



# IMPROVING THE EFFICIENCY OF AUSTRALIAN COAL CHAINS

## ECONOMIC PRINCIPLES AND PERSPECTIVES

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### OVERVIEW

In 2007, significant vessel queues waiting to load coal at Australia's largest coal export port in Newcastle became the most visible reference point in an ongoing public debate about the capacity of Australia's export infrastructure. Those queues were symptomatic of capacity constraints affecting all major Australian coal chains, imposing substantial direct and indirect costs.

In his 2007 'Goonyella Coal Chain Capacity Review', undertaken on behalf of the Queensland Government, Mr Stephen O'Donnell estimated approximately A\$1.2 billion per year was being lost in foregone revenues and demurrage costs from that coal chain alone, resulting principally from a mismatch between port and rail system capacities and operational inefficiencies through the coal chain.<sup>1</sup> These estimates are consistent with those made in other assessments, all of which highlight large losses to Australia's GDP. The importance of alleviating infrastructure constraints – and specifically those experienced in the Hunter Valley coal chain – has been raised publicly by foreign governments, including China's ambassador to Australia.<sup>2</sup>

These losses reflect difficulties with the management of capacity in Australia's coal chains. Understanding the economic factors that cause these difficulties, and advancing principles that can help address them, is the purpose of this Report. The proposals made in this Report are intended to build on existing initiatives for coal chain coordination, rather than being a new template. Significant progress in increasing coal chain efficiency and throughput has been made since 2004 by greater industry coordination.<sup>3</sup> The principles outlined in this paper represent the next logical steps market participants can take to secure and extend the gains they have made to date and unlock further benefits.

The problems besetting the coal chains arise in large measure from the number of participants each coal chain involves – participants with often widely varying interests, but for whom outcomes are interdependent. These participants include coal producers, above rail operators, rail infrastructure owners, port and loading facility operators and governments. Collectively these parties face the same key questions that other infrastructure chains with multiple users must grapple:

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<sup>1</sup> Stephen O'Donnell, Goonyella Coal Chain Capacity Review, 2007, quoted in BHP Billiton White Paper April 2008 "Regulation for the future of Australia's Natural Resources Sector"

<sup>2</sup> Speech by Ambassador Zhang Junsai to Australia-China Business Council and WA Chamber of Commerce and Industry Forum, reported in 'China could tackle Australian infrastructure shortfalls', 14 August 2008 <[www.longwalls.com/storyview.asp?storyid=267859&sectionsourc=r5](http://www.longwalls.com/storyview.asp?storyid=267859&sectionsourc=r5)>

<sup>3</sup> NSW Maritime has noted a 15 per cent increase in output from the Hunter Valley coal chain arising from better coordination. See NSW Maritime, *Improving competitive outcomes and landside productivity at NSW ports* at [http://www.maritime.nsw.gov.au/docs/PMAA\\_BRS.pdf](http://www.maritime.nsw.gov.au/docs/PMAA_BRS.pdf)



- How should the daily operation of the system be managed?<sup>4</sup>
- How should limited capacity be allocated between users?<sup>5</sup>
- How can participants ensure capacity is expanded in a timely and efficient way?<sup>6</sup>

As matters currently stand, and despite the considerable progress the industry itself has made to date, the various participants have greater scope to impede efficient decisions from being taken in each of these respects than they do to reach agreements that fully maximise the overall value of the resources they manage. This reflects a decision-making framework that remains inadequate in that it neither supports efficient decisions through market (or market-like) mechanisms, as might arise from multilateral trade, nor provides for efficient collective action. More fundamentally, the current arrangements do not align for each participant the costs and benefits of decisions.<sup>7</sup> They consequently lead to outcomes in which participants inefficiently impose costs on one another. Congestion is the most obvious form these externalities take, along with over-bidding for capacity that is subject to allocation by rationing (and which then results in capacity rights being held by parties who may not be the highest value users of those rights). At the same time, the misalignment between costs and benefits means that worthwhile projects for better using and expanding capacity are not undertaken, as the benefits of those projects would not flow to the parties that would bear their costs.

These are the issues economists classically associate with common pool resources, i.e. resources where there is imperfect or incomplete exclusion in use, but where use is rivalrous (in the sense that consumption by any one user reduces the amount available for others). The incompleteness of price rationing in those cases leads to congestion and over-use, and to an allocation of the resource that does not maximise its value to society. At the same time, the common pool nature of the resource undermines incentives for efficient investment, so that the allocative and productive inefficiencies are compounded by a dynamic inefficiency. In the case of the coal chains, these dynamic inefficiencies are aggravated by problems of hold-out (in which parties try to secure for themselves a larger share of the pie by shifting costs on to others, or by imposing a veto on decisions that do not provide them with a sufficiently large share of the resulting gains). The overall outcome is a gridlock that is as serious as it is difficult to resolve.<sup>8</sup>

Fragmented ownership rights mean that these issues cannot be perfectly overcome. However, there is scope to improve considerably on the current arrangements. This involves three key elements:

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- <sup>4</sup> In a coal chain, this will involve the optimal sequencing of trains by a limited number of routes or 'train paths' to port, which will take into account the layout of the network, and safety and other requirements for spacing between trains.
  - <sup>5</sup> For example, how can limited rail and port access be allocated between 17 coal producers operating 40 mines across the Hunter Valley?
  - <sup>6</sup> For example, how can coordination ensure any emerging rail, port or coal loading bottlenecks are addressed?
  - <sup>7</sup> For example, an owner of any key part of the chain, including a coal loading point, trains or track, or coal loading terminal will not face the full costs which a failure to upgrade or replace the equipment imposes on all other links in the coal chain. Such costs could include the entire system operating at suboptimal efficiency due to a need to recognise the capacities of that single piece of equipment. Nevertheless, the equipment owner alone may not have a strong incentive to upgrade or replace it.
  - <sup>8</sup> A case in point is the incentives which a 'first-come-first serve' (or 'turn of arrival') rule creates where congestion is expected. Where such a rule operates and congestion is expected coal producers face a private incentive to maximize throughput by ordering additional shipping capacity. This means congestion effectively becomes a self-fulfilling prophecy caused by the operation of the 'turn of arrival' loading rule.



