Benefit analysis of improved integration of unscheduled price-responsive resources into the NEM

Modelling results

12 February 2024

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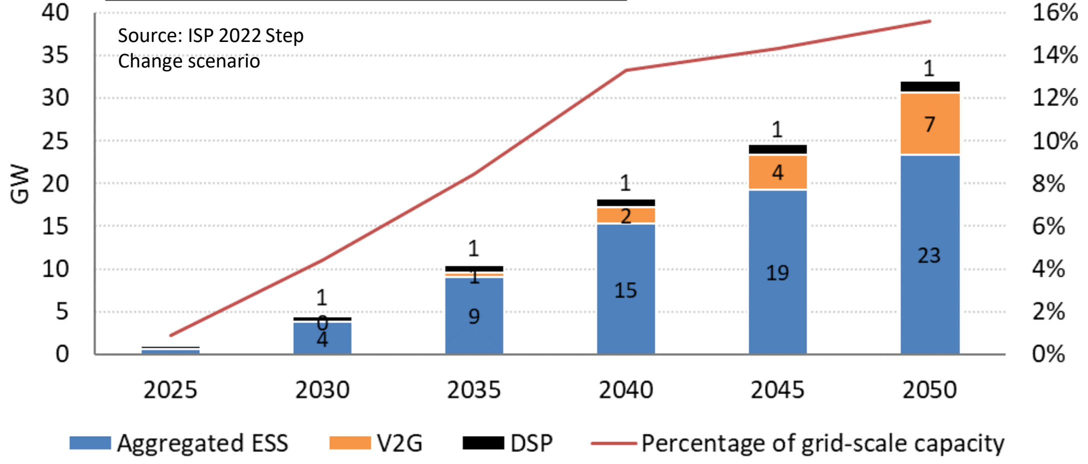
Overview

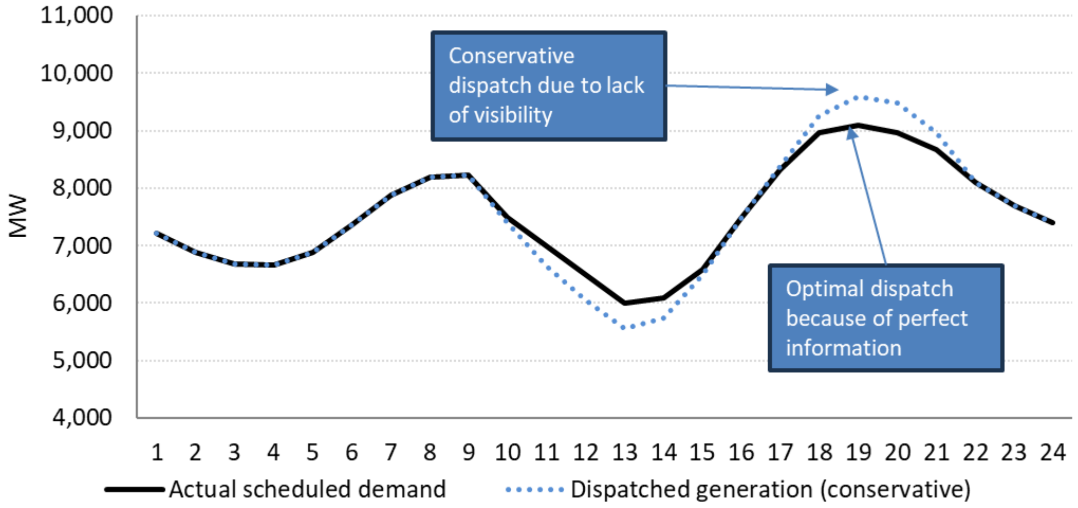
- Unscheduled price-responsive resources and dispatch
- Scope of work and key questions
- Modelling elements
  - Base and reform cases
  - PRR types: VPPs and DSP
  - Cost components and benefit categories
  - Assumption: Forecast accuracy of PRR operations
- Results summary and key findings

