Sonya Petreski

From:	[redacted]@aemo.com.au>
Sent:	Thursday, 30 September 2021 5:41 PM
To:	Hassan, Ali; Burkitt, Blair
Cc:	[redacted]
Subject:	RE: Draft agenda and supporting materials - AEMO/AER meeting Monday 27th September [SEC=OFFICIAL]
Attachments:	AEMO Competition Benefits Draft Consultation document_DRAFT_CLEAN_300921.docx; AEMO Competition Benefits Methodology_DRAFT_CLEAN_300921.docx

Hi all,

Thanks for the chat yesterday.
The current version of the draft provided by EY is attached FYR.
Please treat it as confidential for now.
We look forward to hearing some preliminary thoughts tomorrow.

Regards,

[redacted]

From: Hassan, Ali <Ali.Hassan@accc.gov.au>
Sent: Tuesday, 28 September 2021 3:47 PM
To: [redacted]@aemo.com.au>
Cc: Blair Burkitt <blair.burkitt@aer.gov.au>
Subject: RE: Draft agenda and supporting materials - AEMO/AER meeting Monday 27th September [SEC=OFFICIAL]

OFFICIAL

12.30 -1pm should be fine [redacted].
Although it would be best if it can be done 12pm -1pm as we don't have availability after 1pm.

Cheers
Ali

From: [redacted]@aemo.com.au>
Sent: Tuesday, 28 September 2021 2:39 PM
To: Hassan, Ali <Ali.Hassan@accc.gov.au>
Cc: Burkitt, Blair <blair.burkitt@aer.gov.au>
Subject: RE: Draft agenda and supporting materials - AEMO/AER meeting Monday 27th September [SEC=OFFICIAL]

Thanks Ali,

Tomorrow we could do between 12:30 and 2pm or after 5 pm AEST.
Does 12:30-1pm suit?

Regards,

[redacted]

From: Hassan, Ali <Ali.Hassan@accc.gov.au>
Sent: Tuesday, 28 September 2021 12:34 PM
To: [redacted]@aemo.com.au>
Cc: Blair Burkitt <blair.burkitt@aer.gov.au>
Subject: RE: Draft agenda and supporting materials - AEMO/AER meeting Monday 27th September [SEC=OFFICIAL]
Importance: High

OFFICIAL

Hi [redacted]
We are available to meet tomorrow either between 11am and 1pm or after 3.15pm (AEST).

Cheers
Ali

From: [redacted]@aemo.com.au>
Sent: Monday, 27 September 2021 11:48 AM
To: [redacted]@aemo.com.au>; [redacted]@aemo.com.au>; [redacted]@aemo.com.au>; [redacted]@aemo.com.au>; [redacted]@aemo.com.au>; Burkitt, Blair <blair.burkitt@aer.gov.au>; Kaniyal, Ashok <Ashok.Kaniyal@accc.gov.au>; Oakeshott, Craig <Craig.Oakeshott@aer.gov.au>; Rasmus, Christian <Christian.Rasmus@aer.gov.au>; Ralston, Tom <Tom.Ralston@accc.gov.au>; Hassan, Ali <Ali.Hassan@accc.gov.au>
Subject: RE: Draft agenda and supporting materials - AEMO/AER meeting Monday 27th September

All,

Please find attached the slides presented earlier about competition benefits.
We look forward to continuing the discussion soon.
@Hassan, Ali, please let me know which time and day suits you and team later this week.

Thanks,

[redacted]

From: [redacted]@aemo.com.au>
Sent: Friday, 24 September 2021 4:28 PM
To: [redacted]@aemo.com.au>; [redacted]@aemo.com.au>; [redacted]@aemo.com.au>; [redacted]@aemo.com.au>; [redacted]@aemo.com.au>; Blair Burkitt <blair.burkitt@aer.gov.au>; Ashok Kaniyal <Ashok.Kaniyal@accc.gov.au>; Craig Oakeshott <craig.oakeshott@aer.gov.au>; Christian Rasmus <Christian.Rasmus@aer.gov.au>; Tom Ralston <Tom.Ralston@accc.gov.au>; Hassan, Ali <Ali.Hassan@accc.gov.au>
Subject: RE: Draft agenda and supporting materials - AEMO/AER meeting Monday 27th September

Good afternoon all,

Please find a final agenda attached for our meeting on Monday.

Have a great weekend,

[redacted]
Principal Analyst, Regulation
Australian Energy Market Operator
T [redacted]

M [redacted]
[redacted]@aemo.com.au | www.aemo.com.au

In response to the COVID-19 pandemic, AEMO has adopted digital and remote ways of working to protect our people and critical operations.
Please be aware that most meetings will now be conducted digitally, preferably using WebEx, to minimise physical contact and allow business to continue.
Given the dramatic increase in load on our systems, please bear with us while we work through any technical issues that may result.

From: [redacted]
Sent: Thursday, 23 September 2021 3:15 PM
To: [redacted]@aemo.com.au>; [redacted]@aemo.com.au>; [redacted]@aemo.com.au>; [redacted]@aemo.com.au) <[redacted]@aemo.com.au>; [redacted]@aemo.com.au>; Blair Burkitt <blair.burkitt@aer.gov.au>; Ashok Kaniyal <Ashok.Kaniyal@accc.gov.au>; Craig Oakeshott <craig.oakeshott@aer.gov.au>; Christian Rasmus <Christian.Rasmus@aer.gov.au>; Tom Ralston <Tom.Ralston@accc.gov.au>; Hassan, Ali <Ali.Hassan@accc.gov.au>
Subject: Draft agenda and supporting materials - AEMO/AER meeting Monday 27th September

Good afternoon all,

Please find attached the following for Monday's meeting:

- Draft agenda for your review – **please let me know of any proposed amendments by midday tomorrow**. I'll send out a final agenda tomorrow afternoon to reflect any proposed changes.
- A memo originally shared with the ISP Consumer Panel that outlines AEMO's proposed approach to the Delphi panel process (to discuss in item 5).

Regards,

[redacted]
Principal Analyst, Regulation
Australian Energy Market Operator
T [redacted]
M
[redacted]@aemo.com.au | www.aemo.com.au

In response to the COVID-19 pandemic, AEMO has adopted digital and remote ways of working to protect our people and critical operations.
Please be aware that most meetings will now be conducted digitally, preferably using WebEx, to minimise physical contact and allow business to continue.
Given the dramatic increase in load on our systems, please bear with us while we work through any technical issues that may result.

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Consultation Paper – Draft Competition Benefits Methodology

October 2021

Consultation Paper

For Integrated System Plan (ISP)

Important notice

PURPOSE

AEMO publishes the Consultation Paper – Draft Competition Benefits Methodology pursuant to section 5.22.8(d) of the National Electricity Rules (NER). This Consultation Paper includes key information and context for the methodology proposed to be used by AEMO to quantify competition benefits as part of the ISP process where a Transmission Network Service Provider (TNSP) has included such benefits in a Regulatory Investment test for Transmission (RIT-T) assessment, such as the TransGrid RIT-T for the HumeLink project.

DISCLAIMER

AEMO has made all reasonable efforts to ensure the quality of the information in this publication but cannot guarantee that information, forecasts and assumptions are accurate, complete or appropriate for your circumstances. This publication does not include all of the information that an investor, participant or potential participant in the National Electricity Market (NEM) might require, and does not amount to a recommendation of any investment. Anyone proposing to use the information in this publication (which includes information and forecasts from third parties) should independently verify its accuracy, completeness and suitability for purpose, and obtain independent and specific advice from appropriate experts. Accordingly, to the maximum extent permitted by law, AEMO and its officers, employees and consultants involved in the preparation of this document:

- make no representation or warranty, express or implied, as to the currency, accuracy, reliability or completeness of the information in this document; and
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Version Control

Version	Release date	Changes
1.0	01/10/2021	Initial Release

Executive Summary

Notice of consultation

The Integrated System Plan (ISP) is a whole-of-system plan that provides an integrated roadmap for the efficient development of the National Electricity Market (NEM) over the next 20 years.

Leveraging expertise from across the industry is pivotal in developing a robust plan that supports the long-term interests of energy consumers. AEMO is committed to facilitating a stakeholder engagement process that ensures a collaborative approach to developing the 2022 ISP.

When developing an ISP, the NER require AEMO to develop, consult on and publish the ISP Methodology and Inputs, Assumptions and Scenarios Report (IASR) in accordance with the Australian Energy Regulator's (AER's) *Forecasting Best Practice Guidelines*[1] ('FBP Guidelines').

AEMO has completed this process for the 2022 ISP:

- The 2021 IASR was published in July 2021; and
- The ISP Methodology was released in August 2021.

The purpose of this Consultation Paper is to commence a single-stage consultation process in accordance with the FBP Guidelines on both the IASR and ISP Methodology specifically in relation to competition benefits. The IASR and ISP Methodology otherwise remain unchanged.

Competition benefits and the ISP

Section 5.22.10(c)(1) of the NER requires AEMO to consider a range of market benefits as part of preparing an ISP. These classes of benefits are documented in the NER and further discussed in the AER's *Cost benefit analysis guidelines* ('CBA Guideline'). Competition benefits are one type of market benefit referred to in the NER and CBA Guideline.

In the ISP Methodology, AEMO concluded that it will not by default include competition benefits in its CBA analysis. However, AEMO noted that competition benefits could be included by TNSPs as part of subsequent RIT-T analysis on any actionable projects. AEMO's decision to not routinely calculate competition benefits as part of the ISP Methodology was driven by the significant complexity associated with modelling these benefits. This complexity is compounded when considering benefits of multiple projects that collectively form a candidate development path, rather than individual elements that meet an identified system need.

TransGrid has recently completed the Project Assessment Conclusion Report (PACR) for the HumeLink project as the final stage of the RIT-T process for that project. In the PACR, TransGrid concluded that competition benefits are material for the HumeLink RIT-T, and has therefore quantified competition benefits. Section 5.16A.5(b) of the NER requires a number of conditions to be satisfied before TransGrid can submit a Contingent Project Application (CPA) to the AER for the HumeLink project. These conditions include that:

- TransGrid must receive written confirmation from AEMO that the preferred option in the PACR addresses an identified need and aligns with the optimal development path in the most recent ISP; and
- The costs set out in the PACR preferred option do not change the status of the actionable ISP project as part of the optimal development path.

[1] AER. Guidelines to make the integrated system plan actionable, at https://www.aer.gov.au/system/files/AER%20-%20Forecasting%20best%20practice%20guidelines%20-%2025%20August%202020.pdf.

This process is called the 'feedback loop'.

Given that TransGrid's PACR for HumeLink included competition benefits using an approach that was consistent with the AER's Application guidelines: RIT-T (RIT-T Guidelines), AEMO proposes to adopt this same approach for use in the ISP. To this end, Ernst & Young (EY) has prepared a Draft Competition Benefits Methodology that is the subject of this consultation. It outlines the methodology, inputs and assumptions proposed to be used by AEMO to calculate competition benefits for the HumeLink project. The methodology would also be applied by AEMO to calculate competition benefits on other transmission projects where a TNSP has included them as part of their RIT-T and found them to be material to the selection of the preferred option.

For clarity, AEMO's position is that:

- The approach to competition benefits outlined in the ISP Methodology remains the same, namely AEMO does not by default include competition benefits in the CBA analysis. Competition benefits will only be considered in the ISP where a RIT-T process has identified material competition benefits;
- Where a TNSP through its RIT-T process identifies material competition benefits, those benefits may be assessed for the purpose of the ISP or the feedback loop using the competition benefits methodology published by AEMO; and
- For the purposes of the 2022 ISP, HumeLink is the only previously identified actionable transmission project that has identified material competition benefits through the RIT-T process.

The Draft Competition Benefits Methodology is available at [insert link].

Competition benefit modelling methodology

Section 2 and 3 of this Consultation Paper discusses the proposed methodology prepared by EY to calculate competition benefits, inputs and assumptions and the rationale for the recommended approach where various options exist. The methodology is based on the Frontier Economics approach and is consistent with the approach used by EY to quantify competition benefits for TransGrid's HumeLink project as part of their RIT-T.

Invitation for written submissions

All stakeholders are invited to provide a written submission to the questions outlined in this Consultation Paper, and on any other matter related to the methodologies, inputs and assumptions for calculating competition benefits relevant to the ISP process. Submissions need not address every question posed and are not limited to the specific consultation questions noted in this Paper.

Submissions should be sent via email to ISP@aemo.com.au and are required to be submitted by Monday 1 November 2021. All submissions should be provided in PDF format. Please identify any parts of your submission that you wish to remain confidential and explain why.

AEMO requests that, where possible, submissions should provide evidence and information to support any views or claims that are put forward and suggest alternate implementable approaches if there is disagreement on the approach proposed.

Next steps

The single-stage consultation process begins upon the release of this Consultation Paper. The next steps in the consultation process are summarised below:

- 15 October 2021 – ISP stakeholder workshop to provide stakeholders opportunity to ask questions of clarification
- 19 October 2021 – Consumer workshop to allow consumers to provide verbal submissions as an alternative to written submissions
- 1 November 2021 – Written submissions to this Consultation Paper are due
- 10 December 2021 – Publication of the updated ISP Methodology and IASR.

Contents

Tables

Figures

1. Introduction

1.1 Background

Section 5.22.10(c)(1) of the NER requires AEMO to consider a range of market benefits as part of preparing an ISP. These classes of benefits are documented in the NER and further discussed in the AER's CBA Guideline and include:

- Benefits related to the development and operational costs of generation and storage assets
- Costs associated with demand reduction
- Changes in network losses
- Additional option value
- Changes in ancillary service costs
- Competition benefits.

Section 5.22.10(c)(3) of the NER requires that AEMO treats all the above classes of market benefits as material unless it can provide reasons why:

- A particular class of market benefit is likely not to materially affect the outcome of the assessment of the development path; or
- The estimated cost of undertaking the analysis to quantify the market benefit is likely to be disproportionate given the level of uncertainty regarding future outcomes.

With respect to competition benefits, the ISP Methodology noted that:

- Quantification of competition benefits is a challenging task even when considering a single investment. Including competition benefits throughout the consideration of alternative development paths on a whole-of-system plan would not be possible, nor would the benefits be expected to be material relative to project costs; and
- AEMO does not by default include competition benefits in the CBA analysis, but they could be included by TNSPs as part of subsequent RIT-T analysis on any actionable projects.

The importance of competition benefits has been highlighted by Frontier Economics in 2004, where it stated that: 'as the power system evolves with the connection of new generators and loads in response to the price signals given by the market, the contribution of the other (non-competition related) benefits to the overall benefits of interconnection will diminish. This will mean that competition benefits will become an increasingly important source of the benefits of interconnection. Therefore, more time and effort will need to be spent in understanding the nature of these benefits and how they can be measured"[2].

