Appendix A. Electric bicycles conserve oil, are potential users of solar electricity and enhance public transport Access

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1. Introduction.

The Japanese power assisted bicycle industry designed the first prototype of a pedal/electric hybrid bicycle in 1993. After several year of detail design it evolved into numerous models of an energy efficient light electric bicycle weighing between 18 kg and 25 kg, with a power output of under 250 watts which is now being sold in over 30 countries but not in Australia. The electric power assistance is controlled automatically by a computer chip, like its four wheeled big brother the petrol/electric hybrid car. This hybrid two wheeler is known as a **Pedelec** and it is important to distinguish it from the throttle controlled **E-bike** which also comes in numerous models made in several countries which looks very similar to the Pedelecs models with frames for male and female and frames that fold up. Both the Pedelecs and the E-Bikes have similar riding characteristics to geared bicycles but are a few kg heavier. The mini **E-scooter** is often referred to as an electric bicycle, however it does not look like or ride like a bicycle and is much heavier. Note that the abbreviated names used of the three main types of electric bicycle in this paper are bolded in this paragraph.

Figure 1 Chinese E-bike and a mini E-scooter that does not look like a bicycle

The E-scooter is almost solely powered by a more powerful electric motor and larger batteries, and is throttle controlled. It is usually fitted with perfunctory pedals which are often removable or too short, to conform with road regulations. Most E-scooters have a fixed and very low saddle so that riders do not have an ergonomically optimum position for pedalling but they have a place to rest the riders feet like a petrol powered motor scooter. In 2007 very few E-Scooters were being produced in Japan and China due to regulatory constraints but millions of them are still used in China and some of the early models of E-Scooters have been sold in Australia as bicycles. The E-scooter is not the main concern of this paper as it likely to legally declassified as a bicycle and maybe reclassified as a light moped.

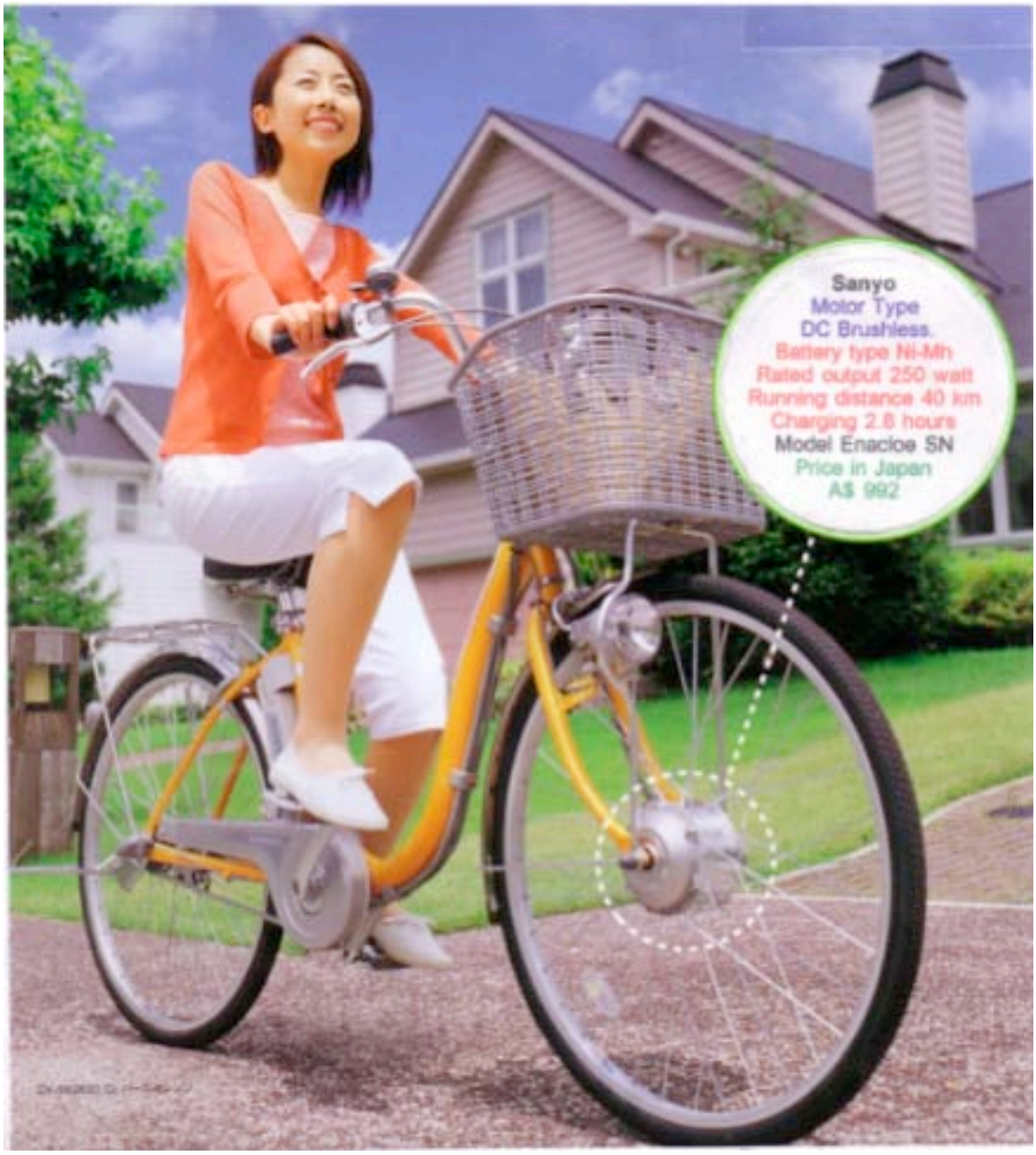


Figure 2. Japanese Pedelec with ladies frame. Note the front wheel motor and small battery behind the riders right foot. It looks and rides like a bicycle as do most Japanese Pedelecs

Australian policy makers are wrestling with developing new road rules and regulations for electric bikes. They have little information about the three types of electric bikes, who uses them, why they are used, and what factors influence electric bike travel. They have no knowledge of the use of Pedelecs because they have not been imported due to obsolete regulations and no Pedelec testing program has taken place. Indeed, only one serious test has been made on an E-bike in Australia (Parker 2006)(Rose and Cock 2003) Compare that with the 20 Pedelecs and E-bikes tested in Germany (Test Report 2008) and Japan.

This paper describes the evolution and future potential of Pedelecs and E-bikes in China and

Japan so as to learn from their experience, which is valuable for assessing the potential benefits of encouraging the use of the Pedelec and E-bike in Australia. Since 1995 Japan has manufactured Pedelecs that conform to Japans safety standards, road regulations and product testing requirements. (Parker 2008)

At present the use of the Pedelec, the lightest and safest electric bicycle, is banned by Australia's obsolete regulations which prevent the import of Pedelecs from Australia's major trading partners, Japan and China. The Pedelec, was invented 9 years before the Australian road rules were published and in 2008 many transport regulators are still not aware of its existence even though millions of them had been produced. Even so Pedelecs need to be legally classified as bicycles and not required to be registered, licensed or subject to compulsory insurance.

