

A BRIEFING ON
TRANSRAPID
MAGLEV
INTERCITY
OR
AIRPORT EXPRESS MONORAILS



This document shows how Transrapid Maglev could be used in Australia to provide high speed rail links in the 100 to 500 km/h speed range without needing a straight, 200 meter wide easement.

Because the Transrapid system is elevated it can be placed above existing freeways avoiding the need for spending hundreds of millions of dollars per kilometre on tunnelling.

Note: Monorails Australia has no commercial relationship with Transrapid.

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<http://www.monorailsaustralia.com.au/Maglev.pdf>

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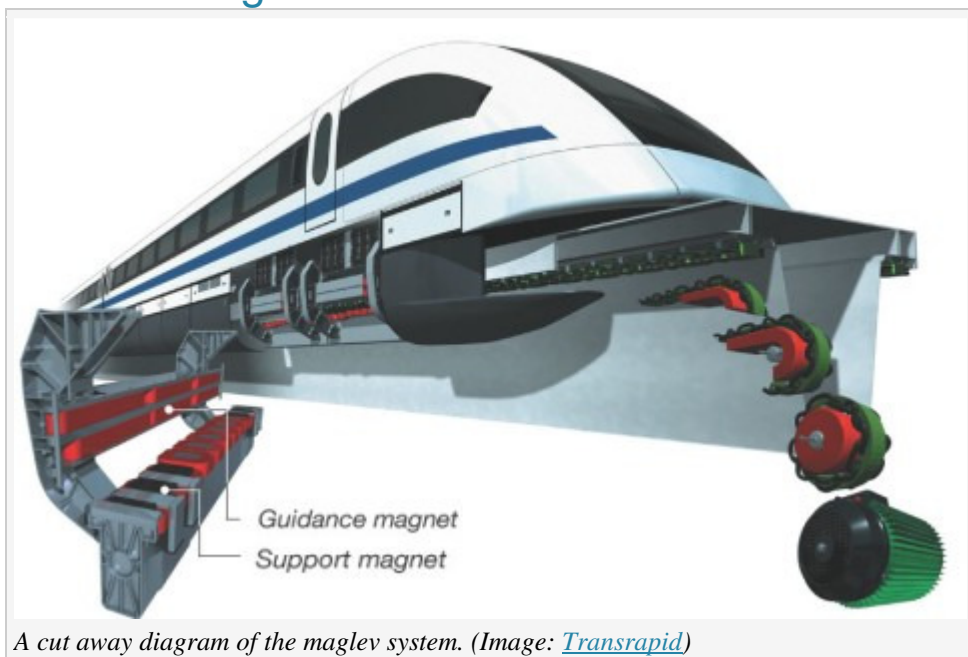
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Why Maglev?

Maglev high-speed rail is the best high-speed rail system for Australia.

- Maglev track is easily elevated through urban areas where there is no surface easement.
- Maglev trains can operate at up to 500 km/h. A maglev train would take 2 hours to reach Sydney compared to over 3 hours for other high-speed systems.
- Maglev track can handle the curve radii and gradients of existing motorway easements so do not need a new easement to be cut through the landscape.
- At \$30 to 40 million per kilometre the Maglev system compares well with many other transport systems.
- Maglev trains can be between two and ten carriages long and are 3.7 meters wide. This allows for up to 900 seated passengers on one train assuming a mix of first and second class seating.
- While Maglev is new compared to other transport technologies the Shanghai Maglev has operated continuously since 2004 proving the concept. The German maglev test track at Emsland operated between 1984 and 2013.

What is Maglev?

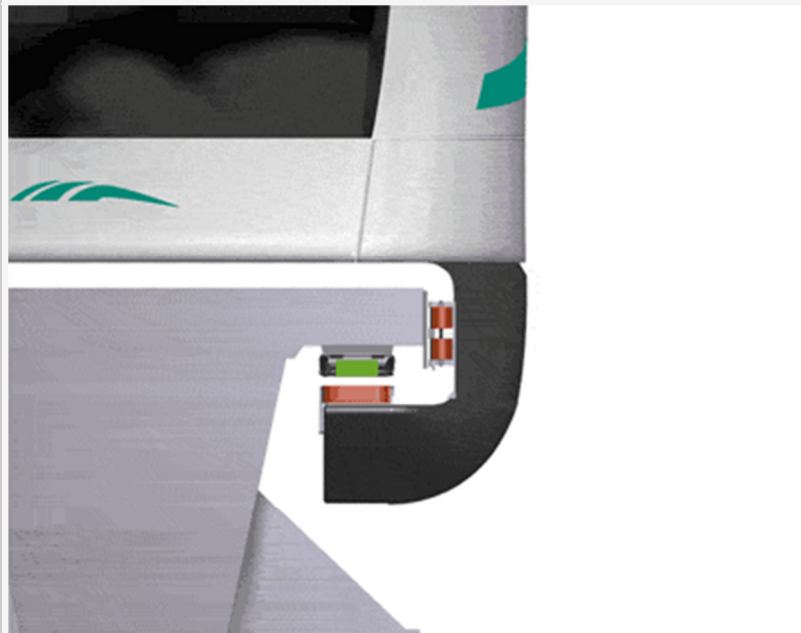


A cut away diagram of the maglev system. (Image: [Transrapid](#))

Instead of wheels, Maglev Fast Rail systems use magnets to magnetically levitate the train above the track. The track itself is an electric motor that has been unwound into a long linear motor. The linear motor propels the Maglev train along the track at speeds of up to 500 km/h.

There is no friction between the train and the track, there are no overhead wires. Inside the train the magnetic field strength is one tenth of the magnetic field of a hair-dryer. The train levitates

using on-board batteries which can keep the vehicle floating for up to an hour without any mains power supply to the track. Outside there is no noise from steel wheels on steel track, no sparking from overhead wires.



Guidance magnets located on both sides along the entire length of the vehicle keep the vehicle laterally on the track. (Image: [Transrapid](#))

Videos

Visit www.MonorailsAustralia.com.au to see the videos.

Maglev Interior

Three x three seating:



Image of the interior of a Shanghai Maglev train showing economy 3 x 3 seating. Note the 3.7 meter wide carriage - normal trains are about 3 meters wide.

Two by two seating:

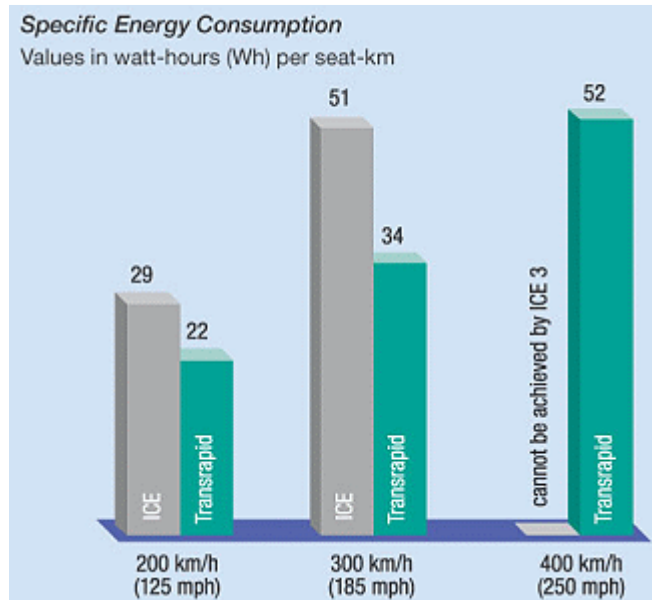


Transrapid TR09 interior. This shows 2 x 2 seating.

