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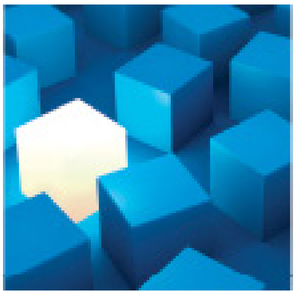

Expert Advice on Coverage of the Day-ahead Auction for Contracted but Un-nominated Capacity

Prepared for the Gas Market Reform Group

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Executive Summary

Background of This Report

In mid-2016, following the completion of its Eastern Australian Wholesale Gas Market and Pipelines Framework Review (East Coast Review), the AEMC recommended the implementation of the capacity trading reform package. This reform package, which relates to transmission pipeline and compression services (jointly referred to as 'transportation services') includes the development of:

- a day-ahead auction of Contracted But Un-nominated (CBU) capacity, which would be conducted shortly after nomination cut-off and subject to a reserve price of zero (with compressor fuel provided in-kind by shippers);
- a capacity trading platform that shippers can use to trade secondary capacity ahead of the nomination cut-off time and provides for exchange-based trading of commonly traded products and a listing service for other more bespoke products;
- standards for key contract terms in primary, secondary and operational transportation agreements to make capacity products more fungible and, in so doing, facilitate a greater level of secondary capacity trading; and
- a reporting framework for secondary capacity trades that provides for the publication of the price and other related information on secondary trades.

The COAG Energy Council (Energy Council) endorsed these recommendations at its August 2016 meeting and accorded the Gas Market Reform Group (GMRG) responsibility for leading the design, development and implementation of these reforms.

To help inform the GMRG's final recommendations to the Energy Council, it has retained NERA to provide expert advice on the coverage of the auction and, in particular, whether the auction should only apply to contractually congested pipelines or if it should have a wider application.

We have addressed this question by first analysing the challenges that prevent the achievement of efficiency under the status quo in the gas market. Second, we assess the expected impact of the proposed auction design on the primary and secondary capacity markets, focusing on allocative and dynamic efficiency. On the basis of this assessment, we have analysed the alternative coverage options for the auction.

In short, this analysis suggests that there are no efficiency related reasons to limit the auction to contractually congested pipelines and that wider coverage of the auction could generate greater efficiency benefits. It also suggests that the proposed auction design will provide a stimulus for secondary capacity trading and have a limited impact on the primary market, because the proposed auction product is an imperfect substitute for firm capacity.

A more detailed summary of our findings can be found below.

The Proposed Auction Design is Likely to Increase Allocative and Dynamic Efficiency

Allocative efficiency is the property that capacity is available to and used by the shippers that value it most on any given day. The AEMC proposed the day-ahead auction principally with the objective of promoting allocative efficiency. Provided that at least some additional

capacity changes hands (from those that value it less to those that value it more), introducing a day-ahead auction for CBU capacity will increase allocative efficiency.

The allocative efficiency benefits of the auction differ according to the degree of physical congestion on the pipeline. On physically-congested pipelines, no new capacity will become available as a result of the auction and therefore there will be no allocative efficiency gains. In contrast, the auction can be expected to result in allocative efficiency gains on pipelines that are not physically congested, although it is not possible to determine a priori whether the allocative efficiency gains will be higher or lower on pipelines with contractual congestion relative to those without.

Dynamic efficiency is the property that the market constructs the efficient level of capacity over the long term. Except for the closure of pipelines, dynamic efficiency is principally a consideration for new capacity. By offering an alternative method of obtaining capacity (at potentially zero cost), the auction could, in principle, discourage shippers from buying as much capacity under long-term contracts as they do under the status quo and reduce the signal for investment. In practice, as described below, the auction product is unlikely to be a close substitute for long term capacity in the primary market, and hence the level of “de-contracting” (i.e. exiting or not renewing some or all long term contracts) may be small.

In any case, de-contracting need not decrease dynamic inefficiency. In fact, given the AEMC’s finding that prices of short term capacity tend to be inflated and secondary markets are illiquid under the status quo, shippers have an incentive to over-contract through long-term contracts to protect themselves against the risk of interruption. Depending on the level of physical and contractual congestion, introducing the auction on any given pipeline enables shippers to pool risk and reduce their contracting from inefficiently high levels.

We constructed a simplified game-theoretic model of capacity contracting and investment decisions for new pipelines. Our simulations suggest that social welfare (and hence dynamic efficiency) increases following the introduction of the auction to all pipelines relative to the status quo, but remains lower than the social optimum.[1] Shippers under-contract after the introduction of the auction because they free ride for some of their demand on the unused capacity of others. However, the benefit of risk sharing and reduced over-contracting exceeds the costs of under-contracting that accompanies the auction. If a liquid secondary market develops after the introduction of the auction, the welfare gains relative to the status quo would be even larger.

De-contracting in the Primary Market Will Be Limited by Imperfect Substitution

By making all CBU capacity available through a market-based mechanism, the day-ahead auction for CBU capacity removes the market power that the pipeline owner may have in pricing as available and interruptible products. The auction’s reserve price of zero will also put material downward pressure on prices of or replace sales of non-firm capacity products.

[1] Only where we adopt extreme assumptions about economies of scale (costs increase with the hundredth root of capacity and doubling capacity increases costs by only 0.7 per cent), social welfare falls with the auction relative to the status quo.

The precise effect of the proposed auction design on contracting levels and pipeline revenues will depend on the degree of congestion. The auction is unlikely to result in de-contracting on physically congested pipelines, because the auction will not make capacity available. On physically uncongested pipelines, a more material reduction in contracting levels and pipeline revenue is more likely where there is routinely excess supply in the auction and therefore auction prices are low.

It is important to note though that shippers cannot (collectively) fully de-contract from long term contracts under the proposed auction design because the only capacity available through the auction will be capacity that shippers have purchased under long term contracts. In any case, individual shippers are unlikely to want to de-contract fully under the proposed auction design because the primary market offers greater certainty about availability and price, a less frequently interrupted product and a range of duration options.

The Auction Design Provides Potential Stimulus for Secondary Market Trading

On the one hand, shippers may rely on the auction which could undermine the secondary market. On the other hand, the day-ahead auction may incentivise shippers to trade on the secondary market by reducing incentives to hoard capacity and by providing a transparent price signal for the value of capacity.

From the perspective of increasing allocative efficiency, it does not matter whether shippers obtain capacity through the secondary market or the auction. In any case, the proposed auction design is likely to increase secondary market trading because:

- Shippers are unlikely to perceive the auction product as a perfect substitute for firm capacity, as the latter provides a superior quality product (in terms of priority of scheduling, curtailment and re-nomination rights), greater certainty about the available quantity and the price of capacity and is available for longer than one day-ahead;
- The proposed product, "second-priority firm", is second only to firm capacity, and may be attractive enough to shippers to encourage participation in the auction; and
- By requiring auction quantities and clearing prices to be published, the proposed auction design is likely to reduce information asymmetry and increase transparency.

Efficiency Benefits of the Auction Point to Wider Coverage

One of the AEMC's suggested outcomes[2] for the auction is that pipelines that are not fully contracted could be exempted from the day-ahead auction on a case-by-case basis.[3] The main argument for limiting the scope of the auction to contractually congested pipelines concerns the distribution of revenues between shippers and pipelines. If policymakers are particularly concerned about ensuring that contractually uncongested pipelines recover their

[2] The AEMC categorised a number of its recommendations as 'suggested outcomes'. This categorisation was used when the AEMC thought the proposal had in-principle benefits but required further consideration by the GMRG.

[3] The GMRG proposed that the auction should cover all transmission pipelines linking major demand centres and supply sources in the east coast, but only contractually congested pipelines in regional areas. See GMRG (October 2017), Day-Ahead Auction of Contracted but Un-nominated Capacity & Reporting Framework, Consultation Paper, p84.

sunk costs or are less concerned about abuse of market power by such pipelines, they may wish to exempt them from the auction. However, on the evidence available and drawing upon the discussion above, it is not clear that contractually uncongested pipelines price their services more competitively or have greater difficulty recovering their costs.

Efficiency considerations do not provide a basis for limiting the coverage of the auction to contractually congested pipelines (including new pipelines): The auction may provide greater efficiency improvements on either contractually congested or uncongested pipelines with spare physical capacity. Our simulations suggest that the auction may assist with the development of new capacity of an economically-efficient scale. Moreover, widening the scope of the auction to all pipelines presents a possible efficiency benefit by reducing aggregation risks, given the combinatorial auction design. The risk of gaming any definition of contractual congestion and the forecast high and increasing levels of contractual congestion would require detailed scrutiny of exemptions. The benefits of such exemptions may be lost in the administration of them.

1. Introduction

The COAG Energy Council established the Gas Market Reform Group (GMRG) in the second half of 2016 to lead the design, development and implementation of a range of reforms set out in the Gas Market Reform Package, which includes reforms to capacity trading.[4] These reforms require, among others, the introduction of a day-ahead auction for Contracted But Un-nominated (CBU) capacity, with a view to making capacity available in the short term and to encourage firm capacity holders to trade unused capacity on the secondary market. On 10 October 2017, the GMRG published a Consultation Paper that presents the GMRG's preliminary view on the format for the day-ahead auction.[5]

To help inform the GMRG's final recommendations to the Energy Council on the design of the day-ahead auction, it has retained NERA to provide expert advice on the coverage of the auction (i.e. which pipelines should be subject to the auction). We have addressed this question by first analysing the challenges that prevent the achievement of efficiency under the status quo in the gas market. Second, we assess the expected impact of the proposed auction design on the primary and secondary capacity markets, focusing on allocative and dynamic efficiency. On the basis of our findings, we analyse the alternative coverage options for the auction.

This report is structured as follows:

- Chapter 2 presents a summary of structural changes and the AEMC's suggested reforms to the eastern Australian gas market;
- Chapter 3 sets out the key efficiency concepts that we will rely upon in our assessment of economic efficiency;
- Chapter 4 summarises the proposed auction design;
- Chapter 5 assesses the impact of the proposed auction on allocative efficiency;
- Chapter 6 shows that the impacts on efficiency and contracting in the primary market on each pipeline will depend crucially on the degree of congestion on each pipeline;
- Chapter 7 assesses the impact of the proposed auction on dynamic efficiency;
- Chapter 8 presents the implications of our analysis for coverage of the auction and concludes on the expected impact of the proposed design of the auction.

4 COAG Energy Council, Bulletin Two: Gas Market Reform Package, August 2016.

5 GMRG (October 2017), Day-Ahead Auction of Contracted but Un-nominated Capacity & Reporting Framework, Consultation Paper, http://gmrg.coagenergycouncil.gov.au/publications/day-ahead-auction-contracted-un-nominated-capacity-and-reporting-framework.

2. Rationale of the Day-Ahead Auction for CBU Capacity

The impact of the day-ahead auction on the primary and secondary capacity markets will depend critically on conditions in the local gas market. For instance, an auction for transport capacity may have a significantly different impact in an environment where the demand for capacity is rapidly growing and access to capacity under current conditions is limited, than an environment in which demand is falling and capacity is uncongested.

This chapter provides a brief summary of the market conditions that led to the proposed introduction of the auction for gas capacity:

- Section 2.1 explains the structural changes in the eastern Australian gas market that have prompted reforms to the gas market;
- Section 2.2 describes the COAG Energy Council's response to market circumstances and the results of the Australian Competition and Consumer Commission (ACCC) and AEMC's investigations into the sector;
- Section 2.3 explains that the AEMC recommended a day-ahead auction of capacity in order to remedy the inefficiencies associated with contractual congestion and excessive prices for contracted but un-nominated capacity; and
- Section 2.4 explains that the volume of contracted but unused capacity on pipelines in the east coast has been relatively high in recent years and that contractual congestion is set to increase in the future.

2.1. Structural Change Provides the Impetus for Reform

The gas transportation market in eastern Australia consists of a series of interconnected gas transmission pipelines under different ownership, which connect receipt and delivery points across five states (Queensland, New South Wales, Victoria, Tasmania, and South Australia, see Figure 2.1).

The Australian context is unlike that in Europe, where national or regional monopolists build capacity with the promise of recovery through regulation from the generality of consumers. Outside of the Declared Transmission System in Victoria, the market for transmission capacity is a merchant system ("contract carriage"), where individual shippers pay for the capacity that they own and use. Pipeline owners have traditionally constructed gas transportation capacity that has been underpinned by long-term contracts with shippers. Shippers have also historically relied on long term gas supply contracts with downstream customers and/or upstream producers to support the long term contracts for capacity. The consequence of these arrangements has been that much of the pipeline capacity is in the possession of shippers with existing long term contracts. In the absence of a liquid secondary market for contractual capacity, shippers are unable to transfer capacity between themselves cheaply to ensure that capacity is always in use whenever there is a social value to gas transport.

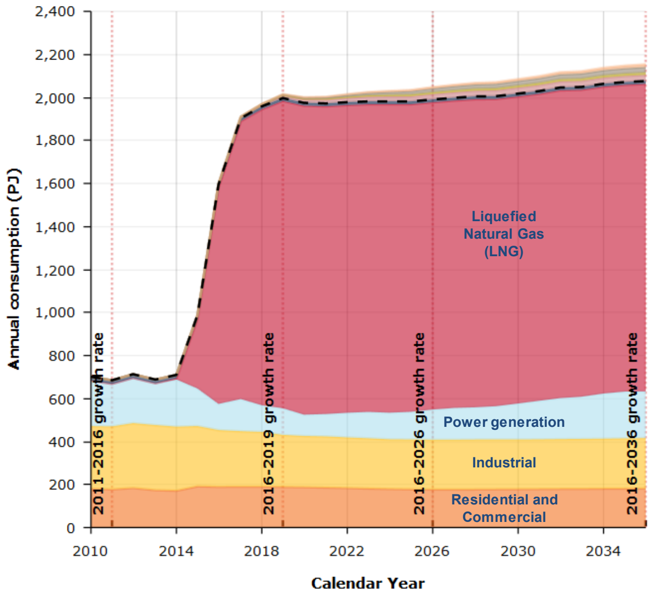
Figure 2.1
Eastern Australian Gas Pipelines

Source: AEMO, Natural Gas Services Bulletin Board, http://gasbb.com.au/, accessed 27 September 2017

Structural changes in the gas market have brought potential inefficiencies in the historical arrangements for procuring gas capacity into starker relief. The structural changes in the east coast have largely been brought about by the trebling of demand for gas, which was promoted by the development of the Queensland LNG export industry (see Figure 2. 2). The development of this industry has accelerated the ongoing trend of the eastern Australian pipeline network to become more interconnected and supporting increasingly interlinked markets,[6] which provides shippers with the opportunity to utilise more flexible transportation arrangements. In parallel t these developments, gas prices have increased considerably from historical levels. In this type of market, the value of capacity, and the economic inefficiency that results from being unable to secure access to capacity, is arguably greater.

[6] AEMC, Stage 2 Final Report: East Coast Review, 23 May 2016, p. 1.

Figure 2.2
Total annual natural gas consumption in eastern Australia (actual and forecast)



Source: National Gas Forecasting Report, Forecasting Dynamic Interface, http://forecasting.aemo.com.au/, accessed 1 October 2017; blue labels added by NERA.

2.2. The AEMC Recommended an Auction to Increase Efficiency

In December 2014, the COAG Energy Council set out its "vision" for the Australian gas market:[7]

> "The Council's Vision is for the establishment of a **liquid wholesale gas market** that provides market signals for investment and supply, where responses to those signals are facilitated by a supportive investment and regulatory environment, where trade is focused at a point that best serves the needs of participants, where an **efficient reference price is established**, and producers, consumers and trading markets are connected to **infrastructure that enables participants the opportunity to readily trade between locations** and **arbitrage trading opportunities**. " (emphasis added)

Shortly thereafter, the ACCC and the AEMC were asked to carry out reviews of the eastern Australian gas market.

The ACCC reported in April 2016 and found that the growth in the LNG industry coincided with the expiration of a large number of long-term gas supply contracts and that upstream providers were offering new contracts at "higher prices, for shorter durations and with more restrictions on volume flexibility".[8] Gas users are therefore likely to rely increasingly on short-term trading to balance their portfolio of supply and demand. The ACCC also found

[7] COAG Energy Council (December 2014), Australian Gas Market Vision, p1.

[8] ACCC (April 2016), Inquiry into the east coast gas market, April 2016, p. 18. AEMC, Stage 2 Final Report: East Coast Review, 23 May 2016, p. 1.

evidence of monopoly pricing by pipeline operators both in relation to long-term and short-term capacity.[9]

The AEMC released the final report from its *East Coast Review* in May 2016. This report recommended a set of reforms to allow for greater flexibility and efficiency in trading gas outside of long-term supply agreements and in managing the risk related to spot price volatility. The AEMC's proposals include reforms to both the wholesale and the transportation markets (see Table 2.1 below).[10]

The AEMC's key objective for reform in the transport capacity market is to support the development of a more liquid market for gas and pipeline capacity. Shippers' demand for gas is inherently locational. A liquid market in capacity means that shippers are more able to balance their supply and demand efficiently because they can obtain the capacity necessary to transport gas to the location of purchase to that of its end use. The focus of this report is on the day-ahead auction for CBU capacity (point 5), which is one of several measures intended to improve flexibility and efficiency of the market for gas transportation capacity.

Besides making un-nominated capacity available through the auction itself, the AEMC intended that the day-ahead auction would encourage firm capacity holders to trade unused capacity on the secondary market. To promote the development of secondary market trades between shippers, the AEMC also recommended the introduction of an exchange-based capacity trading platform (see point 7 in Table 2.1).

The AEMC's recommendations were formally endorsed by the Energy Council at its August 2016 meeting.

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9 ACCC (April 2016), Inquiry into the east coast gas market, April 2016, p. 14.

10 AEMC, Stage 2 Final Report: East Coast Review, 23 May 2016, p. i, iii and p. 14.

Table 2.1
Summary of AEMC's recommendations for gas market development (May 2016)

Area	Recommendations
Wholesale markets	**1.** Focus development efforts on two primary trading hubs – a Northern and Southern hub – with common trading arrangements to improve price discovery and reduce participation barriers.
	2. The Northern Hub to be located at Wallumbilla, with existing physical trading limitations addressed in the first instance through implementation of Optional Hub Services.
	3. The Southern Hub to be transitioned from the existing DWGM design to continuous exchange-based trading, supported by a system of firm capacity rights.
	4. Simplification of Short Term Trading Market hubs for balancing mechanisms following the development of the two hubs, and pipeline capacity trading.
Transportation capacity markets	**5.** Introduce a ***day-ahead capacity auction*** of contracted but un-nominated pipeline capacity to be conducted shortly after the nomination cut-off time.
	6. Standardise provisions in capacity agreements to make capacity more fungible and allow shippers greater receipt and delivery point flexibility.
	7. Develop capacity trading platforms to facilitate sales by capacity holders ahead of the auction and provide for exchange based trading.
	8. Require the publication of information on secondary trades of pipeline capacity and hub services.
Information to support the market	**9.** Improve transparency and expand coverage of the Natural Gas Bulletin Board so that a wider range of information is provided.
Implementation and governance	**10.** Establish a Gas Reform Group tasked with developing the recommended package.
	11. – 15. Various legal amendments and reporting requirements.

Source: AEMC, Stage 2 Final Report: East Coast Review, 23 May 2016, p. viii, 14.

