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What policy rationales can underpin high speed, fast and improved passenger rail in Australia?

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Abstract

Future upgrade of Australia's non-urban passenger rail networks must be backed by a widely accepted policy rationale to sustain public investment and action over time. Focusing on a 400 kilometre radius around Australia's five major capitals and on mainland eastern intercapital corridors (including Adelaide), the paper presents six 'candidate' rationales. These are: building productivity through the business specialisation impetus that convenient, intercity connectivity can provide; avoiding a 'megacity' future through rebalancing population growth; strengthening small regional centres that depend, for medical specialist and other services, on sufficiently fast public transport, yet are too close to capital cities for viable air links; future-proofing convenient day return access to the centres of major capitals against any threat of capacity constraint at centrally located airports; contributing to net zero emission transport; and eliminating disconnects in Australia's national rail network. Different upgrade types are appropriate, depending on particular 'time-space' considerations and policy goals. High speed rail would help maximise productivity growth opportunities between Sydney and Canberra. Between major capitals, it can future-proof convenient day return access to central Sydney in particular and would underwrite some reduction in transport carbon emissions. Fast rail responds to productivity growth opportunities for Newcastle – closer to Sydney than is Canberra. Both fast and improved rail may help push population growth rebalancing beyond a one hour drivable distance – its main locale to date. Finally, improved passenger rail can offer a 'fast enough' day return option for smaller regional centres within 350 kilometres of a major capital and lacking air service, such as Bathurst and Bairnsdale.

1. Introduction

Investment in Australia's rail freight networks is primarily sustained by its importance for domestic and international goods trade, while improvement in the country's metropolitan passenger rail networks underpins functioning and growth of city economies. What public policy rationale can comparably motivate public investment in fast, high speed and improved regional passenger rail? Drawing on 'strategic triangle' theory (Moore 2012, Moore and Khagram 2004), a compelling 'public value proposition' is a prerequisite of successful public initiatives, one that sits alongside two others. These are sources of 'legitimacy and support' from the initiative's 'authorizing environment' – in effect, a mandate from governments, who are accountable to their electorates and 'operational capabilities' – ie sufficient human, financial, organisational and institutional capability and resourcing to achieve the goal. Each of the three is critical to policy success. But a compelling policy rationale is the starting point.

The paper reviews six 'candidate' policy rationales in the context of overlapping geographies that have received recent attention: firstly, routes between the five major capital cities and surrounding regional centres up to 400 kilometres (km) distant and, secondly, the intercapital corridors that connect Brisbane, Sydney, Canberra, Melbourne and Adelaide (see Glazebrook and Lowrey 2023, King 2022, Michell E 2020, National Faster Rail Agency 2022, Terrill

2020). The paper also distinguishes three types of passenger rail upgrade: improved, fast and high speed. Opportunities in each and the policy rationales with which they align are presented.

The paper's methodology comprised, firstly, a statistical profile of existing train, coach and air services in the two geographies. This provided an essential reference point in considering and presenting notionally upgraded services. Secondly, a set of expert interviews allowed perspectives on a wide range of relevant policy-related and technical topics, in combination, thirdly, with literature research. Literature on the 'time-space effects' of air and rail transport (Chen and Hall 2011, Preston 2013, Rosewell and Venables 2014) is central.

2. Existing service profile

Seventy-three Australian Bureau of Statistics significant urban areas (SUAs) – towns and cities with populations of at least 10,000 – are within 400 km of the five major capital cities. Together, these 78 SUAs comprise 83 per cent of Australia's 2021 population. Up to three regional[1] SUAs in corridors radiating from each major capital were included in a major capital surrounds dataset: the two largest by population and the furthest within the 400 km range. In South Australia and Western Australia – less densely populated states – all SUAs along corridors radiating from Adelaide and Perth respectively were included.

The major capital surrounds dataset (shown in full for reference, Table 1) comprises train, coach and air services between each of the five major capital cities and 45 surrounding SUAs, in 23 radial corridors. Many services to smaller regional centres in New South Wales and Victoria include a coach leg that connects with a train service at larger regional centres closer to the major capital. For simplicity, these services are not distinguished from full train services.

The major capital surrounds dataset was compiled from publicly available operator schedules and booking systems. Indicators comprise the number of weekly return services, median service time, median scheduled journey speed and median fare per 100 km. Data compilation commenced in November 2022, for a booking week up to 21 days ahead and ceased in January 2023 (Christmas and New Year weeks were excluded). The service indicator methodology is as outlined in Potterton (2022). The data set also includes self-drive speeds, sourced from Google Maps and adjusted to simulate a 15 minute rest period every two hours (RACV 2023).

A second intercapital corridor dataset centres on air routes between Brisbane, Sydney, Canberra, Melbourne and Adelaide. There are just two additional regional SUAs: Kempsey and Wagga Wagga, both in New South Wales. There are 30 air routes: 10 between capital cities (Table 2), 18 from the four major capitals within the footprint to regional SUAs and two between regional SUAs. Train and/or coach services run on 17 of the 30 air routes. Given multiple stopping patterns, these services also feature in Table 1.

3. Types of passenger rail upgrade

In passenger rail, one hour service times enable daily commuting trips, while times up to around two hours allow convenient day return business travel (Chen and Hall 2011). Between Australia's major capitals, three hour or longer door to door trips for day return travel are commonplace – notionally, 90 minutes service time and a further 90 minutes time at the airport and travel to and from it. In European markets where rail and air compete, the two modes typically have similar market shares where the rail 'travel time excess' is no more than 90 minutes (Preston 2013), the 'excess' notion capturing rail's greater reliability, comfort and ease of access. So three hours is also a relevant service time limit for a feasible rail return day trip.

[1] For clarity, Canberra-Queanbeyan is a 'regional SUA' in the southwest corridor radiating from Sydney.

