ENERGY SECURITY BOARD

POST 2025 FUTURE MARKET PROGRAM

TECHNICAL WORKING GROUP (TWG)

7 APRIL 2020

IMPORTANT NOTES

These slides are solely for workshop purposes only. The content provides general information to support informed stakeholder engagement and feedback.

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

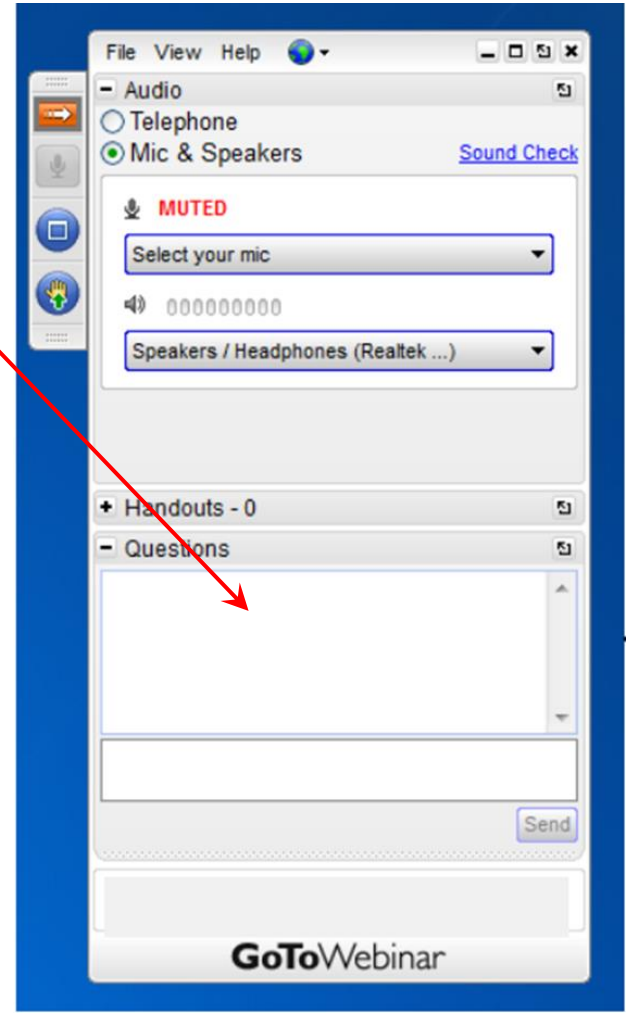
The webinar is being recorded and a link to the recording will be provided after the webinar.

All previous webinar recordings and slides are available here for your reference.

WEBINAR LOGISTICS

- All participants are currently in listen-only mode
- We will pause periodically to answer typed questions: please type them here.
- Time allowing, we aim to open the audio during each Q&A pause and late in the webinar; please:
  - use the *Raised Hand* to signal that you want to speak; and,
  - make sure you are not on mute.

Today's webinar is being recorded and a link to the recording will be provided after the webinar



POST 2025 FUTURE MARKET PROGRAM (P2025)

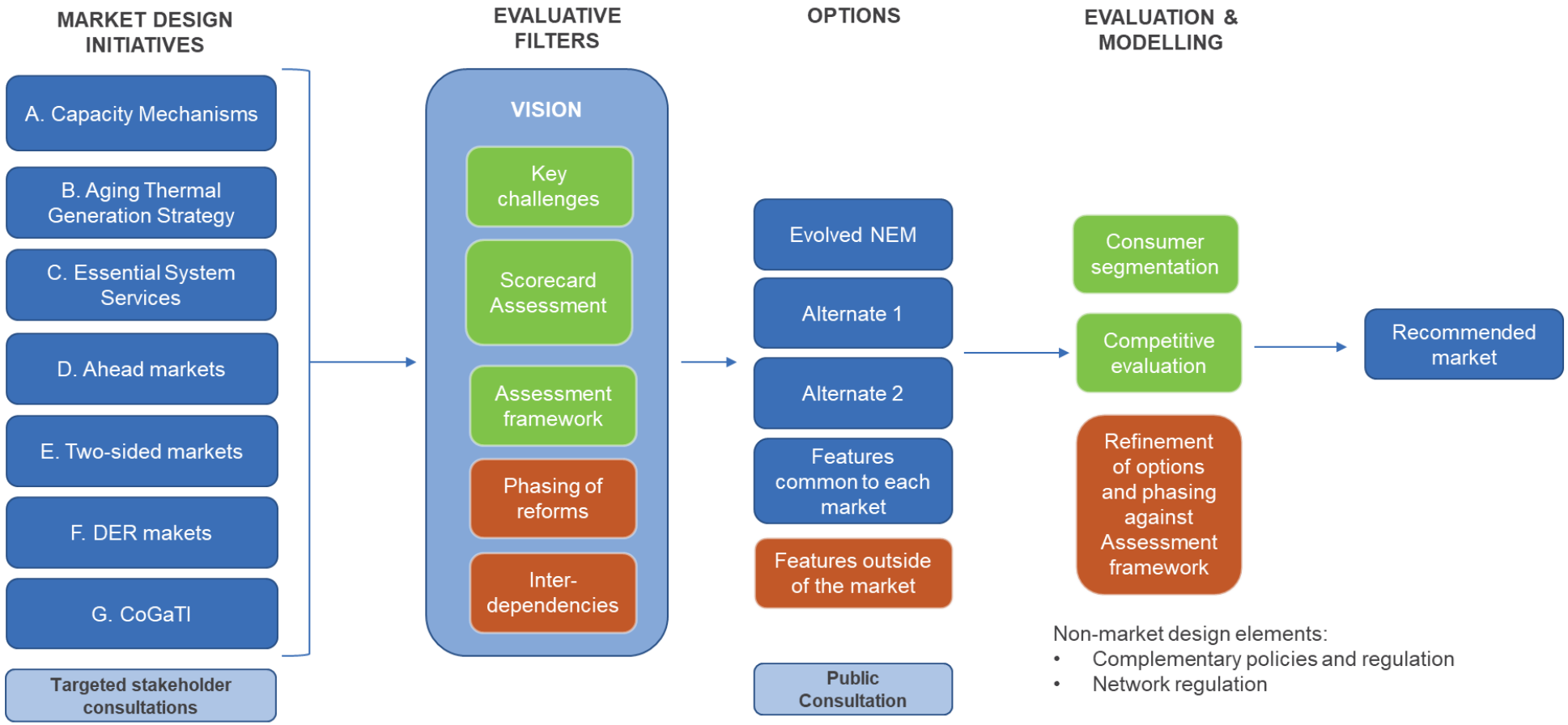
The COAG Energy Council tasked the ESB with developing advice on a

