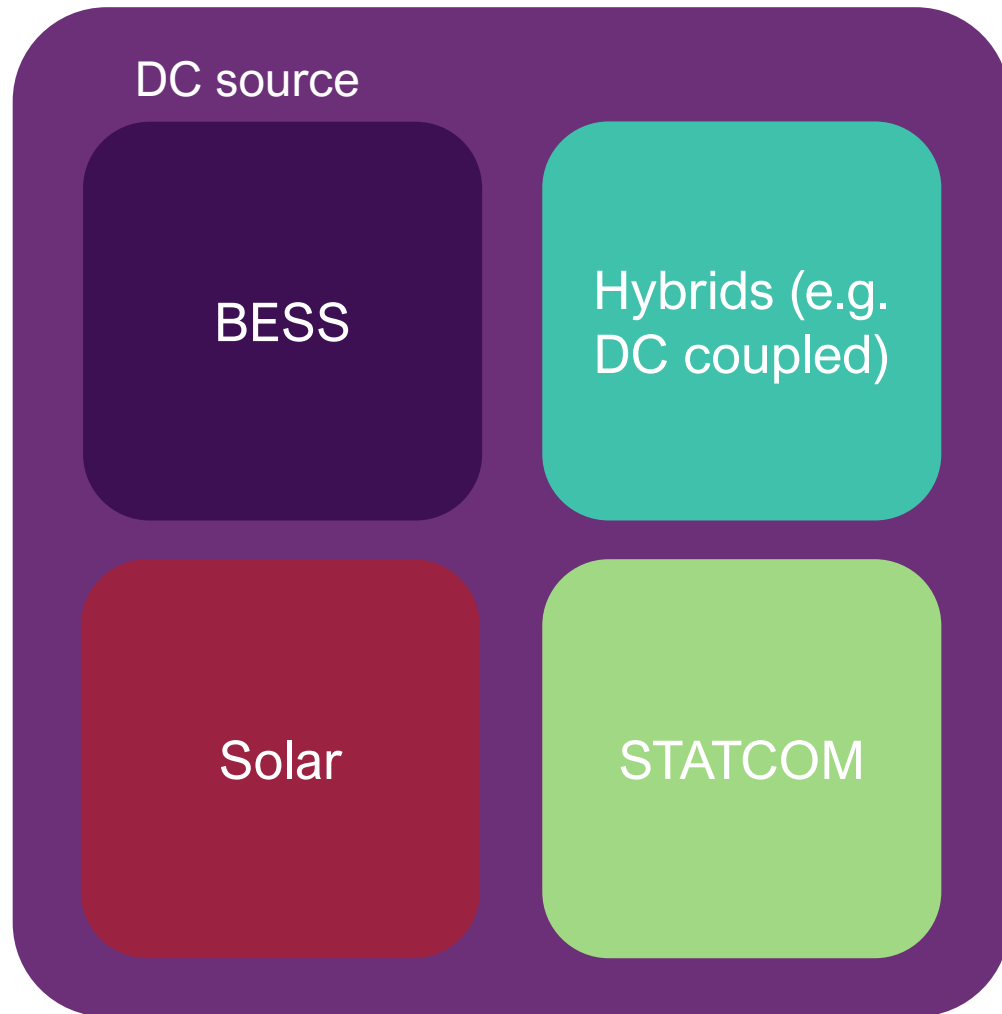
Inverter-based loads

Developing new access standard assessment methodologies

Changes to system level requirements

Changes to access standards for synchronous or grid-following plant

Technologies covered



Discussion 1

Are there any aspects you consider important which are not currently included in AEMO's overall methodology?

3. Learnings to date

What AEMO has done



1.

**ARENA/AEMO
knowledge
sharing studies on
GFM technology**



2.

**Support on GFM
connection
applications**



3.

**Communication
with OEMs**



4.