All that is required is that Pedelec importers provide evidence to the regulatory agencies that their models of Pedelec have gone through the Japanese testing and approval process and comply with new battery safety standards when they are approved by Japanese Chinese and European regulators. Failing to do this is a denial of the consumer's right to buy the best available technology and a restriction of free trade. (Parker 2008)

2. The evolution of a high tech electric bicycle industry in Japan and China

The prototype Pedelec was designed in Japan in 1989 to take 50% of the effort out of cycling for elderly cyclists at the request of the government. The design concept was to provide power assistance upon starting, when on hills, when riding into the wind, and when carrying lots of shopping. They did not want the power assistance to be used by irresponsible cyclists to go fast on footways or narrow access roads shared with pedestrians so the power fades out from 20 to 24 kph. The extra dead weight of the motor and battery limits further acceleration when pedalling. In 2008 in Japan the objective of enhancing the mobility of the elderly has been achieved and the largest niche market for electric bicycles has been women over 55 years of age. However in China people of all ages ride E-bikes.

The statistical data for electric bicycle production each year in Japan show that most electric bicycles made in Japan were Pedelecs. From 1993 to 2000 they mostly had lead acid batteries or NiCad batteries; from 2001 to 2004 they were nearly all NiCad or Ni-MH batteries; by 2007 most batteries were Lithium Ion which were lighter, longer lasting and cost more. The annual sales of Pedelecs in Japan (shown in figure 3) are stable at around 270.000 a year. (CyclePress 2004- 2005-2006)

Chinese Electric bicycle production data shown in figure 3 but does not distinguish between Pedelecs, E-Bikes and E-Scooters. Industry sources state that in the early years E-Scooters predominated in China but by 2007 far more E-Bikes with better quality lead acid batteries were produced for the domestic market and Pedelecs with Ion Lithium batteries were produced for export mostly to Japan . In future years more Pedelecs will be produced for the domestic market and E-scooters will be produced for the US market (CyclePress 2004-2005-2006) (Cycle Press 2008)

Figure 3 shows that Chinese production of all 3 types of electric bicycle increased to 19.5 million units in 2007 and production is expected to level out at around 20 to 25 million in a year or so. The sale of bicycles in Japan and China are also shown because a high level of bicycle use is partly responsible for people choosing to use electric bikes. Sound regulations are another factor and the Chinese regulations introduced in 2004 are resulting in an increasing proportion of Pedelecs being produced for export to Japan, better E-bikes with speed limiters for the Chinese domestic market. New markets for 500 watt and 600 watt E-Bikes and E-

scooters have opened up in the US and Canada. In the US 2 million E-scooters were sold in 2006 and 100,000 E-bikes.

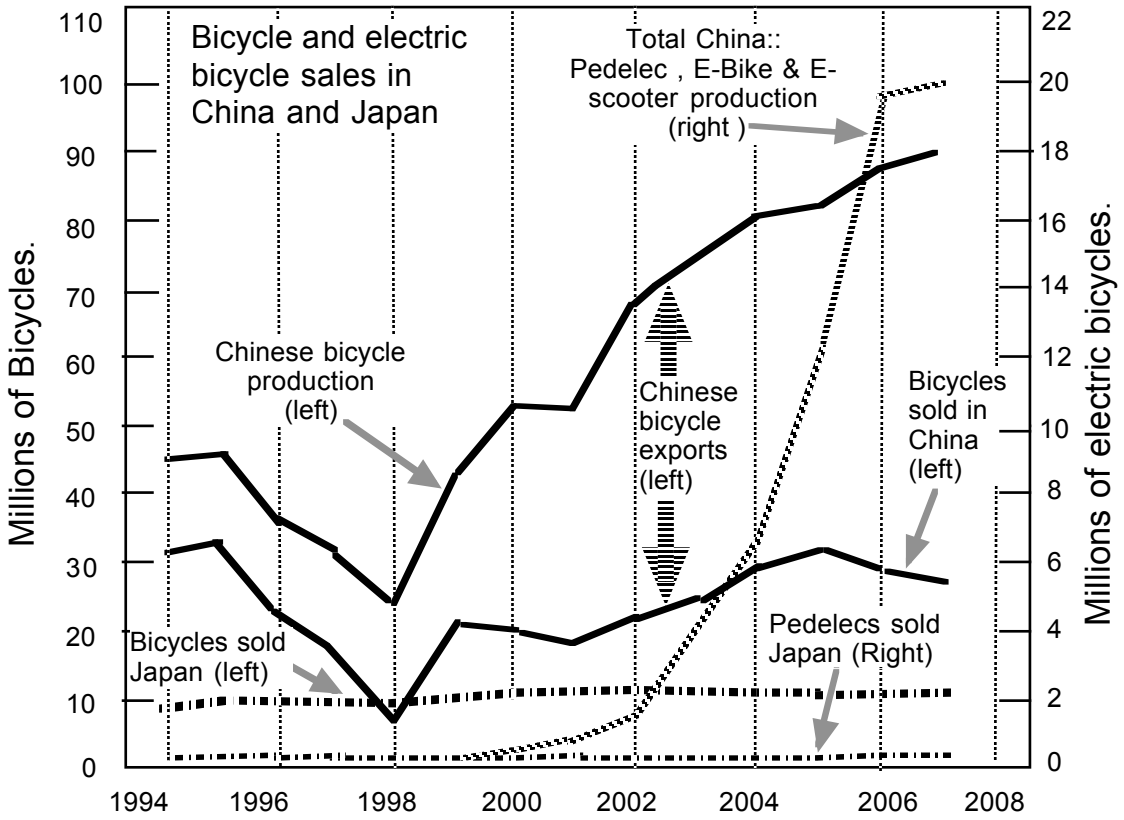


Figure 3 Bicycle and electric bicycle production in Japan and China
Data source Cycle Press (2008)

Japanese regulations that originated in 1993 and defined the characteristics of the Pedelec as a bicycle in traffic law, are still in effect without change 13 years later. The power ratio of one to-one up to 20 kph (12 mph) still applies and above that speed motor effort is reduced until it automatically shuts off at 24 kph (14.4 mph) (Jamerson & Benjamin 2005-2007). Japanese regulations came as result of bicycle companies lobbying regulators in 1992 to establish nation wide rules that all manufacturers would agree to, in order to have a uniform legal framework. E-bikes that are throttle controlled are in a category similar to E-scooters and both require a license and insurance before they can be used on the road.