Technical Data

Energy Efficiency

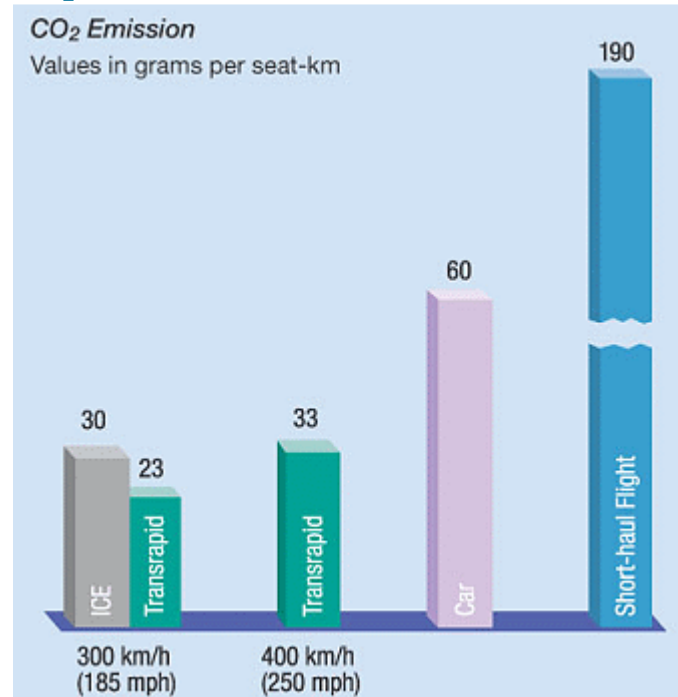
The graph below shows Transrapid Maglev energy efficiency, as stated by Transrapid on their web site and in their official submission to the Victorian State Government.



Critics have suggested that energy requirements for maglev are massive and several new nuclear power stations would be needed to run the maglev track. Impartial analysis and inspection of the Shanghai maglev track should be able to uncover any such hidden nuclear power stations and determine exactly what the energy requirements are.

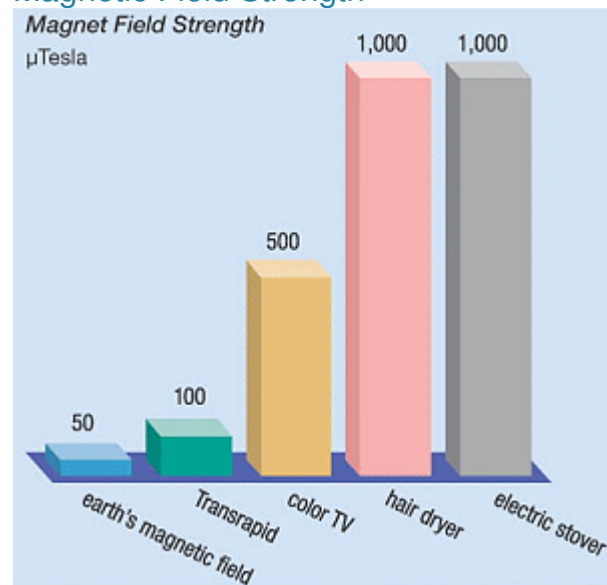
We note that Transrapid claims their trains can continue to levitate on battery power alone in the event of a power failure to the track.

CO₂ Emissions



Transrapid CO₂ emissions.

Magnetic Field Strength



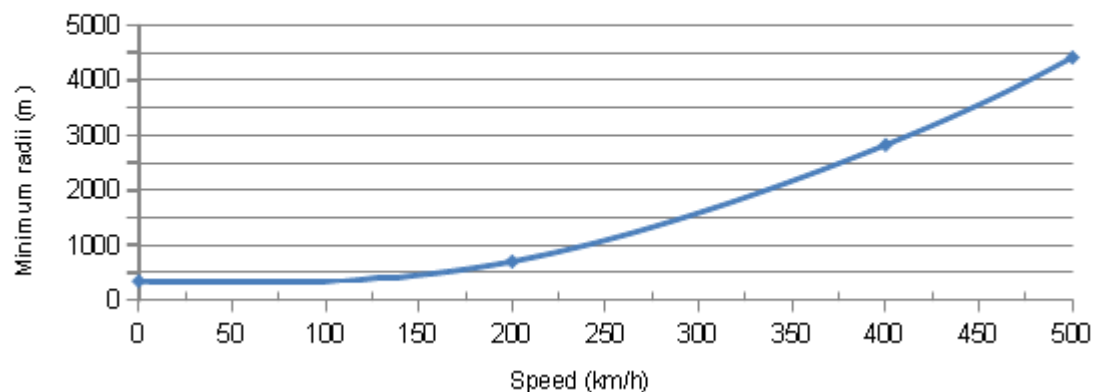
Transrapid magnetic field strength inside the cabin compared to a hair dryer.

Curve radii

The Transrapid web site gives data four points of data for curve radii [here](#). Plotting this as a graph enables estimation of minimum curve radii for any given speed.

Note that at 200 km/h maglev is able to turn through curves with a radius of just 705 meters. This is one of the key benefits of this technology.

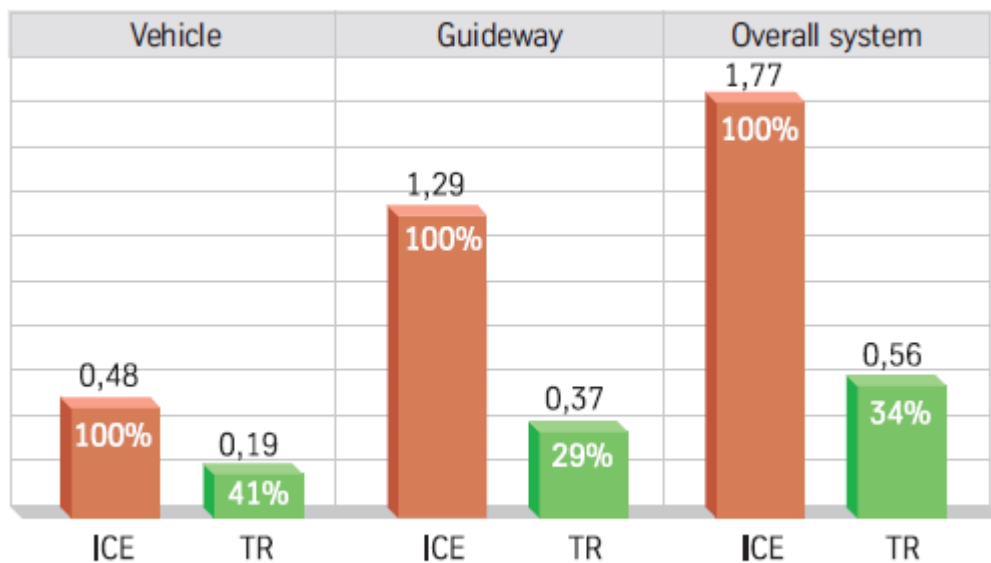
Transrapid curve radii for given speed



Maintenance Costs

Due to the non-contact nature of the technology operating costs are greatly reduced as are system downtimes.