Unscheduled price-responsive resources and dispatch

Price-responsive resource capacity outlook



Dispatch with and without PRR information



- 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

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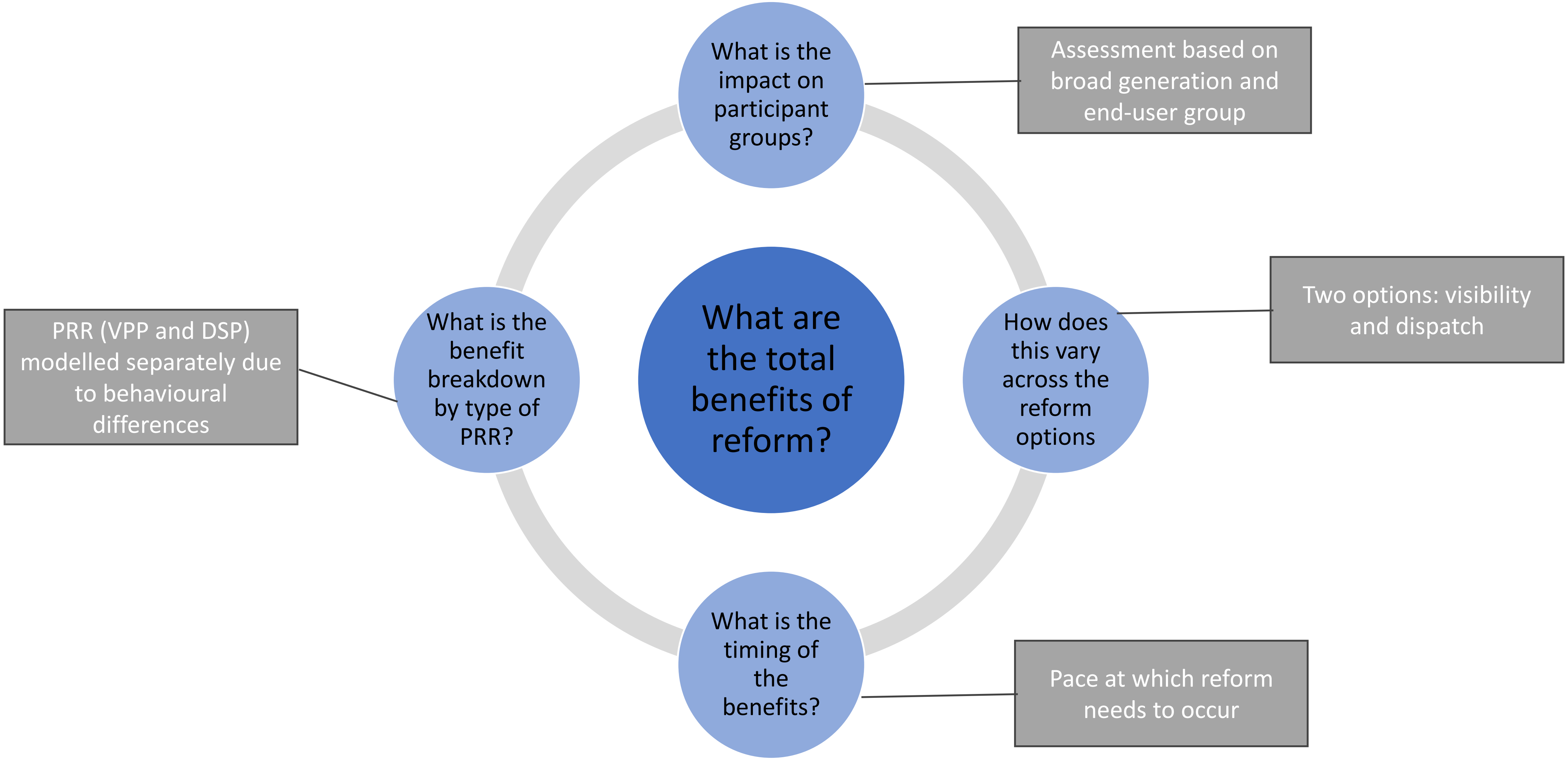
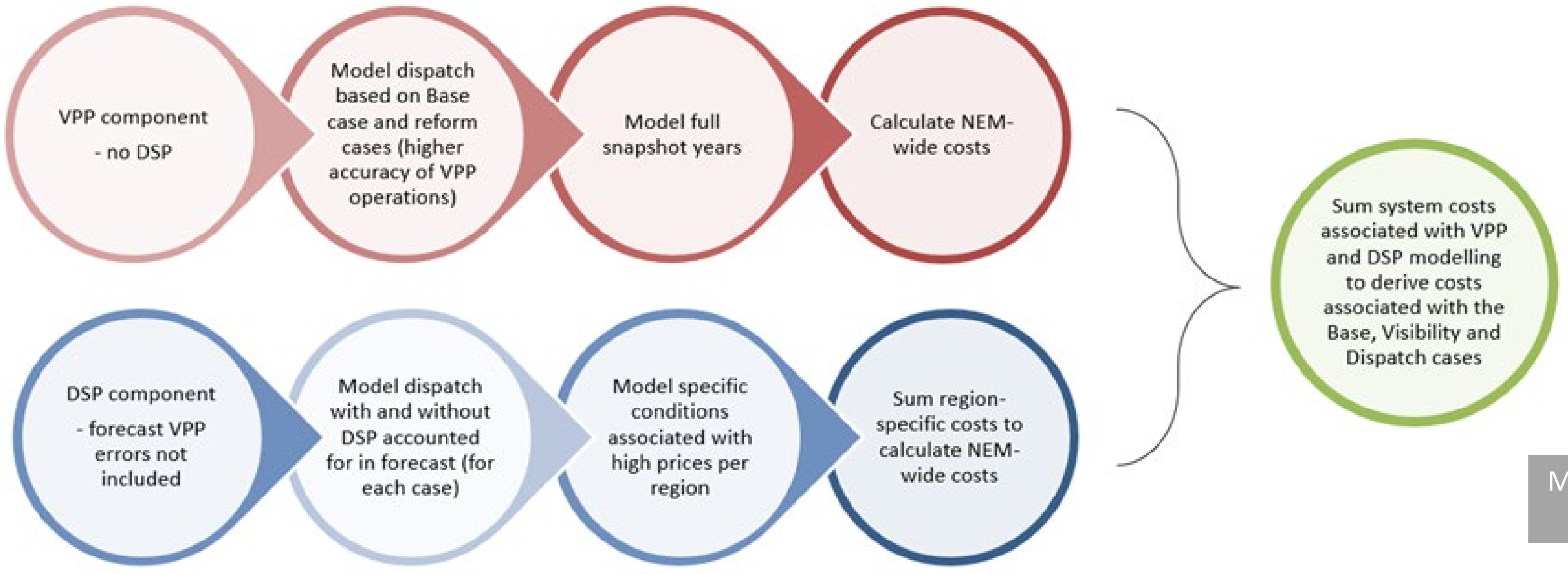
Scope of work and key questions