2.3. The Auction Aims to Address the Inefficiencies Associated with Contractual Congestion and Excessive Prices for Short-Term Capacity

In line with point 10 of the AEMC's recommendations (see Table 2.1), the Energy Council established the GMRG in the second half of 2016, to lead the design, development and implementation of the reforms, including the day-ahead auction for CBU capacity.[11]

CBU capacity is capacity held by firm capacity holders, which they decide not to nominate by nomination cut-off time on the day before the gas day. On the day itself, shippers may renominate the quantity of their contracted capacity that they wish to use and they may then

[11] COAG Energy Council, Bulletin Two: Gas Market Reform Package, August 2016.

take priority over any purchasers of CBU capacity. Absent any systematic under or over-nomination to game the level of CBU capacity available, the quantity of CBU capacity available for the auction reflects firm capacity holders' expected capacity needs for the day ahead.[12]

The existence of CBU capacity is not, in and of itself, a reason to believe that the market results in inefficient outcomes. The demand for capacity fluctuates throughout the year and capacity will not always be fully utilised. The AEMC proposed the day-ahead auction for CBU capacity to address "contractual congestion" and to allow the market, rather than service providers, to determine the prices for contracted but un-nominated capacity. The term 'contractual congestion' is used in this context to refer to circumstances where:

> "a shipper is unable to gain access to an asset, despite it having physical capacity, because another shipper owns the rights to that capacity and is unable or unwilling to sell that capacity".[13]

Provided a third party shipper desires access to capacity at a price above the (very low) marginal cost of making capacity available, contractual congestion results in economic inefficiency: the capacity exists to serve the demand of a third party shipper but the shipper cannot access that capacity.

The existence of CBU capacity would not imply that the pipeline was contractually congested if:

- firm capacity holders sold unused capacity to other shippers in the short term (in a competitive secondary market); and/or
- pipeline owners sold CBU capacity on an interruptible basis at competitive prices.[14]

However, in its *East Coast Review*, the AEMC stated that pipelines in the Australian gas market did not typically meet these conditions (see Table 2.2 below). In the absence of such a functioning secondary market for capacity, any pipeline that has CBU capacity meets the AEMC's definition of contractual congestion and will result in inefficient market outcomes.

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[12] On the day itself, capacity holders can revise their nominations through so-called re-nominations which reflect their actual capacity requirements. On average, we would expect the amounts used to be close to the amounts nominated, where shippers reveal their true expectations at the nomination stage.

[13] AEMC, Stage 2 Final Report, East Coast Wholesale Gas Markets and Pipeline Frameworks Review, 23 May 2016, p vii, fn 11.

[14] In theory, competitive pricing would imply setting prices at short run marginal cost. In practice, in an imperfectly competitive market, we would expect the price to be in the range of the sum of short run marginal cost and transaction costs (lower bound) and shippers' willingness to pay (upper bound).

Table 2.2
Expected benefits of the day-ahead auction given inefficiencies in the eastern Australian gas capacity market

Inefficiency	Expected benefit of day-ahead auction
1. The bulk of CBU capacity is not being offered on the secondary market, due to high transaction costs and potential benefits from withholding capacity	Day-ahead auctions make all un-nominated capacity available to others, and thereby encourage shippers to sell unused capacity on the secondary market prior to the nomination cut-off
2. Prices of as available and interruptible services tend to be high and may prevent efficient capacity utilisation	Auction provides opportunity for shippers to purchase competitively priced capacity (it is a non-discriminatory, market-based process)
3. Bilateral negotiation inefficient in allocating CBU capacity, given complex market structure and multiple agents	Auction is less costly than bilateral negotiations and can help reach the welfare-maximising allocation of CBU capacity

Source: AEMC, Stage 2 Final Report: East Coast Review, 23 May 2016, pp. 72, 73

2.4. Contractual Congestion is Likely to Increase

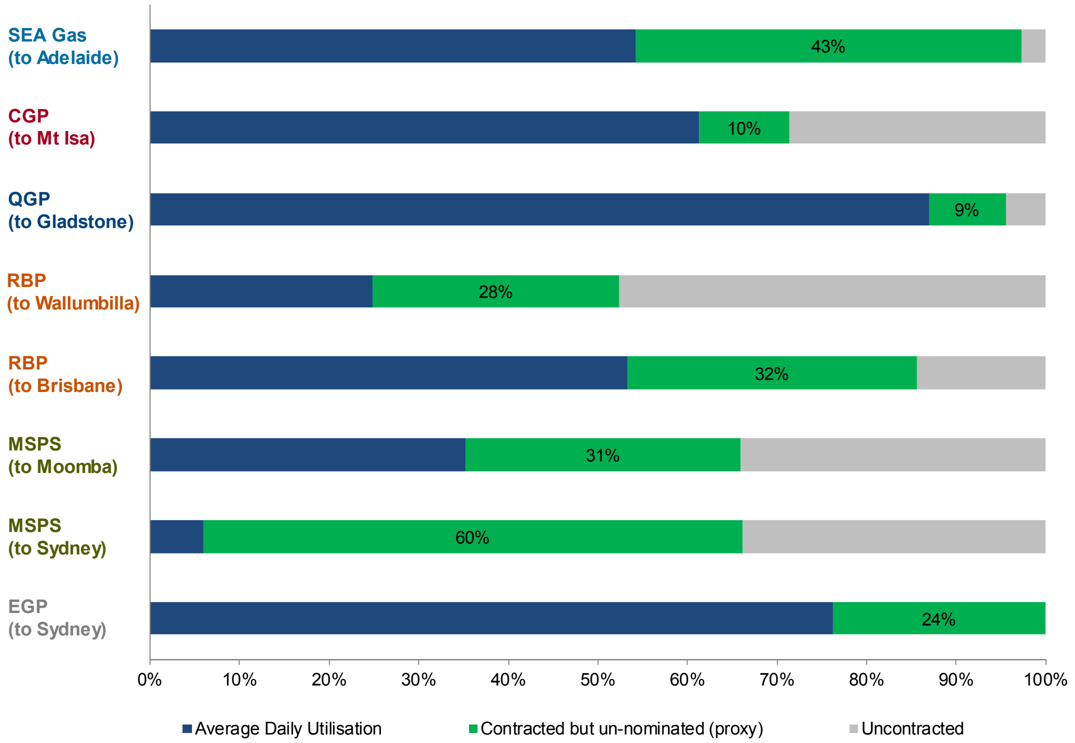
A cursory examination of the data available in the public domain suggests that CBU capacity represents a substantial proportion of the physical capacity in eastern Australia. Figure 2.3 shows the average share of contracted and utilised capacity for a subset of seven pipelines for which data was available, based on daily data from the past year.[15] The blue portion is the average share of nameplate capacity that was actually used, and the grey portion is the average uncontracted share. The green portion is the average share of nameplate capacity that was contracted but not used, as proxied by the difference between the share of contracted capacity and the share of used capacity.[16]

The pipelines shown in this figure were not typically contractually congested on average over the entirety of the year in question. Six of the seven pipelines had at least some uncontracted capacity available on average of the course of the year. For periods within the year, for instance in peak months, the pipelines may have been fully contracted. For this sample of pipelines, we find that the share of contracted but unused capacity was between 9 per cent and 60 per cent, with most shares being at least 20 per cent of nameplate capacity. Introducing an auction for CBU capacity would free up this potentially contractually congested capacity for use by third parties.

15 This is the subset of pipelines subject to organised secondary trading; this data is readily available only for these pipelines. The figure should be understood as an illustration rather than as a complete assessment of contracting and utilisation levels over the past year.

16 This measure is likely to understate the amount of CBU capacity, in that the utilised share also includes products sold by the pipeline owner in the short term (i.e. outside long-term contracts). The actual CBU capacity, which is quantity to be auctioned, is likely to be higher.

Figure 2.3
Many eastern Australian pipelines have high shares of contracted but unused capacity (% of nameplate capacity, Oct. 2016 – Sept. 2017 average)



Source: *AEMO, Natural Gas Services Bulletin Board, http://gasbb.com.au/, accessed 29 September 2017.*
Note: *This is the subset of pipelines only and should be understood as an illustration rather than as a complete assessment of contracting and utilisation levels over the past year.*

Table 2.3 presents an overview of the expected degree of congestion of pipelines in eastern Australia over the next 12 months, which is based on information on uncontracted capacity reported by pipeline operators on the *Natural Gas Services Bulletin Board*. Based on this data, all pipelines except for the CGP would be considered contractually congested, if we define contractual congestion as having an expected percentage of contracting of above 90 per cent in at least one flow direction.[17] Even under the most restrictive definition of contractual congestion (i.e. 100 per cent contracted in at least one flow direction), we expect that about half of the pipelines would be contractually congested (APLNG, CRWP, DDP, GLNG, MAPS, SEA Gas, SGP and WGP).[18] However, we note that the lowest expected congestion level (maximum of both flow directions) is as high as 79 per cent (CGP).

[17] Our measure of contractual congestion is: forecast amount contracted/nameplate capacity (monthly data from AEMO's *Natural Gas Services Bulletin Board*).

[18] See Appendix A for a complete list of pipelines and acronyms.

Table 2.3
Expected degree of contractual congestion in the period Sept. 2017 to Aug. 2018

Pipeline	Capacity (TJ/d)	% Contracted (Sep17-Aug18 average forecast)	100% contracted	More than 95% contracted	More than 90% contracted
APLNG (to Curtis Island)	1560	100%	x	x	x
BWP (to Wallumbilla)	164	92%			x
BWP (to Roma)	276	0%			
CGP (to Mt Isa)	119	79%			
CRWP (to Roma)	950	100%	x	x	x
CRWP (to Wallumbilla)	175	100%	x	x	x
DDP (to Wallumbilla)	270	100%	x	x	x
DDP (to Roma)	530	100%	x	x	x
EGP (to Sydney)	358	95%			x
GLNG (to Curtis Island)	1430	100%	x	x	x
MAPS (to Adelaide)	237	100%	x	x	x
MAPS (Moomba)	85	100%	x	x	x
MSPS (to Sydney)	439	75%			
MSPS (to Moomba)	120	91%			x
QGP (to Gladstone)	138	91%			x
QGP (to Wallumbilla)	40	0%			
RBP (to Brisbane)	233	96%		x	x
RBP (to Wallumbilla)	125	59%			
SEA Gas (to Adelaide)	314	100%	x	x	x
SWQP (to Moomba)	404	99%		x	x
SWQP (to Wallumbilla)	340	60%			
SGP (to Wallumbilla)	142	100%	x	x	x
SGP (to Spring Gully)	40	100%	x	x	x
TGP (to Hobart)	129	67%			
TGP (to Longford)	120	92%			x
WGP (to Curtis Island)	1588	100%	x	x	x

Source: AEMO, Natural Gas Services Bulletin Board, http://gasbb.com.au/, accessed 29 September 2017.

3. Economic Efficiency Concepts

Economists assess alternative policy options from the perspective of economic efficiency. This section describes economic efficiency as a concept and applies it to gas pipelines. It proceeds as follows:

- Section 3.1 explains that perfectly competitive decentralised markets deliver economically efficient outcomes;
- Section 3.2 defines allocative efficiency for the purpose of this report;
- Section 3.3 defines dynamic efficiency for the purpose of our report; and
- Section 3.4 describes the conditions under which policymakers may increase efficiency by intervening in the market for gas capacity markets.

3.1. Classical Economic Theory Points to "Pareto Efficiency" as the Outcome of Competitive Markets

Classical economics views efficiency as the single property of an allocation of resources that an omniscient and benevolent social planner could make where no agent can be made better off without another agent being made worse off (often referred to as "Pareto efficiency" after Vilfredo Pareto). The Pareto definition of efficiency provides the mathematical basis for the economic support of free markets: the *First Fundamental Theorem of Welfare Economics* demonstrates that given certain abstract mathematical conditions, a market economy of self-interested agents will achieve a "Pareto efficient" equilibrium.[19]

The economic case for intervention in markets relies on "market failures", which are essentially violations of the assumptions required under the *First Theorem*. The mathematical conditions required are restrictive in practice. Combined with the accompanying textbook theory of "perfect competition", they necessarily require a market to possess *among other properties*: a large number of price-taking buyers and sellers; a set of production possibilities (available to all) in which output can always be increased by small increments, but always at an ever-increasing incremental, or "marginal", cost; and a complete set of property rights over all goods in the economy.

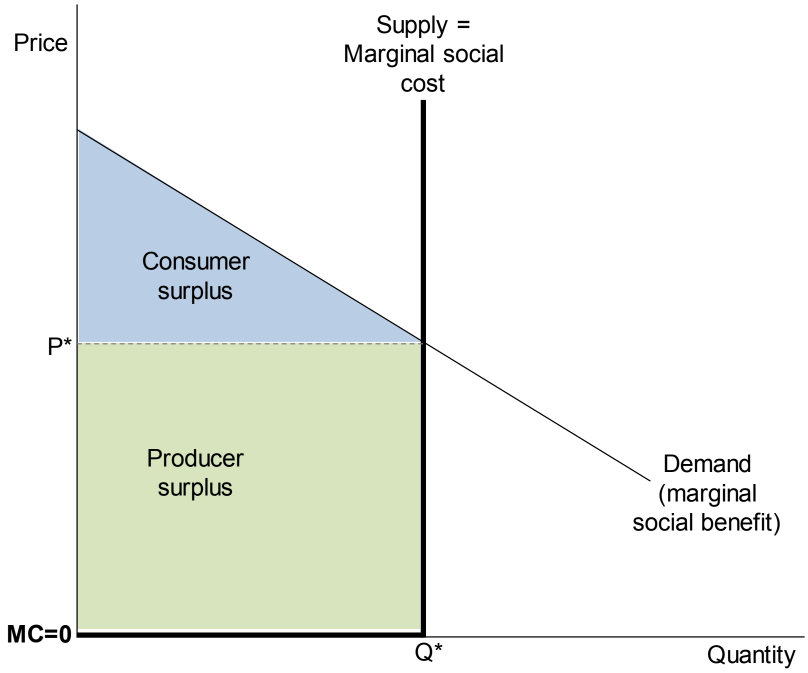
In assessing efficiency in real-world markets, where the abstractions and assumptions necessary for the *First Theorem* do not apply, economists may break this high-level concept of Pareto efficiency down into narrower subcategories. The proposed day-ahead auction is essentially aimed at ensuring that transmission capacity is in the hands of the shippers who value it most: in other words, allocative efficiency. In assessing the expected impact of the day-ahead auction for CBU capacity on the transportation market, we will distinguish between allocative and dynamic efficiency.

[19] See for instance, the discussion in: Arrow, K.J., "An Extension of the Basic Theorems of Classical Welfare Economics," Proceedings of the Second Berkeley Symposium, University of California Press (Berkeley), 1951.

3.2. *Allocative* Efficiency: Shippers with the Highest Valuations Hold Capacity

We refer to the property of capacity being available on any given day to those shippers value it most as *allocative efficiency*. Gas pipelines require large up-front investments taken over multiple years and offer a close to fixed capacity between investments. Once that investment has been made, pipeline companies have no or limited marginal costs.[20] As a result, pipelines have marginal costs of zero up to the point where capacity is reached, and perfectly inelastic supply beyond because no more capacity may be made available, at any price (illustrated in Figure 3.1). The allocatively efficient outcome is to satisfy all demand if demand is less than capacity at a price of zero. If demand is not less than capacity, the allocatively efficient outcome satisfies the demand of the shippers who place the highest valuation on capacity. In a competitive market, the price of capacity in the short term would be the price necessary to ration capacity amongst the competing shippers, such that prices rose to the marginal benefit of that capacity.

Figure 3.1
In the Short Term, Allocative Efficiency Would Require Pipelines to Serve the Shippers with the Highest Valuations



Source: NERA.

[20] In practice, the marginal cost of transporting gas will be close to but not be exactly zero, given costs such as the cost of compressor fuel. Whether we assume a marginal cost that is very small or zero does not materially change our argument.

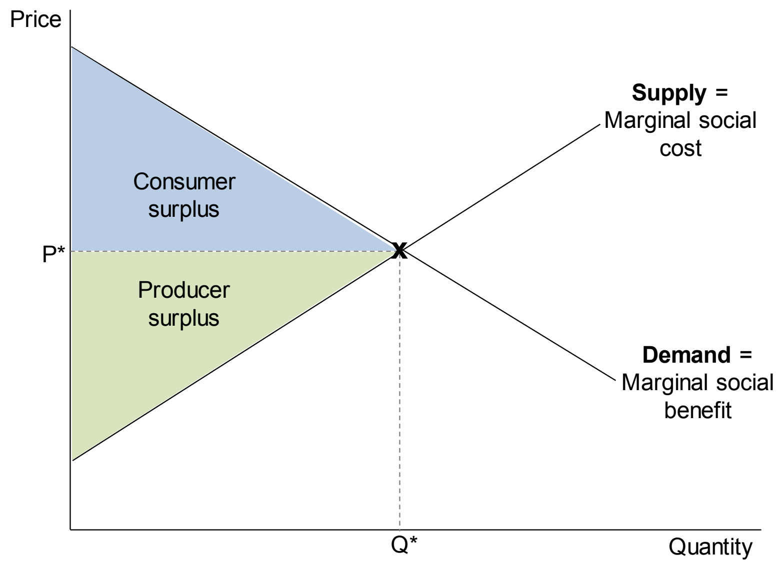
3.3. *Dynamic* Efficiency: Shippers' Demand Met at Incremental Cost over Time

Dynamic efficiency can be thought of as the long-run analogue of allocative efficiency. Over the longer term, the capacity of gas pipelines is not fixed. We use the term "dynamic efficiency" to describe the long-term property that pipelines meet the demand of all shippers whose valuation of capacity is above the incremental costs of investing in new capacity (illustrated in Figure 3.2, below).

At the dynamically efficient equilibrium, the marginal benefit of gas transportation capacity to shippers is equal to the incremental cost of making that capacity available. Only those shippers who value capacity more than the resulting price purchase it (and gain a "consumer surplus" shown in blue in the Figure 3.2). Only those pipelines whose marginal costs are lower than equilibrium prices provide capacity (and gain a "producer surplus" shown in green in the Figure 3.2).

Achieving the dynamically efficient outcome is equivalent to maximising social welfare, which equals to the sum of consumer surplus and producer surplus.

Figure 3.2
The Dynamically Efficient Outcome Provides Capacity Provided that Shippers' Valuation for Capacity Exceed Its Costs



Source: NERA.

3.4. Opportunities to Improve Efficiency in Imperfect Markets for Transportation Capacity

In a perfectly competitive, frictionless market with trivial up-front costs, there would be no trade-off between allocative and dynamic efficiency. Indeed, there would be no need for long term contracts, not just for transportation capacity but for all other goods and services in the economy. The costless operation of spot markets for goods and services would ensure both short term (allocative) efficiency and long term (dynamic) efficiency.

In such a market, taking away capacity from its owners to make it available to others could only be distortionary and reduce overall social welfare. In any case, the contractual congestion which motivates the proposed auction would not occur because market participants would not have any need for long term contracts.

In contrast, long term contracts exist in imperfect, real-world markets like the market for gas transportation in eastern Australia. In such a market, they can help to provide the conditions necessary to ensure investment and increase *dynamic* efficiency.

