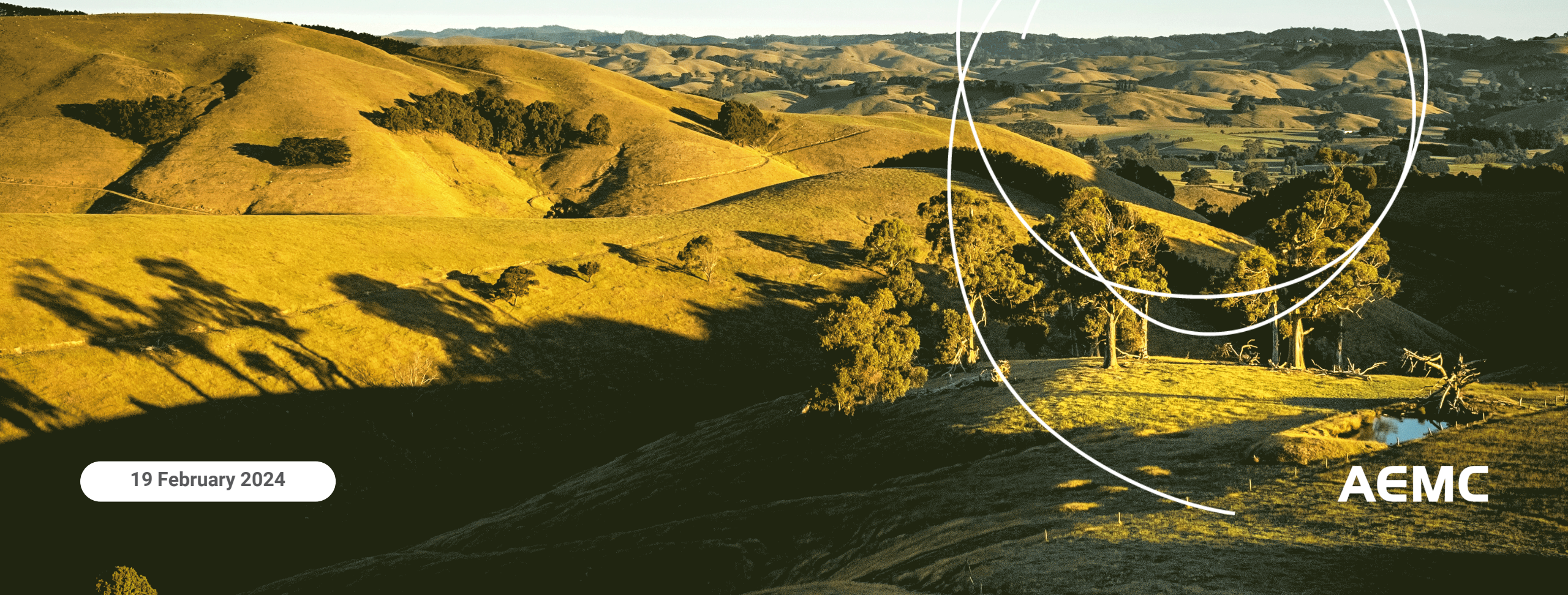
Integrating price responsive resources into the NEM

Public Forum



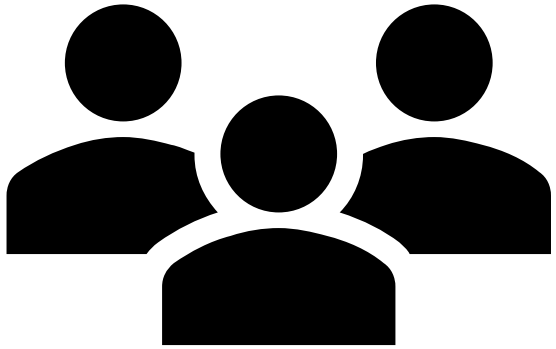
19 February 2024

AEMC

ACKNOWLEDGEMENT OF COUNTRY

The AEMC acknowledges and shows respect for the traditional custodians of the many different lands across Australia on which we all live and work. We pay respect to all Elders past and present and the continuing connection of Aboriginal and Torres Strait Islander peoples to Country. The AEMC office is located on the land traditionally owned by the Gadigal people of the Eora nation.

AEMC project team



Project sponsor: Ben Davis
Project leader: Rachel Thomas

Lead areas
Dispatch lead: Harrison Gibbs

Visibility lead: Sam Markham, Craig Oakeshott

Incentives lead: Rachel Thomas

Agenda

1. Welcome by Charles Popple
2. Introduction to today's forum by Ben Davis
3. Overview of the rule change process by Rachel Thomas
4. Benefits modelling methodology and assumptions by IES
5. Benefits modelling results by IES
6. Break
7. Overview of visibility option by Craig Oakeshott
8. Wrap up

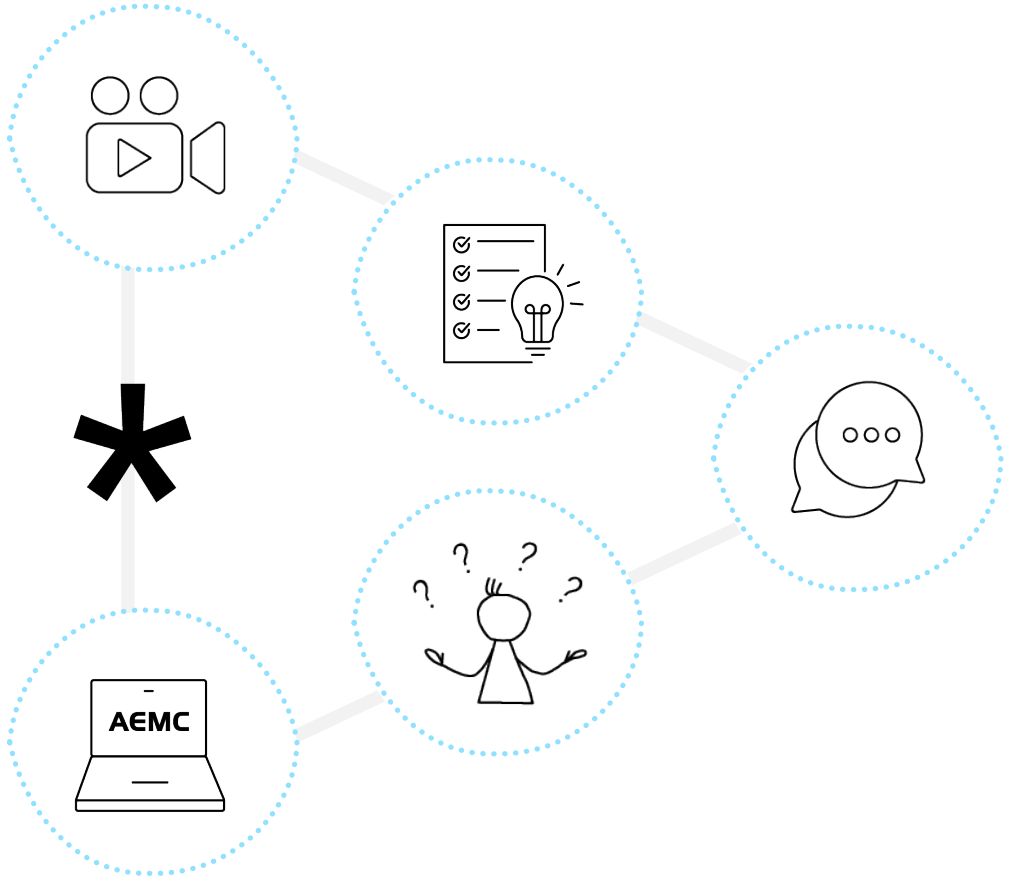
CONSENT TO USE OF PERSONAL INFORMATION

By participating in this forum, **you give your consent** to our collection, use and disclosure of the personal information you provide to us during this forum (like your name) for the purpose of completing our consultation and publishing our draft and final determinations and reports on this rule change or review.

This may include **publishing a recording or transcript of the forum, including your questions or comments.** We will not publish any participant questions or comments that we consider inappropriate, including offensive or defamatory language.

Please read our privacy policy for more information.

We may publish a transcript or recording of this forum, which may include your questions or comments



COMPETITION PROTOCOL

COMMUNICATION AND MEETING GUIDELINES

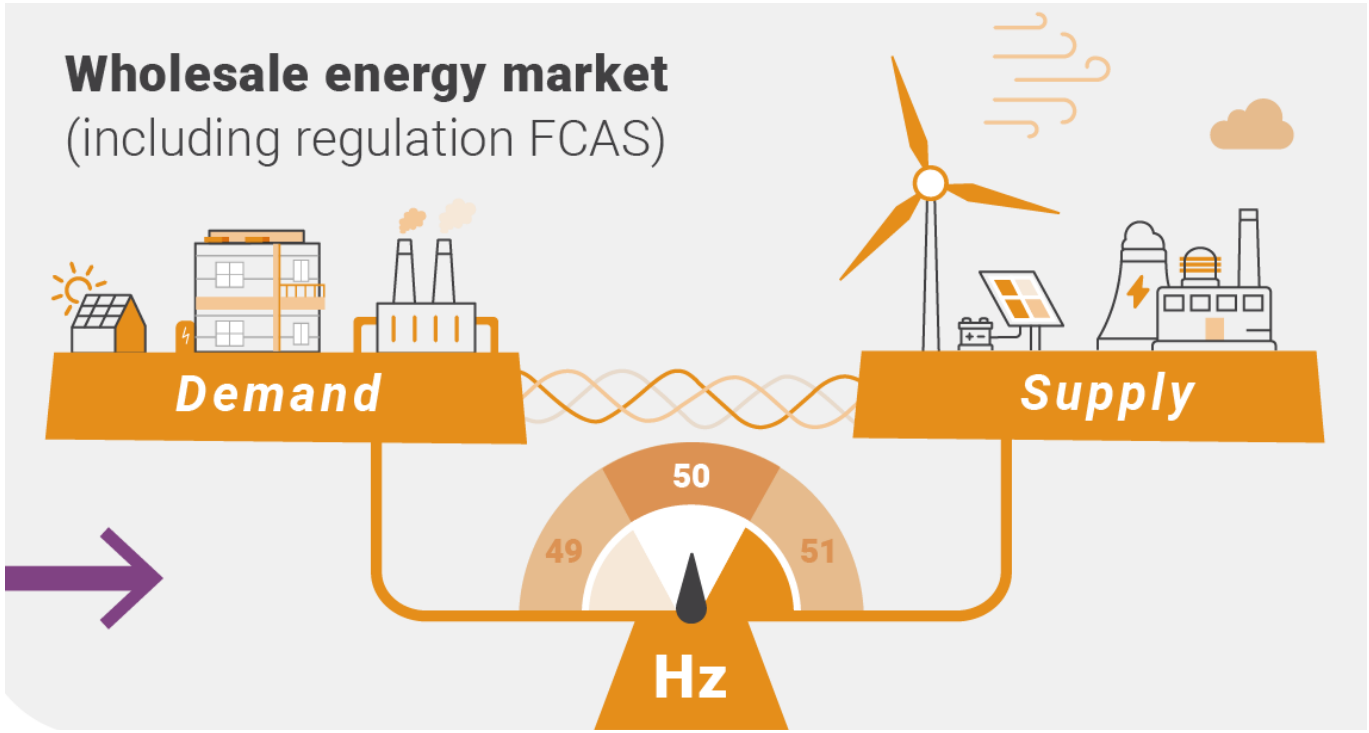
Attendees must ensure that all communications (including emails and verbal discussions) adhere to the ***Key Principles***.

This forum will be conducted in accordance with the following rules:

- The agenda for this forum does not include anything that could contravene the Key Principles set out in this protocol.
- We will read and minute the below *competition health warning*:
  - Attendees at this forum must not enter into any discussion, activity or conduct that may infringe, on their part or on the part of other attendees, any applicable competition laws. For example, attendees must not discuss, communicate or exchange any commercially sensitive information, including information relating to prices, marketing and advertising strategy, costs and revenues, terms and conditions with third parties, terms of supply or access.
  - Participating in this forum is subject to you having read and understood the protocol including the Key Principles.
- We will keep accurate minutes of the forum, including details of attendees.
- If something comes up during the forum that could risk contravening any competition laws, attendees should:
  - Object immediately and ask for the discussion to be stopped.
  - Ensure the minutes record that the discussion was objected to and stopped.
  - Raise concerns about anything that occurred in the forum with their respective legal counsel immediately afterwards.
- All attendees understand that any competitively sensitive matters must be subject to legal review before any commitment/agreement can be given.
- Any decision about whether, and on what terms, to engage with customers and suppliers is an independent and unilateral decision of each attendee.