Maintenance costs per seat/kilometer Eurocent/seat-km

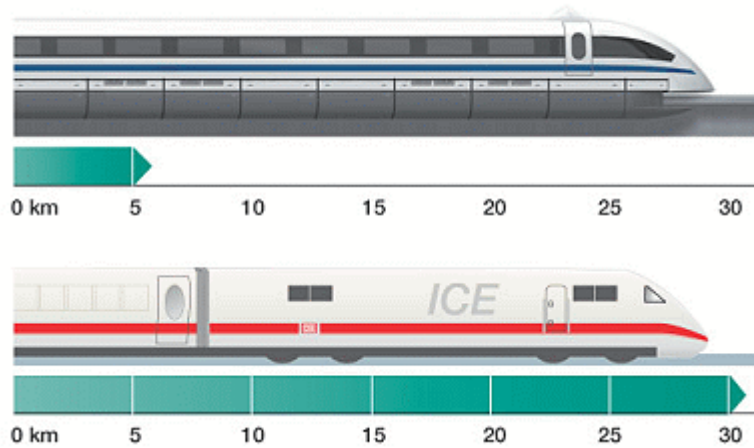


Operating speed: ICE (high-speed train) = 250 km/h,
TR (Transrapid) = 450 km/h

Acceleration

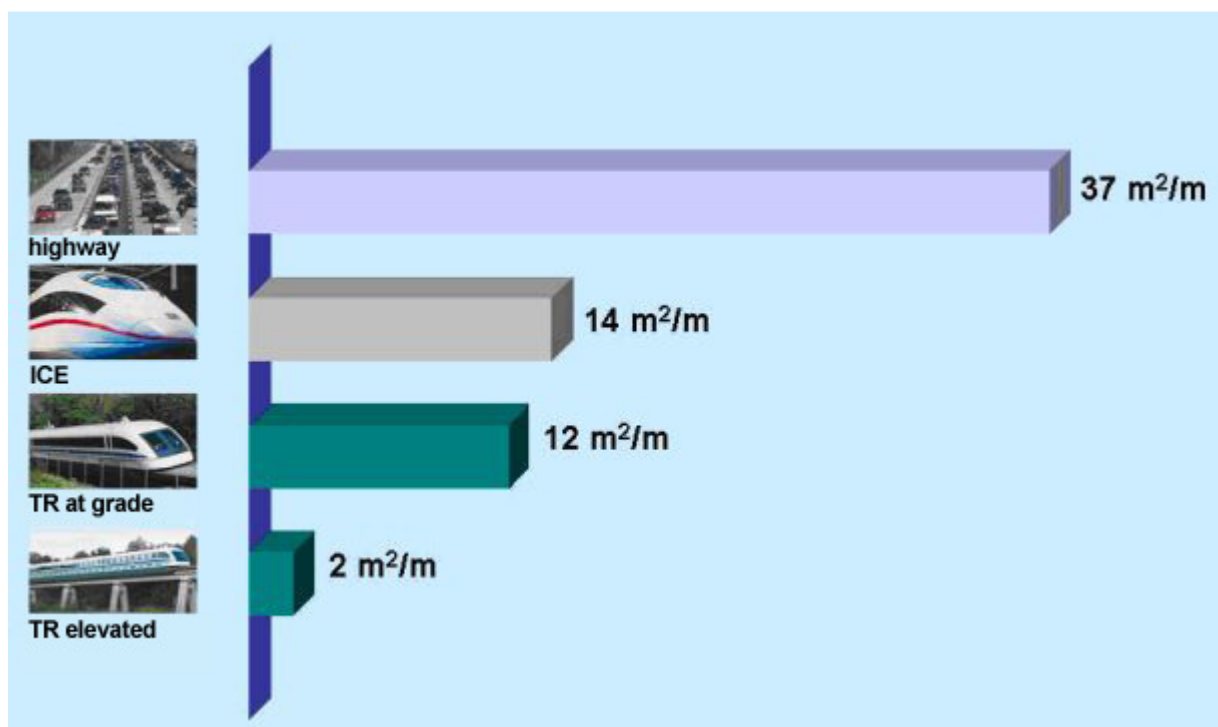
Transrapid maglev trains are able to accelerate much faster than conventional trains resulting in faster trip times/

Acceleration to 300 km/h (185 mph)



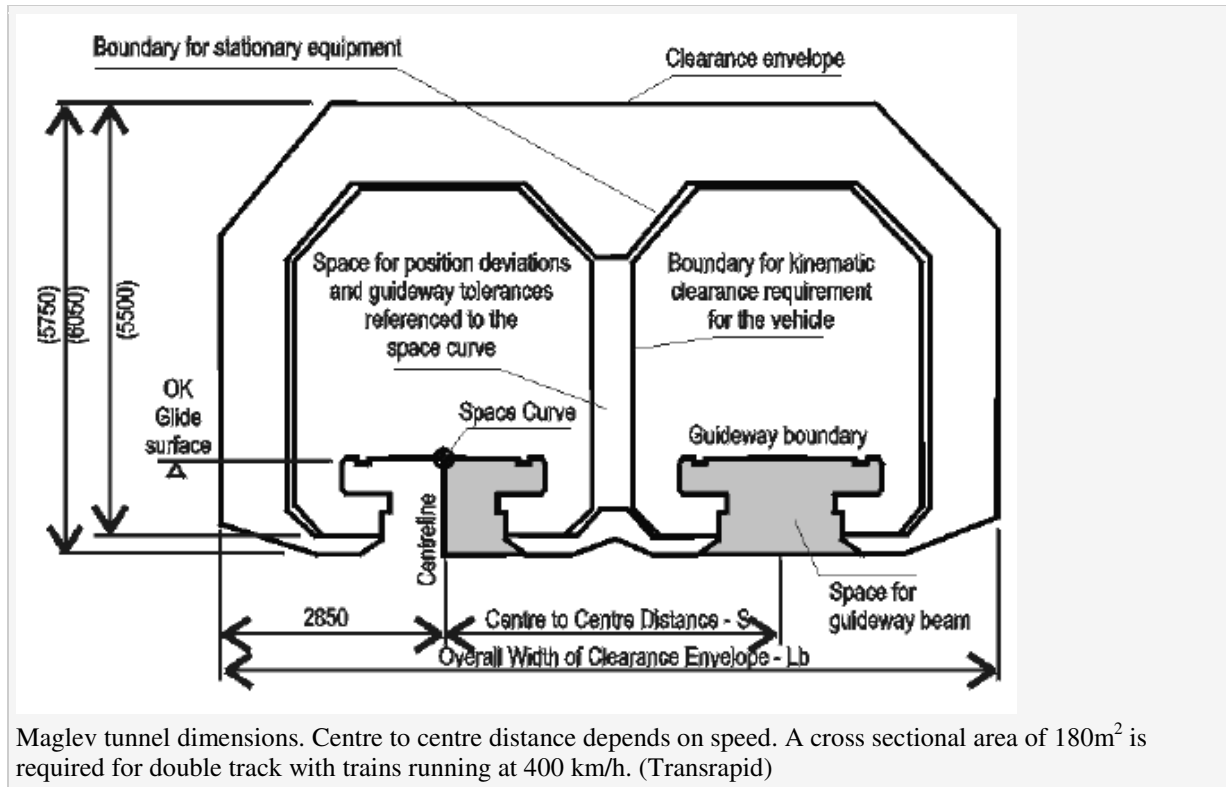
Land Usage

Elevated Transrapid maglev has very low land usage which is a key advantage when trying to thread new high speed rail links in and out of congested urban areas.