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 STRUCTURE & ASSESSMENT FRAMEWORK



P2025 PROGRAM – KEY DELIVERABLES

P2025 PROGRAM – STAKEHOLDER ENGAGEMENT PRINCIPLES

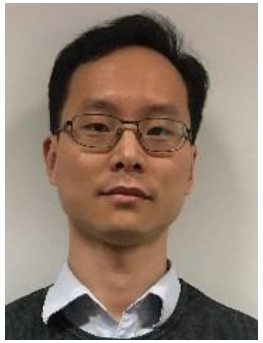
PRINCIPLE	DESCRIPTION
Inclusive	A proactive approach is taken to ensure relevant stakeholder groups are engaged and provided opportunities for involvement.
Transparent	Processes are conducted in an open and frank manner with key premises, assumptions and boundaries communicated clearly.
Coherent	The work program and schedule is logically structured and effectively communicated to external stakeholders.
Comprehensible	Content is designed to be as accessible to informed energy sector generalists as possible while recognising that specific content will of necessity involve significant technical complexity.
Responsive	Stakeholder input is given appropriate consideration and their needs and concerns are proactively explored and addressed where possible.

WEBINAR PRESENTERS

Peter Geers
Chief Strategy and Markets Officer
AEMO

Frank Montiel
Executive Officer
Strategy and Markets
AEMO

Nicole Dodd
Senior Analyst
Market Design
AEMO



Franklin Liu
Principal Analyst
Market Design
AEMO

P2025 PROGRAM – SYSTEM SERVICES AND AHEAD

MARKETS WORKSTREAMS

TWG #1
TUESDAY 7 APRIL

ROLE OF THE TECHNICAL WORKING GROUP ON THIS WORKSTREAM

- COAG Energy Council has tasked us 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 TWG to help develop the designs

OBJECTIVE OF THIS MEETING

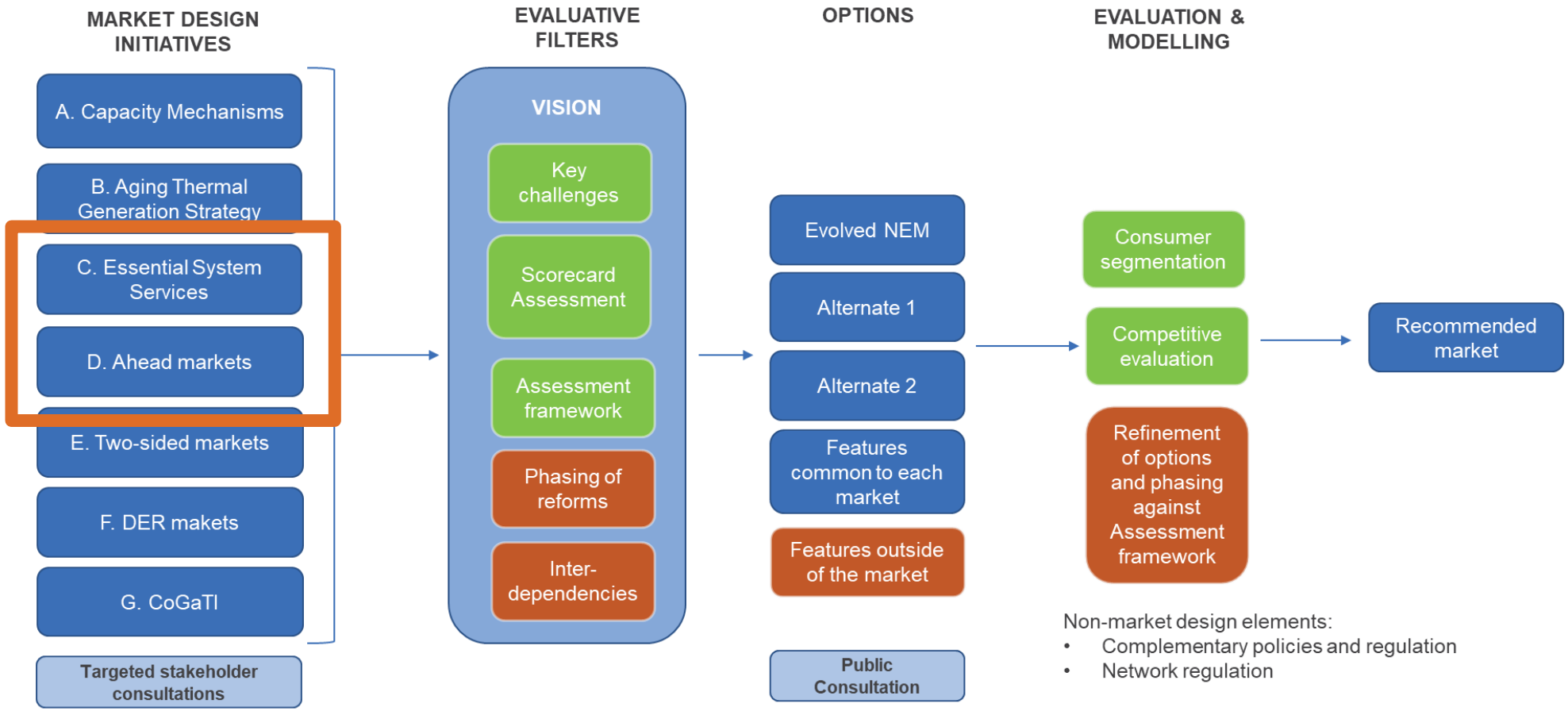
- Provide context for where the workstream fits in with the rest of the P2025 program
- High level overview of the problem statement and scheduling framework.
- High level description of the key design elements of ahead markets.
- How we would like to engage with the TWG – seeking your input and future sessions