Concurrently with AEMO developing the ISP Methodology, TransGrid has been progressing the RIT-T for the HumeLink project. In its Project Assessment Draft Report (PADR), TransGrid concluded that it did not expect competition benefits to be material in terms of identifying the preferred option for this RIT-T. However, additional testing of expected competition benefits undertaken following the PADR identified that competition benefits do in fact constitute a substantial benefit category for the HumeLink project, and that failure to adequately consider competition benefits would underestimate the potential market benefits associated with HumeLink, and therefore the net market benefit. As a result, TransGrid did include

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[2] At https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf

competition benefits in its RIT-T for HumeLink using an approach outlined in its Project Assessment Conclusions Report (PACR)[3].

For the HumeLink project to proceed, TransGrid will need to submit a Contingent Project Application (CPA) to the AER (following finalisation of the AER's dispute resolution process). Section 5.16A.5(b) of the NER requires a number of conditions to be satisfied before the CPA can be submitted. These conditions include that:

- TransGrid must receive written confirmation from AEMO that the preferred option in the PACR addresses an identified need and aligns with the optimal development path in the most recent ISP; and
- The costs set out in the PACR preferred option do not change the status of the actionable ISP project as part of the optimal development path.

This process is called the 'feedback loop'.

1.2 Purpose of this Consultation Paper

Given that HumeLink was identified as an actionable ISP project in the 2020 ISP and TransGrid has subsequently identified material competition benefits through its RIT-T process, AEMO considers it necessary to develop and consult on a methodology for calculation of competition benefits. For clarity, AEMO's position is that:

- The approach to competition benefits outlined in the ISP Methodology remains the same, namely AEMO does not by default include competition benefits in the CBA analysis. Competition benefits will only be considered in the ISP where a RIT-T process has identified material competition benefits;
- Where a TNSP through its RIT-T process identifies material competition benefits, those benefits may be assessed for the purpose of the ISP or the feedback loop using the competition benefits methodology published by AEMO; and; and
- For the purposes of the 2022 ISP, HumeLink is the only previously identified actionable transmission project that has identified material competition benefits through the RIT-T process.

EY was engaged to prepare a Draft Competition Benefits Methodology that could be used for this purpose. EY modelled the approach to competition benefits quantification used by TransGrid in the HumeLink RIT-T that was undertaken in accordance with the AER's RIT-T Guidelines.

AEMO is now undertaking a single-stage consultation process in accordance with the AER's FBP Guideline to seek stakeholders' views on the Draft Competition Benefits Methodology given that these will supplement the existing IASR and ISP Methodology.

The key points of consultation, as outlined in this Consultation Paper, relate to:

- The proposed methodology to be applied to calculate competition benefits (section 2 of this Consultation Paper); and
- The proposed inputs and assumptions that underpin the methodology (section 3 of this Consultation Paper).

Specific points of consultation have been identified throughout the Consultation Paper, but stakeholders are encouraged to provide feedback on any aspect of the proposed methodology, inputs or assumptions relevant to calculating competition benefits.

The Draft Competition Benefits Methodology is available at: XXXX.

[3] At https://www.aemo.com.au/-/media/files/stakeholderconsultation/consultations/nsp_consultations/2021/transgrid-pacr-humelink.pdf?la=en, p15

1.3 Related Documents

Error! Reference source not found. ~~Table 1~~ below outlines related documents relevant to the development of the Draft Competition Benefits Methodology. Stakeholders are invited to refer to these documents for further background and context.

Table 1 Related documents

Methodology / Procedure	Description	Location
ISP Methodology, AEMO 2021	The ISP Methodology provides an overview of the modelling methodologies applied to develop the 2022 ISP.	https://aemo.com.au/-/media/files/major-publications/isp/2021/2021-isp-methodology.pdf?la=en
CBA Guidelines, AER 2020	The CBA Guidelines set out the classes of market benefits that are relevant and can be considered in the ISP	https://www.aer.gov.au/system/files/AER%20-%20Cost%20benefit%20analysis%20guidelines%20-%2025%20August%202020.pdf
2021 IASR, AEMO 2021	The IASR includes the scenarios, inputs and assumptions used in AEMO's 2021-2022 forecasting and planning activities, including the 2022 ISP.	https://aemo.com.au/-/media/files/major-publications/isp/2021/2021-inputs-assumptions-and-scenarios-report.pdf?la=en
Application guidelines, regulatory investment test for transmission, AER 2020	The application guidelines provide guidance for the operation and application of the RIT-T for RIT–T projects that are not actionable integrated system plan (ISP) projects.	https://www.aer.gov.au/system/files/AER%20-%20Regulatory%20investment%20test%20for%20transmission%20application%20guidelines%20-%2025%20August%202020.pdf
Evaluating interconnection competition benefits, Frontier Economics 2004	The evaluating interconnection competition benefits report tests whether a workable method for estimating competition benefits can be developed in the context of the regulatory investment test. The report developed by Frontier Economics forms the basis of the approach applied when developing the competition benefits methodology.	https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf
Decision of the review of the Regulatory Test for Network Augmentations, AER 2004	The document describes the 'Biggar approach' to determining competition benefits	https://www.aer.gov.au/system/files/Review%20of%20the%20regulatory%20test%20final%20decision%20-%2011%20August%202004.pdf
HumeLink PACR, TransGrid 2021	The PACR represents the final stage in the RIT-T consultative process conducted to identify options for reinforcing the New South Wales (NSW) Southern Shared Network to increase transfer capacity to demand centres.	https://www.aemo.com.au/-/media/files/stakeholder_consultation/consultations/nsp_consultations/2021/transgrid-pacr-humelink.pdf?la=en
Modelling of Liddell Power Station Closure, Frontier Economics 2019	The report defines the generators and portfolios with some degree of market power considered in the Draft Competition Benefits Methodology.	https://www.energy.gov.au/sites/default/files/Frontier%20Economics%20Modelling%20of%20Liddell%20Power%20Station%20Closure.pdf

2. Competition benefits modelling methodology

2.1 Definition of competition benefits

The CBA process undertaken as part of developing the ISP involves quantifying the costs and market benefits of various transmission projects. Market benefits can be split into two components:

- Traditional benefits which include benefits associated with the development path that are not 'competition benefits'. For example, cost saving benefits resulting from more efficient dispatch due to fewer constraints[4]; and
- Competition benefits that occur if the development path could impact the bidding behaviour of generators (and other market participants) who may have a degree of market power relative to the base case.

In its 2004 Regulatory Test – Decision paper, the Australian Competition and Consumer Commission (ACCC) defined 'competition benefits' as the difference arising from the following two network scenarios:

- The augmented network with bidding assumed to be the same as in the status quo network; and
- The augmented network with bidding which accurately and fully reflects any market power in the augmented network[5].

Not all changes in bidding behaviour count as competition benefits. Where changes in bidding behaviour result in lower cost generation displacing higher cost generation, this may be counted as a competition benefit. Where changes in bidding behaviour do not affect the generation that is dispatched, this may not be counted as a competition benefit[6].

Importantly, competition benefits are not an estimate of wealth transfer but instead reflect the difference between the overall economic surplus resulting from changed bidding behaviour.

Figure 1 Traditional benefits and competition benefits

For the purposes of developing the ISP, the AER's CBA Guideline states that valuing competition benefits entails modelling the likely impact of an ISP development path on the bidding behaviour of generators (and

[4] At https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf

[5] At https://www.aer.gov.au/system/files/Review%20of%20the%20regulatory%20test%20final%20decision%20-%2011%20August%202004.pdf

[6] At https://www.aer.gov.au/system/files/AER%20-%20Cost%20benefit%20analysis%20guidelines%20-%2025%20August%202020.pdf

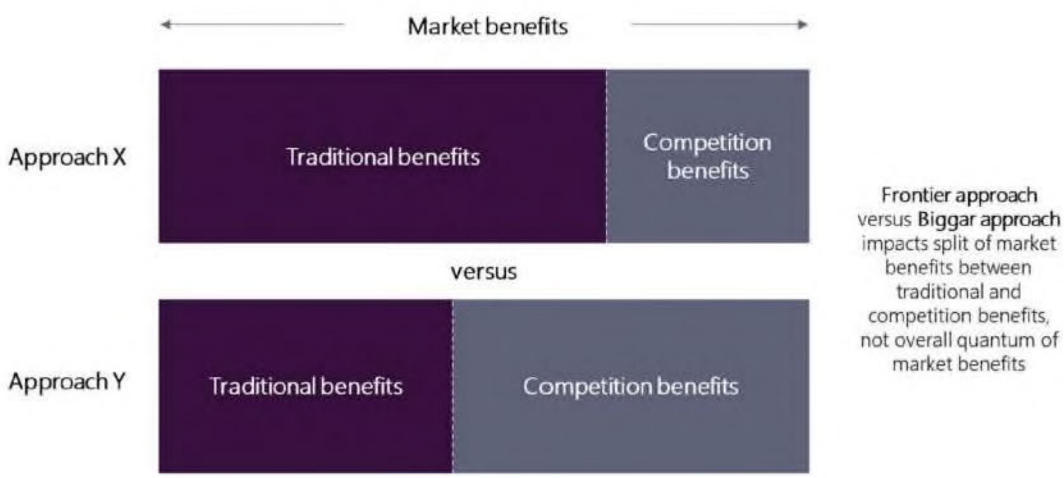
other market participants) who may have a degree of market power relative to the counterfactual development path[7].

There are two generally accepted approaches for quantifying the component of market benefits attributable to competition benefits: the "Biggar approach" and the "Frontier approach"[8],[9]:

- The Biggar approach requires a modelling process that allows the bidding behaviour to be 'held constant' while the underlying network is changed. This method involves finding the difference between the overall economic surplus arising in a network with the credible option:
  - with the bidding behaviour of market participants reflecting any market power they have in a network with that option in place; and
  - with the bidding behaviour of market participants reflecting any market power they have in the base case network.
- The Frontier approach involves finding the difference between the change in overall economic surplus resulting from the credible option;
  - assuming bidding reflected the prevailing degree of market power both before and after the augmentation; and
  - assuming competitive bidding both before and after the augmentation.

Both approaches involve the same methodology for calculating the overall market benefits of a credible option and provide identical outcomes in terms of total market benefits. The difference between them relates to how to divide the overall market benefits of a proposed augmentation between competition benefits and other benefits. Figure 2 provides a conceptual depiction of the differences between the two approaches.

Figure 2 Biggar and Frontier approaches



[7]At https://www.aer.gov.au/system/files/AER%20-%20Cost%20benefit%20analysis%20guidelines%20-%2025%20August%202020.pdf

[8] These approaches are outlined in the AER's Application guidelines - Regulatory investment test for transmission and the ACCC's 2004 Review of the Regulatory Test – Decision. The Frontier approach is at https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf The Biggar approach is https://www.aer.gov.au/system/files/Review%20of%20the%20regulatory%20test%20final%20decision%20-%2011%20August%202004.pdf

[9] The Frontier and Biggar approaches are set out in both the 2020 RIT-T Guidelines and the CBA Guidelines. The 2020 RIT-T Guidelines apply to RIT-T projects that are not actionable ISP projects, while the 2020 CBA Guidelines apply to AEMO in preparing the ISP, and TNSPs in applying the RIT-T to actionable ISP projects. 2020 CBA Guidelines are at https://www.aer.gov.au/system/files/AER%20-%20Cost%20benefit%20analysis%20guidelines%20-%2025%20August%202020.pdf 2020 RIT-T Guidelines are at https://www.aer.gov.au/system/files/AER%20-%20Regulatory%20investment%20test%20for%20transmission%20application%20guidelines%20-%2025%20August%202020.pdf

The AER allows a RIT-T proponent to adopt either approach (or another approach) while ensuring the competition benefits are not double counted. Further, the CBA Guideline refers AEMO to Appendix A of the RIT–T Guideline for non-ISP projects for example methodologies for valuing each class of market benefit if the market modelling of states of the world do not capture all material market benefit classes[10].

EY's methodology report, proposed to be adopted by AEMO, applies the Frontier approach in the competition benefits modelling for the following reasons:

- The Frontier approach - which assesses the competition benefits over and above the traditional benefits – should ensure that the market benefits, particularly efficiency savings, already calculated in the competitive (Short Run Marginal Cost (SRMC)) bidding are not double counted in the total benefits of augmentations;
- There is previous experience and application of the Frontier approach, including most recently in the calculation of competition benefits in the HumeLink PACR;
- The Frontier approach has been used for the SNOVIC upgrade with details applied in the NEM. It has also been used for the recent study on the Liddell closure which provides background and information about the modelling and particularly the strategic players and bidding[11]; and
- The Frontier approach is more implementable given the level of detail described by Frontier Economics[12] and the subsequent practical experience applying it to calculate competition benefits.

Frontier approach

The Frontier approach for defining competition benefits is to measure the additional benefits that an augmentation might accrue if the assumption of competitive bidding is relaxed[13]. These benefits are over and above conventionally-measured market benefits, which are expected to flow from taking into account likely bidding behaviour.

Therefore, the Frontier approach involves finding the difference between the change in overall economic surplus resulting from the proposed augmentation project:

- Assuming bidding reflected the prevailing degree of market power both before and after the augmentation; and
- Assuming fully competitive bidding (that is, perfect competition) both before and after the augmentation.

The Frontier approach identifies two analysis types for competition benefits:

- "Static benefits", which are concerned with making more efficient use of existing inputs and are based on the changes to the dispatch and pricing of existing plant; and
- "Dynamic benefits" which consider the changes in investment patterns driven by strategic behaviour, and capture the increased competition in the market due to avoiding generators (or proponents) with a degree of market power investing in new capacity earlier than an independent investor, in order to entrench its market position. This is commonly called 'pre-emptive new entry'.