Table 1: Major capital to regional SUA corridors and routes, self-drive speed and train, coach and air service indicators, Dec 2022-Jan 2023

Major capital, corridor direction	Regional SUA	Population 2021	Road distance km	Self-drive speed kph	TRAIN[1]*					COACH			AIR				ALL MODES Total services
					Rail distance km	Return services pw	Sched. time mins	Scheduled journey speed kph	Fare $/ 100km	Return services pw	Scheduled journey speed kph	Fare $/ 100km	Air distance km	Return services pw	Scheduled journey speed kph	Fare $/ 100km	
BRISBANE																	
North	Sunshine Coast	355,631	106	66	104	140	110	57	14	16	64	34					156
	Fraser Coast[2]	86,061	255	75	224	14	220	61	20	25	40	41	230	19	276	113	58
	Bundaberg	74,433	362	78	351	14	270	78	15	18	47	32	297	24	324	101	56
South	Gold Coast-Tweed Heads (NSW)	706,673	79	57	89	315	91	59	16	28	59	25					343
	Lismore NSW	28,844	197	72						28	56	8	70				28
	Coffs Harbour (NSW)	74,177	384	90	388	14	460	51	16	17	42	22	325	8	355	63	39
Southwest	Warwick	15,759	158	60								39					8
West	Toowoomba	143,994	127	76	162	2	265	37	16	62	66	29	106	3	159	159	67
	AVERAGE	185,697	209	72	220	83	236	57	16	25	55	31	284	17	318	92	94
	MEDIAN	80,247	177	73	193	14	243	58	16	22	58	31	297	19	324	101	57
SYDNEY																	
North	Central Coast	340,203	76	63	81	268	85	57	8								268
	Newcastle-Maitland	509,894	161	80	168	174	164	62	4	21	67	23	114	3	137	169	198
	Port Macquarie	50,104	385	94	455	21	398	69	10	17	66	19	314	42	290	64	80
South	Wollongong	305,880	86	80	83	145	97	51	8	7	43	22					152
	Nowra-Bomaderry	38,939	158	83	153	107	174	53	4	7	49	17					114
	Batemans Bay	17,492	280	73						7	46	17	236	6	283	80	13
Southwest	Bowral-Mittagong	41,419	118	84	98	171	144	41	7								171
	Goulburn	24,683	197	93	225	36	152	89	11								36
	Canberra (ACT)-Queanbeyan	482,250	286	93	330	21	248	80	12	89	82	17	247	247	80	146	357
West	Bathurst	37,490	200	69	229	52	242	57	5								52
	Orange	42,151	257	69	323	55	287	67	11				259	20	311	81	75
	Dubbo	41,014	390	76	463	14	415	67	12				302	29	259	72	43
Northwest	Mudgee	12,577	264	74	279	14	309	54	9				207	5	226	87	19
	AVERAGE	160,960	216	80	237	97	219	63	8	25	59	19	272	69	245	89	130
	MEDIAN	41,785	198	80	225	55	174	62	8	12	57	18	259	29	283	80	97
MELBOURNE																	
North	Shepparton-Mooroopna	53,983	192	87	182	71	163	67	15								71

Major capital, corridor direction	Regional SUA	Population 2021	Road distance km	Self-drive speed kph	TRAIN[1]*					COACH			AIR				ALL MODES Total services
					Rail distance km	Return services pw	Sched. time mins	Scheduled journey speed kph	Fare $/ 100km	Return services pw	Scheduled journey speed kph	Fare $/ 100km	Air distance km	Return services pw	Scheduled journey speed kph	Fare $/ 100km	
Northeast	Wangaratta	19,877	251	94	234	30	160	88	14								30
	AlburyNSW-Wodonga	97,676	251	95	299	31	216	83	14	11	75	27					42
East	Warragul-Drouin	42,870	99	74	100	125	100	60	18								125
	Traralgon	43,128	165	82	158	122	143	66	20								122
	Bairnsdale	15,648	281	82	275	31	238	69	14								31
Southwest	Geelong	289,400	75	68	73	392	62	70	19								392
	Warrnambool	35,754	258	84	267	32	214	75	15								32
	Portland	11,182	352	86	369	24	312	71	13								24
Northwest	Melton	78,792	47	62	37	268	37	61	12								268
	Ballarat	111,702	116	77	119	182	85	84	19								182
	Horsham	16,944	300	89	327	41	251	78	13								41
N.northwest	Gisborne-Macedon	22,366	54	73	64	157	48	80	19								157
	Bendigo	102,899	160	84	162	131	111	88	21								31
	Echuca-Moama	22,478	224	83	250	58	251	72	12								58
	AVERAGE	64,313	188	81	194	113	159	74	16	11	75	27					114
	MEDIAN	42,870	192	83	182	71	160	72	15	11	75	27					71
ADELAIDE																	
North	Port Pirie	14,297	228	88						13	72	22					13
	Port Augusta	14,125	309	91						13	74	20					13
	Whyalla	21,868	385	91						13	70	18	229	8	275	89	21
Northeast	Mildura-Wentworth (VIC)	53,677	397	90									334	4	308	69	4
Southeast	Murray Bridge	18,864	75	83	97	2	107	54	52	40	39	32					42
South	Victor Harbor	28,850	83							24	40	34					24
	AVERAGE	25,992	330	90						21	59	25	281	6	291	79	20
	MEDIAN	18,083	347	90						13	70	22	281	6	291	79	17
PERTH																	
North	Yanchep	15,348	56	75	55	243	67	49	7								243
South	Bunbury	79,252	169	89	167	95	150	67	21	21	56	34					116
	Busselton	41,906	222	90						81	58	19					81
	AVERAGE	45,502	149	84	111	169	109	58	14	51	57	26					147
	MEDIAN	41,906	169	89	111	169	109	58	14	51	57	26					116
TOTAL																	
	AVERAGE	104,057	206	77	207	100	190	66	14	26	58	26	240	34	173	68	104
	MEDIAN	41,906	197	77	175	57	164	67	14	18	59	24	241	14	242	76	63

1. Services for some regional SUAs in Sydney and Melbourne corridors comprise train and connecting coach services. 2. Fraser Coast comprises Maryborough and nearby Hervey Bay SUAs.