Where long term capacity rights are tradable, there need be no conflict between the existence of long term capacity contracts and access to capacity in both the short and long term. Ronald Coase, the founder of transaction cost economics, argued that in certain circumstances resources will be used efficiently regardless of who initially owned them.[21]

In the Australian context, however, the AEMC observed that a liquid secondary market has failed to emerge (see section 2.3). As Coase readily acknowledged, for such a market to emerge, agents require perfect competition, well-defined property rights, sufficiently low transaction costs, complete information, and the absence of other barriers to efficient resource allocation. To date, a workably competitive "Coasian" gas transportation market has only emerged in the United States, for at least three reasons:

- Firstly, market power in wholesale gas markets creates an additional incentive for capacity hoarding in many international jurisdictions. In principle at least, shippers may abuse market power by over-contracting and refusing to trade secondary capacity in order to foreclose competitors from the upstream or downstream markets;
- Secondly, in most international jurisdictions, property rights are incomplete. Makholm (2012) notes that "competitive gas pipeline transport arose in the US once the value of the intangible contract right to point-to-point pipeline transport became so well defined and predictable that it rose to the level of private property";[22,23] and
- Thirdly, transactions costs can be high relative to the cost of tradable capacity in international regimes.[24]

In the absence of any institutional or regulatory measure to address these issues, access to long-term contracts alone may result in shippers with low valuations holding capacity and effectively excluding shippers with higher valuations (i.e. allocative inefficiency). This may also result in the expensive construction of excessive capacity in the long term, which reduces dynamic efficiency. In such circumstances, allocative and dynamic efficiency may be enhanced by intervening to increase the availability of, particularly short-term, capacity.

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21 Ronald H Coase, "The Problem of Social Cost", Journal of Law and Economics 3 (1960): 1-44.

22 See Jeff D Makholm, "The Political Economy of Pipelines – A Century of Comparative Institutional Development", The University of Chicago Press (2012), p9.

23 The Hope Natural Gas decision (1944) was a landmark decision in this regard. The US Supreme Court defined the value of private property that could not be taken from investors by the actions of regulators under the protections for property embodied in the US Constitution. Federal Power Commission v. Hope Natural Gas, 320 US 591 (1944).

24 Regulators can work to keep transaction costs low by enforcing any non-discrimination conditions which force pipelines to provide access to capacity, mandate ownership unbundling, provide transparent information about costs and include regulatory oversight of technical standards.

4. Proposed Auction Design

The GMRG has been tasked with developing the design of the day-ahead auction.[25] Table 4.1 below summarises the GMRG's preliminary view on the key features of the auction design.[26]

Table 4.1
Overview of the GMRG's preliminary view on the auction design

Item	Proposed design
Auction timing	On a daily basis, shortly after nomination cut-off time
Auction product	Second-priority firm product
Auction format	Single- round, partial combinatorial auction
Auction quantity	All technically feasible contracted but un-nominated capacity to be released through the auction
Coverage	The auction should apply to: ▪ All transmission pipelines[27] linking major demand centres and supply sources in the east coast; and ▪ Only contractually congested pipelines in regional areas.
Pricing rule	Pay-as-cleared, i.e. bidders pay the price of the lowest accepted bid
Published information	Information on auction quantities and the clearing prices will be published on the Bulletin Board
Reserve price	Zero dollars (with compressor fuel provided by shippers in-kind)

Source: GMRG (October 2017), Day-Ahead Auction of Contracted but Un-nominated Capacity & Reporting Framework, Consultation Paper, http://gmrg.coagenergycouncil.gov.au/publications/day-ahead-auction-contracted-un-nominated-capacity-and-reporting-framework

As Figure 4.1 illustrates, the proposed auction for CBU capacity will take place shortly after the nomination cut-off time on the day prior to the gas day D. In line with the AEMC's requirements, re-nominations by incumbent shippers following the auction will be accommodated, i.e. the auction product will be interrupted if required to accommodate firm capacity holders' re-nominations.

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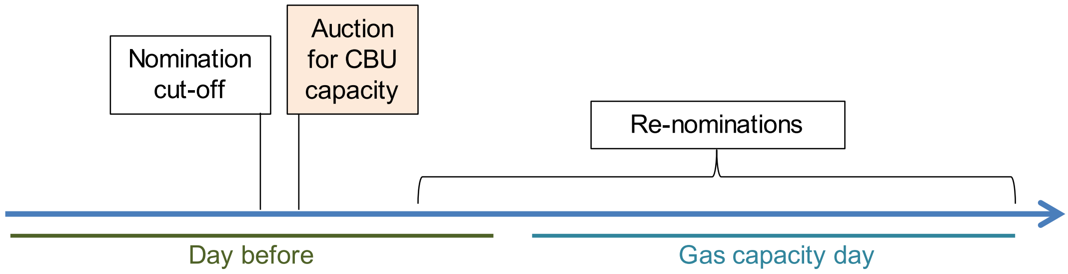
25 See consultation paper, p.21.

26 GMRG (October 2017), Day-Ahead Auction of Contracted but Un-nominated Capacity & Reporting Framework, Consultation Paper, http://gmrg.coagenergycouncil.gov.au/publications/day-ahead-auction-contracted-un-nominated-capacity-and-reporting-framework

27 Excluding the Declared Transmission System.

Figure 4.1
The day-ahead auction will be held after the nomination cut-off time, re-nominations will be accommodated



Source: NERA.

The precise detail of the auction design is still under consultation. For the purpose of this report, we have assumed that effective market conduct rules will address any gaming incentives faced by shippers. When analysing the expected impacts on efficiency, we therefore assume that shippers will reveal their true preferences when bidding in the auction.

With regard to the auction design, the key question is whether the auction product will be sufficiently attractive to shippers to meet their capacity needs in the short-term (see section 2.3). We examine this question in the remainder of this section, focusing on the firmness of the auction product and the partial combinatorial design.

4.1. The "Second-Priority Firm" Product Aims to Promote the Secondary Market

The firmness of the auction product will at least partly determine whether the proposed auction design will meet its objective of increasing efficiency. If the auction product is of very low quality, auction demand may be low, and the auction may not succeed in incentivising incumbent shippers to trade on the secondary market. On the other hand, if the auction product is de facto firm, shippers may not be willing to buy firm products on the secondary market if the auction product is cheaper. As such, the quality of the auction product will be decisive in achieving the objectives of the auction.

In general, an interruptible product is less valuable than a firm product, given its nature of a second-class right, and shippers will reflect this in their bids.

In practice, the quality of an interruptible capacity product will depend on the risk of interruption. In a report prepared for the GMRG, *EnergyEdge* analysed contracting and utilisation data on a number of eastern Australian pipelines over the period November 2016 to June 2017, and estimated the risk of interruption to be low (<10%) to moderate (<50%) more than 90 per cent of the time.[28]

In this context, the GMRG discussed the sequence of interruption for non-firm products in relation to the CBU capacity. The current proposal is that the auction product should be a

[28] EnergyEdge (14 August 2017), Auctionable Quantity Risk, pp 3-5.

"second-priority firm" product, i.e. it should be interrupted after other interruptible products, but before the firm products of incumbent shippers.[29]

As a result, the auction product is likely to be relatively "firm" on most days, and hence sufficiently attractive to shippers. Moreover, the reserve price of zero is likely to attract even shippers with relatively low valuations.

On the other hand, shippers face both volume and price risks when relying on the auction for their short-term capacity needs. Unlike the secondary market, shippers bidding in the auction cannot be sure how much capacity they will get (or if they will get any), and what the clearing price will be. Moreover, the risk of interruption is not immaterial, and will be high on some days, based on *EnergyEdge's* analysis. This may be a concern for shippers, especially given the proposed (partially) combinatorial auction design and the pro-rata curtailment rule.

Overall, under the proposed design, the auction product offers a credible alternative source of capacity for shippers. However, given the price and volume risk that shippers face in the auction, as well as the remaining risk of interruption, shippers are unlikely to consider the auction product as a quasi-perfect substitute for any firm capacity that they could buy on the secondary market. In short, a liquid secondary market would offer shippers the following advantages compared to the auction:

- **Certainty about availability and price**: the availability and price of the auction product depend on i) amount of CBU capacity, and ii) demand for the auction product; when buying on the secondary market, shippers can avoid the volume and price risks of the auction;
- **Quality of the product**: on the secondary market, shippers can buy firm products, whereas the auction product will be interrupted by firm capacity holders' re-nominations; and
- **Timing and product durations**: the auction only provides capacity for the day ahead; on the secondary market, shippers can buy gas further in advance, and for extended periods (e.g. for a three-month period instead of only for the next day). The latter reduces transaction costs relative to buying capacity on a day-ahead basis.

4.2. The Combinatorial Auction Design Shields Bidders from Aggregation Risks

The day-ahead auction will have a partial combinatorial format and identify winning bids and quantities using a linear program.

To flow gas from one point to another, bidders will generally seek to ensure that they have the same quantity for all products that connect these two points (i.e. receipt points, delivery points, pipeline segments, as well as compression services). If bidders had instead competed

[29] GMRG (October 2017), Day-Ahead Auction of Contracted but Un-nominated Capacity & Reporting Framework, Consultation Paper, http://gmrg.coagenergycouncil.gov.au/publications/day-ahead-auction-contracted-un-nominated-capacity-and-reporting-framework

for individual products in separate auctions, they risk winning capacity at only a subset of them, which may not be of value to them.

The partial combinatorial format allows participants to bid the same quantity across a number of products at the same time. A participant's bid may be partially filled, but if this occurs then it will win the same quantity for all products included in the bid. By protecting them from winning unusable subsets of the segments included in their bids, the partial combinatorial auction design shields bidders from aggregation risks.

The proposed pay-as-cleared pricing rule establishes a uniform price-per-unit for each product that all auction winners pay, which is determined by the lowest accepted bid in the auction for each product (i.e. the clearing price). As a result, the auction will set different prices for different products, depending on demand and bid prices, and taking into account routes. The clearing price will be a meaningful reference for the value of short-term capacity products.

4.3. Conclusion on Auction Design

For the auction to increase allocative efficiency, it must be sufficiently attractive for shippers to consider it as an alternative to the sale of uncontracted or CBU capacity by the pipeline owner. If the capacity available through the auction did not meet this standard, it would not affect the current market equilibrium and therefore could not to promote allocative efficiency or the secondary market. If the auction made capacity available on terms that strictly dominated those that could come to be available on the secondary market, shippers would rely on the auction and the secondary market could not develop independently.

The auction design aims to strike precisely such a balance by offering capacity that is less firm than the capacity that may be available in the primary and secondary markets, but more reliable than the interruptible products available from pipeline owners. The auction further provides clear reference prices for price formation in the secondary markets.

5. Impact of the Proposed Auction Design on Allocative Efficiency

This chapter examines how the proposed auction design will affect allocative efficiency. In general, the day-ahead auction can increase allocative efficiency both directly and indirectly:

- **Directly**: Day-ahead auctions make un-nominated capacity available to the shippers that value it the most; and
- **Indirectly**: Day-ahead auctions may promote secondary market activity and pose a constraint on the market power of pipeline owners in relation to the release of CBU capacity.

The direct effect of the auction improves allocative efficiency by making unused capacity available to any bidder who places a positive valuation on that capacity. We understand from Bulletin Board data that the proportion of CBU capacity has been high for most pipelines (see also Figure 2.3). On this basis, the day-ahead auction for CBU capacity could be expected to make relatively large shares of capacity available to other shippers and therefore the potential allocative efficiency benefits are material.

Given that the direct effects on allocative efficiency of the auction are relatively clear-cut, this chapter focusses on the indirect effects on allocative efficiency and how they are affected by the proposed auction design. It proceeds as follows:

- Section 5.1 makes the case that the current level of activity in the secondary market is low. The gains from making capacity available are commensurately higher than would be the case in a fully-functioning and liquid market for capacity;
- Section 5.2 describes the impact that the auction may have on reducing incentives to hoard capacity for existing shippers, given the proposed product definition;
- Section 5.3 describes the information and signalling benefits that the auction may bring to the functioning of the secondary market, given the additional information made available under the proposed auction design;
- Section 5.4 considers the likely impact of the auction on the pricing of access to capacity by pipeline companies, given the proposed product definition; and
- Section 5.5 concludes that the proposed auction design is likely to meet the objective of improving allocative efficiency and that those improvements are potentially material.

5.1. The Secondary Market for Capacity is Currently Illiquid

Whether the presence of a day-ahead auction will materially increase secondary market activity in practice depends on the current level of activity in the secondary market. In particular, in an environment where a liquid secondary market was already in place, the additional value of a day-ahead auction in promoting allocative efficiency is likely to be limited.

This is not, however, the current situation in Australia, with only a small proportion of secondary capacity being traded under bilateral arrangements. Bilateral negotiations are typically an inefficient method of conducting trade with scope for delays, information

asymmetries, and the lack of a clear reference price. Only a subset of transmission pipelines currently has a secondary trading platform and all of these operate through a listing service, rather than providing for exchange-based trading.

Under the National Gas Rules, pipeline operators in eastern Australia who own, control or operate a secondary pipeline capacity trading platform, must provide the secondary trading data for all their pipelines listed on the secondary pipeline capacity trading platform, for publication on the Bulletin Board.[30]

Table 5.1 shows average data on contracted capacity, CBU capacity, and capacity traded on the organised secondary market for these pipelines over the period October 2016 to September 2017.

Table 5.1
Despite high levels of CBU capacity, secondary capacity trading has been very limited in eastern Australia (% of nameplate, Oct. 2016 – Sept. 2017 average)

Pipeline	Contracted capacity (%)	CBU capacity (%)	Traded on secondary market (%)
A	B	C	D
EGP (to Sydney)	100%	24%	0%
MSPS (to Sydney)	66%	60%	0%
MSPS (to Moomba)	66%	31%	0%
RBP (to Brisbane)	86%	33%	**3%**
RBP (to Wallumbilla)	52%	27%	0%
QGP (to Gladstone)	96%	9%	0%
CGP (to Mt Isa)	71%	10%	0%
SWQP (to Wallumbilla)	64%	59%	0%
SWQP (to Moomba)	74%	20%	0%
SEA Gas (to Adelaide)	97%	43%	**10%**

Source: AEMO, Natural Gas Services Bulletin Board, http://gasbb.com.au/, accessed 29 September 2017

First, we note that data is only available for 7 of the 18 major gas transmission pipelines (excluding Victorian DTS), indicating that the majority of pipelines are not currently listed on a secondary trading platform.

30 AEMO (6 October 2016), Natural Gas Services Bulletin Board Procedures Version 7.0, http://gbb.aemo.com.au/~/media/Documents/Procedures/Natural%20Gas%20Services%20Bulletin%20Board%20Procedures%20V70.pdf#page=21, accessed 1 October 2017.

Second, Table 5.1 shows that the share of CBU capacity is relatively high for the majority of pipelines that are listed on the platforms (see column C).[31] For example, the EGP (to Sydney) was fully contracted but only 76 per cent utilised, leaving at least 24 per cent of CBU capacity that could be auctioned off to other shippers. The RBP (to Brisbane) also had a high level of contracting, with a share of CBU capacity as high as 33 per cent.

Nevertheless, we see very little secondary market activity for these pipelines (see column D). In fact, positive average trading amounts have only been recorded for the RBP (to Brisbane) and SEA Gas. For the other five pipelines, the data suggests that shippers do not use the secondary trading platform for trading purposes. Where there is trading (i.e. on the RBP (to Brisbane) and SEA Gas), it constitutes a small share relative to the CBU capacity of 3-10 per cent (see column D).[32]

It is not possible to identify precisely how much trading would occur in the secondary market if it were functioning efficiently. The best one can do is compare market outcomes in Australia with international benchmarks. Comparisons with the US, where the secondary market for gas capacity is most developed, are unflattering.

Table 5.2 shows total trading volumes (in billion cubic feet, Bcf) and a deal count for the 20 US gas pipelines with the highest degree of secondary market activity in 2015. Many of these pipelines have deal counts in the hundreds or thousands, with total trading amounts ranging from 156 Bcf to 2,492 Bcf. In contrast, the total traded volumes on RBP (to Brisbane) and SEA Gas (i.e. the only pipelines in eastern Australia with positive trading amounts in the past year), were only around 3 Bcf and 10 Bcf, respectively.[33]

The secondary trading data published on the Bulletin Board confirms the AEMC's finding that the eastern Australian market lacks a liquid secondary capacity market. The evidence presented suggests that providing a listing service per se is unlikely to lead to a material increase in trading. Even where the listing service is offered, which lowers transaction and search costs for bilateral negotiations, we see that firm capacity holders are not sufficiently incentivised to sell unused capacity.

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31 We proxy the share of CBU capacity with the difference between the share of contracted capacity and the share of capacity used for shipping gas. This measure is likely to understate the amount of CBU capacity, in that the share of used capacity also reflects products sold by the pipeline owner in the short term (i.e. outside long-term contracts). The actual share of CBU capacity, which is quantity to be auctioned, was therefore at least as high as suggested by this proxy measure.

32 In theory, this would not preclude substantial secondary trading based on bilateral negotiations. However, it is understood that this form of secondary trading is also relatively low.

33 We note that this is an illustrative example rather than a detailed comparison of the secondary markets for pipeline capacity in eastern Australia and the US. The recorded traded amounts for RBP (to Brisbane) and SEA Gas over the period October 2016 to September 2017 were 2,715,000 GJ and 10,860,000 GJ, which is equivalent to around 3Bcf and 10Bcf, respectively.

Table 5.2
Secondary capacity trading amounts tend to be much higher in the US (data for 2015)

2015 Rank	Pipeline	Total Traded (Bcf)	Deal Count
1	Transcontinental Gas Pipe Line	2,492	4,684
2	Texas Eastern Transmission	2,371	2,308
3	ANR Pipeline	827	535
4	Columbia Gas Transmission	899	3,787
5	Rockies Express Pipeline	891	52
6	Tennessee Gas Pipeline	632	3,563
7	Dominion Transmission	618	2,183
8	Gulf South Pipeline	425	407
9	Algonquin Gas Transmission	407	919
10	Southern Natural Gas	363	1,061
11	Panhandle Eastern Pipe Line	303	1,141
12	Enable Gas Transmission	772	105
13	El Paso Natural Gas	328	42
14	Northwest Pipeline	263	117
15	Natural Gas Pipeline	380	95
16	Florida Gas Transmission	471	995
17	Columbia Gulf Transmission	192	1,498
18	Northern Natural Gas	205	582
19	East Tennessee Natural Gas	268	67
20	National Fuel Gas Supply	156	689
	Totals:	**13,261**	**24,830**

Source: Capacity Center Website, Capacity Center Top 20, http://www.capacitycenter.com/Pipeline-Ranking-2015.pdf, accessed 17 October 2017. Notes: Bcf = billion cubic feet.

5.2. The Proposed Auction Design May Limit Market Power and Capacity Hoarding

Competitive secondary markets reallocate capacity to those who value it most in the short term. Primary capacity holders sell their capacity to other shippers who are willing to pay a price above the short-term valuation of the firm capacity holder.[34] As long as the intangible property rights of capacity holders are well defined and protected, and as long as pipeline owners cannot refuse to write new contracts or to expand capacity, a liquid secondary market may well be all that is needed to correct allocative inefficiencies.

[34] See Dan Alger & Michael Toman (1990), Market-Based Regulation of Natural Gas Pipelines, Journal of Regulatory Economics; 2:263-280, p267-269; Jeff D. Makholm (October 1994), Secondary Market Can Compete, Natural Gas, John Wiley & Sons.

However, the benefits of a secondary market in capacity are only achievable where that market is competitive.[35] Where shippers can earn a substantial premium by preventing competitors from getting access to the capacity they contracted in the primary market, their incentive to trade on the secondary market is low and allocative efficiency is limited. The day-ahead auction can therefore play an important role in reducing firm capacity holders' incentives to withhold capacity.

Table 5.3
By reducing market power, the day-ahead auction can incentivise incumbent shippers to sell (more) unused capacity on the secondary market

		Is there a day-ahead auction?	
		No	Yes
Action taken by incumbent shipper	Sell on secondary market	**P**	**P**
	Do not sell on secondary market	$\pi^{\text{Market Power}}$	**0**

Source: NERA.

