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Executive Summary

The purpose of this report is to develop a futuristic vision of the preferable state of a sustainably integrated transport sector in the Eastern States of Australia in 2030. This vision is based on the possible unfolding scenarios due to the effects of climate change, the overall increasing population and the shifting wants/needs of the community.

This report focuses on the main areas of transport in eastern Australia. Including the on land public transport system which comprises predominantly of bus’i, trams and trains. On land private transport system which involves mostly cars, motorcycles/scooters, cycling and walking. Air transport (Aviation) which contains both domestic and international passenger aircraft. As well as on water transport (Marine) which encompasses both cargo ships and ferries.

Each of these derived transport categories will include a brief introduction which discusses the current system. Then a detailed discussion of the possible changes that may be seen in infrastructure, the way the form of transport uses and sources energy, the efficiency of the involved vehicle/craft, the health and safety they provide, other technological advancements that may be of interest as well as cost comparisons.

The report will also feature a section discussing the integration of the entire transport system. How this may be achieved and what this will mean. This section will also develop ideas for the future ticketing and fare system and the possibility of the implementation of a carbon credit card.

This report will conclude with a brief summary of the possible transport system in 2030 as well as an explanation into the benefits that will be achieved by this. With a focus on the environment and the community, such as how the system will minimise its emissions and energy consumption whilst maximising its performance and how commuter efficiency will be increased and commuter stress decreased.
1. Introduction
Since the civilisation of the eastern Australian states; Tasmania, Victoria, New South Wales and Queensland transport has played a major role, being a core component of trade and commerce. Now in 2013, the eastern Australian transport system is relied on even more heavily, playing a vital role in almost the entire population’s everyday lives. However as the needs of both the environment and the community change so too must the transport system.

Currently there are numerous unfolding scenarios that will change the eastern Australian transport system, which will change the needs of the environment and the community. The impact of climate change (caused by either global warming or global cooling, whatever is deemed to be) will cause major changes to the transport system. It has been observed over past years that the combined emission release in Australia has continually increased (see Figure 1.1). This has occurred to such a degree that in 2011 the Australian transport system was responsible for approximately 16% of Australia’s greenhouse gas emissions (excluding land use) and in 2007 was responsible for the release of roughly 3.8 tonne of Carbon Dioxide (CO$_2$) per capita (see Figure 3.2). Thus, Australia has one of the highest emission ratings per capita in the world (Loader, 2012). These statistics are based on Australia as a whole, though they show similar trends to the eastern Australian states alone. However over the time leading up to 2030 increasing pressure will be placed on all forms of transport to dramatically reduce emissions.

Another major issue for the eastern Australian transport system is the fast depletion of current fossil fuel supplies. This depletion is leading to increasing prices of energy. The burning of fossil fuels is also the cause of majority of transport emissions. So the transport system will need to look at new ways of sourcing energy as well as ways in which to reduce energy consumption.

Fig 1.1: Australian transport emissions (Loader, 2012)
Another major issue in relation to the environment is the current use of materials in the eastern Australian transport system. These materials include those used in both infrastructure and vehicle/craft and usually consist of unrenewable materials with a high embodied energy such as plastic and steel. This is not a sustainable practise as it results in the use of materials that cannot be replaced as well as an over the top consumption of energy. Thus the material use in the transport system will need to be altered.

The changing community needs will be heavily impacted on by the increasing population. By 2030 the population in the eastern Australian states could almost double (see Figure 1.3). Currently large portions of the eastern Australian transport system are poorly designed, having a heavy reliance on inefficient and land wasting forms of transport such as private cars. For example in in Melbourne 64.2% of transport emissions were contributed to by cars (See Figure 1.4). It is feared that this situation will only be exacerbated by the dramatic forecasted population increase, which will see cities becoming more densely populated and a larger degree of urban sprawl, therefore leading to issues in overcrowding and congestion. To facilitate this increasing population more transport will need to be provided, with the effectiveness of this transport maximised as well as curbing the behaviour of private commuters. More transport options along with more commuters could become quite confusing and stressful for people thus additional planning will be required to minimise this.
The transport system will also need to be reliable and resilient. Because with a higher number of modes of transport available and more integration, comes greater impact in a break down situation. For example if a train breaks down it will make countless other trains late which will then impact on buses and so forth. The community will also require cost fairness and advancements that facilitate modern day needs.

Thus it can be said that the transport system in the eastern Australian states in the year 2030 will be remarkably different to that presently implemented. There will be major changes to all forms of transport; in particularly on land public and private transport as well as aviation and marine. The 2030 transport system will ensure that the needs of both the environment and the community continue to be met.

**Figure 1.4:** Melbourne Transport emissions 2013 (*Loader, 2012*)
2. On Land Public Transport
2.1. Introduction

As Australia’s population continues to grow, there will be great pressure on federal and state government to provide a reliable public transport system in all major cities and large regional towns. Statistics have proved that wealthy countries like Hong Kong, Tokyo and most of Europe have decreased their dependency on car usage, and have invested large sums of their wealth into its public transport infrastructure (Newman, P, NA). It is vital that Queensland, New South Wales and Victoria upgraded current modes of transport and invests in better network integration.

