# NEM Engineering Framework

Initial Roadmap Stakeholder Q+A Forum
February 2022

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# Welcome to 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, present and emerging.

# Agenda

**The session will be split into two parts:**

1. General overview of the report and next steps.
2. Detailed overview of the summary of gaps and initial roadmap with extended time for feedback.

**For Q+A please go to**

**Sli.do**

**& enter**

**#NEMEF**

Please use the **Audience Q&A tab** to ask and upvote questions, as only the top voted questions will be answered verbally

If your question is selected, we will unmute after the question is answered to confirm interpretation and acceptance.

# Engineering Framework

General Overview

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# Objectives | Engineering Framework Overview

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Provide context for the Engineering Framework

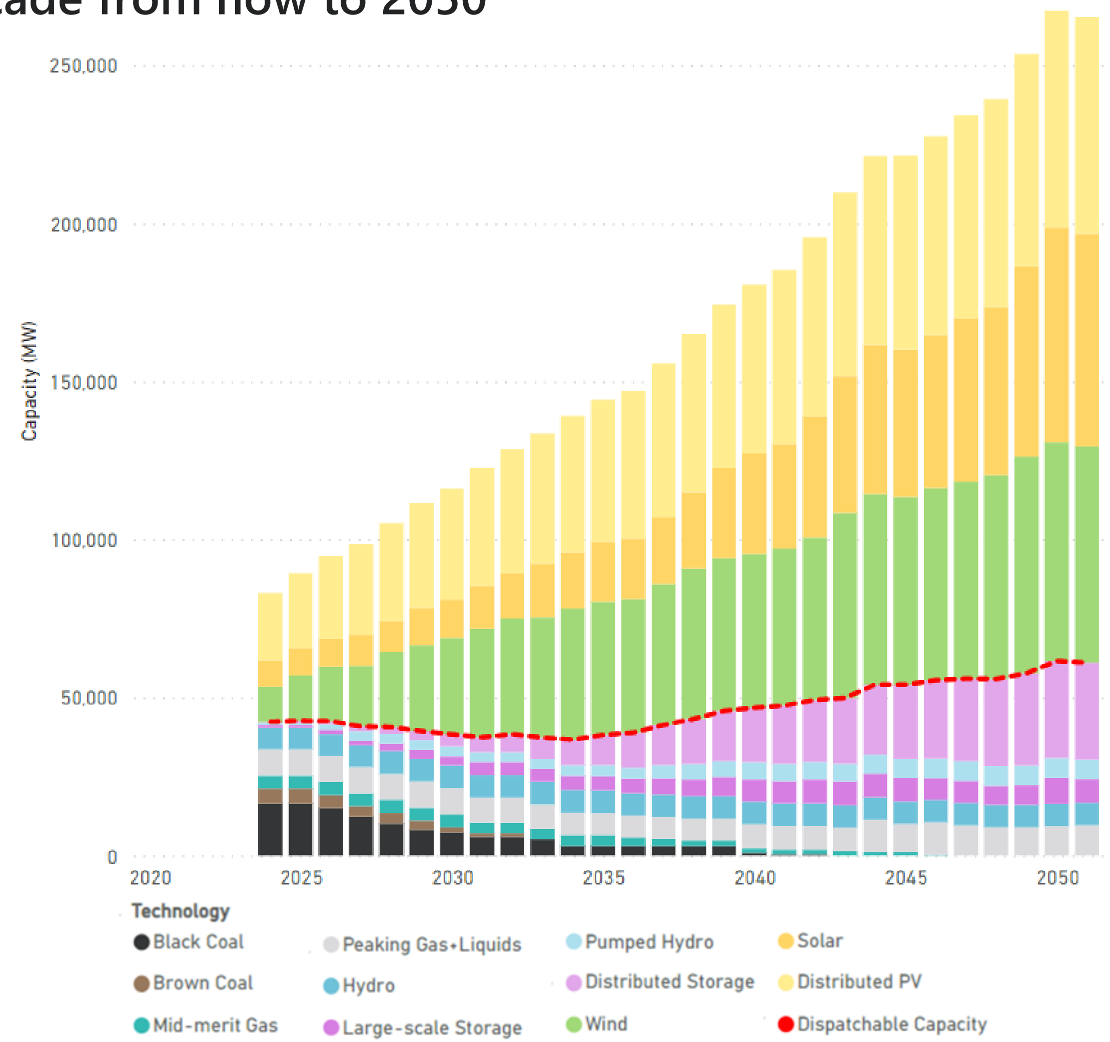
Provide a high-level overview of the Initial Roadmap report and its navigation

Present draft prioritisation principles for feedback from attendees

Explore next steps in the Engineering Framework process

# Background | Transformational Change is Forecast

## Renewable generation capacity to at least double every decade from now to 2050




The Draft ISP 2022 highlights that **profound transformation** is anticipated that will **rapidly cross uncharted operational conditions**.

| | Fewer synchronous generators<br>*Coal capacity (GW)* | Ubiquitous rooftop solar<br>*Installed DPV (GW)* | Extensive VRE<br>*VRE capacity (GW)* |
|---|---|---|---|
| *Today* | 23 | 15 | 15 |
| *2025* | 21 | 24 | 23 |
| *2030* | 9.0 | 35 | 43 |

| | Widespread energy storage<br>*Storage (GWh)* | Responsive demand<br>*VPP and demand response (GW)* | Structural demand shifts<br>*Electric vehicles (number)* |
|---|---|---|---|
| *Today* | 13 | 0.7 | 26 k |
| *2025* | 20 | 1.6 | 225 k |
| *2030* | 400 | 6.0 | 2.3 m |