**Activities in
AEMO
Engineering
Roadmap
Framework**

Activities under AEMO Engineering Roadmap Framework

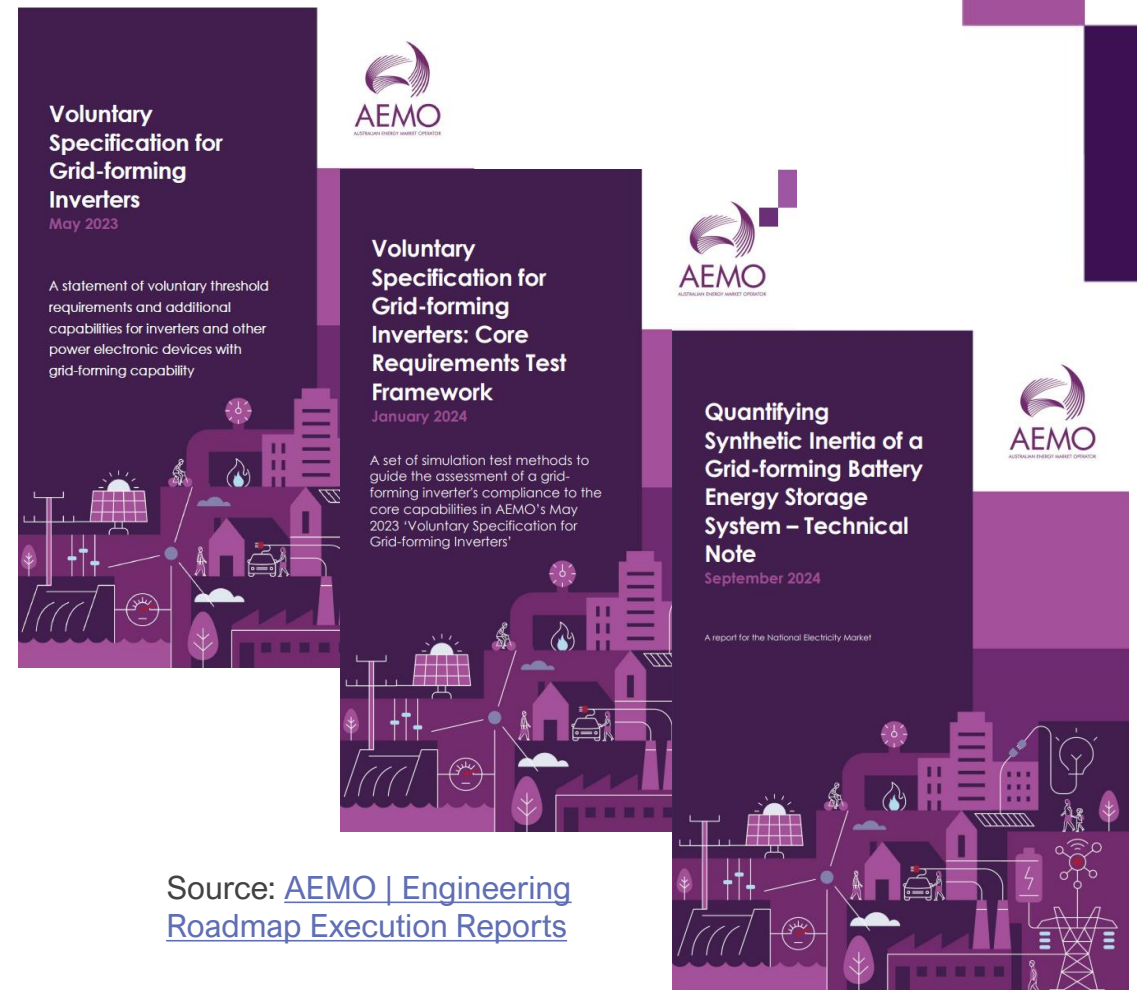
- Voluntary specifications for grid-forming inverters
- Voluntary specifications for grid-forming inverters – core requirements test framework
- Quantifying synthetic inertia of a grid-forming storage system – technical note



- AEMO internal modelling and testing to better understand the capability of GFM technology available in the NEM



- Leverage knowledge gained from these activities in proposing GFM technical requirements



Source: [AEMO | Engineering Roadmap Execution Reports](#)

Support on GFM connection applications

Support on GFM connections

- ✓ Package & issue-tracker review
- ✓ Investigation into model issues
- ✓ Communicating with OEMs
- ✓ GPS^{Note1} review

Note 1: Generator Performance Standards



Contributions

- ✓ Practical project experience
- ✓ OEMs' feedback

GFM ASR

Findings

- **Performance shortfalls** => trade-offs in GFM's capability (e.g., inertia)
- **Special control philosophies** proposed => comprise GFM's capability (e.g., stabilising system)
- **Absence of requirement** => lack of proper assessment on GFM's capability

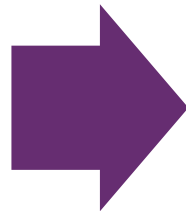
GFM Knowledge Sharing Studies

Study goals:

1. Identify **gaps** in the current NER S5.2 technical requirement for assessing GFM technology.
2. Understand the **trade-offs** between negotiations on Generator Performance Standard (GPS) and GFM plants' performance on improving system stability.

SMIB studies

- Frequency disturbance
- Small voltage disturbance
- Large voltage disturbance
- Post-contingency SCR change tests
- Oscillation rejection tests



More studies

- Wide area studies
- Others...

Discussion 2

Do you have any recommendations for additional studies, tools or methodologies that shall be considered in AEMO studies?