CONTEXT

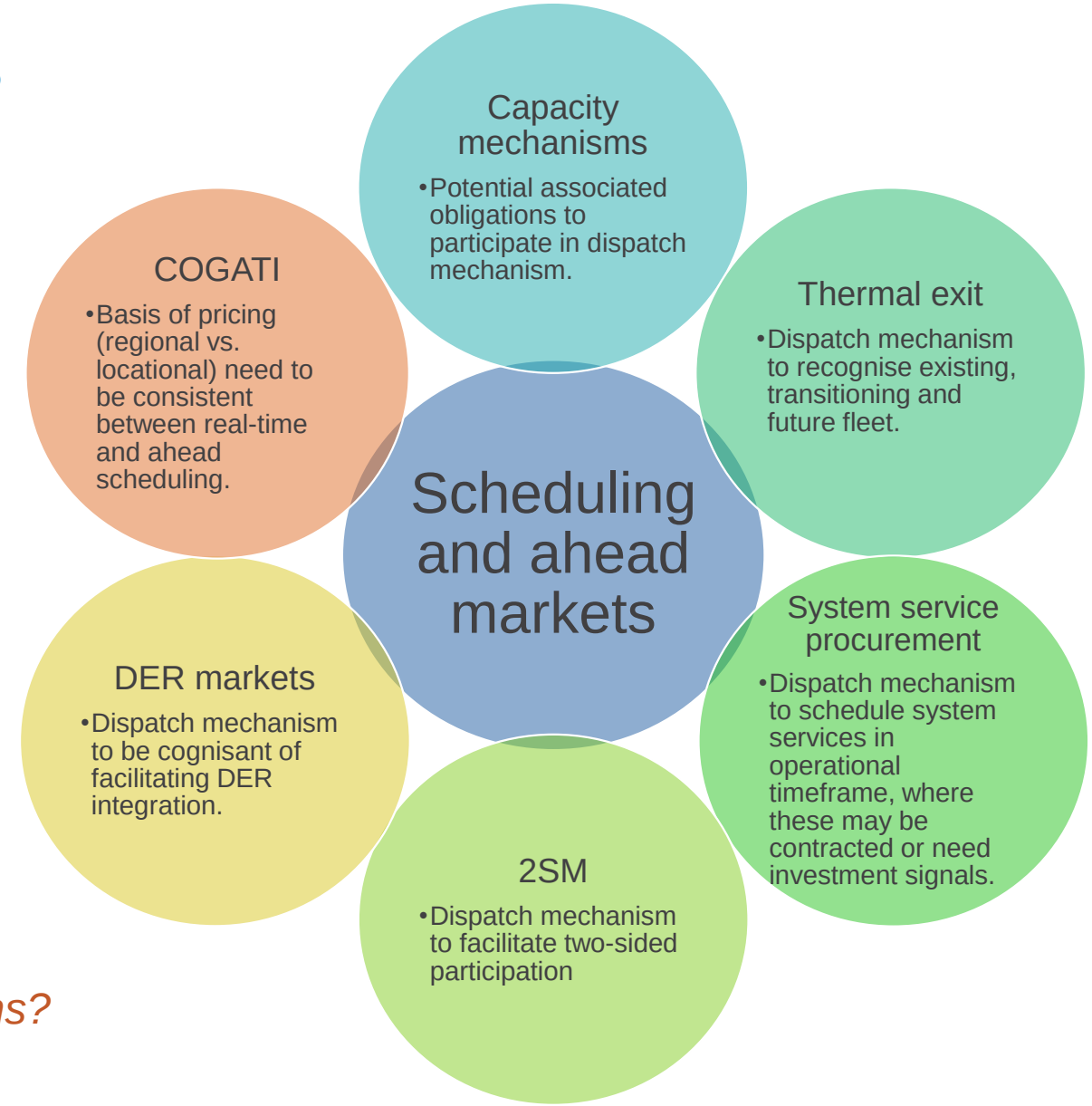
Where does the ahead market workstream fit in?

How does it interact with the other workstreams?

TODAY'S SESSION



INTERACTIONS WITH OTHER WORKSTREAMS



Q: Any other key interactions?

OVERVIEW

Needs of a power system

Trends impacting the operation of the system

Market delivery of the power system needs

Overall framework for scheduling of system services

MULTI-FACETED NEEDS OF A POWER SYSTEM

System attribute	Requirement	Service
Resource adequacy	Provision of sufficient 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 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 in the system 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 forefront internationally of much of the technical integration challenges. We must transition prudently, retaining services until alternatives are proven

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 ISP

Draft was published in December 2019

Consultation through Q1 2020

Expected final publication in mid 2020

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

Renewable Integration Study

Preliminary results were referenced in the COAG paper and have helped form initial views. Target for publication in late April 2020.