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



Modelling carried out in PLEXOS

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

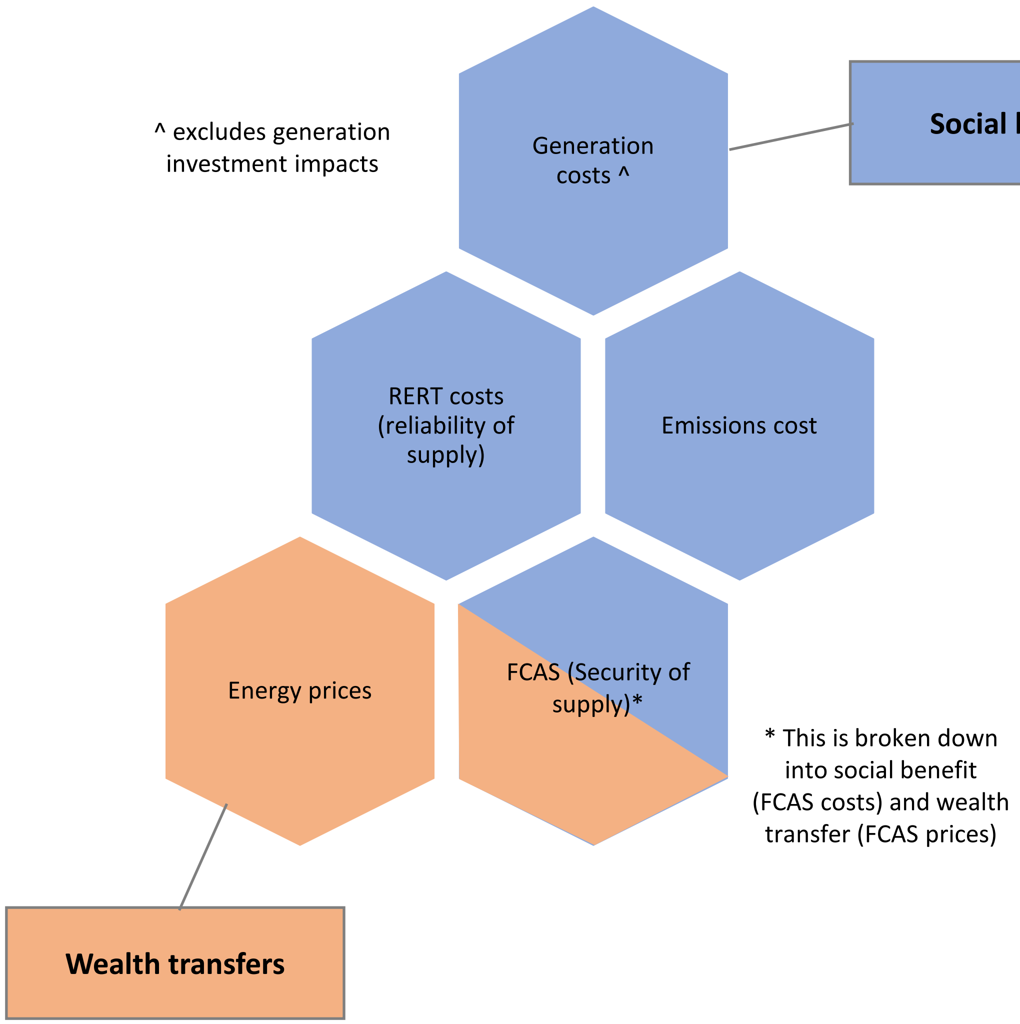
- PRR would remain unscheduled and operate outside central dispatch
- Arrangement for PRRs to submit operational info to AEMO
- Lower barriers of entry which will incentivise higher participation offset by informational inaccuracies

Dispatch

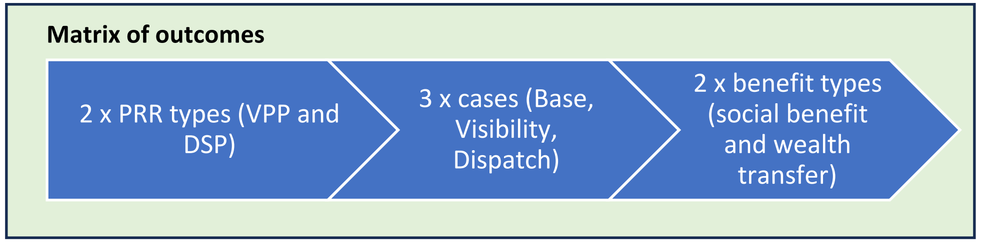
- Integrate unscheduled PRR into the NEM central dispatch and scheduling processes
- Higher barriers to entry than Visibility, but central dispatch means higher conformance
- Higher participation in FCAS markets because of dispatchability

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.

Functional areas and benefit grouping

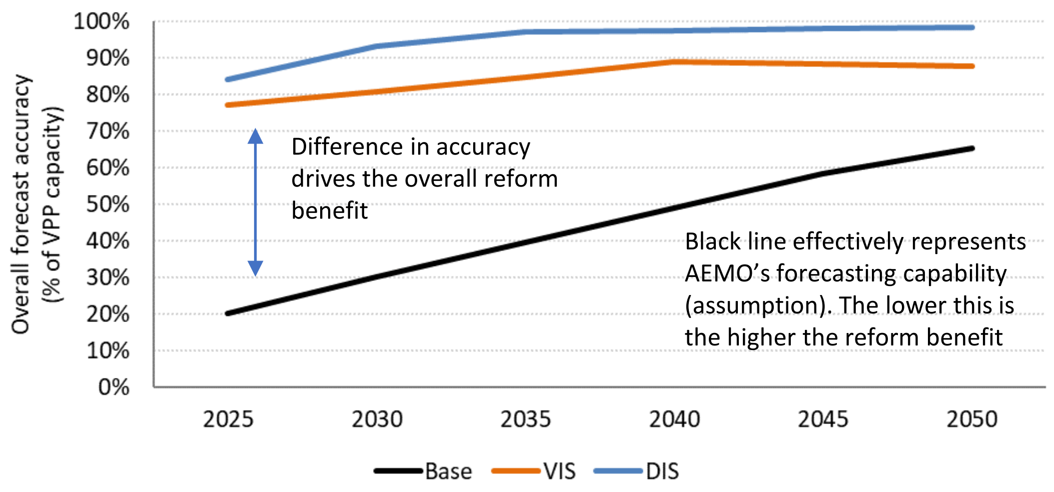


- Five functional areas drive the overall costs associated with each of the modelled cases
- There are volume and price differences across the Base and Reform cases which corresponds to the overall reform benefit.
  - Social benefits are actual cost savings (reduction in system costs and emissions) from 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