4. Technical Considerations

Part I: Classification and general capabilities

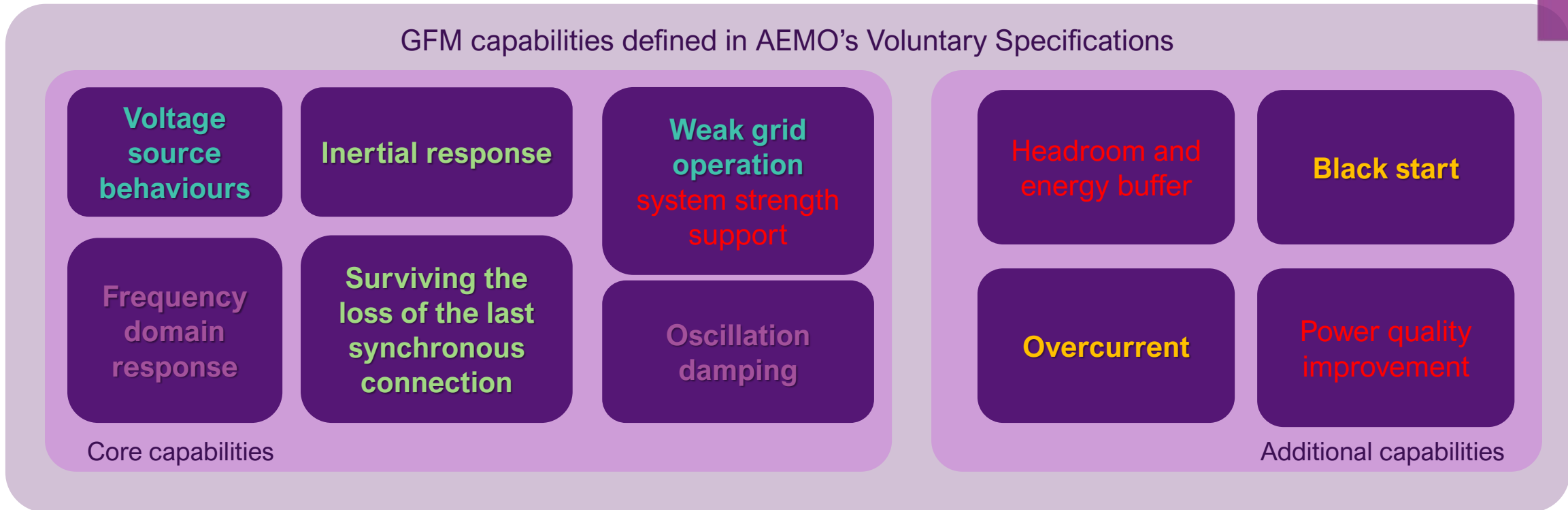
Part II: Limitations & Dependencies

Part III: Experience with the existing S5.2 technical requirements

Part IV: Specific technical capabilities of GFM technology

Part I: GFM Capabilities & GFM ASR Scope

GFM capabilities defined in AEMO's Voluntary Specifications



Capability key:

Aqua: Core capabilities considered achievable and necessary for all GFMs

Green: Capabilities considered necessary for some GFMs

Pink: Capabilities under further investigation

Amber: Capabilities considered to better understand the relationship between access standards and system services.

Red: Capabilities not considered for access standard development

Part I: General capabilities

Synchronisation techniques

Quantity used

Need for a PLL/PLL-like function

Impact of changes in network parameters on the GFM

Over-current capability

Time-current capability

Potential impact on GFM capability

Part I: Classification of GFM

GFM definition

Synchronous

Asynchronous

Other items

AEMO proposed

AEMO's preliminary view

- Distinct differences on S5.2.5.5
- Several aspects such as harmonics, SCR, load rejection and rotor speed only have a meaning for GFM or synchronous generator

- Inherent philosophy distinctively differs from current definition in the NER
- Nonetheless, both are implemented in the power electronics inverters

- Proposed terms generally focus on capabilities rather than limitations
- Sometimes there are more similarities than differences between the GFL and GFM

- ✓ Asynchronous generation can be sub-divided into standard and enhanced categories
- ✓ Building on similarities but capturing the differences too

Discussion 3

Please share your view on the definition/classification of GFM.

4. Technical Considerations

Part I: Classification and general capabilities

Part II: Limitations & Dependencies

Part III: Experience with the existing S5.2 technical requirements

Part IV: Specific technical capabilities of GFM technology

Part II: Limitations

Voltage source behaviour

1. Reactive/active current performance
2. Active power recovery performance
3. Synchronisation at deep faults

Power Plant Controller (PPC)

1. Computational power
2. Sampling rate

Others

1. Type and status of DC source
2. Site design (collector network, etc)

Part II: Dependencies

New modelling methodologies

1. Methodology for passivity assessment
2. Methodology for control stability assessment
3. Extent of shareable information

Network conditions

1. Optimal SCR range
2. Deprioritising certain aspects under very low SCR
3. Very high SCR impact
4. Other criteria and metrics

Mode switchover

1. GFL/GFM switchover for non-islanding conditions

Discussion 4

What aspects of limitations and dependencies do you consider important?