Tunnels

Tunnels are best avoided as irrespective of the guideway system they are extremely expensive and risky. However, maglev tunnel dimensions are somewhat smaller than conventional rail tunnels.

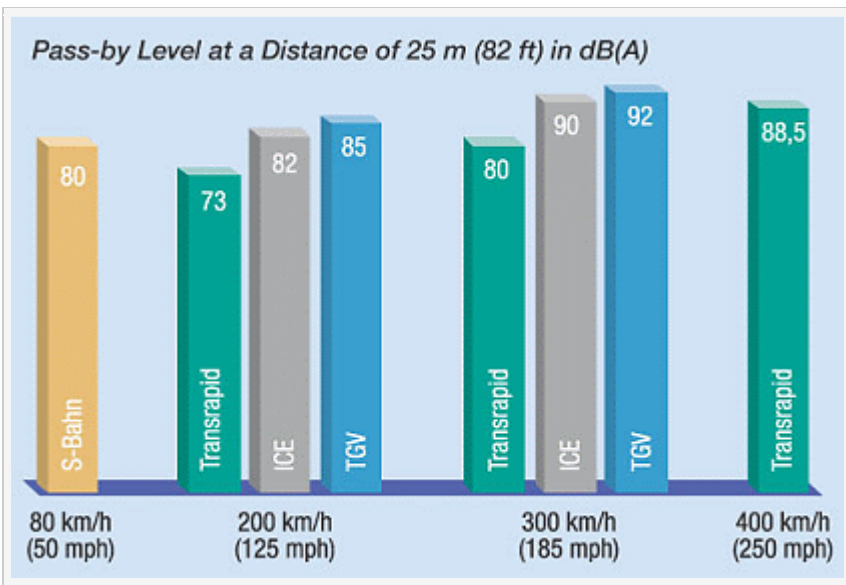


Gradients

As the Transrapid is capable of climbing steep gradients (ten per cent compared to four per cent for normal rail roads) and able to handle tight curves (1950 meters at 300 km/h compared with 3200 m for normal rail roads), it is possible to flexibly adapt its guideway to the landscape and to have it tightly follow existing roads, rail road tracks, and power lines.

Noise

At speeds around 200 km/h, you can hardly hear the Transrapid. It can quietly hover through cities and urban areas because with its non-contact technology, there is neither rolling nor engine noise. At higher speeds, there is only the noise of the wind. At 300 km/h, the Transrapid maglev vehicle develops only as much noise as light rail trains travelling at 80 km/h, and even at speeds above 400 km/h, it is not much louder than considerably slower rail roads.



Air Turbulence

When the Transrapid passes by it generates minimal turbulence. Thanks to the aerodynamic optimization of the Transrapid vehicle, there is nothing more than a slight gust at a distance of 2 meters when the Transrapid passes by at a speed of more than 380 km/h. There is no perceptible air movement under the elevated guide way and the air movement produced by the vehicle on at-grade guide way at a speed of 330 km/h is only as strong as a moderate wind.



Freight

Transrapid maglev is quite capable of carrying freight. Freight trains could be scheduled to run in off-peak times or else the first and last segments could be dedicated to carrying freight with the central segments carrying passengers.



A cut-away image of a Transrapid maglev freight train. (Image: Transrapid)

Assembly of Modular Track

The highly modular track design speeds up track construction, keeps costs down and maintains high quality.

As the track is mostly elevated anyway the cost and complexity of dealing with bridging many small features like roads and rivers is avoided. In farmland and natural habitat people, animals and equipment can easily move under the guideway.



'At Grade' track under construction for the (now dismantled) Emsland test track. Girders are completely equipped with Stator Packs and Cable Windings. (Image: US Maglev Coalition)

The windings are added to the track segments in the factory.



Preparation of the Long Stator Winding. (Image: US Maglev Coalition)

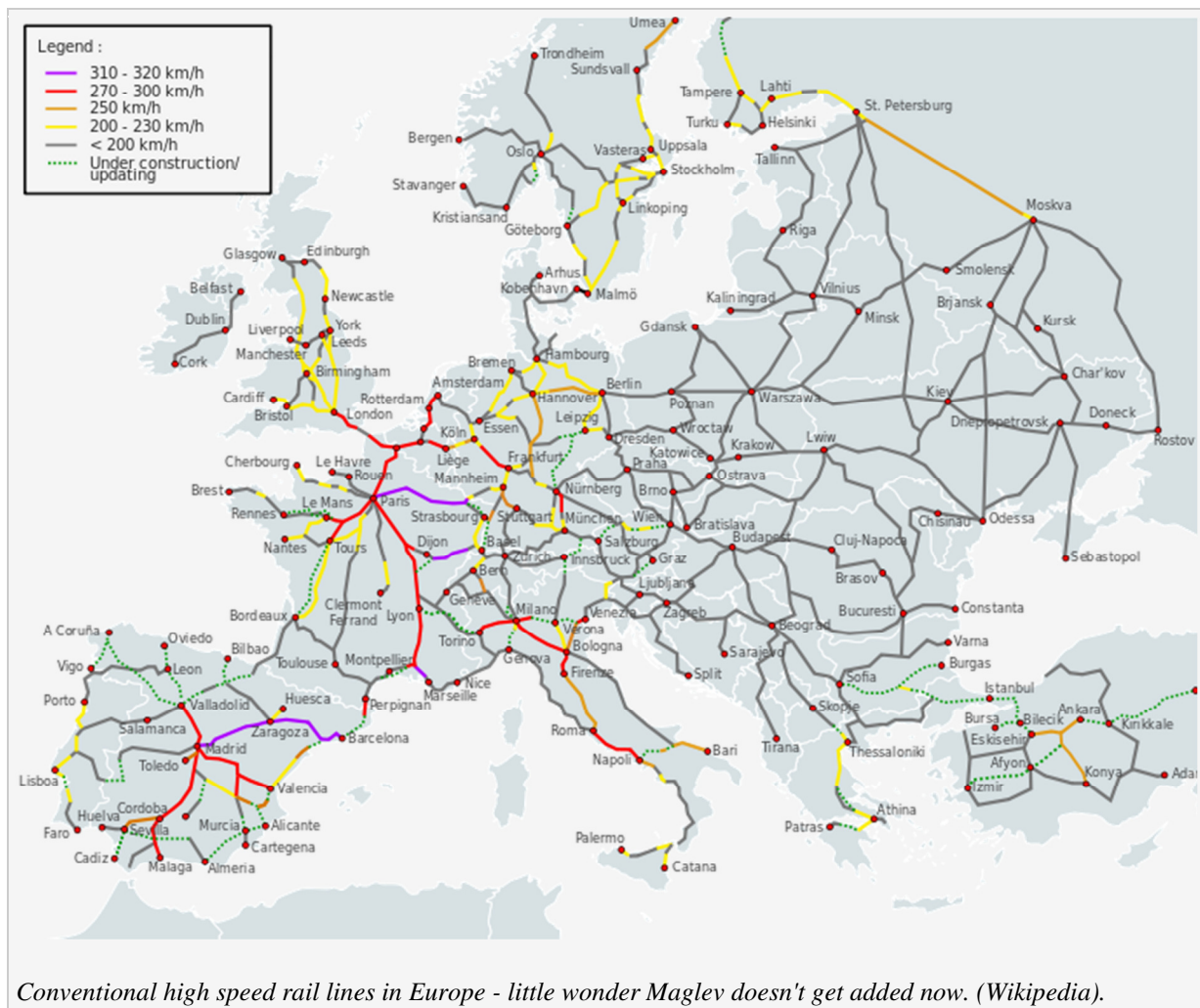
Why aren't there more Maglevs?