To introduce regulations for the Pedelec, in 1993 the Japanese National Police Agency established the rules for speed limitation and controls. The Road Traffic Law Enforcement Regulations were established in 1995 which allowed these electric bicycles to operate on roads with traffic. Approvals for new Pedelec models require the following procedures:

1. The design, quality control, handling instructions, and test results are submitted to the National Public Safety Commission for examination and approval.
(Jamerson and Benjamin 2005 and 2007)

2. The Commission asks the Japan Traffic Management Technical Association to test

> the models and report back the results. When tests and other requirements are met, the Technical Association grants a certificate of approval to the manufacturer. (Jamerson and Benjamin, 2005 and 2007)

The Japan Bicycle Association Foundation of the major manufacturers has committees on Bicycles, Components, Safety and Trade that offer advice and assistance. The Bicycle Committee includes experts on electric bicycles with automatic speed limitation. This Committee has a relationship to the Safety Promotion Committee of the National Police Agency in matters dealing with the safety aspects of electric bicycle design. This appears to be a very bureaucratic system but it provides products that are well engineered with high quality. It is of great benefit to Japanese consumers. It could also be of benefit to Australian consumers if we adapted our regulations to allow the imports and sale of Japanese approved Pedelecs into Australia and be classified as bicycles.

3. Tomorrow's niche markets for the solar electric Pedelec in Japan

Since the Japanese government signed the Kyoto Protocol in 2001 they have become interested in schemes to use Pedelecs instead of cars to reduce greenhouse emissions. Japan is completely dependent on imported fuels and the cost of electricity is very high. In 2003 Japan imported 5.5 million barrels of oil a day and has proven oil reserves that will not last more than a year. Japan has been implementing an energy security policy since the mid 1970s that focuses on reducing oil consumption. This explains the large investment in the rail network and the 27% of trips made to work or education by public transport. Five million people cycle to the rail system every workday; around 15% of the population cycle all the way to work and another 12 % walk to work. Japan's energy security policy has reduced oil dependence in the transport sector from 80% in 1973 to 50% in 2004, thus reversing a negative trend (Hooke 1994).

A Japanese economist states the economic benefits of the energy security policy as follows: -

> This policy... was part of a broader policy to nurture its domestic industries, constrain consumption and encourage savings and minimise the costs of inputs to industry. By minimising aggregate transportation costs, Japan has been able to minimise ... production costs, making their goods more competitive in international markets. Further by discouraging the use of automobiles and encouraging savings a larger pool of potential investment capital was created ... and encouraged investments in modern technology... The bicycle far from being a symbol of economic backwardness is rather a symbol of a society able to meet its passenger transport needs in a most cost effective and least environmentally damaging way, allowing scarce economic resources to be invested elsewhere." (Hooke 1994)

This also explains why Japan has been exploiting renewable energy resources since the early 1990s and now generates half the world's solar power. This fits in with the evolution of the mains electric Pedelec into a solar powered means of transport. Solar powered electric cars requiring 50,000 or more watts power output have a limited future, but electric Pedelecs with a power output of only 250 watts are economically viable now and will be on the market within a few years. Indeed, the Japanese solar power industry is expected to grow fivefold by 2010 when over one million homes will generate their own electricity from solar electric panels. In the last three years there have been several experiments using solar electricity for the recharging of batteries of a Pedelec and other domestic appliances. A long-term vision is emerging of the electric Pedelec charged from roof mounted solar electric panels as an ecologically sustainable means of transport, which is used by people of all ages even in hilly cities. (See figure 4)

The solar electric Pedelec has been used sensibly to solve environmental problems in

Shimonoseki City in the prefecture of Yamaguchi. Yamaha designed a project for the charging of batteries of 30 Yamaha “PAS” electric Pedelecs using solar power. Yamaha plans to promote electric Pedelec solar energy charging parking lots in many other areas (Cycle Press 2003). Sanyo has also been providing facilities for the solar electric charging of its workers Pedelecs.

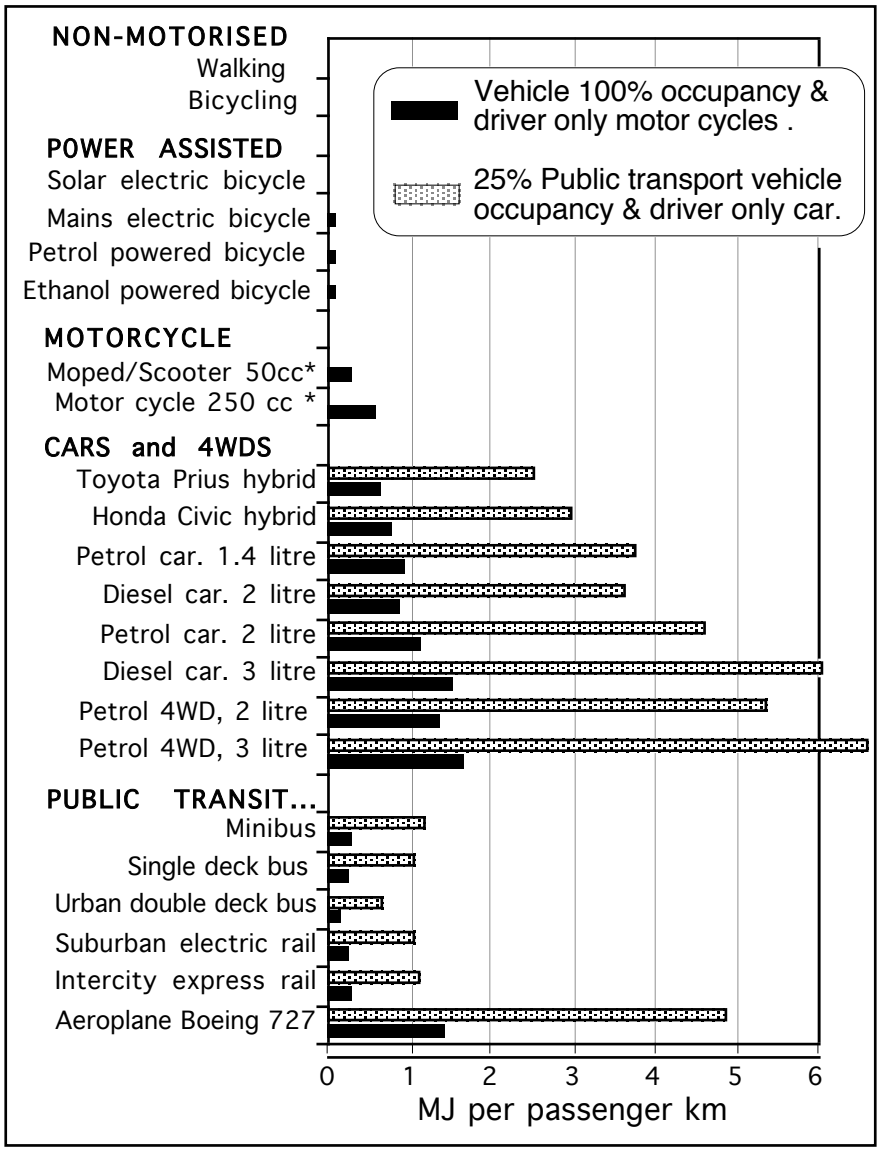


Figure 4 shows the energy efficiency per passenger km of Japanese Pedelecs and petrol/electric hybrids compared to other vehicles.