Table 5.3 illustrates this point. It provides the pay-off matrix of a simple game in which a shipper with market power in the wholesale market and rights to valuable capacity considers whether or not to sell that capacity through the secondary market. The matrix shows only the shipper's payoffs from the decision to sell capacity on the secondary market or not, with or without a day-ahead auction for CBU capacity.

In general, firm capacity holders will only sell on the secondary market where capacity is valuable, i.e. where they can earn a positive profit P, taking into account transaction costs. However, they may not want to do so even if capacity is valuable, especially if they can earn a premium ($\pi_{\text{Market Power}}$) by preventing competitors from entering the market (see bottom left quadrant in Table 5.3).

A day-ahead auction can remove the ability of firm capacity holders to withhold unused capacity because if they do not use the capacity themselves they must surrender that capacity to another shipper through the auction mechanism. After the introduction of the auction, shippers that previously benefitted from withholding capacity may have an incentive to trade

[35] As Alger and Toman put it: "the benefits of the [secondary] market are maximised if any potential market power is effectively checked". See Dan Alger & Michael Toman (1990), Market-Based Regulation of Natural Gas Pipelines, Journal of Regulatory Economics; 2:263-280, p268.

on the secondary market instead, earning a positive profit P instead of "wasting" their capacity for no additional return (see top right quadrant in Table 5.3).

Whether this effect will materialise depends on the quality of the auction product. As explained in chapter 4, the auction product needs to be sufficiently attractive to shippers to remove market power. Only if shippers regard the auction product as a sufficiently attractive and hence buy material amounts, firm capacity holders will be incentivised to sell their CBU capacity on the secondary market. As stated in chapter 4, we find that the second-priority firm product definition is fit for purpose, as it is the most firm definition possible given the AEMC's requirement of accommodating firm capacity holders' re-nomination rights. Given that the risk of interruption is likely to be low to moderate, we expect shippers to consider the second-priority firm product as sufficiently attractive for meeting their short-term capacity needs.

Alger & Toman (1990) presented some of the most detailed ideas in the economic literature on how regulators can control the shippers' tendency to hoard capacity and refrain from the secondary market. The authors propose that the pipeline owner should sell un-nominated capacity on an interruptible basis, which can make unused capacity available to others. This possibility already exists in Australia but has not been effective in encouraging firm capacity holders to trade on the secondary market to date, for at least two reasons:

(1) Pipeline companies themselves have market power over capacity and wish to sell higher-priced capacity products; and

(2) Pipeline companies rely on long term contracts funded by existing shippers and therefore have limited incentives to undermine the value of those contracts, especially if they hope to sign contracts in future.

This is consistent with the AEMC's and ACCC's finding that pipelines are charging more for CBU capacity than would be expected in a workably competitive market. In such circumstances, firm capacity holders would continue to benefit from withholding capacity from the secondary market. The day-ahead auction may be more effective at reducing hoarding because it takes the choice over how much capacity to offer and the price at which it must be offered out of the hands of the pipelines. As explained in chapter 4, shippers are likely to consider the auction product as sufficiently attractive, given the combinatorial design and the product's relative firmness (i.e. it will be interrupted after other as available or interruptible products sold by the pipeline owner).

Although hoarding by shippers presents a theoretical reason for withholding of capacity from the secondary market, the potential market power of shippers has not been a major concern raised by the inquiries into the sector to date. For instance, in 2016, the ACCC found that there was "no evidence that would support a conclusion that shippers were withholding capacity for the purpose of achieving a competitive advantage in a related market [and] no evidence of economic withholding of capacity by shippers on major arterial pipelines".[36]

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[36] See ACCC (April 2016), *Inquiry into the east coast gas market*, p146. However, the study did find some issues with regional pipelines, where all or significant portions of capacity are often contracted by a single retailer, which may deter other retailers from entering regional markets (see pp. 153, 154).

Market power in gas transport may be localised and evidence on economic withholding of capacity is notoriously difficult to collect and interpret. Accordingly, even if it is not widespread or the evidence is missing, the market power of shippers may be a contributing factor and/or localised reason for withholding capacity from the market.

5.3. The Proposed Auction Design May Reduce Transactions Costs in General and Information Asymmetry in Particular

Shippers may not currently trade extensively through the secondary market in part because the transactions costs of doing so exceed the likely benefits. These transactions costs might include agreeing on terms of payment, delays in effecting a trade of capacity and dealing with the uncertainty of whether capacity will be available. If participating in the auction requires shippers to incur lower transactions costs to acquire capacity, the auction may result in shippers being able to get access to unused capacity at lower cost and introducing the auction will (at least weakly) increase allocative efficiency.[37] If the costs of transacting through the secondary market remain high, shippers may prefer to transact through the auction. In such circumstances, the auction will not promote the secondary market even though it increases allocative efficiency. However, if the transactions costs that hinder the secondary market are informational, the proposed auction design may work to reduce transactions costs in the secondary market also and promote both allocative efficiency and the secondary market.

In current market conditions, information asymmetry may be inhibiting effective trading of capacity in the secondary market. For instance, firm capacity holders may be unaware of the demand for the capacity they do not use and simply expect that the revenue generated would not exceed the overall cost and effort of trading on the secondary market. The AEMC's *East Coast Review* suggests that this might explain most of firm capacity holders' historical reluctance to trade on the secondary market.[38]

Firm capacity holders' belief that it is not worth engaging in the secondary market may not always be wrong. The possibility to trade on the secondary market is only valuable where the expected gains exceed the costs, including transaction costs. However, firm capacity holders may face an understandable reluctance to incur the transactions costs (or even opportunity costs of forgoing their own principal business activity) in order to test the market even though there may be material demand for firm products sold on the secondary market. Based on the information we have about secondary trades today, it is impossible to predict the size of this demand.

The value of the auction in resolving information asymmetry is that it provides a clear and regular signal to firm capacity holders. It can reveal whether there is substantial demand for

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37 If the deadweight loss associated with administering the auction were greater than the benefits that result from it, allocative efficiency could also decrease. However, if shippers who participate in the auction ultimately fund the costs of operating the auction and transactions costs are still lower than through the secondary market, the auction may only be (weakly) efficiency enhancing.

38 See AEMC, *Stage 2 Final Report, East Coast Wholesale Gas Markets and Pipeline Frameworks Review*, 23 May 2016, p 72, 73. Even if it has not been a major concern in the past, market power may increase going forward with the increase in capacity demand from the LNG industry, and hence we maintain that both reasons should be taken into account.

un-nominated capacity and how much firm capacity holders can potentially charge for this capacity. In particular, under the proposed auction design, the auction quantities and the clearing prices will be published on the Bulletin Board following the auction.[39]

This information will help firm capacity holders assess their potential gains from trading, and where these exceed their costs, incentivise them to trade capacity more freely in the secondary market, thereby increasing allocative efficiency relative to the status quo.[40]

5.4. Pipelines May Make Capacity Available at Lower Prices

Besides encouraging firm capacity holders to trade on the secondary market, the introduction of the day-ahead auction for CBU capacity also has the benefit of reducing pipeline owners' market power in selling CBU capacity after nomination cut-off time.

Under the status quo, pipeline owners have discretion over how much CBU capacity they sell (on an as available or interruptible basis) and at what price. In this regard, the ACCC found that the prices of as available and interruptible products sold by pipeline operators were well above the SRMC and noted that on some pipelines these prices were 185 per cent - 350 per cent higher than the prices charged for firm capacity.[41] Where pipeline owners have discretion over how much CBU capacity they sell and at what prices, they may exert their market power and extract monopoly rents on these products. Charging monopoly prices has an effect equivalent to withholding capacity, as fewer shippers will buy at these prices relative to competitive prices.

The day-ahead auction for CBU capacity will provide an additional source of such capacity at market-based prices and may therefore reduce any such market power. This will also place downward pressure on prices of capacity that pipeline owners are selling on a short-term basis. Given that capacity has a marginal cost close to zero, the auction necessarily increases allocative efficiency by making more CBU capacity available at lower prices, where shippers consider the auction product to be sufficiently attractive for meeting their short-term capacity needs.

As explained in chapter 4, the combinatorial design and the product's relative firmness make the auction product a sufficiently high quality product, which is likely to encourage shippers to substitute away from potentially over priced products that pipeline owners offer on a day-ahead basis.

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39 GMRG (October 2017), Day-Ahead Auction of Contracted but Un-nominated Capacity & Reporting Framework, Consultation Paper, http://gmrg.coagenergycouncil.gov.au/publications/day-ahead-auction-contracted-un-nominated-capacity-and-reporting-framework, p 72, 73.

40 Where firm capacity holders do not currently have a business function dedicated to optimising capacity use, introducing the auction may have smaller benefits for the secondary market in the short term. See AEMC, Stage 2 Final Report, East Coast Wholesale Gas Markets and Pipeline Frameworks Review, 23 May 2016, p 72.

41 ACCC (April 2016), *Inquiry into the east coast gas market*, p147. Also see AEMC, Stage 2 Final Report: East Coast Review, 23 May 2016, pp. 72,73.

5.5. The Proposed Auction Design is Likely to Increase Allocative Efficiency

In summary, by making all CBU capacity available to other shippers, the introduction of the day-ahead auction is expected to i) increase allocative efficiency directly, and ii) incentivise capacity holders to sell unused capacity on the secondary market, and thereby increase allocative efficiency indirectly.

With regard to the indirect effects, the day-ahead auction encourages secondary market activity by reducing firm capacity holders' market power and also reduces the pipeline owner's market power in selling capacity. These effects are likely to materialise given the combinatorial auction design (which reduces aggregation risks) and the relative firmness of the auction product. The proposed auction design and product definition make the auction product sufficiently attractive to encourage shippers to fully or partially rely on the auction for their short-term capacity needs. Where they do, firm capacity holders are more likely to sell CBU capacity on the secondary market, and the pipeline owner is likely to reduce the prices of short-term products relative to the status quo.

The day-ahead auction also has the potential of indirectly improving allocative efficiency by addressing information asymmetries. This effect is likely to materialise as under the proposed design, auction quantities and clearing prices will be published on the Bulletin Board following the auction. These are the relevant metrics to help firm capacity holders assess whether the expected revenues from selling CBU capacity exceed the total cost of doing so.

6. Allocative Efficiency Effects Depend on Congestion

The economic rationale for introducing the day-ahead auction is to improve allocative efficiency. In chapter 5, we provided a theoretical assessment of how the auction can increase allocative efficiency. In this chapter we show that, the size of the effect will depend on the degree of physical and contractual congestion on each pipeline.

We also assess the level of de-contracting and effects on pipeline revenues with regard to the degree of physical and contractual congestion. Under long term contracts, pipeline owners receive fixed charges from firm capacity holders, i.e. a secure revenue stream. De-contracting in response to the auction may lower pipeline revenues, and will in any case make revenues more volatile. The following assessment of the potential impact of the auction on pipeline revenues is provided for completeness. As we discuss in Section 8.4.1, the revenues earned by existing pipelines are, in principle, irrelevant for the purpose of assessing dynamic efficiency.

Table 6.1 summarises the expected impact under the three realistic congestion scenarios:

- Both contractual and physical congestion (top left);
- Contractual congestion but no physical congestion (bottom left); and
- Neither contractual nor physical congestion (bottom right).

In the following sections, we present details on the expected effects on allocative efficiency, pipeline revenues, and de-contracting under each of these scenarios. Throughout, we take as given the absence of a liquid secondary market for capacity in the absence of the auction for CBU capacity.

Table 6.1
The expected efficiency effects of the auction design depend on the degree of contractual and physical congestion

	Contractual congestion	No contractual congestion
Physical congestion	Scenario 1: **Allocative efficiency:** None **Pipeline revenues:** None **De-contracting:** None	x[42]
No physical congestion	Scenario 2: **Allocative efficiency:** ▪ New gas shipped, potential cannibalisation of short-term as available capacity **Pipeline revenues:** ▪ (Weakly) lower, extent depends on auction demand **De-contracting:** ▪ Some de-contracting, extent depends on auction demand	Scenario 3: **Allocative efficiency:** ▪ New gas shipped, potential cannibalisation of short-term firm and as available capacity **Pipeline revenues** ▪ (Weakly) lower, extent depends on auction demand **De-contracting:** ▪ Some de-contracting, extent depends on auction demand ▪ Decontracting may be of more concern (for *revenue adequacy* rather than *efficiency* reasons).

Source: NERA analysis.

6.1. Scenario 1: Both contractual and physical congestion (top left)

The auction will have zero or close to zero efficiency effects in the case of pipelines with both contractual and physical congestion.

For physically congested pipelines, by definition, un-nominated quantity will be close to zero on most days:

- When there is no un-nominated capacity, shippers will not be able to purchase capacity through the auction because the auction only makes CBU capacity available; and

[42] The top right scenario would imply that despite that fact that the pipeline is not fully contracted, it is physically congested. This could only occur if shippers persistently use material amounts of capacity in addition to their contracted amounts (i.e. overrun), a practice which we understand is not common in Australia.

- On the few days where there is un-nominated capacity, there would be an auction, but the amounts are likely to be trivial.

Regarding dynamic efficiency, we do not expect any material de-contracting under this scenario. The pipeline is fully utilised, indicating that demand is high. In such situations, most shippers will want to keep their long-term contracts, either to ship gas themselves or to sell this valuable capacity product to others.

6.2. Scenario 2: Contractual congestion but no physical congestion

In contrast to physically congested pipelines, conducting the auction on contractually congested but physically uncongested pipelines may result in an increase in allocative efficiency.

Figure 6.1 illustrates nominations and capacity for a pipeline that is fully contracted (i.e. contracted capacity equals physical capacity), but not fully utilised (i.e. the nominated amount is lower than the contracted amount). This difference is "auctionable quantity" (Q_{AUC}).

Under the Status Quo, Q_{AUC} goes unutilised by shippers. If there are shippers who placed a positive valuation on that capacity, society suffers a deadweight loss from the inefficient under-use of pipeline capacity.

Under the GMRG's proposed design, AEMO will offer the difference between the contracted/physical capacity through day-ahead auctions at a reserve price of zero. Where shippers without long-term capacity have positive demand and place bids in the auction, the auction will allocate un-nominated capacity to them under the day-ahead auction. The auction will lead to an increase in allocative efficiency if it leads to an increase in the volume of gas being shipped, either because:

a) existing buyers without long-term capacity buy more capacity given the lower prices that emerge as a result of the auction; and/or

b) new shippers enter into the market as they can get capacity more cheaply than before.

Assuming that pipeline companies are profit maximising before the introduction of the auction, the auction will necessarily reduce pipeline revenues overall. However, the scale of the impact on pipeline revenues will depend on the supply and demand of capacity in the auction. In particular, the price of capacity in the auction will be zero if total auction demand is lower than the auctionable quantity (Q_{AUC}). If total auction demand is greater than the auctionable quantity the price in the auction will be greater than zero, and pipeline revenues may even increase in the short term.

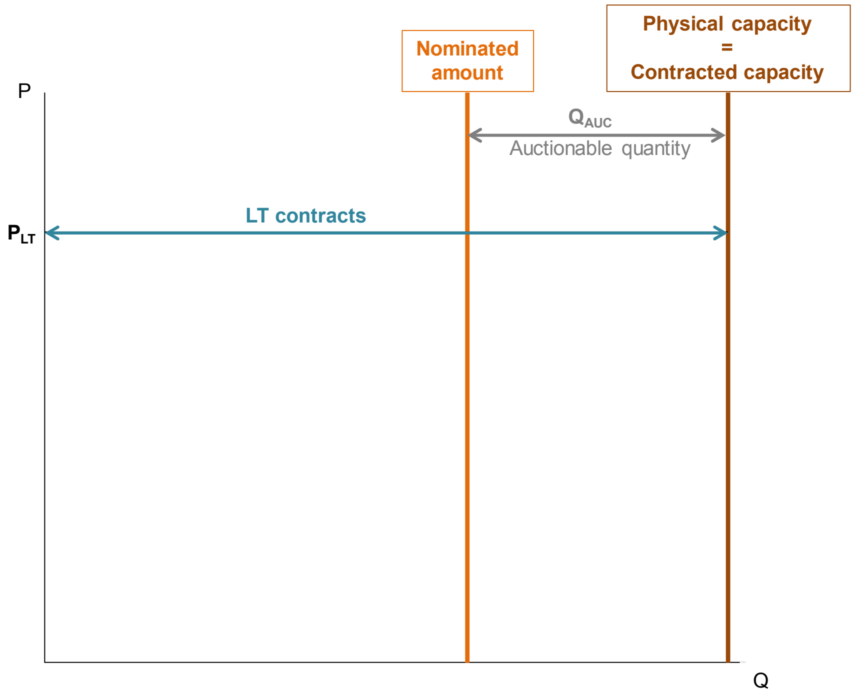
Over the long-term, firm contract holders are likely to de-contract more (or re-contract less) where demand is below total capacity after the auction (i.e. the pipeline remains physically uncongested after the auction). The lower de-contracting results from:

(1) uncertainty over whether capacity will actually be available is greater where the auction results in physical congestion; and

(2) prices for capacity obtained through the auction are higher, which makes contracting through the primary market more attractive.

Sections 6.2.1 and 6.2.2 provide worked examples of auction outcomes for contractually congested pipelines where the auction does and does not result in physical congestion on a previously underutilised pipeline.

Figure 6.1
Illustration of Contractual Congestion and Auctionable Quantity



Source: NERA analysis.

6.2.1. Scenario 2A: Auction demand < auctionable quantity

Figure 6.2 illustrates contracting, the use of capacity, and prices where the auction demand is lower than the auctionable quantity (i.e. physical congestion does not emerge as a result of the introduction of the auction).

In this scenario, because we assume contractual congestion, shippers have signed long term contracts for all of the physical capacity on the pipeline (shown in brown). However, at the day-ahead stage, incumbent shippers nominate a smaller quantity of capacity (shown in orange).

The auctionable quantity (Q_{AUC}) is the difference between the contracted capacity and the nominated amount.[43] In this scenario, we assume that shippers bid their "Bid price" in the auction. Because the total auction demand (Q_{AD}) is lower than the auctionable quantity, all shippers who bid for capacity win in the auction. As shown in the first panel of Figure 6.2,

[43] For the sake of simplicity, we assume that there are no re-nominations in this example.

the allocative efficiency benefit of the auction is the value of the additional capacity to the bidders in the auction (Bid Price) multiplied by the additional volume of capacity shipped (Q_{AD}), i.e. area A.[44] Due to the excess capacity in the auction, the auction clearing price is the reserve price, i.e. zero, and shippers receive all of the efficiency benefits of the auction.

Over the long term, repeated auctions provide an incentive for de-contracting. Where incumbent shippers expect to be able to get short-term capacity for free, they are likely to de-contract to some extent: shippers may reduce their costs by obtaining that de-contracted capacity (marked as Q_{DC} in the Figure) through the auction. We mark the de-contracting by the blue arrows in the second panel of Figure 6.2. As a result of de-contracting, pipeline companies' revenues decrease by B, i.e. the product of the de-contracted quantity (Q_{DC}) and the price paid for long-term firm products (P_{LT}).

The auction structure provides a natural break on de-contracting. Incumbent shippers will be less likely to de-contract when doing so raises the total expected auction demand above the expected auctionable quantity. If they did so, the clearing price would no longer be zero, but set by the lowest successful bid (see Scenario 2B below). Moreover, firm capacity holders would face the risk of not being successful in the auction, as will be the case if others value short-term capacity more than them (in particular, if other bids are higher than the price paid for long-term firm products P_{LT}). Lastly, they will trade off the risk of being interrupted due to re-nominations against any expected cost savings from buying through the auction rather than through long-term contracts.