Overview of the rule change

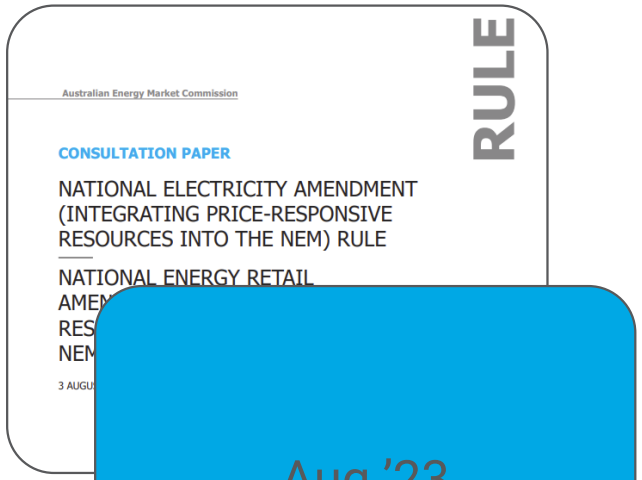
Context: unscheduled price-responsive resources



The increasing ability of distributed resources to be used flexibly is a significant opportunity;

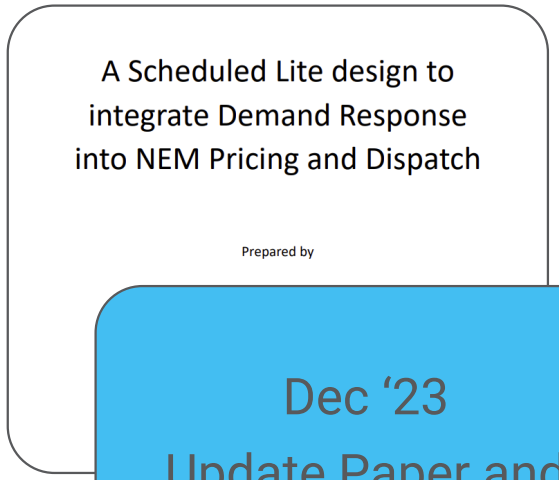
But aren't generally visible to the market or AEMO or scheduled in the wholesale market

Timeline to date



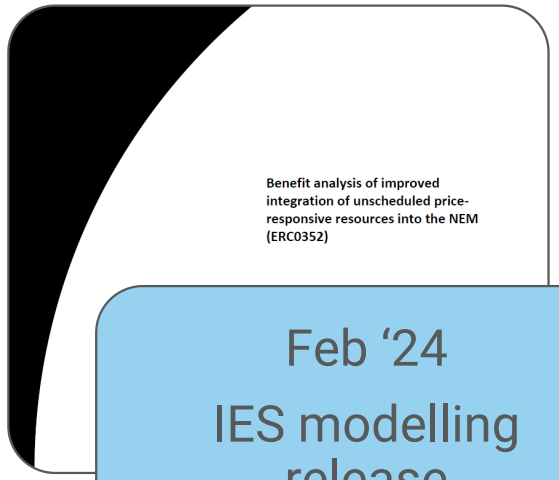
Aug ’23

Consultation Paper



Dec ‘23

Update Paper and Creative Energy Consulting visibility design



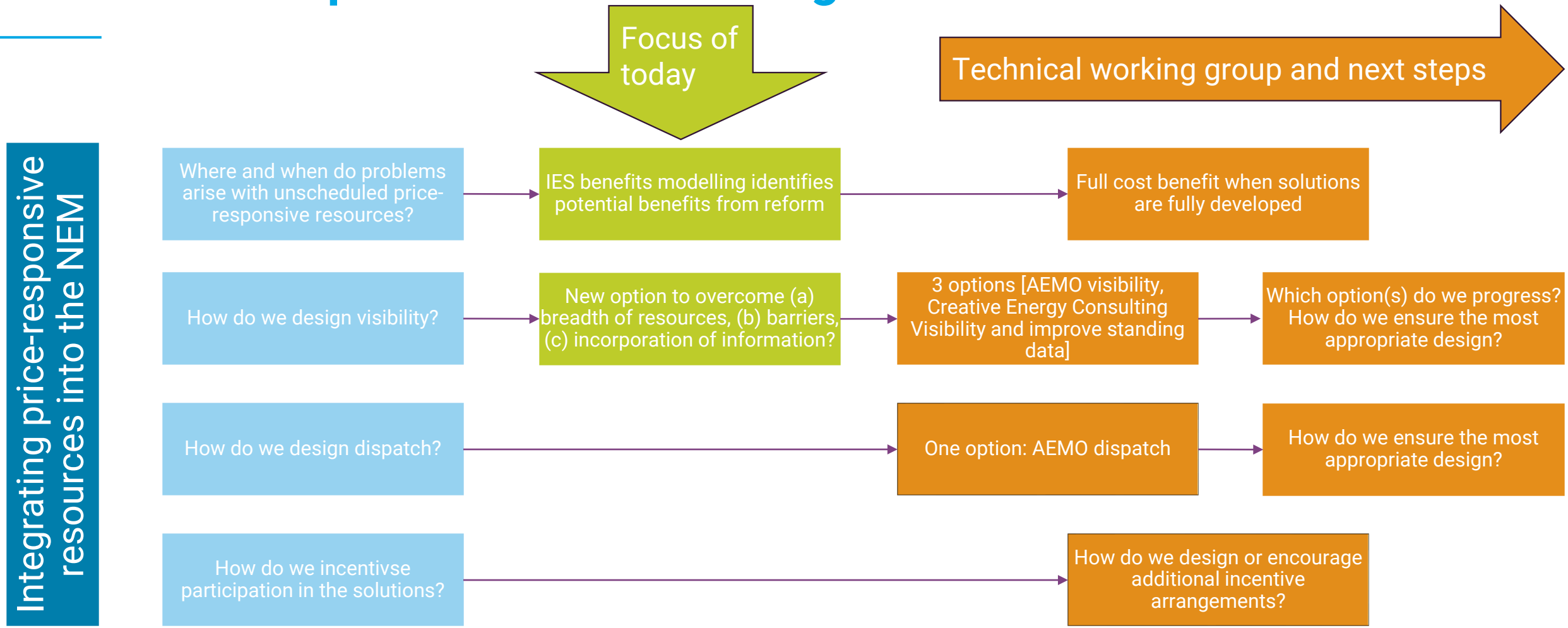
Feb ‘24

IES modelling release

&

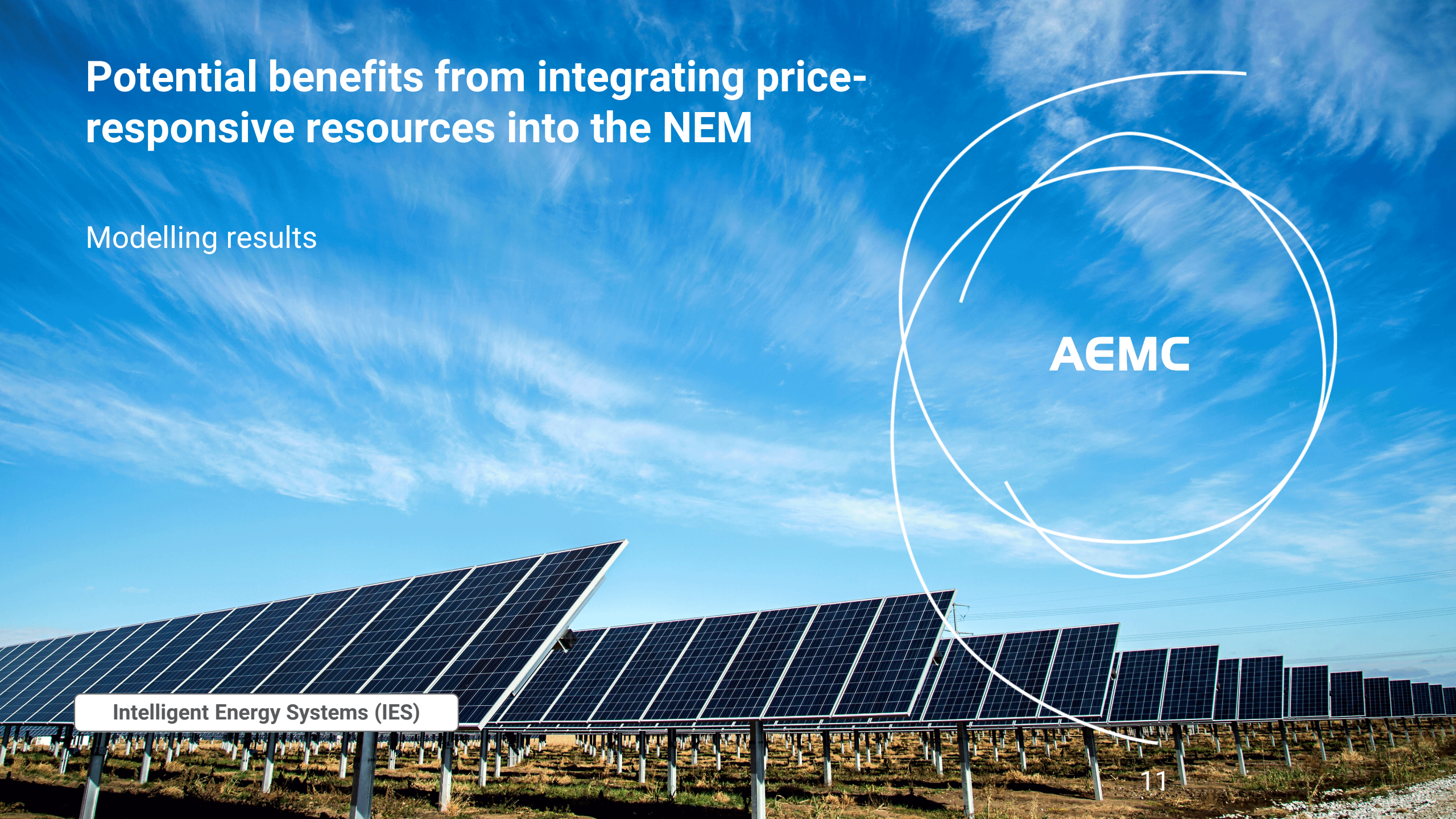
Commence technical working group

The different parts to the rule change



Potential benefits from integrating price-responsive resources into the NEM

Modelling results



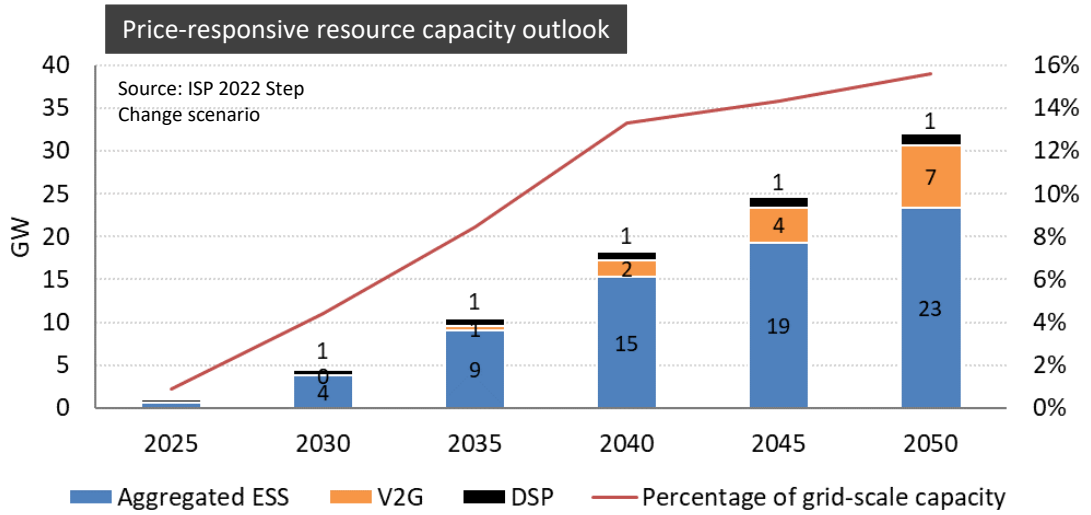
Intelligent Energy Systems (IES)

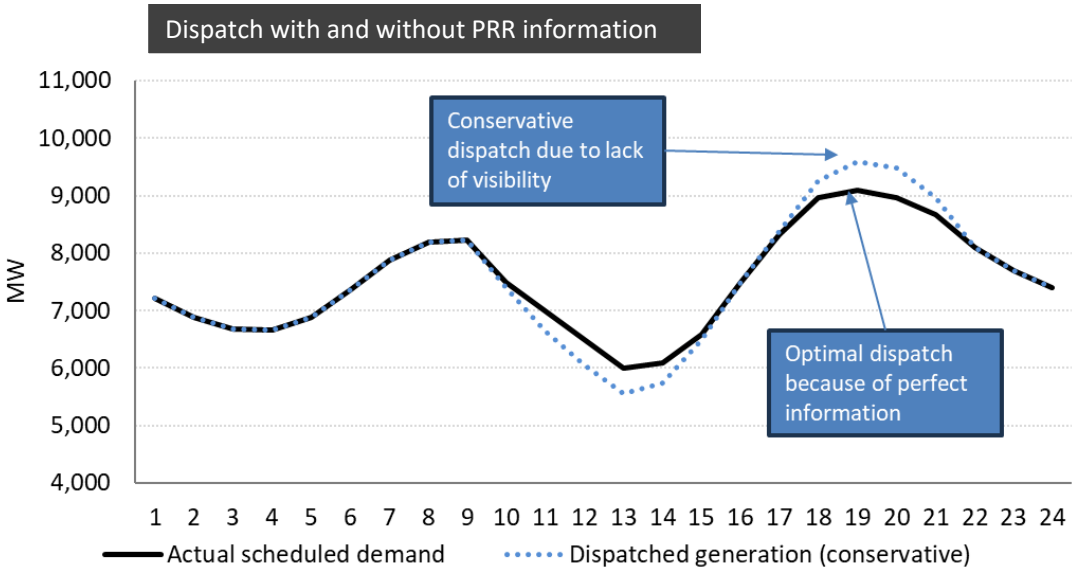
Benefits methodology and assumptions

Overview

- Unscheduled price-responsive resources and dispatch
- Scope of work and key questions
- Modelling elements
  - Base and reform cases
  - PRR types: VPPs and DSP
  - Cost components and benefit categories
  - Assumption: Forecast accuracy of PRR operations