Table 2: Capital to capital air service indicators, mainland[1] eastern Australia, Dec. 2022-Jan. 2023

Route	Air distance km	Service time mins	Return services pw	Fare $ per 100 km
Brisbane-Adelaide	1,601	145	68	36
Brisbane-Canberra	654	100	35	67
Brisbane-Melbourne	1,381	130	68	32
Brisbane-Sydney	750	95	255	27
Sydney-Adelaide	1,162	115	108	30
Sydney-Canberra	247	80	146	107
Sydney-Melbourne	703	95	484	41
Canberra-Adelaide	959	105	25	46
Canberra-Melbourne	467	70	76	75
Melbourne-Adelaide	654	80	151	37
AVERAGE	858	102	142	50
MEDIAN	727	98	92	39

1. Hobart is also part of a day return eastern intercapital air transport system, with some services geared to day return travel. In April 2023, there were 48 weekly return services between Hobart and Sydney, with a median service time of 105 minutes.

Track-related constraints and intermediate stops aside, a train's top operating speed determines scheduled service time. Using an industry-based three-quarters factor[2] to set the relationship between maximum and average operating speeds, this paper adopts the speed ranges shown in Table 3 to distinguish three passenger rail upgrade types: improved, fast and high speed.

Table 3: Train speeds and one, two and three hour maximum distances, by upgrade service type

Passenger rail upgrade	SPEED KPH		MAXIMUM DISTANCE KM		
	Max. operating speed	Av. operating speed	1 hour	2 hours	3 hours
Improved rail	140-160	105-120	105-120	210-240	315-360
Fast rail	200-220	150-165	150-165	300-330	450-495
High speed rail	300-350	225-263	225-263	450-525	675-788

Improved rail (maximum speed up to 160 kph) would allow track sharing between passenger and freight trains, potentially with more, longer passing loops to accommodate the latter's slower speeds. As currently, track sharing could apply except where passenger train densities are high – notably in and near metropolitan areas – or where separate freight lines are in place. However, fast rail and high speed rail require essentially dedicated infrastructure, with paths for freight train use possibly available at night only, or other times of low traffic density.

With the higher power to weight ratio that faster trains require, line electrification is a prerequisite for both fast rail and high speed rail.[3] It would be appropriate also for improved rail, where the passenger density can warrant its cost. Improved lower density lines, or sections of lines, would continue with diesel or bi-mode (electric and diesel) powering, as currently.

4. Existing services – examining a performance gap

Passenger trains provide two thirds or more of public transport services to SUAs within 400 km of Brisbane, Sydney, Melbourne and Perth (Table 5). In South Australia, where regional passenger rail services were withdrawn in 1990, coach services make up over three-quarters of the total. Air transport supplies almost a quarter of services to regional SUAs surrounding Sydney and Adelaide. In Sydney's case, four of six SUAs with air service have below median self-drive speeds, whereas route distances surrounding Adelaide are longer than elsewhere. Both factors are inherently favourable to air transport provision.

Just two regional SUAs, Melton and Gisborne-Macedon, each around 50 km from Melbourne, have median train service times under one hour (Table 5). Ten have service times within two hours (median distance 96 km) and eight under three hours (median distance 173 km). 16 at longer distances – nearly half of a total 36 with passenger rail connections – show service times

[2] Interview Richard Bullock, 2 December 2022.
[3] Interview Martin Baggott, 6 March 2023.

Table 4: Mode shares of weekly return services, major capital-regional SUA routes up to 400 km

Major capital	No regional SUAs	SUA median road distance km	Train	Coach	Air	Total return services per week
Brisbane	8	177	66%	27%	7%	755
Sydney	13	198	68%	9%	22%	1,578
Melbourne	15	192	99%	1%		1,706
Adelaide	6	268		76%	24%	51
Perth	3	169	77%	23%		440
TOTAL	45	197	79%	12%	9%	4,530

above three hours, including three SUAs (Port Macquarie, Dubbo and Coffs Harbour) with times exceeding six hours.

Table 5: Train services[1] by service time ranges, major capital-regional SUA routes up to 400 km

Train service time	No regional SUAs	Median rail distance to nearest major capital km	Median regional SUA population 2021 000	Median return train services per week	Med. train speed *less* med. self-drive speed kph
Up to 1 hour	2	51	51	213	3
1-2 hours	10	96	201	164	-8
2-3-hours	8	173	42	101	-19
3-4 hours	4	271	61	31	-7
Above 4 hours	12	328	42	21	-9

1. These include train and connecting coach services to some regional SUAs.

Median SUA train route speed is 67 kph (Table 1), 10 kph below median self-drive speed Eight SUAs (22 per cent) have speeds faster than self-drive. In order of increasing distance these are Gisborne-Macedon, Geelong, Gold Coast-Tweed Heads, Ballarat, Bendigo, Wangaratta and Orange.

On adjoining intercapital corridors, train services, while offering stopping services, provide less than ten per cent of total services on any route (Table 6). The shortest distance route, from Sydney and Canberra (286 km by road, 330 km by rail), has a service time above four hours. All air routes in contrast have scheduled service times around 90 minutes or less.