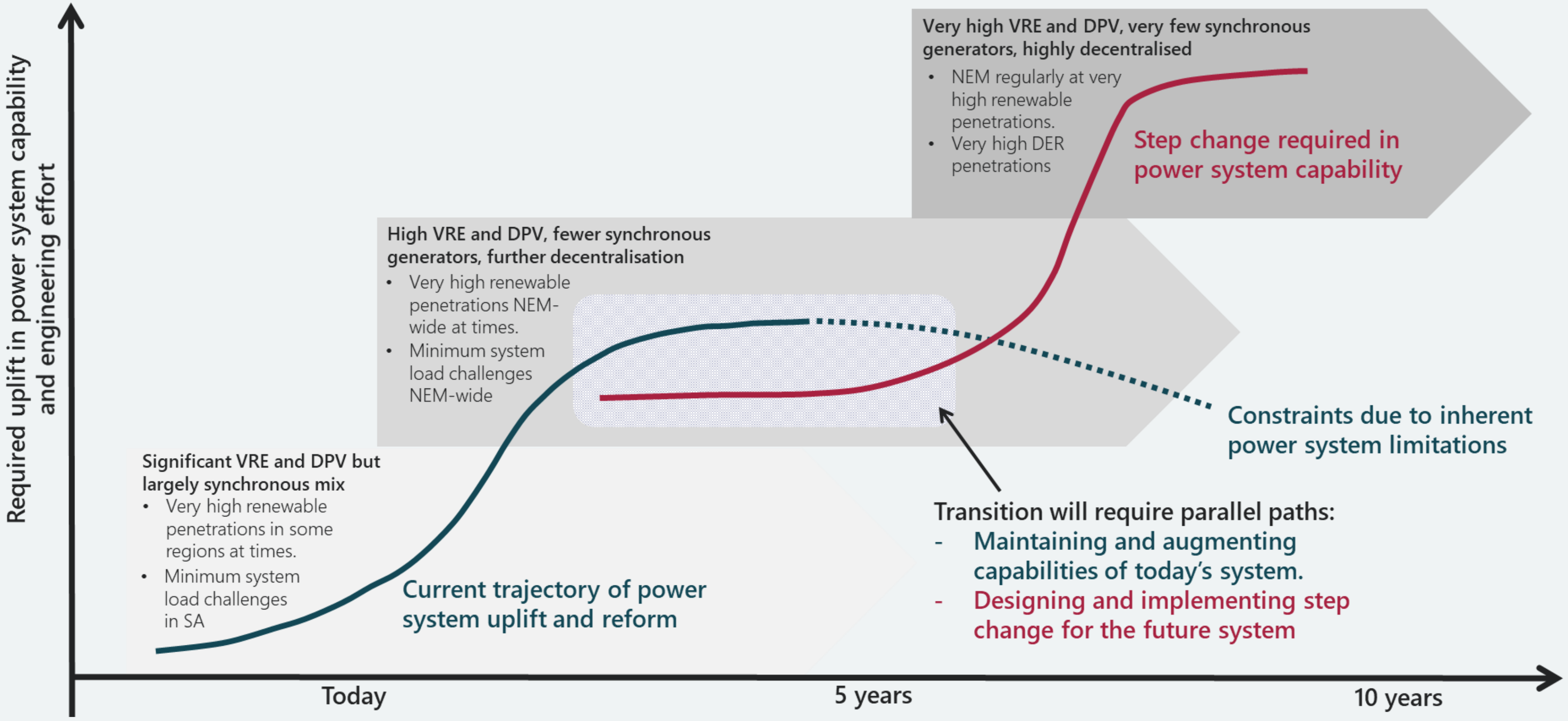
| Operational demand | *Maximum (GW)* | *Minimum (GW)* |
|---|---|---|
| *Today* | 32 | 15 |
| *2025* | 36 | 9.4 |
| *2030* | 38 | 4.9 |

Source: AEMO's Draft 2022 Integrated System Plan: Forecast NEM capacity to 2050, Step Change scenario, with transmission

# Background | Transformational uplift is necessary

The path to the power system of the future will need to be **carefully engineered and intentionally designed** with both today's power system and the ultimate end state in mind.

Legacy approaches will need to be **maintained in parallel** with **designing a step change in capability**.

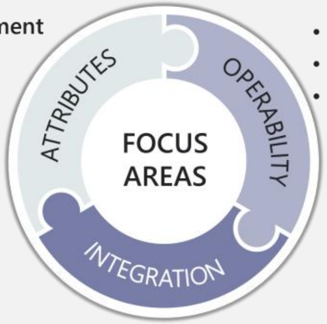


# Initial Roadmap | Overview

***The Engineering Framework takes a holistic view of the changing characteristics of our energy system to help ensure the operability of the NEM over the next 10 years.***

## Current knowledge and work (March 2021)

- Frequency Management
- System Restoration
- System Strength
- Voltage Control
- Resource Adequacy




- System Analysis
- Control Room and Support
- Resilience

- Distributed Energy Resources
- Performance Standards

## Potential Gaps and Actions (December 2021)


## Operational Conditions Summary (July 2021)

1. Fewer synchronous generators online
2. Ubiquitous rooftop solar
3. Extensive grid-scale VRE
4. Structural demand shifts
5. Responsive demand
6. Widespread energy storage

# Initial Roadmap | Process to develop and how to navigate the report

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## 1 Stakeholder collaboration to identify potential gaps

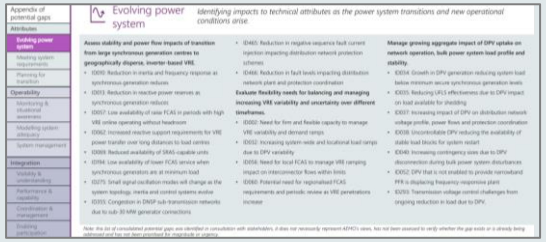
Gaps identified by considering operational conditions and focus areas, includes:

- technical understanding,
- engineering design and analysis,
- technology capability,
- operational systems and processes, and
- market and regulatory frameworks.

**Potential gaps** represent steps that may be necessary to *'bridge the gap'* between today and future. If *not actioned*, the energy transition may *be inhibited or constrained.*

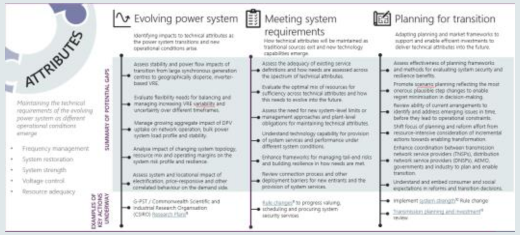
## 2 Individual potential gaps

Detailed catalogue of potential gaps by focus area[1]. Original list was reviewed, cleaned and consolidated.