Unscheduled price-responsive resources and dispatch

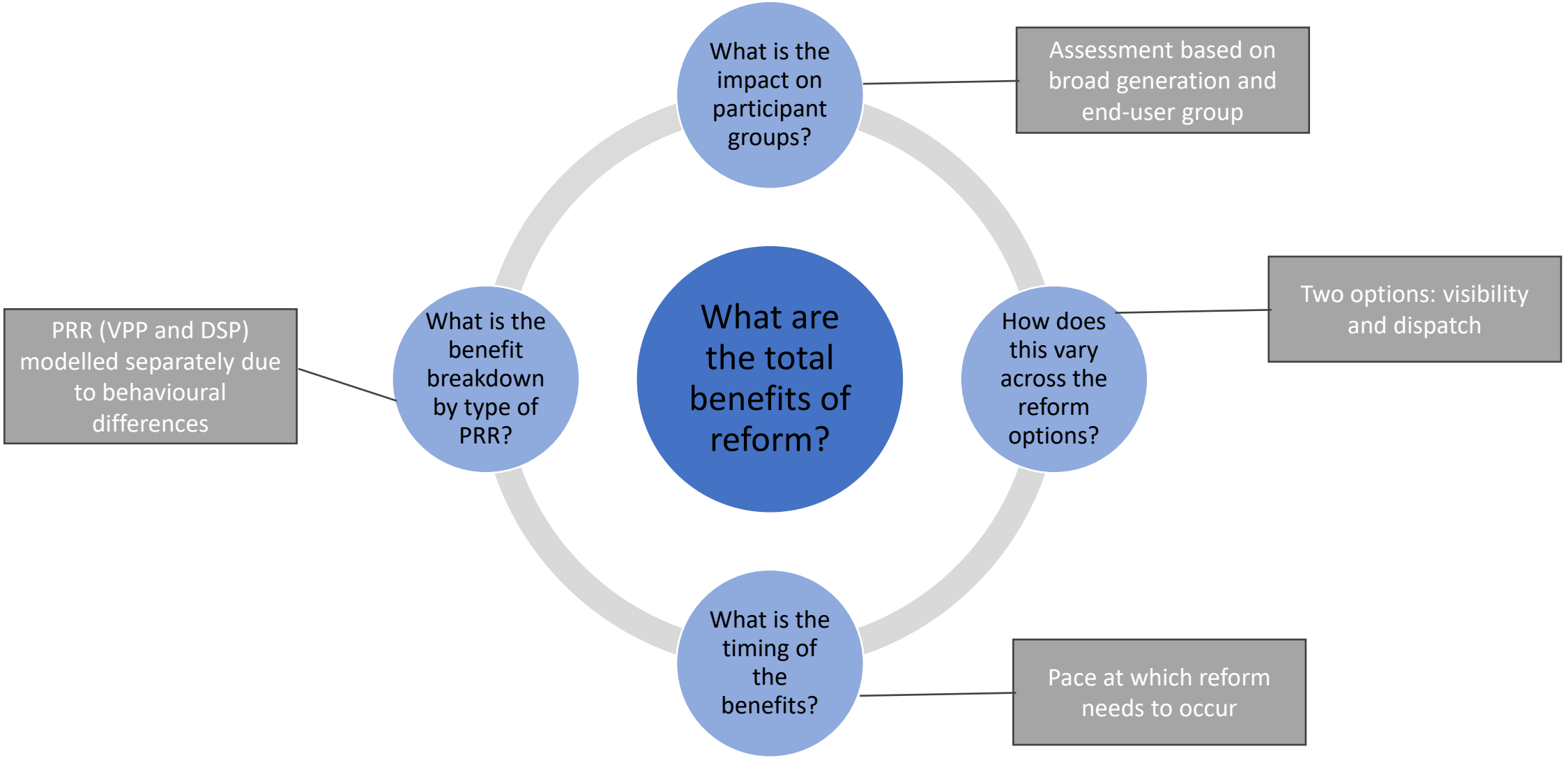




- Currently low but rapid uptake forecast by AEMO
  - These resources respond to both wholesale price changes and system requirements
  - Price-responsive resources (PRR) includes aggregated energy storage systems and vehicle-to-grid (VPP), and demand-side participation (DSP)
- AEMO has limited information on when these resources are operating but needs to account for it in its scheduled demand forecasts which ultimately impacts the level of dispatched scheduled resources
  - Example: during tight system conditions, there will be PRR operating but without visibility of its operations, AEMO most likely will discount its contribution to the and rely more on scheduled generators
- Leads to inefficient dispatch outcomes, primarily:
  - Higher generation costs because forecast demand is higher than actual demand
  - Results in scheduling errors and frequency deviations which will translate into higher FCAS (regulation) requirements and costs

IES Intelligent Energy Systems

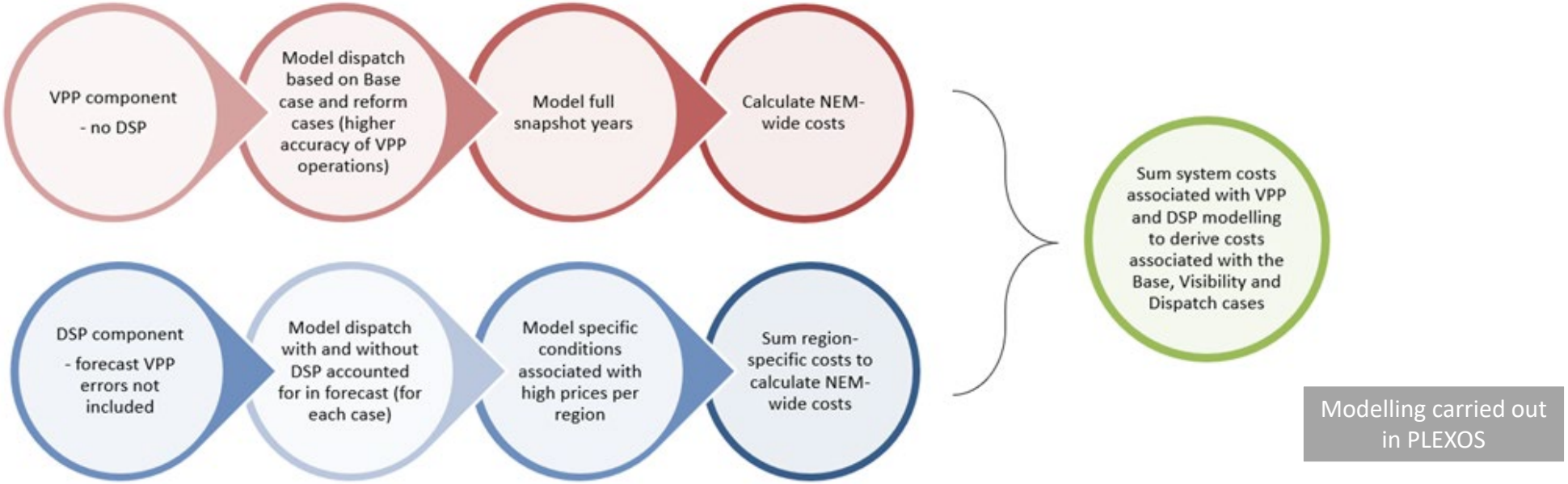
Scope of work and key questions



IES Intelligent Energy Systems

VPP and DSP is modelled separately

- VPP and DSP is modelled separately as the operating features are different
  - VPP: operate daily and we need to capture year-round impacts
  - DSP: triggers only during high price events, or limited intervals per year
  - Modelling has been structured so the total benefit is the sum of the VPP and DSP benefit
  - Implementation cost may vary across VPP and DSP
- The modelling approach to VPP and DSP is fundamentally the same. We are assessing dispatch costs based on AEMO being able to forecast unscheduled PRR operations accurately



Base case and reform cases

Base

- Current arrangements where AEMO's forecasting systems attempt identify potential PRR in its demand forecast without specific reliable information
- Substantial PRR volumes over time lead to material forecasting errors and inefficient dispatch outcomes.

Visibility

- PRR would remain unscheduled and operate outside central dispatch
- Arrangement for PRRs to submit operational info to AEMO
- Lower barriers of entry which will incentivise higher participation offset by informational inaccuracies

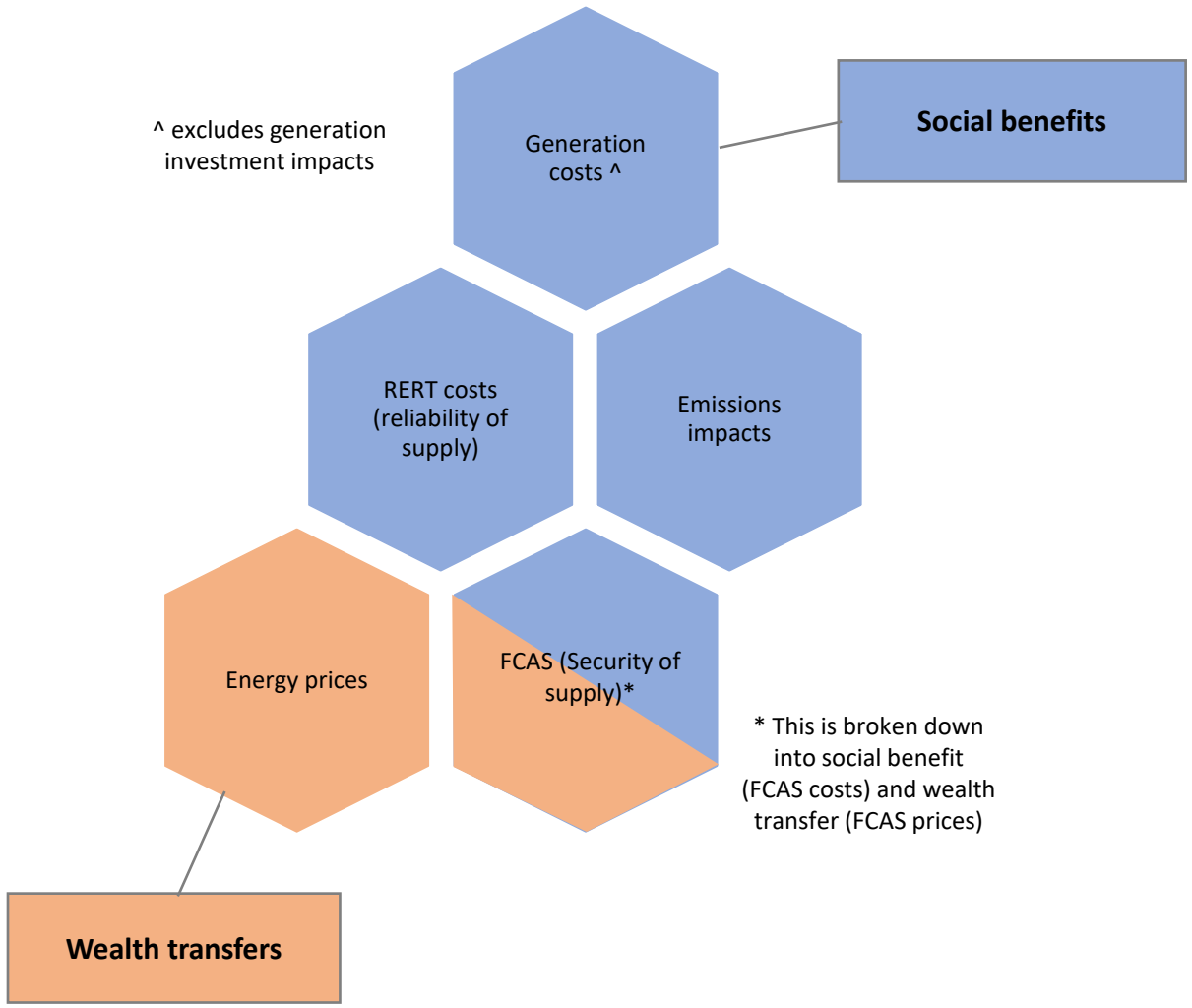
Dispatch

- Integrate unscheduled PRR into the NEM central dispatch and scheduling processes
- Higher barriers to entry than Visibility, but central dispatch means higher conformance
- Higher participation in FCAS markets because of dispatchability

Increased operational information provided to AEMO leading to lower forecasting errors. We assume the same uptake of PRR across all cases, the only difference is participation and therefore information supplied.