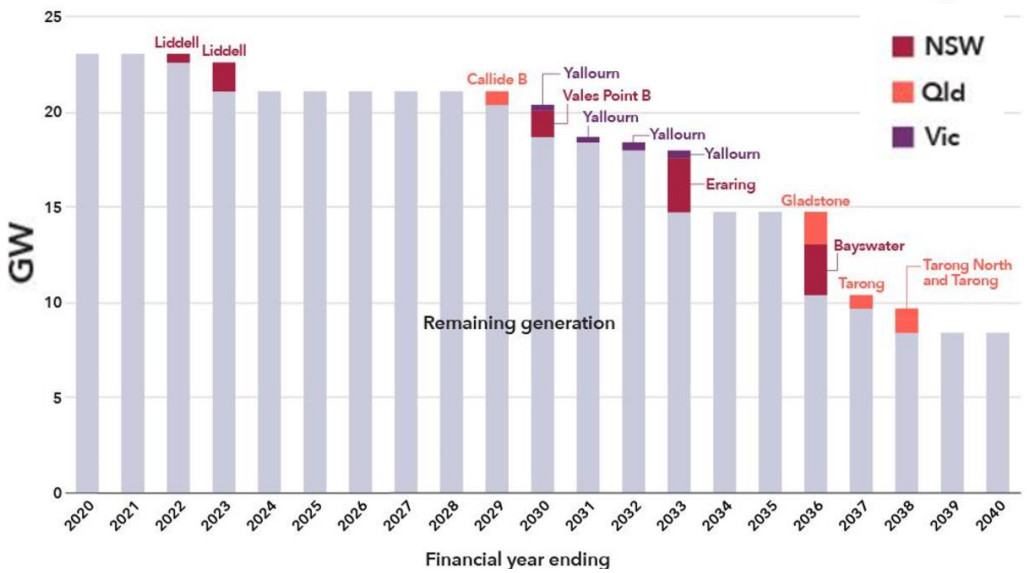
A stakeholder briefing will be held after publication.

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

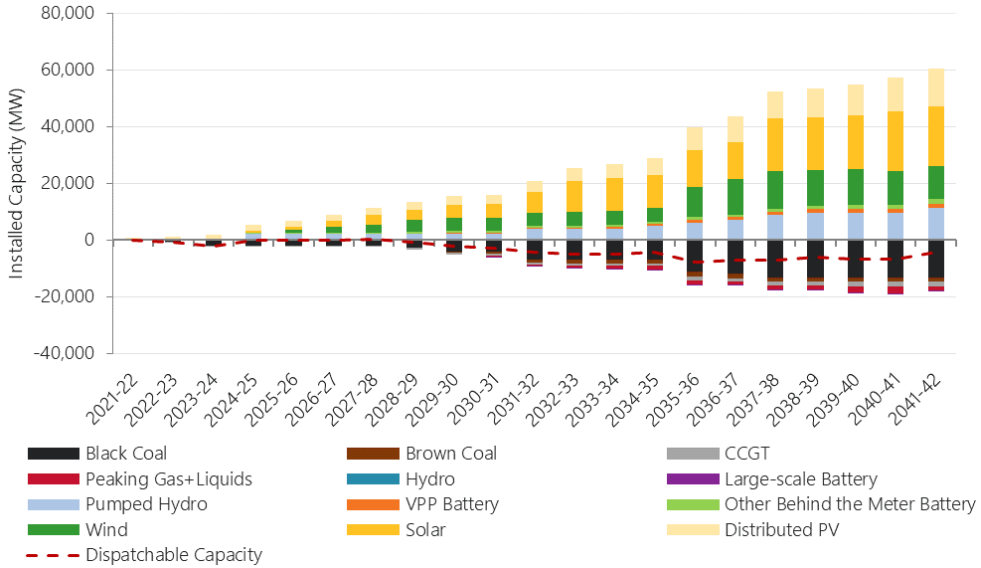
https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/system-operations/future-grid/renewable-integration-study

CONTINUED 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

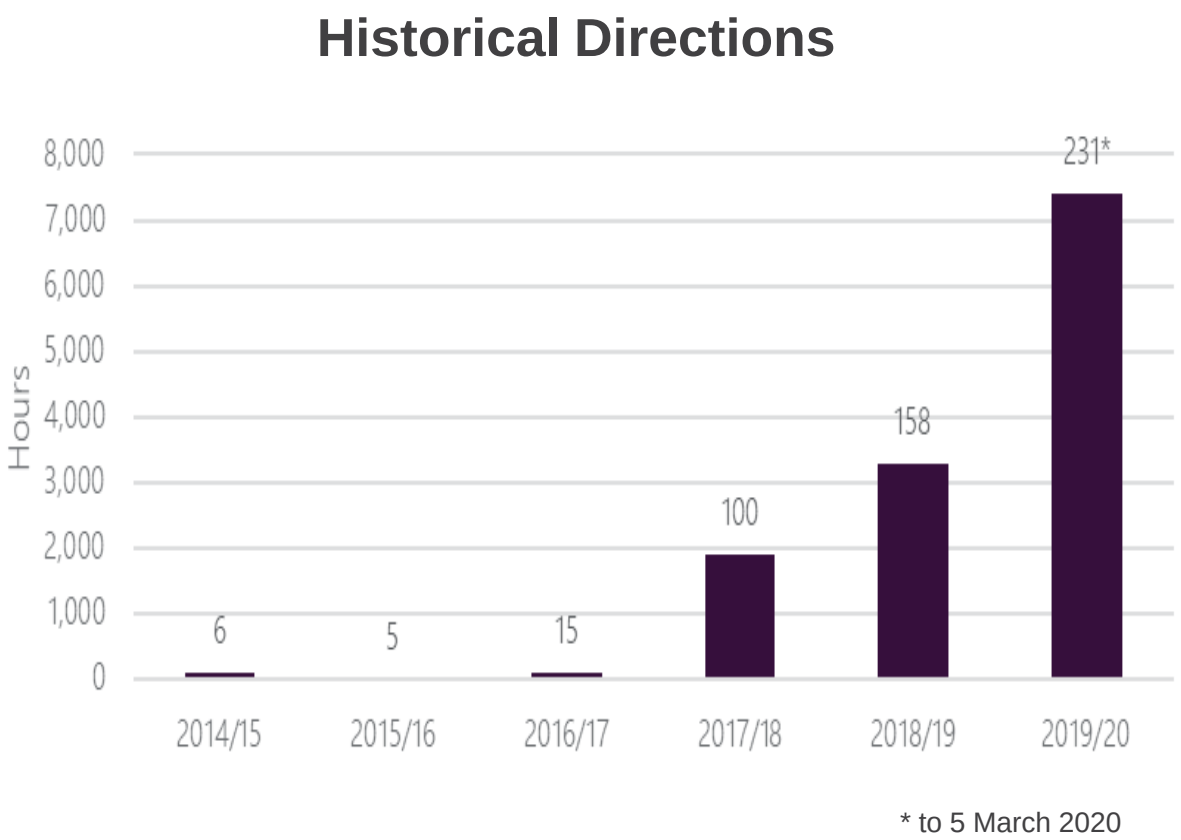
C **Distributed energy generation** capacity expected to double or triple by 2040 meeting 13% to 22% of annual consumption.