Table 6: Train, coach and air services to adjoining capitals, mainland eastern intercapital corridors

Route	Road distance km	TRAIN			COACH			AIR		Total services pw
		Time h/min	Share return services	Stops	Time h/min	Share return services	Stops	Time mins	Share return services	
BNE-SYD	909	16h20	5%	23	16h30	7%	20-38	95	88%	290
SYD-MEL	878	10h48	3%	17	12h	3%	4-15	95	94%	515
SYD-CBR	286	4h08	8%	9	3h30	35%	0	55	57%	256
CBR-MEL	663	9h08	6%	18	8h	25%	12	70	68%	111
MEL-ADL	726	10h25	1%	11	9h45	10%	11	80	89%	170
TOTAL			4%			13%			83%	1,342

5. Six policy rationales

This section sets out six in principle ‘public value propositions’ that may hold potential to gain the support and acceptance that would be needed for sustained upgrade over time of Australia’s non-urban passenger rail services.

5.1. Building better business productivity

In recent decades, high speed rail in France, Japan and China and fast rail in the United Kingdom has helped spur documented productivity growth in some of these countries’ larger, second tier cities (Bonnafous 1987, Chen and Hall 2011, Jin et al 2013, Yoshino and Abidhadjaev 2016). Whereas clustering of businesses in central areas helps drive productivity growth within cities, reducing ‘economic distance’ between separate cities by means of rapid public transport is a catalyst for intercity productivity growth (World Bank 2009). Moreover,

intercity (and international) connectivity has assumed increased importance as, over time, firms' production patterns have fragmented, supply chains have lengthened and a knowledge-intensive business services sector has expanded (Adeney 2018).

With long distances between major capitals in particular, air transport connectivity is the principal means by which Australian businesses located in different cities establish and maintain the linkages that enable them to trade domestically, specialise, become more efficient and increase scale. But, as a report for the Committee for Melbourne notes, with reliance on air transport and its city pair route networks for in-person contact, *"it is much harder to incrementally link smaller cities, such as those located between Melbourne and Sydney, into their economic relationship"* (SGS Economics and Planning 2020).

Which regional Australian cities have most to gain in productivity terms from addition of upgraded passenger rail to the transport mix? A 'knowledge city index' (Pratchett et al 2017)[4] offers insight. Australia, its authors suggest, has five 'knowledge cities': in descending order, Sydney, Melbourne, Canberra-Queanbeyan, Brisbane and Perth. 20 cities have potential, with 12 in this paper's geographic footprint. These are: Adelaide, Sunshine Coast, Gold Coast-Tweed Heads, Newcastle-Maitland, Wollongong, Central Coast, Toowoomba, Geelong, Albury-Wodonga, Ballarat, Bendigo and Bunbury.

Excluding Adelaide, only Canberra-Queanbeyan and Toowoomba have air service to the nearest major capital. At $146 per 100 km and $157 per 100 km respectively (Table 2), air fares are costly, due to short distance[5] and with no low cost carrier option. Only Geelong has train service (to Melbourne) of around one hour service time. However, improved rail radiating from Brisbane, Sydney, Melbourne and Perth could provide service times of less than 90 minutes for ten of 11 regional SUAs. Fast rail from Melbourne to Albury-Wodonga (the 11th) and Sydney to Canberra-Queanbeyan would yield service times around two hours. Similarly, fast rail between Canberra-Queanbeyan and Albury-Wodonga would give a two hour service time. So business productivity benefits of upgraded passenger rail are there to be grasped.

5.2. Population growth rebalancing

City-based economic growth brings negative as well as positive impacts to which redirection of population growth towards regional centres, it is argued (Regional Australia Institute 2022), offers an answer. Population growth rebalancing aims to pre-empt a 'megacity' future where, with numbers approaching 10 million, outer area residents are too far from jobs and services and traffic congestion and housing unaffordability is widespread. In addition, flooding risk, heightened by climate change, provides a rationale to relocate future housing development away from parts of Sydney, as argued by the NSW Floods Inquiry (2022).

Table 7: Change in Australia's population 2001 to 2021, by location type and distance to a capital city

Population location	2001 (000s)	2021 (000s)	Absolute change (000s)	*Av. annual change*
All 8 capital cities	11,987	16,502	4,515	*1.6%*
Significant urban areas (SUAs) up to 100 km from a capital city	1,294	1,838	545	*1.8%*
Ballarat (116 km), Bendigo (160 km) VIC	1,571	2,146	58	*1.6%*
Other SUAs 101-200 km from a capital city	1,121	1,493	372	*1.4%*
SUAs beyond 200 km from a capital city	1,761	2,226	465	*1.2%*
Not in any SUA (all distances)	2,955	3,415	459	*0.7%*
TOTAL AUSTRALIA	19,275	25,688	6,413	*1.4%*

Source: ABS 2022 and author analysis

[4] The index, covering 25 Australian cities, combines workforce measures of tertiary qualifications, digital access, migration and mobility, industry of employment, income and working from home ('smart work').
[55] See also Section 5.3.

Nationally, nearly three quarters of Australia's population growth between 2001 and 2021 was in the eight capital cities (Table 7). However, SUAs within 100 km of a capital city grew slightly more quickly in percentage terms, at 1.8 per cent per year, compared to 1.6 per cent for the capitals. As Salt (2022a) puts it, *"new lifestyle, sea-change and treechange, and now work-from-home communities thrive within drivable distances of every capital: Victor Harbor outside Adelaide, Mandurah near (and now part of) Perth, Surf Coast outside Melbourne."* A stimulus to working from home provided by COVID-19, combined with a 30s and 40s age cohort seeking larger housing space, reinforces this trend (Salt 2022b).

Between 101 and 200 km from a capital city, Ballarat (1.6 per cent) and Bendigo (1.5 per cent) have experienced slightly faster growth than both the national average (1.4 per cent) and other Victorian SUAs in this distance range. The Victorian government's promotion of growth in these two cities and in Geelong[6], through improved passenger rail services, in combination with relocation of state government functions, has underpinned this outcome (Glazebrook and Lowrey 2023, Searle 2018).