## 3 Summaries of potential gaps

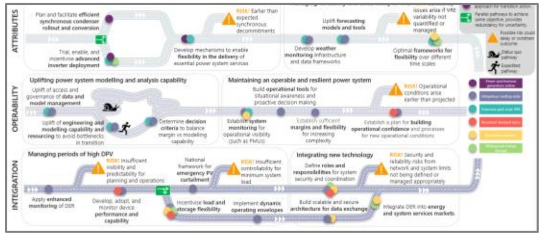
Summarised view of potential gaps, grouped by shared objective. These summaries are intended to stimulate discussion on further actions required




## 4 Key Decisions on approach for near-term actions

*Select priority gaps are highlighted for near-term key decisions on approach*

High-level view of key decisions on the approach to achieve objectives necessary for the transition.




[1]This list presents potential gaps raised through a consultative process and does not necessarily represent AEMO's views.

# Initial Roadmap | Summary of report

## Summary of key messages

- Transformational change is needed to 2030
- Clarity is required across the transition
- Step-change needed in engineering efforts
- We need to work together, quickly

## Key findings from gaps and decisions

- 300+ unique gaps identified, summarised into 50 shared objectives.
- Key decisions on approach may simultaneously progress towards multiple future operational conditions
- Near-term decisions on approach may involve parallel pathways to achieve the same objective

# Prioritisation principles | Context

- The **next step** of the Engineering Framework is to determine priority actions in the near-term.
- Given the anticipated volume of work to address potential gaps, and limited time and resources, **difficult decisions** will need to be made on which priorities are highest.
- **Prioritisation principles** will be used for decision making.
- The principles are intended as a **guide for decision making** and not to be applied as a quantitative assessment.
- **Feedback is welcome** on the proposed prioritisation principles (either during the session or open survey).

# Prioritisation principles | Proposed principles

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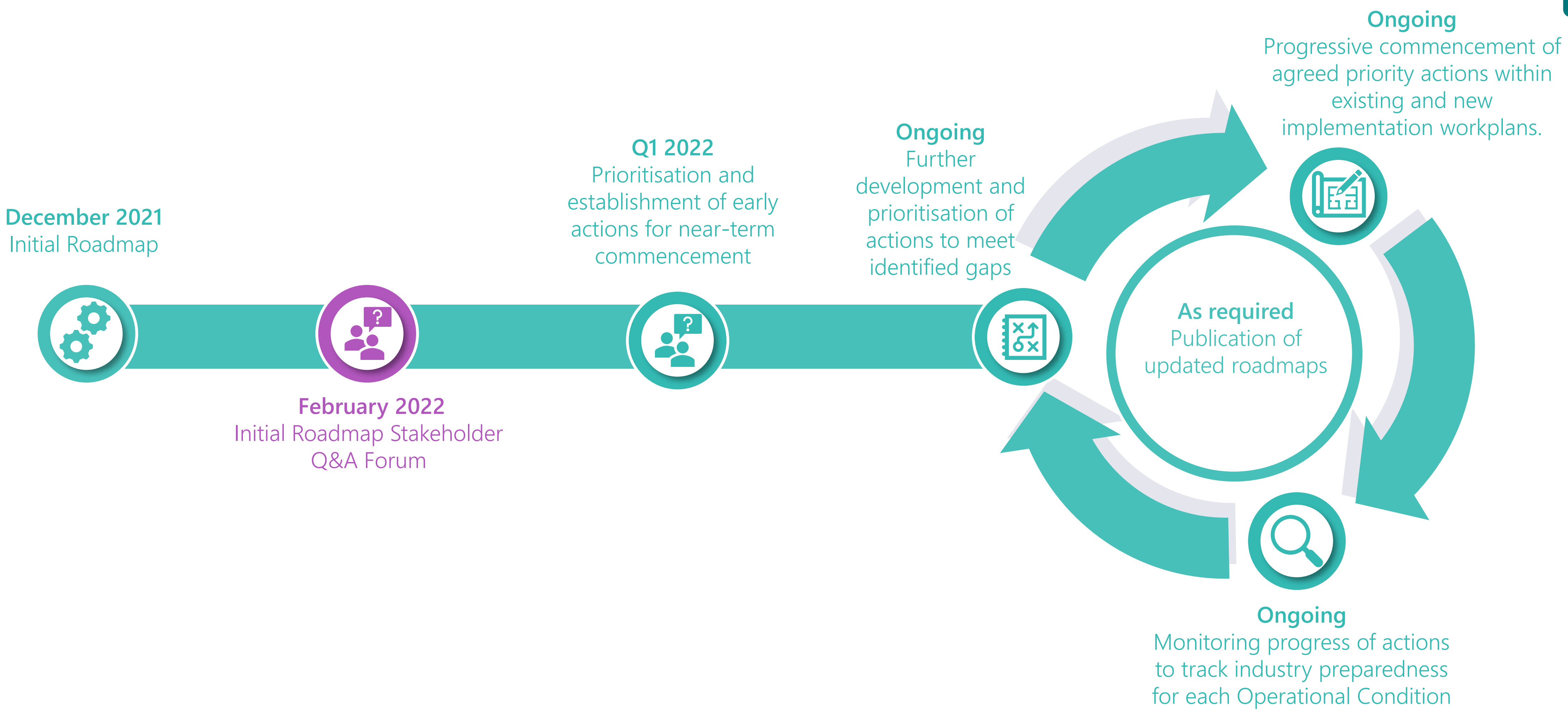
| | |
| --- | --- |
| Value | • Consumer outcomes<br>• Market benefits<br>• Power system security |
| Urgency | • Timing of when issue will arise<br>• Time taken to complete work<br>• Timing alignment with committed industry activities |
| Minimising regrets | • Likelihood of gap occurring regardless of when<br>• Risk and consequence of being unprepared if gap arises |
| Leveraging existing processes | • Leveraging existing processes where early action is taken |
| Funding and resourcing | • Suitable funding sources to be confirmed<br>• Resource implications for all stakeholders |

# Next Steps | Timeline



# Next Steps | Immediate next steps for early 2022

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The immediate next steps will be undertaken in collaboration with stakeholders.

