EnergyWatch

The Journal of the Sustainable Energy Forum Inc.

"Facilitating the use of energy for economic, environmental and social sustainability"

Published by: - The Sustainable Energy Forum Incorporated, PO Box 11-152, Wellington 6142

Email: -info@sef.org.nz Web: - www.sef.org.nz; and www.energywatch.org.nz

The Sustainable Energy Forum Inc. was registered as a charitable entity under the Charities Act 2005 on 30th June 2008. Its registration number is CC36438.

Issue 78, January 2017

editor: Steve Goldthorpe

ISSN 1173-5449 (print) ISSN 1179-4054 (online)

EDITORIAL

A Time of Reckoning

The Paris agreement has now progressed into international law. So, New Zealand is legally committed to reducing sources of greenhouse gases so that the gross emissions in 2030 are no greater than 53 million tonnes of carbon dioxide equivalent (mtCO_2e). A question being asked in many quarters is *"How will that be achieved in practice?"*. It is time to crunch the numbers.

See comment on Indulgences on page 4

New Zealand's Intended Nationally Determined Contribution (INDC) presented to the global community in Paris last year included, a reference to NZ's 2013 inventory and projection, which was submitted as the annual report to the United Nations Framework Convention on Climate Change (UNFCCC). A look at those numbers shows the enormity of the challenge facing New Zealand on emissions abatement.

The NZ INDC offer, at 30% below 2005 levels by 2030, in combination with similar INDC offers from other countries, would, at best keep global temperature rise down to 3°C, which is inadequate to meet the Paris objective of <2°C; and preferably 1.5. Nevertheless, it requires major actions over the next 14 years. The foundations for those actions are not being put in place. The 2013 UNFCCC inventory forecasts New Zealand's gross Greenhouse Gas emissions under Business-as-Usual (BAU) to rise to 82 mtCO_2e by 2030. Hence a way must be found of reducing that number by about 30 mtCO_2e per year; in short order.

Back in the days of the first Kyoto Protocol, which has now expired, the New Zealand negotiators ensured that the effect of forest growth could be considered. So, our Kyoto targets were set on a net CO_2 emissions basis. At present the impact of Land Use, Land Use Change and Forestry (LULUCF) means that New Zealand's net emissions are 6 million tonnes lower than they otherwise would be. But by 2030 that short-term measure will have run its course and LULUCF is projected to make NZ's inventory contributions worse by about 2.5 mtCO_2e. Hence NZ's INDC apparently uses the straightforward gross emissions basis.

If BAU, including population growth, economic development etc. takes NZ's emissions to 82 million tonnes by 2030 then achievement of the INDC target requires a 35% reduction from that pathway. Half of NZ's emissions arise from the agricultural sector, which does not have a major emission reduction mechanism in prospect soon. So, the energy sector is even more challenged. Systematic changes in the way NZ uses energy are needed.

Kerry Wood discusses the prospects for light rail in this issue, which would be a move in that direction. However, at the same time, both the Wellington buses and the Overlander rail route seem destined to switch from part-electric driven to complete diesel powering.

The Government is relying on the NZ Emissions Trading Scheme to enable the free market to achieve the miracle transition of the NZ energy sector that is required. In this issue of Energy Watch, I question whether the NZ ETS is fit for that purpose.

At the end of the day the Government is clear that NZ will only be able to balance the Greenhouse books by buying credits (Indulgences? See page 4) on the international market. However, there is no international carbon market in place yet.

At a recent Climate Change and Business conference I asked the Climate Change Minister Hon. Paula Bennett which countries had surplus credits that NZ could buy. She was vague, but she mentioned the EU carbon market as a source of low cost carbon credits. At the same conference a speaker from Europe said that the EU carbon market was a closed market just for EU countries and that it would not be widening its ambit before 2030. So, the question of the source of foreign credits to balance NZ's books remains unanswered.

Furthermore, as explained in my discussion on ETS schemes, the carbon price in Cap and Trade schemes will increase rapidly due to reducing supply, growing demand and a sinking lid. Hence the international price will, in due course, exceed the NZ$25/tonne that NZ is prepared to pay.