As distances increase, the opportunity to readily access capital city-based services and facilities lessens. Noting Searle's suggestion that a population "approaching 100,000 or beyond" is needed to support the level of services that can attract residents, the necessary regional city size may also increase somewhat with distance. Nevertheless, the Victorian experience illustrates how upgraded passenger rail, faster and more reliable than road, may, given a coordinated planning framework (Gurran et al 2022), help attract new residents to regional SUAs that would sit within either a two hour – and possibly three hour – service time link to a major capital.

5.3. Supporting regional centres in the 'aviation rain shadow'

Beyond an easily drivable distance of around 100 km from a major capital, many regional centres require, for health and other essential service functioning as well as for business, a fast public transport option that allows for convenient day return travel. However, most centres within around 350 km – beyond which an air link to the nearest state capital is universal (Potterton 2022) – lack such an option. Nationally just two SUAs in the 100 to 350 km distance range, Ballarat and Bendigo, have rail service faster than the private vehicle, while only seven – Fraser Coast, Toowoomba[7], Newcastle-Maitland, Batemans Bay, Canberra-Queanbeyan, Orange and Mudgee – of a remaining 26 in scope, have air service to the closest major capital.

Where in place at smaller regional SUAs, air transport brings in visiting medical specialists to help sustain hospital services (Potterton 2022). Medical personnel, government and business travellers comprise over 80 per cent of Regional Express Airlines' passenger load, much of it day return (Rex 2019). But air transport closer to capital cities has long been in decline, as the quality of road infrastructure and vehicles continues to improve (BITRE 2008, Harris 2021) and as air fares remain pitched well above those on larger longer, air routes that command airline economies of scale and distance (Zhang et al 2018). Using data included in Table 1, the median air fare per 100 km for the seven regional SUAs listed above is $113, in comparison to $39 for 10 mainland eastern intercapital routes (Table 2).

Reducing train service times that approach or exceed four hours to around three hours could ensure essential day return connectivity for regional centres in the 'aviation rain shadow' – the zone where air services are either not in place or may be vulnerable in future to improving road transport. Examples include Bairnsdale to Melbourne (passenger rail only) and Maryborough (Fraser Coast) to Brisbane and Orange to Sydney, routes with both passenger rail and air.

[6] The Victorian and Commonwealth governments co-funded Regional Fast Rail from Melbourne to Geelong.
[7] Unusually for air routes and in contrast to passenger rail services, the Brisbane-Toowoomba air route, part of a service with three more distant stops, is provided through Queensland Government subsidy (DTMR 2023)

5.4. Future-proofing convenient intercity access to centres of major capitals

Australia, one of the world's largest countries, has long, busy air routes (Table 8). With route service times of 90 minutes to two hours, airports near city centres are able to offer a short first and last mile trip, benefitting day return travel in particular. Airports face competing priorities of, on the one hand, maximising long run capacity – through measures including additional runways and a more extensive flight path footprint – and, on the other, maintaining neighbourhood 'social licence', by addressing noise concerns linked to actual or planned capacity expansion. With growing air transport demand, airports sited on or beyond the city fringe can often find a market offering flights that primarily service the airport's nearby suburbs and towns. 'Second' airports can also relieve capacity pressure at a centrally located airport.

Table 8: Top 5 air routes, China, USA and Australia, with country area and median route distance

Country	Country area m sq km	Top 5 routes (by no of seats)	Median air distance km
China	9.60	Beijing-Shanghai; Guangzhou-Shanghai; Shanghai-Shenzhen; Beijing-Shenzhen; Guangzhou-Huangzhou	1,260
USA	9.17	Las Vegas-Los Angeles; Honolulu-Kahului; Atlanta-Orlando; New York-Los Angeles; Denver-Las Vegas	826
Australia	7.69	Sydney-Melbourne; Brisbane-Sydney; Brisbane-Melbourne; Gold Coast-Melbourne; Gold Coast-Sydney	909

Source: BITRE 2022, Gallagher 2023; OAG 2023 and author analysis

Before COVID-19, peak weekday morning aircraft movements at Sydney Airport, located 13 km from the city centre and without the opportunity for an additional long, national and internationally capable runway, stood at around 90 per cent of its legislated hourly movements cap.[8] In May 2023, the movement level had returned to 80 per cent. With a new airport under construction on Sydney's western edge, some 40 km further from the central business district than Sydney Airport, it is unclear to what extent travellers to and from other cities and with a central Sydney origin or destination will be willing to use it for day return travel.

If there were no capacity for additional peak period flights at Sydney Airport and aircraft upgauging opportunities had been exhausted, the consequence could be the reverse of the positive economic impact that followed introduction of high speed rail between Paris and Lyon (France) in the 1980s. Here two hour rail trips eliminated many businesses' need for overnight stays, so reducing travel costs, increasing trips between the two cities and boosting business growth (Bonnafous 1987). In contrast, for travel to Sydney, businesses would face a choice between the higher costs of a longer overall trip with overnight stays, or the higher costs of a day return trip, with airlines and airport managing demand through higher pricing.

Like Sydney, Melbourne and Brisbane also have large built-up areas in world terms[9]. Comparable central city connecting issues could apply in either city for a second airport, in the event of a future binding capacity constraint at the principal airport. However, a binding constraint at Sydney Airport alone would disrupt efficient travel for many cities in connecting conveniently to central Sydney. Provided its trains could access a future central Sydney[10], competition and capacity provided by high speed rail would avoid this outcome.

5.5. Assisting lower and net zero emission transport

On high density air routes under 1,000 km, there is an opportunity to partly replace aviation with high speed, electrified passenger rail services, powered by future zero emission electricity.

[8] Airservices Australia 2019 and 2023, Sydney Airport 2019 and author analysis. Sydney Airport has an hourly aircraft movements cap of 80 per hour.