SOURCES: Public transit: European Commission 1992 “The impact of Transport on the Environment”. Greenhouse office fuel consumption guide 2002-2003. Parker 2004 Electric Bike data

Another of Honda's environmental initiatives is the concept of “Intelligent Community Vehicle Systems” (ICVS). This is based on moving individual vehicle ownership to “shared vehicle use”. Honda's vision is of a transport system that is “kind to people, the city and the planet” The ICVS aims to provide a solution to environmental conservation, coexistence with nature, better use of public space, smoother traffic flow and insufficient parking space. The basic

concept of this system is based on moving from the individual ownership of vehicles to the shared ownership of environmentally friendly vehicles. This includes energy efficient cars, microbuses and electric Pedelecs for door-to-door trips and to access an efficient rail system. (See figure 4)

For the future there are four niche markets that can reasonably be expected to grow and contribute to a more sustainable passenger transport system:

1. People of all ages using their own or company electric Pedelec at apartments, factories and offices with mains electricity or solar battery charging and secure storage facilities.
2. Commuters and students using electric Pedelec to access rail stations and modal interchanges. Five million Japanese park bicycles at rail stations every workday. Electric Pedelecs will progressively move into that niche market for multi-modal travel, as many users need a bicycle at both ends of their rail journey.
3. Young male and female bicycle riders using electric Pedelec to take the extra physical effort out of riding in hilly cities so that they are as mobile as cyclists in flat urban areas.
4. The elderly for all kinds of trips particularly for recreation and shopping: lightweight fold-up electric Pedelecs are allowed on bullet trains and easily fit in the boot of a car.

4. Pedelecs are enhancing the mobility and health of the elderly in Japan .

Japan has a proportionally larger elderly population than Australia and the Japanese public health agencies are aware of the need to enhance the mobility of the elderly, many of whom had been lifelong cyclists. They conducted tests based on ergonomically sound science which proved that able bodied people riding a bicycle use the 'mechanical advantage' of pedalling over walking to go 3.5 times as far as walking and to access around ten times the area for the same physical effort. They assumed correctly that elderly cyclists needed a two wheeler that took 50% less effort to go from A to B so that the elderly could do what they did in their youth. (Parker 2002) Their doctors knew that cycling could strengthen muscles, maintain joint mobility and position, improve heart and lung fitness, reduce stress , control weight, improve sleep and contribute to overall wellness and coping strategies.

Japanese public health agencies provided the initiative for the bicycle and vehicle manufacturers to develop the Pedelec to keep their cyclists cycling into old age. What was needed was an efficient and non polluting way of reducing the effort of cycling short distances by half. It took a decade to improve the detailed design of today's lightweight and safe Pedelec and around 270,000 of them are now sold each year. This figure includes both shopping tricycles and lightweight fold up bicycles.

For people over 55 to have a serious health problem that stops them from walking or working is a serious handicap. Being without work for more a short time means that many long term unemployed cannot to afford to drive a car. After the age of 55 an increasing proportion of the population find that walking can be painful because of arthritis in their hip, knee or ankle joints. Walking is the most natural form of exercise but if it is too painful then people need to find another healthy form of exercise such as cycling that reduces shock loading and places less stress on these joints. When cycling, most of the body weight is carried on the saddle of the bicycle and the body is not subject to the shock loading that comes from walking on hard surfaces.(Parker 2002)

Riding bicycles with low gears provides a moderate and controlled level of exercise in flat areas. Riding Pedelecs takes half the effort so that elderly people find it much easier to cycle up hills or against winds.

Millions of elderly Australians, many of whom are partially disabled with arthritis and other ailments that result in lameness, could enhance their mobility by using a Pedelec but they do not have that choice. The same applies to the growing numbers who are obese by middle age and have various forms of heart disease. There were 2,466,000 Australians over 55 years of age with arthritis in 2007 and this will increase to around 4.5 million by 2030. How many of the arthritics could benefit from using a Pedelec or a 350 watt E-bike is unknown.

This writer,s personal experience in coping with a serious heart problem is that Ithere is lot of benefit from the gentle exercise when riding an E-bike on the flat with a max power output of 200 watts. Being overweight there is also a need to manage the extra effort required to ride uphill. Pedelecs provide automatic power assistance on uphills so that it is possible to safely maintain a safe level of physical effort exercise for those who are not overweight and of average height but for the overweight it is not . A choice of a Pedelec or E-bike that has sufficient power output for riding uphills is definitely needed. The tests conducted in Germany on 20 Pedelecs and E-bikes reveal that some of the them give relatively less power output on the flat but provide more assistance on hills. The tests results enable potential buyers to pick the ones most suitable for their needs which vary according to the terrain they ride on. (ExtraEnergy Test report 2007)

Many older people also have problems with their declining eyesight, or the effects of medication or reduced reaction times and are advised to give up driving cars. Even so they may be able to ride Pedelecs on bikepaths and safe on-road routes for a few extra years but no-one can legallyadvise that because there is no hard data for users available. The only apparent choice is a three or four wheeled scooter designed to be used by the disabled on the footpath. This provides no exercise benefit whereas the Pedelec has to be pedalled.

Japanese experience shows that the Pedelec bridges the gap between driving a car and the very limited mobility provided by three and four wheeled footpath scooters. It is worth noting that many elderly people need more power assistance than 1 to 1 they may need power assistance of 2.5 to 1. Indeed New Zealand recently made provision for Pedelecs and e-bikes with power outputs of up to 650 watts to be used by the elderly and partially disabled at the “discretion of the Director of Land Transport (NZTS 2002) There is no good reason why a similar provision could not made in Australia.

5. Pedelecs make bikeway networks feasible in hilly Australian cities

Access to transport is a fundamental need of everyone, particularly in outer suburbia. The use of Pedelecs could become the main means of local transport and to access rail stations or express and trunk bus route, providing that secure parking is available for the Pedelec. For all practical purposes tomorrow's electric two wheelers are destined to join the bicycle and walking as the only forms of transport that emit no emissions if charged from solar cells.

Most cities have sprawled beyond the plains and are spread across hilly terrain. If bikeway networks existed Pedelecs could overcome these constraints and could be used to enhance personal mobility in much the same way as bicycles do in flat cities. Modern multi geared bicycles are a help in climbing hills but, as recent experience in Japan shows, housewives and elderly cyclists start to give up cycling when it becomes too strenuous but if high quality and safe electric Pedelecs are available they will use them.