The Government is also promoting electric vehicles (EVs) as a means of shifting the energy source for our transport sector from fossil fuels to largely renewable electricity. Norm Stannard contributes a detailed commentary on the future for EVs in New Zealand and the extent to which they could be commonplace by 2030.

However, EVs are still a rarity in NZ and the motor manufacturers seem to view pure EV's only as a stepping stone to the convenience of plug-in hybrids and hydrogen fuel-cell vehicles.

Two years ago, I installed an EV charging point at my backpacker's hostel and became an electricity retailer at $2/hr at 15 amps. My total electricity sales income to date is $43. I expect that my modest business investment will take some time to yield dividends.

In this EW, I estimate the potential CO_2 emission reductions that EVs might achieve in NZ. I then reckon that that saving may be completely negated by increasing the motorway speed limit.

The missed opportunity in NZ is to engage with four million kiwis, many of whom are looking for leadership in changing their behaviour to play their part in addressing Climate Change. However, the only guidance we get is based on the pursuit of BAU, treating people only as unchangeable economic consumer units.

Editor

CONTENTS

Light rail for New Zealand?

By Kerry Wood

Ideas about light rail are gaining traction, even in car-obsessed New Zealand. Auckland Transport has a business case and initial planning for a Wynyard–Mt Roskill route, and now the Labour Party has a policy to pay half the cost. Symonds Street is already struggling with 120 buses an hour at peaks, each way, and light rail will take another decade or so. There are also plans for light rail to Auckland airport, which would be slower than heavy rail, but much cheaper.

Unsurprisingly, the present government has pooh-poohed Labour's new policy, but it is no different in principle from paying half the cost of Auckland's CBD rail loop. Indeed, in a world of climate change and crumbling oil reserves, it might make more sense for central government to pay half the cost of Roads of National Significance and all the costs of passenger rail.

In the 1990s, Montpellier (population 270,000), the fastest-growing conurbation in France, chose light rail, on cost and urban planning criteria. When a third line opened in 2009 a main advantage given was, *"By 2050, the cities that manage to create a transport infrastructure network not running on oil will have a decisive advantage."*

Christchurch City Council released, in 2011, an initial proposal for a $400 million route to the University, with outline plans for continuing to the airport and up to two more routes. The new bus-hub has been planned with light rail in mind. Planning in Wellington is only by rival pressure-groups, but has gained ground in the recent City Council elections.

Across the ditch, Sydney has a minor route and is building much more (Circular Quay to Central and the south east). Canberra has decided to go ahead with its own line. If light rail makes sense in low-density, wide-road Canberra it should make sense in larger NZ cities.

Light rail is just a fancy term for trams. Not the old romantic red-rattlers, but vehicles at least as sophisticated as any modern car. A century ago many cities built too many tram routes because there was then no alternative. Today, buses are a mature alternative, with battery-buses looking promising. They can take the minor routes, allowing more effective trams on the busiest routes.

In Wellington, both Regional and City Councils have made a mess of public transport planning (EW 70) and have yet to face up to a rethink. The main 'golden mile' bus route is busier than Symonds Street, with narrower roads, and the City Council has been unable to find a second bus route. Strategic planning has been delegated to traffic engineers unwilling to contemplate well-established space-allocation methods such as narrower lanes. Planned mitigation of bus congestion includes double-deck buses on some busier routes, and some rationalization of routes.

A modern tram in Reims

Unfortunately, most of Wellington's gains from fewer buses will be lost in bus delays at stops. Double-deck buses have only two doors, and it is a long way down from the back seats on top. Double-deckers have been very successful on Auckland's North Shore busway, but they stop only at off-street interchanges. Wellington's golden mile stops are in narrow streets with no opportunity for overtaking, often with buses queuing to enter the stop.

The best route for modern trams is where they can be fastest and most reliable. The need is on streets that attract most traffic. In Wellington that could take in the airport (unless air travel is collapsing by then) the Kilbirnie spruce-up zone, the zoo, higher-density areas of Berhampore, Newtown and Mt Cook; Wellington Hospital, the Adelaide Road redevelopment zone, Massey University and the CBD. An extension to Johnsonville, which is intended as secondary hub, would be possible. However, it would be pricey, because the single-track line would need duplication.