## Gap identification

**(This report)**

- In collaboration with stakeholders identified a list of potential gaps

## Finalise prioritisation principles

**(February)**

- Engage on principles used for prioritisation.

## Convert potential gaps to early actions

**(Q1 2022)**

- Leverage prioritisation principles to order gaps and convert to actions.
- Coordinated decisions on action ownership.

## Commence early works

**(ASAP)**

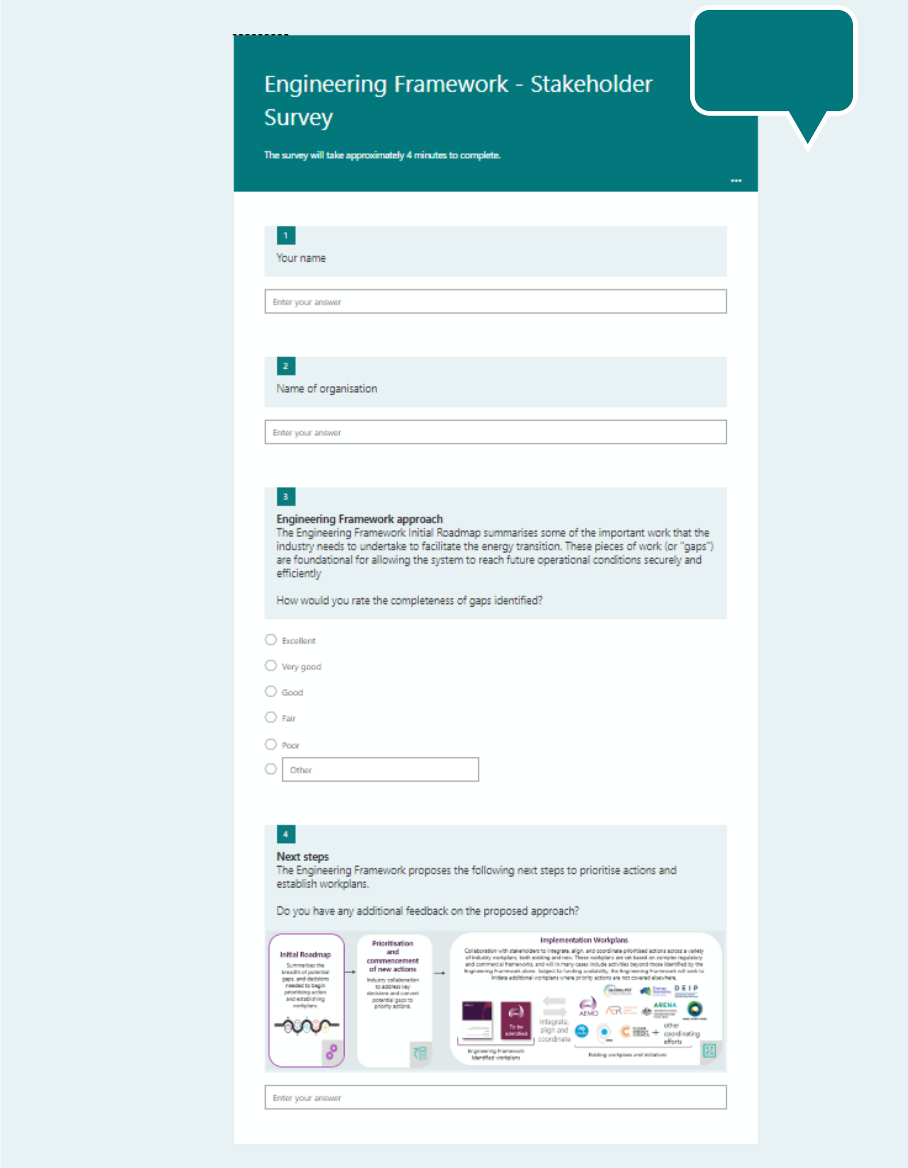
- Works should commence urgently on low regret priority actions.
- Opportunities should be taken to maximise benefits from existing processes.

# Next Steps | Convert potential gaps to early actions

- The Engineering Framework needs to **strike a balance** between planning and ensuring timely progress on actions.
- In the interest of time, the next stage (over Q1 2022) will focus on developing **priority actions for the near-term**.
  - AEMO will **prepare an initial shortlist of actions that AEMO intends to pursue over the next 1-2 years**
  - We'll also make some suggestions on **priority gaps and actions** where we think **industry collaboration and leadership** may be valuable.
  - This initial shortlist will be refined through targeted stakeholder discussions.
- **Feedback is welcome** on the proposed process.

# Get involved | Survey

- Please provide feedback via our Survey, available until **11 February 2022**.
- Survey is seeking feedback on:
  - Content included in the Initial roadmap report,
  - Input on the critical next stage of prioritisation, and
  - Ongoing engagement and process of the Engineering Framework.
- To provide further feedback or to contact us, please email FutureEnergy@aemo.com.au


Engineering Framework - Stakeholder Survey

The survey will take approximately 4 minutes to complete.

1 Your name

Enter your answer

2 Name of organisation

Enter your answer

3 **Engineering Framework approach**
The Engineering Framework Initial Roadmap summarises some of the important work that the industry needs to undertake to facilitate the energy transition. These pieces of work (or "gaps") are foundational for allowing the system to reach future operational conditions securely and efficiently

How would you rate the completeness of gaps identified?

- Excellent
- Very good
- Good
- Fair
- Poor
- Other

4 **Next steps**
The Engineering Framework proposes the following next steps to prioritise actions and establish workplans.