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[10] CBA Guideline, p27

[11] At https://www.energy.gov.au/sites/default/files/Frontier%20Economics%20Modelling%20of%20Liddell%20Power%20Station%20Closure.pdf

[12] At https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf

[13] At https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf

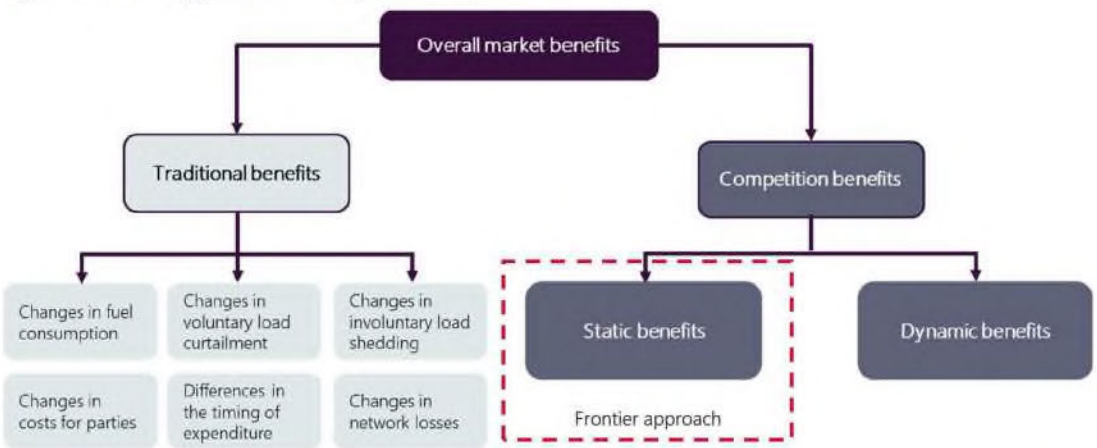
The Frontier approach focusses on modelling the static benefits to remove the need for the complexity of calculating the dynamic benefits unless there is a sufficient justification for undertaking further complex analysis beyond that of the static competitive analysis. The Frontier approach states that if the static competition benefits are not significant, it is likely that the dynamic competition benefits will also be small, and therefore the benefits of undertaking further modelling to assess them will not be worthwhile.

In developing the EY methodology, consideration was given to whether static or dynamic competition benefits should be calculated. It is proposed that static competition benefits only should be calculated because:

- Capital investment dynamic benefits are already calculated in the methodology used to assess traditional benefits, including the optimised development of new generation to replace aging generation on a market basis;
- Where RIT-T benefits are calculated using competitive (SRMC bidding), this allows the costs and benefits of transmission upgrades to be compared in an unbiased manner;
- As capital investment dynamic benefits are already captured in the calculation of traditional benefits, the incremental utility of calculating dynamic competition benefits relative to the computational complexity is limited;
- By capturing capital investment dynamic benefits through traditional benefits analysis and adopting a static competition benefits approach, this results in the most conservative estimate of competition benefits.

AEMO also considers that any additional capital deferral benefits associated with increasing competition in the market and reducing pre-emptive new entry is likely to be minimal relative to the other classes of market benefit and the cost of undertaking the analysis to quantify the market benefit is likely to be disproportionate given the level of uncertainty regarding future outcomes.

Figure 3 Frontier approach to competition benefits



Competition benefits can be further broken down into:

- Competition cost savings — enhanced efficiency cost savings due to creating an increased level of competition associated with the expanded transmission capacity, and less propensity for withholding capacity to higher priced bid offers than without the interconnection; and
- Competition benefits due to a demand response — response to lower electricity market prices, resulting in an increase in the level of aggregate supply and demand, which is due to elasticity of demand to wholesale market price. For the purposes of calculating competition benefits, 'demand response' refers changes in underlying demand for electricity to wholesale price. It does not refer to 'demand response' in

the context of customer demand or VPPs responding to short-term price signals through their retailer or via the Demand Response Mechanism.

The methodology for determining these constituent elements of competition benefits is outlined in section 2.3.

What is not clear in either the Frontier approach or the AER's RIT-T Guidelines is whether, in determining the 'prevailing degree of market power both before and after the augmentation' subsequent investment / divestment decisions from market participants in response to the augmentation should be taken into account. For example, if, under the traditional benefits approach, significant capital deferral benefits were identified with the augmentation, this deferral of additional capacity should arguably be taken into account when determining the prevailing market power and associated changes in dispatch and pricing with and without the augmentation. However, it is not necessary to account for the changes to the capital deferral in calculating the static competition benefit. The main capital changes due to the interconnector are capital deferral and shifting of renewable generation development from the downstream side of the augmentation to the upstream side. These shifts do not impact materially on the drivers of strategic bidding behaviour of incumbent dispatchable capacity, particularly coal fired generation. Strategic bidding takes place whether the augmentation is or is not developed. Therefore the static competition benefits can only be measured against a single development plan. The rationale for measuring against the same development plan, whether or not the augmentation is developed, is that the bidding behaviour is dependent on the particular development plan and not comparable for different generation development patterns, as is the case before and after the augmentation. There could however, be a case to assess competition benefits for both the Base case and the augmentation case and average the two. If the analysis considers before and after augmentation, then there is significantly greater computational complexity for minimal benefit.

To elucidate, the following examples draw on example 34 of Appendix A in the AER's RIT-T Guidelines.

Example 1: no capital deferral benefit associated with augmentation

Assume:

- Load is 200 MW.
- There are three generators capable of serving this load:
  - Coal-fired generation with a SRMC of $10/MWh and 120 MW capacity.
  - Mid-merit gas-fired generation with a SRMC of $50/MWh and 100 MW capacity.
  - Peaking oil-fired generation with a SRMC of $100/MWh and 40 MW capacity.
- The credible option entails developing an interconnector with a capacity of 140 MW to a competitive region that supplies electricity at a constant SRMC of $12/MWh.
- The coal-fired generator behaves strategically. That is, it maximises its short-run profit, given by: Quantity*(Price – SRMC).
- The coal-fired generator, due to technical requirements, has a minimum generation level of 60 MW and must offer its capacity in increments of 10 MW.

All other generators (including the power supplied through the interconnector) behave competitively. That is, they bid their full capacity into the market at SRMC.

In the base case:

- The three generators in the region make the following offers:
  - Coal-fired generation offers 90 MW at $10/MWh.
  - Mid-merit gas-fired generation offers 100 MW at $50/MWh.
  - Peaking oil-fired generation offers 10 MW at $100/MWh.
- The peaking generator sets the market price at $100/MWh.
- Total dispatch costs are 90*$10 + 100*$50 + 10*$100 = $6,900 per hour.

In the state of the world with the credible option:

- The interconnector enables the supply of 140 MW of electricity at $12/MWh.

- The generators in the region make the following offers:
  - Coal-fired generation offers 120 MW at $10/MWh
  - Mid-merit gas-fired generation offers 100 MW at $50/MWh.
  - Peaking oil-fired generation offers 40 MW at $100/MWh.
- The marginal generator in the adjacent region sets the market price through the interconnector at $12/MWh.
- Total dispatch costs are 120*$10 + 80*$12 = $2,160 per hour

The change in the total dispatch cost between states of the world with and without the credible option, assuming competitive bidding in both states of the world is:

(120 * $10 + 80 * $50) – (120 * $10 + 80 * $12) = $3,040 per hour.

The change in the total dispatch cost between a state of the world with and without the credible option, assuming strategic bidding in both states of the world is:

(90 * $10 + 100 * $50 + 10 * $100) – (120 * $10 + 80 * $12) = $4,740 per hour.

The competition benefit is thus: $4,740 – $3,040 = $1,700 per hour

So competition benefit = {change in total dispatch costs with competitive bidding} – {change in total dispatch costs with strategic bidding".

Example 2: there is capital deferral benefit associated with augmentation and this reduced capital investment is considered when calculating competition benefits of the credible option

Now consider what would happen if load in the above example was 350 MW and a generator has just retired, leaving a supply shortfall of at least 90 MW.

In the base case:

- a new mid-merit gas-fired generator of 100 MW is built to help meet the load and it offers 100 MW at $40/MWh.
- The oil-fired peaking generator still sets the market price at $100/MWh.
- Total dispatch costs are 120[14] * $10 + 100 * $40 + 100 * $50 + 30 * $100 = $13,200 per hour.

In the state of the world with the credible option:

- This new mid-merit gas-fired generator is not needed
- Total dispatch costs are 100[15] * $10 + 140 * $12 + 100 * $50 + 10 * $100 = $8,680 per hour.

Now the change in the total dispatch cost between states of the world with and without the credible option, assuming competitive bidding in both states of the world is:

(120 * $10 + 100 * $40 + 100 * $50 + 30 * $100) – (120 * $10 + 140 * $12 + 90 * $50) = $5,820 per hour.

And the change in the total dispatch cost between a state of the world with and without the credible option, assuming strategic bidding in both states of the world is:

(120 * $10 + 100 * $40 + 100 * $50 + 30 * $100) – (100 * $10 + 140 * $12 + 100 * $50 + 10 * $100) = $4,520 per hour.

The competition benefit is thus: $4,520 – $5,820 = -$1,300 per hour

[14] Withholding capacity is no longer a profit maximising option for this coal generator as the marginal price is already at $100/MWh

[15] Withholding 20 MW of capacity is profit maximising as it results in the marginal price being $100/MWh rather than $50/MWh

Example 3: there is capital deferral benefit associated with the augmentation , but this reduced capital investment is not considered when calculating competition benefits of the credible option (this example is most closely aligned with EY's approach)

If the capital deferral with the credible option is ignored, then the additional gas-fired generation would be assumed to exist in both states of the world with and without the credible option.

In that case, the change in the total dispatch cost between states of the world with and without the credible option, assuming competitive bidding in both states of the world is:

(120 * $10 + 100 * $40 + 100 * $50 + 30 * $100) – (120 * $10 + 140 * $12 + 90 * $40) = $6,720 per hour.

And the change in the total dispatch cost between a state of the world with and without the credible option, assuming strategic bidding in both states of the world is:

(120 * $10 + 100 * $40 + 100 * $50 + 30 * $100) – (100 * $10 + 140 * $12 + 100 * $40 + 10 * $50) = $6,020 per hour.

The competition benefit is thus: $6,020 – $6,720 = -$700 per hour.

In the last two examples with 350 MW of load, the competition benefits are actually negative regardless of whether the new gas fired generator is assumed to be available in the state of the world with the credible option, but the magnitude of the value varies considerably depending on approach taken, as does the change in dispatch price. Small negative competition benefits are not uncommon in RIT-T assessments and can be highly sensitive to assumptions around strategic bidding or future ownership structures, which is why, up until now, most RIT-T proponents have concluded that the benefits are not material.

The above examples do not consider the ability of the strategic player (coal here) to move capacity to higher price bid bands, which is the observed historical situation identified by Frontier. In such examples, the competition benefits are likely to be positive. In determining how best to treat capital deferral in the Frontier approach, consideration needs to be given to ensuring:

- There is no double counting of a credible option's competition benefits; and
- The total benefit (traditional plus competition benefit) is the change in total dispatch costs between states of the world with and without the credible option, assuming strategic bidding.

Matters for consultation

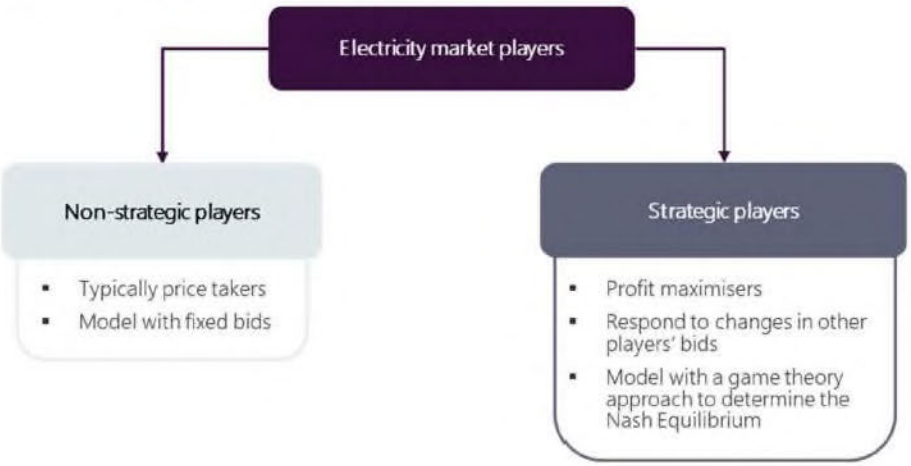
- Do you agree with the proposal to use the Frontier approach to quantify competition benefits?
- In using the Frontier approach, how should investment/divestment in response to the credible option be considered in the calculation to avoid double counting of a credible option's competition benefits while still ensuring that all competition benefits are captured?
- Is there another modelling approach that AEMO should consider?

2.2 Strategic bidding and Nash Equilibrium

One requirement for calculating competition benefits is a robust approach to determining strategic bidding. The AER suggests that it should be based on a credible theory as to how participants are likely to behave in the market over the modelling period, while taking into account the interaction of participants in their bidding behaviour[16].

In a modelled representation of the electricity market, electricity market players can be classified as non-strategic and strategic players. While non-strategic players are typically price takers and can be modelled with fixed bids, strategic players are those players that respond to changes in other players' bids to maximise their profit.

Figure 4 Strategic versus non-strategic players



The number of potential combinations of bids for strategic players in the electricity market is vast. It is not possible, nor useful, to attempt to try and guess the 'right' combination of bids from the millions of possible combinations[17]. There are several reasons for this:

- It is likely that mostly larger generators and portfolios will attempt to influence market prices by changing their bids or withholding some level of capacity in order to increase their profit;
- Generators which can influence constraints, particularly constraints which impact interconnector flows, are likely to have some market power;
- Strategic bidding depends on other factors such as the available capacity in the market; and
- The contract levels of generators capture their impact on marginal bidding decisions. However, the contracts and their prices are not expected to change the optimal bidding sets when assessing the optimal bidding strategies from a combination of bidding sets[18].

Game theory provides a systematic process for selecting the optimal strategy in the context of strategic players. While there are a range of game theory models, the game theory model used to calculate competition benefits derives a Nash Equilibrium which identifies an equilibrium point from which no participant has an incentive to depart because they return back to that point through competition. The Nash Equilibrium identifies a set of bids that participants in the electricity market would choose if acting rationally

[16] At https://www.aer.gov.au/system/files/AER%20-%20Regulatory%20investment%20test%20for%20transmission%20application%20guidelines%20-%2025%20August%202020.pdf

[17] At https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf

[18] At https://www.energy.gov.au/sites/default/files/Frontier%20Economics%20Modelling%20of%20Liddell%20Power%20Station%20Closure.pdf

under a given set of market conditions[19]. An equilibrium outcome is found when the best response of all players coincides[20]. That is, all strategic players maximise their profit from all the combinations of bids. A range of bids can be used for a game theory approach, including capacity bids, price bids, or a combination of both[21]. Note that strategic players can be a single generator or portfolios which have multiple generators in one region or two or more regions in the NEM.

Hydro generators can also play strategically in the market. Modelling hydro generators (including pumped hydro generators) strategically is complex, as their energy-constrained dispatch depends on several factors such as storage capacity, inflow and availability. The Frontier approach in 2004 modelled hydro generators and storages as price takers. In Frontier's view, this assumption tends to underestimate the competition benefits[22] although AEMO notes that this may depend on ownership structures and concentration of market power in any particular circumstance.

