ENERGY SECURITY BOARD

POST 2025 FUTURE MARKET PROGRAM

ESSENTIAL SYSTEM SERVICES – TECHNICAL WEBINAR #1

1 MAY 2020

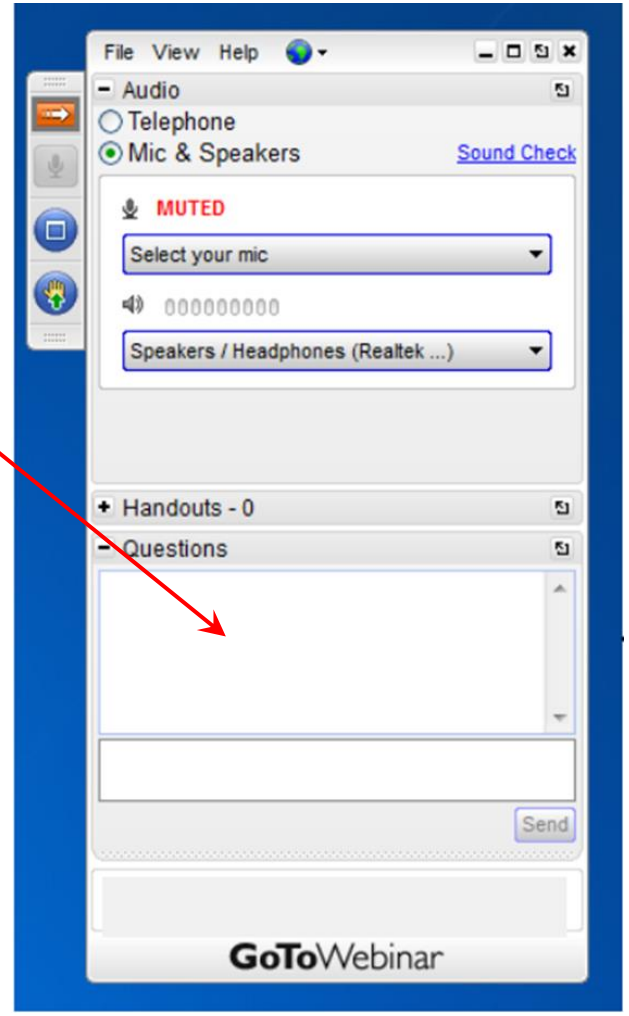
IMPORTANT NOTE

These slides are solely for workshop purposes only. The contents provide general information for the purpose of fostering a diversity of thinking and enabling stakeholder engagement and feedback.

The content of these slides does not represent the official position of the Energy Security Board or any related body.

WEBINAR-WORKSHOP LOGISTICS

- All participants are currently in listen-only mode
- We will pause at the end of each page where you see the ? symbol to answer questions. Please:
  - Type your questions here as we proceed through the content (double-check before sending); and/or,
  - Use the *Raised Hand* to signal that you would like to speak when we open the audio.
- Today's webinar is being recorded and a link to the recording will be provided after the webinar



POST 2025 FUTURE MARKET PROGRAM (P2025)

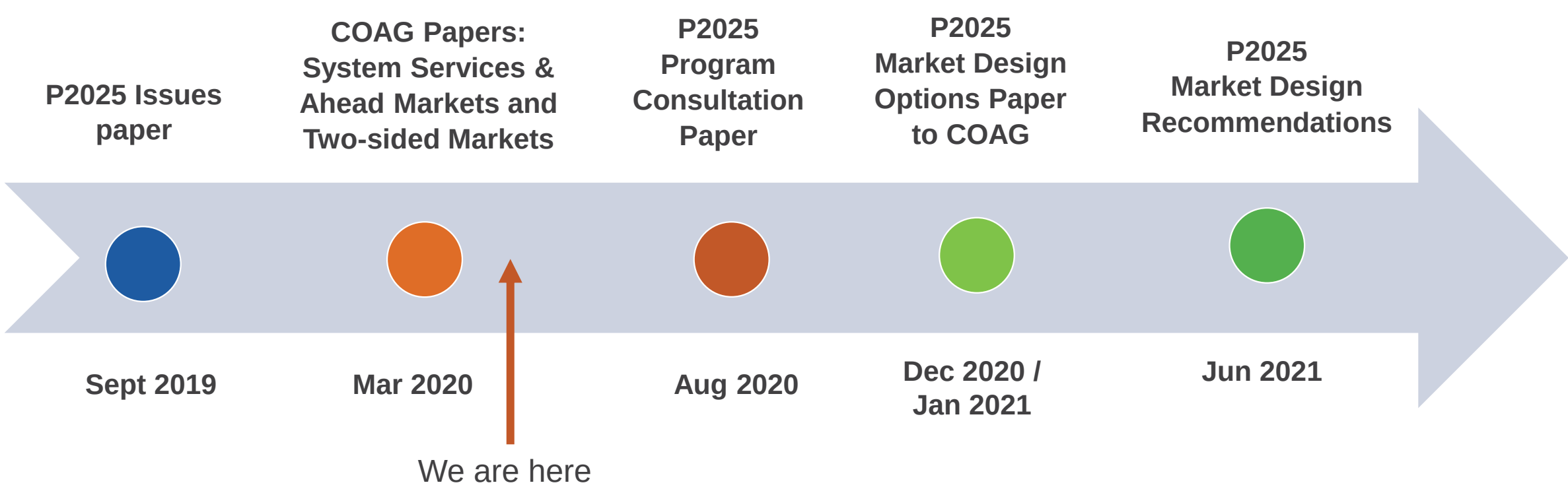
The COAG Energy Council tasked the ESB with developing advice on a

long-term, fit-for-purpose market framework

to support reliability that could apply from the mid-2020's.