2.2. Cost

A reliable and well performing public transport system, like that of Tokyo or Europe, will decrease the number of cars used in the CBD and surrounding suburbs. Car dependence is costly and places extra stresses environmentally, socially and economically. In a report by Peter Newman, it is estimated that in the late 1990’s the government had an overall road deficit of $8billion. That included all expenses from accidents, pollution and noise. When more money is invested into a public transport system it has numerous benefits not only for the government but also for the public. Less money would need to be spent on roads and less people will need to purchase and maintain a car. To put things into perspective, Translink, Queensland’s public transport operators state a fare for public transport is four times cheaper than using a car and in Peter Newman’s report a car is estimated to cost around 85c per km whereas public transport is 50c to 60c.

2.3. Efficiency

According to the Australian Bureau of Statistics, one in five Australians use public transport as their preferred way to travel to work or study (ABS, 2009). In London this statistic is well over 50% (Global Rail, 2011). Currently London’s Public Transport is orientated around a rapid transport network, whereas all of Australia’s major cities are focused around a commuter rail system. Although Australia’s larger cities are operating some of the best commuter rail networks in the world, these networks will not keep up with demand as the population increases. The Victorian State Government has taken a step forward contracting the operations of its rail network to Metro. Metro draws their experience from three of the leading rail companies, including MTR who operate Hong Kong’s rapid transport network (Metro, 2012).
Figure 2.3.1: The 10 year average spend on Roads and Other transport as % (ABS, 2010)

Note: Other refers to bridges, railways and harbours

Australia has built a country around car dependency just like America. In Melbourne, this has caused a lack of funding towards public transport since its privatization in 1997. Network planning has become a major issue with most commuters facing 5-20 minute waits while switching from buses, trams or trains. It also does not help that Melbourne’s public transport system is reaching capacity as more peak hour services are getting overcrowded. More services are needed and better integration between busses, trams and trains will see a rise in patronage usage and more satisfied customers.

2.4. Reliance

Melbourne’s train operators Metro are pride them self on reaching monthly targets for both punctuality and service delivery. This is a great initiate taken by Metro and the Victorian State Government in order to achieve a more reliable service. Sydney and Brisbane should follow the same principle as the Victorian State Government and Metro to achieve a more reliable service and restore trust to the public that improvements are being made to better their cities transport network.

Figure 2.4.1: Metros performance over 3 consecutive days (Metro, 2012)

In Sydney it is found that a lot of people use public transport as a way into the city. Only 19% of people drive into work where as 46% use trains (Mees. P & Dodson. J, 2011) yet many commuters travelled by bus only or train only because of a lack of integration between the different transport networks.
2.5. The Future: 2030

By 2030 Australia’s major cities should have a developing hybrid rapid transport and commuter rail system that is operational. Australia’s east coast should follow a similar development of the infrastructure that is currently operating in Tokyo and Europe, where each major city has a successful rapid transport metro and public transport system with high speed rails that connect the major cities. Innovative ideas and new technologies need to be applied to our transport networks to reduce our need of fuel and oil related transport.

For Melbourne and Sydney there should be a start in developing underground metros to achieve a rapid transport system. This will help ease the congestion along the commuter transit and allow country rail companies like Vline or Country Link to provide faster and more efficient services to rural towns. These simple developments will encourage more people who travel by car to use public transport in Melbourne’s CBD and will see an increase in people using country services. As Melbourne is the only major city that does not provide a train network from the airport to the city, it should consider a metro that runs underneath the Tullamarine Freeway while making some suburban stops before connecting with the city loop. It will be key feature in making the airport accessible to the city since Melbourne Airport are planning to expand the airport to help increase the number of domestic and international flights arriving in future years.

Melbourne’s tram network is currently one of the largest in the world and should push to be a world leader in providing an effective tram system. Currently Yarra Trams operates 250km of tram tracks in Melbourne and manages 29 tram routes (Yarra Trams, 2013). Instead of investing more money into developing better tramlines and extending or creating routes, money should be invested to build trams that use less energy. As trams and trains along Australia’s east coast are powered through electricity, it should be mandatory that new trams should be fitted with solar panel roofs and tram depots fitted with solar panels. The same can be done in the suburban rail networks. This will significantly reduce the need to draw energy from coal fired power stations and aim to have Australia’s public suburban train and tram networks 100% energy efficient by 2050.

Although Sydney and Brisbane terminated its tram networks in replacement for busses, there should be serious considerations to run an electric operated light rail with the CBD. There are two options in which both cities can take. Providing pre-existing tram infrastructure is in place and operational they can bring back trams to operate long the existing lines. The other option is to use introduce rail less trams like that found in Vancouver. The rail less trams operate just like busses yet draw power from over-head power lines. This allows greater manoeuvrability in the city districts and should be a favoured option in Sydney and Brisbane as the introduction to new tram lines would cause too much disruption.