IES Intelligent Energy Systems

Functional areas and benefit grouping



- Five functional areas drive the overall costs associated with each of the modelled cases
- There are volume and price differences across the Base and Reform cases which corresponds to the overall reform benefit.
  - Social benefits are actual cost savings (reduction in system costs and emissions) from volume impacts
  - Wealth transfers represent a shift in prices and therefore costs from one group to another (generator to consumers).
- Social benefit + wealth transfer = total benefit, assuming the total amount will flow through to the consumer

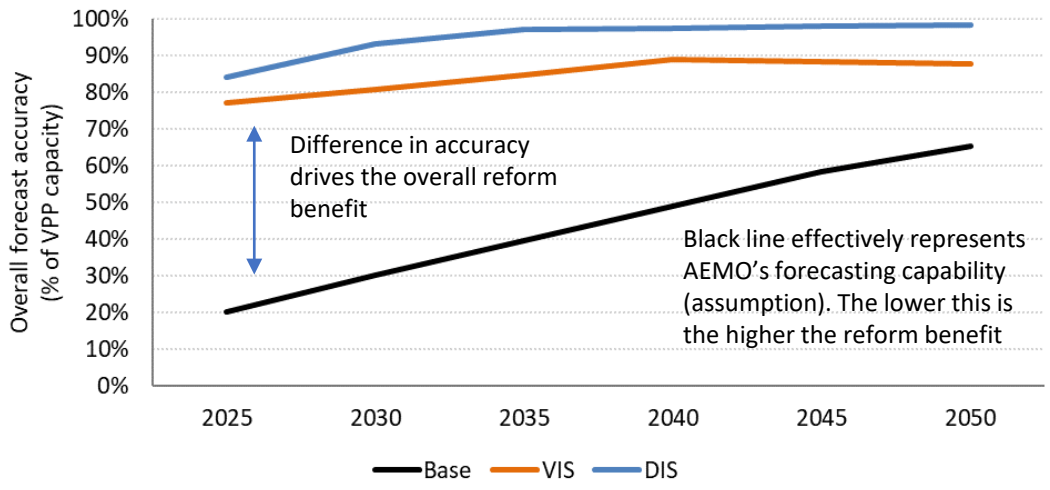
Matrix of outcomes

2 x PRR types (VPP and DSP) → 3 x cases (Base, Visibility, Dispatch) → 2 x benefit types (social benefit and wealth transfer)

IES Intelligent Energy Systems

Key assumption: Forecast accuracy of PRR operations

Overall forecast accuracy assumption (percentage of VPP capacity)

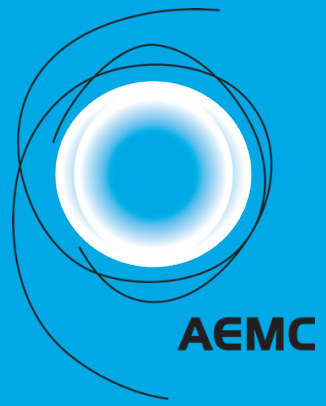


Factors driving forecast accuracy assumption (VPP)

VPP	Base	Visibility	Dispatch
1. Participation, or provision of info	No reform	Very high	High
2. Conformance		Med-high	100%
3. Forecast correction	Improves over time. Rate of improvement is held constant across all cases		
Overall accuracy	20-65	80-90	85-99

- The Base and Reform cases differ with respect to AEMO's forecast accuracy of PRR operations. Accuracy is a function of three factors:
  1. Operational information provided to AEMO through participation of reform mechanism
  2. Conformance against operational information
  3. AEMO's forecasting capability in addressing structural errors or inaccuracies from (1) and (2)
- The higher the scheduling accuracy, the more efficient dispatch or lower the cost. Dispatch mode has the highest visibility
- DSP is not dispatchable, and the Reform cases collapses into a single case. Assume 100% accuracy for DSP in reform case

Q&A



Results

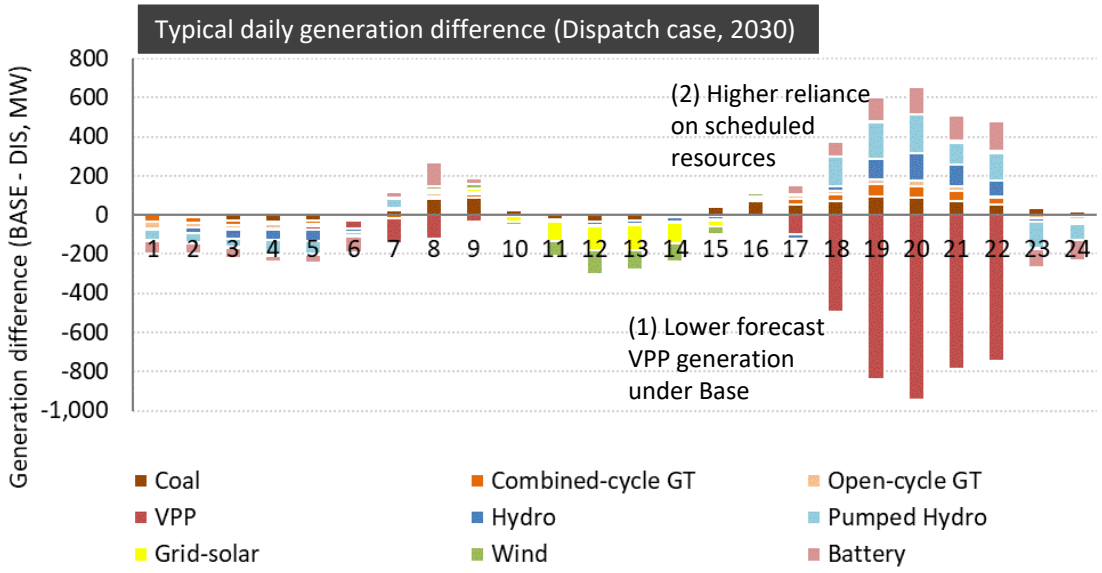
Results overview

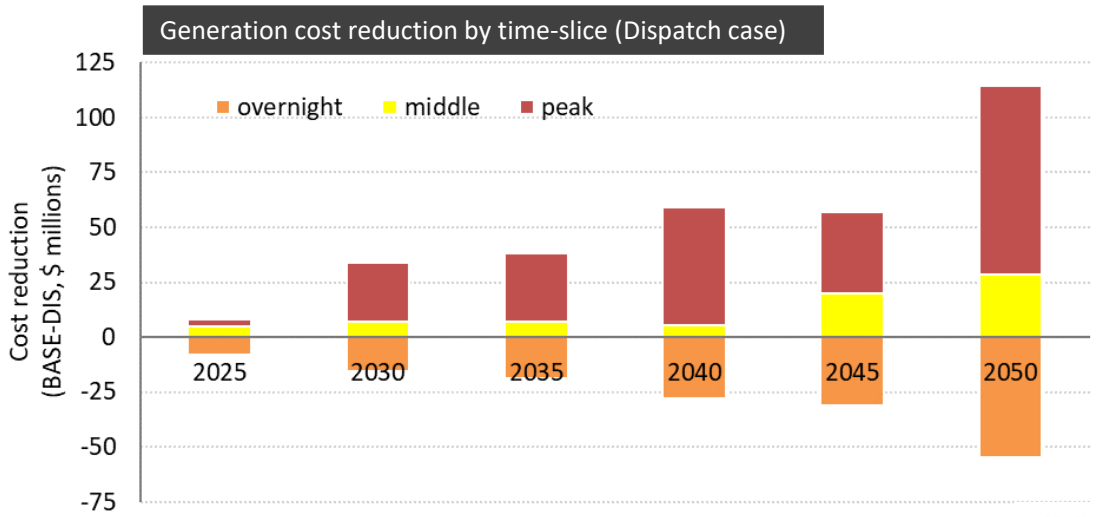
- Results section has been split into social benefits and wealth transfers across the relevant cost categories
- All figures are in June 2023 dollars and NPV figures are calculated as of 2025 at 7% pa

($ millions, NPV)	Social benefit	Wealth transfers
Generation	154 – 186	0
FCAS	711 – 889	586 - 738
RERT	121	0
Emissions	514 – 719	0
Energy	0	10,425 - 11,011
Total	1,500 - 1,915	11,011 - 12,064

IES Intelligent Energy Systems

Social benefits – generation cost (VPP)



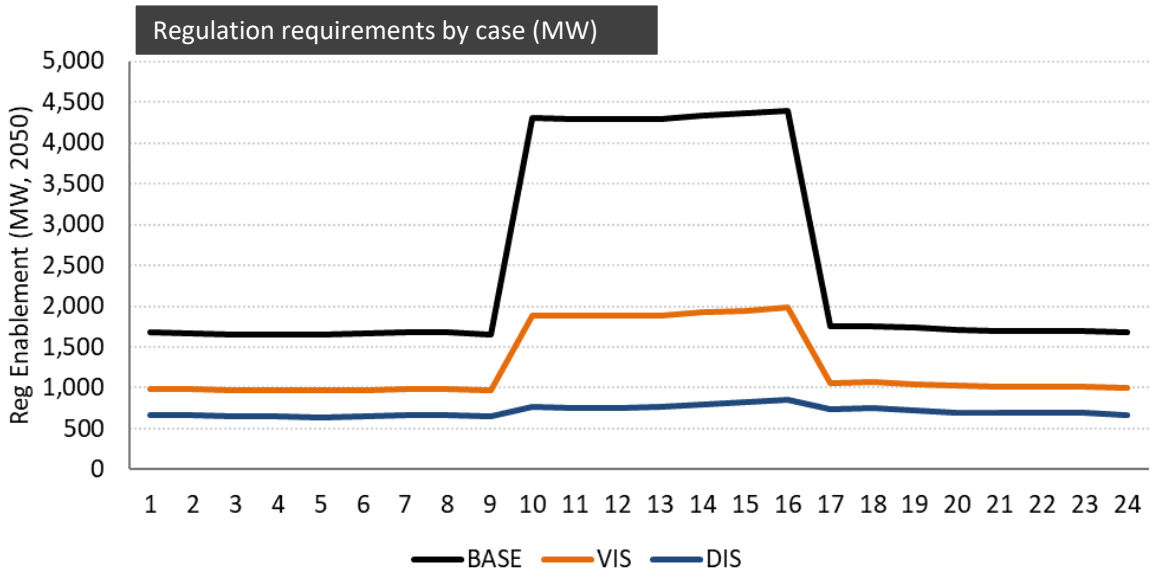


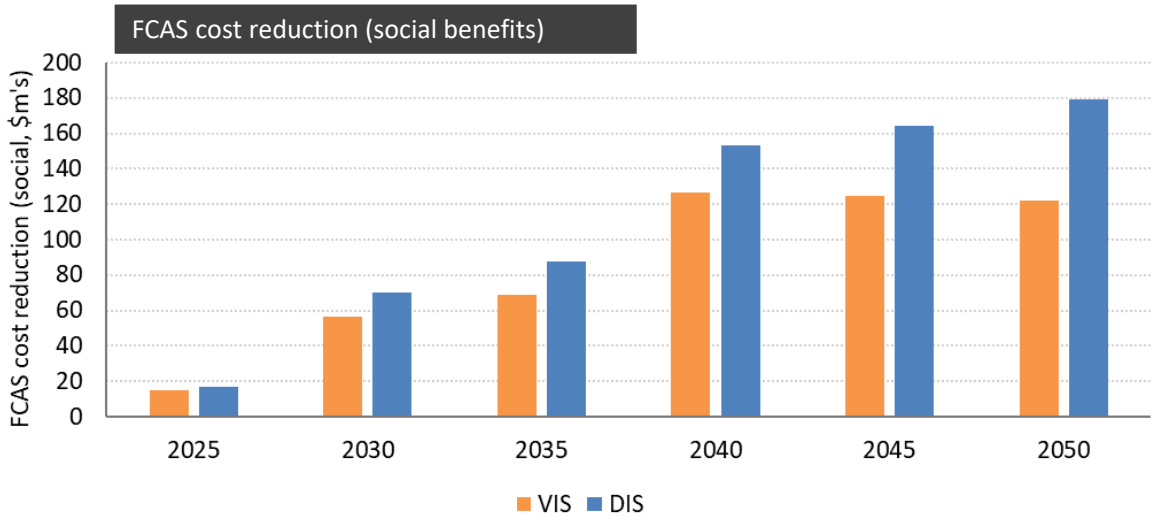
- Generation cost savings mainly from VPP modelling as DSP triggers very infrequently and therefore minimal generation volume differences
- VPP included in the generation difference chart for reference to show the lower levels of VPP contribution to Base case evening peak which results in additional scheduled generation
  - Thermal generation comprises a subset of this which results in higher generation costs under the Base case.
- Aggregating the costs by time of day, there are cost savings during the daily peak hours offset by higher costs during overnight periods.
  - Higher forecasting accuracy leads to higher VPP charging requirements. This is largely met by low-cost generation