In the hilly parts of Australia's cities the more powerful 350 watts machines would enable able-bodied people to cycle much more than they do now. It would enable them to be more active as part of their daily life, increase their mobility, reduce isolation and improve health. An important safety consideration is having enough power assistance to ride up hills without weaving and to reduce the speed differential with motor vehicles when riding in the kerb lane

or a bike lane. This why the Bicycle federation of Australia recommends a 350 watt power output for Pedelecs.(Salomon 2008)

If safe back routes to rail stations, secure bicycle parking at stations and modal interchanges were available electric Pedelecs and E-Bikes could make it much more convenient to use public transport and effectively enlarge rail catchment areas. From a strategic transport planning perspective investing in urban bikeway networks would be more cost effective in Australian cities if they also enabled electric Pedelec and E-Bikes to be used safely instead of cars (Parker 2002).

Figure 5 Shows an able bodied female around 55 kg in weight riding easily up hill. An overweight male of around 110 kg would stall the motor very quickly. This is why those with weight problems need a extra 150 watts more than the existing 200 watt maximum power output.

6. The need to reduce air pollution and road congestion in China

Policy decisions in 1949 resulted in bicycle friendly infrastructure becoming pervasive throughout China's cities. Users rely on the non-motorized vehicle lane and parking infrastructure to improve travel speed, safety, and convenience. This extensive infrastructure partly explains the high demand for E-Bikes compared to other Asian cities without the infrastructure. (Zang 2007)

Many millions of bicycles powered with small and dirty two stroke engines were in use in China prior to 2004 and most of them are now banned in polluted urban areas. In 2006 there were 13 million petrol powered motor cycles sold and some cities are banning their use. In response to air quality concerns and rising fuel prices, motorcycle are getting cleaner through innovations in engine design and exhaust control . As E-bike improve so does their main competitor the motorcycle .

Air quality and traffic problems in cities, are in part due to rapid urbanisation, have led to strong political support by local government for motorcycle bans and bans of power assisted bicycles with dirty two stroke petrol engines and the loose enforcement of E-Bike standards. A specific example is Shanghai which has a population of 20 million people and nearly a million licensed petrol powered bicycles so the city government decided not to issue new licenses for them but only to issue them for E-bikes, as was done in Beijing.

Given the high and growing health costs of urban air pollution which cause around 400,000 deaths a year in addition to around 200,000 road deaths a year in China It is likely that more environmental legislation will be introduced to constrain car use in cities and increase the demand for Pedelecs and E-Bikes. National support is in part due to national energy efficiency and reduced air pollution goals. Public transport in the largest cities has become strained from the effects of the fast growth of urbanisation and car ownership, which has stimulated greater demand for E-Bikes and E-Scooters. (Weinert et al, 2008)

China is at an earlier stage of industrial development than Japan and the concern of the Chinese government is to reduce air pollution and enhance the mobility of working families who cannot afford cars by providing clean Pedelecs and E-bikes to replace bicycles in preference to motor cycles. Also the Chinese electric bicycle industry has matured a great deal since 1998 when they produced only 58,000 E-Bikes and E-Scooters. In 2007 21.4 million Pedelecs, E-Bikes and E-Scooters were produced; after nine years of product development. After new regulations were introduced in 2004, E-scooter production was scaled down and E-bikes production increased. The 2007 models of E-bikes are lighter and better quality batteries and after sales and service for consumers than before. (Cycle Press 2008) The new regulations were also designed to enable Chinese made Pedelecs to to be exported Japan and the European Union, which by 2004 had introduced new safety standards for Pedelecs and E-Bikes. (Jamerson, and Benjamin 2007) China is likely to introduce new regulations for E-Scooters in 2008 for both domestic use and to exploit export opportunities in the US and Canada.

In 2006 most Chinese could not afford the very expensive Ion lithium batteries fitted to most Japanese Pedelecs and 85% still used improved lead acid types so there is still an environmental problem. Compared to the US and Europe China has less efficient processes for the extraction and refining of lead and less efficient methods of recycling the lead. The same applies to the less efficient methods of coal production and less efficient power stations to produce the electricity to charge the batteries. Even so the Chinese government is cleaning up most mining operations up grading recycling and increase in the standard of living will decrease lead acid battery usage in a few years. (Cherry,.Weinert.Ma (2007)

7. The solar electric future of the Chinese electric bicycle industry ?

China has encouraged Japanese companies like Shimano, Taiwanese companies like “Giant “ and many others to mass produce their products in China for its 450 million adult bicycle users and for export. This has almost eliminated bicycle manufacture in the US which made 7.5 million bicycles in 1991 but less than half a million in 2007 while Chinese bicycle imports increased from 1.3 million to 18 million. This is happening in many countries; in Australia Chinese imports have wiped out bicycle manufacture. Given current trends in the solar ectricity industry these two industrial have the potential to produce tens of millions of solar electric pedelecs and E-bikes.

There are also formidable forces resisting electric bicycle industry growth. Seven cities throughout China have banned or restricted E-bikes in recent years, in addition to banning motorcycles. Some officially cited reasons for the bans include improving traffic flow, increasing road accidents, and reducing environmental pollution from worn-out batteries (Shanghai Daily, 2005). The superior performance of motorcycles is a powerful limiting factor, especially in areas where motorcycles are not banned and incomes are high. Bans on E-bikes could also limit their growth if they spread to other cities that are trying to promote public transit products in order to reduce automobile congestion. Added investment in transit infrastructure for rapid transit may improve performance to compete better with E-bikes.(Weinert et al, 2008)

High levels of bicycle ownership in China (see figure 1), when combined with manufacturing policy and environmental regulations which are designed to reduce air pollution provide a secure market for Pedelec and E-Bikes manufacturers in most cities except for those cities built in a mountainous terrain. The detail design Improvement of Pedelecs, E-bikes and new battery technology is also a driving force that can be partially due to the open modular industry structure of around 400 suppliers and assemblers. This type of structure was made possible by the highly modular product design, which resulted in product standardisation and enhanced competition. (Weinert, Ma, Yang, Cherry 2008)

Chinese urban workers are upwardly mobile and wanting to enhance their mobility, but most will not be able to afford a car. The domestic E-Bike market will be dominated by the better-paid workers in the new industrial parks and office complexes. In 2007 there were around 400 million urban adult bicycle users, 50 million E-Bike and E-scooter users and is likely to increase first in the 12 cities of more than 10 million population and then in the provincial cities servicing rural areas as the standard of living increases. However some cities have restricted the mobility of bicyclists and E-bike users because they are very hilly with narrow streets and steep grades which are not conducive to any kind of bicycling. The trends in domestic sales suggest that around 60 million bicycles and E-bikes and Pedelecs will be produced in the next five years with an increasing proportion of E-bikes and Pedelecs

Today teenagers and the retired have only a small part of the E-bike market however that is changing as well. According to the latest census predictions China's population was 1.31 billion in 2005. The age structure is also changing as China continues to see a gradual ageing of its population. Chinese demographers estimate that China will see zero population growth by 2035, when the country's population reaches 1.5 billion. By mid-century China is projected to have more than 400 million seniors accounting for 20 percent of the total population; a huge future market for E-bike and Pedelecs.