Once all the major cities have an operational electric service in the CBD and surrounding suburbs, there should be a push to ban busses and bus routes from entering the CBD. There should already be sufficient transport within the CBD without the busses causing too much congestion. The only exception to having no busses in the CBD would be on weekends when night services are provided to transport late night partygoers to their suburban homes.
The bus networks should solely be used to transport and make connections in suburban areas. In Melbourne’s strategy to connect the east to west a new bus service was introduced called the smart bus. The smart busses are replacing less effective bus services and have had a positive influence to Melbourne’s bus network. These services operate regularly with 10 minutes between services at peak times and 15 minutes for off peak. The smart bus service has a better integration with most of Melbourne’s trains. However most bus services are operating on diesel fuelled engines. In 2011 Sydney’s bus network trialled the use of hybrid busses. Although the study proved emissions reduced by 15% the cost involved in maintaining and repairing the hybrid busses was far too costly (Rare, 2012). Once technology advances with hybrid technology and it becomes more affordable all bus companies should start making a switch to the hybrid buss by 2030.

The Australian Government has been analysing plans to introduce a high-speed rail (HSR) starting in Melbourne and ending in Brisbane and stopping at other major towns in between. The first stage from Sydney to Canberra is not going to be operational until 2035 with the entire project to be fully operational in 2065 (Australian Government Department of Transport, 2013). Once the HSR is fully operational plans should be looked at to extend the rail to Adelaide to encourage more tourism within Australia without paying for overpriced airfares or timely coaches.

We have most of the infrastructure in place to operate and effective transport system. Yet these privately owned companies are lacking funding from governments and there are slow improvements being made. However the major Australian cities need more network planning and ensuring busses, trains, trams and ferries are synchronized to best reduce waiting times between services. If Australia can improve its network planning and improve the network as the population continues to increase we could be a world leader in proving an effective public transport system.
3. On Land Private Transport
3.1. Introduction

Private transport is transport not available to the general public. Thus there is minimal to no dependence on transport network timetables and routes. The main forms of private transport include vehicles such as cars and motorbikes as well as cycling and walking.

Until now, cars have been the most commonly used form of transport, but climate change along with the declining availability of fuel will promote the need for the rise in use of other more sustainable forms of transport. With sustainable forms of transport such as cycling and walking use increased.

In the eastern States of Australia there are on average 7.2 cars for every 10 people, with roughly 53% of the total domestic transport emissions being produced by cars and motorbikes. If these trends continue it is feared that there will be roughly 9.7 cars for every 10 people and an even greater emission release (Siemens, 2012). If the road network is continually developed then this fear will come into being. Thus to ensure this does not happen road construction must be dramatically reduced if not stopped completely. This would also result in the reduction of CO₂ emissions and the possible enhancing greenhouse effect.

It’s essential to curb the general population’s current living habits away from unsustainable means of transport and towards more eco-friendly options. This could be achieved through the facilitation of eco forms of transport through the addition of specifically infrastructure such as bike paths and walking tracks.

3.2. Infrastructure

In recent years, only 6% of the transport budget has been spent on bike paths and walking tracks (Moving Australia 2030, 2012). With majority of transport funding instead going towards road infrastructure. In the years leading up to 2030 greater focus should be put on healthy and sustainable transport like cycling or walking, thus more funding should be allocated to these areas.

In the city centers, more could be done to facilitate these forms of transport such as providing lockers and showers. As well as restricting private vehicle access from central business districts, limiting the access to pedestrians, cyclists, public transport and emergency vehicles. This would improve safety and reduce congestion. Furthermore, the construction of new off-road bike paths in growing areas must be considered. The preferential infrastructure to be developed should revolve around cycling and walking cities rather than motorized movement cities.
As discussed earlier road construction will need to be severely minimized in the coming years, though it may still occur. When they have to be developed, they will always follow the “Standard environmental requirements”. Material and procedures considered by Vic-Roads such as lower temperature asphalts, recycled concrete and flexible pavements which include thin reseal and/or polymers and perpetual pavement technology could be used. Construction procedure must also be taken into consideration, with emphasis being put on a simple, cost effective design that will require minimal maintenance. Materials should also be sourced from areas close by to reduce transport requirements. The overall construction process and material manufacture ensure a carbon footprint as small as possible.

Figure 3.2.1: Solar energy signage. (Science learning, 2011)

Figure 3.2.2: Solar panel parking ticket machine. (Voip supply, 2011)

In addition, all the signage in roads or even parking ticket machines (Voip supply, 2011) must be powered by renewable energy. Solar energy is one of the most reliable because it could be charged during the day and used at night. The materials that may be used in road signage will consist predominantly of polymers.

3.3. Cost

The cost of road and pavement surface varies. With the cost of constructing an off road bike path far less than the cost of a concrete footpath which is less than an asphalt road. With the most expensive being a concrete road.