NPV of generation cost benefit ($m's)
Visibility: $154 million
Dispatch: $186 million

IES Intelligent Energy Systems

Social benefits – FCAS costs (VPP)



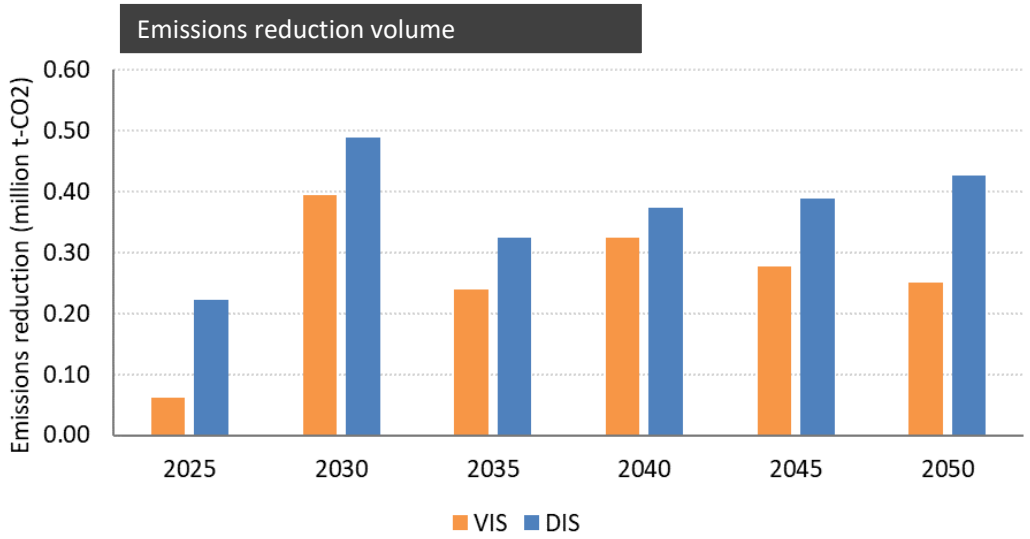


- FCAS benefits, under the VPP modelling, arise from reduction in volumes and prices. The social benefit refers to the change in volume only (based on holding prices constant)
- The level of forecast inaccuracy increases over time due to non-visible VPP operations and limited forecast correction assumptions.
- Under the Base case this reaches 10 GW by 2050, leading to significant forecasting errors. The modelled raise regulation requirements to address the maximum deviation between forecast and actual demand exceeds 4 GW
- The additional regulation increases and results in up to $180 million pa in additional (opportunity) costs over time

NPV of FCAS cost benefit – volume change ($m's)
Visibility: $711 million
Dispatch: $889 million

IES Intelligent Energy Systems

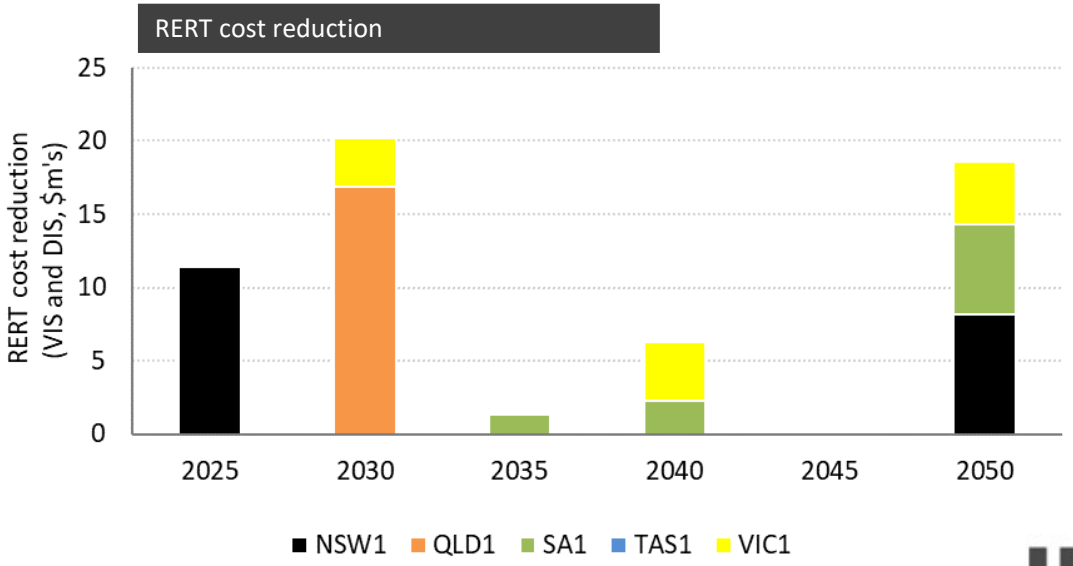
Social benefits – emissions (VPP) and RERT costs (DSP)



- Emissions reduce in line with generation cost outcomes. Savings of up to 0.5 Mt CO2 pa in the reform cases due to over-scheduling of peaking (thermal) generation associated with the Base case. Roughly 0.8% of total NEM emissions
- Corresponding value of emissions from NSW Treasury (to be replaced with Commonwealth VER when available)*

NPV of emission cost benefit ($m's)
Visibility: $514 million
Dispatch: $719 million

* $123/t increasing to $150/t by 2032, and $204/t in 2050 (extrapolated)

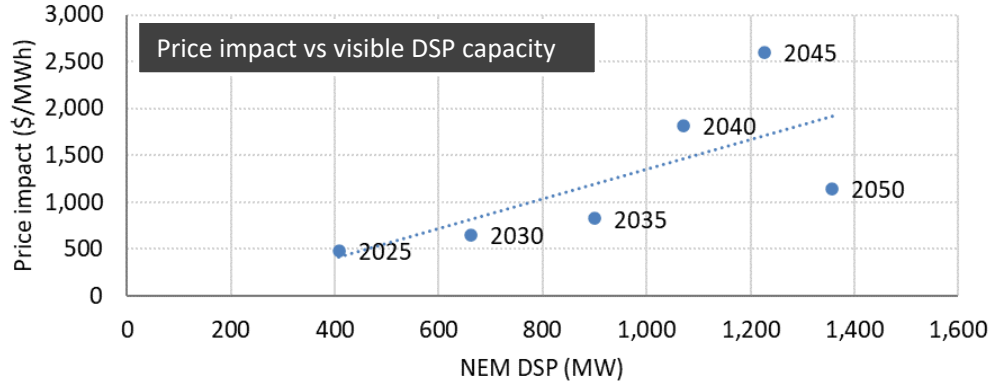


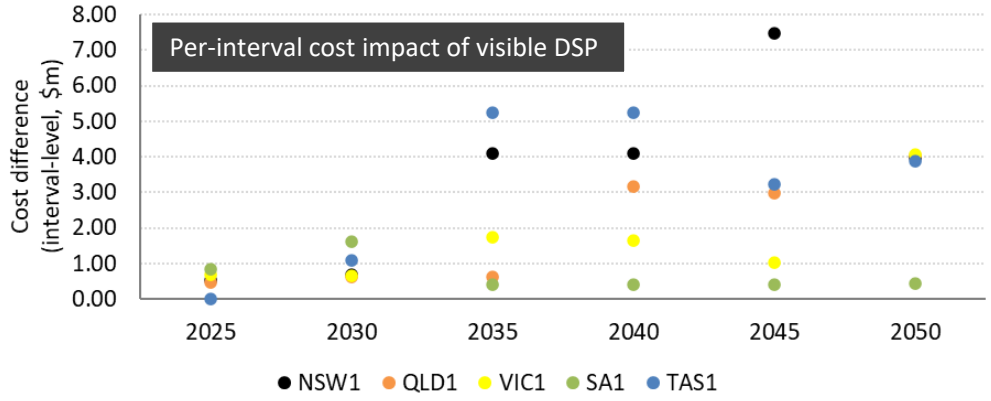
- There are substantial RERT/intervention cost savings on a per event/interval basis because of the reduction in RERT volumes from having more reliable DSP operational information
- The overall cost is low as the frequency at which RERT is expected to occur based on historical weightings is significantly lower than other costs.

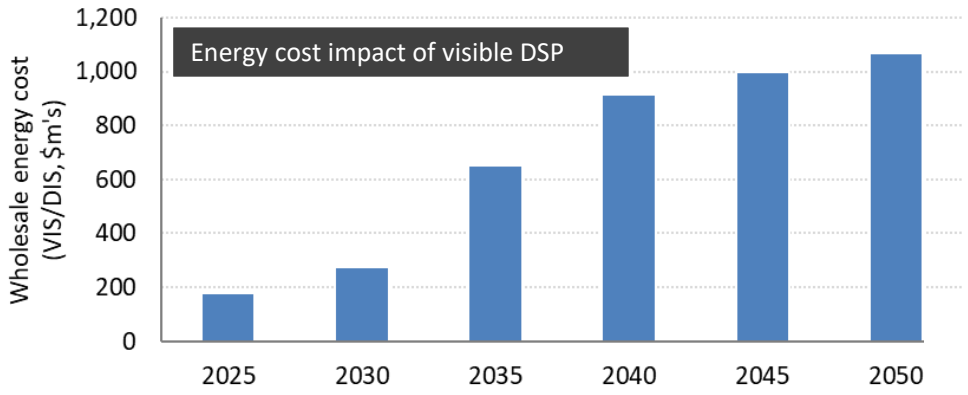
NPV of RERT cost benefit ($m's)
Visibility and Dispatch: $121 million
Single reform case under the DSP modelling

IES Intelligent Energy Systems

Wealth transfers – energy prices (DSP)





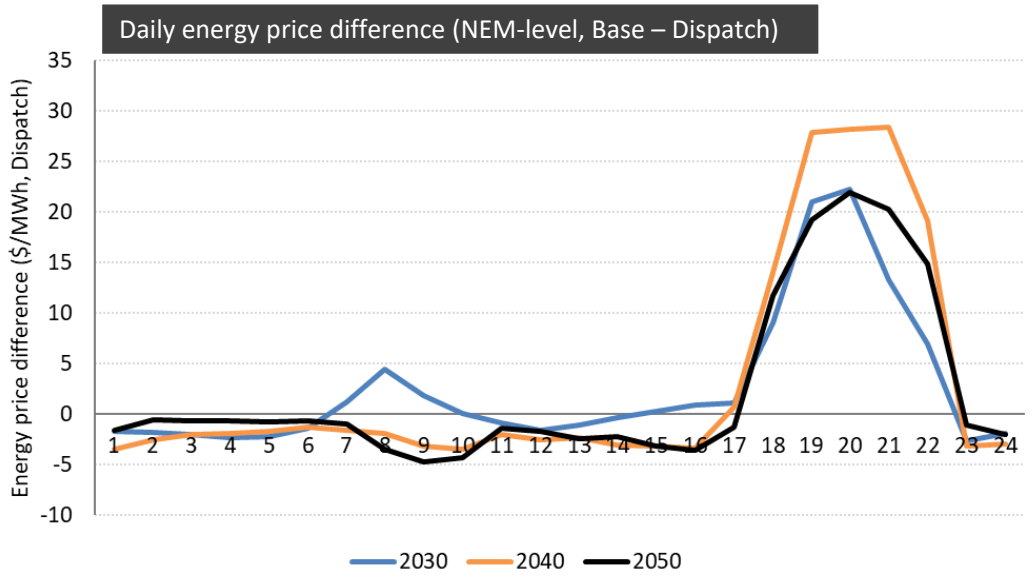


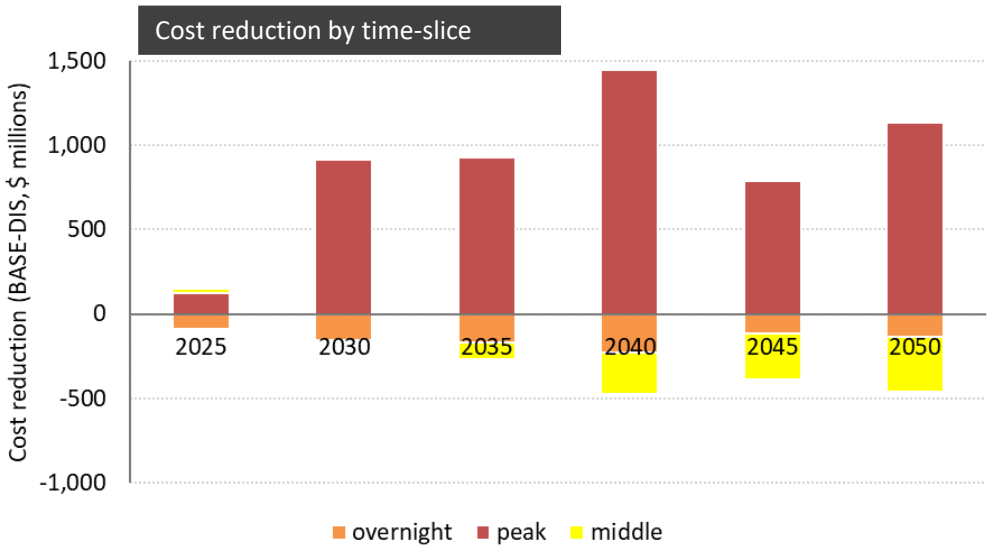
- DSP modelling creates significant wholesale energy price impacts
- This arises due to over-dispatch in the absence of integrating DSP, resulting in higher spot prices
- Pricing impact, up to $2,500/MWh, increases with increasing DSP volumes over time (up to 1.4 GW by 2050)
- The pricing impact applies to the entire scheduled demand, and every instance of DSP accounted for in scheduling potentially results in savings from $1 to $8 million per interval
- The per-interval savings are multiplied by the number of historical high-price intervals to derive the annualised cost savings which increases from $170 million initially up to $1.1 billion pa by 2050