While China recently eclipsed Japan as an oil consumer, China is now second only to the United States. What the Chinese passenger transport system will be like in 2050 is most uncertain. Vehicle sales would continue to expand at double-digit rates this year to 10 million in the world's second largest car market, according to the China Association of Automobile Manufacturers. China's oil consumption would rise from 346.6 million tons in 2006 to 407

million tons in 2010 and 563 million tons in 2020, the Chinese Academy of Social Sciences forecast in a new report. (China View2008) However it is perhaps more likely fewChinese will be driving and that oil will be so scarce that it will have to be conserved for critical essential purposes. See section 12 for an assessment of the threat of oil depletion.

If China's current investments in solar energy come to fruition, their solar electric powered Pedelec industry will become the largest in the world. In the short term the ambition of the Chinese PV industry is to grow by about 400% in the coming 5 years. Although the domestic PV market is still in its infancy, the production and export of solar grade silicon, cells and modules have grown by 50-100% in 2005. The total available production capacity for cell and module production (of the current 30 major companies involved) is already more than 20% of the world's total, coming from less than 1% in only 5 years. Currently, China is the world's third country in terms of solar cell production capacity. The overall goal of the Chinese government is to have 450 mega watts cumulative PV power installed in China by 2010: an average sales growth of 40% per year until 2010 is needed. The target has been set at 8,000 MW by 2020 when PV could have become cost competitive. (SolarPlaza 2005)

Already Pedelec and E-Bike manufacture is the fastest growing powered vehicle industry in the world. It is arguably the most innovative and ecologically sustainable transport development in the world today. China argues that its successful one-child policy has already helped the fight against global warming by avoiding 300 million extra births, the equivalent of the population of the United States. China's has demonstrated that it is the only world power that still has the political will to make tough decisions prior to a crisis emerging. It could turn back the middle class tide of car buying once its elite is convinced of the damaging consequences of peak oil and climate change on future economic development.

In 2007 China decided to give much greater priority to environmental protection and the increased enforcement of environmental regulations and started to lower the carbon intensity of the electricity grid. The recently passed Renewable Portfolio Standard and increasing crackdown on small inefficient coal power plants increasing generation from renewables and nuclear power. E-Bike and Pedelecs now provide a pathway toward future low-carbon personal transportation and providing an example of how regulatory policy can change the transport behaviour of millions and create a new mode of transport for the rest of the world to follow. (Weinert et all 2008)

8. Freeing up restrictions of international trade in electric bicycles in the EU

The European Union (EU), like Japan, has legislation that allows electric bicycles with a 250 Watt maximum power output. Their view is that one of the means to attain free circulation of new products and green products, like electric bicycle,s is the harmonisation of the technical requirements with which they have to comply. Harmonised technical requirements allow manufacturers to develop one and the same product for the whole European Union, whereas, without harmonisation they have to develop different variants in order to comply with Dutch , French, Italian and other. national regulations.

This also avoids possible problems caused by excessive speed and/or tampering with the vehicles, as is the case with speed controls and engine tuning on traditional mopeds. The 27 member states of the EU had to replace their national legislation. Other countries have taken timely action to produce sensible legislation and so should Australia

Around 100,000 Pedelecs were sold in the Netherlands in 2007 and that is expected to increase to 250,000 in five years. Another 150,000 E-bikes and Pedelecs were sold in the rest of Europe in 2007.(ExtraEnergy 2007)

The non-profit German company Extra Energy tested 17 electric Pedelecs and eight E-Bikes, most of which where made in Europe. Hannes Neupert of Extra Energy seeks to promote the benefits of E-bikes and Pedelecs through product testing and by raising concerns about battery use and disposal. He states that:

"Pedelecs technology is still far from perfect. The issues of battery recycling, solar recharging and the need for 'smart or smarter chargers', and considerable information on these subjects, including the full test results, are on our web site; www.extraenergy.org." (Neupert, 2002)

In 2006 Neupert's company was testing the performance of 20 E-bikes and Pedelecs and their batteries which were available in Europe in a systematic way on two test routes one hilly and the other flat. These published test results show a sophistication and a test methodology that is far superior to any E-bike tests in Australia or anywhere else in the world outside China, Taiwan and Japan. The field test reports show very clearly that the scope for tailoring E-Bikes and Pedelecs to people with specific transport and recreational needs and for the elderly and people with health problems. Indeed all future tests will focused on the needs of specific user groups (Test Report 2007)

9. There are problems with batteries and electrical component standards

Some experts suggest that there could be a serious fire risk problem with the use of some commercially available lithium ion batteries in Australia where the temperature exceeds 45˚C in the cities and regional centres in the north and central Australia on many days and on a few days in Adelaide and Brisbane. Other experts suggest that coping with high temperatures is not going be a major constraint in the future because of new developments in battery technology. It may not be long before we see some evidence of a fire risk because in In 2007 more than 250 million lithium cells were shipped throughout the world. when international safety standards where still evolving. There may be a need for more rigourous tests and standards. (LEV Conference 2008)

To ensure that all ion lithium batteries are safe and that their safe temperature limits are not exceeded a standard manual was released at the Light Electric Vehicle Conference in Taipei in Taiwan on March 13 2008.(BATSO 2008) This safety and certification standard manual was considered vital to the future of the electric bicycle industry. (LEV Conference 2008)

At the Conference workshops it was decided to develop a new standard to encourage future growth of the light electric vehicle industry . An organisation (EnergyBus) was set up and will operate out of Germany to achieve what Blue tooth has done for the cellphone industry and what the USB standard has done for the computer industry. EnergyBus will standardise the hardware and software interface and will easily connect batteries and chargers of different voltages from different manufacturers without causing damage or destroying batteries. It will be a key element in creating a mass market for light electric vehicles. For example battery safety and compatibility of electrical components are especially important for the future development of E-bike or Pedelec bicycle rental systems.

10. Integrating the electric bicycle with domestic solar electric power

Australian road and traffic agencies should be aware that the next advance in the design of intelligent electric bicycles is on its way. Japanese experimental electric bicycles with solar PV battery rechargers enhance mobility with minimum resource depletion. In the near future these solar charged electric bikes will be mass produced in China and Japan. The opportunity now exists for Australian industry to develop mass produced roof mounted solar cells to

charge the batteries of commercially available Pedelecs and E-bikes.

State and Commonwealth environment agencies should provide marketing incentives for imported electric bikes to be sold as part of a package, complete with a PV 24 Volt or 36 Volt DC battery charging system coupled to solar panels. Solar PV battery recharging installations should be introduced in new housing schemes, new flats, factories and office complexes. This should be part of a strategy to reduce oil use by substituting for single occupant car journeys without increasing the demand for electricity from power stations.