The cost of a freeway construction is $13m/km, while a new bike path is around $200,000/km or $60,000/km if it’s on-road. So, by using an equal amount of funding provided for road investment over the years, we could design an advanced cycling network for all of the eastern cities.
Strategies to curb people’s behavior away from cars and towards cycling and walking are critical. See below for a brief comparison study on the cost of transportation for a standard family over 20 years:

<table>
<thead>
<tr>
<th></th>
<th>CAR</th>
<th>BIKE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>$40,000/car * 2 car / family * 2 trade-ins = $160,000</td>
<td>$1,000 * 4 persons * 4 changes (each 5 years) = $16,000</td>
</tr>
<tr>
<td>Fuel/energy</td>
<td>US$ 300/barrel will result in gas being $9.85/gallon, therefore 9.85 *400 gallons * 2 cars * 20 years = $157,600</td>
<td>-</td>
</tr>
<tr>
<td>Breakdowns and revisions</td>
<td>$ 500 / year car * 20 years * 2 cars = $ 20,000</td>
<td>$100/ reparation* 4 bikes * 20 years = $ 8,000</td>
</tr>
<tr>
<td>Insurance</td>
<td>$ 800 * 2 cars * 2 changes * 20 years = $ 64,000</td>
<td>-</td>
</tr>
<tr>
<td>Parking</td>
<td>$ 500 / year * 20 years = $ 10,000</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td><strong>$ 411,600</strong></td>
<td><strong>$ 24,000</strong></td>
</tr>
</tbody>
</table>

**Table 3.3.1: Cost Comparison for 2030 (GasCalc, 2013 & Best on Gas, 2013)**

The comparison study shows that the difference in expenditures for a family with 2 cars in 2030 compared with a family with four bicycles in 2030 are huge. With a cost difference of approximately $387,600 over 20 years which equates to roughly a 1700% cost increase!!! Thus yearly a family with 2 cars should expect to spend roughly $19,000 more than a family with 4 bicycles. Thus the swap from cars to bikes could not only increase health but also life quality. A more detailed study of this could be used in an awareness campaigns with the aim being to curb inefficient transport behavior. This could be conducted simultaneously with the improvements in infrastructure, helping to achieve a successful transport network.

### 3.4. Energy

Currently 32% of the total energy supply is destined to transport (Ashby. M pp. 237, 2013), and more than 90% of this energy is powered by fossil fuels.

The reduction in the availability of fossil fuels (as discussed in section 1) will mean other energies must be considered to run cars in the near future. As currently majority of the car fleet are run on fossil fuels, with less than 1% of the total car fleet being run on electricity. Thus it is extremely likely these statistics will see significant change in the coming years.

This energy required for transportation has to make the switch to renewable sources that are more sustainable and eco-friendly. With fuel mix (hybrids) and charging systems the key.
Some of the options are:

- Battery power from renewable energies such as wind and solar. This would enable the vehicle network to be used as a dynamically-adjustable load on the electricity network. Thus when a peak in electricity generation occurs, batteries could be charged, thus storing this energy for times of low electricity generation. The batteries could then be swapped/brought at ‘service stations’ of the future.

- Solar panels over the roof and sides of the car.

- Biofuels or hydrogen powered engines may further develop as technology advances.

- The possibility to auto-generate energy from the friction on roads caused by traffic

- As well as a small amount being generated from the wind hitting the front of the car and from the brakes when they are applied.

In terms of self-powered transport such as bikes, new technologies have been started emerging which help speed optimisation. These advancements include electric-bikes, which generate energy while cycling and then keep and save the excess energy in a battery. Thus allowing the rider to utilise this energy to get high speed in bad weather circumstances or when time is important.
3.5. Efficiency

To save on energy consumption all vehicles (especially cars) must be more efficient. For this to occur, numerous advancements must be made. Engines must be more effectively designed for maximum output with minimum input. The vehicles must feature better aerodynamics such as being more compact and wind resistant. The overall design must be smarter with less friction on occurring between axles and an overall lighter weight.

However it is obvious that cars will never achieve the efficiency that bikes have (almost 100%). Thus can any innovative ideas really compete? As no matter what private cars will still require much energy to use.

To completely achieve a Zero Carbon Footprint there is no discussion needed. The answer is simple the use of private vehicular transport must be eradicated and replaced where possible (distance can be an issue) with bikes.

3.6. Health & Safety

The number of transport deaths in 2009 was 1447. Most of these deaths occurred on roads with over 72% vehicular collisions (as can be observed in the pie chart). Pedestrian and cyclists fatalities were at 13% with majority of these deaths also a result of private motorized vehicles (ABS, 2012).

These figures highlight the lack of safety on our roads. This issue must be considered in new infrastructures and vehicle technologies. One of the primary reasons for such high fatalities on our roads is speed. Private vehicles are capable of excessive speed in seconds. Are our roads a race-track? No then why are our vehicles capable of reaching such extremes. There are also other factors which have contributed to high fatalities on our roads and they could never be completely eliminated. Thus we must ask ourselves the question does the handiness of private transport out way the importance of other people’s lives?