High speed rail was pioneered in Europe and Japan many years before maglev became a viable system in the late 1980's. By the time maglev was an option an extensive network of conventional rail lines had been established across Europe and Japan.

In this context any new high speed line is most likely to use conventional rail technology to fit in with the rest of the network.

Additionally the distances involved in Japan and Europe do not demand speeds of 500 km/h.

The lack of extensive maglev networks has been a major handicap for maglev as there is great resistance to trying anything new or different.



In Australia we have a clean slate with no fast rail and large distances to cover so we should be looking at what is best for us, not what has evolved overseas.

Other Criticism

Maglev fast rail has attracted substantial criticism, most notably from Sir Rod Eddington, head of [Infrastructure Australia](#).

The key criticisms are as follows:

- **Lack of Use**

"The most powerful evidence to dismiss maglev is that it does not work anywhere in the world. [Even the Pudong system] is a relatively small stretch. It is not even to downtown Shanghai; it is just to Pudong." Rod Eddington ([April 2007](#)).

Responses

(a) Further human progress will be very difficult if all new technologies are dismissed because they are not already in use.

(b) Where the Shanghai maglev was built is not relevant to a discussion of the viability of the technology.

- **Speculative Technology**

Maglev is "speculative technology" with "fuzzy" economics. Rod Eddington ([April 2007](#)).

Responses

(a) The Shanghai Maglev and the Emsland test tracks have proven that Transrapid's maglev system works. Various other maglev projects including [JR Maglev](#) also prove the technology is viable.

(b) The per - kilometre cost of building the Shanghai maglev was similar to other elevated fast rail systems. The costs quoted by Transrapid for Australian maglevs are also similar to other fast rail and in fact cheaper than many conventional rail projects undertaken in Australia recently.

- **Power Consumption**

Maglev is too power hungry.

Responses

(a) Transrapid has explicitly stated that its system uses less power than ICE 3 high speed trains in its submission to the Victorian Government. Deliberately lying to the government would be a serious matter. Appropriate independent study of the Shanghai system should be able to quickly establish the facts.

(b) We note the capability of Transrapid maglev to continue to levitate for one hour after losing power using on-board batteries.

- **Incompatibility**

Maglev is incompatible with old rail technology.

Responses

(a) This is correct but fast rail systems (i.e. over 250 km/h) of whatever technology need to be built on new tracks or guide ways. They cannot operate in between heavy freight on existing steel rail track. Given new track has to be laid the point is moot.

(b) New technology is very often incompatible with old technology.

(c) Transrapid maglev [freight trains](#) are compatible with standard air-freight containers.

Melbourne to Sydney in 2 hours - by train!

This is a proposal for a Melbourne - Sydney high speed [Maglev Monorail](#) with a link to Canberra from Yass.

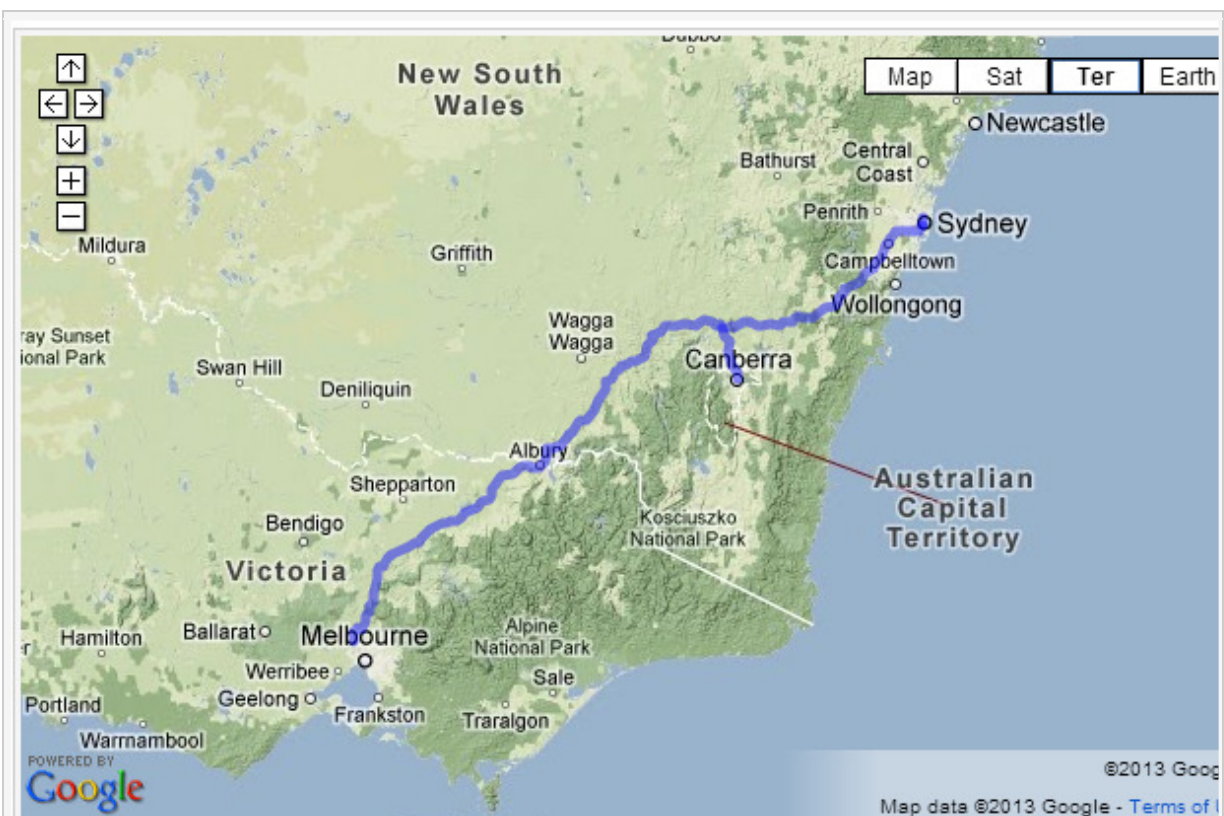
Express Melbourne-Sydney travel time is likely to be about 2 hours with stops at Albury and Yass. Stopping all stations trains would take about 2.5 hours.

Trains would travel below 250 km/h in urban areas but up to 500 km/h in the country. Sound barriers would keep noise levels similar to existing freeway and railway noise levels.

Approximate Route within 10 km

The approximate route of the proposed 800 km Melbourne Airport to Sydney Maglev is shown below.

While the road distance is about 850 km this can be cut to about 800 km with some straightening.



View [Melbourne - Sydney](#) in a larger map

Approximate route of the **Melbourne - Sydney Maglev** from [Melbourne Airport Maglev Link](#) to Sydney Town Hall.

Maglev Route Details

Melbourne

The Melbourne-Sydney maglev would be a continuation of the 22 km / 8 minute [Melbourne Airport Maglev Link](#).