The ESB needs to recommend any changes to the existing market design or recommend an alternative market design to enable the provision of the full range of services to customers necessary to deliver a secure, reliable and lower emissions electricity system at least-cost.

P2025 PROGRAM – KEY DELIVERABLES



*COAG has tasked the ESB, through the AEMC and AEMO, to concurrently develop the market design for a **two-sided market** and a **new framework for system services and ahead market** arrangements to identify a recommended design by the end of 2020, and to undertake public consultation as part of the development process.*

CONTEXT

Scope and objectives for this meeting

How does this workstream fit with other reforms and other P2025 initiatives?

ROLE OF THE TECHNICAL WORKING GROUP ON THIS WORKSTREAM

- COAG Energy Council has tasked the ESB with:

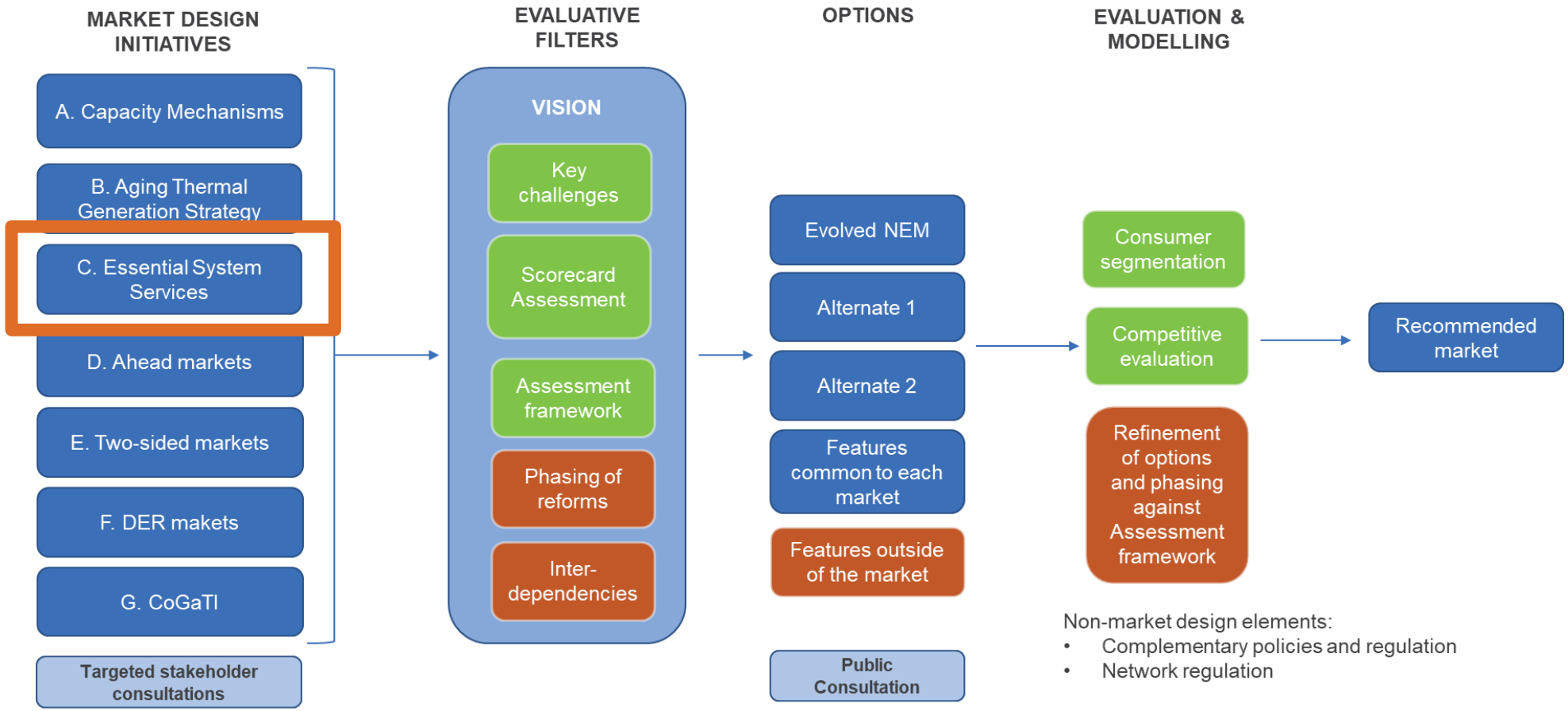
  the concurrent development of the market design for a two-sided market and a new framework for system services and ahead market arrangements to identify a recommended design by the end of 2020.