In summary, under Scenario 2A, we generally expect the auction to clear at a price of zero, with some de-contracting by firm capacity holders. The pipeline owner's revenues will be reduced by area B as well as any revenues previously earned by selling un-nominated capacity on an as available or interruptible basis.

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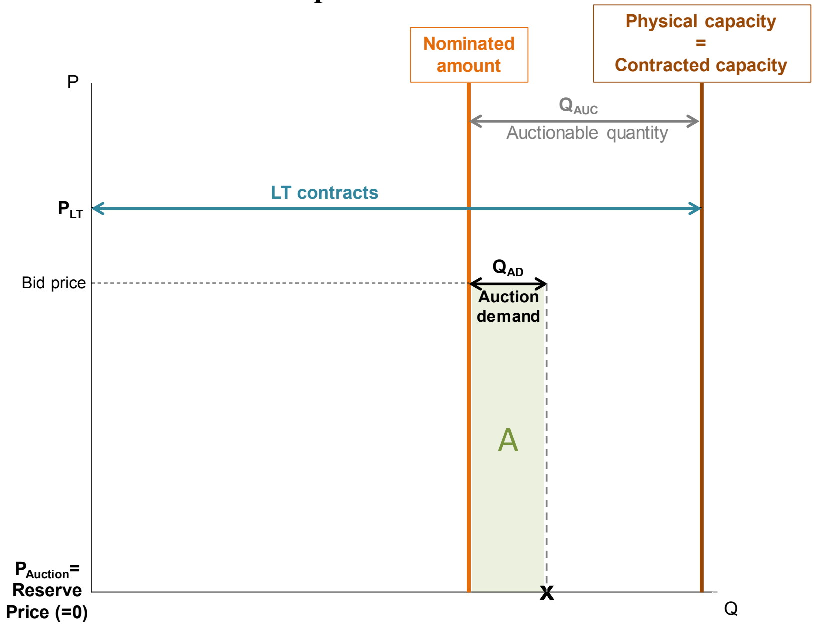
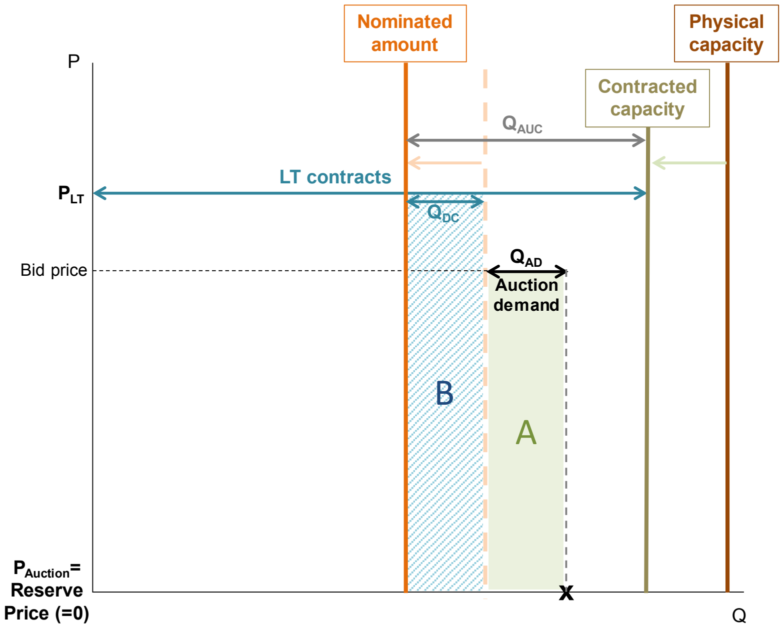
44 Strictly speaking, the allocative efficiency benefit for society is the area under the auction demand curve. Note that the Figure does not show a realistic auction demand curve where different bidders have different valuations for the auction product. For illustrative purposes, we assume that all bidders have the same valuation, and hence the area under the auction demand curve is Q_{AD} multiplied by the common bid price.

Figure 6.2
Where auction demand < auctionable quantity, the day-ahead auction will clear at a price of zero



If the day-ahead auctions repeatedly clear at zero, shippers have an incentive to de-contract at least some capacity over time



Source: NERA analysis.

6.2.2. Scenario 2B: Auction demand > auctionable quantity

Figure 6.3 illustrates the use of capacity and prices in the case where the auction demand is higher than the auctionable quantity. In this scenario, holding the day-ahead auction reveals that there is physical congestion on the pipeline (i.e. total demand exceeds the physical capacity of the pipeline). The lowest successful bid will determine the auction clearing price.

The allocative efficiency benefit for society will be the area under the auction demand curve (area A in the first panel of Figure 6.3).[45] The auction clearing price will be the set by the intersection of the lowest winning bid in the auction.

Where there is no excess capacity in the auction, pipeline owners and shippers share in the efficiency gains from the auction. The pipeline owner will keep the revenues earned through the auction (area A in the Figure), i.e. the product of the auctionable quantity Q_{AUC} and the clearing price $P_{Auction}$ (see first panel of Figure 6.3). Nonetheless, if the pipeline owner sells short-term capacity in a profit-maximising way in the absence of the auction, introducing day-ahead auctions will reduce pipeline revenues relative to the status quo. In other words, pipeline companies' *share* of the efficiency gain will be lower than the *rents from market power* they can extract in the absence of the auction.

Where there is excess demand for CBU capacity, firm capacity holders have a weaker incentive to de-contract relative to Scenario 2A, as shown in the second panel of Figure 6.3. In this example, incumbent shippers would see an increase in their revenues as a result of de-contracting, representing the benefit of contracting at the auction price rather than the long term contract price. This gain is the part of area B that is above the bid price line, which is smaller than under Scenario 2A, where CBU capacity is free. Moreover, valuations of shippers bidding in the auction could be higher and some might even exceed the price of long-term contracts P_{LT} on some days. As a result, shippers risk failing to get any capacity through the auction or get capacity for a price that is only marginally lower than their valuation. Lastly, where auction demand exceeds the auctionable quantity, the risk of interruption is higher, which makes the auction product less attractive.

Over the long term, pipeline owners would see a reduction in their revenues due to de-contracting in this scenario (see area B in the second panel), albeit that the extent of that reduction is likely to be lower than in scenario 2A. In scenario 2B, de-contracting itself is likely to be lower than in scenario 2A because the attractiveness of buying through the auction is lower for shippers holding long term contracts. Moreover, de-contracting tightens the auction supply and demand and may increase prices or result in the de-contracting shipper failing to obtain its target volume of capacity.

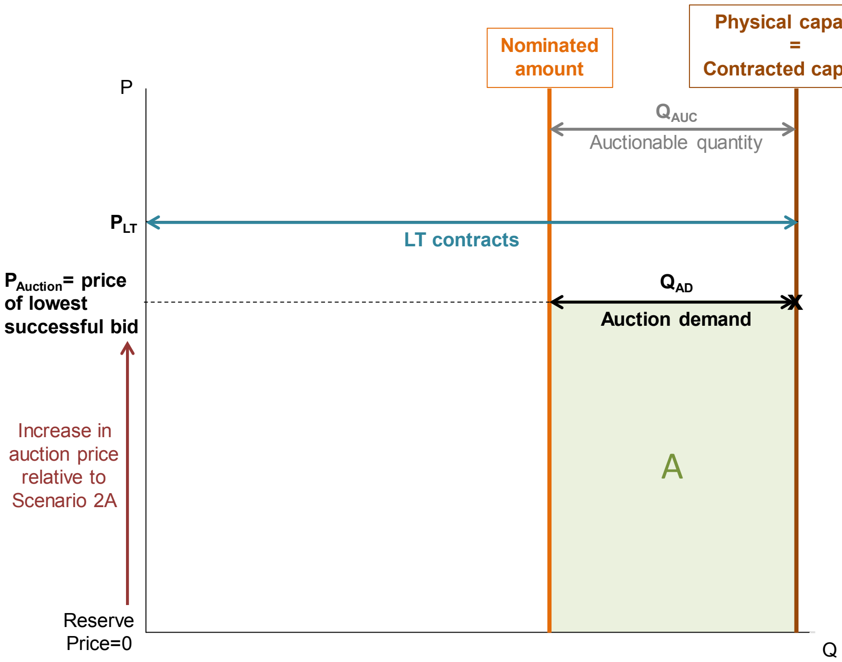
The overall change in the pipeline owner's revenues is +D-B. Where incumbent shippers de-contract, this will crowd out a proportion of new demand (Q_{AD}) that would otherwise be met by the auction, and therefore reduces the allocative efficiency benefit (compare area A' in the second panel to area A in the first panel).

In conclusion, we expect less de-contracting on pipelines where introducing the auction reveals underlying "physical congestion". This conclusion holds if we assume that firm capacity holders enter into long-term contracts for the sake of shipping gas (i.e. they buy according to their expected capacity needs plus a safety margin). We would draw a different conclusion where firm capacity holders contract more in order to gain market power (i.e.

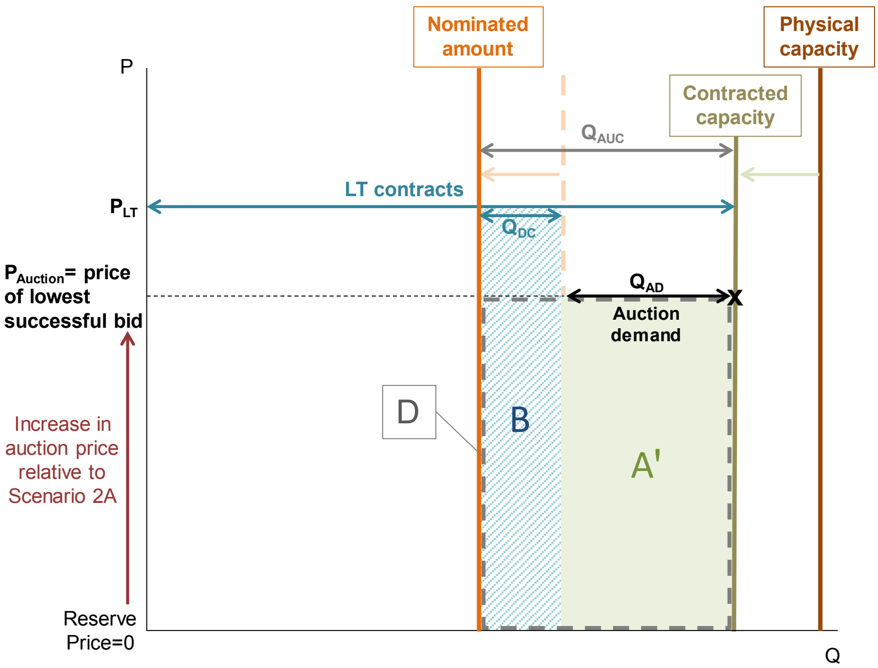
[45] Note that the Figure does not show a realistic auction demand curve where different bidders have different valuations for the auction product. For illustrative purposes, we assume that all bidders have the same valuation, and hence the area under the auction demand curve is Q_{AD} multiplied by $P_{Auction}$.

prevent other shippers from obtaining capacity in the short-term). In the latter case, introducing the auction would encourage firm capacity holders to de-contract, not with a view to obtaining capacity through the auction, but because they can no longer prevent other shippers from obtaining capacity, and hence do not have an incentive to over-contract.

Figure 6.3
Where auction demand > auctionable quantity, the day-ahead auction will clear at a price greater than zero



De-contracting is less attractive for incumbent shippers and runs greater risk of increasing auction prices and/or resulting in failing to obtain capacity



Source: NERA analysis.

6.3. Scenario 3: No congestion

In this Scenario, as under Scenario 2, introducing day-ahead auctions is likely to increase allocative efficiency. However, it is unclear a priori if the efficiency benefits are greater or smaller than under Scenario 2. As in Scenario 2, the impact of the auction on prices and revenues will depend on whether capacity in the auction is in excess supply.

Figure 6.4 provides a graphical representation of this Scenario. Overall, introducing the auction will be likely to lead to greater gas flows, at lower prices. New shippers (with lower valuations) will purchase capacity (represented by Q_{AD} in the Figure).[46] The increase in allocative efficiency is the volume of additional demand served multiplied by the valuations of those shippers (see area A).

Even in the short term, shippers who were unable previously to ship their gas will not necessarily be the only bidders in the auction. Some of the demand satisfied by the auction may be for shippers who would have contracted for capacity in any case. Where pipelines are not contractually congested, shippers are normally able to purchase firm or relatively reliable interruptible products from the pipeline owner (represented by demand for un-contracted capacity Q_{UC} at a price of P_{UC}). These shippers do not need to rely on the auction to obtain access to capacity. However, as illustrated in the second panel of Figure 6.4, these shippers may prefer to participate in the auction because the reserve price is zero and they may therefore be able to obtain access to capacity more cheaply. This in turn will put downward pressure on prices offered by the pipeline owner for capacity. Serving this portion of demand through the auction does not increase allocative efficiency: the auction merely transfers rents (area C) between pipelines and shippers.

Over the long term, firm capacity holders are likely to substitute away from long-term contracts to some extent, where cheaper capacity is likely to be available through the auction. The extent of de-contracting will, all else equal, be larger on contractually uncongested pipelines: On days on which auction demand is very high, they could still buy uncontracted capacity from pipeline owners in short term markets. The risk of ending up without capacity is therefore lower than under Scenario 2.

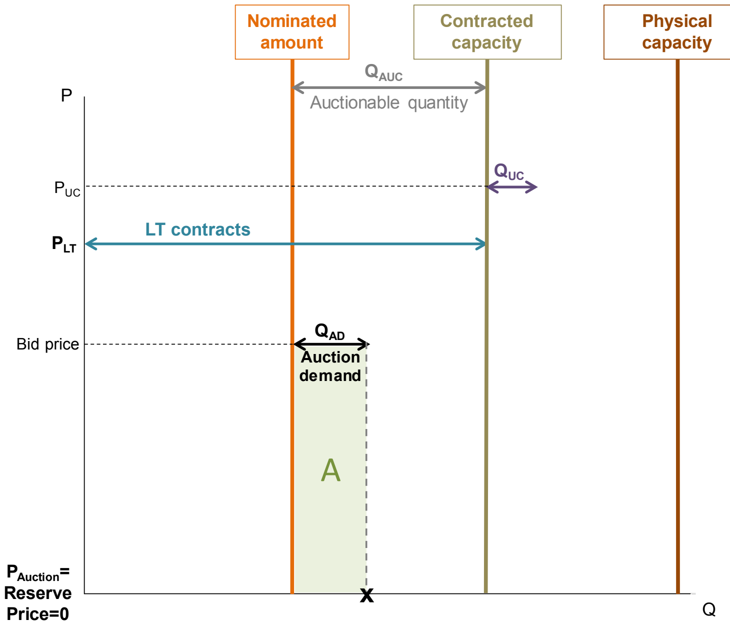
As under Scenario 2, the effect on pipeline revenues depends on whether the combined demand in the auction exceeds the auctionable quantity or not. Where the total auction demand (the uncontracted capacity formerly bought from pipeline owners Q_{UC}, the de-contracted capacity Q_{DC}, and any additional capacity from shippers with lower valuations Q_{AD}) is below the auctionable quantity, the clearing price will be zero. In this case, the pipeline owner's revenue will be reduced by the sum of the areas B and C, as well as any amounts paid by shippers for as available capacity that the pipeline owner previously sold from CBU amounts.

Where the total auction demand is above the auctionable quantity, the lowest successful bid will set the clearing price. In this case, the change in pipeline owner's revenues will be +D-

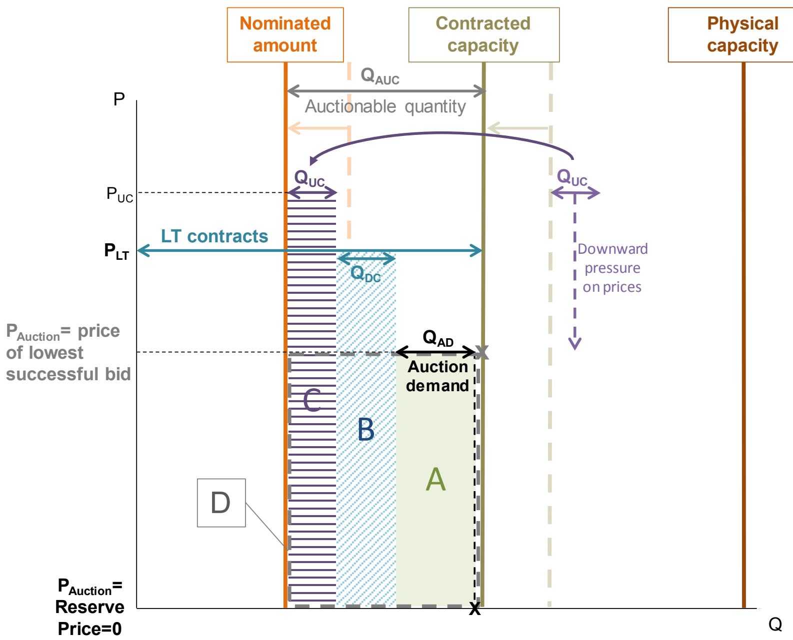
46 We note that with the auction, existing shippers may want to buy more capacity than they would buy at the prices set by pipeline owners.

B-C, and will be further reduced by any amounts paid by shippers for as available capacity that the pipeline owner sold from un-nominated amounts. Whereas the sign of this change could be positive or negative for any given auction, we expect it to be negative where the pipeline owner used to sell capacity in a profit-maximising way.

Figure 6.4
For contractually uncongested pipelines, we expect some de-contracting



Existing short term buyers are likely to participate in the auction, as well as those de-contracting from long-term contracts



Source: NERA analysis.

6.4. Conclusion on Impact on Allocative Efficiency, Pipeline Revenues, and De-Contracting

In summary, we find that material allocative efficiency gains can only be achieved in physically uncongested pipelines. On physically congested pipelines, we expect neither material allocative efficiency benefits nor a material effect on pipelines revenues or contracting levels.

Among physically uncongested pipelines, allocative efficiency will be (weakly) improved in all scenarios. However, it is unclear a priori if allocative efficiency benefits are greater in physically uncongested pipelines with or without contractual congestion. The allocative efficiency benefit of the auction is essentially the total additional willingness to pay of shippers who are able to ship gas as a result of the auction. That collective willingness to pay may be greater or lower on pipelines that are currently physically congested than those that are not.[47]

For the same reason, it is unclear whether the auction will decrease pipeline revenues more or less on contractually congested or contractually uncongested pipelines. In all cases, assuming that pipelines are maximising revenue with respect to the quantity of as available capacity they bring to market, one would expect pipeline revenues to fall as a result of the auction, at least over the long term. As we discuss in Section 8.4.1, the revenues earned by existing pipelines are, in principle, irrelevant for the purpose of assessing dynamic efficiency.

[47] It is initially plausible that the allocative efficiency benefits of the auction are higher on contractually congested pipelines than on uncongested pipelines: Additional demand served on contractually congested pipelines could not previously have obtained capacity at any price, whilst shippers were simply not willing to pay for the additional capacity on uncongested pipelines. However, this conclusion is erroneous. For instance, the volume of unserved demand may be much higher on contractually uncongested pipelines than congested ones. Alternatively, demand for congested pipelines could be much more inelastic, resulting in very low valuations for the incremental capacity provided.