Melbourne - Sydney

The Melbourne-Sydney maglev track would largely follow the Hume Highway / Freeway with some smoothing off of corners in places to straighten the track.

Yass

At Yass passengers could transfer to a single-track shuttle service to Canberra which would take about 10 minutes.

Campbelltown to Sydney Approach

At the south-east edge of greater Sydney the maglev track runs to a new maglev station adjacent to the existing Campbelltown station which allows interchange with many Sydney rail services. From there the track follows the rail line and then the South Western Motorway to near Bexley North station.

From Bexley North the maglev follows the rail line and enters the Sydney Maglev Tunnel just before Central Station.

Sydney Maglev Tunnel

This runs for 7.2 km from south of Central Station to north of St Leonard Station with one maglev underground station linked to the existing Town Hall Station. This allows maglev trains to run at below 120 km/h into the Sydney CBD from the north or south.

Compare this with the 170 km/h proposed for conventional high speed rail!

Maglev Stations and Operation



A Shanghai maglev station.

Stations are suggested at the following locations. These stations should be built to accommodate trains of up to ten carriages which requires the platforms to be 260 meters long.

1. **Melbourne - Southern Cross:** Provided as part of the [Melbourne Airport](#) maglev link. Interchange with all Victorian rail and coach services.
2. **Melbourne Airport:** Provided as part of the [Melbourne Airport](#) maglev link.
3. Seymour
4. Wangaratta
5. **Albury**
6. Wagga Wagga: The map shows the main line running along the Hume Highway but it could deviate slightly to Wagga.
7. **Yass:** Interchange for the Canberra shuttle.
8. Goulburn.
9. **Campbelltown:** Interchange with all south-east Sydney rail services.
10. **Sydney - Martin Place:** Sydney CBD and interchange with all Sydney rail services. Maglev trains would continue on to the [Sydney-Newcastle](#) extension if that was built.

The bold stations are for all trains, the other stations are used for off-peak services. The existing conventional railway would be used to provide the stopping-all-stations service and for heavy freight.



Shanghai Maglev Trains at Longyang Station (www.focusonmicroscopy.org)

Maglev Operation

On any two-track system it is difficult to safely alternate express and stopping-all-station services without reducing express services to the speed of the stopping-all-station service.

We suggest that maglev trains stop at all stations they approach between (say) 10:00 and 17:00 and run express for other times.

Note that conventional trains and road coaches would continue to provide a full stopping-all-station service including stops not serviced by the maglev.

Sydney Trains would run from Melbourne Southern Cross all the way to Sydney Town Hall and beyond. (Some trains may just shuttle to Melbourne Airport).

Maglev Station Layout

The proposed stations have three platforms each like those shown above. Passengers enter trains via the central platform boarding whichever train comes first. Departing passengers leave via whichever edge platform their train arrives next to. Exit side doors open first to allow passengers to start clearing the carriages on one side before passengers start boarding from the other side.

Maglev Trains

Initially trains could consist of just two end carriages. As passenger load increases up to eight central carriages can be added to create a train up to 10 carriages long. With a mixture of first and second class seating a ten-carriage train would carry about 900 passengers.

Maglev trains are fully automated. We would place the train operator in a central cabin allowing passengers to choose seats at the front of the train if they wished. Another option is to have the first and last carriages used for light freight and baggage.

Maglev Capital Cost

The initial capital cost would be about \$30 billion for the dual-track, eight stations, trains and a tunnel at the Sydney end. The trains could be expanded to ten carriages later and service intervals can be reduced as demand increases. This excludes any land acquisition costs which can be minimized by mostly using the Hume Freeway reservation.

This compares favourably with the cost of the [National Broadband Network](#) which is likely to exceed \$40 billion.

Approximate Melbourne-Sydney Capital Cost

These are rough figures to give a general idea of cost only. Assumptions:

- Track distance is about 800 km from the end of the [Melbourne Airport](#) maglev link. (Road distance is ~840km).
- Dual-track is used.
- 50% of the track is elevated, 50% at about 1.5 meters.
- A \$2 billion tunnel is needed at the Sydney end.
- Eight stations included.
- Trains consist of 50/50 1st class and 2nd class with no standing passengers.
- Average speed with stops is 420 km/h. (Stopping all stations trains would be slower).
- The single-track Yass-Canberra connect is not included - this would be another \$1.3 Billion with a single 10-segment shuttle train.
- Times are Southern Cross station (Melbourne) to Martin Place (Sydney).
- Costs are from Melbourne Airport end of the [Melbourne Airport](#) maglev link to Martin Place.

Scenario	CBD-CBD Travel time (hours)	Headway (mins)	Number of Trains Needed	Train Segments per train	Max Seated Pass. per hour per direction	Max Seated Pass. per 18 hour day (thousands)	Max Seated Pass. per month (million)	Approx. Cost (\$A Billion)
Current Air travel (March 2010)	2	-	-	-	-	-	0.7	-
Light Maglev	2	20	12	4	1,080	38	1.2	\$31
Medium Maglev	2	10	20	6	3,240	116	3.5	\$32
Maximum Maglev	2	5	41	10	10,800	388	11.8	\$38

Melbourne Airport Maglev

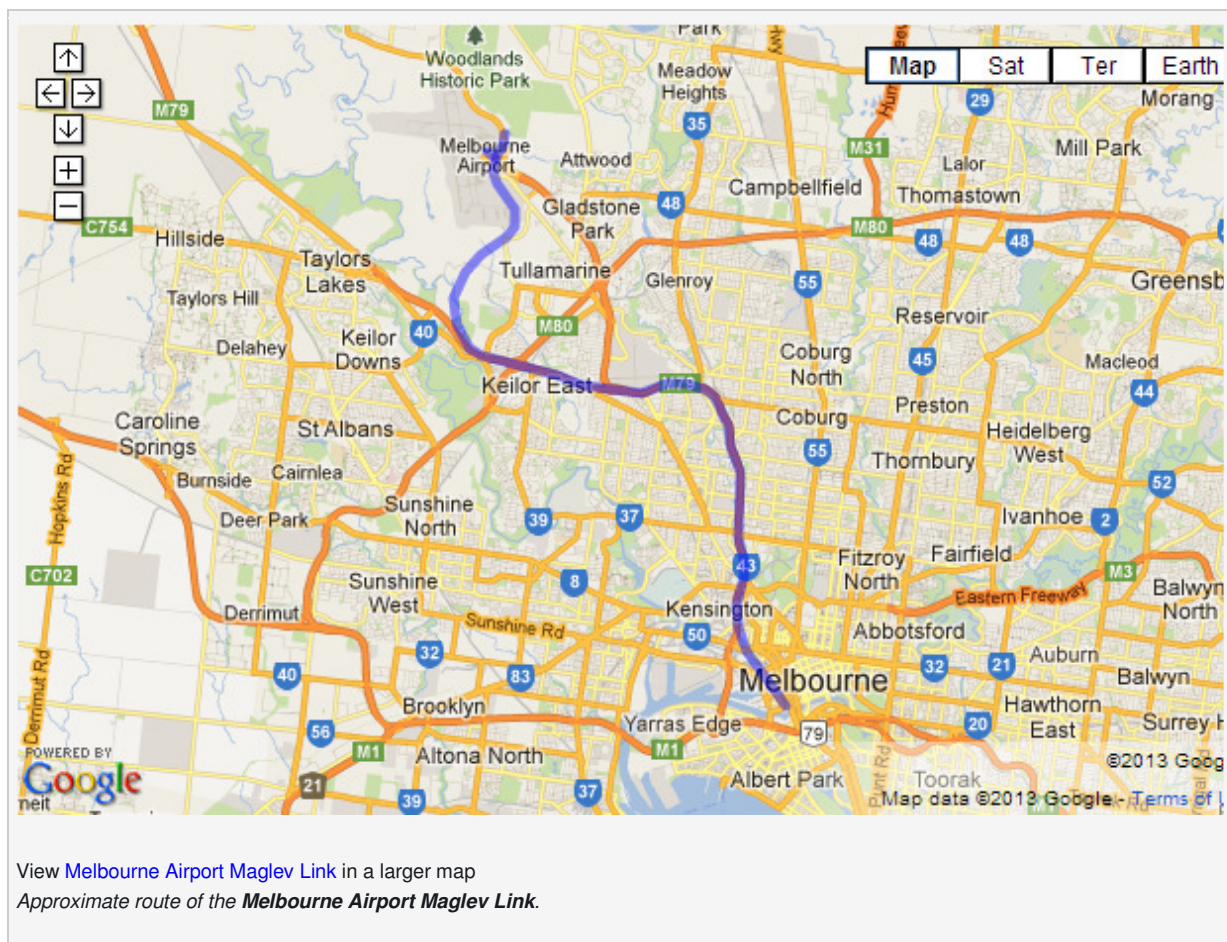
A high speed [Maglev Monorail](#) between Melbourne Airport and Melbourne CBD.