**The first is to better align the costs and benefits of action, thus improving the incentives for decision-making by creating a firm right to capacity.** This requires that each participant more squarely faces the costs of the decisions it takes, especially as regards the usage of current capacity. In turn, this requires that each participant be in a position to acquire a secure, well-defined, capacity right; additionally, participants must benefit when they use that right more efficiently, and face appropriate penalties when they use it less efficiently, especially if doing so imposes a cost on others (in the form of reducing the capacity they can use below their own entitlement). As a result, the crucial first step is to define such a capacity right, and allocate it to users. Vesting that right in the resource owners would place it where the greatest consequences are felt of the efficiency (or inefficiency) with which the right is used; as a result, the resource owners are the natural place in the system at which capacity rights should be vested.

**Second, once such a capacity right is defined, it should form the primary basis both for contracting in the coal chain and more broadly for trading.** There is no intrinsic reason why individual resource owners should not be able to enter into efficient contracts with rail and port service providers; once there is a well-defined capacity right that can form a basis for those trades, those contracts should develop on a take-or-pay basis. At the same time, those resource owners themselves should be able to trade in their rights, allowing the rights to flow to those users (including potential new entrants) who value them most highly.

**Third, better mechanisms need to be defined for those decisions that must be taken collectively.** These include both short-term system control (essentially, managing flows and ensuring compliance with capacity entitlements) and some longer-term capacity expansion decisions. While the vertical and horizontal separation of ownership precludes the 'first best' solution to these problems, there is scope for them to be handled better than they now are. The work done to date by industry groups in each of the coal chains provides a basis on which further steps to improvement can build.

These three key elements are summarised in the principles set out below, and are developed further in the Report.

## RECOMMENDED PRINCIPLES FOR EFFECTIVE COAL CHAIN MANAGEMENT

### **Principle 1 – Align costs and benefits of capacity use through development of a firm right to capacity**

- Develop a common coal-chain-wide capacity definition, such as a reference capacity unit.
- Allocate rights to capacity to those most affected by capacity shocks (the resource owners).

### **Principle 2 – Capacity rights to form the basis of commercial contracting and trading**

- A long-term take-or-pay contractual framework should underpin investment decisions.
- New entrants can buy in capacity rights.



### **Principle 3 – Develop better mechanisms for collective decisions**

- For managing short-term flows and compliance; and
- For longer-term capacity expansion.

Finally, we should note that implementation of these principles should be guided by industry itself, and most notably by the resource owners. It is the resource owners who have the most at stake and hence who are best placed to assess the consequences of alternative options for the long term value of the coal resources. They also have the best access to information about the functioning of the coal chain, and the options for its development. Finally, as they finance the chains' operations, and hence bear the risk associated with poor decisions, it is only natural that they should take the lead in placing the management of the coal chains on an efficient, sustainable, basis.

## **INTRODUCTION**

Australia's coal chains underpin Australia's largest merchandise export earner. They are the product of extremely large capital investments by coal producers, port and rail owners and operators, and governments. Substantial additional investments will be required to underpin future growth. It is, therefore, important to the economic wellbeing and outlook of Australians that the coal chain be used, operated and expanded in the most efficient ways possible. The current mechanisms, including regulatory ones, do not perform as well as they should in these respects. The infrastructure constraints that have arisen in Australia's coal chains have been observed with significant concern by governments in some of our largest export markets.

In economic terms, the coal chains serving the Hunter Valley and Bowen Basin comprise vertically- and horizontally-disintegrated enterprises. Vertically, the chain consists in mines, rail tracks, trains, ports, and port facilities, with very limited cross-ownership. Horizontally, there are many owners and operators of mines; two train operators; and three ports and five coal terminals in the Bowen Basin, while in the Hunter there are two existing terminals and another being built. The only element that simplifies matters is that the port facilities are dedicated to coal, and not shared with other commodities.

A substantial role for regulation adds to this complex picture. Port access at the Kooragang terminal operated by Port Waratah Coal Services is regulated by the NSW Government under a common user provision in the lease. The pricing of access to the rail network is regulated by an access undertaking between Australian Rail Track Corporation (ARTC) and the ACCC (which is currently in draft form). Furthermore, a capacity management system currently allocates capacity at Port Waratah where demand for loading and rail services exceeds system capacity. This quantity-rationing system, which has been authorised temporarily by the ACCC, was developed by participants in the coal chain, and allocates the limited system capacity between coal producers.

A central issue for economic efficiency is the coordination of the varying objectives and plans of the different parties. Efficiency requires that the full costs and benefits of their actions be signalled to decision-makers, and that decision-makers have the incentives to respond accurately. Although there is greater scope for decentralised markets and market contracts in



the industry than presently occurs, nonetheless the underlying economics also points to a continuing and even an expanded role for centralised co-ordination.

This reflects the need to address three key economic issues, which are the:

- problems that arise from the current common pool nature of capacity;
- technical interactions between elements in the coal chain; and
- lumpiness of investments (or, put in economic terms, the fundamental non-convexities in the production system).

We discuss each of these below.

## COMMON POOL RESOURCES

For a resource with a definite upper limit to capacity, the most efficient economic use is when it is allocated to higher-valued and not lower-valued purposes, and when the economic resources employed to gain access are minimised.

Once capacity has been reached, access must be rationed using a rule like first-come first-served, or through quantity rationing, or price rationing. Different rationing systems have very different economic consequences.