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

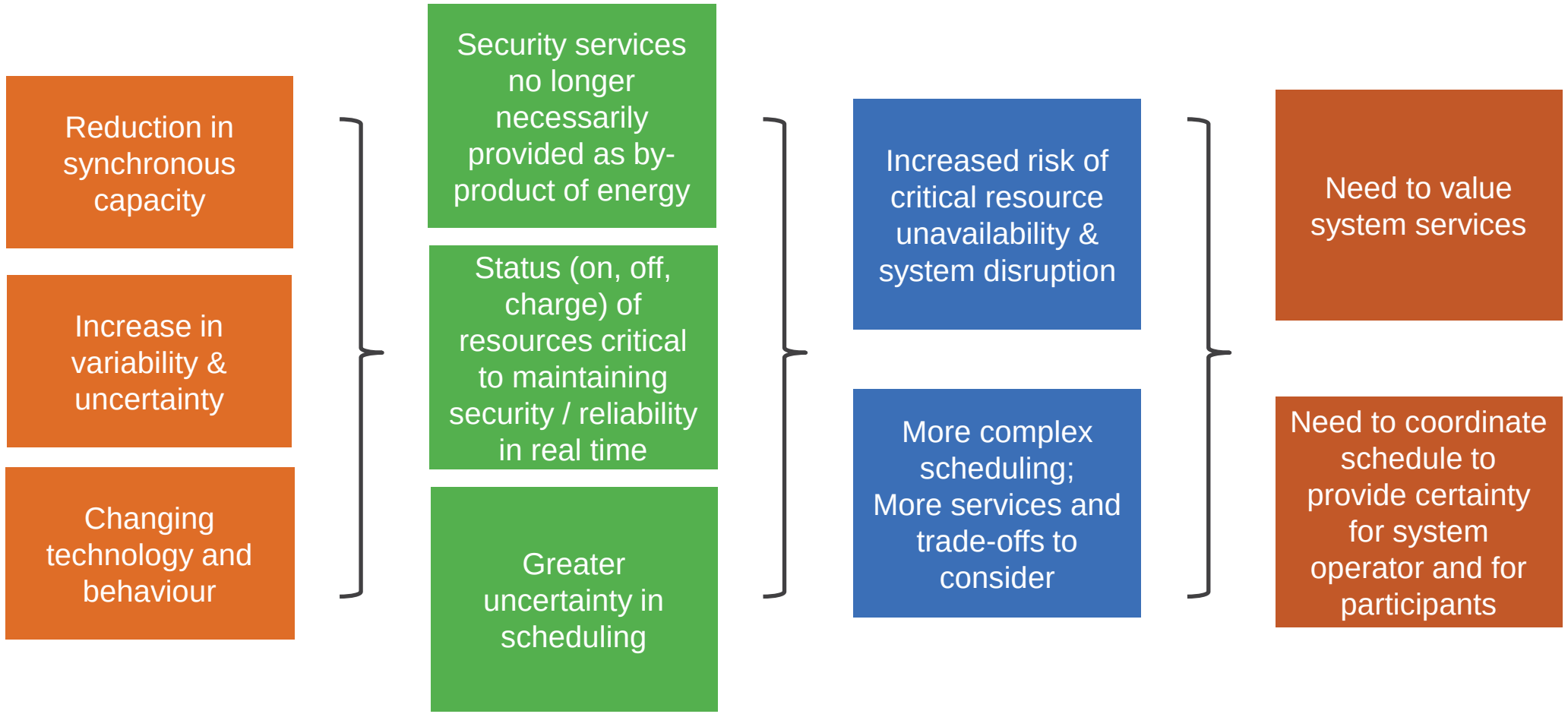
MARKET CHALLENGES WITH SCHEDULING SECURITY SERVICES



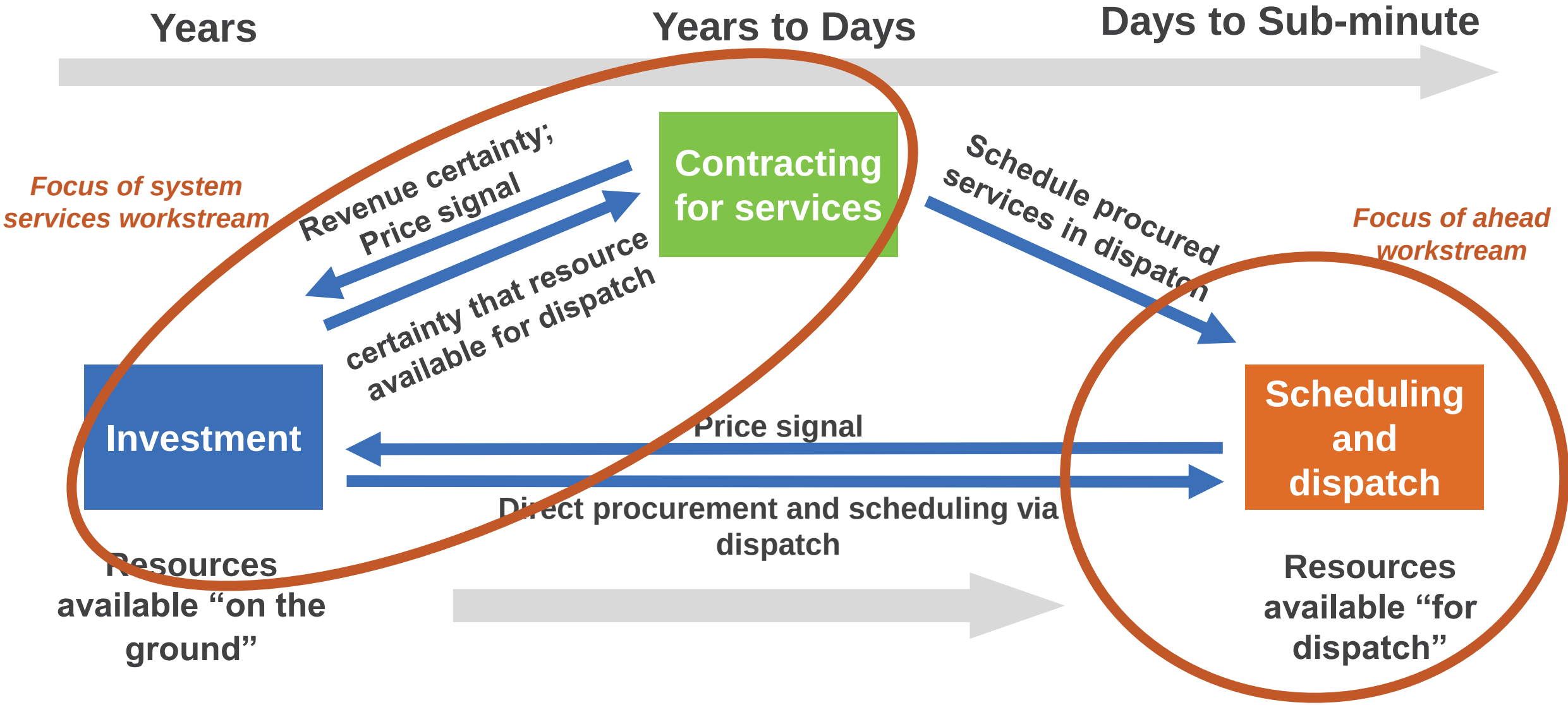
* to 5 March 2020

- Potential system security breach identified in operational timeframe (pre-dispatch) → direction to secure system.
- Potential system security breach may be due to:
  - System service gap materialises as units decommit as energy price insufficient.
  - Uncoordinated scheduling of resources as system becomes more complex; with more resources, separation of services, and potential limited availability of some services.

FUTURE OPERATIONAL CHALLENGES AND THE NEED TO CHANGE THE SCHEDULING MECHANISM



THE RATIONALE FOR 'AHEAD' MARKETS - INVESTMENT *VS* DISPATCH TIMEFRAME



Q&A

Pause for questions for clarification

SCHEDULING SYSTEM SERVICES

Methods for scheduling system services

High level assessment

POSSIBLE FRAMEWORK FOR PROCURING AND SCHEDULING SYSTEM SERVICES

Method	Scheduling	Pricing *	Service features
1. Scheduled and priced in dispatch via co-optimisation	• Co-optimised with all other services in dispatch	• Within dispatch	• Low scheduling and pricing complexity, compatible with marginal pricing, and • High level of competition, and • Used regularly
2. Scheduled in dispatch via co-optimisation	• Co-optimised with all other services in dispatch	• Outside dispatch • potentially based on contracts	• High scheduling and pricing complexity, incompatible with marginal pricing, or Low level of competition, and • Used regularly