- We would like to engage with the TWG to help develop the designs

OBJECTIVE OF THIS MEETING

- Provide context for the ESS workstream and how it fits with other reforms
- Outline the changing generation mix and future operational challenges.
- FTI to present:
  - a map of Essential System Services under consideration
  - Outline a Spectrum of Opportunity and Principles for Design for possible new frameworks
  - approach to analysis and framework development
- Discuss engagement with the TWG – input and future sessions

TODAY'S SESSION



INTEGRATED SYSTEM PLAN AND THE RENEWABLE INTEGRATION STUDY

AEMO is undertaking technical studies to inform the physical operation of the future power system.
This work is being informed by those studies and the teams are working closely to understand implications.

2020 Integrated System Plan

Draft: published December 2019
Consultation: Q1 2020
Final publication: Expected mid-2020

https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2020-integrated-system-plan-isp

Renewable Integration Study

Stage 1 Published 30 April 2020

https://aemo.com.au/energy-systems/major-publications/renewable-integration-study-ris

Context for System Services and Ahead Markets in the March 2020 COAG paper

http://www.coagenergycouncil.gov.au/post-2025/system-service-and-ahead-markets

If you would like to be added to the distribution list for upcoming RIS stakeholder briefings, please email FutureEnergy@aemo.com.au

https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/system-operations/future-grid/renewable-integration-study

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

CONCURRENT REVIEW PROCESSES

(ADDITIONAL TO POST-2025 PROGRAM)

The AEMC as statutory rule maker is currently progressing a number of projects relating to system services. These projects are being coordinated with the work undertaken by the ESB, including the FTI work on system services which is an important input.

AEMC / ESB	Frequency	Operating reserves	Inertia	System strength	Voltage control	System restart
System strength investigation			✓	✓	✓	
Incentives for primary frequency response (AEMO)	✓		✓			
Fast frequency response (Infigen)	✓		✓			
Operating reserves (Infigen)		✓				
Management of system strength on the power system (Transgrid)			✓	✓	✓	
Synchronous services (HydroTas)			✓	✓	✓	
System restart (AEMO – complete)						✓

Essential System Services webinar

Presentation to Technical Working Group and Advisory Group

1 May 2020

Introductions – FTI team presenting this webinar

Project Director

Jason Mann

Jason is a Senior Managing Director, based in FTI Consulting's London office.

Jason has been a leading global advisor to regulators and market participants on the design of different electricity markets and regulatory models since the mid-1990s. Throughout his career, Jason has worked on the design, implementation and operation of wholesale energy markets, and the regulation of energy networks.

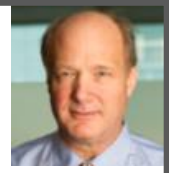
Project Manger

Martina Lindovska

Martina is a Senior Director, based in FTI Consulting's London office.

Martina is an energy economist and has worked as a consultant for over ten years across the energy and wider utilities sector. She has extensive experience in global electricity markets, having worked for Ofgem, MISO and AEMO in recent years on various aspects of electricity market design.

Subject matter expert – US specialist



Dr Scott Harvey

Scott is a Managing Director, based in FTI Consulting's Boston office, and is a member of FTI's US Expert Panel.

Scott is an expert on electricity market design issues, having been involved in the electric power industry design for the last 25 years. He has worked extensively on market design issues in the US, including with CAISO, PJM and NYISO, as well as in Australia with AEMO.

Subject matter expert – NEM specialist / local lead

Robert Prydon

Robert is FTI Consulting's Australian energy lead, based in Sydney.

Robert has extensive experience in market design in Australia, gained over 25 years working for regulators, energy businesses and in consulting on energy market issues. Prior to joining FTI, Rob worked with the AEMC as Senior Economist advising on the strategic framework for energy market development

FTI's workplan and objectives for this workshop

Week commencing	6/4	13/4	20/4	27/4	4/5	11/5	18/5	25/5	1/6	8/6	15/6	22/6	29/6	6/7	13/7	20/7
Workshops and deliverables		Stakeholder workshop 1: modelling options and methodology ◆					Draft report (late May) ◆				Stakeholder workshop 2: draft findings (date TBC) ◆			Draft final report (early July) ◆	Final report (mid July) ◆	

Workshop 1: Overview of the methodology

1. **Identify system requirements**
   - Drivers of future need
   - Implications in terms of magnitude, frequency and urgency of services
2. **Define and analyse required ESS**
   - Key technical and economic characteristics
   - Relevant interactions among ESS, with bulk energy and resource adequacy mechanisms
   - Consider current NEM arrangements and international precedents
3. **Define key design principles for procurement**
4. **Articulate high-level dimensions of procuring the ESS**

Workshop objective 1: Validate FTI's understanding of the ESS in the NEM and present initial observations on the key ESS (slide 4)

Workshop objective 2: Validate key principles for designing ESS procurement (slide 5)

Workshop objective 3: Identify key issues to consider when designing an ESS procurement framework (slides 6-7)

OUTPUT FROM PART 1:
Procurement options for individual and/or groups of ESS

Workshop objective 4: Identify a spectrum of ESS procurement opportunities for the NEM (slide 8).