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

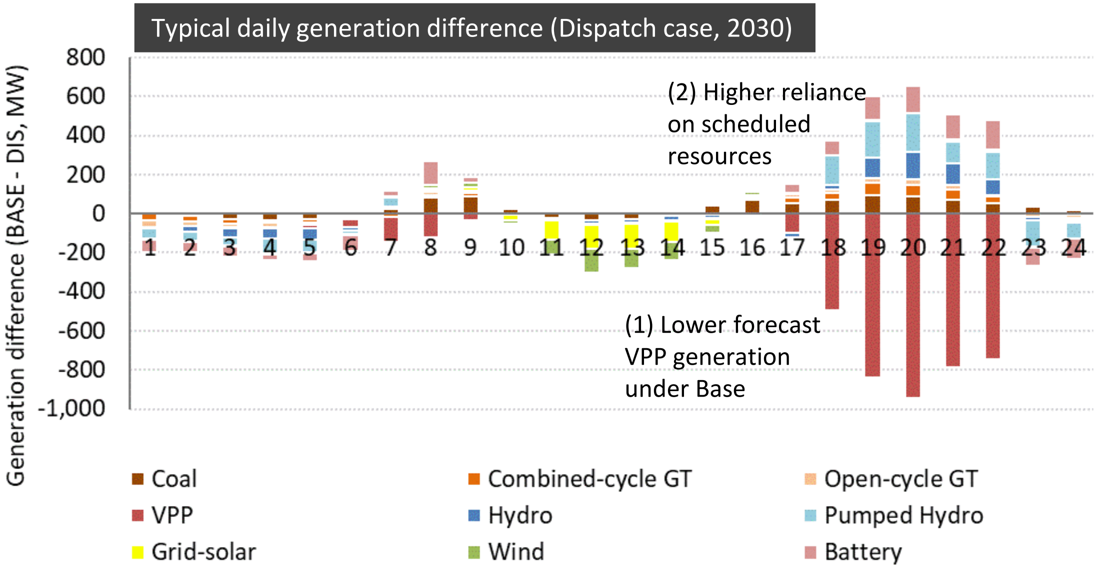
Results

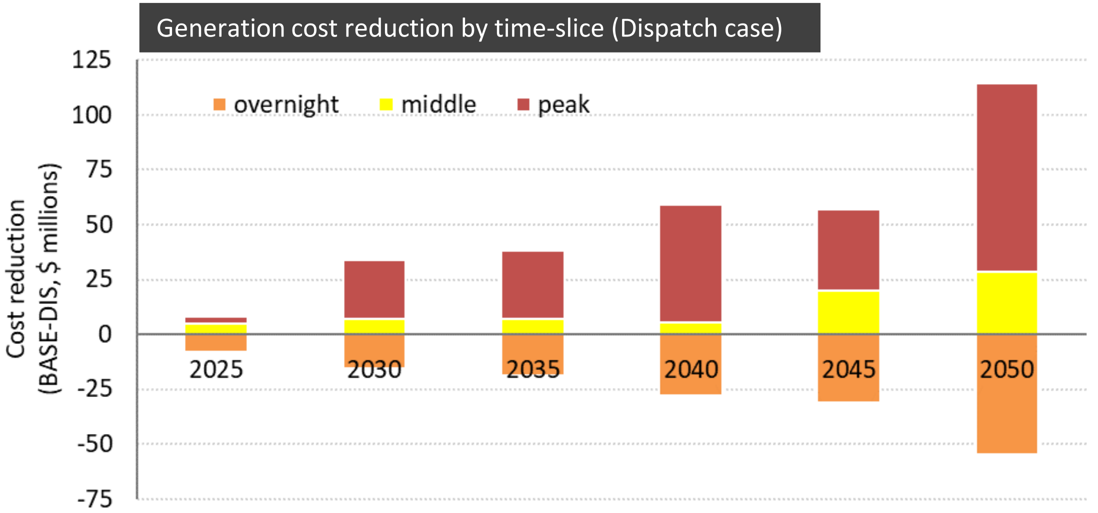
Results overview

- 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 (slides 11 – 13)	Wealth transfers (slides 14 – 16)
Generation (slide 11)	154 – 186	0
FCAS (slide 12 and slide 16)	711 – 889	586 - 738
RERT (slide 13)	121	0
Emissions (slide 13)	514 – 719	0
Energy (slide 14 and 15)	0	10,425 - 11,011
Total	1,500 - 1,915	11,011 - 12,064

Social benefits – generation cost (VPP)



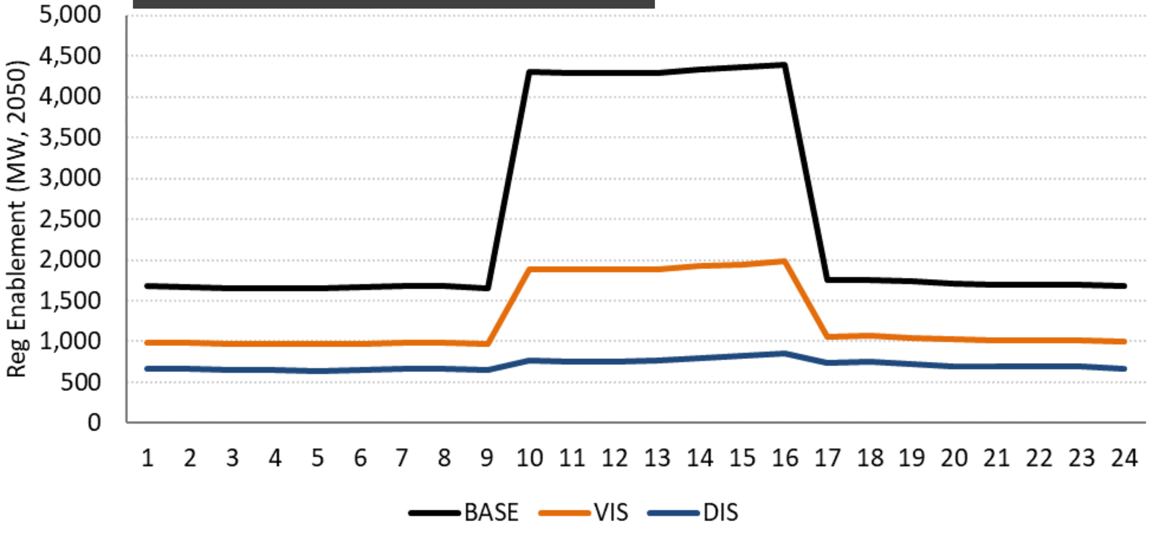


- Generation cost savings mainly from VPP modelling as DSP triggers very infrequently and therefore minimal generation volume differences
- VPP included in the generation difference chart for reference to show the lower levels of VPP contribution to Base case evening peak which results in additional 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