Matters for consultation

- Do you agree with the strategic bidding approach outlined above?
- Do you think it is reasonable to assume that hydro generators are price takers?

2.3 Competition benefits calculations

For quantification purposes, competition benefits are disaggregated into:

- Competition cost savings, which are enhanced efficiency benefits due to creating an increased level of competition associated with the expanded transmission capacity, i.e. less possibility for withholding capacity to higher priced bid offers than without the interconnection. These are additional benefits over and above efficiency cost savings which are expected in a competitive market. The competition cost savings are essentially the gains from improving productive efficiency; and
- Competition benefits due to a demand increase response to lower electricity market prices, resulting in an increase in the level of aggregate supply and demand, which is due to elasticity of demand. The demand response component of competition benefits represents improvements in allocative efficiency. For example, the HumeLink augmentation drives a market adjustment in which both demand (responding to lower prices) and supply (responding to higher levels of demand and greater network capacity) increase. This adjustment is essentially gains from improving allocative efficiency.

Figure 5 provides a diagrammatic view of efficiency benefits and the two components of competition benefits: cost savings and demand response.

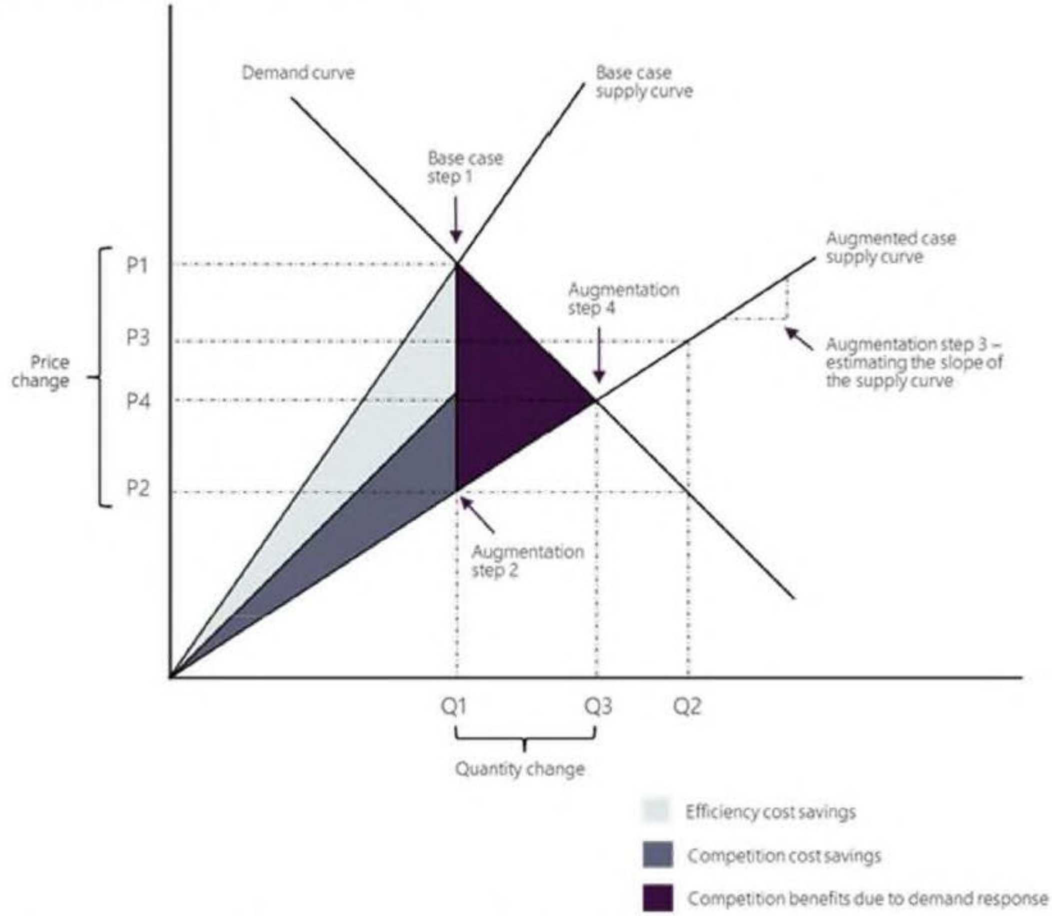
[19] At https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf

[20] At https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf

[21] At https://www.energy.gov.au/sites/default/files/Frontier%20Economics%20Modelling%20of%20Liddell%20Power%20Station%20Closure.pdf

[22] At https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf

Figure 5 Calculation of competition benefits



The steps taken to calculate both competition cost savings and competition benefits due to demand response are summarised below.

First, the list of strategic players and their bidding combinations is identified. A general approach for identifying this list is described in Section 2.2. Having all the combinations of bids, the equilibrium outcomes including the demand-weighted prices for each region can be derived for both the base case and augmentation case (P_1 and P_2 in Figure 5). This allows calculating the dispatch cost savings of the augmentation case relative to the base case, where after subtracting the dispatch cost savings of the augmentation case which are already calculated in the competitive bidding (SRMC) model (efficiency cost saving in Error! Reference source not found.~~Figure 5~~), the competition cost savings are calculated (as shown in the dark grey area in Error! Reference source not found.~~Figure 5~~).

The abovementioned steps in driving the equilibrium point for the augmentation case do not yet consider the elasticity of the demand to wholesale market price. When considering the elasticity of the demand to wholesale market price in the augmentation case, the equilibrium point will be different, which is able to be captured in the competition benefits calculation. To this end, it is proposed to calculate the competition benefits due to an increase in the aggregate level of supply and demand, to the point where the incremental cost of production matches the incremental customer willingness to pay. For this, both augmented case supply and demand curves in Error! Reference source not found.~~Figure 5~~ are required to be constructed. This allows determining the equilibrium point for the augmentation case with the consideration of elasticity of the demand to wholesale market price, and therefore to calculate the competition benefits due to demand response (as shown in the purple area in Figure 5), as represented in Error! Reference source not found.Figure 5.

Figure 6 Steps in calculating competition benefits

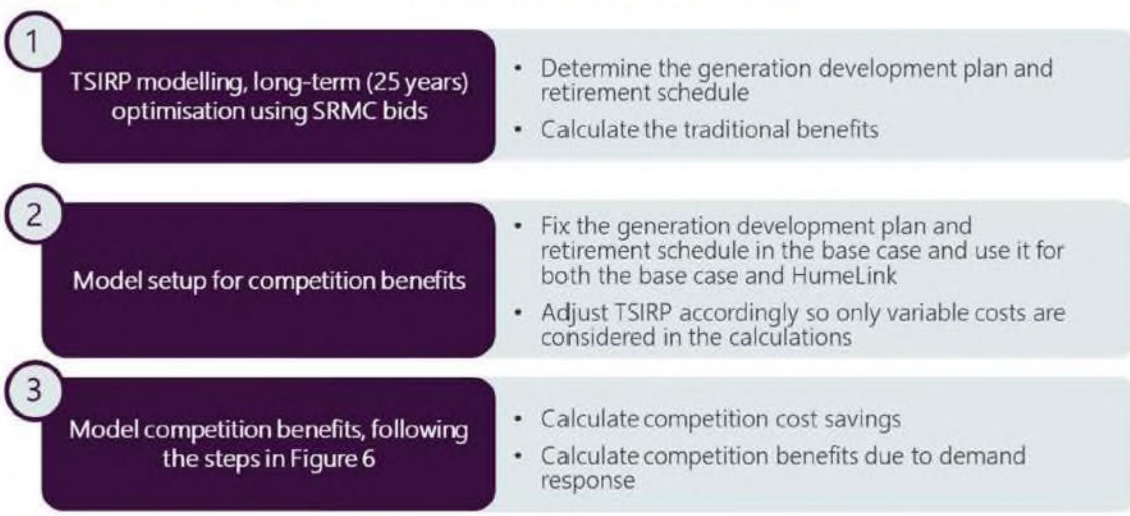
Further detail about competition benefits calculation is provided in the Draft Competition Benefits Methodology.

3. Competition benefits inputs and assumptions

The inputs and assumptions outlined in this section are intended to be replicable across projects, but in some cases are specific to the HumeLink project given HumeLink is the only actionable ISP project that has identified material competition benefits in its PACR. Where inputs or assumptions are specific to the HumeLink project, the information is intended to be read as an applied example of how inputs and assumptions would be used by AEMO for the purpose of quantifying competition benefits.

To model competition benefits for Humelink in the PACR[23], EY used the Time Sequential Integrated Resource Planner (TSIRP) for the calculation of traditional benefits, and adjusted it to compute competition benefits. The TSIRP is adjusted to use the capacity build and retirements schedule which resulted from the long-term investment planning from the base case , which allows modelling economic dispatch and determine variable and fuel costs. EY has modelled hydro and energy-limited storages in such a way that they are optimised in the model in such a way that they maximise their water values, corresponding with minimising the cost of thermal generation. The model is run on both the base case and HumeLink Option 3C for two sets of bidding, i.e. competitive (SRMC) and strategic bidding. The modelling of competitive bidding allows subtracting the benefits of fuel and Variable Operations and Maintenance (VOM) from the total benefits in the strategic bidding in order to avoid double counting these benefits in non-competition benefits modelling and competition benefits simulation.

Figure 7 Steps in EY calculations of RIT- benefits, including competition benefits



[23] TransGrid, HumeLink PACR , https://www.transgrid.com.au/humelink

3.1 Strategic bidding selection

Strategic bidders and strategy options

To calculate the HumeLink PACR competition benefits, EY used 2019 analysis conducted by Frontier Economics to identify a list of strategic players and their bidding strategies as well as the historical offerings over a six-year historical periods[24].

Table 2 Bidding strategies in Frontier modelling for Liddell closure[25]

Portfolio	Generators	Strategy options (proportion of capacity offered at SRMC)	**Historical analysis**
AGL NSW	Bayswater, Liddell	40%, 70%, 80%	50-60% Liddell 70-80% Bayswater
AGL VIC	Loy Yang A	80%, 95%	90-95%
EA NSW	Mt Piper	40%, 75%, 80%	50-85%
EA VIC	Yallourn	80%, 95%	75-95%
Stanwell QLD	Stanwell, Tarong, Tarong North	40%, 70%, 90%	70-80% Stanwell 40-85% Tarong 50-85% Tarong North
CS QLD	Callide B, Callide C, Gladstone, Kogan	40%, 70%, 90%	55-95% Callide B & C 40-70% Gladstone 80-100% Kogan
Origin NSW	Eraring	70%, 85%	50-75%
EA VIC	Yallourn	80%, 95%	75-95%

Despite being done in 2019, this analysis remains relevant as a starting point as it concluded that new peaking generation would be profitable due to the strategic bidding of incumbent generators maintaining prices at profitable levels. These new peaking generators, Kurri Kurri and Tallawarra, have been incorporated in the ISP 2022 assumptions book as committed. The timing of Liddell retirement and the new entry generators in NSW are still current information to be used in the 2022 ISP and no new information has come to light that would render this information out of date.

The list of strategic players was then shortened by EY for the purposes of the HumeLink competition benefits modelling. EY's shorter list of strategic players was because some strategic players identified in the Frontier Economics analysis would either retire earlier than the proposed HumeLink commissioning date, or within a short time after that with the assumption of economic retirement in the HumeLink modelling. Those generators were therefore modelled to continue bidding at SRMC levels consistent with a fully competitive market until they exit the market before or shortly after HumeLink is commissioned. As generators retired over the calculation period they no longer participated, but the remainder continued to bid strategically until retired or the study finished.

[24] At https://www.energy.gov.au/sites/default/files/Frontier%20Economics%20Modelling%20of%20Liddell%20Power%20Station%20Closure.pdf

[25] At https://www.energy.gov.au/sites/default/files/Frontier%20Economics%20Modelling%20of%20Liddell%20Power%20Station%20Closure.pdf

EY's methodology then involved assigning a number of 'strategy options' for each strategic player representing the percentage of capacity which is assumed to bid at SRMC. The full combinations of the bidding strategies shown in Table 2 were then modelled to determine the Nash Equilibrium. The strategy options selected were based on Frontier Economics assessment of the long history of strategic players in the NEM. These strategies were reviewed and it was considered that they were unlikely to change until all the players leave the market, unless the rules for bidding are changed.

Consideration was also given to the potential for strategic players to withhold capacity that leads to high prices such as the market price cap though very high prices typically do not last long and interventions are expected. The modelling approach included a conservative metric of withdrawing capacity to $500/MWh, which is less likely to result in unrealistic modelling results of withholding capacity. The $500/MWh figure was selected following computational testing of three separate levels:

- Withdrawal of capacity from bidding at any price,
- Withdrawal to market price cap; and
- Withdrawal to $500/MWh.

The lowest of these levels was adopted as it gave the lowest competition benefits and was therefore the most conservative option. $500/MWh was also the level that Frontier Economics identified as a break point between cost based bidding and defence of caps and the higher values adopted for strategic bidding. The selection of $500/MWh is a more conservative approach than used in the Frontier approach which assumes the withholding of capacity which is more aggressive (that is, it results in higher competition benefits than the $500/MWh figure proposed by EY).

Table 2 provides the full list of strategic players and their bidding strategies from Frontier's 2019 analysis. Table 3 provides the list of generators adopting strategic bidding in the modelling undertaken by EY for the HumeLink PACR.

Table 3 Bidding strategies in HumeLink PACR

Portfolio	Generators	Strategy options
AGL NSW	AGL NSW	40%, 70%, 80%
AGL VIC	Loy Yang A	80%, 95%
EA NSW	Mt Piper	40%, 75%, 80%
Stanwell QLD	Stanwell, Tarong	40%, 70%, 90%

In EY's approach, the bid behaviour of strategic players and the optimum bidding strategy chosen was computed to deliver the highest profitability of all strategic players over the 25 year competition modelling period and was not varied as time progressed and generators retired. This was necessary due to the level of modelling complexity that would be needed to allow changes in the optimum bidding strategy over time. The range of strategies spans a wide band between full output and minimum load for a number of generators, so this was considered to be an acceptable approach. The outcomes of applying this approach in the HumeLink PACR showed that profitability was similar over a range of bids around the optimum set. As generators retired they no longer participated, but the remainder continued to bid strategically until retired or the study finished.

The remaining generators and storages are assumed to be non-strategic. Non-strategic players bid their full capacity at their SRMC.

For the purposes of AEMO's assessment of the HumeLink project, AEMO would adopt the same list of strategic players as outlined in Table 3 and adjust for generators that have retired, or will retire shortly after HumeLink becomes operational. For future project assessments, AEMO would need to consider updates to this list of strategic players based on the retirement timeframes of generation versus the proposed augmentation.