Do you have any additional feedback on the proposed approach?



Enter your answer

# Q+A

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# BREAK

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# Engineering Framework

Discussion on gaps identified in the Initial Roadmap

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# Objectives | Initial Roadmap

To provide a summarised overview of the gaps identified in the Initial Roadmap

To highlight the key decisions on approach identified in the Initial Roadmap

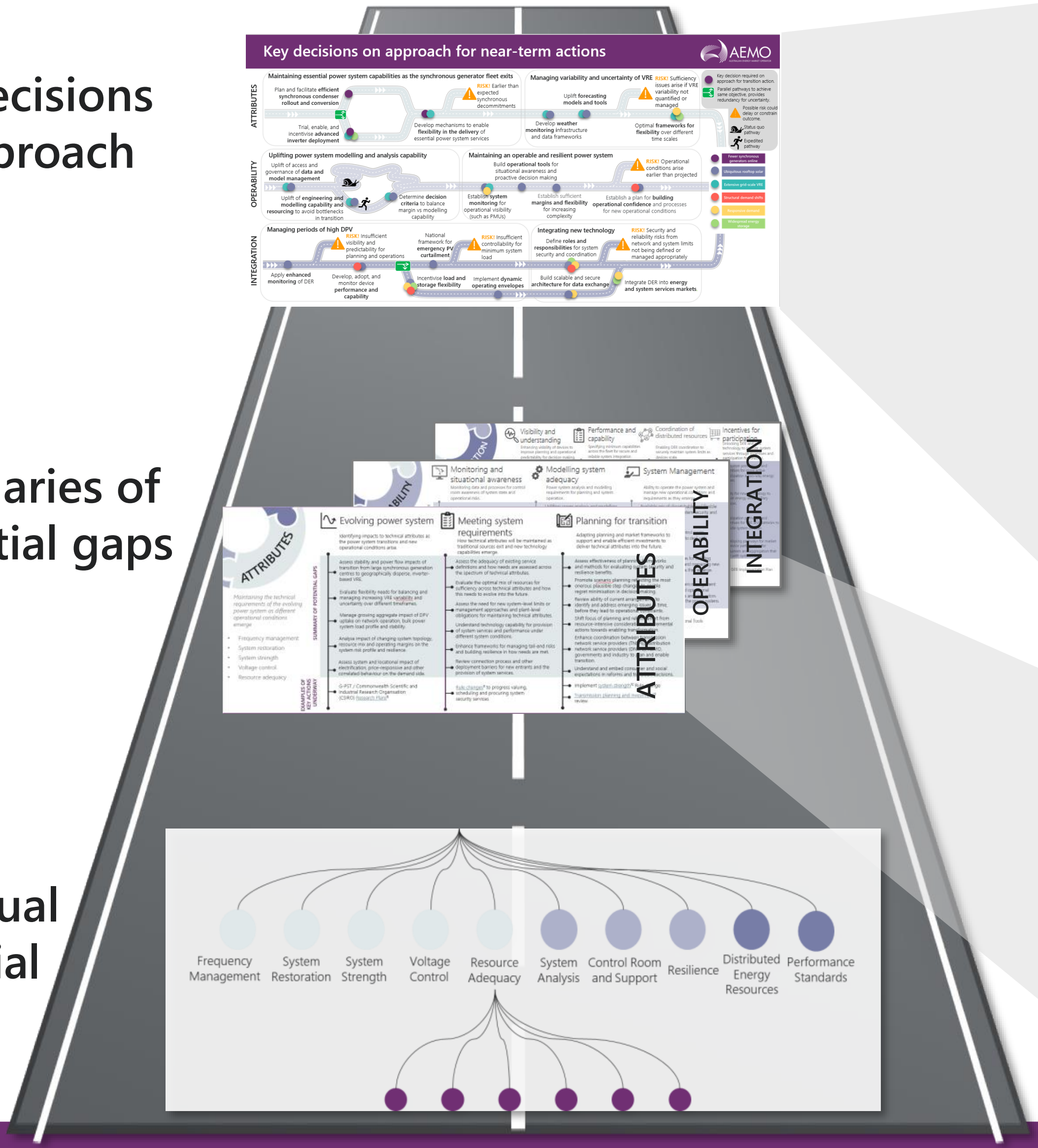
To answer questions and facilitate discussion from attendees on the Initial Roadmap content

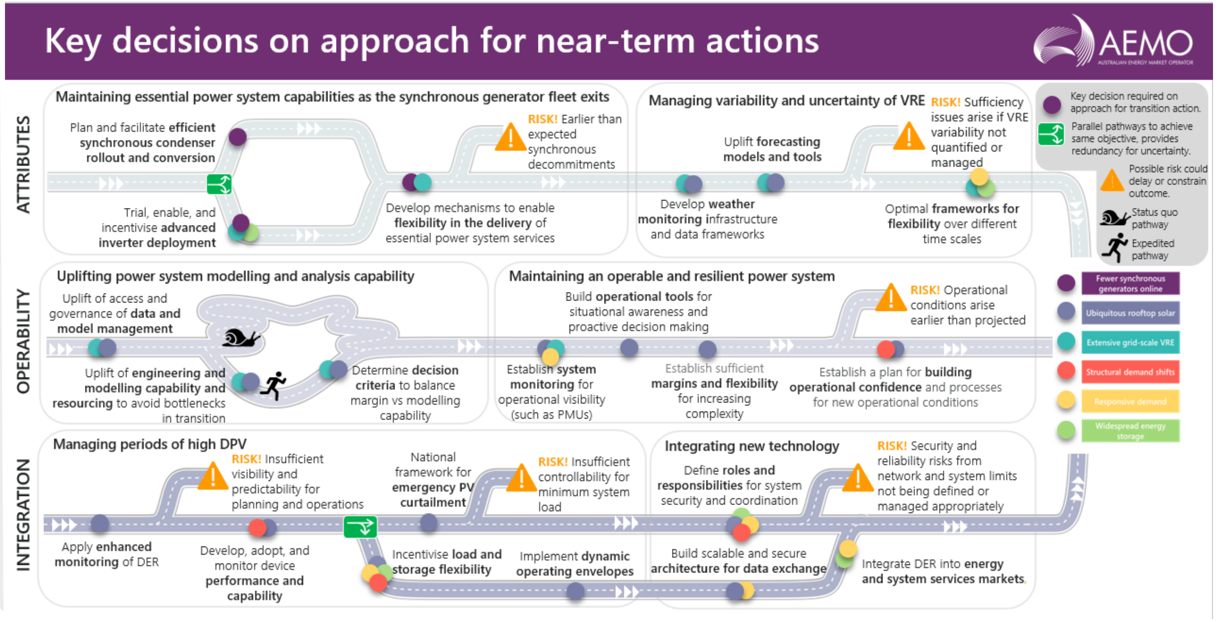
# Initial Roadmap | Elements of the roadmap