The proposed new regulation of electric bicycles should not create a constraint on the use of PV charged electric bike batteries. These should be available in a couple of years and will reduce oil consumption and carbon dioxide emissions without increasing the consumption of grid electricity. The new regulations should anticipate this development and should not Constrain the Australian Solar PV industry from expanding it PV cell production. The stimulus for Australia is the predicted increases in world crude oil prices which will also induce a decline in Chinese demand for Australian minerals.

Peak oil will handicap Australia's economic growth,put a limit on car production for their domestic market. China as the world's major producer Pedelecs and E-bikes will looking at the Australian market to export to and in a year or so new designs of Australian solar cells could be produce to gether with advanced batteries to produce a most energy efficient replacement for many urban car trips. All new commercial developments and blocks of flat should provide secure bicycle, Pedelec and E-bike parking with electric charging points.

It is important to ensure that these trends will interact with one another in a positive way. It seems reasonable to assume that the mass use of electric bicycles, powered from rooftop photo voltaic cell arrays in cities, will be the next transport / sustainable housing innovation. Current research clearly shows the outer metropolitan suburbs are extremely vulnerable to high oil prices and possible fuel rationing in the long term. (Dodson and Sipe 2005) (Parker and Worth (2006)

11. The worst case climate scenario

Planning to cope with climate change needs an "all of government "approach and bipartisan support to confront the reality of the worst case scenario. For example, climate change expert Sir Nicholas Stern says:-

> *"he underestimated the threat from global warming in a major report 18 months ago when he compared the economic risk to the Great Depression of the 1930s. Latest climate science showed global emissions of planet-heating gases were rising faster and upsetting the climate more than previously thought"* (Reuters interview 17-4-08)

Evidence is growing that the planet's oceans - an important "sink" - are increasingly saturated and could not absorb as much as previously of the main greenhouse gas carbon dioxide (CO2). Methane Emissions from the Arctic tundra are more dangerous than CO2 and are growing much faster than we'd thought, so the absorptive capacity of the planet is less than we'd thought, the risks of greenhouse gases are potentially bigger than more cautious estimates, and the climate is changing faster. (Pearce 2008)

This is a very real risk to Australian National Security and that is likely to be recognised in the final Garnaut report on climate change. The electricity grid needs to be decarbonizes by increasing generation from renewables, geothermal sources and carbon sequestration. solar charged E-Bikes and Pedelecs can provide a pathway to reducing emissions and oil dependence from personal transport. The energy efficiency of E-Bikes and Pedelecs is

shown on figure 5.

12. Pedelecs and E-bikes will be needed to reduce oil consumption

Depleting oil supply is the major threat to Australian national security. In 2000 Australia's production of crude oil and condensate satisfied nearly 100% of its needs but by 2007 40% was being imported and this could be 80% by 2012. The threat comes from world crude oil production peaking between 2008 and 2012 which will increase imported crude oil prices, perhaps to $200, a barrel. This could cause permanent oil shortages and necessitate fuel rationing. The future, of course, is uncertain but a risk management approach to the future is the way to go. The mass use of Pedelecs charged by rooftop solar cells would certainly make life less difficult if petrol use had to be rationed. (Parker 2007)

The Vice President (Cheney 1999)once said that peak oil was only a few years away and in March 2008 in the Melbourne age he said *"One of the problems we've got now obviously is that there is not a lot of excess capacity world wide... there's just not a lot out there, and some of that excess capacity represents high sulphur crude for example, it's not very attractive and not easily marketed.... ... But it reflects primarily the realities in the marketplace,"*

The price of West Texas Crude was $US 132 a barrel on 28-5-08 an event which was not anticipated In studies by Commonwealth agencies who have assumed that the price of oil in 2020 will be around $US 25 a barrel. In 2005 the Bureau of Transport and Regional Economics (BTRE), the IEA, EIA and Opec produced a grossly inaccurate projection of future oil prices which are shown on Table 1. The unsound forecasts of the International Energy Agency (IEA) and other prestigious overseas energy agencies were blindly assumed to be true by Commonwealth bureaucrats, particularly the Productivity Commission and the BTRE. Some government economists have made serious errors of judgement because they have put their faith in oil reserve estimates that ultimately are derived from the nationalised oil industries of dictatorial regimes. These countries do not publish details about how much oil is extracted from each reservoir, what methods are used to extract that oil; nor do they permit external audits. (Economist 2006)

Table 1 Oil price forecasts for the period 2010, 2020 and 2030 (US $ per barrel)

Government or intergovernmental source	2010	2020	2030
International Energy Agency (IEA).	22	26	29
Energy Information Agency (EIA); US Department of Energy.	23	25	
European Commission (EC)	28	33	40
Organisation of Petroleum Exporting Countries (OPEC)	19	19	
Institute of Energy Economics Japan (IEEAJ)	24	27	
Centre for Global Energy Studies (GGES)	20	15	

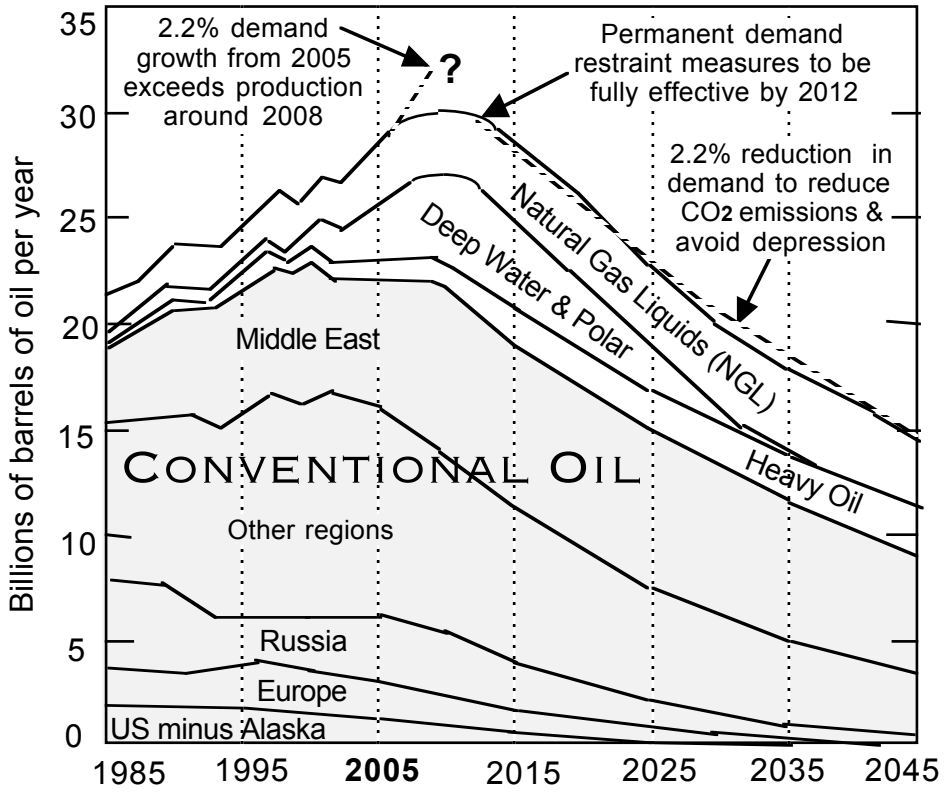
Source: (BTRE 2005 working paper 61. p. 24).