[9] With a built-up area of 2.70 million square km, Melbourne ranks 33rd in the world. Brisbane (2.65 million square km) places 35th and Sydney (2.18 million square km) 45th (Demographia 2022).

[10] John Austen (interview 17 April 2023) queries whether Sydney Metro construction has impeded such access.

The opportunity leverages the gap in zero emission technology readiness between, on the one hand, passenger rail – ie that is already electrified, or of sufficient market size to be suitable for electrification – and, on the other, large passenger jet aircraft.[11]

Air transport generates a small, growing share of Australia's domestic transport carbon dioxide (CO_2) emissions: eight per cent in 2019, projected to increase to 10 per cent in 2035 (Department of Climate Change, Energy, the Environment and Water 2022). A high speed rail network connecting, from north to south to west, Brisbane, Gold Coast, Newcastle, Sydney, Canberra, Melbourne and Adelaide and points between would, if in place today, compete with services on 27 air routes[12]. These routes comprise 30 per cent of Australia's domestic air passenger km and a likely similar share of its aviation emissions (Table 9). Assuming 50 per cent of air travel migrated to high speed rail (AECOM et al 2013), there would be a 'first round' reduction in Australia's air passenger km travelled of some 15 per cent. If, notionally, the network were in place in 2035, Australia's transport sector emissions would fall by 1.6 per cent and Australia's total emissions by 0.4 per cent – or a little less, allowing for 'rebound' in air transport demand, in response to increased system capacity. With continued growth in aviation emissions, reduction in national emissions would approach two thirds of one per cent by 2050.

Table 9: CO2 emission reductions from operations of a notional 2035 HSR four major capital network[1]

	Aviation Mt	Transport Mt	AUSTRALIA		EMISSIONS CHANGE 2035	
			Mt	Aviation share	Transport	Australia
Emissions 2022						
Total	6.5	90.6	486.9	1.3%		
27 HSR air routes (est.)	2.2					
Emissions 2035						
Total	10.0	99.0	383.0[2]	2.6%		
27 HSR air routes (est.)	3.0					
Emissions change 2035						
70% HSR mode share	-2.1	96.9	380.9		-2.2%	-0.6%
50% HSR mode share	-1.5	97.5	381.5		-1.6%	-0.4%
20% HSR mode share	-0.6	98.4	382.4		-0.6%	-0.2%

1. Network construction emissions, net of displaced airport-related construction and aircraft manufacturing activity, are not included.
2. DCEEW 2022 'baseline scenario' comprising existing policies and measures.

Source: DCCEEW 2022, BITRE 2022 and author analysis

Road passenger transport (ie car, light commercial vehicle, bus, motorcycle) transport emissions are projected to decline from 65 megatonnes (and 65 per cent of transport emissions) in 2019 to 51 megatonnes (52 per cent) by 2035, in a context of growing light vehicle fleet electrification (DCCEEW 2022). This improvement is not, however, a barrier to also achieving emission reductions on rail routes around major capitals, through upgraded rail. Firstly, improvements in service times, reliability and frequency enable rail to leverage its traditional point of difference as the lowest emitting motorised passenger transport mode per passenger-kilometre (International Energy Agency 2022). Secondly, green hydrogen powering in particular may hold promise for lower density, non-electrified lines.[13]

[11] Production and use of sustainable aviation fuel (SAF) is a near term strategy for reducing, but not eliminating, large jet aircraft emissions. Van Dyk (2021) writes: *"For aviation to achieve net zero emissions by 2050, the bulk of SAF will likely have to come from e-fuels. However, the technology is currently only at pilot scale and e-fuels are very expensive to produce"*. Whereas the constituents of e-fuels (fuels produced from electricity) are air and water, commercial production of SAF is based on limited land-based feedstocks, eg used cooking oil, solid waste. Larger crop sources that can complement food crops are being trialled (Taheripour et al 2021).

[12] See Section 2. Of 30 air routes in scope, three between Adelaide and east coast cities other than Melbourne are excluded, due to indirect land distances and resulting large service time differences between the two modes.

[13] Alstom (2022) reports that its hydrogen Coradia iLint train, in service in Germany on short distances since 2018, undertook a demonstration journey of 1,175 km without stopping for (currently conventional) refuelling.

5.6. A better connected national rail network

Passenger rail upgrades that align with the preceding five policy rationales are likely to achieve better social and economic outcomes if implemented with a parallel goal of taking opportunities to overcome system interface constraints and disconnects.

As a two gauge state, Victoria faces a challenge that is accentuated by operational issues in dual gauging broad and standard gauge track.[14] Existing arrangements are the source of well-publicised additional costs for rural shippers and rail freight operators (Verley and Darling 2021), while also limiting opportunities for better passenger connectivity (Shepherd 2020). Firstly, standardisation of Victoria's regional network, in conjunction with full separation from the electrified Melbourne suburban system, would eliminate conflict between frequent suburban trains and less frequent regional trains that run with few stops and at higher speeds (Michell M 2018). Secondly, as Shepherd suggests, Melbourne's future upgraded Sunshine interchange could provide an entry point into the metropolitan area for standard gauge high speed rail. And thirdly, standardisation between Melbourne, Ballarat and Ararat would provide a 40 km shorter Melbourne-Adelaide route than the existing one via Geelong and a superior alignment on which to plan upgraded intercapital services.

Queensland has been less affected than Victoria by past Commonwealth-initiated standardisation, which reaches only to Brisbane, under 200 km from the New South Wales border. However, there is no rail connectivity between the Gold Coast and its northern New South Wales hinterland (Kinsella 2018). Improved or fast rail from Brisbane, undertaken with standard or dual gauge track, could provide a platform to overcome this disconnect through a southern extension to reach the NSW North Coast Line via Lismore. [15]

6. Policy rationales, 'time-space' considerations and upgrades

This section aligns the six policy rationales with 'time-space' considerations and passenger rail upgrade type choices, in major capital surrounds and mainland eastern intercapital corridors.