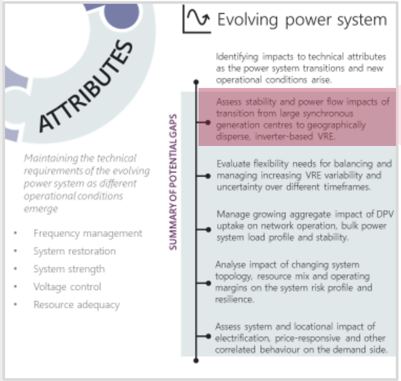
Key decisions on approach

Summaries of potential gaps

Individual potential gaps




List of gaps

# Initial Roadmap | Summary of potential gaps – Attributes

ATTRIBUTES

*Maintaining the technical requirements of the evolving power system as different operational conditions emerge*

- Frequency management
- System restoration
- System strength
- Voltage control
- Resource adequacy

SUMMARY OF POTENTIAL GAPS

## Evolving power system

Identifying impacts to technical attributes as the power system transitions and new operational conditions arise.

- Assess stability and power flow impacts of transition from large synchronous generation centres to geographically disperse, inverter-based VRE.
- Evaluate flexibility needs for balancing and managing increasing VRE variability and uncertainty over different timeframes.
- Manage growing aggregate impact of DPV uptake on network operation, bulk power system load profile and stability.
- Analyse impact of changing system topology, resource mix and operating margins on the system risk profile and resilience.
- Assess system and locational impact of electrification, price-responsive and other correlated behaviour on the demand side.

## Meeting system requirements

How technical attributes will be maintained as traditional sources exit and new technology capabilities emerge.

- Assess the adequacy of existing service definitions and how needs are assessed across the spectrum of technical attributes.
- Evaluate the optimal mix of resources for sufficiency across technical attributes and how this needs to evolve into the future.
- Assess the need for new system-level limits or management approaches and plant-level obligations for maintaining technical attributes.
- Understand technology capability for provision of system services and performance under different system conditions.
- Enhance frameworks for managing tail-end risks and building resilience in how needs are met.
- Review connection process and other deployment barriers for new entrants and the provision of system services.

## Planning for transition

Adapting planning and market frameworks to support and enable efficient investments to deliver technical attributes into the future.

- Assess effectiveness of planning frameworks and methods for evaluating system security and resilience benefits.
- Promote scenario planning reflecting the most onerous plausible step changes to enable regret minimisation in decision-making.
- Review ability of current arrangements to identify and address emerging issues in time, before they lead to operational constraints.
- Shift focus of planning and reform effort from resource-intensive consideration of incremental actions towards enabling transformation.
- Enhance coordination between transmission network service providers (TNSPs), distribution network service providers (DNSPs), AEMO, governments and industry to plan and enable transition.
- Understand and embed consumer and social expectations in reforms and transition decisions.

# Initial Roadmap | Key decisions - Attributes

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*Maintaining the technical requirements of the evolving power system as different operational conditions emerge*

- Frequency management
- Resource adequacy
- System restoration
- System strength
- Voltage Control
- Resilience

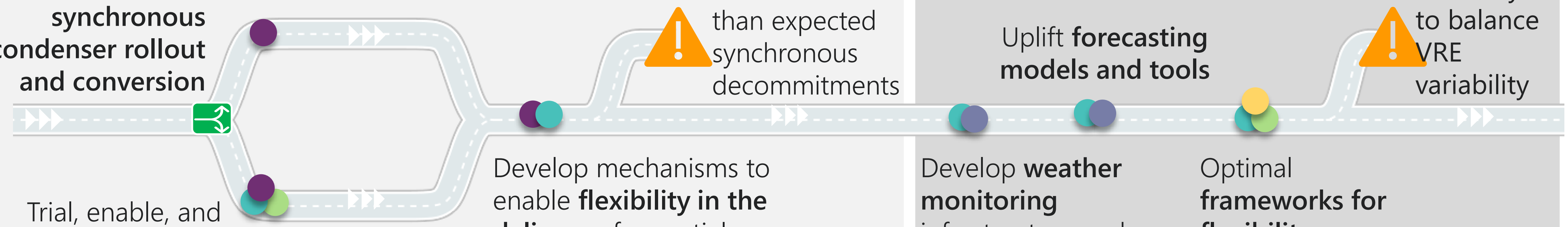
## Maintaining essential power system capabilities as the synchronous generator fleet exits

Plan and facilitate **efficient synchronous condenser rollout and conversion**

Trial, enable, and incentivise **advanced inverter deployment**

Develop mechanisms to enable **flexibility in the delivery** of essential power system services

RISK! Earlier than expected synchronous decommitments



## Managing variability and uncertainty of VRE

Uplift **forecasting models and tools**

Develop **weather monitoring** infrastructure and data frameworks

Optimal **frameworks for flexibility** over different time scales

RISK! Insufficient flexibility to balance VRE variability

## Operational Conditions

- Fewer synchronous generators online
- Ubiquitous rooftop solar
- Extensive grid-scale VRE
- Structural demand shifts
- Responsive demand
- Widespread energy storage

# Initial Roadmap | Summary of potential gaps – Operability

OPERABILITY

*System analysis, and operational tools and practices to support and enable increasingly complex power system operation*

- System analysis
- Control room and support

SUMMARY OF POTENTIAL GAPS

## Monitoring and situational awareness

Monitoring data and processes for control room awareness of system state and operational risks.