In Wellington, a reasonably comfortable tram capacity would be about 420 people. Stop lengths of 60–70 metres are possible, giving a route capacity of about 14,000 passengers an hour. Just as important, light rail is viable from the peak-of-the-peak demand down to about 3000 passengers an hour. It is no coincidence that buses start forming queues at this level. Peak demand in central Wellington is already about 6000 southbound and 5000 northbound—close to a hard limit—so light rail should be viable at once.

Montpellier has found that trams cost less than buses, if both are running on suitable routes. Combined capital and operating costs for trams are about 70% of bus costs, whether measured against ‘passenger-kilometres offered’ (capacity x frequency) or passengers carried. An important part of the reason is the driver. Seven bus drivers to one tram driver, although the concept of self-driving buses might make a difference here.

And the rival pressure groups? One thinks the omens look good and wants a business case studied. The other thinks a much more costly and ambitious project is a foregone conclusion.

Hopefully, solutions in Wellington can grow from new Councillors and portfolios, political pressures and the leadership coming from Auckland Transport. With luck, funding in Wellington can be easier and trams cheaper because both are ‘the same as Auckland.’

Kerry Wood

Repentance and Redemption vs Indulgence

In the middle ages the Catholic Church’s tradition of atonement for past sins with penances, became extended to include gifts of money to the Church in penitence for past sins. Gradually, those gifts of money became a significant means of funding the construction of fine churches. As this form of fundraising gained in importance, the practice of selling indulgences evolved, whereby the concept of paying money to atone for past **and future** sins evolved. This was an abuse of the concept of repentance and redemption, which should have embodied the intent of the sinner to change his sinful ways. Eventually, despite the adverse impact on Church finances, the practice of selling indulgences was discontinued because the implicit condoning of immorality brought the Church into disrepute.

A modern-day example of indulgences occurred when we had teenage children living at home. I used to reprimand the youngsters for leaving lights and heaters on when they went out. When my mother-in-law visited, she offered that she would pay for the wasted electricity, so that I did not need to admonish the kids for being careless.

Does the parallel between indulgences and carbon trading need to be spelled out further?

Editor

Is the NZ ETS fit for purpose?

By Steve Goldthorpe

Twenty Emissions Trading Schemes (ETS) have been developed worldwide. The objective is to minimising the costs to market participants of responding to emission control obligations, by facilitating market-based price determination. The NZ ETS is one of those schemes.

An ETS scheme is based on an obligation for Carbon Credits to be surrendered by an emitting entity in proportion to emissions. Those Carbon Credits can either be generated by the implementation of a certified emission reduction scheme or by purchase from another emitting entity that can generate surplus certified Carbon Credits.

The International Emissions Trading Association (IETA) was formed in 1999 to establish a functional International framework for trading in greenhouse gas emission reduction. IETA has produced a series of case study reports for the 20 ETS schemes that are in existence worldwide[1].

Table 1 presents a summary of key features of these schemes, with the carbon prices on a common basis of US$/tonne of CO_2. Figure 1 shows the historical path of carbon prices for seven schemes for which time series data are available. Line thickness indicates the scale.

There is a trend for individual ETS schemes to amalgamate into larger regional schemes, of which the European ETS scheme is the largest.