On average Australians spend roughly 27 minutes travelling to and from work each day (news.com.au, 2011). So, in many cases these journeys could be completed by bikes, as the distances are not excessive. If not there is the other sensible option of combining cycling and public transport to complete the trip each day.

![Figure 3.6.1: Transport fatalities in Victoria 2011 (ABS, 2011)]
If private vehicular transport is increasingly replaced by bikes over the coming years than road congestion will be eased, pollution will be reduced and most importantly the overall fatalities will dramatically decline due to higher safety. There is also the added bonus of increased health with the reduction in issues such as obesity, shortness of breath, asthma and lung cancer.

3.7. Technological Advancements

Additional technological advancements may include radar control which acts as cruise control but with the addition of steering! This will occur through the use of GPS and sensors to detect danger. It is also likely for complete 360° camera views to come stock standard for parking and security purposes.

It is also very likely that total car costs will decrease due to technological advances. As technology advances older technology features becomes more affordable. For example Lithium-ion batteries, which are the single most expensive component in electric cars have considerably reduced in cost and advanced in technology since they first came into being.
4. Aviation
4.1. Introduction

Currently aviation is responsible for a large percentage of international and domestic transportation, especially between major cities. The number of air passenger movements through eastern Australian airports is projected to grow strongly over the next 20 years (see Table 4.1.1). This is largely due to a positive economic outlook for Australia and its trading partners (Needham, 2012).

<table>
<thead>
<tr>
<th>Airport</th>
<th>% increase per annum</th>
<th>Million Passengers in 2030-31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cairns</td>
<td>3.7</td>
<td>8</td>
</tr>
<tr>
<td>Gold Coast</td>
<td>4.4</td>
<td>13.1</td>
</tr>
<tr>
<td>Brisbane</td>
<td>4.2</td>
<td>45.1</td>
</tr>
<tr>
<td>Newcastle</td>
<td>3.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Sydney</td>
<td>3.6</td>
<td>72</td>
</tr>
<tr>
<td>Canberra</td>
<td>3.3</td>
<td>6.1</td>
</tr>
<tr>
<td>Melbourne</td>
<td>3.9</td>
<td>60.4</td>
</tr>
<tr>
<td>Hobart</td>
<td>3</td>
<td>3.5</td>
</tr>
<tr>
<td>Townsville</td>
<td>3.7</td>
<td>3.4</td>
</tr>
<tr>
<td>Launceston</td>
<td>2</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Table 4.1.1: Domestic and international air passenger forecast (Needham, 2012)

The main uncertainties impacting on air travel comprise of the elimination of fossil fuels as an energy source, land constraints and the changing views of society. In 2012 Airbus underwent a study on commuter’s expectations on air travel in the future, finding the following results:

- 63% of people believe they will fly more in the future,
- 60% do not think social media will replace the need to see people face-to-face,
- 96% believe aircraft will need to be more sustainable or ‘eco-efficient’,
- 39% feel air travel (door-to-door) is increasingly stressful,
- 86% of people think less fuel burn is key and 85% a reduction in carbon emissions,
- 66% want quieter aircraft and 65% planes which are fully recyclable.

Thus in summary majority of passengers want to see air travel becoming more sustainable, less stressful and more travel options (Airbus, 2012). Therefore to ensure customer expectations in 2030 are met, improvements will presumably be made to current infrastructure and aircraft in eastern Australia.
4.2. Infrastructure

Currently numerous airports in eastern Australia are fast approaching full capacity, with Sydney Airport having already reached capacity. Thus by 2030 Sydney airport along with many others will not be able to cope with the demand. Inevitably between the present and 2030 major works will be carried out on airport infrastructure, including extensions and in the more critical cases the construction of an additional airport. These additional airports will be constructed on the outskirts of the city if possible. But if the scarcity of land in 2030 makes this too difficult, then the option of implementing an airport on water may be looked into (see Figure 4.2.1). This will include the design and use of aircraft that are capable of both land and water take-off (further discussed in technological advancements). These extensions/constructions will be integrated with other forms of private and public transport such as road and rail, allowing for easy commuting to not only the inner city but also to surrounding regions. This will minimise hassle and maximising efficiency for commuters to and from the airport (Needham, 2012).