Deleterious economic consequences typically occur when an economic resource is treated as a common pool, excepting the limited (and here not relevant) cases associated with customary use (where shared, traditional, norms prevent over-use). The twin characteristics of a common pool resource are that the right of use is imperfectly restricted, but that use by one party reduces what is available to others—use is rivalrous. The classic example in economics of the problems open access gives rise to in these circumstances is the over-exploitation of fisheries. In the case of the coal chain, the regulatory structure has converted elements of that chain, and its effective capacity, into a common pool resource.

The problems this gives rise to are readily explained, and easily observed in the Australian coal chains. When total demand exceeds the capacity of a resource with a definite upper capacity limit, then each user's demand reduces what is available to others. The logical stopping point for an individual user is where the additional net benefit to the user has been driven to zero (i.e. extra benefit of use is just to equal the extra cost to the user). With a common pool resource, the benefit to any one user is at the full (or more-than-full) expense of other users; but that user does not compensate the others for these costs. As a result, each user faces the average, rather than the full marginal, cost of its use, and since marginal costs are rising (as a result of the congestion effect) each user has incentives to inefficiently seek to over-use the resource.

In the case of the coal chains, when a new mine starts production, or an existing mine increases its output, the coal so produced can be carried at the expense of the carriage of someone else's coal (unless the efficiency or capacity of the coal chain can be enhanced). Access to capacity must then be rationed.

Under the existing 'Common User Provisions' and 'Priority Frameworks', there is quantity rationing in the coal chain, pro rata to annually-preannounced claims on the capacity of the port services. With this form of rationing, there is no guarantee that capacity has been



allocated to the highest-valued use, and no guarantee that uneconomical efforts have not been made to gain access to the coal chain. In particular, the new coal output may displace coal that has lower extraction cost, thereby reducing the national economic benefits of the coal export industry. Uncertainty of access to contracted capacity also adversely affects mine planning, financing and expansion and hence harms development of the coal industry.<sup>9</sup> While it may be argued that the current pro rata approach might increase competition in the *rights* to explore for or exploit deposits, if the capacity rationing approach inefficiently allows higher cost producers to displace lower cost producers (as is possible under a system with a lack of effective price signals) then net economic benefits will be reduced. In addition, believing such an approach does not distort future incentives for investment requires an assumption that current new entrants never contemplate their own new capacity allocations may in turn be reduced in the future.

In contrast to pro rata quantity rationing, rationing by price makes each user bear the full costs that its use imposes on others by displacing them in the chain, in so far as the new or expanded user is required to purchase the necessary entitlement to capacity from some other user. This encourages the allocation of a given capacity to the most highly-valued uses (and lowest-cost users).<sup>10</sup> Importantly, it also puts an economic value on additions to or subtractions from capacity, allowing better investment decisions, and provides a surer basis for contracting between parties along the vertical chain.

### Rationing by price

The use of a price system requires:

- Defining a (transferable) unit of capacity, and estimating the total system capacity;
- An initial assignment of capacity to users (of no more than capacity);
- Facilitating trade in entitlements to capacity.

*Unit:* Arriving at a definition of a unit of capacity is an important technical task for the industry to solve. However, it seems that the capacity of the system varies with the assignment of rights to access the system.

For instance, the inclusion in the chain of inefficient elements (older or less efficient trains, or loaders) would degrade capacity, compared with the situation in which their places were taken by faster or more efficient available elements. As a result, nominal entitlements to use parts of the system (for example, a train path capable of handling a shipment of given quantity), may not reflect the actual volumes that can be transported, as those volumes will be affected by conditions in each link of the chain. Those link-by-link entitlements therefore do not amount to firm capacity rights, and hence expose operators to the risk of deviations between rated or nominal entitlements on the one hand and the actual capacity of the chain at any point in time on the other.

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<sup>9</sup> For example, the financing or 'bankability' of a proposed mine may rest on certainty of access to export markets. In a rationing environment, an assessment of access to export markets will be discounted by views on infrastructure constraints in the coal chain, and by a factor recognizing the lack of certainty of access.

<sup>10</sup> In practice, this would lead to coal mines with the most economically extractable coal being exploited ahead of those with less certain or easy to extract resources.



This need to define a firm or reference unit of capacity is by no means unique to coal chains. Rather, it is a common feature of any network where capacity is subject to congestion from complex interaction effects across links. For example, in circuit-switched telephony networks, it is conventional to determine capacity in terms of *erlangs*, which is a unit of traffic density in a voice channel.<sup>11</sup> That unit then provides an important point of reference when telephony networks need to be interconnected, as it supports the definition of interconnection standards that permit end-to-end service quality to be maintained. Capacity units such as the erlang also play an important role in allowing contracting between linked telecommunications service providers, as they provide a reference point in terms of which capacity contracts can be written and performance levels enforced.

In exactly the same way, the definition of a firm capacity unit in the coal chain would provide a reference point for contracting both between resource owners, and between resource owners and other service providers. However, the definition of such a unit in these chains requires an initial optimisation step that needs to be performed centrally. That optimisation step involves first, establishing the configuration of use (in terms of elements such as train speeds) that corresponds to the maximum value of the system, and second and on that basis, defining a capacity unit that allocates the throughput the system can manage at that assumed configuration.

That standard capacity unit – the ‘reference capacity unit’ – is then the capacity each user can expect to obtain, on the assumption that the conditions on which the optimisation has been based were to prevail. Variations from those reference point conditions, to the extent to which they reduce the capacity of the system, will then impose third-party costs (negative externalities) on other users, assuming system demand is no less than supply (i.e. the capacity constraint is binding).

Absent appropriate signals, these third-party costs will undermine efficient use of the facilities. To avoid this, users of the system whose use imposes such costs should face a requirement to purchase additional capacity units up to the point that reflects their impact on system capacity.