7. Impact on New Pipeline Investment and Dynamic Efficiency

Regulators internationally often discriminate between new and existing capacity in the design of market rules. For instance, whilst established capacity in European markets is subject to the third party access regime under the third package and the requirement to offer entry-exit tariffs, pipelines may obtain exemptions from third party access obligations and offer long term contracts for new capacity. The rationale for adopting different regulatory arrangements may be that new and existing capacity face different economic conditions: New capacity must incur upfront costs whilst the costs of existing capacity are already sunk. Different treatment for new and existing capacity may reflect regulatory opportunism and an ex post expropriation of sunk costs.

In this chapter, we examine how the CBU capacity auction will affect investment in new pipelines and dynamic efficiency more generally. By simulating shippers' contracting decisions, we show that lower contracting levels that may result from the auction need not be inefficient, and can in fact prevent inefficient overbuilding. In other words, our analysis suggests that there is no efficiency case for exempting new pipelines from the auction.

This section is structured as follows:

- Section 7.1 explains why the status quo need not provide efficient investment incentives;
- Section 7.2 summarises our model and assumptions for simulating shippers' contracting decision with and without the auction;
- Section 7.3 shows that under our model, dynamic efficiency and social welfare increase as a result of the auction;
- Section 7.4 explains that the simplifying assumptions of the model are likely to overstate de-contracting and understate the benefits of the auction; and
- Section 7.5 concludes on the impact of the day-ahead auction on new pipelines.

7.1. The Status Quo May Not Provide Efficient Investment Incentives

Dynamically efficient markets provide capacity to meet all demand where the incremental value of capacity to the shipper (or more generally society) is greater than the incremental cost of building and operating that capacity. In Australia, pipelines have historically financed investment by entering into long term contracts with shippers. That shippers were willing to sign long term contracts demonstrates that shippers demanded that capacity, at least given the options that they faced at the point of signing the contract.

Although not required in the frictionless markets of classical economic theory, long term contracts facilitate investment in gas capacity, much of which may be dynamically efficient, in the real world markets in which pipeline companies operate (see section 3.4 above). The introduction of a day-ahead auction offers an alternative option for sourcing capacity than long term contracts and may therefore result in at least some de-contracting from current levels. The claim that, as a result, the day-ahead auction will diminish dynamic efficiency is, however, a non-sequitur for the simple reason that not all of the existing investment need have been dynamically efficient.

In the absence of a liquid short term market in gas transport capacity, shippers have been unable to meet their short term needs for capacity without signing long-term contracts. It follows that shippers may have over-contracted in order to insure themselves against the risk of high-demand. Our own simulations, set out in the subsequent sections, show that in the absence of a liquid secondary market, shippers may have over-contracted, which has encouraged overbuilding.

Economic retirement of capacity aside, dynamic efficiency is principally a concern for new capacity. Whatever impact the introduction of the day-ahead auction has on investment incentives, there will be no efficiency effects on existing capacity because the pipeline company has already sunk the costs of construction. The day-ahead auction may, however, have a distributional effect for existing pipelines: by making existing capacity available more freely, the prices that pipelines may charge for capacity may fall.[48]

For new capacity, the availability of short-term capacity through day-ahead auctions may reduce inefficient overbuilding, and thereby increase dynamic efficiency. Moreover, by providing more shippers with access to certain pipeline segments, new demand may arise for adjacent areas which may provide an incentive to build network extensions. The impact of the auction on dynamic efficiency may therefore be substantial and positive.

7.2. Simulation of the Auction Results

We examined the impact of the auction on contracting decisions using a simple game-theoretic model. Although simple in structure, our model does not have a simple closed-form solution. As a result, we simulated optimal decision-making and market outcomes, for three alternative sets of institutional arrangements:

- Shippers' individual decisions over the extent of long-term contracts decision without the auction;
- The contracting level that maximises social welfare (i.e. the level of contracting that would be delivered by an omniscient and benevolent social planner or a perfectly competitive market, including a liquid secondary market in capacity); and
- Shippers' individual decisions with the auction.

For each simulation, we assume shippers earn a constant revenue from shipping gas (denoted v), the cost of capacity is constant (denoted c), and the distribution of gas demand faced by shippers (denoted F). We then assess the each of the three contracting decisions and compare

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48 The distributional effects for existing investors are not entirely without effect on dynamic efficiency. Investors in new capacity will consider the behaviour of regulators to investors who have already sunk capital when deciding on investment. If investors were to perceive that the risk of ex post intervention to reduce returns by policymakers is high, the hurdle rate for investment would increase, consumers would ultimately pay more for new investment and the market would not serve some marginal demand. In practice, and as discussed in detail below, the existing market structure may promote over-investment and a reduction in the investment signal may be dynamically efficient. In any case, it is far from clear that investors could reasonably consider the introduction of an auction to promote allocative efficiency of CBU capacity to constitute an unreasonable intervention which is outside the usual range of regulatory and commercial risks.

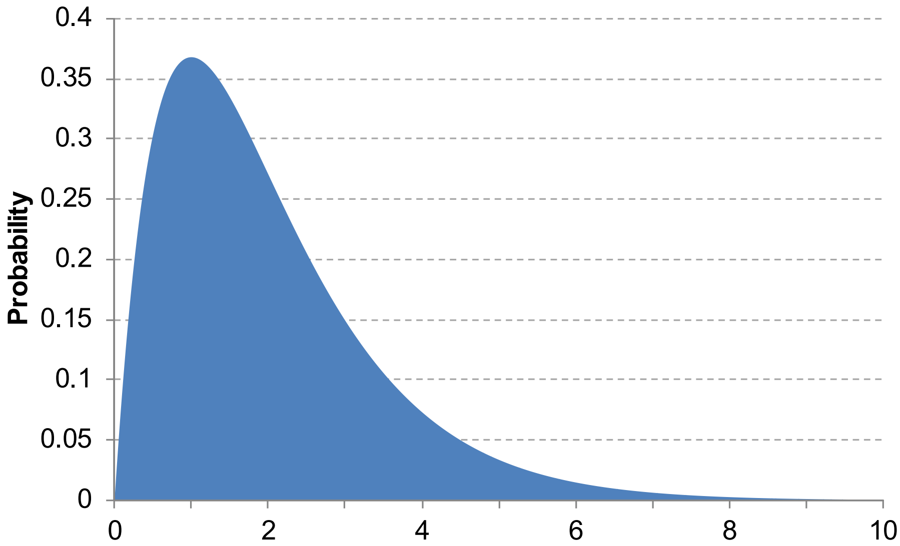
the social welfare achieved. In particular, we compare the social welfare achieved with the auction to the no-auction outcome and the socially optimal result.

We make the following further simplifying assumptions:

- The pipeline capacity built is (only) the capacity contracted (under long-term contracts);
- The market for construction of *new* pipeline capacity is competitive;
- Shippers are risk neutral;
- The auction product is a firm product, i.e. the risk of interruption is zero;
- All auction capacity is available at the reserve price of zero; and
- All shippers face the same distribution of demand *F*.

Our model is ordinal rather than cardinal and as a result the precise units used are unimportant. For the purpose of our simulations we adopted a Gamma distribution with most of the weight of the distribution between 0 and 3, as illustrated in Figure 7.1 below. A gamma distribution has the virtue of, like shipper demand, being weakly positive. Alternatives such as a normal distribution would range between *plus* and *minus* infinity.

Figure 7.1
Assumption on distribution of demand: Gamma (2,1)



Source: NERA analysis.

7.3. Our Results Suggest that Dynamic Efficiency and Social Welfare Will Increase as a Result of the Auction

To ensure that the results are robust, we run multiple simulations varying the shippers' revenue, the cost of capacity, the distribution of demand, and the number of shippers. We present the technical details of the model and results for the variety of scenarios we examined in Appendix C.

The model presented is a stylised example that makes a number of simplifying assumptions. As a result, the relative results of the three scenarios are more meaningful than the absolute amounts, which do not reflect the actual magnitude of capacity traded.

The following results hold in each of the simulations:

1. The level of contracting and capacity in the absence of a day-ahead auction or liquid secondary market is higher than the socially optimal level. This is because under the social optimum, we transfer spare capacity to shippers with excess demand, i.e. shippers may share the risk of individually experiencing high demand for capacity. The overinvestment in capacity in the absence of a liquid secondary market increases with the number of shippers because risk sharing becomes more effective.
2. The equilibrium outcome with the auction is welfare enhancing relative to the outcome with no auction and secondary market. In our model, this will always be the case because a shipper could choose the same amount of capacity after the auction is introduced and be weakly better off. Therefore, by enabling shippers to share risks, the auction enhances overall welfare.
3. The equilibrium outcome with the auction involves some under-contracting relative to the social optimum. This is because the auction introduces an externality: one shipper’s capacity benefits not only itself but other shippers, who may be able to use it if the shipper has spare capacity and they have excess demand. Under the assumption that auction capacity is free and that pipelines not shippers keep the revenues from the resale of their unused capacity, shippers are incentivised to contract somewhat less where they can get capacity from others for free.
4. The level of under-contracting relative to the social optimum is lower than the degree of over-contracting in the status quo in our simulations. Shippers only get capacity from the auction when other shippers do not need it, i.e. they only have a secondary claim, which limits the incentive to free-ride on other shippers’ capacity.

Table 7.1 presents the results of three representative simulations.

Simulation 1 has a ratio of unit revenue (denoted *v)* to unit cost (denoted *c*) of 10. Without the auction, an individual shipper will contract 3. 8 units on average. In the socially optimal solution, on the other hand, shippers would contract only 3. 3 units, given the possibility of transferring capacity between shippers (i.e. risk sharing). When introducing the auction, individual shippers will contract 3 units, on average. This is below the social optimum. However, social welfare (as measured by the sum of the welfare of all shippers) with the auction is 6. 2 per cent higher than when there is no auction.

Simulation 2 is identical, except that the ratio of *v* to *c* is 100 instead of 10. As is intuitive with a higher social value of gas transportation capacity, the level of contracting in each case is higher than under the baseline. In this simulation, shippers would contract 6. 7 units without the auction, whereas in the social optimum shippers would only contract 4. 9. With the auction, shippers would contract 4. 6 units, which is relatively closer to the social optimum and welfare enhancing (+1. 1 per cent) compared to the no auction scenario and very close to the social optimum.

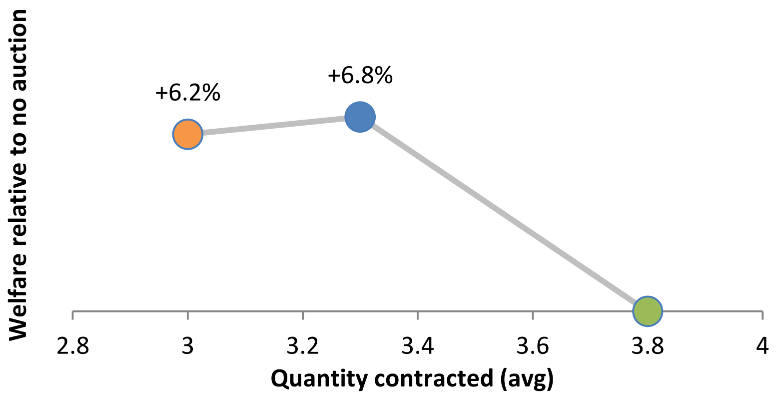
Simulation 3 is like Simulation 1, except that we assume ten shippers instead of two. The level of contracting when there is no auction is the same as under Simulation 1 because the number of shippers does not affect an individual shipper's contracting decision when there is no means of exchanging unused capacity. The socially optimal level of contracting and the level with the auction are significantly lower than under Simulation 1 (2. 6, and 2. 1, respectively). This is because risk sharing becomes more effective with more shippers, and hence each individual shipper requires less capacity. Similarly, the welfare difference between the no-auction outcome and the other outcomes is significantly higher in the simulation with ten shippers. For instance, the welfare increase for the outcome with the auction relative to the outcome without the auction is 12. 0 per cent instead of 6. 2 per cent.

In all three simulations, we find that introducing the auction is welfare enhancing, but leads to some under-contracting relative to the social optimum.

Table 7.1
Simulation shows that de-contracting due to the auction is welfare enhancing relative to no auction

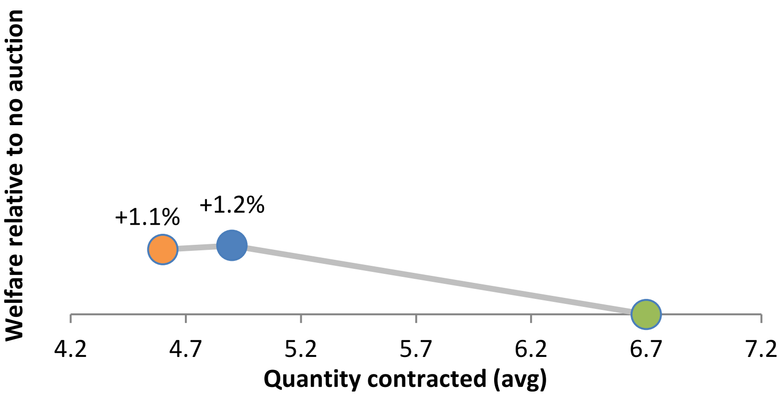
Simulation 1

v = 1, c = 0. 1
F = Gamma(2, 1)
n = 2



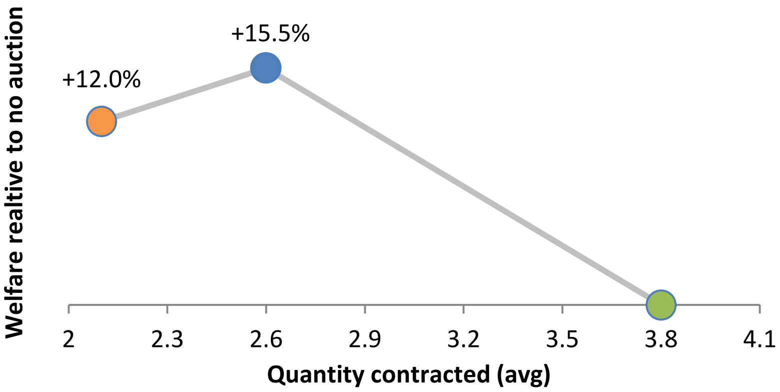
Simulation 2

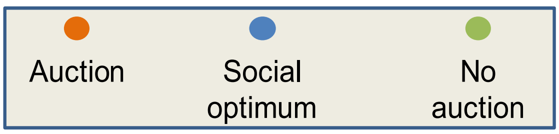
v = 10, *c = 0. 1*
F = Gamma(2, 1)
n = 2



Simulation 3

v = 1, c = 0. 1
F = Gamma(2, 1)
n = 10





7.4. Simplifying Assumptions in Our Model Mostly Overstate De-contracting and Understate the Benefits of the Auction

Our model makes several simplifying assumptions which are likely to overestimate the extent of de-contracting due to the auction and exaggerate the difference between the auction and the social optimum. These assumptions include:

1. We assume capacity is available for free in the auction. In practice, shippers will have to pay a positive price where the auction demand exceeds the auctionable quantity, which reduces the attractiveness of the auction product;
2. We assume that the auction product is firm. In reality, the risk of interruption makes the auction product less attractive, which should reduce de-contracting relative to the model presented;
3. In practice, the cost of having insufficient capacity may be higher than the value of unserved demand. For instance, shippers may face penalties from not meeting contractual obligations and reputational damage, which again reduces the level of de-contracting; and
4. The model does not reflect the possibility that a liquid secondary market emerges after introducing the auction. In section 5.2, we explain that the day-ahead auction may encourage incumbent shippers to sell their capacity on the secondary market, as the auction reduces information asymmetries and market power. If a liquid, competitive secondary market emerged as a result of the day-ahead auction, the outcome with the auction would be closer to the social optimum, as shippers would be able to make welfare-enhancing trades.

Given these assumptions, our results are conservative with respect to de-contracting, i.e. they are likely to overstate the extent to which the auction is going to reduce contracting levels.

On the other hand, the model does not allow us to conclude that introducing the auction will *always* be welfare enhancing relative to the no-auction outcome. For instance, pipeline construction is likely to benefit from economies of scale. Economies of scale create an externality between shippers: one shipper's capacity decision affects other shippers' marginal cost, as marginal cost decreases with the size of the pipeline (in this example, the size of the pipeline is the contracted amount). In theory, this externality of de-contracting could make the auction welfare decreasing relative to the no-auction outcome. In our simulations, we found that this was the case only under extreme levels of economies of scale: specifically in the examples we examined, economies of scale outweighed the benefits of risk sharing on when costs increased in proportion to capacity to inverted one-hundredth power (i.e. $k^{1/100}$). In other words, costs would have to rise by only 3. 5 per cent as capacity doubled at all levels of capacity. For reasonable levels of economies of scale, we found that the benefits of risk sharing routinely outweighed the losses from the externality.

Our model does not reflect shipper market power, if present. In principle, shippers may over-contract to increase their market power in up or downstream markets (see section 5.2). Introducing shipper market power into the model would tend to increase the welfare loss associated with the no-auction scenario, relative to the social optimum. Shipper market power will not affect the socially optimal contracting level. Introducing the auction removes the incentive to hoard capacity, so our estimates of the equilibrium contracting level in the scenario with the auction should not be affected by introducing shipper market power into the

model either. As a result, introducing shipper market power would only increase the relative benefit of the auction relative to the status quo.

7.5. Conclusion on Impact of Day-ahead Auction on Dynamic Efficiency and New Pipelines

Overall, the simulation results show that the availability of short-term capacity through day-ahead auctions can increase dynamic efficiency as introducing the auction is likely to prevent inefficient overbuilding. As a result, there is no reason to exempt new pipelines from the day-ahead auction based on efficiency considerations. In fact, exempting new pipelines is likely to reduce dynamic efficiency.

8. Conclusion and Implications for Coverage

To help inform the GMRG's final recommendations to the Energy Council on the design of the day-ahead auction, it has retained NERA to provide expert advice on the coverage of the auction (i.e. which pipelines should be subject to the auction). We have assessed the expected impact of the proposed auction design on the primary and secondary capacity markets, focusing on allocative and dynamic efficiency. On the basis of our findings, we make recommendations on coverage options for the auction.

8.1. The Proposed Auction Design is Likely to Increase Allocative and Dynamic Efficiency

Allocative efficiency is the property that capacity is available to and used by the shippers that value it most on any given day. The AEMC proposed the day-ahead auction principally with the objective of promoting allocative efficiency. Provided that at least some additional capacity changes hands (from those that value it less to those that value it more), introducing a day-ahead auction for CBU capacity will increase allocative efficiency.

The allocative efficiency benefits of the auction differ according to the degree of physical congestion on the pipeline. On physically-congested pipelines, no new capacity will become available as a result of the auction and therefore there will be no allocative efficiency gains. In contrast, the auction can be expected to result in allocative efficiency gains on pipelines that are not physically congested, although it is not possible to determine a priori whether the allocative efficiency gains will be higher or lower on pipelines with contractual congestion relative to those without.

Dynamic efficiency is the property that the market constructs the efficient level of capacity over the long term. Except for the closure of pipelines, dynamic efficiency is principally a consideration for new capacity. By offering an alternative method of obtaining capacity (at potentially zero cost), the auction could, in principle, discourage shippers from buying as much capacity under long-term contracts as they do under the status quo and reduce the signal for investment. In practice, as described below, the auction product is unlikely to be a close substitute for long term capacity in the primary market, and hence the level of "de-contracting" (i.e. exiting or not renewing some or all long term contracts) may be small.