As air traffic is privatised and very competitive the works will also place a large emphasis on ensuring the needs/wants of passengers travelling for both business and pleasure are met. These advancements may well include upgrades to check in technologies such as the implementation of a system in which passengers are supplied a hand held GPS device (or an application for their mobile phone), which will provide instant notifications and directions to ensure optimal time for flight loading and minimise stress for passengers. This device could also be used as a locate people running late for flights. Another major upgrade will be the way in which passengers (especially the handicapped and elderly) move around the airport and are loaded onto the aircraft. There will be a greater use of conveyer-belts and lifts with the possible implementation of pod loading! Instead of passengers having to manually walk onto the aircraft the waiting terminals in which they are seated will be a detachable pod, thus once the plane has landed, the pod positioned in the airport with passengers ready to ‘board’ will be switched with the pod on the aircraft containing arriving passengers, thus optimising efficiencies and minimising passenger hassles (airbus, 2012).
4.3. **Cost**

Current prices are high and in all likelihood they will not reduce. As a rule of thumb, a 1% improvement in flight efficiency knocks more than $1 million off an airliner’s fuel bill over its lifetime of roughly 20 years, says Ihssane Mounir, Boeing’s vice-president of sales for China. However the cost of the technology to achieve this is at this stage unknown.

4.4. **Energy**

Currently air travel is responsible for the consumption of high quantities of energy. The construction/design consists predominantly of materials with high embodied energies such as steel and plastic. The aircraft are inefficient and produce high emissions with the energy consumed during there working life being derived from fossil fuels. However by 2030 this will not be so as the key to success will be sustainability.

To ensure aircrafts are sustainable and ‘eco-friendly’ they will be designed using less material (discussed further in efficiency). Majority of the used materials will be composites consisting of materials with low embodied, derived from renewable resources or recycled. These materials will also be recycled rather than wasted when the aircraft is broken down.

Some of the possibilities for the source of energy for aircraft in 2030 include:

- Harvesting the body heat that is transferred to seats off of staff and passengers.
- Covering the shell of the aircraft in photovoltaic cells thus capturing the energy from the sun’s rays, therefore utilising solar power (see Figure 4.5.1). In fact recently an aircraft fuelled entirely by solar energy completed its first night and day flight (roughly 26 hours).
- Biofuels and biomass produced from natural means such as algae, which is grown from sea water, sunlight and carbon! It is believed that by 2030 biomass fuels could provide up to 30% of all commercial aviation jet fuel (Airbus, 2012).

![Possible Solar powered aircraft](admin, 2012)
4.5. Efficiency

The evolution of technology provides the assumption that by 2030 aircrafts will cover greater distances in shorter times using less energy. To make this a possibility operational efficiency must be maximised, thus cutting edge approaches to engine, air-frame and avionic design will be required.

The design of aircraft and flying practises will follow lessons learned from nature, “bio mimicry inspired mankind to follow birds into the skies and it is likely that we can copy many other tricks that nature has evolved” (Nucsa, 2010). Aircrafts may well be flown in bird-like form and formation, taking advantage of gliding like birds and flying in ‘V’ formations. These practises will reduce drag and save energy. Aircraft mass will be lighter thanks to the use of new materials and innovative techniques such as “topological optimisation” (Ashby 2013, p. 425) which allow for the use of less material per unit of function. Supersonic planes (planes which travel above the atmosphere at record speeds) may also be used for optimal time performance on intercontinental journeys (airbus, 2012).

The efficiency may be further maximised through the deployment of self-guided and remotely piloted aircraft (which are currently being pioneered by the U.S. military). It seems unlikely that a passenger plane would have no pilot by 2030 but a freight plane could be a candidate (Nucsa, 2010).

4.6. Health & Safety

As discussed earlier by 2030 it is very likely that there will be many more aircraft in the sky than at present. These aircraft will be much faster and travel closer together (bird like formations). Therefore increasing the possibility of collision, yes?

No, improvements in both on ground and in-aircraft safety and guidance technologies will be developed and utilised. These modernizations will consist strongly of electronics and computing. With more forward-thinking navigational equipment being used, including wireless sensor technology and the guidance of aircraft being provided by computer simulation and control. Though the human touch will never be completely eradicated as clarification will still be necessary to ensure as close to 100% safety as possible (Nucsa, 2010).

4.7. Technological Advancements

Further technological advancements will maximise passenger comfort and enjoyment with simple changes being implemented such as in flight Wi-Fi connection, the latest in entertainment systems and lower noise producing engines. With cutting edge technologies also being applied such as walls that become transparent at the touch of a button (See Figure 4.8.1), giving passengers the possibility of 360o views!

Some aircraft may also be designed to carry a high numbers of passengers and be able to land and take off on either land or water (See Figure 4.8.2). This would be made possible through the addition of underwater wings which work like fins during water landings and take-off (Admin, 2012).
Figure 4.7.1: 360° views envisioned by airbus (Nucsa, 2010).

Figure 4.7.2: Aircraft taking off from water (Admin, 2012)
5. Marine
5.1. Introduction

Marine transport is responsible for roughly 99% of Australia’s exports and a substantial proportion of Australia’s domestic freight, these statistics will be very similar for eastern Australia (Department of Infrastructure and Transport, 2013). Marine transport also provides an alternative and often overlooked form of transport for commuters travelling both long and short distances; intercontinental, interstate or across the bay. The chief marine craft used for these applications are cargo ships and ferries.