For example, a user holding 100 capacity units, using all of those units, and doing so in a way that reduces overall system capacity by an additional 10 units, should be required to purchase 10 additional units (over and above the initial 100). This would ensure that user in fact valued its way of operating its capacity holding at no less than the system cost of its use, taking fully into account the capacity reduction its use pattern imposed on others.

The same logic requires that resource owners that invest in expanding the effective capacity of the system (for instance, by improving the efficiency of their use of system resources) should retain the entitlement over the resulting capacity gain. For instance, a resource user that by further optimisation of its contracts with rail and port could derive an additional 10 units of capacity, without in the process imposing any adverse third-party costs, should be allowed to retain those 10 units, so as to ensure that it had the incentives to bear the costs achieving that optimisation entailed.

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<sup>11</sup> One erlang is the equivalent of one call (including call attempts and holding time) in a specific channel for 3600 seconds in an hour. The 3600 seconds need not be, and generally are not, in a contiguous block. The unit is named after A. K. Erlang, a Danish pioneer of queuing theory, who developed the tools necessary to model capacity in telephone system.



This, of course, requires that prices for capacity, i.e. the implied price of the reference capacity unit, reflect the marginal value of capacity to the system at or around the optimal point. While central determination of these reference prices is obviously complex, given the non-convex nature of the relevant cost and value functions, it is reasonable to assume:

- first, that agreement can be reached on system capacity given a tolerably efficient pattern of use, including acknowledging work done to date on optimising the capacity of the chains;
- second, that an initial allocation can then be made of this reference level of system capacity, and be used as a basis for horizontal and vertical contracting; and
- third, that those contracts can themselves help define prices that reflect changing values of the reference capacity unit.

Overall, the definition of this capacity unit is the single most important step in allowing more efficient use of the system, as it forms the pivot for horizontal and vertical contracting, as well as for long-term system planning. Its determination should therefore be a matter of priority, and once defined, it should serve as the unit in which regulatory and contractual decisions are expressed.

*Initial allocation:* Economics can guide the initial assignment of capacity to users. In general, an asset or property right is best allocated to the party that bears the bulk of the relevant risks and responsibilities, and has the capacity to make and act on decisions that will most influence the value of the right. Such an allocation tends to minimise the transactions costs incurred in the use of the market to re-assign a right to a higher-valued use.

For the coal chain, those economic considerations would point to allocations initially being made to the producers. A sensible basis for the initial allocation is the shares of capacity used in the current rationing system—converting the existing shares into fixed amounts of capacity entitlements.

However, in the Hunter Valley, the commissioning of the coal loading facility to be operated by the Newcastle Coal Infrastructure Group on a closed or exclusive basis means that the total capacity of the chain will increase within a couple of years—that and any other additional capacity would need to be allocated at the appropriate time.

*Facilitating trade:* Finally, definition of a reference capacity unit will provide a basis for trade, both within levels in the vertical chain and between them.

In the short run, it is likely that the vertical dimension will dominate, as resource owners contract with facilities and service providers in ways that maximise the value they derive from their capacity entitlements. Specifically, to the extent to which resource owners can rely on actually securing capacity that corresponds to those entitlements, they will be in a position to enter into firm contracts with rail and port service providers for corresponding volumes at those stages. This should reduce the immediate risk those service providers face, allow them to optimise their own operations, and facilitate their longer term capacity expansion decisions.

Over the longer run, entry, expansion, contraction and exit decisions by resource owners will alter the optimal allocation of capacity entitlements. Capacity units, denominated in standardised form, would then be capable of being traded between resource owners, with any units that were surplus to requirements and not yet or otherwise allocated being made



available centrally. As well as permitting the system to adapt efficiently to the changing pattern of resource exploitation, these reallocations would help reveal the value (in an opportunity cost sense) of capacity, facilitating efficient use decisions by individual owners and efficient investment decisions for the system as a whole.

### **The advantages of a pricing system and the issue of open access**

Substantial economic advantages flow from the implementation of a pricing system for capacity. In the short-term, the market price for capacity can become the basis for charges levied on users, when their use reduces the system's capacity (due, say, to slow or unreliable trains or loaders). In the medium term, the price for capacity can become the basis for more efficient and complex contracts between the various parties in the coal chain. In the longer term, a high price of access to capacity can signal the benefits from investment in capacity itself, either by one party acting on its own initiative, or through contractual arrangements within a subset of the parties, or through centrally-coordinated planning.<sup>12</sup>

An obvious issue in respect of the approach set out above is the extent to which it is consistent with open access or common user provisions. There is, in particular, a clear contrast between that approach – in which users must obtain capacity entitlements so as to participate in the coal chain – and the current arrangements, which give all resource owners a 'right' to seek a share of whatever capacity is going. The efficiency problems inherent in those arrangements have been discussed above, and are in any event evident in the poor performance of the coal chains to date.

The question then is whether the approach proposed here would create problems of its own, in particular for entrants into the industry. In addressing this issue, it is important to note that merely giving all resource owners a 'right' to demand a share of whatever capacity there is does nothing to increase that capacity – indeed, by promoting its inefficient use, it reduces effective capacity below the levels that would otherwise be available. As a result, if it accommodates entrants, it does so only at the expense of incumbents, including in cases where the entrants have higher costs than the incumbents that they displace. It is difficult to see what virtues, if any, there could be in such an arrangement. We consequently see no merit, from an economic perspective, in the current arrangement.

That said, what matters is that entrants should not be artificially disadvantaged in securing access to capacity when they can put that capacity to efficient use. It is, in other words, desirable that capacity be available on a reasonably non-discriminatory basis. However this is likely to occur naturally, given a relatively wide initial distribution of capacity, with no single holder of capacity controlling the bulk of capacity entitlements. As a result, there is no obvious reason for imposing any specific non-discrimination requirements on the system, all the more so given the harm such requirements can create in the form of regulatory gaming.