Workshop 2: Proposed focus

- Recap on the required ESS, their key drivers and characteristics, and procurement dimensions / approaches
- **Deep dive on specific ESS** and procurement and scheduling options, their pros and cons, in the NEM context
- **Part 2 analysis**: **Regulatory framework** to procuring and scheduling ESS

FTI CONSULTING™

Overview of Essential System Services in the NEM and their key features

Key focus 2: Inertia

3
- Mostly system-wide service
- Historical oversupply from synch gens but growing shortfalls
- Uncharted technical minimum

Interdependency between inertia and RoCoF

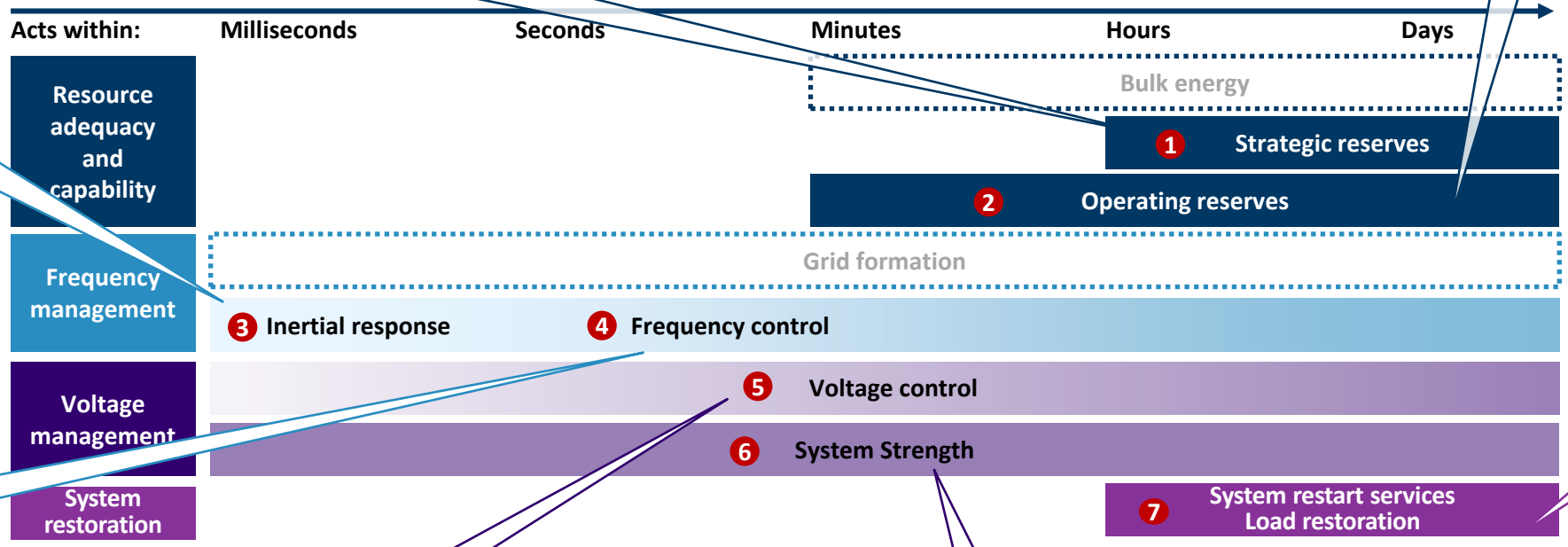
4
- Existing 8 FCAS products, co-optimised with energy
- Growing degradation of frequency stability
- Potential for wide participation

1
- RERT
- Intervention pricing used
- Interim "out of market" reserve to 2025

Key focus 1: Reserves

Interaction between OR and SR; and link to Resource Adequacy mechanisms

2
- Provided by market participants
- No separate operating reserve product in NEM



7
- Well known
- Variety of international procurement approaches

5
- Mostly local…
- …with risk of abuse of market power

Interaction between voltage support and system strength (the latter also linked to inertia)

6
- General "system service"
- No unit of measure
- Not an explicit "product" (e.g. cannot buy "waveform maintenance")
- Historical oversupply from sync gens but growing shortfalls

Key focus 3: System strength

Legend
Out of scope
Within scope

DRAFT FOR DISCUSSION

Principles of ESS procurement design

These principles will be used to evaluate the attractiveness of potential ESS procurement / scheduling processes and regulatory frameworks

1 Operational efficiency (subject to quality of service)

- ESS procurement design to facilitate an **overall efficient dispatch**
- Efficient **price signals in operational timeframes** for availability and utilisation of existing resources (subject to the quantity, quality and nature of service)
- Should be based on **voluntary bids and offers**, and subject to rules to mitigate the exercise of market power
- Some ESS would be **co-optimised** with energy
- Maximise **market-based outcomes** / minimise intervention by AEMO

2 Efficient investment signals and overall grid resilience

- Market design that promotes **efficient and timely investment** in, and provision of, ESS, which delivers the desired levels of reliability and security
- Market design that delivers ESS that promote **overall grid resilience** (i.e. holistic perspective)

3 Cost recovery / risk allocation

- Participants who **cause costs** should be exposed to them
- Risks should be borne by participants best able to manage them

4 Proportionate procurement

- ESS may be provided via a **competitive process**, or as a **mandatory service** (e.g. licence condition): the choice should be appropriate for the type of service procured
- If a competitive process is used, a **clear process** and terms of contract should be applied
- **No excessive complexity** that would unnecessarily delay procurement of ESS