Currently there is a lack of ferry services in eastern Australia. With existing services often being poorly managed, stopping at few wharfs, collecting few passengers and performing minimal trips. It is for this reason that ferries are regularly seen as a form of transport for tourists rather than commuters. However one city in eastern Australia has seen the full potential of ferry services. Currently in Sydney there are 28 operating ferries that do a combined 14.7 million trips every year (NSW Government, 2013). Sydney has big plans for the future of its ferry services including the addition of more wharfs and travel routes (see Figure 5.1.1) along with more frequent timetabling and an upgrade to all infrastructure and ferries. Thus the plans for Sydney harbour is a prime example of where ferry services in eastern Australia will be in 2030.

Marine transport is currently one of the most ecological friendly forms of transport due to the fuel efficiency per load (NYK, 2010). They are also time competitive with other forms of transport such as road and rail, depending on location. However by the year 2030 standards will be higher, thus both cargo ships and ferries will need to be more sustainable and more competitive.

![Sydney Ferries Future Network](image)

**Figure 5.1.1: Sydney Ferries Future Network (NSW Government, 2013)**

5.2. Infrastructure

Infrastructure for all cargo ports and ferry slips (wharfs) will need major upgrades and construction. It is expected that cargo shipping will remain the dominant form of exports in 2030. Thus to ensure the growing demand and the expected efficiency of unloading/loading is met, works will be carried out on all existing ports. This will include the addition of more computer controlled loading systems and new loading techniques, such as having cranes positioned inside the hull. This will reduce loading time by up to 50% (NYK, 2010).
To ensure ferry services meet/exceed customer expectations and to ensure that the full demand possibilities are met extensive works will be carried out on the construction/extension of wharfs. As more wharfs mean more flexibility in ferry services and therefore higher patronage numbers. These wharfs will also provide access for all patrons through the use of steadily sloped ramps and provide services such as bike racks and lockers.

5.3. Cost

The cost of marine transport is mainly due to the capital cost that is the cost to set up a dock and buy the ferry/boat. Once the setup is complete running costs are minimal. Thus the more the system is used the cheaper it will get.

5.4. Energy

Currently marine travel consumes less energy than majority of other forms of transport. However to keep with growing trends it will need to be more sustainable. Marine craft are designed using high embodied energy materials and powered by fossil fuels. But by 2030 this will not be so as the key to success will be sustainability.

By the year 2030 ships will most likely be powered by a mix of wind and solar, with additional energy if needed being sourced from alternative energy providers such as biomass. Most ship designs will include multi-purpose retractable panels situated on the roof, these panels will be lined with photovoltaic cells whilst also performing as sails, thus capturing energy from both the wind and the sun (see Figure 5.4.1). These panels are already being developed (See Figure 5.4.2) and currently provide significant fuel savings and have a capital cost of roughly 10% - 15% of initial ship cost and a pay-back period of roughly 2-4 years (SolarSailer, 2013). Thus by 2030 it is imagined that technological advancements will further increase their efficiency and therefore their fuel and cost savings. Marine craft will also have permanently positioned solar panels along the sides of the cabin and on the hull above the water line which will adjust their inclination to follow the sun for optimal efficiency. Cargo ships will have detachable flexible solar panels which will be rolled out across cargo containers after loading and removed prior to unloading (NYK, 2010).

As wind and solar energy fluctuates additional fuels will be utilised. For example biomass (discussed in aviation energy) may be compacted into fuel cells for use if needed. Energy may be harnessed from passenger seats and beds or advancements may be made in the design of hydrogen powered engines.
The evolution of technology provides the assumption that by 2030 marine craft will cover greater distances in shorter times using less energy. To make this a possibility operational efficiency must be maximised, thus cutting edge approaches to engine and craft design will be needed.

For marine transport to stay competitive in the future they must be capable as well as permitted to travel at greater speeds. For example currently on the Yarra speed limits are 6-10 knots, to be competitive with cars and rail these restrictions would need to be lifted to 15-30 knots (Masanauskas, 2013). Also the route and speed will be planned in accordance with weather conditions to ensure optimal efficiency and time. As well as the implementation of new loading concepts for on deck and in hull loading of cargo ships, thus minimising time spent in port.
The propulsion system of marine craft will most certainly be modernised, with the possibility of following the thoughts explored in aviation once more and undergoing the bio-mimicry of nature, with fish like tails developed for propulsion purposes. Ship/ferry weight will be minimised through means similar to those discussed in aviation. Superconductive cabling will be used to eliminate power loses. While advanced frictional resistance techniques such as ejecting air bubbles from under the bow to provide lubrication between the ship and water boundary layer will minimise drag by at least 10%.

5.6. Health & Safety

Similar technologies will be implemented for safety in marine transportation as in aviation. That is the deployment of forward-thinking navigational equipment including wireless and sensor technology and more computer simulation and control when it comes to guidance. The sail panels will also be retractable to ensure that they cannot cause damage in stormy conditions.