In any case, de-contracting need not decrease dynamic inefficiency. In fact, given the AEMC's finding that prices of short term capacity tend to be inflated and secondary markets are illiquid under the status quo, shippers have an incentive to over-contract through long-term contracts to protect themselves against the risk of interruption. Depending on the level of physical and contractual congestion, introducing the auction on any given pipeline enables shippers to pool risk and reduce their contracting from inefficiently high levels.

We constructed a simplified game-theoretic model of capacity contracting and investment decisions for new pipelines. Our simulations suggest that social welfare (and hence dynamic efficiency) increases following the introduction of the auction to all pipelines relative to the

status quo, but remains lower than the social optimum.[49] Shippers under-contract after the introduction of the auction because they free ride for some of their demand on the unused capacity of others. However, the benefit of risk sharing and reduced over-contracting exceeds the costs of under-contracting that accompanies the auction. If a liquid secondary market develops after the introduction of the auction, the welfare gains relative to the status quo would be even larger.

8.2. De-contracting in the Primary Market Will Be Limited by Imperfect Substitution

By making all CBU capacity available through a market-based mechanism, the day-ahead auction for CBU capacity removes the market power that the pipeline owner may have in pricing as available and interruptible products. The auction's reserve price of zero will also put material downward pressure on prices of or replace sales of non-firm capacity products.

The precise effect of the proposed auction design on contracting levels and pipeline revenues will depend on the degree of congestion. The auction is unlikely to result in de-contracting on physically congested pipelines, because the auction will not make capacity available. On physically uncongested pipelines, a more material reduction in contracting levels and pipeline revenue is more likely where there is routinely excess supply in the auction and therefore auction prices are low.

It is important to note though that shippers cannot (collectively) fully de-contract from long term contracts under the proposed auction design because the only capacity available through the auction will be capacity that shippers have purchased under long term contracts. In any case, individual shippers are unlikely to want to de-contract fully under the proposed auction design because the primary market offers greater certainty about availability and price, a less frequently interrupted product and a range of duration options.

8.3. The Auction Design Provides Potential Stimulus for Secondary Market Trading

On the one hand, shippers may rely on the auction which could undermine the secondary market. On the other hand, the day-ahead auction may incentivise shippers to trade on the secondary market by reducing incentives to hoard capacity and by providing a transparent price signal for the value of capacity.

From the perspective of increasing allocative efficiency, it does not matter whether shippers obtain capacity through the secondary market or the auction. In any case, the proposed auction design is likely to increase secondary market trading because:

- Shippers are unlikely to perceive the auction product as a perfect substitute for firm capacity, as the latter provides a superior quality product (in terms of priority of

[49] Only where we adopt extreme assumptions about economies of scale (costs increase with the hundredth root of capacity and doubling capacity increases costs by only 0.7 per cent), social welfare falls with the auction relative to the status quo.

scheduling, curtailment and re-nomination rights), greater certainty about the available quantity and the price of capacity and is available for longer than one day-ahead;

- The proposed product, "second-priority firm", is second only to firm capacity, and may be attractive enough to shippers to encourage participation in the auction; and
- By requiring auction quantities and clearing prices to be published, the proposed auction design is likely to reduce information asymmetry and increase transparency.

8.4. Implications for Coverage

Before introducing the auction, a decision must be made about the coverage of the auction (i.e. whether all or only some pipelines should be subject to day-ahead capacity auction).

One of the AEMC's suggested outcomes[50] for the auction was that pipelines that are not contractually congested could be exempted on a case-by-case basis. In doing so, it noted that the key rationale for introducing the auction is to address contractual congestion and to address the market power held by pipeline owners in the market for day-ahead capacity and that this rationale may not be present in pipelines which are less than fully contracted.[51] The AEMC did, however, acknowledge that given the system-wide auction design and the gaming incentives of the pipeline owner, it may be preferable not to exempt pipelines.

In our view, when deciding on coverage, consideration should be given to:

- The expected efficiency effects for individual pipelines (as analysed in chapter 6);
- The efficiency implications of the proposed combinatorial auction design;
- The pipeline owner's incentive to engage in a coverage game; and
- The forecasts of future contracting levels.

We address each of these points below.

8.4.1. Expected efficiency effects for individual pipeline segments

From the perspective of an individual pipeline, we have shown that material allocative efficiency gains can only be achieved in physically uncongested pipelines (see chapter 6). However, it is unclear a priori if allocative efficiency benefits are greater in physically uncongested pipelines with or without contractual congestion. The allocative efficiency benefits will be greater wherever the collective willingness to pay of shippers for CBU capacity is greater. In current market conditions, we cannot accurately observe this unserved demand. As a result, there is no clear-cut justification for exempting contractually uncongested pipelines for allocative efficiency reasons.

For similar reasons, also detailed in chapter 6, it is unclear whether the auction will decrease pipeline revenues more or less on contractually congested or contractually uncongested

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[50] The AEMC categorised a number of its recommendations as 'suggested outcomes'. This categorisation was used when the AEMC thought the proposal had in-principle benefits but required further consideration by the GMRG.

[51] AEMC, Stage 2 Final Report, East Coast Wholesale Gas Markets and Pipeline Frameworks Review, 23 May 2016, p 83.

pipelines. The revenues earned by existing pipelines are, in principle, irrelevant for the purpose of assessing dynamic efficiency, which is concerned with the efficiency of new investment. In practice, however, policymakers may be concerned that revising the market design to reduce long term contracting after pipeline companies have made investments on the back of those contracts may undermine investment signals in future.

It is unclear why a concern about the revenue adequacy of pipelines should result in the exemption of contractually uncongested pipelines in particular. Contractually uncongested pipelines could, for example, be more written down than most pipelines and their original contracts that supported the original investment may have expired. On the other hand, contractually uncongested pipelines may be engaging in monopoly pricing and be more commercially successful than some contractually congested pipelines. At best, contractual congestion is an imperfect metric for pipelines that are unable to recover their costs. Only if de-contracting were a particularly salient concern for contractually uncongested pipelines (for reasons that are not clear), could dynamic efficiency provide a rationale for exempting such pipelines from the auction.

A dichotomy between new and existing pipelines provides an alternative dichotomy in the obligation to offer capacity through the auction. Long-term contracts have supported most new investments in gas capacity in Australia (outside of Victoria) in the last twenty years. Offering new pipelines an exemption from the auction would secure the business model of building pipelines based on long term contracts. To do so, however, would be at the expense of dynamic efficiency.

As we demonstrated in Chapter 7, shippers have a systematic tendency to over-contract in the absence of a liquid market for secondary capacity.[52] Unless such a market emerges, imposing the auction on new capacity is very likely to increase efficiency by reducing wasteful over-contracting and ensuring that new investments are of the socially-efficient scale.

8.4.2. Expected efficiency effects given combinatorial auction design

The choice of coverage should also take into account the proposed auction design, which will affect the efficiency of different coverage options. The GMRG has proposed a combinatorial auction design and pro-rata curtailment in case of interruption, where shippers are given a choice between being curtailed on only the interrupted segment or on their entire route.

Given this design, exempting pipelines from the auction may increase rather than reduce overall costs. In particular, where shippers bid for capacity on an entire route rather than on individual segments, not offering an auction on some of the pipelines may undermine the realisation of potential efficiency gains. If shippers are not able to get capacity on certain segments of their route at a reasonable price despite there being un-nominated capacity (e.g. on contractually uncongested pipelines not subject to the auction), they will have less incentive to bid in the auction. This would weaken the auction product in its role as a

52 Our simulations are based on a model where shippers make contracting decisions, and pipeline capacity will be built to the extent that shippers decide to contract. We find that the auction is likely to reduce contracting, but that this reduction is welfare enhancing relative to the status quo.

substitute for primary capacity, which may in turn decrease incentives for firm capacity holders to trade on the secondary market, as we explained in chapter 4.

The extent of this problem depends on whether in practice, shippers participate in the auction to buy capacity for routes or for individual segments. It will not be a major concern where shippers tend to bid for individual segments only.

8.4.3. A universal obligation reduces gaming risks

Where the auction obligation is not universal, pipeline owners may engage in a "coverage game" (i.e. gaming the coverage criteria in order to avoid the obligation of introducing day-ahead auctions).

It is unclear whether the pipeline owner has an incentive to engage in the coverage game in the Australian context. On the one hand, the pipeline owner will keep any positive revenues from the auction and therefore may want to participate. On the other hand, pipeline owners could choose to auction its own capacity with a reserve price of zero and they have not chosen to, which suggests that doing so would reduce their revenues (unless the aggregation benefit of a combinatorial auction were substantial). Even if participating in the auction were profit-maximising in the short term, the auction may also lead to a less secure revenue stream for the pipeline owner, if firm capacity holders decide to de-contract. Moreover, auction sales may reduce short-term products that the pipeline owner is currently selling at prices in excess of what would prevail in a workably competitive market. Overall, there is a risk that the pipeline owner will engage in the "coverage game" where it considers its cost from the auction to be larger than any additional revenue it expects to earn.

This gaming strategy could be prevented by introducing the auction on all pipelines. When evaluating different coverage options, the expected efficiency losses due to the "coverage game" should be weighed against the cost savings from only including pipelines where there are material expected efficiency benefits.

In theory, coverage does not have to be based on contracting levels, but could instead be decided based on qualitative criteria. Quantitative cut-offs (such as "X% of nameplate capacity contracted") may be easier to game. Qualitative criteria are no panacea and can be gamed as well. They are also more open to challenge. As a result, the cost of implementing qualitative criteria, including detailed scrutiny and preparation for appeal, could be considerably higher than the cost of setting a numerical cut-off.

8.4.4. Expected efficiency effects given combinatorial auction design

When considering exempting pipelines from the auction based on their degree of contractual congestion, one should also examine how many pipelines are likely to be exempted under such a rule. If this number is small, the efficiency savings may not justify the costs related to combinatorial bidding and monitoring the degree of contractual congestion.

As we have shown in Table 2.3, contracting levels are forecast to increase in the next 12 months. Specifically, the data provided by pipeline operators on the 12 month forecast of

uncontracted capacity indicates that all but one of the reported transmission pipelines will be contractually congested over this period, if we define contractual congestion as having an expected percentage of contracting of above 90 per cent in at least one flow direction.[53] Under the most restrictive definition of contractual congestion (i.e. 100 per cent), we expect that about half of the pipelines to be contractually congested.

Given the ongoing structural changes in the eastern Australian market, the degree of contractual congestion may change frequently even under the most restrictive numerical cut-off. This would be an even larger challenge with qualitative coverage criteria. Overall, given the forecast data on contracting levels, there may not be a strong rationale for exempting contractually uncongested pipelines from the auction.

8.4.5. Conclusion on coverage

In summary, we do not expect material efficiency benefits from including physically congested pipelines in the auction. For physically congested pipelines the aggregation benefit of the auction is limited because bidders relying on physically congested capacity are unlikely to win material volumes of capacity through the CBU auction. With regard to the degree of contractual congestion, we note that from the perspective of individual pipelines, there is no clear efficiency reason to exempt contractually uncongested pipelines.

However, given the combinatorial auction design and the pipeline owner's incentives to engage in a coverage game, exempting any type of pipeline may undermine efficiency where shippers frequently bid for routes rather than individual segments. Moreover, forecast data on contracting levels suggests that any efficiency gains or cost savings from exempting pipelines may be small. On this basis, it may be appropriate to start with universal coverage (or coverage of all the major transmission pipelines).

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53 Our measure of contractual congestion is: forecast amount contracted/nameplate capacity (monthly data from AEMO's *Natural Gas Services Bulletin Board*).

Appendix A. Overview of Eastern Australian Pipelines

A.1. List of Pipelines

Pipeline code	Pipeline name
APLNG	APLNG Pipeline
BWP	Berwyndale to Wallumbilla Pipeline
CGP	Carpentaria Gas Pipeline
CRWP	Comet Ridge to Wallumbilla Pipeline
DDP	Darling Downs Pipeline
EGP	Eastern Gas Pipeline
GLNG	GLNG Gas Transmission Pipeline
LMP	Longford to Melbourne Pipeline
MAPS	Moomba to Adelaide Pipeline
MSPS	Moomba to Sydney Pipeline
QGP	Queensland Gas Pipeline
RBP	Roma Brisbane Pipeline
SEA Gas	SEA Gas Pipeline
SWP	South West Pipeline
SWQP	South West Queensland Pipeline
SGP	Spring Gully Pipeline
SWP	South West Pipeline
TGP	Tasmania Gas Pipeline
WGP	Wallumbilla to Gladstone Gas Pipeline

Source: AEMO, Natural Gas Services Bulletin Board, http://gasbb.com.au/, accessed 27 September 2017

Appendix B. Market Failures Motivate Long-Term Contracts

This appendix provides more details on the special economic features of gas capacity markets. It proceeds as follows:

- Section B.1 explains that the volatile value of gas capacity creates a role for long-term contracts to promote dynamic efficiency;
- Section B.2 explains that gas pipelines may be natural monopolies and have the incentive and ability to misuse their market power, but for regulatory intervention or long term contracts; and
- Section B.3 explains that transactions costs and the hold-up problem may inhibit investment and dynamic efficiency but the presence of long term contracts may limit these effects.

B.1. The “All or Nothing” Problem and Financial Market Imperfections

Early nineteenth century economists noted that as the value of agricultural produce rose or fell, so the value of the scarce land required to produce it rose and fell. As the owners of a scarce factor of production, Landholders benefitted from rising agricultural prices. The payment to Landholders resulting from the scarcity of that land came to be known amongst economists as “Ricardian rent”.[54]

Gas pipelines have many of the features that land has in the agricultural sector. Pipelines have high up-front investment costs (albeit not necessarily as large as reclaiming land), relatively low fixed operating costs and very low marginal costs of providing capacity.[55] Demand for capacity is derived from demand for gas in much the same way that demand for land is derived from demand for food. Gas and transportation capacity faces inelastic demand rather like food, at least for 19th century consumers.

Gas pipelines differ from land in ways that increase the Ricardian rent. Gas demand can be volatile because of the nature of some end-use demand (e.g. electricity generation and domestic heating). Pipelines are a necessary input for the transport of gas at least in the short run. As a result, the short term social value of capacity and therefore the short-term price of capacity in a perfectly competitive market fluctuates between nothing and the (potentially very high) Value of Lost Load to the marginal shipper.

Figure B.1 illustrates this principle. This figure shows short term equilibrium prices and quantities of gas shipped for two states of pipeline demand. In the low demand state, there is

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54 The idea that scarcity is what leads to positive rents was put forward as early as 1809, when David Ricardo stated, in the context of land, as rent is “that portion of the produce of the earth which is paid to the landlord for the original and indestructible powers of the soil.” Ricardo presented a famous example where the use of land is initially free, but as demand grows, less productive types of land have to be used to produce food, which leads to positive rents for superior land. He defines the economic rent as the surplus which arises on the superior units of land relative to the inferior units. In his theory, Ricardo emphasised that rent is a reward for the services of land which is fixed in supply. David Ricardo (1809), “On the Principles of Political Economy and Taxation”, Chapter 11 ‘On Rent’.

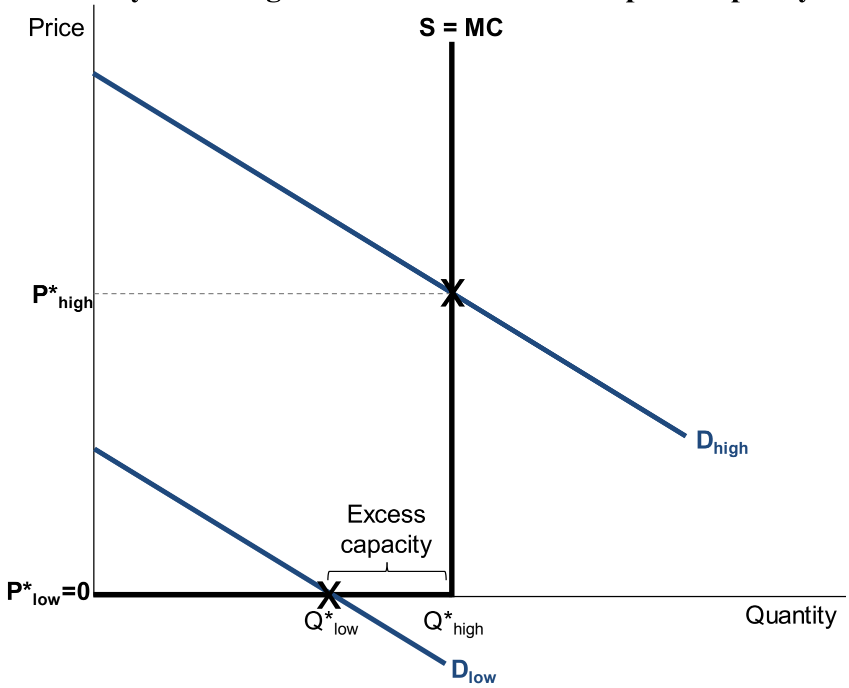
55 Ofgem, for example, allocates 85 per cent of totex spend to “slow money”, originally intended to reflect the proportion of long-term investment costs in network businesses in GB.

excess capacity, shippers transport quantity Q_{low} and the price of capacity would be zero. In the high demand state, demand exceeds capacity, capacity is fully utilised and the (potentially very high) marginal value of gas to the shipper sets the price. As a result, depending on whether there is excess capacity or not, the pipeline will earn nothing or a (potentially very high) positive amount.

In principle, in a perfectly competitive market, it would be possible to finance a pipeline based on this stream of unpredictable and/or volatile returns. In practice, capital market imperfections would make financing an investment impossible. If a pipeline company in a perfectly competitive market built capacity anticipating demand and relying purely on short-term contracts, unless that demand materialised to the extent that capacity on that pipeline was scarce, it would never realise any revenues on its investment. Given the asymmetries of information between pipeline companies and potential providers finance and the excess costs of financial distress that could ensue, such a business proposition would not be practical.

In these circumstances, long-term contracts promote *dynamic* efficiency by facilitating investment and allocating risk between shippers and pipeline owners.

Figure B.1
If the Gas Transport Market were Perfectly Competitive, the Equilibrium Price Would be Set by the Marginal Benefit of Gas Transport Capacity



Source: NERA.

B.2. Gas Pipelines Can be Natural Monopolies

The cost structure of pipelines does not itself promote deep and liquid competition. Transporting gas requires large up-front investments which are often specific to upstream

sources or downstream customers. As a result, and in common with many network businesses, pipelines may constitute natural monopolies (a concept often attributed to John Stuart Mill).[56]

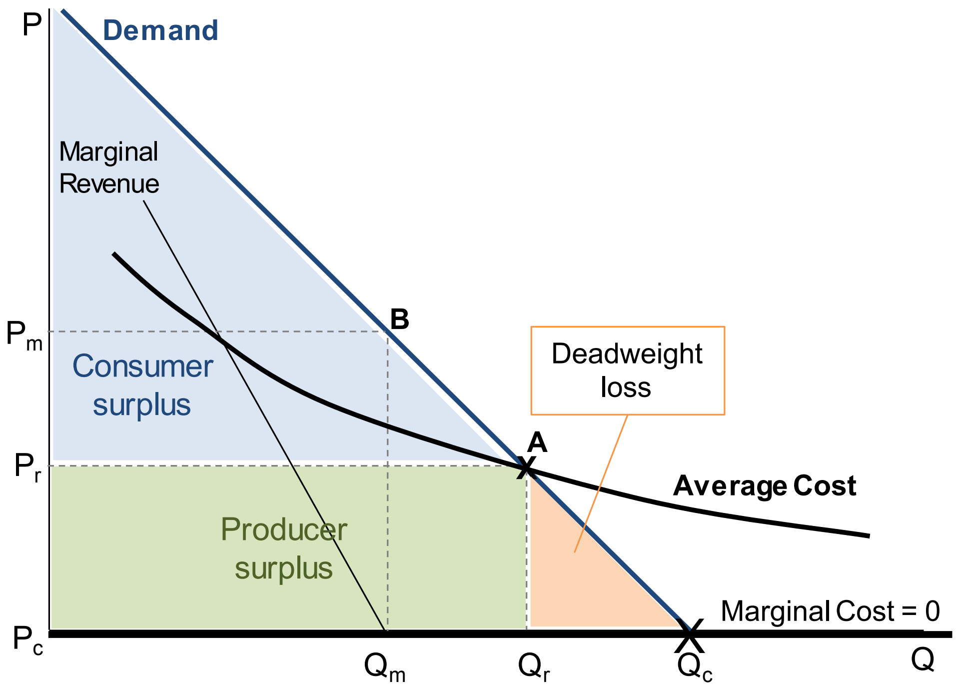
Figure B.2 illustrates the cost structure of a natural monopoly, without a capacity constraint. In line with the neoclassical argument, average cost declines throughout the entire range of output for a natural monopoly. Allocative efficiency is maximised where the pipeline owner provides the competitive output (Q_c), i.e. the amount where demand is equals to marginal cost. In the case of pipelines, the marginal cost is close to zero and hence P_c would be zero where demand is unconstrained. Q_c is the welfare maximising quantity, with all the surplus going to the shipper.