5 Transparent process

- **Minimise operator interventions** – particularly if they are seen as opaque by market participants
- Requirements for services should be **communicated in a timely and clear manner** to all relevant parties
- Outcomes of any procurement process (whether competitive or mandatory) should be communicated

6 Adaptability

- Market design that is **flexible** to adapt to evolving market and technical circumstances
- **Supports innovation** and encourages 'learning by doing' from exploring previously uncharted territory

7 No undue discrimination

- **Equal treatment** for all participants (subject to relevant technical and economic differences), but no "undue" discrimination
- Market participants able to **respond to incentives** and act without discrimination
- May require some **power market mitigation tools**

FTI CONSULTING

High-level dimensions of procuring ESS

Dimension	Options
A **Service definition:** What is the system service required?	▪ Definition and physical units (if possible – not always the case)
B **How much** of the service is required?	▪ X MW (traditional 'contingency') or flexible amount
C **How urgently** is the service needed (likely to be on a spectrum)?	▪ Highest urgency where services are already under-provided and require out-of-market intervention
D **How critical** is the service? What is the effect of the service not being provided?	▪ Highest criticality where service shortfall is associated with high costs that cannot be mitigated easily (or in advance)
E **Lead time:** When can / should the service be procured / deployed?	▪ Procurement/contracting (incl. new resources) ▪ Deployment (existing resources)
F **Cost recovery:** Who pays for the service (and for the cost of under-provision)?	Various options available, including allocation to load and "polluter-pays" rules

Reserves, inertia, and system strength?

Key driver of operational and investment decisions

Dimension	Options
G **Process:** How should the service be obtained?	One or more of: decentralised (market provision); mandatory provision; centralised (competitive or bilateral) or from TNSPs
H **Who** can the service be procured **from**?	▪ Synch gen, IBR, storage, DR ▪ Syn cons (or gen in syn con mode) ▪ Facilitated by interconnection
I **(Dis)aggregation:** What level of granularity should services be divided into?	▪ Complex trade-off: less granular markets with fewer products allow for a deeper market with more participants (and vice versa)
J **Co-optimisation:** To what extent should services be co-optimised?	• Co-optimisation with bulk energy and/or with other ESS
K **Active vs passive:** How much of the service must be actively provided?	▪ Purely active, purely passive (e.g. tech standards and tuning), or a combination

Technology neutrality and compatibility with future innovation

Key consideration for regulatory framework design

More co-optimisation may be preferred subject to efficiency and practicality considerations

FTI CONSULTING

DRAFT FOR DISCUSSION

Spectrum of opportunity for ESS procurement

Dimensions of ESS procurement

- **Extent of granularity of ESS** :
  - Specification, procurement / scheduling optimised for each ESS separately…
  - … but ideally optimised in aggregate (to the extent practicable)
- **Approach to price signals** for individual services :
  - e.g. one-part vs multi-part price signals for investment and dispatch

1 Status Quo (NEM)	2 Adapt existing ESS (e.g. FCAS)	3 Central procurement of new ESS (Bilateral / out-of-market / mandatory actions)	4 Reconfigure all ESS (potentially with co-optimisation with energy)	5 Decentralised responsibilities (transfer from AEMO to market participants)
▪ 8 FCAS services ▪ NSCAS	Examples: ▪ New inertia product ▪ Ramping	Range of options: ▪ Explicit new product ▪ No specific "product; but co-provided with other ESS (system strength?) ▪ Technical and performance standards	▪ Nested, fully co-optimised design ▪ SO as the fulcrum	▪ Participants to self procure some ESS ▪ Co-ordinate with wider NEM post-2025 reforms

Key question: where along this spectrum could the NEM go through the post-2025 reforms?

This depends on:

1) **Urgency** of the underlying drivers of the need for specific ESS
2) Ability to articulate **specific products** and physical units of procurement
3) Whether priority is given to new services that are likely to form part of the '**enduring solution**', rather than transient solutions
4) **Risk allocation** preferences: how much risk should sit with consumers vs resources?
5) Progress with other **NEM reforms**
6) Cost of **transitioning** / technical limitations (e.g. software)
7) How much **discretion** policy-makers wish to give to the system operator
8) Technical **interrelatedness** of ESS (simultaneous provision of multiple services)

EXPERTS WITH **IMPACT**

ENGAGING IN THE TWG

Next steps

SEEKING YOUR INPUT

Some issues we specifically want feedback on

Overview:

- What other key interactions between market design streams are useful to highlight?
- What other operational challenges facing the NEM should be considered?

Essential System Services – seeking your feedback on:

- The map and features of ESS
- Principles of ESS procurement design
- High level dimensions for procurement of ESS
- Spectrum of opportunity for ESS procurement

How you can provide feedback

Please provide feedback to info@esb.org.au with email subject heading titled '*TWG essential system services briefing'* by **Friday 8 May**.

Please get in contact if you have further questions.

TWG meeting on Resource Adequacy Mechanisms will take place on 8 May.

The next TWG meeting on Essential System Services is expected to be 17 June.

Note: Engagement for the Ahead Markets workstream will continue in parallel

END OF PRESENTATION

Pre-reading slides

ESSENTIAL SYSTEM SERVICES

What are Essential System Services?