- Establish network and system monitoring for operational visibility, state estimation, analysis and model development.
- Build real-time and forward-looking stability, adequacy and risk assessment tools for situational awareness and proactive decision-making.
- Develop weather monitoring infrastructure, coordination and data frameworks for an increasingly weather-dependent system.
- Explore operational data and communication that could enhance understanding and encourage optimised participant decisions.

## Modelling system adequacy

Power system analysis and modelling requirements for planning and system operation.

- Identify and resource technical studies and analysis necessary for the transition to new operating conditions.
- Uplift forecasting models and tools for adequacy assessment and quantifying risk and uncertainty over different timescales.
- Uplift power system analysis capability by improving existing and developing new models, methods and approaches.
- Enhance coordination between planning and operations so adequacy studies reflect operational realities and constraints.
- Establish engineering criteria for timely decision-making with imperfect information, recognising inherent limitations of modelling.
- Establish responsibilities and governance frameworks for AEMO, NSP and participant access to system and plant models.

## System Management

Ability to operate the power system and manage new operational conditions and requirements as they emerge.

- Develop a plan to build operational confidence, processes and tools to manage new operational conditions as they emerge.
- Establish appropriate operating margins and system flexibility to manage increasing complexity and uncertainty.
- Review suitability and scalability of current control room practices with increasing operator demands and complexity.
- Assess ongoing effectiveness of processes for quantifying and managing the technical envelope of the power system and re-evaluate design decisions that increase operational risk.
- Build processes for new system management tasks requiring enhanced coordination with DNSPs and new actors.

# Initial Roadmap | Key decisions - Operability

*System analysis, operational tools and practices to support and enable increasingly complex power system operation*

- System analysis
- Control room and support

## Uplifting power system modelling and analysis capability

Uplift of access and governance of **data and model management**

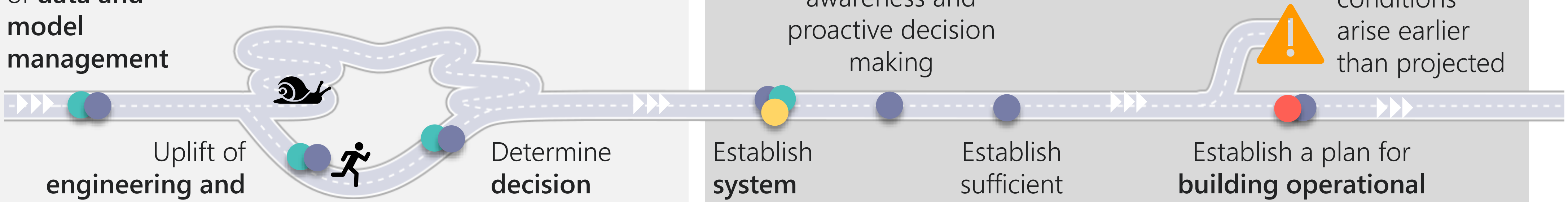
Uplift of **engineering and modelling capability and resourcing** to avoid bottlenecks in transition

Determine **decision criteria** to balance margin vs modelling capability

## Maintaining an operable and resilient power system

Build **operational tools** for situational awareness and proactive decision making

RISK! Operational conditions arise earlier than projected



Establish **system monitoring** for operational visibility (such as PMUs)

Establish sufficient **margins and flexibility** for increasing complexity

Establish a plan for **building operational confidence** and processes for new operational conditions

## Operational Conditions

- Fewer synchronous generators online
- Ubiquitous rooftop solar
- Extensive grid-scale VRE
- Structural demand shifts
- Responsive demand
- Widespread energy storage

# Initial Roadmap | Summary of potential gaps – Integration

INTEGRATION

*Optimally deploying and incentivising new and existing technologies, both grid-scale and distributed, within the power system and market.*

- Performance standards
- Distributed energy resources

SUMMARY OF POTENTIAL GAPS

## Visibility and understanding

Visibility of new and existing technology for planning and operational decision-making.

- Establish data collection and access frameworks on new technology uptake for forecasting, planning and operations.
- Enhance operational visibility and monitoring data access frameworks for estimating DER behaviour and system impact.
- Develop methods and tools to represent DER locational and aggregated behaviour in power system studies.
- Assess distribution network and system limits with increasing DER uptake and evaluate technical solutions and opportunities.

## Performance and capability

Device capability reflecting the changing role and nature of technologies in the power system.

- Establish technology performance requirements that minimise customer, network and power system risks.
- Enable last-resort curtailability and fail-safe behaviours for extreme, abnormal system conditions.
- Adopt device interoperability requirements enabling flexibility, tuning and optimisation, service provision and customer choice.
- Establish robust compliance assessment and conformance monitoring over the life of assets
- Prioritise standards development and adoption, capitalising on established international standards and norms.

## Coordination and management

Architecture to enable many new actors and increasing volume and complexity of data exchange.

- Define roles and responsibilities for system security and operational coordination for a highly decentralised power system.
- Develop scalable operational data communication architectures, data exchange processes and standards.
- Establish system integration and telemetry requirements for management, participation and service provision.
- Design resilient and cyber secure communications architectures and risk management frameworks.

## Enabling participation

Incentivising technology and consumer participation to provide system-level flexibility and services.

- Seek to establish consumer social licence on need for last-resort control and benefits of management options.
- Empower and incentivise optimised consumer decisions in a two-way energy system.
- Technically specify the services different technologies can provide and requirements for participation.
- Develop pathways for VRE, storage, responsive loads and aggregators to participate in the energy market and provide services.
- Remove barriers for network storage to provide system-level flexibility and services.