That recommendation notwithstanding, were such non-discrimination requirements imposed, they would need to be designed in a way that did not itself distort efficient use and investment decisions as between the current common user facilities and those competing facilities that are proprietary (such as NCIG or Hay Point). The difficulty of crafting provisions that properly ensure these distortions do not arise is a further argument against imposing particular non-

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<sup>12</sup> For instance, the market price for an additional unit of capacity may be a useful input into either future private commercial negotiations or regulatory arrangements surrounding capacity expansion projects.



discrimination provisions on the current common user ports absent matching provisions for their competitors. A preferable alternative would be to have agreements between these entities as to how each would allocate spare capacity to the other, with that spare capacity then being available to help absorb changes in usage patterns.

## INTERACTIONS WITHIN THE COAL CHAIN

The second economic characteristic of the coal chain (and similar facilities) is the high degree of interdependence, of a kind that is difficult to capture in and coordinate through arms-length commercial contracts. This interdependence manifests itself in day-to-day operations, as well as in decisions about investment.

In coal chains, the capacity of the total system is determined by the capacity of the weakest link. Thus, integrated coal chains are susceptible to costly disruptions arising from relatively minor system failures or variations. These disruptions can be caused, for example, by mismatches in planned maintenance schedules between loading facilities and track; or through train breakdowns. Due to the integrated nature of the chain, the total costs to the participants in the system from these disruptions can bear little relationship to size of the triggering event—for example, a train derailment that could have been ‘cheaply’ avoided can impose very large costs on other producers, and other operators. Critically, parties responsible for the disruption may not be individually exposed to these costs, and therefore may not have the financial incentive to make what may be the comparatively small investments to avoid them or to mitigate their effects.

In economic terms, these kinds of interdependencies are ‘externalities’: i.e., costs or benefits that the actions or inactions of one party impose or bestow on other parties. To achieve efficient levels of these externalities, they need to be ‘internalised’, that is, the costs and benefits of action previously imposed on others should be borne by the actor (at least on the margin). Many externalities can be internalised through the re-assignment of ownership or property rights; and, in particular, through common ownership of all of the elements involved. A single ‘firm’ internalises what would otherwise be externalities.<sup>13</sup>

However, common ownership is ruled out for these coal chains, by the size of the capital required, and by the extent of the required span of internal control (which limits the efficient size and scope of private firms), as well as by existing economic regulatory frameworks and government policies.

Failing common ownership, a second possible economic mechanism to deal efficiently with externalities is generally referred to in economics as ‘Coasian bargaining’, after the famous article by Nobel Laureate Ronald Coase (who also explored the limits of the firm).<sup>14</sup> Say that one party is imposing a large cost on another party, and has no prior legal obligation to desist or to pay compensation. Then, the alternatives for the injured party, other than doing nothing, include investing in abating the nuisance; or paying the injuring party to reduce the extent of injury. This last is Coasian bargaining. The efficient ideal is that the choice (in this case, between abatement of the damage or reduction in the cause of the damage) is made so as to maximise the net benefits to the two parties collectively—and both parties would gain from

<sup>13</sup> Examples of systems with costs currently internalized by ownership are the dedicated iron ore rail and port facilities operating in the Pilbara by BHP-Billiton and Rio Tinto.

<sup>14</sup> See Coase, R. 1960. ‘The problem of social cost’, *Journal of Law and Economics* 3: 1–44



such an outcome. The allocation of tradable rights to capacity would facilitate such agreements.

Nonetheless, in the coal chain, such spontaneous and *ad hoc* bargaining is unlikely to represent more than a partial solution. This is because there are both too many possible causes of externalities and too many enterprises with similar interests in reducing the costs caused by others, but with incentives to wait on amelioration by another. All this points to the advantages of a portmanteau agreement or arrangement to 'internalise externalities' via centralised control and coordination of operations.

### **A strengthened system operator**

In light of the high number of stakeholders with competing interests in the coal chain, and the multiple causes of externalities, there are likely to be efficiency advantages in the creation of a system operator to manage the day-to-day resolution of competing demands on shared infrastructure, based on a set of transparent business rules. The task is to ensure the ongoing operation of infrastructure, and the optimisation of use of existing capacity. To avoid 'free riding' on the efforts of others and effective system optimisation, all parties should be bound by the decisions of the system operator.

System operators are a common feature of shared infrastructure networks. For example, the Victorian Energy Network Corporation provides market operation functions across electricity and gas transmission. In New South Wales, the Gas Market Company operates market rules, and also operates a mandatory Gas Supply Continuity Scheme. This scheme is designed to match supply and demand of gas and avoid system imbalance. During periods of supply disruptions, the scheme provides market-based incentives to restore balanced system operation. Where system operation appears to be threatened, the Gas Market Company conducts tenders to bring forward alternate supplies from gas shippers, and also allows for payments to be made to system users to reduce their usage.<sup>15</sup> In the National Electricity Market, generation facilities provide 'bids' of capacity on a half hourly basis, and generators are 'dispatched' following a bidding and scheduling process administered according to detailed market rules. The primary purpose of these rules is to maintain safe and reliable system operation, but market rules also have a secondary function of establishing a market clearing price for wholesale energy. This system has operated since 1998 in the initially interconnected markets of Queensland, New South Wales, Victoria, South Australia and the ACT.

As even this brief survey shows, the extent of the powers and the nature of the responsibilities vested in a system operator can differ significantly from case to case. For example, in some natural gas systems, balancing markets are sufficiently thick (in the sense of there being an ongoing high level of asks and offers relative to the extent of the balancing required) that the system operator's role is essentially that of a market maker and of ensuring residual system reliability requirements, with allocation functions being decentralised to the balancing market. In contrast, in the NEM, the system operator has a critical dispatch role, and sends direct quantity signals (run/do not run) to individual units. Determining the appropriate role for the system operator requires careful consideration of the physical characteristics of the system (including importantly, its resilience in the face of changes in

<sup>15</sup> See Market Operations Rules (NSW Gas Supply Continuity Scheme) 2008 at [http://www.dwe.nsw.gov.au/energy/gas\\_market.shtml](http://www.dwe.nsw.gov.au/energy/gas_market.shtml)



use patterns), of the problems those physical characteristics give rise to, and of the relative efficiency of addressing those problems centrally as against through the Coasian bargains referred to above.