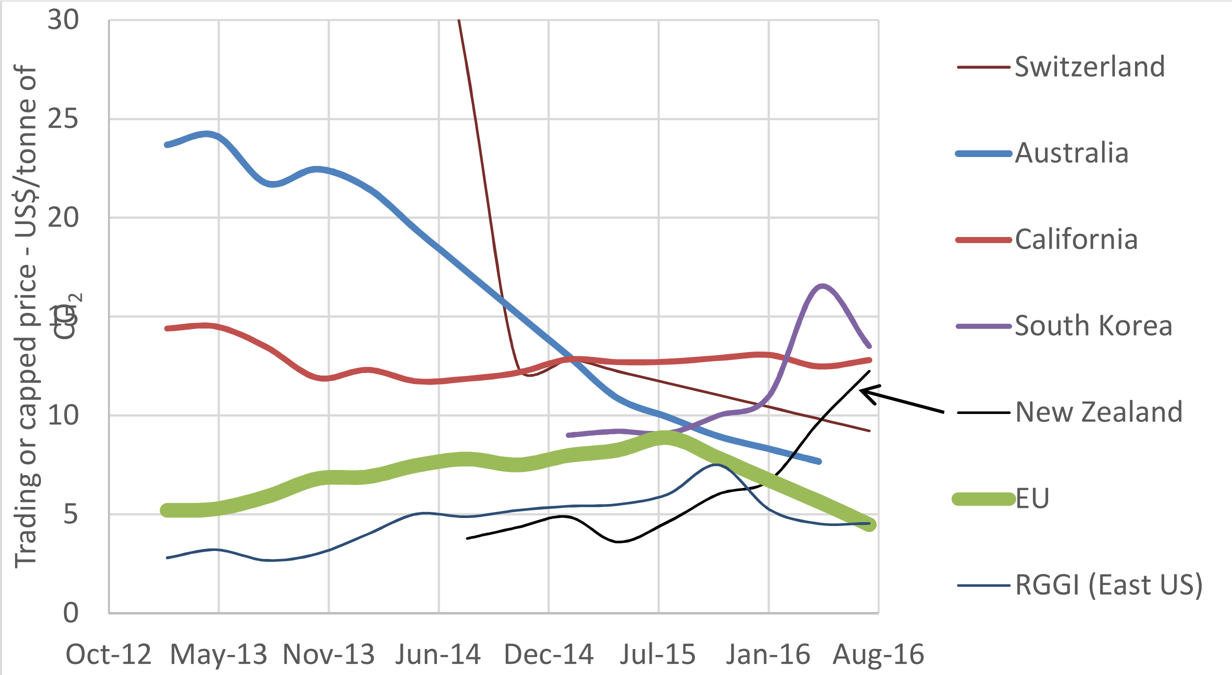
Most of the ETS schemes have evolved out of the decision by an authority to set a sinking cap on the CO_2 emissions within that jurisdiction and then to auction allocations within that cap.

Table 1 Comparison of ETS schemes

Authority	Scheme type	Scale mtCO₂/y	Price US$/tonne
Alberta	Emission reduction goals at facility level	267_{2013}	$\$12_{2015}$
Australia	Government operated Emissions Reduction Fund	409_{2014}	See chart
Brazil	Cap and trade, including reducing deforestation	501_{2016}	N/A
California	Cap and trade, with auction of allocations	459_{2012}	See chart
China	Regional schemes combining to a national scheme	10540_{2014}	N/A
European Union	Sinking cap and trade, with auction of allocations	1964_{2015}	See chart
India	Perform, Achieve and Trade (PAT) scheme developing	2341_{2014}	N/A
Japan	Action-focused voluntary emissions trading	1408_{2013}	$\$31.5_{2015}$
Kazakhstan	ETS being developed to assist with CO_2 reductions	236_{2014}	$\$2.3_{2105}$
South Korea	Cap and trade at the industry level	539_{2015}	See chart
Mexico	Carbon tax to evolve into ETS	456_{2014}	$\$3.50_{2013}$
New Zealand	Unlimited ETS with forestry credits and a price cap	81_{2014}	See chart
Norway	ETS linked to EU ETS	53_{2012}	As EU
Quebec	Cap and trade, linked to California scheme	83_{2013}	$\$12.1_{2105}$
RGGI (Eastern USA)	Sinking cap and trade	61_{2015}	See chart
South Africa	Carbon tax to be implemented in 2016	392_{2014}	N/A
Switzerland	Cap and target scheme with CO_2 levy as a limit	53_{2013}	See chart
Taiwan	Cap and trade under development	277_{2014}	N/A
Tokyo	CO_2 emissions reduction plan with cap and trade	70_{2012}	$\$58_{2014}$
UK	Operated from 2001 to 2007 then combined with EU	415_{2014}	As EU

[1] http://www.ieta.org/The-Worlds-Carbon-Markets
A Case study guide to emission trading., 2016,

Figure 1 Comparison of carbon trading prices or limits in Emission Trading Schemes



A Cap and Trade ETS enables an authority to implement a plan to work towards a specific quantity of controlled greenhouse gas emissions by 2030, as promised in the Paris Agreement.