5.7. Technological Advancements

Further technological advancements will be made in all forms of marine craft. Cargo ships will be designed to ensure that they have optimal storage space. They will have additional propellers empowering them to perform more delicate steering, thus eliminating the need for tugs. They will have a modular design, making them capable of breaking into segments for faster loading/unloading (See Figure 5.7.1) (NYK, 2010). Ferries will have Wi-Fi connections and real time notification both on wharfs and on board, as well as entertainment units and thermal blinds which can be rolled down to capture heat, as the water breeze can be chilly!

Figure 5.7.1: Modular design (NYK, 2010)
6. Integration & Public Tendencies
Currently the transport system in Eastern Australia is poorly designed, as discussed in section 1. The system is often run as a series of individual transport systems, with separate timetable stops and ticketing systems. By the year 2030 the transport system will be fully integrated. With all forms of transport collaborating together, complimenting one another and achieving an optimal system.

This will be conducted through intelligent control. Using automated systems to optimise patron travelling time by timetabling all modes of transport to link. That is, train timetables will alter between bus timetables and so forth ensuring patrons can simply walk off of one form of transport onto another until they reach their destination. This process will be further maximised through the use of real time notifications on all forms of transport as well as the relevant infrastructure. There may be applications available for mobile phones which patrons can simply enter their initial address and their desired destination and the application will provide options of transport based on expected time and cost. The patron can then choose their route from the options and the application will direct them where to go via GPS at each station, as well as giving them real time notifications of expected departure and arrival times. This will reduce the stress and hassles experienced by patrons.

Infrastructure will be designed to help maximise the possibility of integration whilst remaining totally accessible to everyone. That is all forms of transport infrastructure (wharfs, stations, airports etc.) will facilitate one another by means of co-construction. For example a train station will be built in conjunction with a bus station, a wharf, walking/cycling paths and lockers and showers to help facilitate those. This will help to facilitate all passengers and ease cross form transport trips.

Tickets and fares among all forms of transport will become integrated. With an advanced form of Myki, the ticketing system currently being utilised in Victoria being utilised in all of the Eastern States (if not Australia). Though significant advances will be made to the current Myki system, it will be used in all forms of public transport not just road and rail. Myki cards will also be able to be used when purchasing items such as food and drink at transport stations, similar to the Oyster card in the United Kingdom, making purchasing items easier and simpler for commuters. The Myki system may be available as an application on phones, meaning that when passengers select their mode of transport from the route calculator app it automatically purchases the required tickets for them.

To further reduce energy usage, carbon emissions (if they are still happening) and congestion these advanced Myki cards may also become carbon credit cards. This will provide a system where passengers who use ‘smart’ forms of transport (public and manual transport) will be rewarded whereas passengers who use inefficient forms of transport (private cars) will be penalised. These rewards may include discounted ticketing fares while the penalties may be additional tolls. As majority roads in 2030 may have tolls/fares to help control the demand.

This integration system for the Eastern States will require the cooperation between the transport departments of every eastern state, as well as agreements from private transport companies.
7. Conclusion
By the year 2030 the entire Eastern Australian system will have significantly changed. This change will have been for the greater good and many benefits for both the environment and the community will be achieved as a direct result of these changes. The system will have a much greater reliance on smart public and active transport such as cycling and much less reliance on inefficient forms of private transport, such as cars.

The system will be much more “eco-friendly” and sustainable. No longer reliant on energy derived from fossil fuels, inefficient technologies/designs and unsustainable materials. Instead majority of the transport system will have implemented self-sustaining energy technologies harnessing the power from renewables such as wind and solar. Thus not only significantly reducing emissions but also giving eastern Australia immunity against global supply chain pressures (Siemens, 2011). This will also result in energy going a lot further than it does today.

These savings will be further made through a better choice of materials, choosing low embodied renewable energies rather than their high embodied energy counterparts. The design and technologies used in both infrastructure and vehicle craft will be cutting edge and revolve around sustainability principles. With major updates to the layout and general way in which a passenger’s commute is organised and conducted.

Integration will be a key component with all forms of transport effectively linking to one another through intelligent control. Well-designed infrastructure along with real time notification technology and an advanced Myki ticketing and carbon crediting system will allow for optimal efficiency among commuters and minimal stress. Whilst also further reducing congestion and therefore energy wastage and emissions.

However none of what has been previously presented can be achieved without government investment. To receive government investment, public backing is firstly needed. To achieve public backing detailed investigation must be done on future project options and budgets demonstrating to the general public what can be achieved through the implementation of such ideas.

In conclusion due to the advancements made in technology and forward thinking planning the Eastern Australian system in the year 2030 will be far more efficient, easier to navigate and sustainable than the current system. If the suggested technological advancements and innovative ideas are made and the theorised strategies and techniques implemented, then unbelievable changes will be made to the transport system and in tangent intense reduction in environmental effects and improvements in community lifestyle.

Figure 7.1: Myki (Myki, 2013)
Reference List

• Newman, P, NA, Why do we need a good public transport system? PB-CUSP Parsons Brinckerhoff