NPV of energy cost benefit – DSP ($m's)
Visibility and Dispatch: $5.5 billion
Single reform case under the DSP modelling

IES Intelligent Energy Systems

Wealth transfers – energy prices (VPP)





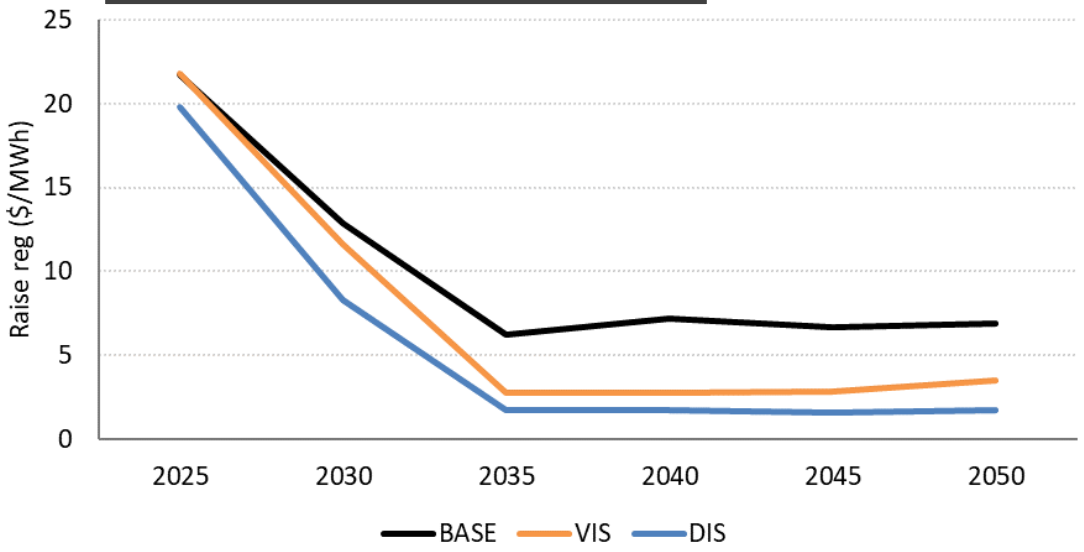
- There are high wealth transfers from a change in energy prices under the VPP modelling
- The scheduling of more generation resources during the peak (as seen earlier) under the Base case result in higher energy prices
- Scheduled demands are roughly 2.5 GW and 3.5 GW lower in the Visibility and Dispatch cases by 2050, which translate to energy prices that are on average $25/MWh and $30/MWh lower across the evening peak (Dispatch case shown here)
- The total energy cost reduction across the evening peak corresponds to this energy price difference multiplied by the actual demand level, which is the same across all cases

NPV of energy cost benefit – VPP ($m's)
Visibility: $4.9 billion
Dispatch: $5.8 billion

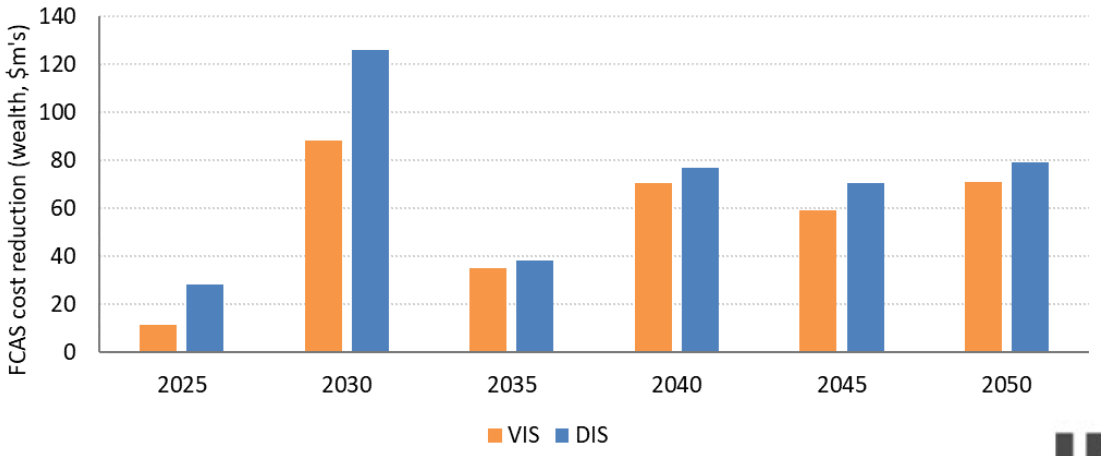
IES Intelligent Energy Systems

Wealth transfers – FCAS prices (VPP)

Annual regulation price by case (time-weighted)



FCAS cost reduction by case (wealth transfers)



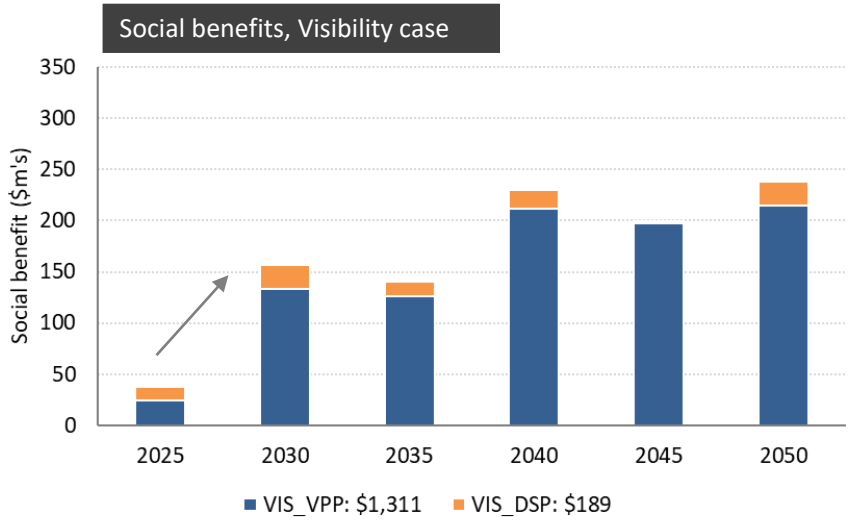
- Higher regulation requirements in the Base case, combined with lower FCAS provision assumptions across VPPs, lead to higher regulation prices and costs
- Wealth transfers arising from FCAS costs are based on fixing FCAS enablement levels and show up to $120 million in additional FCAS costs under the Base case in 2030

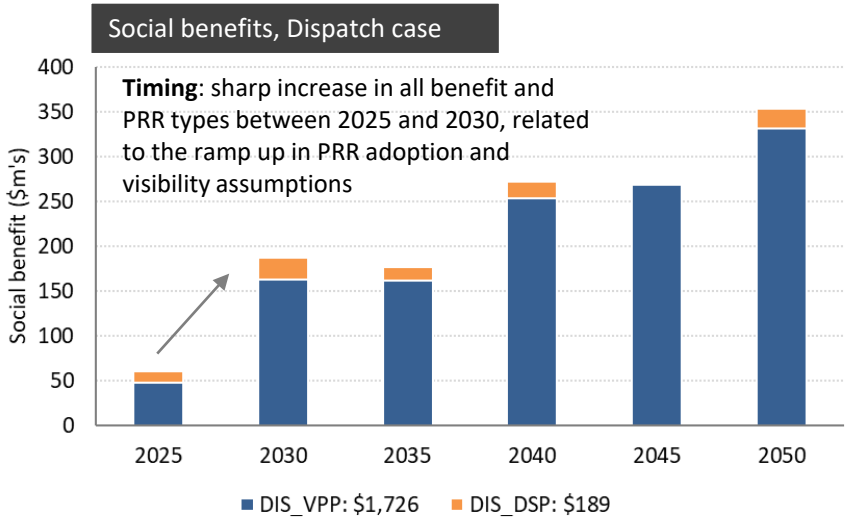
NPV of FCAS cost benefit – price change ($m's)
Visibility: $586 million
Dispatch: $738 million

IES Intelligent Energy Systems

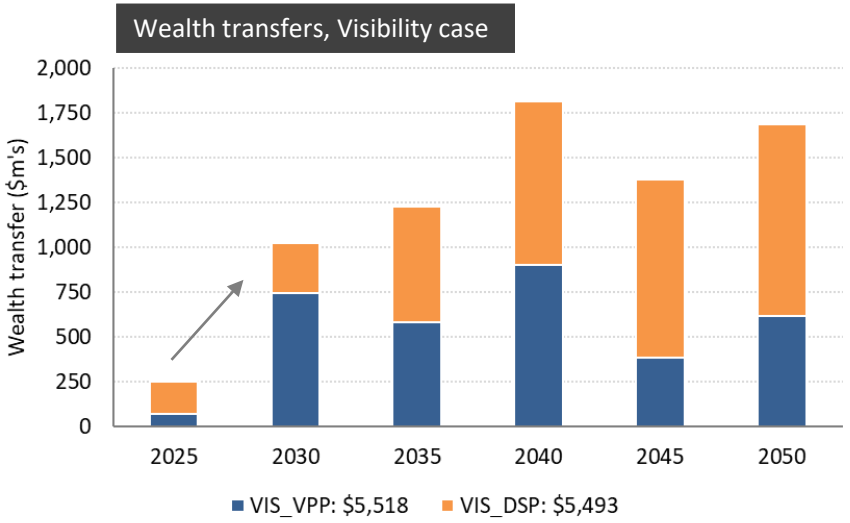
Timing of benefits by PRR type and reform option

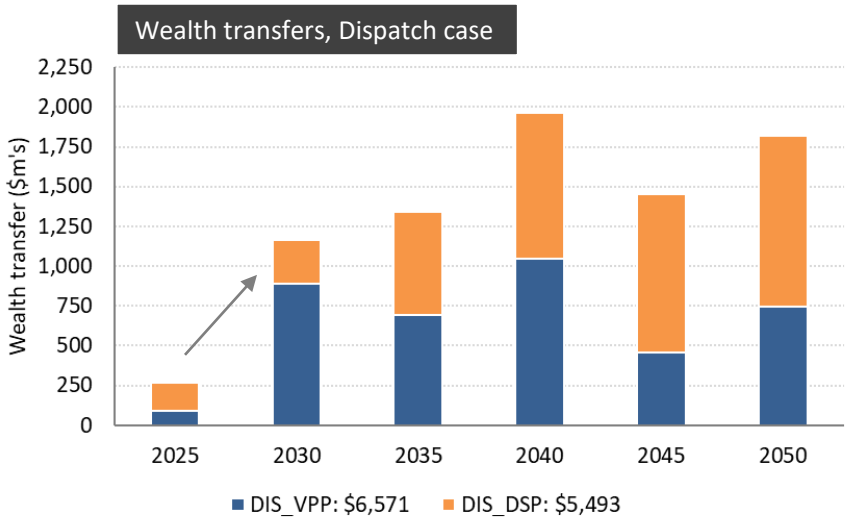
- **Social benefits** associated with VPPs ($1.3 - $1.7 billion) are significantly higher than under the DSP modelling ($189 million). This is due to higher reductions in thermal generation and emissions under the VPP modelling, whereas DSP triggers infrequently.





- **Wealth transfers**, is equally significant across both PRR types and significantly higher than the social benefit. However, the modelling ignores generation investment impacts which would have otherwise occurred in the Base case from higher pricing signals, dampening the pricing impacts.