In contrast, the New Zealand ETS scheme does not have a cap of the quantity of greenhouse gas emissions. Instead the NZETS has a cap of NZ$25/tonne of CO_2eq (i.e. US$17.5/tonne) on the carbon price. At present, NZ emitters can elect to simply purchase unlimited amounts of carbon credits at that maximum price. Whilst the NZ ETS price remains below $25/tonne it is cheaper for emitters to buy traded Carbon Credits. However, when the NZ ETS traded price reaches $25/tonne then it will simply become a fixed price carbon tax with no limit on quantity.

For example, a $25/tonne carbon tax will be equivalent to 5.4 cents per litre of petrol, which is too low to significantly impact on behaviour.

Figure 1 shows that. as ETS schemes become established, the typical traded carbon prices are currently converging on a US$5-15 range. This is because there are many schemes, such as fuel switching, efficiency improvements and forest planting, which, whilst not economic without carbon controls, can meet the rules for certification as Carbon Credit producers at that carbon price level. Such schemes might be called the "low-hanging fruit", which are easily implemented. As time goes by, the supply of such low-cost Carbon Credits will be used up and the demand will increase due to growth and the sinking lid, so the price level at which Carbon Credits are traded is bound to increase rapidly.

When the carbon price in Cap and Trade schemes becomes several times higher than at present, costly CO_2 abatement schemes such as Carbon Capture and Storage (CCS) on coal-fired or gas-fired power plants or CCS in industrial plants will become an economic source of carbon credits for sale to other GHG emitting entities under ETS Cap and Trade schemes.

In the case of the NZ ETS, effectively with a low carbon tax of NZ$25/tonne, there is no incentive to go the extra mile with costly greenhouse gas emissions reductions. Therefore, the NZ ETS is not fit for the purpose of enabling NZ to achieve the 30% reduction in emissions promised in the Paris Agreement. *Steve Goldthorpe*

2016 Status of Electric Vehicles

By Norm Stannard

Where has the world got to in the development of vehicles that do not make climate changing CO_2 emissions? History is a good starting point.[2]

A brief history of automotive vehicles

In 1769, Frenchman Nicholas Cugnot built a steam-powered motor carriage capable of six miles per hour. In 1807 François Isaac de Rivaz built a short lived internal combustion (IC) engine car fuelled with hydrogen. However, historically the first cars were battery driven before gasoline-fuelled IC engines appeared[3].

In 1800, Volta invented his "voltaic pile" the first battery. Sturgeon discovered electromagnetism in 1820 and in 1886 in England there was an electric-powered taxicab, using a battery with 28 cells and a small electric motor built by ERC[4]. They had 75 in service, with battery changes achieved in 2 or 3 minutes. Subsequently ERC produced hundreds prior to the rise in use of IC engines[5] Electric vehicles held the World Land Speed Record until 1907.

Today the London black cab fleet is charging forward to have Chinese electric cabs before the low emissions zones regulations come into force driven by the new mayor.[6] To some extent the alternative fuels cycle is nearly complete and the road transport world maybe moving on.

The development and implementation of alternative automotive vehicle technologies is following the typical jumpy innovation route with forward steps incurring double steps backward and then 3 forward related to materials or systems faults revealing themselves and a lot of instances of subversion by vested interests. Electric vehicle history is no exception.[7]

EV developments in NZ

Small as it is, New Zealand was in the EV lead in some respects, for example: -

To gain a measure of the potential of electricity as a national road transport resource, and therefore its likely degree of growth and spread in national electrical grid loading requirements, in 1997 ECNZ carried out a very successful project.

ECNZ bought one of Auckland Council's diesel fuelled buses and asked Professor John Boys of Auckland University Engineering School to convert it into an electric hybrid. It was no problem to John, with the NZ engineering industry being world leaders in compressed natural gas (CNG) transport technology. His team removed the diesel engine and fitted the well proven Muldoon-era simple CNG tank, pipework and control system to an urban car sized engine. The constant speed engine generated electricity for topping up the battery set, which powered the bus's electric motors. This cheaply converted bus was tested successfully on Auckland City bus routes over many months and proved to be a very reliable vehicle.