Existing coordination groups in the Hunter Valley and Bowen Basin coal chains do provide day to day system coordination. These groups seek to optimise the use of existing infrastructure, and include representatives of all major coal producers, as well as port and rail operators. These bodies have emerged on a voluntary basis from a common recognition by coal chain participants that coordination is required to maximise system use. For example the Hunter Valley Coal Chain Logistics Team (HVCCLT) was formed in 2003, initially on a trial basis between the rail operator Pacific National and Port Waratah Coal Services. The HVCCLT undertakes both daily planning activities aimed at maximising the fulfilment of customer orders by coordinating such system components as ship berthing, train journeys, and management of coal stockpiles.

These bodies have been effective to date in lifting system capacity through improved chain coordination, yet they remain cooperative bodies relying on the voluntary participation of participants. It is important that consideration be given to vesting them with higher status, while preserving their role as industry bodies. That role provides them with effective checks over their governance, as the resource owners are the parties best placed to assess how the chain should be managed, and are likely to carry out the job of monitoring and controlling such bodies far better than could governments.

There is also a case to consider for more centralised coordination of other actions, including investment decisions. This takes us to the third of the three economic characteristics of the coal chain, concerning investment.

## INVESTMENT

### **Objective for investment**

From a public interest standpoint, the appropriate criterion with which to judge the performance of the industry is its contribution to national economic welfare. In view of the competitive nature of the export market, the national economic objective should be to maximize the present value of the annual flow of economic surpluses derived from the resource, manifest as industry profits and as royalties and taxes. In alternative language, the objective is to maximise the flow of 'rents' from the resource, which is the same as maximising the value of the resource itself, net of the efficient costs of getting it to market. All costs are to be recompensed by the customers of the coal, via the owners of the ultimate resource.

Maximising the efficient use of the resource requires efficient decisions about the type, amount, and timing of investments, and about their financing, including cost recovery.

Although short-term forecasts have been scaled down in recent weeks, the demand for Australian coal, especially from China and India, is expected to rise considerably over the next decade. To bring the increased volumes to market, large coordinated investments need to be made; and various plans along those lines have been announced. Delay in investment in some element of the chain beyond the optimal date, or inefficiently-small investments,



harms the industry and the economy, but could be rational for the entity delaying or under-investing, in that it may enable it to earn an excessive return on its investment.

### Challenge of coordinating efficient investment

The same reasons that make day-to-day operations of the coal chain and with it, the allocation of installed capacity more complex than those facing a single integrated owner, also make complex the appropriate mechanisms for efficient investment decision-making—a number of different parties are involved, with potentially differing interests and time horizons. The problems are then exacerbated by the fact that some of those entities are not strictly profit-seeking entities (and are not subject to threats of buy-out).

The coal chain comprises long-lived assets, most of which are specialised (that is, they have no or low value in other uses). The various elements are complements: nothing can be delivered to ships without the use of all of the links—the presence of competitors does offer a degree of horizontal substitution in some links in the chain, but there are no substitutes for any vertical link (e.g., coal, unlike wheat, cannot economically be carried to port by road).

The usual commercial basis for investment in such assets involves the allocation of risk between the various parties, either through loans or equity, or through irrevocable commitments to make complementary investments, or through take-or-pay contracts. Those with most value at risk are those with the largest sunk investments, that is, the coal producers collectively, according to their share of the ultimate resource—the coal producers have the greatest incentive to arrive at efficient arrangements. As a result, they would, in an efficient market structure, take the lead in devising and implementing the relevant contracts.

However, in central New South Wales, more than in Queensland, the bases for such commercial arrangement are deficient or lacking, including as a result of the open access arrangements discussed earlier (which distort the incentives to invest) and the lack of an agreed definition of capacity (which make it difficult to devise and implement efficient contracts).

Efficient pricing based on a standardised unit should provide a basis for more efficient future investment decisions, based on private long-term take or pay contracting, collective levies to recover system-wide improvements, and an ability for coal producers or infrastructure providers to add 'entrepreneurial' capacity expansions. However, while ameliorating the problem, it will not resolve it entirely. This is for two reasons.

### Characteristics of the required investment decisions

Where production systems involve chains of processes, with each link in the chain being 'lumpy', in the sense that investments involve minimum increments of fixed, often large, size, efficient investment decisions may not be made without some degree of coordination, above and beyond that provided by price signals.

This is because decisions taken under those circumstances depart from two crucial assumptions conventionally made in economic models of choice of investment:

- that the set of alternatives is *convex*, which means that if two options are available, any combination of those options (i.e. any intermediate point) is also available; and



- that the objective function (that is, the function that measures how outcomes, such as profits, vary depending on the decision taken) is *concave*, which means that if two options lead to the same outcome, then an intermediate decision would lead to a higher outcome (so that the objective function looks like a smooth climb to, and descent from, a single peak).

When both these assumptions hold, there is a single optimum. Moreover, that optimum can be found by exploring small variations around the current point, as a simple rule can be followed: change any dimension of performance, and if that change improves performance overall, continue to change it in the same direction until the improvements become smaller than the costs. As a result, it is easy to decentralise decision-making, allowing each unit to explore the options and assess the impact on its performance, without losing overall efficiency.

However, these assumptions plainly do not hold in production systems such as the coal chains. Because investment decisions are indivisible (one cannot continuously vary the number of tracks, mines or ports), the set of alternatives is non-convex. For the same reason (and because of increasing returns to scale associated with redundancy in capacity), the objective function is non-concave. Put in practical terms, this has two implications.