However, at that output, the equilibrium price is below the pipeline's average cost, and the pipeline will not recover its upfront investment cost and hence require tax-financed or other subsidies to survive. To recover its cost, the pipeline owner would have to set the price of transport capacity at or above its average cost, which reflects both the up-front investment and the marginal production cost. In line with this theory, regulators would generally require the pipeline owner to provide an amount of capacity Q_r at price P_r. This outcome is not allocatively efficient in the competitive sense, as there is unmet demand at a marginal cost of zero. However, it gives the producer a positive surplus and allows it to recover its up-front investment cost. The previous consumer surplus is reduced by a) the increase in the producer surplus, and b) by a deadweight loss, i.e. loss in overall welfare (see triangle A-Q_r-Q_c).

Without prior commitments through long-term contracts or regulatory intervention, a pipeline owner setting a single price for its services would produce the profit-maximising quantity, i.e. the quantity at which its marginal cost equals its marginal revenue (Q_m at P_m). This is illustrated in Figure B.3. Selling this quantity is even less allocatively efficient, as there is even more unmet demand at a marginal cost of zero. The producer surplus increases at the expense of the consumer surplus, and the deadweight loss increases as well (triangle B-Q_m-Q_c). This shows that pipeline owners can earn monopoly profits by offering less than the physical capacity, and thereby preventing shippers from obtaining additional capacity although they would value it at or above its marginal cost, as illustrated in Figure B.3.

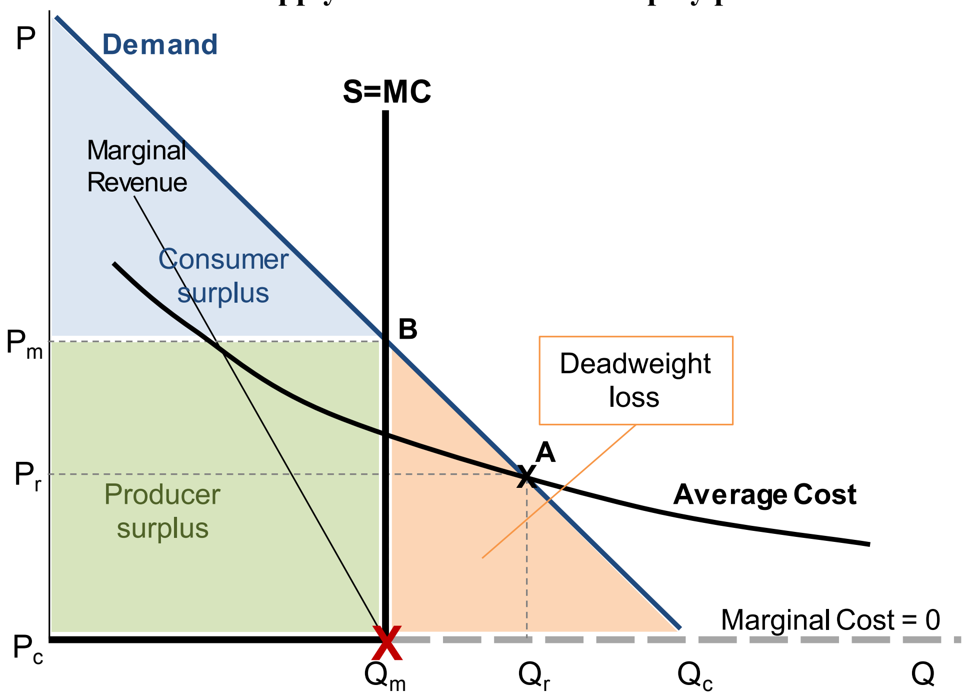
[56] John Stuart Mill (1848), Principles of Political Economy, Book IV 'Influence of the progress of society on production and distribution', Chapter 2 'Influence of the Progress of Industry and Population on Values and Prices', para. 2.

Figure B.2
Given their cost structure, pipeline owners can only recover up-front costs if the price covers at least average cost



Source: NERA.

Figure B.3
Given the cost structure of a natural monopoly, pipeline owners have an incentive to restrict supply in order to earn monopoly profits



Source: NERA.

B.3. Shipper Oligopsony and the Hold-Up Problem

In the same way that pipelines may exert market power over shippers, shippers may have market power as pipeline owners usually depend on a few potential shippers for recovering their investment (i.e. a "natural oligopsony").[57] This natural oligopsony structure may allow shippers to take advantage of the committed capital to extract price concessions that limit the pipeline owner's profitability either through collective bargaining or by intervening through a collective regulatory process.[58]

The hold-up problem may be still worse in cases where the pipeline company makes relationship-specific investments.[59] Asset specificity comes with a high risk of opportunistic holdup, as both sellers and buyers may use their market power to compel the other party to make concessions.[60]

The fact that both pipeline owners and shippers have market power leads to a dilemma for pipeline investment. Both parties may want the pipeline, but neither party is willing to make unilateral up-front commitments as they know that once the pipeline has been built, the other side has an incentive to exploit its market power. Given asset specificity, shippers and pipeline owners need to build reliable commercial relationships before pipelines are built. This is because transaction costs of negotiating spot agreements could be very high where there is a bilateral hold-up problem.

As a result, shippers and pipeline owners have traditionally entered into long-term, up-front agreements ("long-term contracts"). Under long-term contracts, shippers commit to buying a certain amount of capacity upfront at a specific price, and in exchange the pipeline owner commits to make this capacity available to the shipper. This mutual commitment facilitates investment and is dynamically efficient. It is worth noting though that if the length of the contracts does not align with the life of the shipper's assets or the pipeline, then the hold-up problem can still arise.

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57 See for example Roger G. Noll (2005), *"Buyer Power" and Economic Policy*, 72 Antitrust Law Journal No. 2 (2005).

58 In general, a small number of customers tend to be more effective at achieving common objectives than a large number of customers. In 1965, Mancur Olson found that the larger a group becomes the less incentive any individual member has to spend any time or money pursuing common objectives, a phenomenon often discussed in the context of "collective action". Based on this theory, small groups of shippers (e.g. power plant owners, gas distributors) are likely to be more effective in pressing their interests, such as lower prices, than large groups (e.g. millions of gas consumers). Mancur Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups* (Cambridge, MA: Harvard University Press, 1965).

59 Williamson (1980) introduced asset specificity, i.e. the concept that certain assets require large up-front investments and once these investments have been made, they are sunk and dedicated to very specific business relationships

60 In 1983, Williamson presented a general model of asset specificity, for which he assumed unilateral hold-up from the buyer's side. Later research has recognised that asset specificity can be bilateral as buyers face switching costs (see Joskow (1988) and Klein (1988)). This is particularly true for pipelines, where pipeline owners tend to be natural monopolists, leaving shippers with no or few alternative transport options. Oliver E. Williamson (1983), *Credible Commitments: Using Hostages to Support Exchange*, American Economic Review, pp. 519–38. P. L. Joskow (1988), *Asset Specificity and the Structure of Vertical Relationships: Empirical Evidence*, Journal of Law, Economics and Organization (4), pp. 95–117. B. Klein (1988), *Vertical Integration as Organizational Ownership: The Fisher Body - General Motors Relationship Revisited*, The Journal of Law, Economics and Organization, pp. 199–213.

Appendix C. Details on Simulation of Contracting Decisions

In this appendix, we provide the technical details of the model used for the simulations of contracting decisions, as presented in chapter 7.

C.1. Model Setup

C.1.1. Shippers' optimal contracting level without the auction

First, consider the contracting decision faced by a single shipper without the auction. We assume that at time 0, the shipper can buy long-term capacity k from a pipeline operator at a unit cost of c. At time 1, the shipper has demand for capacity of x, where x is drawn from some distribution F on $[0, \infty)$. The shipper earns v from each unit of demand for which it has capacity. Assuming risk neutrality, the shipper's payoffs are:

$$u(x) = \begin{cases} vx - ck & \text{if } x \leq k \\ vk - ck & \text{if } x > k. \end{cases}$$

Note that we assume that the investment amount is equal to the contracted amount, i.e. the pipeline investor does not build more capacity than is contracted.

C.1.2. Socially optimal contracting level with transfers

Second, we consider the socially optimal solution. If shippers are risk neutral, the social welfare is the sum of the individual shippers' payoffs. If capacity can be transferred between shippers, the social optimum will result from the same optimisation problem as individual shippers, but based on total capacity $K = k_1 + k_2$ and total demand $X = x_1 + x_2$:

$$W(X) = \begin{cases} vX - cK & \text{if } X \leq K \\ vK - cK & \text{if } X > K. \end{cases}$$

Note that it is reasonable to assume that social welfare is equal to the sum of shippers' payoffs if v adequately captures society's value for gas transportation.

C.1.3. Shippers' optimal contracting level with the auction

Finally, consider the contracting decision faced by shippers when the auction is introduced. For the sake of simplicity, we present the model assuming only two shippers. At time 0, Shipper 1 can buy long-term capacity k_1 and Shipper 2 can buy long-term capacity k_2. At time 1, the shippers face demand x_1 and x_2, respectively, where x_1 and x_2 are independent and both have distribution F on $[0, \infty)$.

Any capacity that is not required by one shipper can be transferred via the auction. So if Shipper 1 has excess demand but Shipper 2 has spare capacity, Shipper 1 can meet some or all of its remaining demand by using Shipper 2's spare capacity. We assume that the auction always clears at the reserve price, i.e. excess capacity is provided free of charge.

As above, we assume risk neutrality. Shipper 1's payoff function is:

$$u_1(x_1, x_2) = \begin{cases} vx_1 - ck_1 & \text{if } x_1 \leq k_1 \\ vk_1 - ck_1 + vMAX\big[MIN\big((x_1 - k_1), (k_2 - x_2)\big), 0\big] & \text{if } x_1 > k_1. \end{cases}$$

Shipper 2's payoff function is:

$$u_2(x_1, x_2) = \begin{cases} vx_2 - ck_2 & \text{if } x_2 \leq k_2 \\ vk_2 - ck_2 + vMAX\big[MIN\big((x_2 - k_2), (k_1 - x_1)\big), 0\big] & \text{if } x_2 > k_2. \end{cases}$$

We consider symmetric equilibria of the above game, using simulations to calculate the shippers' best-response functions and the resulting equilibrium.

We also look at the case with more than two shippers, using a straightforward extension of the model. With more than two shippers, we assume that the auction clears at the reserve price when there is total excess capacity and at price *v* when there is total excess demand.

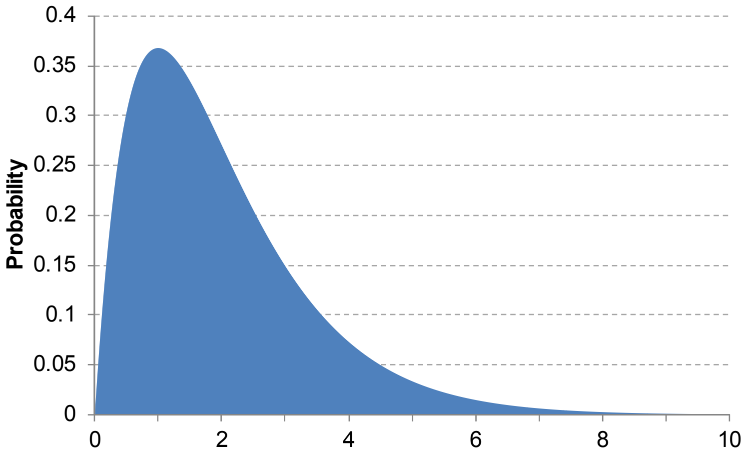
C.2. Simulation of Contracting Decisions – Robustness Checks

In this section we present robustness checks for the simulation results in chapter 7. We present the results of additional simulations, first varying the distribution of demand F, then varying the ratio of the value of gas *v* to the cost of capacity *c*, and finally varying the number of shippers.

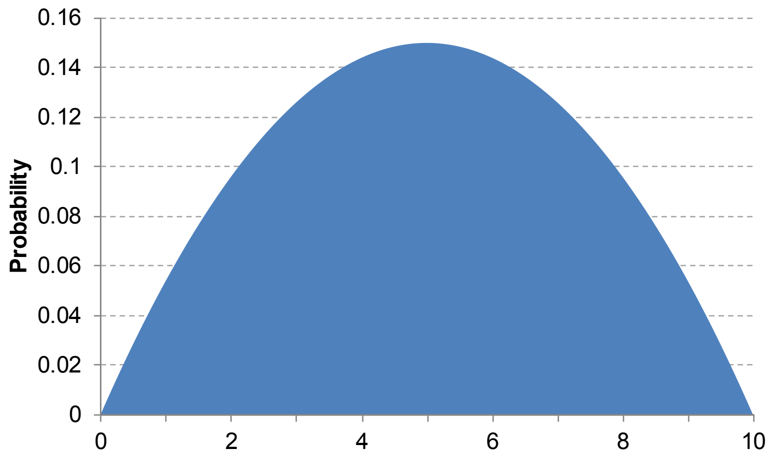
First, we run the simulation using different assumptions on the distribution of demand (F). The first simulation uses a Gamma distribution on $[0, \infty)$ with most of the weight of the distribution between 0 and 3, resulting in relatively low contracting in each of the settings. The second simulation uses a symmetric Beta distribution on [0, 10], which yields relatively high contracting. Finally, the third simulation uses skewed Beta distribution with most of the weight between 1 and 5, which yields an intermediate level of contracting.

Figure C.1 illustrates the three assumptions for the distribution of demand: Gamma (2,1), Beta (2,2), and Beta (2,5).

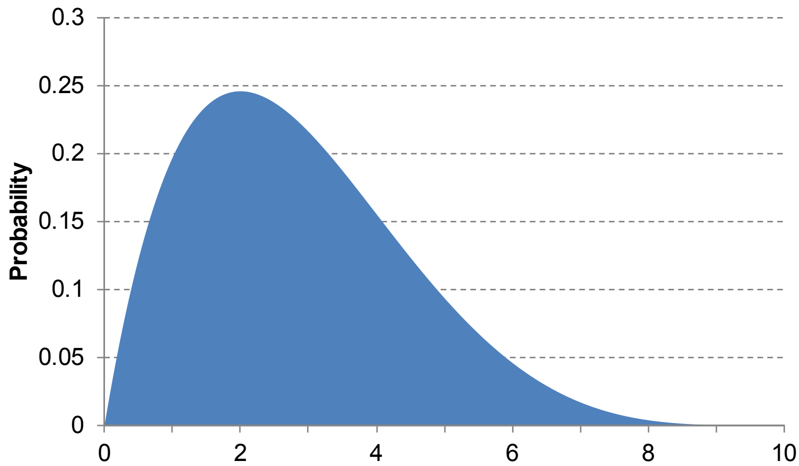
Figure C.1
Robustness checks using different distributions of demand
Gamma (2, 1)



Beta(2, 2)



Beta(2, 5)



Source: NERA analysis.

Table C.1 presents results for these simulations. Under all three distributions, we find that introducing the auction is welfare enhancing, but leads to some under-contracting relative to the social optimum.

Table C.1
Robustness to distribution of demand

		No auction	Social optimum	Equilibrium with auction
Simulation 1 *F = Gamma(2, 1)*	Quantity contracted (avg.)	3. 8	3. 3	3
	Welfare Δ relative to no auction		+6. 8%	+6. 2%
Simulation 2 *F = Beta(2, 2) on [0, 10]*	Quantity contracted (avg.)	8	6. 9	6. 8
	Welfare Δ relative to no auction		+2. 7%	+2. 2%
Simulation 3 *F = Beta(2, 5) on [0, 10]*	Quantity contracted (avg.)	5	4. 4	4. 1
	Welfare Δ relative to no auction		+4. 3%	+3. 8%

Source: NERA analysis. Assumptions: v = 1, c = 0. 1, number of shippers = 2.

Table C.2 presents results for simulations with different ratios of value to cost (*v/c*). Note that the simulations are done by varying *v*, but this is tantamount to varying *v/c*, since the shippers' payoff functions are invariant to scale transformations. As is intuitive, the level of contracting in each setting is increasing in the ratio.

Again, under all three assumptions for *v/c*, we find that introducing the auction is welfare enhancing, but leads to some under-contracting relative to the social optimum.

Table C.2
Robustness to ratio of value of gas to cost of capacity (*v/c*)

		No auction	Social optimum	Equilibrium with auction
Simulation 1 *v = 1, c = 0. 1*	Quantity contracted (avg.)	3. 8	3. 3	3
	Welfare Δ relative to no auction		+6. 8%	+6. 2%
Simulation 2 *v = 10, c = 0. 1*	Quantity contracted (avg.)	6. 7	4. 9	4. 6
	Welfare Δ relative to no auction		+1. 18%	+1. 11%
Simulation 3 *v = 0. 5, c = 0. 1*	Quantity contracted (avg.)	3	2. 8	2. 4
	Welfare Δ relative to no auction		+11. 9%	+10. 5%

Source: NERA analysis. Assumptions: F = Gamma(2, 1), number of shippers = 2.

Table C.3 presents results for simulations with different numbers of shippers. In each simulation, the level of contracting when there is no auction is the same. This is intuitive since the number of bidders does not affect an individual shipper's contracting decision when there is no auction. Another point worth noting is that the welfare difference between the no-auction outcome and the socially optimal outcome is high when there are more than two shippers. This is because the benefits of risk sharing increase with the number of shippers.

As for the previous checks, we find that our result is robust: under all three assumptions for the number of shippers, we find that introducing the auction is welfare enhancing, but leads to some under-contracting relative to the social optimum.

Table C.3
Robustness to number of shippers

		No auction	Social optimum	Equilibrium with auction
Simulation 1 *Number of bidders = 2*	Quantity contracted (avg.)	3. 8	3. 3	3
	Welfare Δ relative to no auction		+6. 8%	+6. 2%
Simulation 2 *Number of bidders = 5*	Quantity contracted (avg.)	3. 8	2. 6	2. 1
	Welfare Δ relative to no auction		+13. 9%	+11. 4%
Simulation 3 *Number of bidders = 10*	Quantity contracted (avg.)	3. 8	2. 6	2. 1
	Welfare Δ relative to no auction		+15. 5%	+12. 0%

Source: NERA analysis. Assumptions: F = Gamma(2, 1), v = 1, c = 0. 1.

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