Changes to the NEM generation mix and future operational challenges

MULTI-FACETED NEEDS OF A POWER SYSTEM

System attribute	Requirement	Service
Resource adequacy	Provision of supply to match demand	Bulk energy
		Strategic reserves
	Capability to respond to changes in energy requirements	Operating reserves
Frequency management	Maintain frequency within limits	Inertial response
		Frequency control
Voltage management	Maintain voltages within limits	Voltage control
		System strength
System restoration	Ability to restore the system	System restart services

Modern power systems rely on a range of essential system services

A Bulk energy supply and system balancing is but one requirement of a power system

B To accommodate variability and uncertainty, flexible operating reserves are required

C Frequency and voltage management are essential for a secure system

D Voltage and frequency stability is increasingly difficult when synchronous generation reduces during periods of high renewables

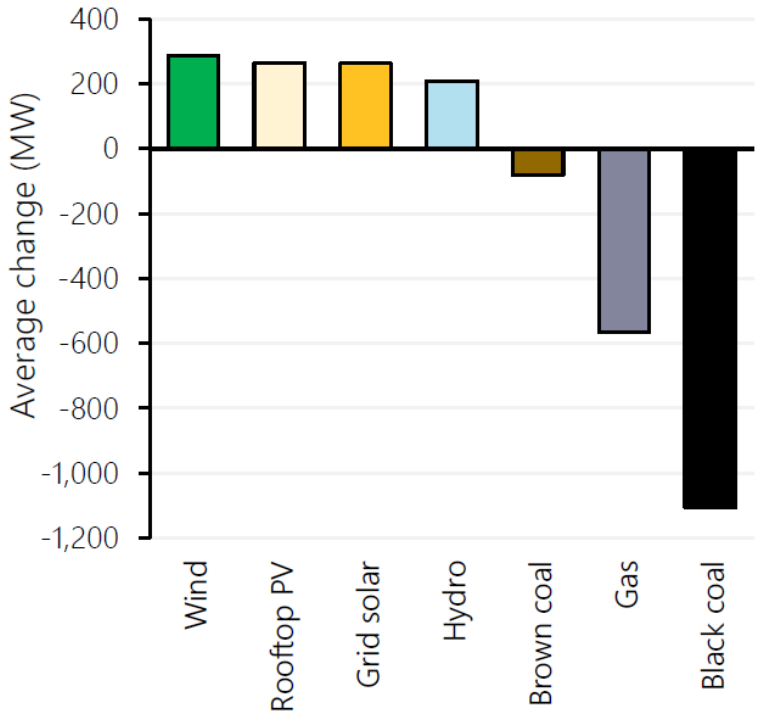
E Australia is at the international forefront of much of the technical integration challenges. We must transition prudently, retaining services until alternatives are proven

CHANGING GENERATION MIX

The resource mix in the NEM is undergoing a major transformation

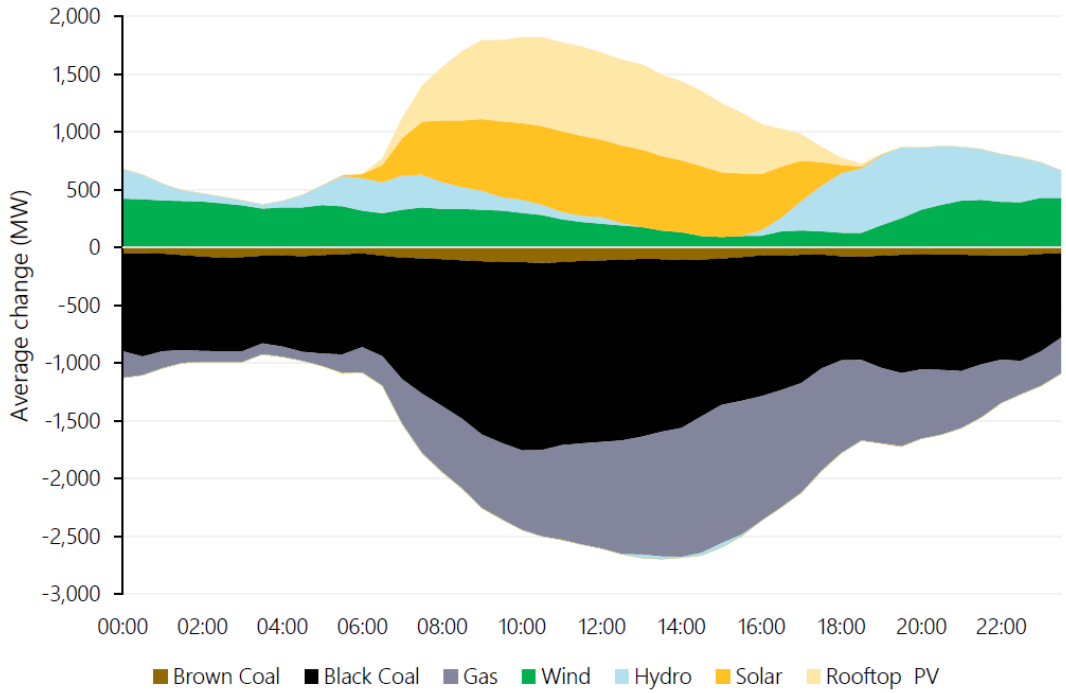
Large reductions from thermal generation