Treatment of hydro and energy-limited storage

EY modelled storage hydro and pumped hydro generators including Snowy Hydro on a competitive bidding basis. Frontier Economics stated that this assumption is expected to result in underestimating the competition benefits. EY specifically considered Snowy and Snowy 2.0 and its ability to be a strategic player and concluded that it was not. The reason for this conclusion was that Snowy, including Snowy 2.0 as applicable, is mostly located in NSW and receives NSW prices, regardless of whether HumeLink was constrained or not. All of Upper and Lower Tumut, totalling 2,600 MW plus Snowy 2.0 with 2,000 MW will be in NSW. The flow limit from Snowy to Sydney within NSW would increase by approximately 1,800 MW from its present value of approximately 3,000 MW due to HumeLink, and HumeLink would therefore reduce the potential for strategic bidding by Snowy. Since Snowy generation in Central NSW is comprised of peaking generation at Colongra 600 MW GT near Newcastle and the proposed Kurri Kurri peaker, this plant would benefit from other strategic bidding by other players rather than by becoming a strategic player itself. Further, Snowy has to compete with renewable generation in southern NSW as well as cheap resources in southern states, which makes it less likely to try to influence the constraints between snowy and central NSW in order to increase the NSW prices. On the other hand, the Snowy gas generators in central NSW are peakers and typically offline which means it is less likely that they withdraw capacity to increase prices.

Role of ISP scenarios

In the HumeLink analysis, modelling was undertaken for four 2020 ISP scenarios to calculate both traditional benefits and competition benefits in each scenario. The total competition benefit can be calculated as the weighted sum of competition benefits across all scenarios where the weighting used to calculate the competition benefit reflected the weighting applied to each scenario in the 2020 ISP.

Because available capacity in the NEM is a key factor that reduces market power, ISP scenarios that had greater spare capacity showed a decline in the market power and competition benefits relative to ISP scenarios that had limited capacity. This manifested in the Slow Change scenario. Conversely, the Step Change scenario which assumed a rapid transitioning of the NEM resulted in an accelerated retirement of strategic players and therefore the competition cost savings declined although demand response continued to be a significant contributor to competition benefits.

Matters for consultation

- Do you agree with AEMO's proposed selection of strategic players?
- Do you think it is appropriate to select bidding strategies purely based on historical behaviour?
- Do you agree with the assumptions that the strategy assumed does not change over time as the market evolves?
- Do you agree with the strategic options percentages proposed to be applied?
- Do you agree with the use of a specific bid price above which it is assumed generators withdraw their respective capacity? If so, is $500/MWh an appropriate value?
- Do you agree that non-strategic players are assumed to bid full capacity at SRMC?
- Do you agree with EY's approach to use the weighted sum of competition benefits across ISP scenarios?

3.2 Selection of generation development plan

Why is a single generation development plan used?

The modelling of traditional benefits, including all aspects outlined in Error! Reference source not found.~~Figure~~ 3, is normally conducted as a single optimisation, as has been done for the HumeLink PACR. All aspects of traditional benefits, both savings due to reduced production costs, and savings due to reduced investment costs, are integrated. This includes making trade-offs between building higher capital cost, more efficient plant such as Combined Cycle Gas Turbines (CCGTs) versus lower capital cost, less efficient plant such as Open Cycle Gas Turbines (OCGTs). It also includes making trade-offs between zero fuel cost variable renewable energy (VRE) generation, and alternatives such as batteries and pumped storage hydro which can reduce the build of VRE plant but must pay the cost of cycling inefficiency from storing and releasing the generation. This optimisation approach necessarily assumes all generators bid SRMC and storage behaves in order to minimise the total cost of energy over the forecast horizon.

At this time, it is not computationally feasible to enable strategic bidding for all generators and portfolios while still finding the optimum as this is fundamentally a non-linear problem and therefore not able to be solved in a single linear programming optimisation.

In order to configure the model to simulate marginal wholesale pool prices, capital decisions must be removed from the optimisation problem. As such, a 'fixed' generation and storage development/retirement plan is established and capital investment options are not available. Static competition benefits are short term by nature as they are chosen by the players in the market every 5 minute dispatch interval, so the assumption of a fixed generation development plan is appropriate.

The generation development plan that forms the basis for calculation of competition benefits is determined using the non-competition approach. This is to ensure that additional consumer and producer surpluses identified are solely associated with competition benefits. The EY competition benefits modelling used the base case generation development plan, as per the "static benefits" defined by Frontier approach.

To determine static competition benefits, the main difference between the Base case and the augmentation case is the presence or absence of HumeLink. Therefore, it is the expanded transmission capacity of HumeLink that was the primary variable for calculation of the competition benefits.

The changes in the generation development plan (mainly locations of renewable generation) are not strong drivers in the assessment of competition benefits. It is the interaction between the existing incumbent generators and HumeLink that is the primary driver of most of the benefits resulting from reducing withdrawal of capacity. The rationale for measuring against the same development plan, whether or not the augmentation is developed, is that the bidding behaviour is dependent on the particular development plan and not comparable for different generation development patterns, as is the case before and after the augmentation. There could however, be a case to assess competition benefits for both the Base case and the augmentation case and average the two. If the analysis considers before and after augmentation, then there is significantly greater computational complexity for minimal benefit.

Matters for consultation

- Do you agree that competition benefits should not consider the capacity response to a state of the world with and without the augmentation?

3.3 Time periods

The Draft Competition Benefits Methodology requires the selection of the period during which strategic players are expected to exert their market power.

EY's proposed Draft Competition Benefits Methodology assumes that when there is less spare capacity in the market, the capability of strategic players to change their bids or withhold their capacity to raise prices is high. For example, with significant rooftop photovoltaic (PV) and large-scale solar, it is unlikely that strategic players could exert market power during the middle of the day. In order to fully assess the impact of strategic bidding two different approaches were modelled. One was to allow strategic bidding in all 24 hours of every day. The other was to allow strategic bidding only in the peak hours from 6-10 am and 6-10pm. The outcome of this analysis was that there was little difference in quantitative outcomes between bidding in all 24 hours of the day versus during peak hours. For this reason, the calculations were performed assuming strategic bidding during peak hours only.

The 24 hour versus peak hour analysis was also used to confirm whether Snowy 2.0 should be treated as a strategic player. Comparing the two outcomes showed strong similarities in the performance of Snowy 2.0 such that the strategic bidding periods were not linked to the level of pumping and generation at Snowy in a significant way. This was expected as strategic withdrawal to higher price bands does not provide benefits to generators during a period of oversupply such as when solar PV is operating at high levels and pumping is the predominant operating mode. Hydro generators (including Snowy) were therefore not included as strategic players.

Matters for consultation

- For the purpose of the ISP, do you agree with EY's proposed methodology of only applying bidding strategies during peak demand periods?
- Do you agree with the selection of peak demand periods being 6am-10am and 6pm-10pm every day?

3.4 Elasticity of demand to wholesale price

Under the Frontier approach, both supply and demand curves are required to be constructed to determine the equilibrium point for the augmentation case with the consideration of elasticity of the demand to wholesale price, and therefore to calculate the competition benefits due to demand response.

Supply curve

The supply curve is the production cost recalculated in the optimum way taking energy limited generation by incrementing the demand in each region in turn. The slope of the augmented case supply curves in each region are estimated. For this purpose, a small change in each region's demand is applied and the resulting prices in that region and other regions are calculated. Calculating the demand weighted price of a region due to a small change in demand allows construction of an inverse cross-elasticity of supply matrix. That matrix is constructed by using the relationships between relative demand changes to relative price changes in each region.

Further detail about the supply curve is provided in the Draft Competition Benefits Methodology.

The Draft Competition Benefits Methodology

Demand elasticity

Elasticity of demand is the ratio between the change in demand and the change in price[26], and is an important factor in the calculation of competition benefits. As shown in Figure 8, apart from the electricity price differences between the Base case and augmentation case, area F is also influenced by the elasticity of the demand. If demand is elastic then (all else being equal) if price reduces demand will increase and vice

[26] Oxford Reference, https://www.oxfordreference.com/view/10.1093/oi/authority.20110803095745343, accessed on 23 September 2021

versa. That is, if demand is highly responsive to the price changes, the slope of the demand curve is flatter and thus the competition benefits due to demand response are higher and vice versa.

There are various documents stating the elasticity of demand to electricity price in the regions comprising the NEM. The elasticity of demand values are generally estimated relative to residential or retail electricity price. For example, the TransGrid 2021 Transmission Annual Planning Report (TAPR) has a range of elasticity of demand between -0.08 and -0.84 for different consumer sectors[27]. The 2019 Electricity Statement of Opportunities (ESOO) considers an elasticity of demand of 1%[28]. In a review of studies about the NEM elasticity of demand, a range of -0.08 to -0.55 is listed for various demand sectors in the NEM[29].

In the HumeLink competition benefits calculation, TransGrid provided EY with elasticity of demand for each region, ranging between -0.1 and -0.21 percent demand response per percent change in price. Considering this range, TransGrid advised using -0.1 for all regions as the most conservative, that is, lowest, value for the elasticity of demand. EY halved this value to -0.05 to approximately represent the reduced impact of wholesale electricity price changes to the retail market. That is, the approximate proportion of network to non-network charges across all sizes of customers is assumed to be 50%.

For the HumeLink PACR, EY did perform sensitivity analysis and found that the higher the elasticity, the greater the benefits. The modelling captured distributed energy resources (DER) and utility battery deployment.

Given the potentially wide range of elasticity of demand values and relatively large impact on the competition benefits due to demand response calculation, sensitivity analysis should be conducted to assess a range of elasticity values.

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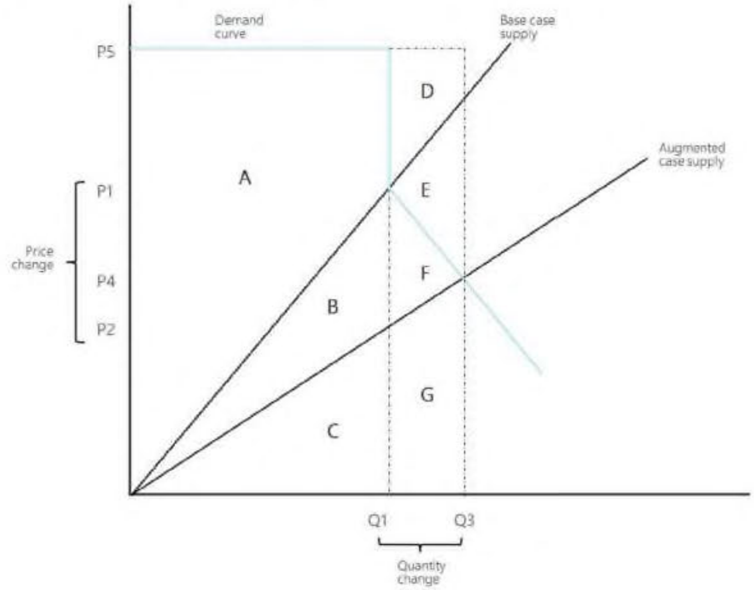
[27] TransGrid, 2021 TAPR, https://www.transgrid.com.au/media/jtabhxws/transmission-annual-planning-report-2011.pdf, accessed on 22 September 2021

[28] AEMO, 2019 ESOO, https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/NEM_ESOO/2019/2019-Electricity-Statement-of-Opportunities.pdf, accessed on 22 September 2021

[29] Centre for Climate Economic & Policy, Australian National University, Impact of the carbon price on Australia's electricity

demand, supply and emissions, https://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2014/08/OGorman-and-Jotzo-Impact-of-the-carbon-price-on-Australias-electricity-demand-supply-and-emissions.pdf, accessed on 22 September 22, 2021

Figure 8 Calculation of surplus



> Matters for consultation
>
> - Is -0.05 an appropriate value for the demand elasticity to be applied for the HumeLink competition benefits assessment?
> - Is there a recommended source to determine the appropriate price elasticity of demand?
> - Do you agree with the approach of halving the demand response value to reduce the impact of wholesale electricity price changes to the retail market?
> - Should the impact of increased transmission charges to consumers be factored into the calculation of demand response benefits?

3.5 Other points of consultation

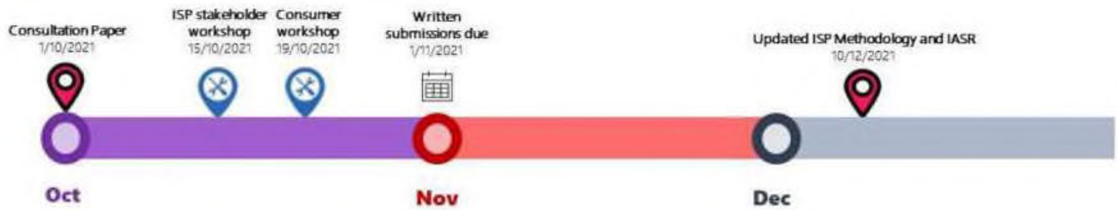
Stakeholders are invited to provide a written submission to the questions outlined in this Consultation Paper, and on any other matter related to the methodologies, inputs and assumptions for calculating competition benefits relevant to the ISP process.

Submissions need not address every question posed and are not limited to the specific consultation questions noted in this Paper.

4. Next steps

The single-stage consultation process begins upon the release of this Consultation Paper. The next steps in the consultation process are shown below in Figure 9.

Figure 9 Next steps



ISP stakeholder workshop

AEMO will undertake a workshop with ISP stakeholders on 15 October 2021. The purpose of this workshop will be to provide ISP stakeholders with the opportunity to discuss and clarify any aspect of the Draft Competition Benefits methodology with AEMO and EY. Should ISP stakeholders wish to formally respond to this Consultation Paper, they should do so by providing written feedback by 1 November 2021.

Consumer workshop

AEMO will also host a Consumer workshop on 19 October 2021. The purpose of the Consumer workshop will be provided consumers and consumer representatives with the opportunity to provide verbal feedback on the Draft Competition Benefits methodology. AEMO will document this feedback and it will be treated as formal written feedback to the Consultation Paper similar to other written feedback received by 1 November 2021.

Updated ISP Methodology and IASR

AEMO will update the ISP Methodology and IASR to reflect the final Competition Benefits Methodology and publish these together with a consultation summary report by 10 December 2021.

Details on major milestones in the ISP process can be found in the ISP Timetable[30], and additional information on upcoming events and consultations for the ISP are outlined on AEMO's website[31]. Details on how to get involved in the consultation process are also provided on the website[32].