The Chief Economist at the IEA is now taking a more realistic approach to future oil prices and states that the price of oil in 2030 will perhaps be US $121 above the estimate in table 1. *(Birol, F. 2008)*

Some government economists do not accept that oil shortages are inevitable. because low cost clean conventional oil is a finite resource. Nor do they accept that the high quality oil gets

used up first and the quality drops off as an oil field becomes exhausted over many years. They believe that by increasing the price of crude oil the market creates more of the good oil, when all it does is to increase the supply of carbon intensive sour and heavy oils, tar sands and other substitutes with a much lower energy return on energy invested. To extract and refine them into fuels costs more and increases CO2 emissions. (Parker 2007)

Because peak oil is certain to occur it would be prudent to conserve oil to maintain essential public services and food production. A major change is needed in the planning and management of the Australian transport sector which has one of the highest levels of per capita car and air travel, road freight carried, greenhouse gas emissions and oil consumption in the world. Figure 3 indicates the need is to reduce oil consumption by 2.2 % per year by decoupling the growth in oil consumption from the growth of GDP and persuading regional neighbours to do likewise. (Heinburgh 2006)



Source: Oil production data from the April 2005 newsletter of the Association for the Study of Peak Oil www.asponews.org

Figure 6 The decline in conventional oil production from around 2010

Note that figure 6 uses data produced by the Association for the Study of Peak oil at about the same time as the BTRE., the IEA and OPEC made their absurd forcasts of the price of oil in 2010 and 2030 shown in table 1. A US study and recent Senate Inquiry into future oil supplies recommended that government take a risk management approach to future oil shortages. However that has not been done so far. (Senate 2006).(Hirsch, Bezdek, and Wendling 2005)

13 Required action

At present the use of Pedelec- the best, the lightest and safest power assisted bicycles - is

banned by regulations which prohibits their import from Australia's major trading partners, Japan and China. This is a restriction of free trade. Most of the the commercially available power assisted bicycles on the world have maximum power outputs of 250 watts. There an urgent need to change the the Australian Road Rules and State regulations. Consumers should have the immediate choice of buying safe “state of the art” Pedelecs that are legally classified as bicycles, not required to be registered, licensed or subject to compulsory insurance and be allowed to use shared footways, bikelanes and when adults are escorting child cyclist (under 12 years of age) on the footpath. These actions should be put into effect by June 30 2009.

The Australian Road Rules and state regulations for electric bicycles should increase the maximum power output from 200 watts to 250 watts provided that the speed control system is fully automatic. After being actuated with a starting key or switch, immediate power assistance will be provided when pedalling , including when starting, when on hills and when riding into the wind, or whenever needed. Electric power assistance will fade out from 20 to 24 kph. This would be the principal safety requirement for their legal classification as bicycles in Australia and would ensure that only those Pedelecs made in China and Japan that meet the safety and testing requirements for import into Japan are imported into Australia. As the market for Pedelecs in Australia will be less than one tenth of the size on the Japanese market this is a sensible requirement as all models of Pedelecs made in China are primarily designed for the Japanese market.

All that is required by state agencies is that wholesalers and retailers must produce evidence from their suppliers that Pedelec models they import have gone through the Japanese testing and approval process. This will also require that the regulators co-ordinate with the Japanese and Chinese agencies to provide full information about their testing and approvals process. There is a also a need for the them to produce a consumers guide to the Pedelecs that are being imported. The Pedelec and its batteries should carry a small identity plates to assist in preventing theft.

A 350 watt maximum power output as suggested by the Bicycle Federation of Australia (Salomon 2008) is fully supported for both Pedelecs and E-bikes because there is a need to cater for the transport and recreational needs of able bodied cyclists who live live in very hilly areas of Australia's cities. A 350 watt maximum power output will be required by the and the partially disabled most of whom require more power assistance to compensate for their lower level of human power output even in those urban areas with moderate inclines. 350 watt Pedelecs with speed controls should also be allowed to ride on shared footways, on bikelanes and when escorting children on footpaths. 350 watt E-bikes should be badged and licensed and subject to a speed limit of 25 km per hour on shared footways not allowed to use footpaths and be allowed to travel on bikelanes and roads up to 40 km per hour. To avoid confusing police these vehicles should have small licence plate attached to the E-bike.

To enhance the mobility of the seriously lame e and disabled, Pedelecs and E-bikes designed by Chinese and European companies for the US and Canadian markets which have a power output of up to 600 watts should be classified as 'bicycles' at the discretion of the road or transport minister, for elderly disabled users as is done New Zealand. (NZTS 2002) To avoid confusing police these vehicles should have licence plate attached to the vehicle.

The existing Australian electric bicycle fleet is nearly all throttle controlled machines which do not have speed limiters that cut out at 24 km per hour and can use power assistance to exceed 30 km per hour. However they should be allowed on bikelanes, shared footways and footpaths if used to escort children below 12 years of age. Throttle controlled machines will no longer be imported so that the existing electric bicycle fleet will fade away with time and nearly all of them replaced in five years with Pedelecs or E-bikes with license plates.

There is a need for policy support from the Commonwealth and state environment agencies to provide marketing incentives for imported electric bicycles to be sold as part of a package, complete with a PV 36 volt or 48 Volt DC battery charging system coupled to solar panels. A study is needed to develop a prototype solar PV battery recharging installation for electric bicycles, test the recharging installation over a period of one year and produce a feasibility study and detailed costing for factory production.

There is a need for policy support for solar PV battery recharging installations which should be introduced in new housing schemes, new flats, factories and office complexes and for the general public to purchase. There is no necessity in the long-term to recharge batteries from the mains electricity. This would reduce the demand for oil and electricity from mains electricity or coal powered generators.

14. Conclusion

This paper proposes action by Australian government bodies to enable Pedelecs and E-bikes to be used so as to reduce carbon emissions, air pollution and enhance the mobility of the elderly and the partially disabled. Those concerned with the twin threats of global warming and peak oil need to know that the next advance in the design of Pedelecs is on its way

Today the mains charged Pedelecs and E-bikes are potentially just as important as the various kinds of hybrid car in reducing carbon dioxide emissions and for reducing the growing dependence on imported crude oil that will probably increase to US$150 plus per barrel by 2009 (Parker 2007). Australia needs both these hybrid vehicles and lots of them as quickly as possible. In a few years the solar electric charged Pedelecs and E-bikes have the potential to be the most important form of motor transport in cities to replace car trips of less than 10 km and to access public transport for longer trips. The problem is not just the lack of political will but the absence of a future vision of what really needs to be done.

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