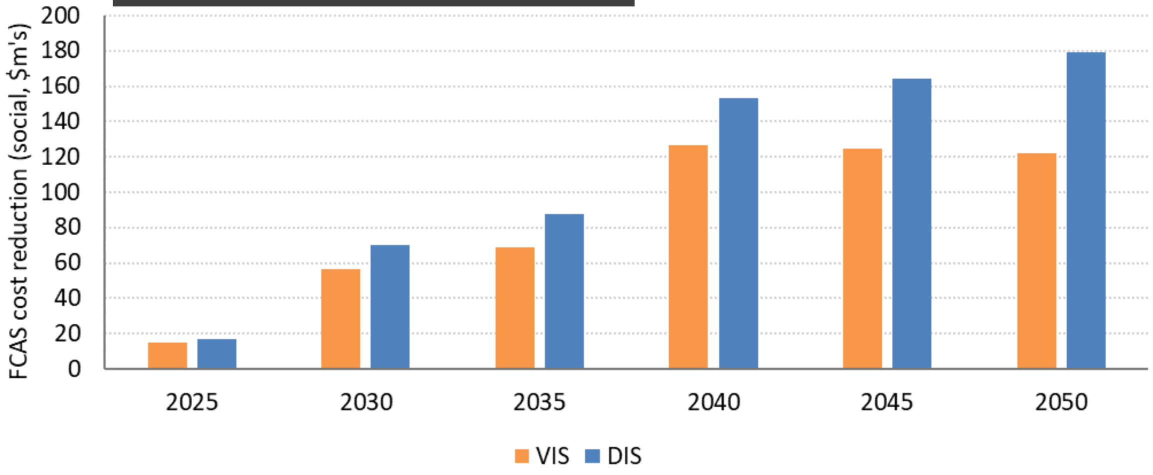
NPV of generation cost benefit ($m’s)
Visibility: $154 million
Dispatch: $186 million

Social benefits – FCAS costs (VPP)

Regulation requirements by case (MW)



FCAS cost reduction (social benefits)



- 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

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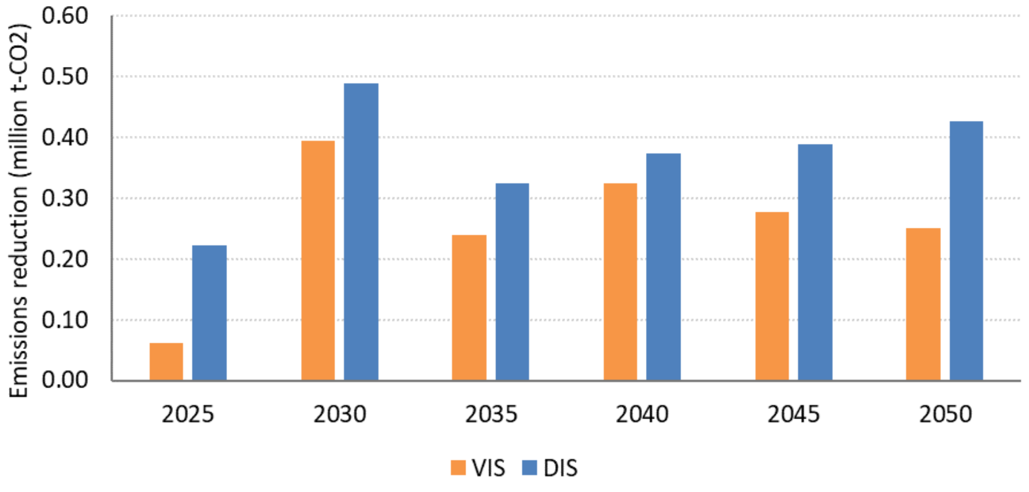
Social benefits – emissions (VPP) and RERT costs (DSP)

Emissions reduction volume

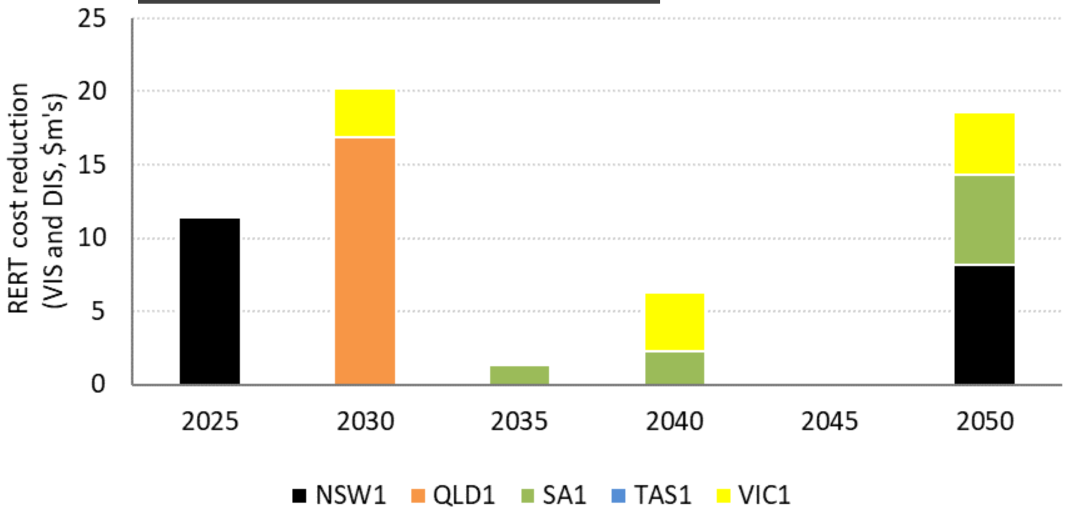


- Emissions reduce in line with generation cost outcomes. Savings of up to 0.5 Mt CO2 pa in the reform cases due to over-scheduling of peaking (thermal) generation associated with the Base case. Roughly 0.8% of total NEM emissions
- Corresponding value of emissions from NSW Treasury (to be replaced with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