The first is that there may be multiple outcomes that are 'local' equilibria, in the sense that small variations around those outcomes will result in worse performance. As a result, any decentralised process that involves individual decision-makers 'exploring' whether performance would improve by making slight changes around an initial position will not be able to identify the global, i.e. overall, optimum – that is, the configuration of assets that maximises the value of the system as a whole.

Second, and even more important, changes in any one dimension of the system at a time may not suffice to indicate whether that dimension should in fact be varied; rather, finding the optimal configuration requires changing (or at least modelling changes) in all aspects of the chain at once.

As a result, there is a need for some mechanism that coordinates the investment plan along each of the links in the chain. Typically, this coordination would occur within the firm, with central management considering the options and trade-offs as between altering capacity at mine, rail and port. However, the Australian coal chains lack such integration, and hence alternative mechanisms are needed if efficient investment paths are to be found and implemented.

### **Investment as an anti-commons**

Separate ownership also complicates efficient investment through its effects on incentives.

Earlier, the difficulties in arranging the efficient allocation and use of installed capacity were analysed in terms of the problem of the *commons*: the decisions of one user can impose uncontracted and uncompensated costs on other users. Unless these externalities are internalised through contract, common ownership or regulation, the facility will not be used to produce its highest economic value.

For investment, the same issues arise but are compounded by a symmetrical economic problem, that of the *anti-commons*. Different elements in the chain are owned by different



entities, but the elements are strict complements—each is needed.<sup>16</sup> The whole is worth more, much more, than the sum of the parts. Consequently, owners of the various links may wish to capture as much of the resource rent as possible, including by delaying investment for which the users would be willing to compensate at commercial rates, or even undertake themselves from their own funds (especially if regulations permit them to reap the full rewards). A sequence of such hold-ups could seriously damage the efficiency of the industry; and in the event could deprive game-players of all or most of the hoped-for benefits.<sup>17</sup>

### Potential solutions - an indicative planner?

The struggle over the division of the rent would not matter to the national interest if it did not cause a reduction in the overall value of the resource. Unfortunately, this is not the case. The flip-side, however, is that better coordination of investment will – also because of the economic characteristics of these investments, as discussed above – increase the size of the rent pool, which leads to the possibility of an industry-wide agreement to achieve coordination, from which all parties expect to gain (compared with the current alternative).

Conceptually, what is required is a replication of the investment decisions that would be taken by a single integrated entity. If, for reasons discussed above, decentralised decisions are unlikely (in theory and arguably in practice) to arrive at an efficient sequence of investment, then some form of collective decision-making needs to be investigated. This collective decision-making body could take the form of a more formal indicative system planner. That is, a coal chain planning body with a set of constrained functions focused on developing a 'whole of chain' system plan.

A key conceptual issue in planning bodies of this type is their governance and incentives. That is, how will the body be structured so as to produce similar planning outcomes to that which would arise in a vertically integrated chain, and what incentives will it face? A planning body with extremely diverse and unaligned membership could represent an ineffective extra layer of cost on an industry facing global competitive pressures. One mechanism to seek to avoid this outcome may be to explore making it possible for a number of members of a planning body to offer to 'buy out' other members. This could have the effect of moving the coal chain somewhat closer to the more transparent model of planning that would arise in a vertically integrated chain.

Indicative planning (that is, planning with no direct power to direct investment) is a feature of many network infrastructure regimes around the world. In the Australian energy sector, for example, the Council of Australian Governments has moved to establish a National Transmission Planner which will have the task of developing long term strategic plans for the

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<sup>16</sup> Goods A and B are complements if an increase in the quantity of A increases the marginal benefit associated with a marginal increase in the quantity of B. Complementary is to be distinguished from spillover effects, which (again in the case of two goods, A and B) are situations where an increase in the quantity of A increases the value of B, but does not increase the marginal gain from an increase in the quantity of B.

<sup>17</sup> Experimental economics indicates that the inefficiencies of the anti-commons are likely to be greater than those of the commons: S. Vanneste et al., 'From "tragedy" to "disaster": Welfare effects of the commons and anticommons dilemmas', *International Journal of Law and Economics* 26, pp. 104-122. However, one issue that can be put to one side in the current context is 'double marginalization'. Export demand for coal from the eastern coal chains is effectively perfectly-elastic. Consequently, if each element in the coal service chain were to set profit-maximizing service prices, the result total charge would not be higher than that set by an integrated monopolist: see G. Dari-Mattiacci and F. Parisi, 'Substituting complements', *Journal of Competition Law and Economics*, 2(3), (2006), pp. 333-47.



electricity transmission network, taking into account likely impacts from generation location decisions, shifting demand and supply patterns, and electricity flow paths.

Indicative regimes may not fundamentally alter participants' capacity to game or mislead in relation to their needs or commercial plans. Yet they also provide a common basis for a range of commercial and other stakeholders to consider investments in the chain. While the benefits of indicative planning may be modest, such a planning approach represents a good first step in achieving better overall capital investment coordination.

A further reason to consider an indicative planning approach is that it is a non-regulatory option with lower costs than other alternatives. For example, greater regulatory involvement in directing planning processes and outcomes would bring real risks. Government is unlikely to have access to reliable information on costs or demands, and hence faces a substantial risk of error. Compounding that risk is the fact that it is not government, but the resource owners, who would bear the greatest consequences of poor decisions. Collective decision-making by the industry is undoubtedly imperfect, but at least self-interest, and the scope for mutually beneficial decisions that 'expand the size of the pie', provide some crucial disciplines that government intervention largely lacks.

### **Allowed rates of return**

A final issue with respect to investment involves allowed rates of return on regulated assets (such as rail links and in the case of privately held ports, the port itself) that are used in the coal chains.