Travel time is likely to be 7 or 8 minutes with service intervals of about 5 minutes.

Support pillars are covered in creepers and hanging plants to create a pergola effect over the existing motorway.

Approximate Route

The approximate route of the proposed **Melbourne Airport Maglev Link** is shown below.



A high-speed monorail can be routed above the existing [CityLink Toll Way](#) and [Calder Freeway](#). At Keilor the track heads north to the southern airport perimeter.

While Maglev trains may operate at up to 500 km / h it is envisioned that this link would operate with an average speed of between 200 and 240 km/h due to the relatively tight radius corners required. At these speed maglev trains make as much noise as normal road traffic so would not be audible above the existing motorway noise.

Pillars

The pillars are to be covered in hardy creepers such as *Ficus pumila* (below) and hanging plants of various types. The pillars will contain an irrigation system capable of keeping these plants alive in harsh weather.



Stations



A Shanghai maglev station.

Only two stations are to be provided on this link. These stations should be built to accommodate trains of up to ten carriages which requires the platforms to be 260 meters long.

Melbourne Airport Station

The station would be situated above Centre Road and would be linked to the main terminal by [Travelators](#).

The maglev track will extend several hundred meters north of the Airport perimeter to a maintenance and storage facility. This would also allow the track to be extended north towards Seymour, Albury Wodonga and Sydney.

Southern Cross Station

At the Melbourne end of the line new Maglev platforms are to be constructed over [Wurundjeri Way](#) adjacent to the existing Southern Cross Station. These new platforms would provide immediate access to the rest of the station, Collins Street, Bourke Street footbridge, Etihad stadium and to the Melbourne CBD. Air bridges could also be built from the Maglev platform concourse to the buildings on the west side of Wurundjeri Way to improve the link to the Docklands area.

See also this [Station Map](#) (PDF) for Southern Cross Station.



Shanghai Maglev Trains at Longyang Station (www.focusonmicroscopy.org)

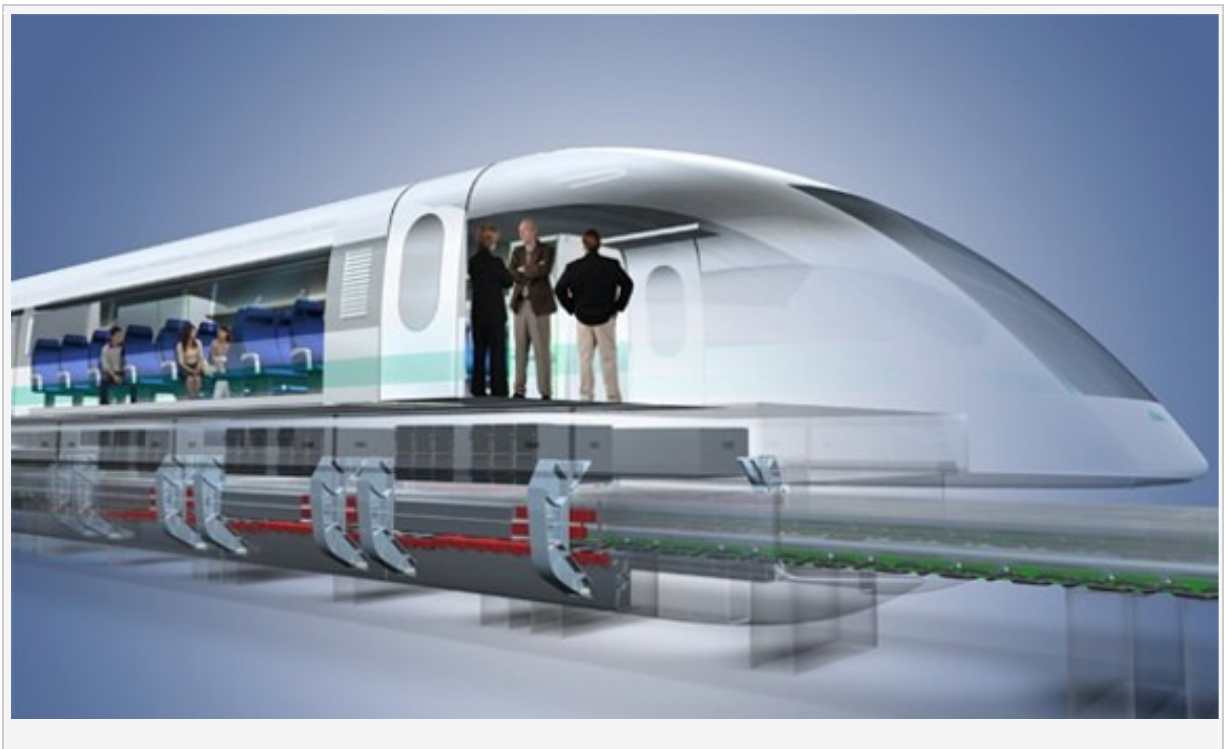
Station Layout

The proposed stations have three platforms each like those shown above. Passengers enter trains via the central platform boarding whichever train comes first. Departing passengers leave via whichever edge platform their train arrives next to. Exit side doors open first to allow passengers to start clearing the carriages on one side before passengers start boarding from the other side.

Operation

Three trains would be used to shuttle passengers from the city to the airport. Using three trains means that normally only one train is accelerating and once decelerating at any given time. This means the electricity generated by the breaking train can be used to assist in the launch of the accelerating train. Normally only one train would be at rest at one of the stations.

No timetable would be used due to the short service frequency. Instead trains will run as often as they can to deliver the best service possible at any given time.



Passenger counters on the platform gates should ensure that there is a seat for everyone although standing in the aisle would be permitted.

Trains



Transrapid TR09 interior. This shows 2 x 2 seating. We would use 2 x 3 for most seating given the 3.7 meter wide carriages. Trains would not contain toilets or cafes given the short duration of the journey.