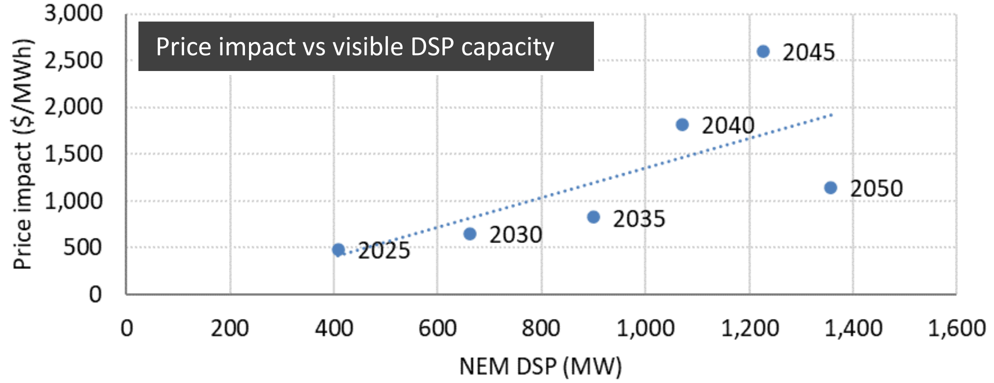
RERT cost reduction

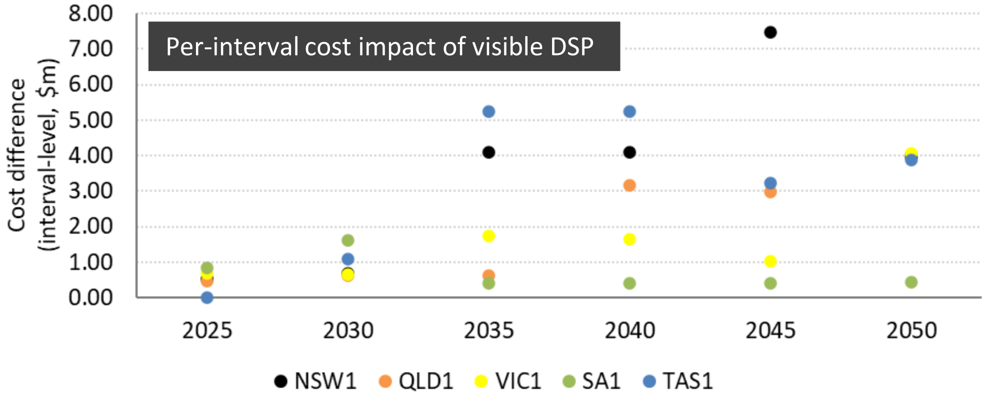


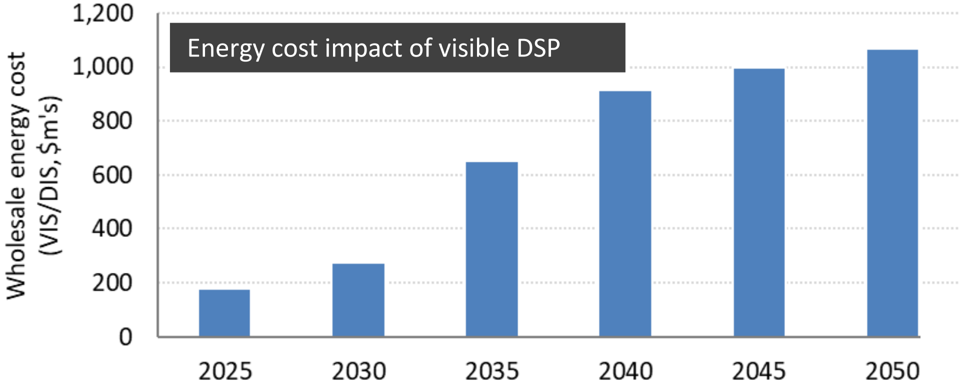
- There are substantial RERT/intervention cost savings on a per event/interval basis because of the reduction in RERT volumes from having more reliable DSP operational information
- The overall cost is low as the frequency at which RERT is expected to occur based on historical weightings is significantly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

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

Wealth transfers – energy prices (DSP)