# Initial Roadmap | Key decisions – Integration

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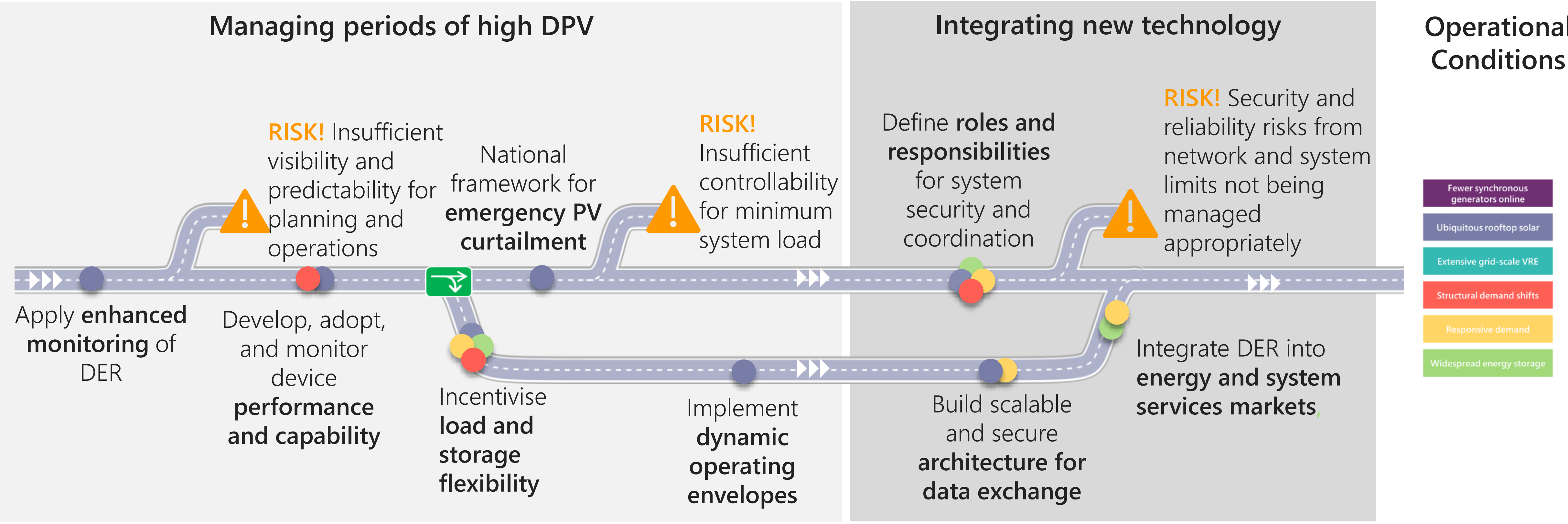

# Q+A

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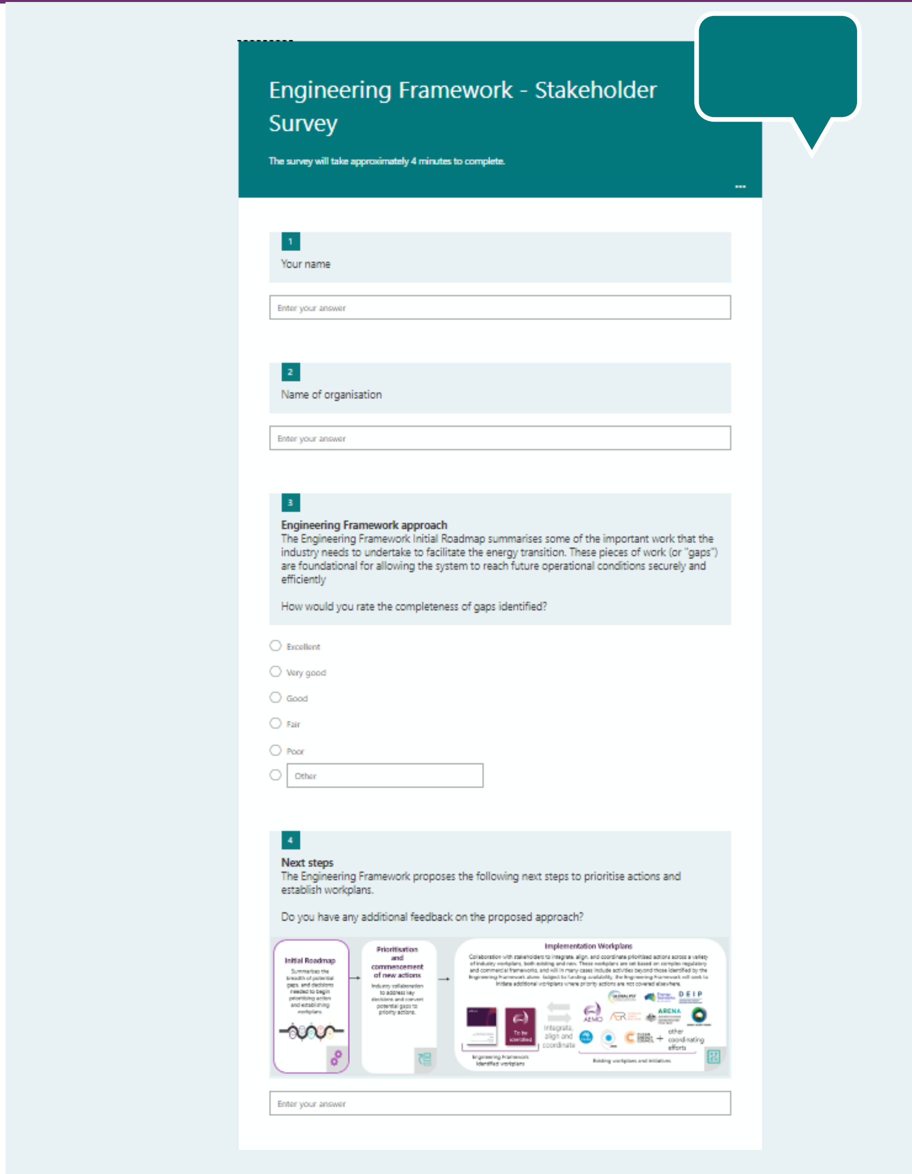

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