3. Not scheduled in dispatch	• Not explicitly scheduled in dispatch • SO intervention or instruction if needed	• Outside dispatch • potentially based on contracts	• High scheduling and pricing complexity, incompatible with marginal pricing, or Low level of competition, and • Rarely used

Objectives

A **Pay for additional services** that are scarce but valuable to the system

B Reward resources based on their value, leading to **efficient operational and investment outcome**

C Expand co-optimisation in scheduling **ensuring efficient resource mix** in dispatch and minimising SO intervention

D **Recognise practical limitations** such as market power and compatibility with marginal pricing – **pricing formation can be within or outside dispatch**

* ‘Dispatch’ refers to real-time market but also an ahead market. Resources could potentially be scheduled both in real-time and ahead markets according to the nature of the service and of the resources’ commitment time requirements.

INDICATIVE CATEGORISATION OF SYSTEM SERVICES

Method	Service	Scheduling and price formation	Degree of competition	Frequency of service need.
1. Scheduled and priced in dispatch via co-optimisation	Energy			
	FCAS			
	Operating reserve			
	Additional frequency control services (including inertial response)			
2. Scheduled in dispatch via co-optimisation	System strength			
	Voltage control			
3. Not scheduled in dispatch	System restart services			

Key

Favourable
Somewhat problematic
Not favourable

AHEAD MARKET DESIGN ELEMENTS

Features of ahead markets

Ahead scheduling

UCS (unit commitment for security)