[30] At https://aemo.com.au/-/media/files/major-publications/isp/2021/2022-isp-timetable.pdf?la=en

[31] At https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp/opportunities-for-engagement

[32] At https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp/get-involved

5. Abbreviations

Term	Definition
ACCC	Australian Competition and Consumer Commission
AER	Australian Energy Regulator
CBA	Cost Benefit Analysis
CCGTs	Combined Cycle Gas Turbines
CPA	Contingent Project Application
DER	Distributed Energy Resources
ESOO	Electricity Statement of Opportunities
EY	Ernst & Young
FBP	Forecasting Best Practice
IASR	Inputs, Assumptions and Scenarios Report
ISP	Integrated System Plan
MW	Megawatt/s
MWh	Megawatt hour/s
NEM	National Electricity Market
NER	National Electricity Rules
NSW	New South Wales
OCGTs	Open Cycle Gas Turbine
PACR	Project Assessment Conclusions Report
PADR	Project Assessment Draft Report
PV	Photovoltaic
QLD	Queensland
RIT-T	Regulatory Investment Test for Transmission
SRMC	Short Run Marginal Cost
TAPR	Transmission Annual Planning Report
TNSP	Transmission Network Service Provider
TSIRP	Time Sequential Integrated Resource Planner
VNI West	Victoria to New South Wales Interconnector West

VIC	Victoria
VOM	Variable Operations and Maintenance
VRE	Variable Renewable Energy

Competition Benefits Methodology

Market Consultation

6 October 2021

Building a better working world

Release Notice

Ernst & Young was engaged pursuant to the terms of its agreement dated 13 September 2021 (the "Agreement") with the engaging client (the "Client") to prepare a methodology report for the calculation of competition benefits, which is also been applied in the HumeLink Project Assessment Conclusion Report (PACR).

The detail of Ernst & Young's work is set out in this report (Report), including the assumptions and qualifications made in preparing the Report. The Report should be read in its entirety including this release notice, the applicable scope of the work and any limitations. A reference to the Report includes any part of the Report. No further work has been undertaken by Ernst & Young since the date of the Report to update it.

Ernst & Young has prepared the Report for the purpose of market consultation (the "Purpose"). Ernst & Young makes no representations as to the appropriateness, accuracy or completeness of the Report for any party other than the Client. Our work commenced on 13 September 2021 and was completed on 30 September 2021. Therefore, our Report does not take account of events or circumstances arising after 30 September 2021 and we have no responsibility to update the Report for such events or circumstances.

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Table of contents

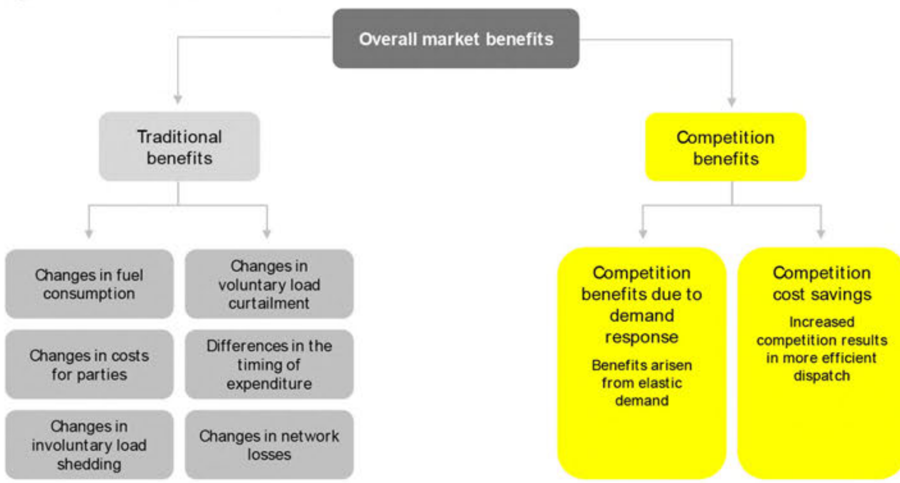
1. Executive summary

EY has been engaged to write a competition benefits methodology report (Report) based on the Australian Energy Regulator's (AER) approved methodologies[1], which is also applied in competition benefits assessment in the HumeLink Project Assessment Conclusion Report (PACR)[2].

The AER has defined the classes of RIT-T benefits in the RIT-T guidelines. In the HumeLink PACR, EY assessed the classes as shown in Figure 1, grouped into traditional benefits and competition benefits. Specifically, Frontier Economics[3] group competition benefits into competition cost savings and competition benefits due to demand response[4].

This Report describes both groups of competition benefits, Frontier approach in calculations of competition benefits as well as assumptions and inputs used in the HumeLink PACR.

Figure 1: Breakdown of market benefits[5]



[1] AER, August 2020, *Application guidelines - Regulatory investment test for transmission.* Available at: https://www.aer.gov.au/system/files/AER%20-]%20Regulatory%20investment%20test%20for%20transmission%20application%20guidelines%20-%2025%20August%202020.pdf. Accessed 28 June 2021.

[2] TransGrid RIT-T website available at: https://www.transgrid.com.au/what-we-do/projects/current-projects/Reinforcing%20the%20NSW%20Southern%20Shared%20Network. Accessed 29 July 2021.

[3] Frontier Economics, September 2004, *Evaluating interconnection competition benefits.* Available at: https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf. Accessed 30 September 2021.

[4] The term "demand response" has been adopted from Frontier's 2004 report, but differs from the general current use of the term as short term demand flexibility (e.g. Wholesale Demand Response).

[5] The diagram is based on AER, August 2020, *Application guidelines - Regulatory investment test for transmission.* Available at: https://www.aer.gov.au/system/files/AER%20-]%20Regulatory%20investment%20test%20for%20transmission%20application%20guidelines%20-%2025%20August%202020.pdf. Accessed 28 June 2021. and Frontier Economics, September 2004, *Evaluating interconnection competition benefits.* Available at: https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf. Accessed 30 September 2021.

2. Introduction

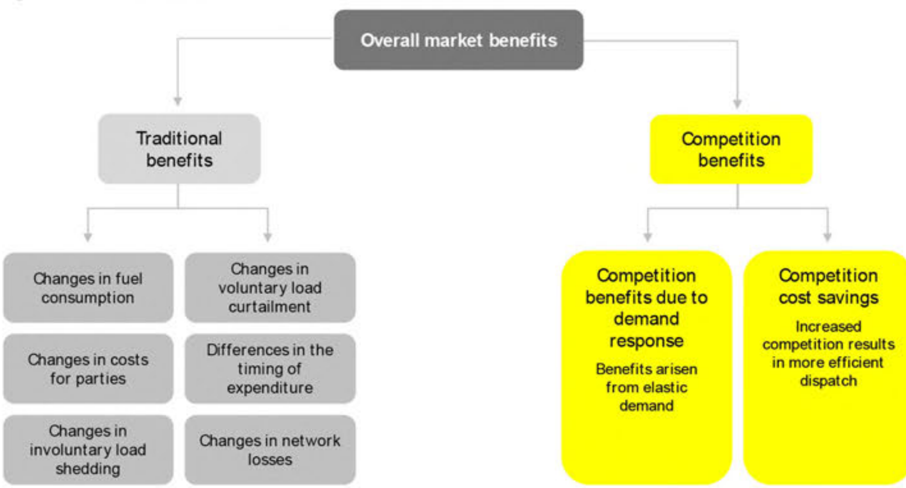
EY has been engaged to prepare a competition benefits methodology report (Report) based on the Australian Energy Regulator's (AER) approved methodologies[6]. EY has recently applied a competition benefits assessment for the HumeLink Project Assessment Conclusion Report (PACR)[7].

RIT–T proponents must apply the RIT–T in accordance with the procedures under the National Electricity Rules (NER) clause 5.16.4 to assess the economic efficiency of proposed transmission network investment options. The RIT–T aims to promote efficient transmission investment in the National Electricity Market (NEM) by promoting greater consistency, transparency and predictability in transmission investment decision making.

Clause 5.15A.2(b)(4)(viii) of the NER requires a RIT–T proponent to consider competition benefits as a class of potential market benefits that could be provided by a credible option[6]. Competition benefits are likely to accrue if a credible option could impact the bidding behaviour of generators (and other market participants) who may have a degree of market power relative to the base case[6].

Figure 2 shows the classes of market benefits which have been calculated in the HumeLink PACR. For the purpose of this market consultation, market benefits which have generally been considered in the RIT-T cost-benefit assessment in recent years are described as "traditional benefits". EY applies its Time Sequential Integrated Resource Planner (TSIRP) software to calculate these traditional benefits applying competitive (short-run marginal cost, SRMC) generator bid modelling. AEMOs ISP modelling framework and software tools are different in detail but apply the same overall mathematical approach to the generation and transmission planning problem by minimising total cost of energy supply in a global optimisation. For the HumeLink PACR, EY has evaluated competition benefits with further modelling, following the Frontier approach, which ensures avoiding the double counting of the efficiency benefits from the competitive bid modelling.

Figure 2: Breakdown of market benefits[8]



[6] AER, August 2020, *Application guidelines - Regulatory investment test for transmission*. Available at: https://www.aer.gov.au/system/files/AER%20-]%20Regulatory%20investment%20test%20for%20transmission%20application%20guidelines%20-%2025%20August%202020.pdf. Accessed 30 September 2021.

[7] TransGrid RIT-T website available at https://www.transgrid.com.au/projects-innovation/humelink. Accessed 30 September 2021.

[8] The term "demand response" has been adopted from Frontier's 2004 report, but differs from the general current use of the term as short term demand flexibility (e.g. Wholesale Demand Response).

The HumeLink project

- This report discusses the methodology applied to assessing competition benefits for the HumeLink project.
- HumeLink is a new 500kV transmission line that will transport electricity to Wagga Wagga, Bannaby and Maragle. The line will be linked to a number of new generation sources, including the upgraded Snowy Hydro scheme.
- A detailed overview of the results of applying this methodology can be found in Section A.2 of EY's PACR[9].

The remainder of the Report is structured in the following sections:

- Chapter 3 provides an overview of the competition benefits modelling and calculation methodology, including its categories, key modelling steps, assumptions and inputs.
- A proposed procedural approach to configuring the market model and the mathematics applied to calculate competition benefits is detailed in Appendix A.

3. Competition benefits

Traditional classes of RIT-T market benefits (e.g. capital expenditure (capex), fuel, operation and maintenance) are calculated based on competitive dispatch and SRMC bidding, with the implicit assumption that the market is fully competitive. However, the SRMC-based market modelling may not capture all the market benefits of a transmission network investment. Clause 5.15A.2(b)(4)(viii) of the NER requires a RIT–T proponent to consider competition benefits as a class of potential market benefits that could be provided by a credible option[6]. Competition benefits are likely to apply if a credible option could impact the bidding behaviour of generators (and other market participants) who may have a degree of market power relative to the base case.

Competition benefits can be calculated when the modelling process calculates market benefits as the difference between the following present values of the economic surplus[6]:

- arising with the credible option, with bidding behaviour reflecting any market power prevailing with that option in place; and
- in the base case, with bidding behaviour reflecting any market power in the base case.

The AER in the RIT-T application guidelines suggest two possible approaches for the calculation of competition benefits, known as the "Biggar approach" and the "Frontier approach". Both approaches involve the same methodology for calculating the overall market benefits of a credible option. The difference between the two approaches relates to how to divide the overall market benefits of a credible option between competition benefits and traditional benefits. The AER allows, by virtue of the guidelines, a RIT-T proponent to adopt either approach (or another approach) for the calculation of competition benefits.

While both approaches are acceptable to the AER, EY has applied the Frontier approach in the competition benefits modelling for HumeLink for the following reasons.

- The Frontier approach which assesses the competition benefits over and above the traditional benefits ensures that the total gross market benefits, particularly efficiency savings already calculated in the competitive bidding, are not double counted; and
- The Frontier approach has been used for the SNOVIC upgrade[9] which outlines the details of modelling considerations for calculating competition benefits in the NEM. It has also been used for the recent study on the Liddell closure[10] which provides reasonable background and information about the modelling and particularly the strategic players and historical analysis of major coal generator bidding strategies.

Figure 3 illustrates a high-level overview of the Frontier approach.

[9] Frontier Economics, September 2004, *Evaluating interconnection competition benefits.* Available at: https://www.aer.gov.au/system/files/Frontier%20Economics%20report%20-%20evaluating%20interconnection%20competition%20benefits%20-%20September%202004.pdf. Accessed 30 September 2021.

[10] Frontier Economics, *Modelling of Liddell power station closure.* Available at: https://www.energy.gov.au/sites/default/files/Frontier%20Economics%20Modelling%20of%20Liddell%20Power%20Station%20Closure.pdf. Accessed 30 September 2021.

Figure 3: Overview of the Frontier approach

1. Determine the likely dispatch pattern for hydro and participants' contract cover
   - Model the efficient operation of generators to satisfy demand
2. Analyse the likely market outcomes given participants' market power
   - Determine equilibrium bidding patterns before and after the interconnect
3. Use the outcomes from Stage 2 to calculate the competition benefits
   - Compare the total surplus under the post-augmentation equilibrium versus the pre-augmentation equilibrium

A detailed description of the Frontier approach and how it may be applied to evaluating competition benefits within the ISP framework for the actionable ISP HumeLink network augmentation is provided in the following section.

3.1 Competition benefits methodology

3.1.1 Frontier definition

The Frontier approach involves finding the difference between the change in overall economic surplus resulting from the credible option; [6]:

- assuming bidding reflected the prevailing degree of market power both before and after the augmentation; and
- assuming fully competitive bidding both before and after the augmentation.

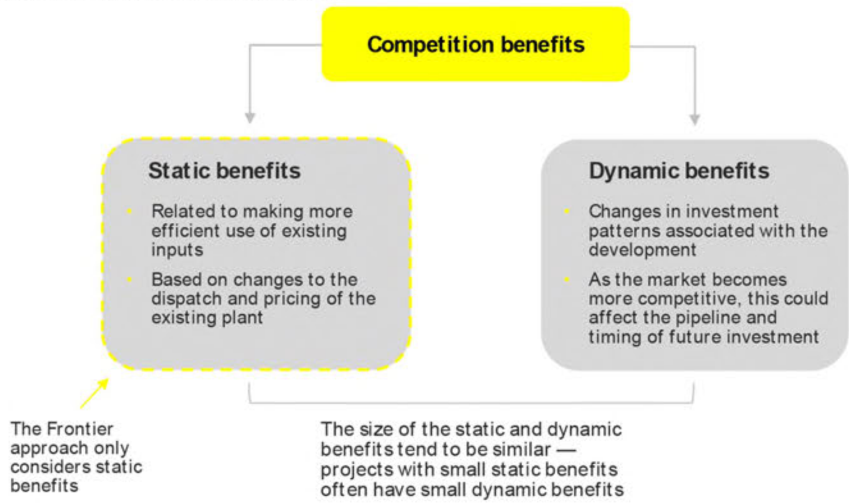
The importance of competition benefits has been highlighted by Frontier Economics as follows[9].