Change in supply Q1 2020 versus Q1 2019



Reduced coal and GPG across the day

Change in supply Q1 2020 versus Q1 2019 by time of day

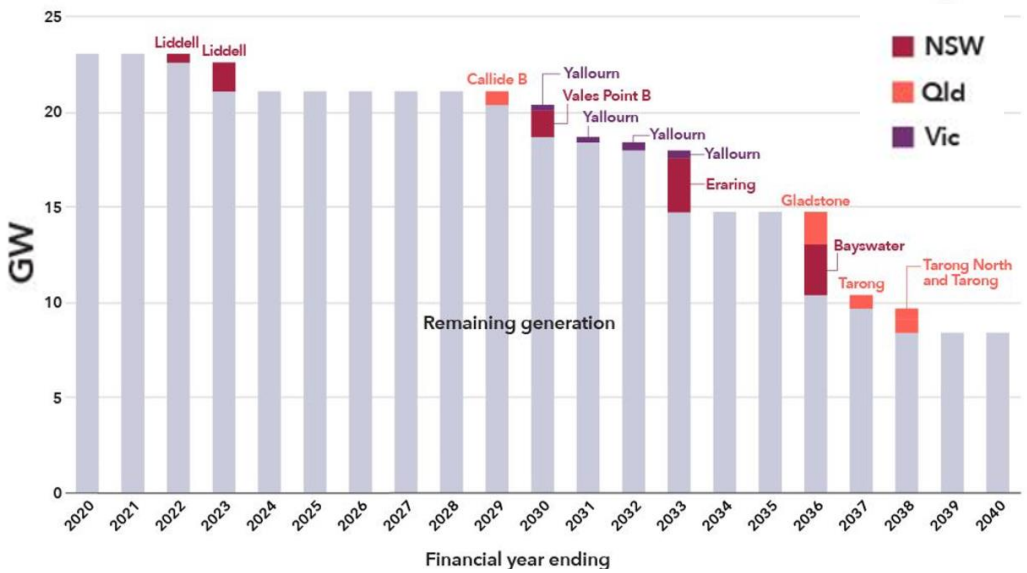


Source: AEMO Quarterly Energy Dynamics Q1 2020

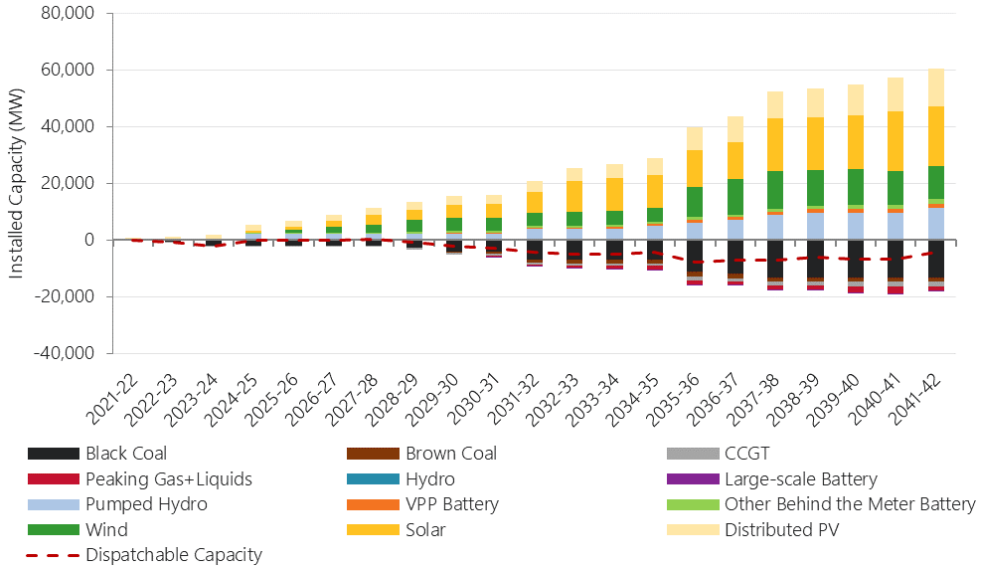
https://aemo.com.au/energy-systems/major-publications/quarterly-energy-dynamics-qed

FORECAST CHANGE IN GENERATION MIX

Expected coal closure profile



Relative change in NEM installed capacity (2020 draft ISP Central case), demonstrating shift from coal to renewable energy



Resource mix will continue towards reducing amounts of synchronous generation online

A **Expected closure** profile has around 15GW (63%) coal-capacity retiring by 2038

B Wind and solar generation (variable) capacity in the NEM could **triple** from 15GW in 2018-19 to 45GW in 2039-40. The RIS finds rapid increase in variability, uncertainty and ramping requirements.

C **Distributed energy generation** capacity expected to double or triple by 2040 meeting 13% to 22% of annual consumption.