4. Technical Considerations

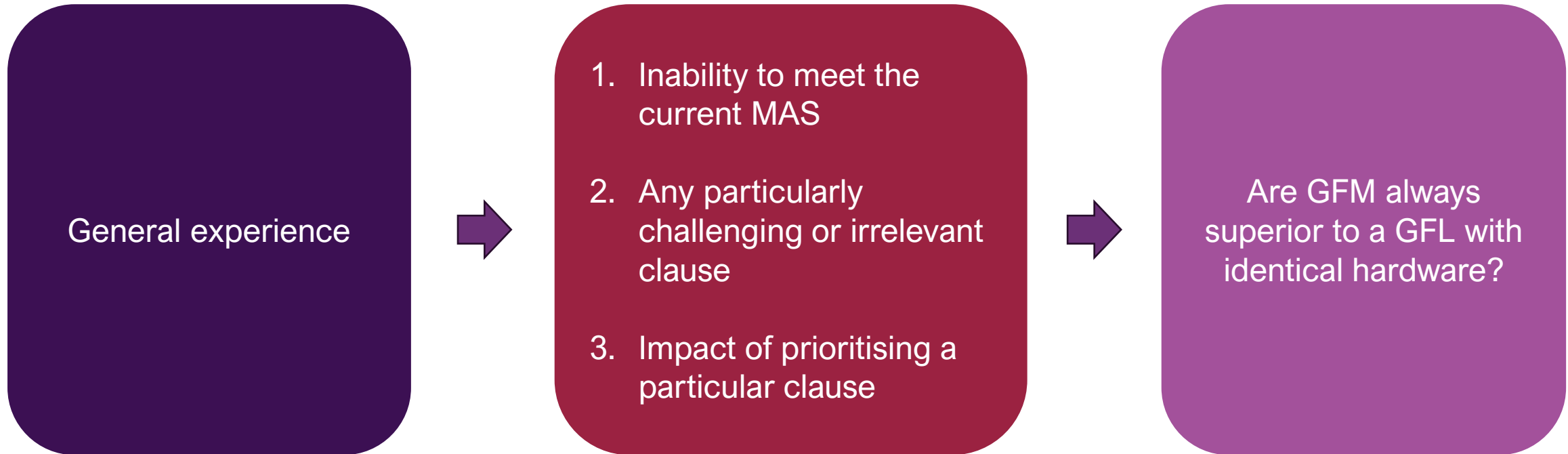
Part I: Classification and general capabilities

Part II: Limitations & Dependencies

Part III: Experience with the existing S5.2 technical requirements

Part IV: Specific technical capabilities of GFM technology

Part III: Experience with the existing S5.2 technical requirements



Discussion 5

Do you think existing NER S5.2 clauses are appropriate to represent capabilities and limitations of your GFM projects and why?

4. Technical Considerations

Part I: Classification and general capabilities

Part II: Limitations & Dependencies

Part III: Experience with the existing S5.2 technical requirements

Part IV: Specific technical capabilities of GFM technology

Part IV: Recap on GFM capabilities

All GFMs

- Voltage source behaviours
- Weak grid operation

Access standards and/or system services

- Black start
- Overcurrent capability

Some GFMs

- Inertial response
- Surviving the loss of the last synchronous connection

Not for access standard development

- System strength support
- Headroom and energy buffer
- Power quality improvement

Further investigation

- Frequency domain response
- Oscillation damping

Part IV: Specific technical capabilities of GFM technology

Operation under non-credible conditions

1. Surviving the loss of the last synchronous machine
2. Sustained islanding
3. System restoration

Response to disturbances in voltage magnitude, phase angle or waveform

1. Phase angle step change
2. Post contingency SCR change
3. Response to contingency events
4. Negative sequence current control

Damping of power system oscillations

1. Electro-mechanical oscillations
2. Electrical oscillations

Discussion 6

What GFM capabilities in your view shall be treated as a system service rather than an access standard?

5. Next Steps

Next Steps

Your contribution

Your contributions to this work are highly valued and you are invited to continue to be a part of this process. We're interested in your preference on this - would it be to complete a technical survey, or 1:1 meetings?

Industry & AEMO collaboration

In 2025, we will begin holding additional workshops and 1:1 conversations as we dive deeper into the key issues discussed today.

Milestone 1: Approach paper for consultation

From these discussions, AEMO will be releasing an approach paper for greater industry consultation in Q1 2025.



For more information visit

aemo.com.au