In principle, the required rate of return should reflect the cost of capital to the regulated service providers, taking account of the risk involved in the services they provide. In theory, the relevant risk is the systematic risk, which depends on the covariance between the net income on the assets and net income on the market portfolio (i.e. the collection of assets that define the economy as a whole). In practice, it is also appropriate to take account of the extent to which the service providers can shift risk to end-users, for instance, by not providing capacity that users would have expected to be available. These changes in service quality effectively give service providers additional options for managing their costs and hence reduce the risk they actually carry. Failing to take account of those options (which allow service providers to degrade service at peak loads) in assessing required returns may lead to service providers being over-compensated.

For exactly the same reason, should service providers genuinely assume service quality risk under the new arrangements, then that should be recognised in allowed rates of return. For example, were rail providers to bear service quality responsibility, so that shortfalls relative to contracted capacity triggered material penalty payments, then it would be appropriate for the resulting risks to be reflected in allowed rates of return. This is both because it is likely that they would be bearing greater systematic risk (as capacity shortfalls would be most likely at cyclical peaks) and because of the need to provide incentives for service providers to efficiently manage quality of service variations.

In that sense, the appropriate level of allowed returns on regulated infrastructure cannot be assessed independently of the wider allocation of risk in the coal chain. Should regulated service providers bear a greater share of that risk (say, as a result of take or pay contracts



with penalty clauses for non-performance), then it is desirable that allowed rates of return be higher than they would otherwise be.

## WHAT ARE THE STAKES?

In short, we recommend:

- First, better aligning the costs and benefits of action, including through the definition and allocation of a firm capacity right, thus improving the incentives for decision-making;
- Second, once such a capacity right is defined, using it as the primary basis both for contracting in the coal chain and trading; and
- Third, defining and implementing better mechanisms for those decisions that must be taken collectively.

In making these recommendations, we note that the stakes in improving coal chain outcomes for the Australian economy, and particularly for the economies of New South Wales and Queensland, are high.

In particular, the failure to resolve the issues discussed in this Report would impose significant costs. These costs are summarised in Table 1 below.

**Table 1 - Potential costs arising from coal chain inefficiencies**

Area	Potential costs
<i>System operation and management</i>	<p>Lack of coordination may impose excessive demurrage charges</p> <p>Administrative costs from coordinating and regulating the system</p> <p>Loss of sales due to costs imposed by lack of flexibility from coordination and regulation</p> <p>Loss of reputation effect – potential for global customers to source from alternate suppliers</p> <p>Productive inefficiencies and deterrence of efficient investment</p>
<i>Capacity allocation</i>	<p>Administrative cost</p> <p>Potential gaming costs, and administrative costs of anti-gaming mechanisms</p> <p>Distortions to the pattern of production and investment</p>
<i>Capacity expansion</i>	<p>Loss of sales due to constrained infrastructure capacity and continued distortions to capacity allocation as between mines</p>

Estimates of the magnitude of some of these costs can be gained from the results of a series of independent reviews and analyses. These have estimated that:

- If coal supply constraints are not addressed in the Hunter Valley, the resulting losses in coal export revenue would amount up to \$7.9 billion in 2015, translating to a loss of \$8.6 billion in New South Wales Gross State Product and around 1900 jobs;



- The cost of demurrage alone at Dalrymple Bay has been as high as \$550 million, with ship waiting times between 23-30 days during some periods, compared to a normal waiting time of 3-5 days at a single-user facility;<sup>18</sup>
- A one year delay in the expansion of Dalrymple Bay coal terminal may have cost up to \$1.0 billion in lost sales;<sup>19</sup>
- Bottlenecks at Dalrymple Bay Coal Terminal have led to lost revenue of \$900m and demurrage charges of \$300m between July 2006 and May 2007;<sup>20</sup> and
- Had Australia maintained its global coal market share between 2002 and 2007, then – at today’s prices – Australia’s miners would have earned another \$17 billion, the equivalent of 1.6% of nominal national income in 2007<sup>21</sup>

Importantly, these costs also have a longer term reputational and economic flow ons for some of Australia’s largest export customers. The importance of alleviating infrastructure constraints – and specifically those experienced in the Hunter Valley coal chain – has been raised publicly by foreign governments, including China’s ambassador to Australia.<sup>22</sup>

These costs emphasise the importance of action to improve infrastructure coordination and investment outcomes across Australia’s coal chains. Significant progress on this front will be a key underpinning of future standards of living, the global competitiveness of a major Australian export, and continuing growth in the face of a challenging international economic environment.

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<sup>18</sup> National Competition Council, ‘Attachment D: Effects on investment in infrastructure as a result of the multi-user nature of a production system and access regulation.’ Available at <http://www.ncc.gov.au/pdf/DERaFoSu-032.pdf>

<sup>19</sup> National Competition Council, ‘Attachment D: Effects on investment in infrastructure as a result of the multi-user nature of a production system and access regulation.’ Available at <http://www.ncc.gov.au/pdf/DERaFoSu-032.pdf>

<sup>20</sup> Goonyella Coal Supply Chain Review for the Queensland Government. Available at [http://www.transport.qld.gov.au/resources/file/eb56f94f2182a66/Pdf\\_goonyella\\_coal\\_chain\\_capacity\\_review\\_full.pdf](http://www.transport.qld.gov.au/resources/file/eb56f94f2182a66/Pdf_goonyella_coal_chain_capacity_review_full.pdf)

<sup>21</sup> Access Economics, *Infrastructure 2020—Can the domestic supply chain match global demand?* May 2008

<sup>22</sup> Speech by Ambassador Zhang Junsai to Australia-China Business Council and WA Chamber of Commerce and Industry Forum, reported in ‘China could tackle Australian infrastructure shortfalls’, 14 August 2008 <[www.longwalls.com/storyview.asp?storyid=267859&sectionsource=r5](http://www.longwalls.com/storyview.asp?storyid=267859&sectionsource=r5)>