D Before retirement, expect that thermal units will want to optimise operation around higher revenue periods (and **operate less**)

E When there are fewer units, the **scheduling** of remaining ones becomes more critical

F Replacement **capabilities** must be available before retirement; mechanism to manage an early exit if it would create a short-term reliability or security issue

FTI SLIDES

Essential System Services webinar

Presentation to Technical Working Group and Advisory Group

1 May 2020

High-level dimensions of procuring ESS (1/2)

Dimensions	Description	Options	Comments / observations
Service definition	What is the system service required and how can it be defined?	▪ Definition and physical units of the product that is to be procured (NB – not all ESS can be defined in this way)	▪ For services that do not have a clear definition and units, consider alternative approaches to procurement ▪ For example: take impact on system strength into account when procuring other ESS
How much	How much of the service is required?	▪ An absolute amount of the service (e.g. X MW) ▪ A flexible amount, possibly dependent on other factors (e.g. intermittent gen penetration, or volume of other ESS procured)	▪ Traditional approach to cover largest single contingency may no longer be sufficient… ▪ …due to net load swings
How urgently	How urgently is the service needed?	▪ Most urgently - the service is already under-provided and represents a binding constraint requiring out-of-market intervention ▪ Somewhat urgent - the service is likely to be required in greater quantities than expected levels of provision the medium term ▪ Not urgent – the service is not needed in materially greater quantities than expected levels of provision	▪ ESS likely to be on a spectrum of urgency ▪ Services that already show frequent and / or material shortfalls in some regions to take priority (e.g. inertia in SA, as well as system strength)
Criticality	How critical is the service? What is the implication/effect of the service not being provided?	▪ More critical – significant costs associated with shortfall that cannot be mitigated easily. May be technical challenges in taking corrective action in RT (e.g. inertia – lack of "advance notice" of shortfalls) ▪ Less critical – shortfall can be mitigated, possibly ahead of time and/or in RT (e.g. reserves – shortfalls potentially identifiable with advance notice, allowing for corrective action)	▪ *[In discussions with ESB/AEMO/AEMC regarding technical input on this area]* ▪ Criticality may vary depending on the quantum of service: there may be a critical minimum quantity of service that must be provided, above which further provision is less critical
Lead time	How far in advance can / should the service be procured / obtained / deployed?	▪ Lead time for procurement/contracting (incl for new investments): days ahead; months ahead; or year(s) ahead ▪ Lead time for deployment (of existing resources): real time, intraday or day(s) ahead (e.g. to secure commitment)	▪ Procurement of ESS has an impact both on investment signals (explored separately) as well as operational (RT) issues ▪ Key factor for the operational side is the potential need for advance commitment by some types of resources
Cost recovery	Who pays for the provision of the service (and conversely who bears the cost of under-provision)	Various options available, including for example: ▪ Averaged and allocated to all allocated to all load ▪ Allocated based on a variety of "polluter-pays" rules ▪ Allocated partly to certain categories of "polluters" and the rest to load ▪ Mix of the above	▪ Non-delivery of some ESS can be penalised through exposure to RT prices, but this is not always the case ▪ General preference would be to allocate costs to the "causer" of the cost

High-level dimensions of procuring ESS (2/2)

Dimensions	Description	Options	Comments / observations
Process	How should the service be obtained (e.g. by AEMO, TNSPs, or market participants)?	▪ Market provision (e.g. operating reserve under current arrangements), i.e. decentralised ▪ Mandatory provision (e.g. licence conditions, regulation, performance or technical standards) ▪ Competitive tender process (centralised) ▪ Bilateral contracts with AEMO (centralised) ▪ Provision by TNSPs (subject to least-cost credible option rules)	▪ ESS may be provided through multiple channels, not just a single one (e.g. frequency response can be part mandatory and part commercial, as in GB) ▪ Complexity of requirements associated with some services may restrict options (e.g. locational nature of some ESS is not conducive to market-wide competitive procurement process)
From whom	Who can the service be procured from?	▪ Synchronous, thermal generation ▪ Intermittent generation (inverter-based gen) ▪ Storage (e.g. batteries) ▪ Demand response ▪ Other technologies e.g. synchronous condensers (or gen operating in syn con mode) ▪ Facilitated by interconnection	▪ Best practice is to apply technology neutrality (while taking into account technical and economic differences – see 'principles' above) ▪ Procurement regulations should aim to be compatible with future technological changes (and possibly even encourage innovation)
(Dis)aggregation of services	What level of granularity should services be divided into?	▪ Trade-off between granularity and market depth: ❑ Less granular markets with few products, but a deeper market with many participants; vs ❑ More granular markets, with many highly specific products but fewer participants in each	▪ Complex area of trade-off and often subject to regulatory change over time as new information emerges ▪ GB case study: historically operated a large number of relatively opaque markets, some of which were over-subscribed and some of which were under-subscribed. Now undergoing multi-year process of streamlining and simplifying the ESS
Co-optimisation	To what extent should services be co-optimised with each other	Co-optimisation with: ▪ Bulk energy ▪ Other ESS	▪ Lack of co-optimisation with energy may be sub-optimal… ▪ …but the preferred degree of co-optimisation also depends on practical issues such as software capability and the incremental value of co-optimisation (which is higher for frequently used services)
Active vs passive	How much of the service must be actively provided vs through better technical standards and tuning	▪ Requires solely active provision ▪ Requires solely passive provision (e.g. technical settings such as relays) ▪ Requires both active and passive provision	▪ Currently an active area of work for AEMC to understand what technical settings can be helpful changed.

EXPERTS WITH **IMPACT**