- "*the original intent of the NEM was to develop arrangements to facilitate the development of (regulated) interconnects to promote competition between the State electricity systems and yet, to-date, the competitive impacts from interconnection have been ignored; and*
- *as the power system evolves with the connection of new generators and loads in response to the price signals given by the market, the contribution of the other (non-competition related) benefits to the overall benefits of interconnection will diminish. This will mean that competition benefits will become an increasingly important source of the benefits of interconnection. Therefore, more time and effort will need to be spent in understanding the nature of these benefits and how they can be measured.*"

The Frontier approach has stated that competition benefits can be grouped into "static benefits" and "dynamic benefits". The static benefits relates to making more efficient use of existing inputs, which are based on the changes to the dispatch and pricing of existing plant. These benefits are different to the dynamic benefits which consider the changes in investment patterns, and capture the increased competition in the market due to avoiding generators (or proponents) with a degree of market power investing in new capacity earlier than an independent investor, in order to entrench its market position.

The reason for modelling the static benefits is to remove the need for the complexity of calculating the dynamic benefits, as outlined by Frontier Economics, unless there is a sufficient justification for undertaking further complex analysis beyond that of the static competitive analysis. The Frontier approach states that if the static benefits are not significant, it is likely that the dynamic benefits are also small, and therefore the significant effort required to undertake the complex modelling would outweigh the benefits.

Figure 4: Static and dynamic competition benefits



The Frontier approach for defining competition benefits is to measure the additional benefits that an augmentation might accrue if the assumption of fully competitive bidding was relaxed[9]. These benefits are over and above traditional market benefits, and are expected to flow from taking into account "realistic bidding"[11] behaviour of generation portfolios.

3.1.2 Strategic bidding and Nash Equilibrium

Calculating competition benefits requires a robust approach to determining realistic bidding. The AER suggest that it should be based on a credible theory as to how participants are likely to behave in the market over the modelling period, while taking into account the interaction of participants in their bidding behaviour[6].

Electricity market players can be generally classified as non-strategic or strategic players (see Figure 5). While non-strategic players are typically price takers and can be modelled with fixed bids, strategic players are those players that respond to changes in other players' bids to maximise their profit.

Figure 5: Non-strategic and Strategic players

Game theory is a branch of mathematical analysis which is designed to examine decision making when the actions of one decision maker (player) affect the outcomes of other players. These actions may elicit a competitive response that alters the

[11] As described in the AERs August 2020, Application guidelines - Regulatory investment test for transmission.

first player's outcome[10]. Game theory is a robust and methodical approach, and one of its model outputs is a Nash Equilibrium. In the context of the NEM:

- The Nash Equilibrium identifies a set of generator and dispatchable load bids/offers which rational participants would choose under a given set of market conditions[9].
- The Nash Equilibrium outcome is found when the best responses of all players coincide[9] – in other words, all strategic players maximise their profit from a particular selected combination of bids/offers.

A wide range of bids can be used for a game theory approach to the NEM. This includes capacity bids (Cournot modelling, shifting capacity between price bands, typically moving/withholding capacity from low price to higher price bands), price bids (Bertrand modelling, modifying price bands whilst retaining capacity at each band), or a combination of both[10]. There are countless possible combinations and it is not possible, nor useful, to attempt to find the theoretically perfect combination of all potential bids[9] for all potential players. There are several reasons for this:

- It is likely that only larger generators and portfolios will attempt to influence market prices by changing their bids or withholding some level of capacity to higher price bands.
- Generators which can influence transmission network constraints – particularly constraints which impact interconnector flows – are likely to have some market power.
- Strategic bidding depends on other factors such as the available capacity in the market.
  - If there is additional spare capacity available in the market – for example, during daytime periods due to the increased rooftop PV generation that reduces grid demand – strategic players' bidding actions will be less impactful.
- The contract levels of generators capture their impact on marginal bidding decisions[10].

Conventional storage hydro generators as well as large pumped hydros can also play strategically in the market. Modelling storage hydros and pumped hydros strategically is complex, as their dispatch depends on several factors such as storage capacity, inflow and availability. Frontier has thus modelled hydro generators and storages as price takers, while stating that this assumption would tend to underestimate the value of competition benefits[9].

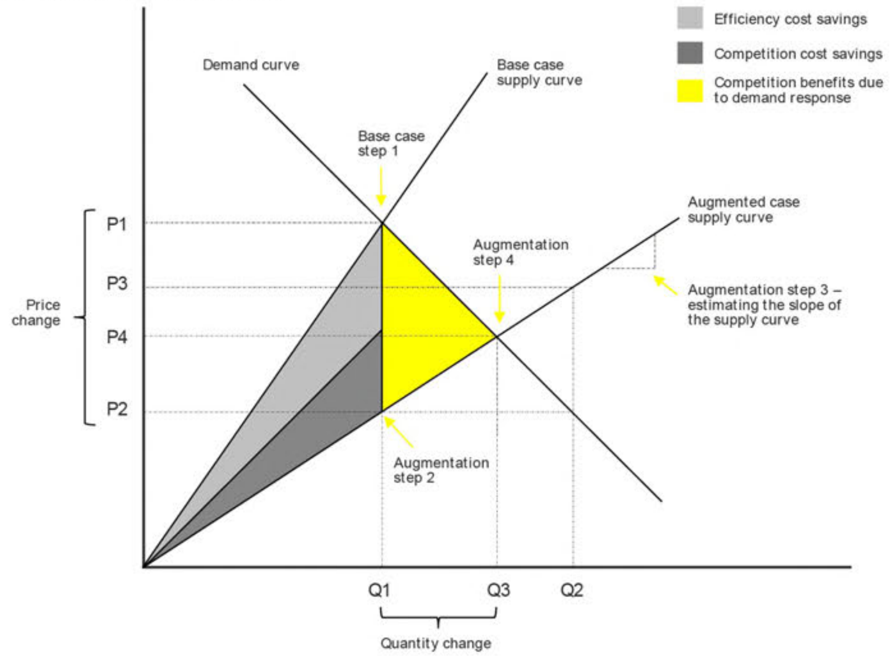
3.1.3 Competition benefits calculations

Competition benefits accrue from competition cost savings due to elasticity of demand to electricity price, which is described by Frontier as demand response, as shown in Figure 6. As seen in Figure 6, The Frontier approach identifies three areas of static benefits associated with a new or upgraded interconnection, called[9]:

- **efficiency cost savings** – due to more efficient dispatch in the SRMC bidding paradigm, which reflects fully competitive bidding without any player having or choosing to exploit market power
- **competition cost savings** – enhanced efficiency cost savings due to creating an increased level of competition associated with the expanded transmission capacity, and less possibility for strategic players to exert market power
- **competition benefits due to a demand increase** – response to lower electricity market prices, resulting in an increase in the level of aggregate supply and demand, which is due to elasticity of demand to wholesale market price. Augmentations might lead to lower prices at least in the importing region, which would encourage more consumption by consumers. This is considered as a competition benefits component as it will add to the total surplus of generators and consumers[12]. This applies even with a shift towards higher levels of renewable generation, where the expanded transmission provides better access to lower cost renewable generation and reduced congestion, which is a major factor limiting the expansion of renewable generation throughout the NEM.

[12] It is important to note that this does not equate to attributing a wealth transfer between producers and consumers to competition benefits, which is explicitly excluded from market benefit calculations by the AER in their August 2020 Application guidelines - Regulatory investment test for transmission and also their August 2020 Cost benefit analysis guidelines.

Figure 6: Calculation of competition benefits[3]



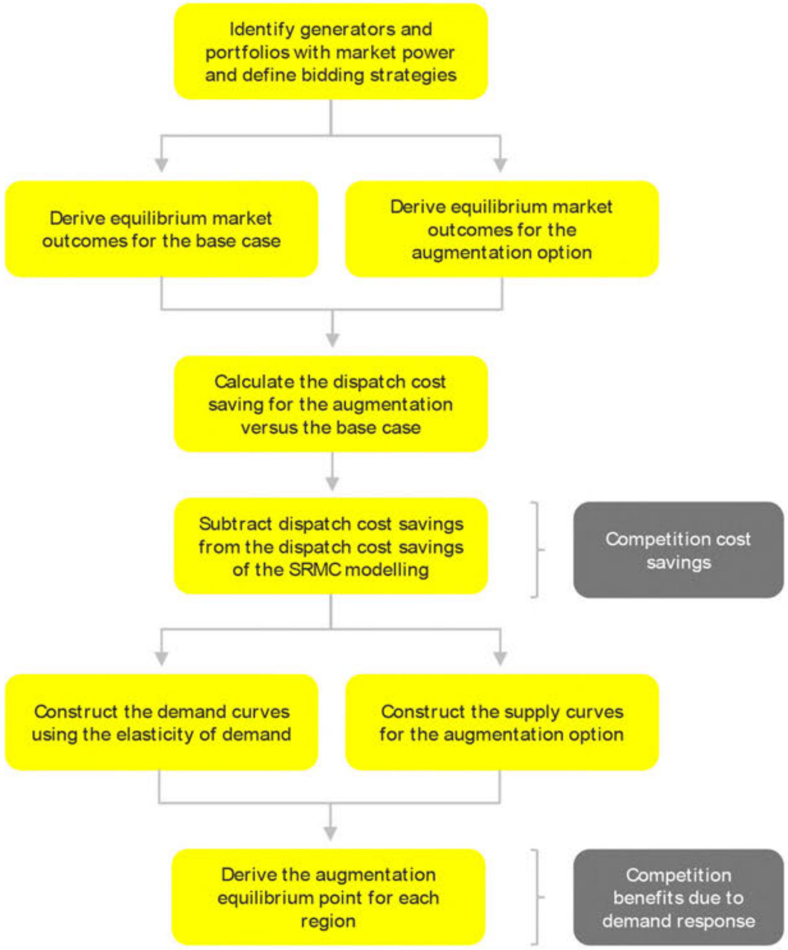
Gross competition benefits are calculated as the difference between the total surplus of the augmentation equilibrium and the base case equilibrium.

The diagram below (Figure 7) illustrates the steps taken to calculate both competition cost savings and competition benefits due to demand response. While the detail of these steps is provided in Appendix A, here we provide a high-level overview of the steps.

First, the list of strategic players is identified and their bidding combinations, as explained in Section 3.1.2 and 3.1.4.1 (which is as modelled in the HumeLink PACR). Having all the likely combinations of bids, the equilibrium outcomes including the demand-weighted prices for each region can be derived for both the base case and augmentation case (P_1 and P_2 in Figure 6). This allows calculating the dispatch cost savings of the augmentation case relative to the base case, where after subtracting the dispatch cost savings of the augmentation case which are already calculated in the competitive bidding model (efficiency cost saving in Figure 6), the competition cost savings are calculated (as shown in the dark grey area in Figure 6).

The abovementioned steps in driving the equilibrium point for the augmentation case do not yet consider the elasticity of the demand to wholesale market price. When considering the elasticity of the demand to wholesale market price, the equilibrium point will be different, which is able to be captured in the competition benefits calculation. To this end, it is proposed to calculate the competition benefits due to an increase in the aggregate level of supply and demand, to the point where the incremental cost of production matches the incremental customer willingness to pay. For this, both supply and demand curves are required to be constructed, as detailed in Appendix A. This helps determining the equilibrium point for the augmentation case with the consideration of elasticity of the demand to wholesale market price, and therefore to calculate the competition benefits due to demand response, as shown in the yellow area in Figure 6.

Figure 7: Steps in calculating competition benefits



3.1.4 HumeLink modelling assumptions

EY has modelled competition benefits for HumeLink in the PACR[13]. EY used the TSIRP for the calculation of traditional benefits, and adjusted it to compute competition benefits. The TSIRP is adjusted to use the capacity build and retirements schedule which resulted from the long-term investment planning from the base case[14], which allows modelling economic dispatch and determine variable and fuel costs. EY has modelled hydro and energy-limited storages in such a way that they are optimised in the model so that they maximise their water values, corresponding with minimising the cost of thermal generation. The model is run on both the base case and HumeLink for two sets of bidding, i.e. competitive (SRMC) and strategic bidding. The modelling of competitive bidding allows subtracting the benefits of fuel and VOM from the total benefits in the strategic bidding in order to avoid double counting these benefits in non-competition benefits modelling and competition benefits simulation.

[13] TransGrid, *HumeLink PACR*, https://www.transgrid.com.au/projects-innovation/humelink, Accessed 30 September 2021
[14] Refer to the HumeLink PACR, TransGrid, *HumeLink PACR*, https://www.transgrid.com.au/projects-innovation/humelink, Accessed 30 September 2021

Figure 8: Steps in EY calculations of RIT-T benefits, including competition benefits

1 TSIRP modelling, long-term (25 years) optimisation using SRMC bids

- Determine the generation development plan and retirement schedule
- Calculate the traditional benefits

2 Model setup for competition benefits

- Fix the generation development plan and retirement schedule in the base case and use it for both the base case and HumeLink
- Adjust TSIRP accordingly so only variable costs are considered in the calculations

3 Model competition benefits, following the steps in Figure 7

- Calculate competition cost savings
- Calculate competition benefits due to demand response

3.1.4.1 Strategic bidding selection

The strategic players and their bidding strategies are selected such that, while all the relevant combinations of bids are modelled, the modelling is practical and computationally feasible. One approach to limit the number of strategic players is to select only the largest generation portfolios in each region and across the NEM.

Frontier Economics has conducted a study for the Liddell closure in 2019[10], in which a detailed study of historical bidding analysis of generators in the NEM, particularly coal generators for the period of up to 10 historical years is presented. From that study, a list of strategic players and their bidding strategies as well as the general observed behaviour over a six-year historical periods is provided. The observed behaviours range from offering SRMC only up to minimum load (~40% capacity at SRMC and 60% withdrawn to high price) through to offering 95% at SRMC.