Real time market

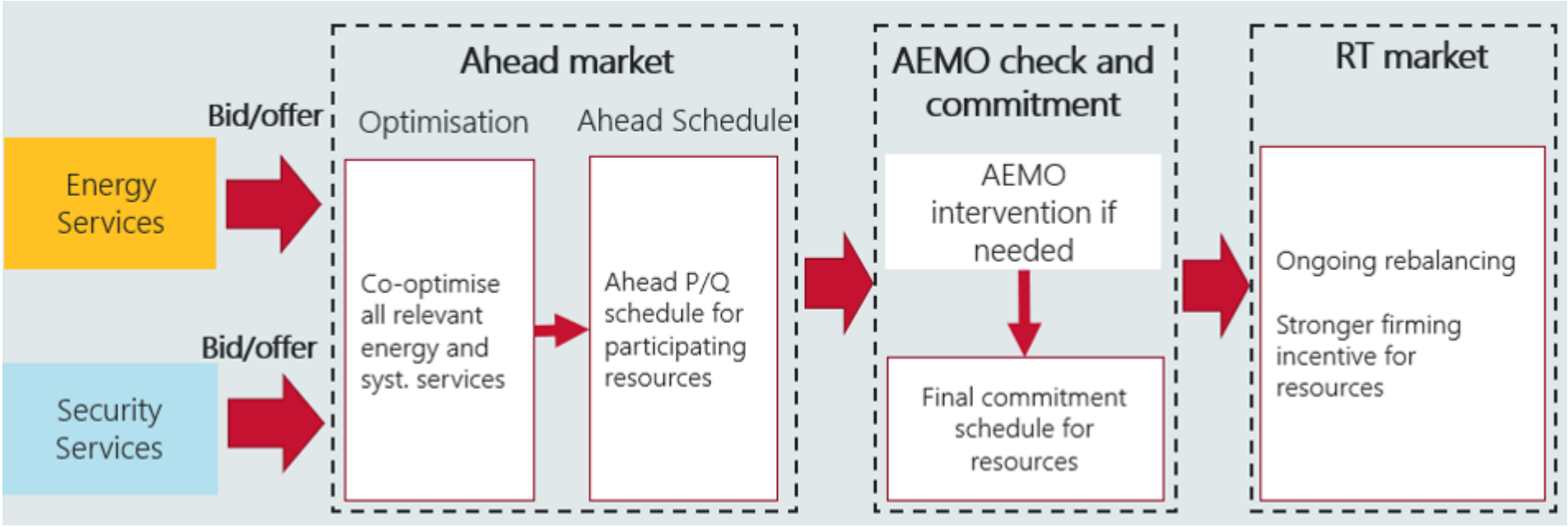
Spectrum of options

DESIGN PRINCIPLES FOR AN AHEAD MARKET

Enhancing system security and reliability	• Facilitate energy mix transition by improving the secure and reliable operation of the system • Ensure adequate resources are available to supply energy and system needs at all times
Improving scheduling and commitment efficiency	• Deliver energy and system services at lowest cost • Efficient utilisation of all NEM resources with different operating characteristics • RT market key to price imbalance and deviation and reward flexibility to meet short-term volatility • Flexibility for participants to respond to commercial incentives and market conditions • Minimise SO out-of-market intervention
Encourage efficient ahead market participation	• Provide value for participants to enter ahead markets • Facilitate forward procurement of system services to manage costs • Allow wide variety of participants to voluntarily take positions in ahead market
Building on existing NEM design	• Add component/s to existing NEM where necessary instead of wholesale replacement • Contracting to remain crucial in future NEM operation and investment framework

Seeking feedback on these principles

FEATURES OF AHEAD MARKET



Ahead market

- Provides revenue certainty to participants
- Potentially can allow participants to better manage system service costs
- Greater certainty and visibility to AEMO of resource availability in real-time if needed

The linkage is crucial

Real-time market condition & price signals provide the right incentive for participants to "honour" their ahead commitment

Real-time market

- Crucial for real-time system balancing at 5-min interval just like now
- RT prices continues to signal the cost of balancing energy and system services
- But also signals the cost of deviation from ahead schedule

AHEAD SCHEDULING

Potential benefit	• Revenue certainty for participants & facilitate coordination of resources (unit commitment, fuel, staff, customer notification and preparation for DR resources) • Potential for participants to manage/hedge system service costs • Stronger incentive for participants to firm supply and allow greater visibility to SO

- Co-optimised ahead scheduling of energy and system services for upcoming dispatch intervals (from several hours to a day depending on design)
- Ahead run produces a quantity (Q) and price (P) (if applicable) schedule of energy and system services for participants
  - Price will also be determined for services in scheduling method 1 (scheduled and priced)
  - Services in method 2 will be scheduled for co-optimisation, but will be remunerated as per contract
- Deviation from ahead schedule will be priced based on real-time system condition (for method 1), or based on contractual agreement

UCS (UNIT COMMITMENT FOR SECURITY)

Ahead scheduling → UCS (Unit commitment for security) → RT balancing

Potential benefit

- More streamlined intervention process to enhance system security and reliability
- Least cost approach to commit out-of-market resources
- Greater certainty to AEMO and participants by reducing *ad hoc* intervention
- UCS at different times (daily vs hourly) to balance system needs and flexibility

Input	UCS	Output
1. AEMO system forecast 2. Combination of PDS and ahead market scheduling outcome (if applicable) 3. Plant economic & technical information on start up, min-gen and incremental costs for SO's out-of-market commitment decisions	1. AEMO assessment of all requirements based on PDS and ahead market outcome 2. Commits "out-of-market" resources if gaps in security and reliability identified in assessment window 3. Least cost approach based on plant economic information	1. Physical Commitment Plan (PCP) which *could* include: I. On/off conditions – start time, run length etc II. Level of variable output – energy and relevant system services (e.g., reserve) 2. Pivotal resources for some system services might require explicit AEMO approval before changing crucial commitment decisions

REAL-TIME BALANCING

- Real-time market remains crucial in the new dispatch mechanism
- Critical for system balancing and signal real-time scarcity cost
- Continues to reward flexibility to respond to short-term fluctuations
- Provides economic basis for participants to deviate from ahead schedules if efficient
  - Participants settle difference b/w RT output and ahead schedule at RT price

An example…

Ahead

A gas turbine receives an ahead schedule:

- Generate 100 MW between 4pm – 5pm
- Ahead price at $75/MWh
- SRMC = $50/MWh

Real-time

- The participants chooses whether to
  - I. Generate 100 MW and meet its ahead schedule by incurring its fuel cost, or
  - II. Generate less than 100MW and "buy the difference" at real-time price
- Better off generating 100 MW if and only if RT price > $50/MWh, otherwise better off producing 0MW (assuming no system service schedule on participant)

RT-market provides participants with the right economic signals to respond to their own commercial needs

AN EXAMPLE OF RT SETTLEMENT

How settlement works

Example uses energy settlement as this is most familiar to participants.
Similar concepts could be applied to system service costs settlement depending on design.