IES Intelligent Energy Systems

Key findings (NPV basis)

- Widespread adoption of PRR, forecast to reach 31 GW by 2050, combined with a lack of visibility is expected to contribute to material scheduling errors
- The significant reform benefits relates to improved visibility of VPP and DSP operations which would allow AEMO to dispatch fewer scheduled resources during peak periods and reduce the need to procure high levels of FCAS regulation to deal with scheduling inaccuracies

Benefits across reform cases

- $12.5 to $13.9 billion
- Approximately 2.5% of total wholesale energy and FCAS costs over the modelling horizon

Benefits across cost categories

- Generation: $170 million (average)
- FCAS: $1.3 to $1.6 billion
- RERT: $121 million
- Emissions: $514 to $720 million
- Energy: $10.4 to $11.3 billion

Benefit type split

- Social benefit: $1.5 to $1.9 billion
- Wealth transfer: $11 to $12 billion
- Wealth transfer overstated as generation investment not accounted for

Benefit across PRR types

- VPP: $6.8 to $8.3 billion
- DSP: $5.7 billion
- DSP benefits are almost as high as VPP and concentrated across small subset of intervals across the year

Timing of benefits

- Total benefits of approximately $300 million in 2025, and increasing four-fold to $1.3 billion by 2030
- Benefit trajectory gradually increases to 2050

IES Intelligent Energy Systems

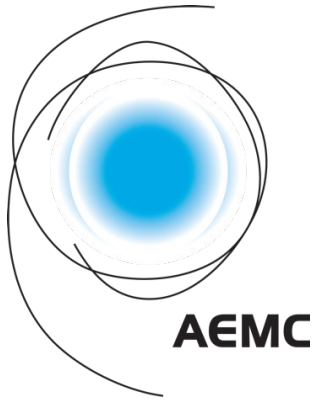
* Quoted ranges are for the Visibility (lower bound) and Dispatch (upper bound) cases

Implications for the rule change

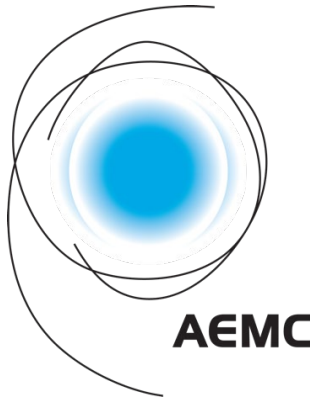
Implications from benefits modelling

IES findings	Implications for rule change
Cost reduction / social benefits amount to $1.5 - $1.9b (visibility – dispatch reform cases)	The findings warrant progressing with the rule change.
Price reduction / wealth transfer benefits amount to $11 - $12b (visibility – dispatch reform cases)	IES held entry and exit of generation constant, which leads to the very high energy price reduction benefits. The likely real-world scenario from high prices in the no reform world is that they would result in new entrants to the market, thereby reducing this (price) benefit but **increasing** the social benefits through a productive efficiency gain. The significant amount further demonstrates the importance of the rule change.
Benefits begin to arise from 2025, with a sharp increase by 2030	This supports our rule change progressing promptly.
Benefits are a 'size of the prize' from this rule change	This modelling is the size of the prize benefits. That is, the benefits if we design two perfect mechanisms and there is full participation from the devices/participants that are capable of participating. The benefits are large but will only occur if we can develop an effective incentive framework for participation. This is a crucial and challenging area of the rule change.
Interactions of visibility and dispatch mode	IES did not model a hybrid mechanism – dispatch and visibility mode. However, the modelling provides evidence that this is the ideal solution. This is because it demonstrates the greater benefits on a per unit basis from dispatch mode **and** the greater benefits from higher participation of visibility mode.

Q&A

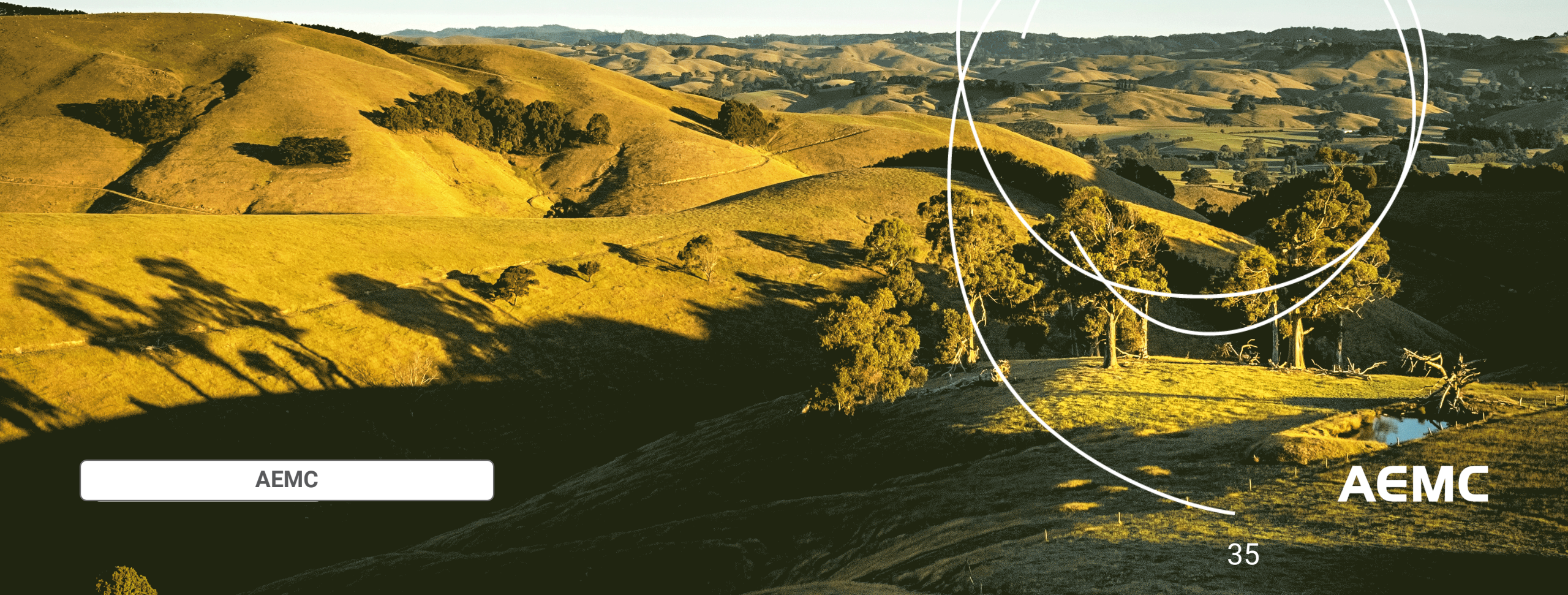


Break



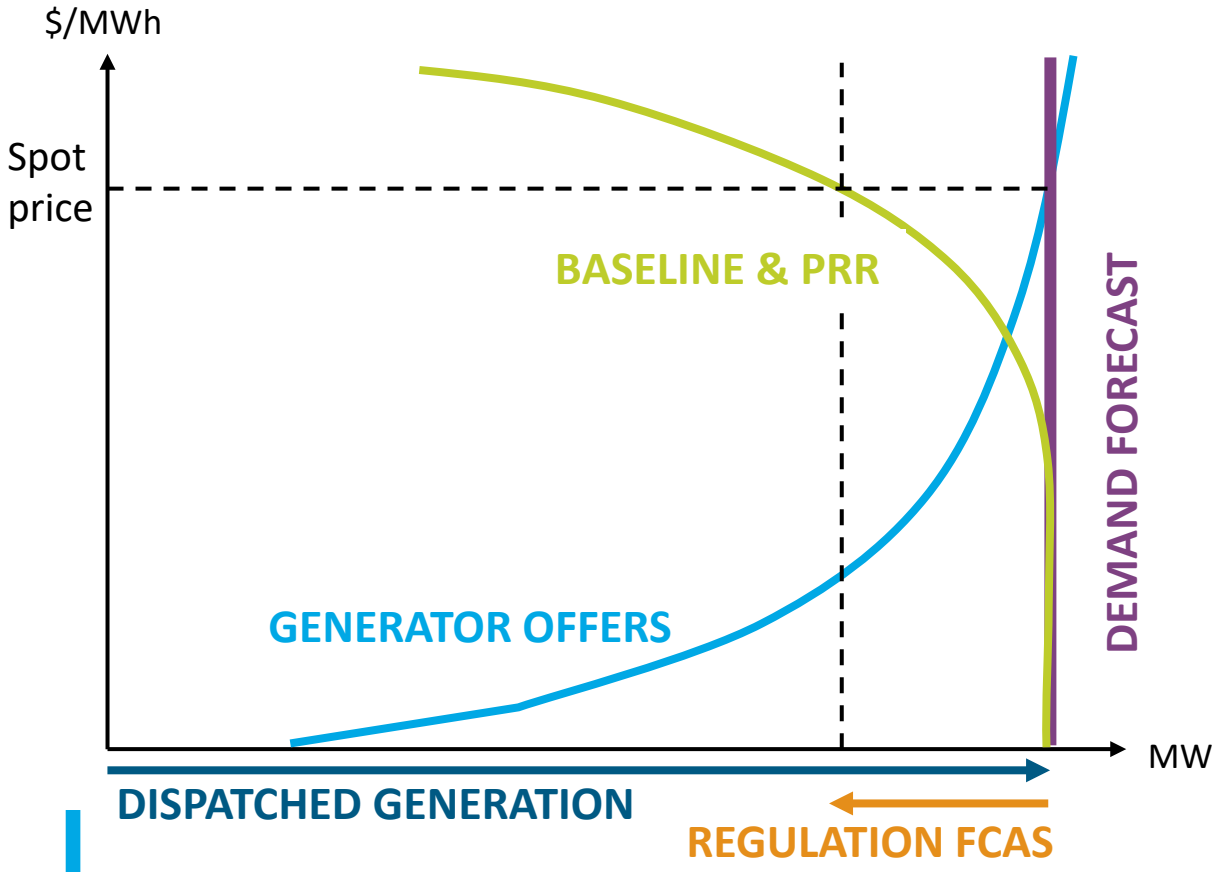
Visibility

Consultant Report



AEMC

Currently Price-responsive resources are invisible



Currently, while demand is assumed to be inelastic, some percentage of customer demand is price-sensitive.

Predicting the response of this price-responsive resource is largely outside the capability of current demand forecasting practice.

Forecasting doesn't iterate to set price and generation to meet forecast demand but that demand is different because of price-responsive resources.

Results in inefficient:

- Dispatch outcomes and increased costs
- Procurement and use of more FCAS to correct for the poor dispatch
- Pricing that is not representative of actual supply requirements

While PRR remains small, there is no threat to system security, but forecasts predict significant volumes in the future and potentially significant additional costs that ultimately affect the price of electricity.

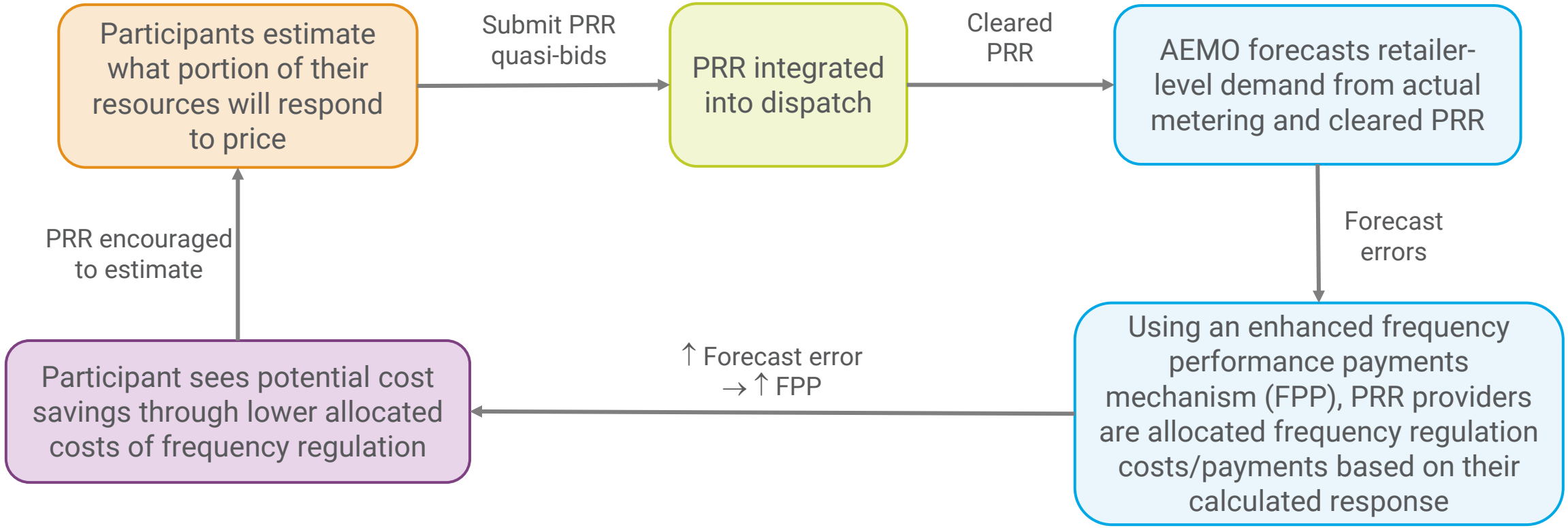
Overview of ‘visibility mode’ objectives

- There are key aspects that we want a visibility solution to achieve:
    1. Incorporate PRR into forecasting to achieve the benefits indicated in modelling
    2. Be applicable to the broad range of participants and the range of price-responsive resources (demand side participation and virtual power plants)
    3. Encourage participation through market mechanisms that reflect the value of the price-responsive resources to the market (to the extent possible)
    4. Simple to participate and hopefully a low barrier to entry

- We are considering three options:
    - AEMO visibility, amended (*AEMO visibility mode*)
    - Alternative approach as discussed by Creative Energy Consulting (*alternative visibility mode*)
    - Improving standing data (*improving standing data*).