Initially trains could consist of just two end carriages. As passenger load increases up to eight central carriages can be added to create a train up to 10 carriages long. With a mixture of first and second class seating a ten-carriage train would carry about 900 passengers.

Maglev trains are fully automated. We would place the train operator in a central cabin allowing passengers to choose seats at the front of the train if they wished.

Capital Cost

Capital cost would be around \$1.2 billion for the dual-track, stations and three four-carriage trains. The trains could be expanded to ten carriages later and service intervals can be reduced to three minutes.

As with other Monorails Australia projects this would be delivered as a PPP for a monthly availability charge. (See [finance](#) page.)

In addition the government would need to purchase space for the maglev pillars from the City Link Tollway operator and from Melbourne Airport. We note that both of these companies have a vested interest in *not* building any viable rail link to the airport as it would reduce tollway and car parking revenue.

Ticket Price

Maglev have low operating costs and minimal wear and tear on the vehicles or guide way so ticket price should be similar to current Metro tickets. Note also that this maglev will operate at the low speed (for a maglev) of about 200 km/h which will reduce energy consumption.

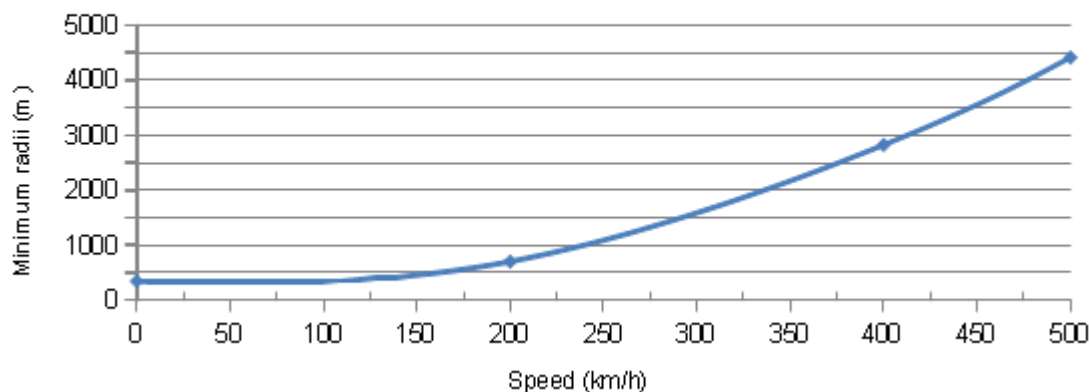
Why not go along the Tullamarine Freeway?

Turning north near the Calder Freeway merge would create a 3 km shorter link to the airport than the route proposed above. However it would also include a 500 m radius turn which would limit speed of the maglev trains to "only" 160 km/h. A more serious problem is that the position of the maglev track above the freeway would too close to the flight path of aircraft using the main Essendon Airport runway. A tunnel could be used in this area but this would be far more expensive than the extra 3km of track needed to go the long way to the airport.

What about the Bell Street bend?

The Transrapid web site gives data four points of data for curve radii [here](#). Plotting this as a graph enables estimation of minimum curve radii for any given speed.

Transrapid curve radii for given speed



Using the above data we estimate the top speed around the Bell Street corners would be about 280 km/h which is probably a higher speed than we would want to run this airport link at anyway.

Guideway Location

The two guideways are supported by separate sets of pillars which are generally located on the eastern verge of the motorway and above the emergency lane in the centre of the motorway. One of the two central emergency lanes would be lost to these pillars. To avoid curving the guideway as much as the motorway the central set of pillars would alternate between what is now the north-bound and south bound emergency lanes so that around 50% of the emergency lane in both directions would be retained.

For most of the route the guideway would be located above the road overpasses at a height of around 12 meters above the motorway surface and at least 4.3 meters above the overpass roads.

South of the Essendon Airport main runway the maglev needs to run at the lowest height possible to avoid any obstruction to the flight path. This is likely to result in lower than 4.3 meter clearance on the Bulla Road motorway bridge and the overpass near Irving Street. Neither of these is likely to be a problem since other routes exist for high vehicles and neither is a significant truck route.

Park and ride

Currently Melbourne Airport derives a substantial part of its profit from car parking. This could continue if a city maglev link was built as residents of nearby suburbs and the north-west drive to the airport and catch the train to Melbourne.

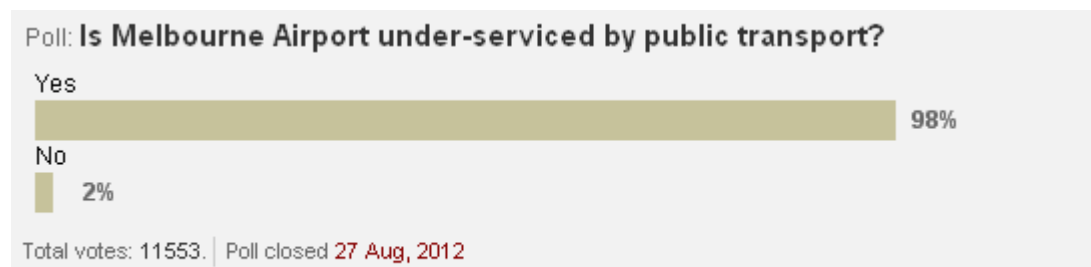
Essendon airport redevelopment

Another option is to close Essendon Airport and re-develop it - in which case a maglev station would be provided. Local residents have campaigned for many years to have the airport closed as have some local MPs. The land could provide much-needed high-density housing in the inner-north area.

Having a station in the middle of the link would slow down the airport trip to around ten to twelve minutes but this is still much faster than any current way of getting to the airport from the city except helicopter.

Public Opinion

Improving public transport to the airport has strong support in Melbourne. This [Age Article](#) and Age Poll is a good example.



Disclaimer: These polls are not scientific and reflect the opinion only of visitors who have chosen to participate.

Alternative airport link options

Over the years various suggestions have been made for creating a heavy-rail link to the airport. None of these meet the key benchmark of "beating the bus". Currently [Skybus](#) takes 20 minutes to reach the airport in off-peak times.

In all cases airport heavy-rail trains would have to compete for track-space at Southern Cross Station and between Southern Cross and the edge of the existing network.

Coolaroo option

This option sees an airport rail line branch off from the Broadmeadows line near Coolaroo at run west to the airport through park and farm land. A key problem is that it takes trains 30 minutes to reach Coolaroo now with existing stopping-all-stations trains running every 10 minutes. Overall journey time to the airport would be around 45 minutes at best.

Essendon option

This option sees an airport rail line branch off from the Broadmeadows line near Essendon and run through a tunnel to the airport. This would require about 8 km of tunnel which would cost \$3 - \$5 billion¹ depending on how many underground stations are required. Existing trains take about 20 minutes to reach Essendon so overall journey times would be around 40 minutes from the CBD.

Albion-Jacana railway line option

This option would use the [Albion-Jacana railway line](#) to create a link to the airport. Again this route is plagued by having to route airport trains over congested existing railway lines. In this

¹ *Based on the cost of the proposed Melbourne Metro of ~\$M500 / km

case slow moving heavy freight trains use the tracks which would severely disrupt services to the airport.

Electronic Version of this document

<http://www.monorailsaustralia.com.au/Maglev.pdf>