6.6.1. Major capital city surrounds

Table 10 sorts 37 regional SUAs into one hour, two, three hour and above three hour 'post upgrade' service time bands. 34 have existing passenger rail service and three would experience a line extension. Choice of service speed determines each SUA's service time. In all, 30 SUAs would have 'improved', four 'fast' and three 'high speed' service.

The business productivity rationale supports improved rail for Gold Coast-Tweed Heads and Wollongong SUAs. At greater distance from Sydney and Melbourne respectively, fast rail fits Newcastle and Albury-Wodonga. Due to distance and knowledge city ranking (Section 5.2), high speed rail is appropriate for Canberra-Queanbeyan[16]. In all, 13 regional SUAs would have service times within one hour.

Drawing on the differential population growth precedent of Ballarat and Bendigo (Section 5.2), population growth rebalancing benefits are in principle applicable in all 24 regional SUAs with upgraded service times within two hours. With median service time reductions around 30 per cent or higher for SUAs situated between two and three hours from a major capital, there may also be population growth rebalancing impacts beyond two hours.

[14] With less than 85 millimetres between the two rails, dual gauging brings "inherent speed restrictions for broad gauge trains" (John Hearsch Consulting 2017).

[15] A New South Wales North Coast branch line from Casino to Murwillumbah (13 km from the Queensland border) via Lismore was closed in 2004.

[16] Bowral-Mittagong and Goulburn, en route to Canberra-Queanbeyan, also show high speed service times.

16 SUAs across all service time bands could benefit, for essential service and business functioning, from upgraded train services that provided a sufficiently fast public transport option in the absence of air service. Six SUAs with air service[17] would be future-proofed, should improving road conditions or other factors result in loss of an air link (Section 5.3).

Table 10: Upgrade service times (shortest first) and policy rationales, major cap.-reg. SUA train routes

Regional SUA	Upgrade type	Rail distance km[1]	Max. speed kph[2]	Av. speed kph	Service time mins	Change in service time	Policy rationale(s)
Up to 1 hour							
Yanchep	Improved	55	140	105	32	-53%	PGR
Melton	Improved	37	160	120	19	-50%	PGR
Bowral-Mittagong[3]	High speed	98	300	221	30	-79%	PGR
Central Coast	Fast	81	220	165	29	-65%	BBP, PGR
Wollongong	Fast	83	220	165	30	-69%	BBP, PGR
Gisborne-Macedon	Improved	64	160	120	32	-33%	PGR
Geelong	Improved	73	160	120	36	-41%	BBP, PGR
Gold Coast-Tweed Heads	Improved	89	160	120	45	-51%	BBP, PGR, NRN
Sunshine Coast	Improved	104	160	120	52	-53%	BP, PGR, ARS, NRN
Warragul-Drouin	Improved	100	140	105	57	-43%	PGR
Goulburn[3]	High speed	225	300	245	57	-63%	PGR
Newcastle	Fast	168	220	165	58	-65%	BBP, PGR, ARS
Ballarat	Improved	119	160	120	59	-30%	BBP, PGR, ARS
1-2 hours							
Nowra-Bomaderry	Improved	153	160	144	65	-62%	PGR, ARS
Canberra-Qbn[3]	High speed	330	300	250	92	-63%	BP, PGR, CMC, NZE
Toowoomba	Improved	162	140	105	93	-27%	BBP, PGR, ARS
Bendigo	Improved	162	160	120	81	-44%	BBP, PGR, ARS
Bunbury	Improved	167	160	120	84	-37%	BBP, PGR, ARS
Traralgon	Improved	158	140	105	90	-44%	PGR, ARS
Shepparton-Mooroopna	Improved	182	160	120	91	-65%	PGR, ARS
Wangaratta	Fast	234	200	150	94	-42%	PGR, ARS
Maryborough	Improved	224	160	120	112	-49%	PGR, ARS
Busselton	Improved	221	140	116	114		PGR, ARS
Albury-Wodonga	Fast	299	200	150	120	-45%	BBP, PGR, ARS
2-3 hours							
Bathurst	Improved	229	140	105	131	-46%	PGR, ARS
Echuca-Moama	Improved	250	140	115	131	-37%	PGR, ARS
Warrnambool	Improved	267	140	109	148	-31%	PGR, ARS
Batemans Bay[4]	Improved	238	140	130	149		PGR, ARS, NZE
Bairnsdale	Improved	275	140	105	157	-34%	PGR, ARS
Mudgee[4]	Improved	279	140	105	160	-48%	PGR, ARS, NZE
Bundaberg	Improved	351	160	133	161	-35%	BBP, PGR, NRN
Orange	Improved	323	160	121	178	-38%	PGR, ARS, NZE
Horsham	Improved	327	140	110	179	-29%	PGR, ARS
Above 3 hours							
Coffs Harbour	Improved	388	160	130	194	-49%	PGR, NRN
Port Macquarie	Improved	455	160	137	202	-34%	PGR
Portland[4 5]	Improved	369	140	108	206	-55%	PGR, ARS
Dubbo	Improved	463	140	116	258	-38%	PGR

1. Existing rail distance. With possible alignment changes, upgrade distances may differ.
2. Maximum speed of the directly connecting line segment, ie Wollongong to Nowra-Bomaderry for Nowra-Bomaderry.
3. Service time assumes a maximum speed of 220 kph in the Sydney metropolitan area.
4. Possible line extension to each of three SUAs and replacing existing connecting coach service (Mudgee, Portland).
5. Portland is 352 km by road from Melbourne, meeting the "around 350 km" limit for inclusion in the aviation rain shadow.