Table 1: Bidding strategies in Frontier modelling for Liddell closure [10]

Portfolio	Generators	Strategy options (proportion of capacity offered at SRMC)	Historical analysis
AGL NSW	Bayswater, Liddell	40%, 70%, 80%	50-60% Liddell 70-80% Bayswater
AGL Vic	Loy Yang A	80%, 95%	90-95%
EA NSW	Mt Piper	40%, 75%, 80%	50-85%
EA Vic	Yallourn	80%, 95%	75-95%
Stanwell QLD	Stanwell, Tarong, Tarong North	40%, 70%, 90%	70-80% Stanwell 40-85% Tarong 50-85% Tarong North
CS QLD	Callide B, Callide C, Gladstone, Kogan	40%, 70%, 90%	55-95% Callide B & C 40-70% Gladstone 80-100% Kogan
Origin NSW	Eraring	70%, 85%	50-75%
EA Vic	Yallourn	80%, 95%	75-95%

In the HumeLink PACR competition benefits, EY has used recent analysis conducted by Frontier Economics[10]. However, a shorter list of strategic players is considered given that, with the assumption of economic retirements in the HumeLink PACR market modelling, some generators in the Frontier Economics list, including the Liddell plant which is the subject of the Frontier report, either retire earlier than the proposed HumeLink commissioning date, or within a short time after that. Those

generators are therefore modelled to continue bidding at SRMC levels consistent with a fully competitive market until they exit the market before or shortly after HumeLink is commissioned. Table 2 provides the list of generators adopting strategic bidding in the modelling undertaken for the PACR. The full combinations of the following bidding strategies are then modelled to determine the Nash Equilibrium. The Nash equilibrium is determined to be one of the 54 combinations that applies for the full 25 year outlook. That is, the Nash equilibrium has not been investigated for each hour independently, or for each year independently. The Nash equilibrium is identified as the combination of strategic bids which results in the net profit of each portfolio over the 25 years being in equilibrium.
EY also assumed the generators withdraw their respective capacity to a price of $500/MWh instead of the assumption of withholding the capacity altogether (which can lead to unserved energy events), or to the market price cap (which is more aggressive and would result in higher competition benefits but potentially stimulate additional investment). $500/MWh was the level that Frontier Economics identified as a break point between cost-based bidding and defence of caps and the higher values adopted for strategic bidding[10].

Table 2: Bidding strategies in HumeLink PACR

Portfolio	Generators	Strategy options
AGL NSW	Bayswater	40%, 70%, 80%
AGL Vic	Loy Yang A	80%, 95%
EA NSW	Mt Piper	40%, 75%, 80%
Stanwell QLD	Stanwell, Tarong	40%, 70%, 90%

The remaining generators are assumed to be non-strategic. Note that it is assumed that non-strategic players bid their full capacity at their short-run marginal cost of supply (SRMC).

EY also modelled battery energy storage facilities, conventional storage hydro and pumped storage hydro generators including Tumut and Snowy 2.0 on a competitive bidding basis. Frontier Economics stated that this assumption is expected to result in underestimating potential competition benefits. Furthermore, there are some key constraints including the network limits between Snowy and the greater Sydney area, which could encourage portfolios with generators on either side of this constraint to play strategically in order to increase the NSW price. In some situations there may be an incentive for a generation portfolio to increase the output at its plant upstream of the transmission limit in order to cause the market constraint to bind, enabling its generating plant near to the reference node to benefit from transient market power[15]. This will be more likely to apply to the Snowy portfolio both in the Snowy Mountains region and in central NSW without HumeLink. With existing and potential future renewable generation development options in southern NSW as well as the interconnector flow from EnergyConnect and VNI West augmentation, it is unlikely that this behaviour is a material factor for the HumeLink competition benefits calculation.

Limiting the complexity of the modelling problem is reasonable where the simplification is expected to underestimate value associated with competition benefits, rather than potentially overstating.

3.1.4.2 Selection of generation development plan

The EY competition benefits modelling used the base case generation development plan, as per the "static benefits" defined by Frontier approach.

The modelling of traditional benefits, including all aspects outlined in Figure 2, is normally conducted as a single optimisation, as has been done for the HumeLink PACR. All aspects of traditional benefits, both savings due to reduced production costs, and savings due to reduced investment costs, are integrated. This includes making trade-offs between building higher capital cost, more efficient plant such as CCGTs versus lower capital cost, less efficient plant such as OCGTs. It also includes making trade-offs between zero fuel cost variable renewable energy (VRE) generation, and alternatives such as batteries and pumped storage hydro which can reduce the build of VRE plant but must pay the cost of cycling inefficiency from storing and releasing the generation. This optimisation approach necessarily assumes all generators bid SRMC and storage behave in order to minimise the total cost of energy over the forecast horizon. At this time, it is not computationally

[15] Darryl Biggar, "THE THEORY AND PRACTICE OF THE EXERCISE OF MARKET POWER IN THE AUSTRALIAN NEM", https://www.aemc.gov.au/sites/default/files/content/1b0947b4-930f-449a-be21-4cf009b2fe7a/AER-Attachment-1.PDF Accessed 30 September 2021

feasible to enable strategic bidding for all generators and portfolios while still finding the optimum as this is fundamentally a non-linear problem and therefore not able to be solved in a single linear programming optimisation.

In order to configure the model to simulate marginal wholesale pool prices, capital decisions must be removed from the optimisation problem. As such, a 'fixed' generation and storage development/retirement plan is established and capital investment options are not available. Static competition benefits are short term by nature as they are chosen by the players in the market every 5 minute dispatch interval, so the assumption of a fixed generation development plan is appropriate.

Furthermore, for determining static competition benefits the primary difference between the base case and the augmentation case is the presence or absence of HumeLink. Any resulting changes in the development pattern of generation due to the presence or absence of HumeLink are smaller second order effects as far as competitive bidding strategies are concerned. Therefore, it is the expanded transmission capacity of HumeLink that has been the primary variable for calculation of the competition benefits.

3.1.4.3 Selection of time periods

It is expected that when there is less spare capacity in the market, the capability of strategic players to change their bids or withhold their capacity to raise prices is high. For example, with significant rooftop PV and large-scale solar, it is unlikely that strategic players could exert market power during sunlight hours. The bidding strategies are applied only during the typical peak demand periods between 6am-10am and 6pm-10pm, in which portfolios with market power are expected to exert their market power. EY has also modelled competition benefits for all periods in the modelling study and found the results are not significantly different.

3.1.4.4 Elasticity of the demand to wholesale price

Elasticity of demand is the ratio between proportional change in quantity demanded and proportional change in price[16]. Elasticity of demand is an important factor in the calculation of competition benefits. As shown in Figure 9, apart from the electricity price differences between the base case and augmentation case, area F is also influenced by the elasticity of demand. That is, if the demand is highly responsive to the price changes, the slope of the demand curve is lower and thus the competition benefits due to demand response is higher and vice versa.

There are various documents stating the elasticity of demand to electricity price in the regions comprising the NEM. The elasticity of demand values are generally estimated relative to residential or retail electricity price. For example, the TransGrid 2021 Transmission Annual Planning Report (TAPR) has a range of elasticity of demand between -0.08 and -0.84 for different consumer sectors[17]. The 2019 ESOO considers an elasticity of demand of 1%.[18]. In a review of studies about the NEM elasticity of demand, a range of -0.08 to -0.55 is listed for various demand sectors in the NEM[19]. AEMO Input, Assumptions and Scenarios Report (IASR) provides elasticity of demand for different types of consumers, ranging between -0.05 and -0.15 for different scenarios[20].

In the HumeLink competition benefits calculation, an elasticity of -0.1 for all regions was assumed which was the most conservative, that is, lowest, value for the elasticity of demand from the range identified. Competition benefits modelling is applied at the wholesale level whereas elasticity of demand is relative to retail electricity price. As such it is appropriate to apply a conversion factor to the elasticity of demand to retail price value. This conversion factor could carefully consider the impact of the cost of the proposed network augmentation on the relative proportion of retail electricity prices attributable to wholesale electricity price. For the HumeLink assessment, the conservative elasticity value proposed by TransGrid was halved to -0.05.

Given the potentially wide range of elasticity of demand values and relatively large impact on the competition benefits due to demand response calculation, sensitivity analysis should be conducted to assess a range of elasticity values.

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[16] Oxford Reference, https://www.oxfordreference.com/view/10.1093/oi/authority.20110803095745343, Accessed 30 September 2021

[17] TransGrid, 2021 TAPR, https://www.transgrid.com.au/media/jtabhxws/transmission-annual-planning-report-2011.pdf, Accessed 30 September 2021

[18] AEMO, 2019 ESOO, https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/NEM_ESOO/2019/2019-Electricity-Statement-of-Opportunities.pdf, Accessed 30 September 2021

[19] Centre for Climate Economic & Policy, Australian National University, Impact of the carbon price on Australia's electricity demand, supply and emissions, https://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2014/08/OGorman-and-Jotzo-Impact-of-the-carbon-price-on-Australias-electricity-demand-supply-and-emissions.pdf, Accessed 30 September 2021

[20] AEMO, 2021 2021 Inputs, Assumptions and Scenarios Report, https://aemo.com.au/-/media/files/major-publications/isp/2021/2021-inputs-assumptions-and-scenarios-report.pdf?la=en, Accessed 30 September 2021

Appendix A Calculation of competition benefits

As per the Frontier approach[9], the following steps have been undertaken to calculate competition benefits:

- Step 1: Equilibrium market outcomes are derived for the counterfactual Base case. This determines the optimal bidding strategy of the strategic players, which results in equilibria with the annual average demand weighted price in the Base case ($P1$ in Figure 9Figure 9: calculation of surplus for the annual demand $Q1$.
- Step 2: Step 1 is repeated for the augmentation case with an assumption that the demand is inelastic. This allows calculation of $P2$. However, this point does not necessarily represent the augmentation equilibrium as the elasticity of the demand is ignored. To consider the impact of demand elasticity, the following steps are required to be taken.
- Step 3: This step estimates the slope of the augmented case supply curves in each region. For this purpose, a small change in each region's demand is applied and the resulting prices ($P_{3,r,c}$) in that region and other regions are calculated. Calculating $P_{3,r,c}$, which is the demand weighted price of region r due to small change in demand in region c, allows the construction of an inverse cross-elasticity of supply matrix, as discussed in Step 4.
- Step 4: The inverse cross-elasticity of supply matrix is constructed by using the relationships between relative demand changes to relative price changes in each region. The elements of the inverse cross-elasticity of supply matrix, S, are constructed as follows:

  $$element\ (r, c) = \frac{\frac{P_{3,r,c} - P_{2,r}}{P_{1,r}}}{\Delta Q_{3,c}}$$

  where, $element\ (r, c)$ is the matrix element in row/region r, column/region c, and $P_{1,r}$ and $P_{2,r}$ are the demand weighted price in region r from Step 1 and Step 2, respectively. $P_{3,r,c}$ is the demand weighted price in region r for a small change in demand in region c. $\Delta Q_{3,c}$ is the relative demand change in region c.

  In addition, the regional demand curves are determined by cross-elasticity of demand matrix, matrix D, which is 5×5 matrix (to represent the five NEM regions) with the diagonal elements being the inverse of the regional demand elasticities and other elements being zero.

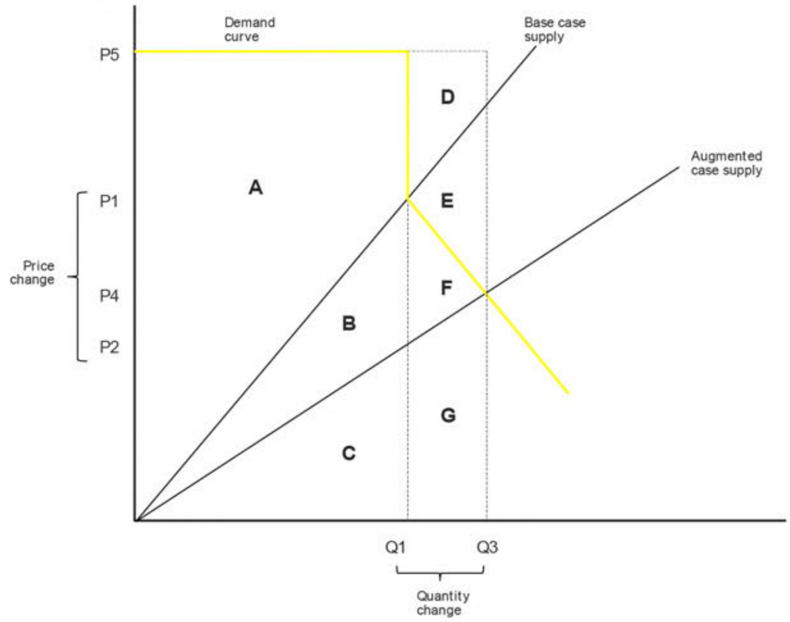
  Having the inverse cross-elasticity of supply and also inverse cross elasticity of demand matrices, a linear approximation of supply and demand curves can be derived and accordingly, the intersection of the two curves in Figure 9 can be calculated. The intersection is at Q_3 and P_4, the augmentation equilibrium point.

  This also enables estimating the production cost at the equilibrium point, which is calculated as the average incremental production costs of each region by constructing the production cost matrix as follows:

  $$element\ (1, c) = \frac{PC_{3,c} - PC_2}{\Delta Q_{3,c}}$$

  where, $element\ (1, c)$ is the matrix element for column/region c, and PC_2 is the total production cost in Step 2. $PC_{3,c}$ is the total production cost in Step 3 for a small change in demand in region c. $\Delta Q_{3,c}$ is the relative demand change in region c. As such, the relative increase in production costs from Step 2 to the post-augmentation equilibrium can be calculated as Cq, where q is the quantity change of the post-augmentation equilibrium for each region relative to the pre-augmentation equilibrium.
- Step 5: Having the intersection of supply and demand curves, as well as the production costs, the gross benefits can be calculated by subtracting the total surplus of Base case equilibrium from augmentation equilibrium, resulting in areas B and F in Figure 9. While area F represents competition benefits due to demand response, area B represents the aggregated productive efficiency of the augmentation due to efficiency and competition cost savings. In order to calculate purely competition cost savings and avoid double counting the efficiency cost savings which is calculated as part of traditional market benefits in the competitive (SRMC) modelling, the benefits from the efficiency cost savings are subtracted from the total benefits.

Figure 9: calculation of surplus[9]



Glossary of terms

Abbreviation	Meaning
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
CAPEX	Capital Expenditure
CCGT	Combine Cycle Gas Turbine
EA	Energy Australia
EY	Ernst&Young
FOM	Fixed Operation and Maintenance
ISP	Integrated System Plan
NCEN	Central NSW
NEM	National Electricity Market
NER	National Energy Rules
NSW	New South Wales
OCGT	Open Cycle Gas Turbine
PACR	Project Assessment Conclusion Report
QLD	Queensland
RIT-T	Regulatory Investment Test for Transmission
SRMC	Short-Run Marginal Cost
TAPR	Transmission Annual Planning Report
TSIRP	Time-sequential integrated resource planning
USE	Unserved Energy
Vic	Victoria
VNI	Victoria-NSW Interconnector
VOM	Variable Operation and Maintenance
VRE	Variable Renewable Energy

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