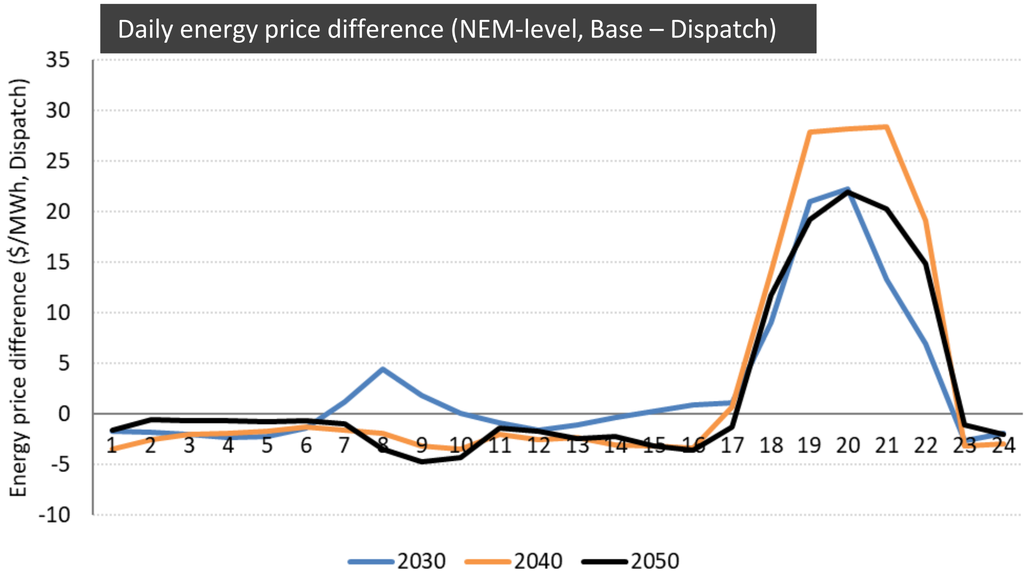


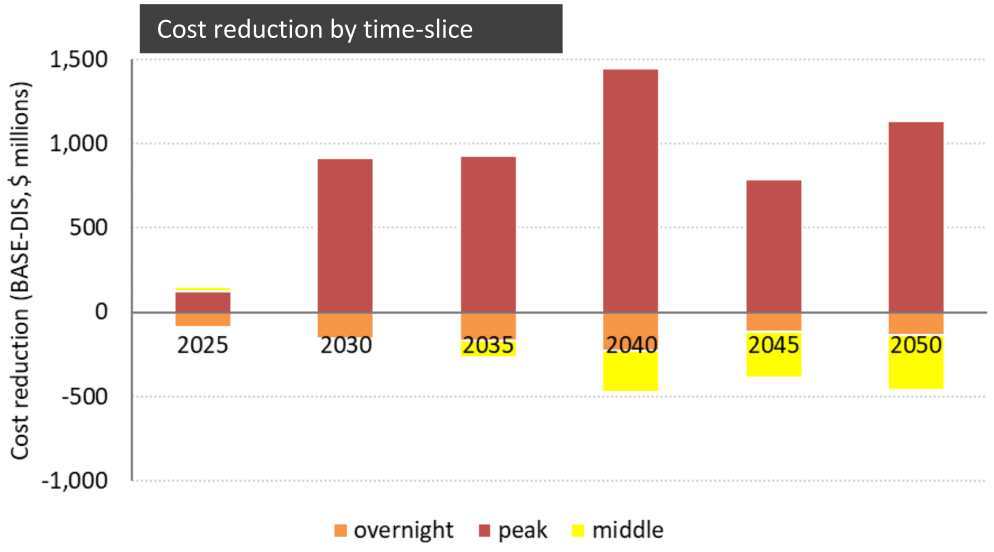


- DSP modelling creates significant wholesale energy price impacts
- This arises due to over-dispatch in the absence of integrating DSP, resulting in higher spot prices
- Pricing impact, up to $2,500/MWh, increases with increasing DSP volumes over time (up to 1.4 GW by 2050)
- The pricing impact applies 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

Wealth transfers – energy prices (VPP)



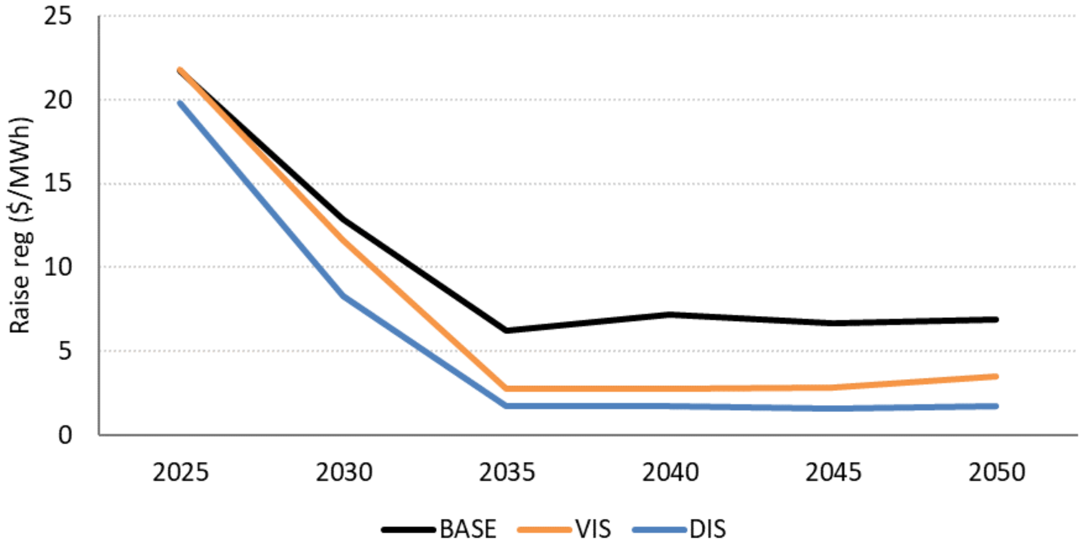


- There are high wealth transfers from a change in energy prices under the VPP modelling
- The scheduling of more generation resources during the peak (as seen earlier) under the Base case result in higher energy prices
- Scheduled demands are roughly 2.5 GW and 3.5 GW lower in the Visibility and Dispatch 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

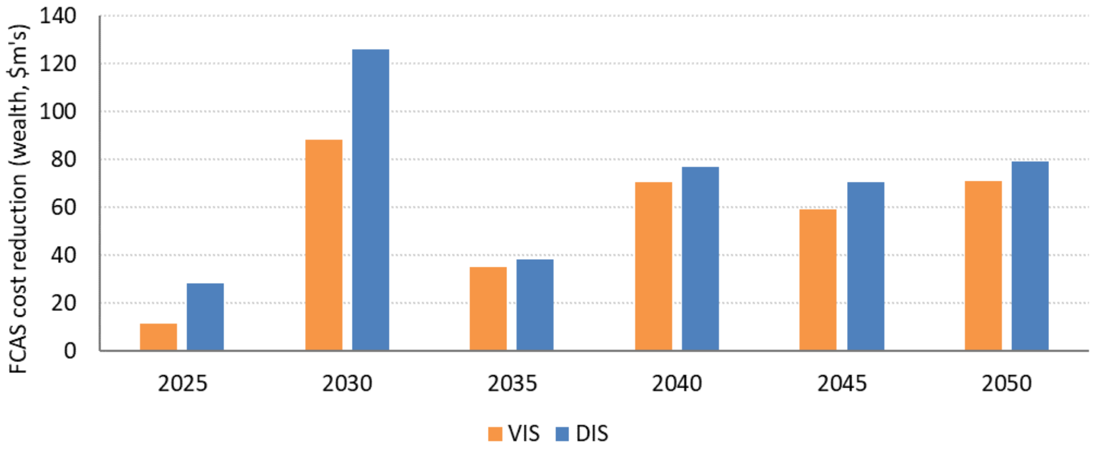
NPV of energy cost benefit – VPP ($m's)
Visibility: $4.9 billion
Dispatch: $5.8 billion

Wealth transfers – FCAS prices (VPP)

Annual regulation price by case (time-weighted)



FCAS cost reduction by case (wealth transfers)