KEY: BBP Better business productivity PGR Population growth rebalancing CMC Convenient access to centres of major capitals ARS Supporting regional centres in the aviation rain shadow NZE Net zero emission transport pathway NRN Connected national rail network

Connecting Brisbane and the Gold Coast with SUAs in northern and central New South Wales would improve connectivity of the national rail network, as also would standard or dual gauging of upgraded rail links to Brisbane's north (Sunshine Coast, Maryborough, Bundaberg).

[17] The seventh, Canberra-Queanbeyan, including the federal capital, might retain air service, even with upgraded rail.

6.6.2. Intercapital corridors

Service times of 10 hours or more, as on the three longer intercapital corridors (Table 6), limit opportunities to run more than one service in daylight hours. A second or third service, with nighttime stops, necessarily has limited appeal at regional centres en route, while the 16 hour Sydney to Brisbane service, is beyond an overnight service time range. Lengthy service times also hamper more efficient train utilisation over a 24 hour period.[18]

Table 11: Improved, fast and high speed non-express service times, intercapital train routes

Route	Upgrade rail distance km[1]	IMPROVED (120 kph)[2]		FAST (165 kph)[2]		HIGH SPEED (263 kph)[2]	
		Mins	Change	Mins	Change	Mins	Change
Brisbane-Sydney[3]	950	7h55	-52%	5h45	-65%	3h37	-78%
Sydney-Melbourne	900	7h30	-31%	5h27	-49%	3h25	-68%
Sydney-Canberra	330	2h45	-33%	2h	-52%	1h15	-70%
Canberra-Melbourne	660	5h30	-40%	4h	-56%	2h31	-73%
Melbourne-Adelaide[3]	790	6h35	-37%	4h47	-54%	3h	-71%

1. Indicative estimates based on AECOM et al 2013 (Gold Coast route, Canberra spur), Laird 2017, 2022, various and author analysis. Fast and high speed distances (and resulting times) in particular may be shorter, due to requirement for alignments with lower track curvature.
2. Average operating speed. 3. Brisbane-Sydney via Gold Coast, Melbourne-Adelaide via Ballarat.

With passenger rail upgrade extended throughout the length of the intercapital corridors, service times would reduce by between 30 and 50 per cent (approximately) for improved rail, 50 to 65 per cent for fast rail, and 70 per cent or more under high speed rail (Table 11). Better customer appeal and more efficient train utilisation would result from all of these upgrades.

Additional business productivity and population growth rebalancing benefits would likely be limited under improved intercapital rail, as only two additional regional SUAs, Wagga Wagga and Kempsey, each more than 400 km from a major capital, would receive improved services and service times would sit well above three hours. However, with intercapital fast rail, Coffs Harbour and Port Macquarie [19], as well as the above two centres, would have major capital service times of three hours or less. Canberra-Queanbeyan and Albury-Wodonga, both top 20 'knowledge cities' (Section 5.1) would be connected by a two hour service time. With high speed rail, service times for all regional SUAs en route would sit within two hours, with the greatest potential for business productivity and population growth rebalancing impacts.

Door to door intercapital air trips to Sydney via future Western Sydney International Airport would likely be shorter than either improved or fast rail for intercapital routes other than from Canberra, notwithstanding the new airport's less central location. More positively, service times below eight to nine hours might generate an expanded overnight market, following recent European precedent.[20] High speed rail would make inroads into the air market (Section 5.4).

All three upgrade types would enhance the connectivity of the national rail network, with benefits to all its users, including rail freight.

7. Conclusions

A compelling policy rationale or rationales will be needed to marshall and sustain support for future upgrade to Australia's non-urban passenger rail services. Six 'candidate' rationales hold promise. These are: the role of fast, convenient intercity public transport in building productivity through the impetus to business specialisation, scale and growth that it offers;

[18] Interview Max Michell, 16 December 2022. Michell suggests that with a six to seven hour service time, trains between Sydney and Melbourne each way could run hourly in a five hour block.
[19] Sydney-Wauchope, for Port Macquarie, would have a longer service time than Brisbane-Coffs Harbour, with a 20 minute (19 km) road transfer to be added also, absent station relocation to nearer the city.
[20] High demand is reported for routes such as from Brussels to Berlin (757 km), spurred by post-pandemic interest in travel with greater personal space than available in air transport (Burroughs 2023).

avoiding a 'megacity' future through rebalancing population growth towards regional centres; strengthening small regional centres that depend, for health and other essential services, on sufficiently fast public transport but, as road infrastructure improves, are too close to capital cities for viable air links; future-proofing convenient access for day return travel to centres of major capitals against a threat of capacity constraint at centrally located airports; assisting a net zero emission transport sector by 2050; and better connecting Australia's rail network.

Strength of alignment with one or more of these rationales, considered in a 'time-space' framework – ie given distance, the service time and operating speed needed to achieve the impacts sought – can guide upgrade type choice between improved, fast and high speed rail. High speed rail is assigned here to the Sydney-Canberra route, providing a within two hour service between two knowledge economy hubs. Between major capitals, high speed rail at around three hours could future-proof convenient day return access to the centre of Sydney in particular. With mode shift from aviation, it would also contribute to reducing transport sector carbon emissions. Fast rail between Sydney and Newcastle and between Melbourne and Albury-Wodonga (business productivity and population growth rebalancing key rationales) would yield one hour and two hour times respectively. Improved rail offers faster times within one hour, two hours and three hours. Bringing centres such as Bathurst and Bairnsdale within a three hour benchmark maximum service time for day return travel addresses the essential service aviation rain shadow constraint and may also aid population growth rebalancing.

With improved rail involving service time reductions of at least 30 per cent, compared to existing services, the required capital investment and potential ongoing operating subsidy cost could be large – and larger again for greater reductions under fast rail and high speed rail. So underpinning policy rationales must be robust. All of the canvassed rationales can sustain further research, as can passenger rail upgrade opportunities and constraints. Both areas would benefit from better information on business, commuting and other travel behaviour and mode preferences over distance.

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