Overview of alternative visibility mode

Key
Prior to dispatch
Dispatch
Metering and settlements
Incentives

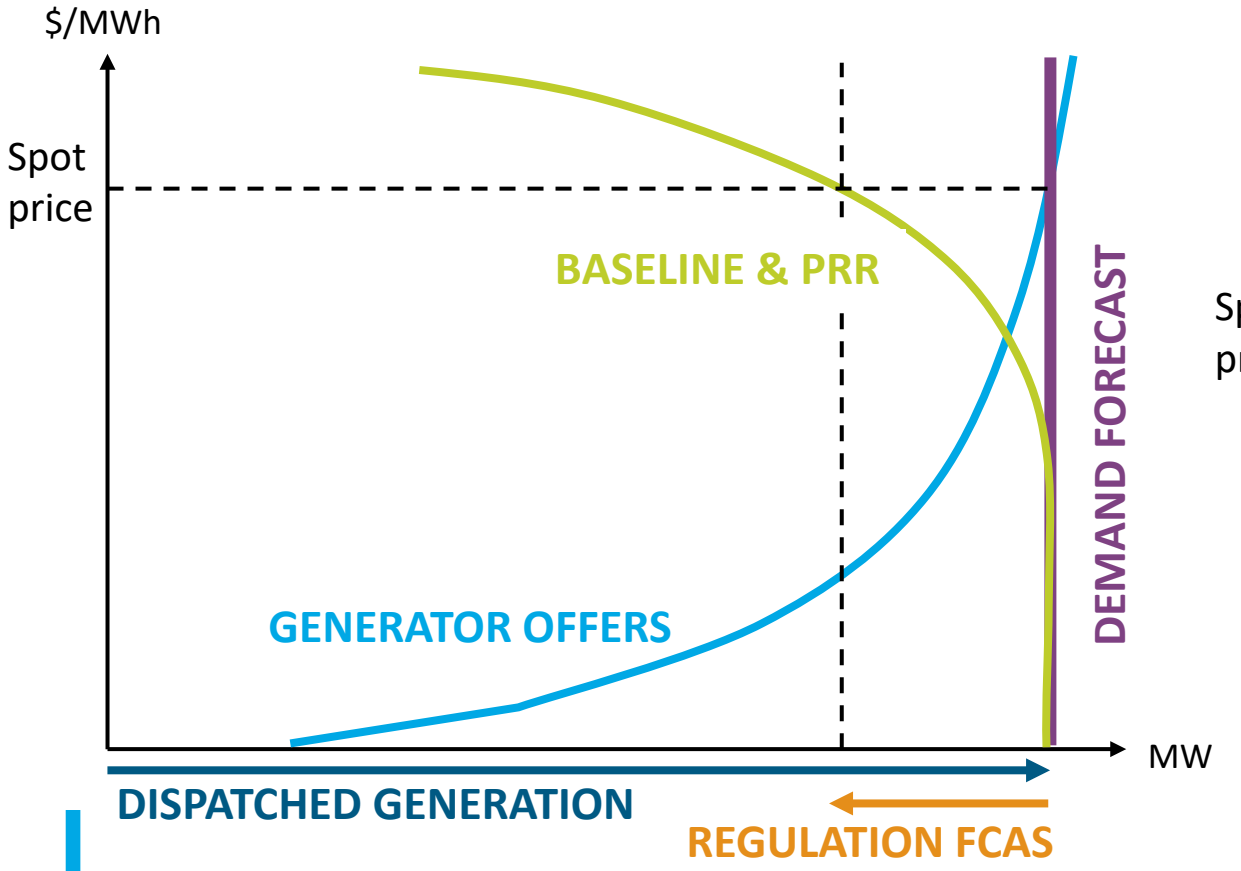


Overview of key features of the alternative design

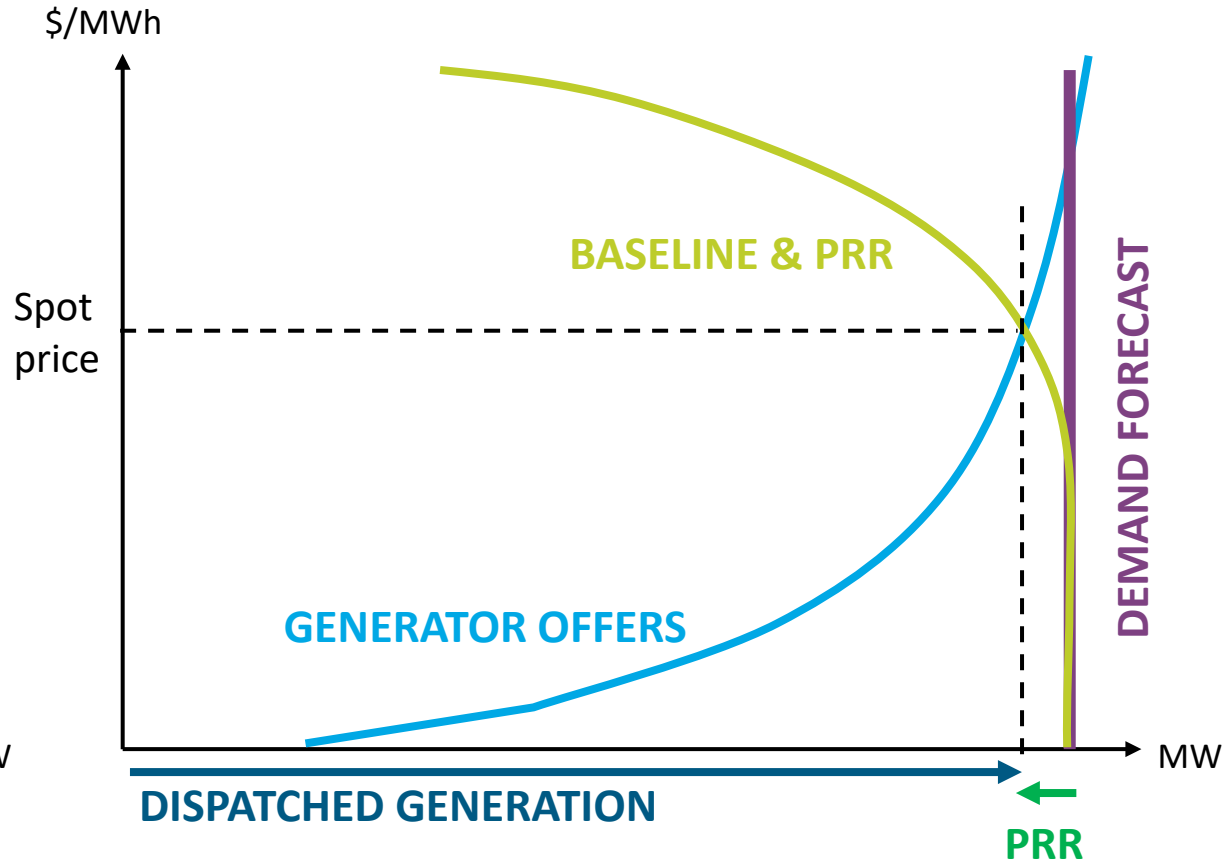
- Relatively low barriers to participation:
  - voluntary participation (as it is in AEMO's proposal)
  - does not impose specific accuracy or compliance obligations
  - works with existing smart metering
  - financial incentives, through FPP settlement, drive compliance.
- PRR represented through "quasi bids":
  - represent the volumes of price-sensitive demand or non-scheduled supply and their price thresholds
  - depending on the resources, could be bi-directional like those for batteries
  - informs dispatch and pricing outcomes but does not result in dispatch targets or conformance obligations to PRR
  - informs forecasting – allows AEMO to forecast the total demand and adjust it for PRR from the quasi-bids
- The design pivots on existing AEMO processes and adapts frequency performance payments (due to commence in 2025).
- The design rewards participants for making the PRR visible to AEMO, in proportion to the benefit that this visibility brings to the market.

Efficiency from incorporating PRR into dispatch

PRR bids not used in dispatch



PRR bids used in dispatch



A hypothetical example

	Retailer A Visible PRR	Retailer B Invisible PRR	Totals
Demand (MW)	1500	1500	3000
PRR (MW)	50	50	100
Current $FPP Cost	$500	$500	$1000
Alternative model $FPP Cost	$400	$550	$950

EXAMPLE ASSUMPTIONS

- Retailer A and B have the same level of customer demand
- Both have 50 MW of PRR that they use when the price hits the same level.
- Retailer A provides a Quasi Bid to AEMO that this PRR will act at a price.

NEMDE:

- expects Retailer A's PRR will react and reduces demand by the Quasi bid **and**
- dispatches the rest of the market accordingly, **but**
- is unaware of Retailer B's intentions

Assuming Retailer A performs as expected then in the final FPP settlement:

total FPP settlement is lower because less Regulation FCAS was procured
Retailer A has a lower FPP cost because it moved as expected
Retailer B has a higher FPP cost because regulation FCAS had to operate to accommodate their unexpected action.

Design features for the 3 ‘visibility mode’ options

	AEMO Visibility Mode *Proposed in the rule change request*	**Alternative visibility mode** *Subject of the paper published in December 2023*	**Improving standing data** *Proposed by stakeholders in September consultation*
Participation / Registration	Voluntary	Voluntary	Enhancements to the DSPIP and DER Register to include more information about prices and volumes
Bids	Yes - info only, but must meet an accuracy threshold	Yes - estimates of volume and price but no accuracy threshold	TBC
Affects dispatch?	No	Yes	No, TBC
NEM Participant compliance	TBC	TBC, compliance reinforced by frequency performance payments and perhaps existing bidding rules	TBC
Incentives	TBC (service payment and possibly $FPP)	TBC, $FPP cost reductions provide incentives; some additional payment may be needed	TBC

Initial consideration of the 3 visibility options

	AEMO Visibility Mode *Proposed in the rule change request*	**Alternative visibility mode** *Subject of the paper published in December 2023*	**Improving standing data** *Proposed by stakeholders in September consultation*
Incorporate into forecasting	• Allows AEMO to collect data to provide situational awareness for operational decisions and the market as a whole • Does not directly affect dispatch making price and system security benefits uncertain	• Response information is fed into the NEM Dispatch Engine (NEMDE) to improve dispatch • Supports accurate demand forecasting by identifying PRR	• Does not feed into pre-dispatch and improve dispatch efficiency • Static information is likely to become inaccurate over time
Type of resources	• Does not cater for the full range of price-responsive resources and demand-response behaviours. More targeting resources such as residential batteries and V2G.	• Suits a wide range of price-responsive resources and demand response behaviours	• Encompasses a range of price-responsive resources and demand-response behaviours

Barriers to entry	• Could be costly as it requires metering and communications
	• Listing all NMIs that are participating could become increasingly burdensome but provides incentives to move to higher levels of participation.
	• Traders will aggregate information from all participating NMIs to make an LSU bid
		• Builds on current processes and metering but needs smart meters to record 5ms data for settlement and FPP calculation
		• Requires system costs for AEMO to implement:
		  • Requires AEMO to split its demand forecast by retailers which would be a new process.
		  • Requires changes to the FPP framework (due to commence in 2025).
			• Easy to amend as it is a system that retailers and AEMO currently use.

Step towards 'dispatch mode'?	• Yes – TBC but could be short term or size limited – incentive to move to dispatch mode	• Does not serve as a stepping-stone for participants to dispatch mode • Would need further consideration in the potential design of dispatch mode	

Potential impacts on participants, markets and consumers

Participant benefits

- Voluntary participation for retailers, non-sched loads and non-sched generation
- Performance incentives directly through frequency performance payments
- Simplified bidding process that focuses only on PRR
- Potentially lower regulation FCAS costs

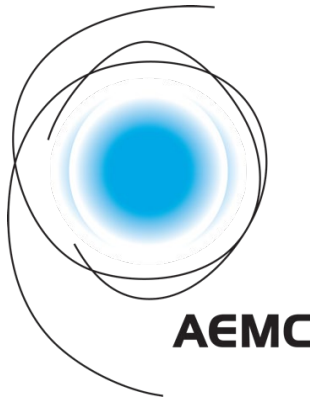
Market benefits

- More efficient market dispatch and pricing
- Greater transparency of information to AEMO and distribution networks
- More efficient forecasting leading to reduced regulation FCAS requirements

Customer benefits

- More efficient dispatch leading to lower generation costs
- Potentially lower prices from incorporating demand response into dispatch at peak price times

Q&A



Closing remarks

Next steps

Project page

For more information and links to any documents mentioned:

https://www.aemc.gov.au/rule-changes/integrating-price-responsive-resources-nem

Next steps

Technical working group, AEMC analysis, bilateral meetings

- Feb - May

Draft determination

- 25 July

Contact

Rachel.Thomas@aemc.gov.au