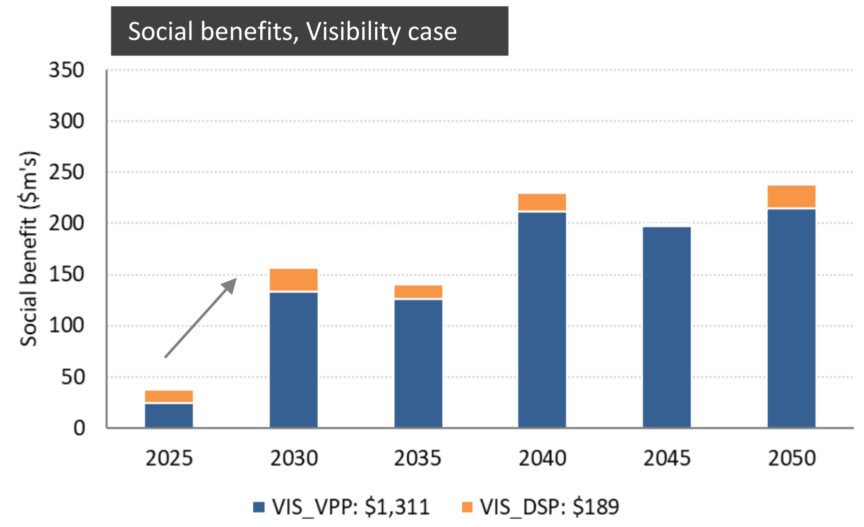


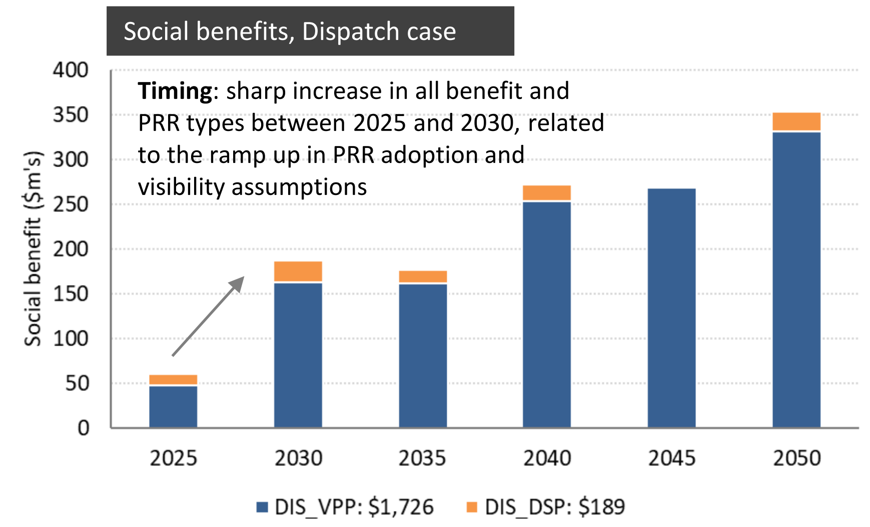
- Higher regulation requirements in the Base case, combined with lower FCAS provision assumptions across VPPs, lead to higher regulation prices and costs
- Wealth transfers arising from FCAS costs are based on fixing FCAS enablement levels and show up to $120 million in additional FCAS costs under the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

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

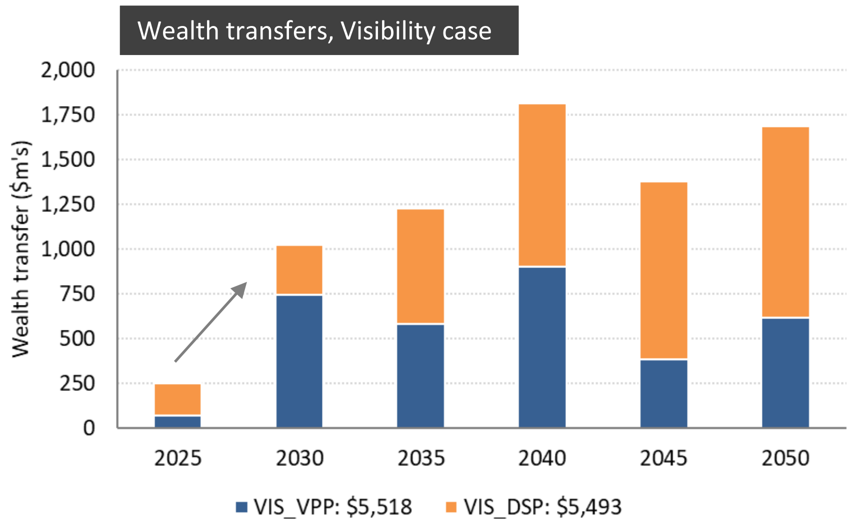
Timing of benefits by PRR type and reform option

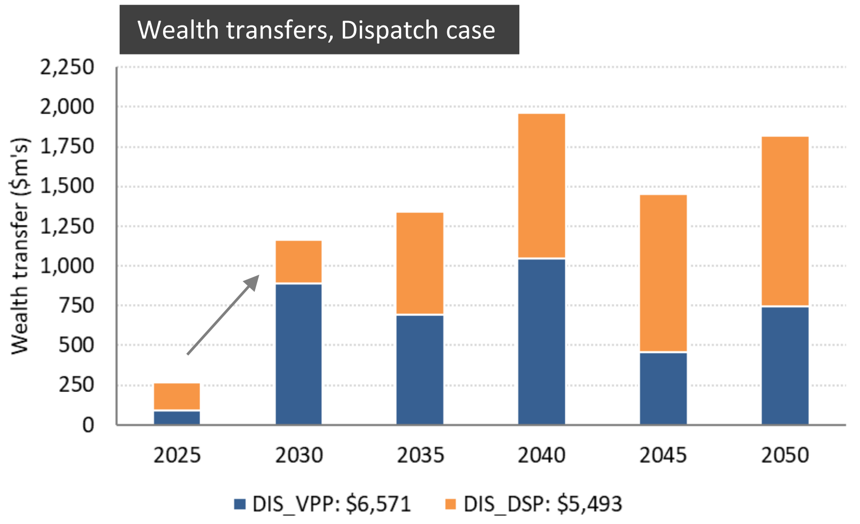
- **Social benefits** associated with VPPs ($1.3 - $1.7 billion) are significantly higher than under the DSP modelling ($189 million). This is due to higher reductions in thermal generation and emissions under the VPP modelling, whereas DSP triggers infrequently.





- **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.





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

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

Questions