- A resource receives an ahead schedule of V MW at ahead price \$$P_A$/MWh for an hour
- Resource generates q MW in real-time for that hour where RT price is \$$P_R$/MWh, with short run marginal cost of \$C/MWh
- The payoff of the resource is

$$\underbrace{P_A * V}_{\text{Ahead revenue.}} + \underbrace{(q - V) * P_R}_{\text{RT settlement}} - \underbrace{q * C}_{\text{cost}}$$

How resources can respond in real-time

- When a resource generate more in real time than ahead schedule ($q > V$), it receives an additional payment for difference at the real-time price
- Conversely ($q < V$), it buys back the difference at the real-time price
- It is better off buying the difference back if and only if $P_R < C$. That is, the real-time price is lower than its own cost
- The incentive and flexibility of the participant in RT operation remains the same as now.

SPECTRUM OF OPTIONS

Minimum change from current NEM → Enhance firming through ST contracts → Co-optimised energy + system services → Most firm commitment

1. Unit Commitment for Security (UCS - only)	2. UCS plus voluntary forward market	3. System security ahead market	4. Compulsory ahead market design
• Resources committed by system operator if reliability and security gap identified ahead of real-time • UCS is an enhanced unit commitment process compared to current arrangement	• UCS plus voluntary short-term forward market for participants to trade energy ahead of RT • STFM can be designed for both energy and other system services	• Formal co-optimised ahead-scheduling for all services • Participation for some system services ahead scheduling might be mandatory • Voluntary participation in other services including enregy	• Similar to option 3, but • Mandatory participation for all energy and security resources in ahead scheduling • More specific individual plant level requirement • More stringent gate-closure rules

- A formalised market-based unit commitment process is in place in all options
- Progressively (from left to right) more coordinated and co-optimised ahead scheduling for resources

AHEAD MARKET ELEMENTS IN THE SPECTRUM

	1. Unit Commitment for Security (UCS - only)	2. UCS plus voluntary forward market	3. System security ahead market	4. Compulsory ahead market design
Ahead scheduling	N/A	Opportunity to trade short term contracts for energy and system services ahead of real-time.	Co-optimised ahead scheduling of energy and system services.	Mandatory participation for all energy and system service resources.
UCS	Inputs: PDS, economic / technical operating information Output: Physical commitment plan (PCP) for out-of-market resources and some pivotal resources	Similar to option 1, with PDS expected to be updated to reflect VFM outcome	Similar to option 1, with PDS expected to be updated to reflect ahead scheduling outcome	
RT balancing	Stays as per now - mandatory gross pool scheduling. PCP affects payment and operation of relevant resources	Similar to option 1, with VFM schedule included in settlement	Similar to option 1, with ahead market schedule included in settlement	

Q&A

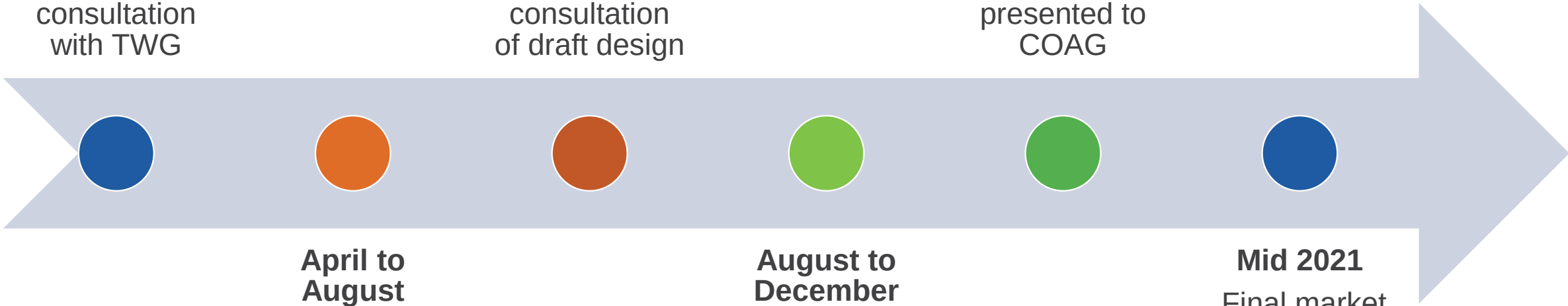
Pause for questions for clarification

ENGAGING IN THE TWG

Proposed plan

Next steps

NEXT STEPS FOR THE AHEAD MARKET DESIGN WORKSTREAM



SEEKING YOUR INPUT

Some issues we specifically want feedback on

Overview:

- Any other key interactions between market design streams?
- What are your views on the future operational challenges facing the NEM?

Ahead Markets – seeking your feedback on:

- the principles for ahead markets.
- key considerations for the design of the UCS, including the commitment of units providing system services that may not otherwise be online.
- key considerations for the ahead market design for providing commercial certainty while maintaining flexibility to respond in real-time to changing market conditions.

How you can provide feedback

- Please provide feedback to info@esb.org.au with email subject heading titled 'TWG ahead markets briefing' by **Tues 14th April**.
- Please get in contact if you have further questions about the material presented today.

- Upcoming TWG meetings:

  14 May – Unit Commitment for Security

  15 June – Ahead market design elements

Note: Essential System Services will be part of separate engagement commencing shortly