At the completion of those trials in 1997, ECNZ, presented the bus to the Auckland City Council for the community's use. That was some 20 years ago now, but the Council must have felt threatened by the "new" technology because in the main it was only used for the visits of high profile big wigs and winning rugby team events to 'show how advanced the city is' rather than widely using the technology to reduce public transport costs.

Today, globally, there are many modern cities with electrically driven bus fleets.

Among his many discoveries and innovations, Prof. John Boys and his colleague Prof. Grant Covic have also re-designed the traditional electric induction motor to gain efficiencies.

[2] https://en.wikipedia.org/wiki/History_of_the_electric_vehicle
[3] http://www.hybridcars.com/history-of-hybrid-vehicles/
[4] http://www.wired.co.uk/article/1897-electric-car
[5] https://en.wikipedia.org/wiki/Hackney_carriage#Motorisation
[6] http://fortune.com/2016/05/20/london-black-cab-electric-car/
[7] www.ev1.org/

Their well-proven patented design is now in global use.

In 1990, Boys and Covic put forward the idea of using inductive power as a means of transferring power to electric vehicles via cables set into road surfaces. The immediate response by world transport experts was "that is a dream!" However, from early this year Berlin has a 1.5km inductive powered bus route, which is the first in the world. Boys' and Covic's patented design is now used internationally[8].

Today John Boys has 37 doctoral students working on the wider developments using this technology. International large corporates are deeply involved and the Auckland University is making millions from its patents and its use in many new products globally[9].

NZ innovation in EVs is largely hidden from the public. It remains the NZ tradition not to value the contribution of the whole range of engineering technologists' contribution to society and its economy. Even its Engineering Institution membership is predominantly viewed as a body of civil engineers.

The history of NZ electric vehicles designed, built, tested and given regulatory approval to run on public roads, started with the arrival in 2005 at Waikato University School of Engineering of mechanical engineer Professor Mike Duke from UK, London South Bank University. At that time Mike had become a favourite with Ken Livingstone, followed by Boris Johnson, Lord Mayors of London for his patented innovations based upon solar technologies, including roading related equipment that help speed up traffic, solar systems for heating homes plus any buildings and associated manufacturing processes, as well as electric cars.

Mike's real passion being solar cars, by the time he arrived in Hamilton he had contributed to

The Ultra Commuter

several solar cars produced in EU Universities' Engineering Schools, and had run in the two yearly "World's Solar Challenge", which is a race for solar powered cars from Darwin to Adelaide.

At Waikato University by 2007 Mike with a lean team of final year BE students, plus the enthusiasm, finance and active physical support of industrial entrepreneur Ian Macrae, had designed and built their battery driven 4-wheel drive "Ultra Commuter"; the first car NZ designed, built, and Government approved for general road use.

The Ultra Commuter completed the 2007 Solar Challenge. With that experience, Mike and his student team of that year upgraded the car and ran it in the 2014 Solar Challenge. Being the first home grown NZ car there are competing bids by national museums for display rights for the rest of the car's life.

[8] http://www.iea.org/topics/transport/subtopics/electricvehiclesinitiative/EVI_GEO_2013_Timeline.pdf

[9] http://www.nzherald.co.nz/technology/news/article.cfm?c_id=5&objectid=11155859
http://sciencelearn.org.nz/Innovation/Innovation-Stories/Celebrating-Success/Videos/Professors-Covic-and-Boys-Inductive-Power-Transfer
http://www.bombardier.com/en/media/newsList/details.bt_20150901_-berlin-erste-hauptstadt-mit-kabellos-geladener-e-bu.bombardiercom.html

Mike Duke's follow up has been the "Bev" a two seater designed for urban needs.

The Bev

The Bev was built by the 2007 final year mechanical engineering BE students' team and approved by the Road Transport Authority. During the following Christmas holidays, it competed against a very expensive German university solar car. The challenge was to complete a run from the top to bottom of NZ. The Bev won. Again, it is a car that could be manufactured in numbers in NZ by medium sized engineering companies, but to date the offer has not been taken up.

Waikato University electric van

During 2007 Mike's mechanical engineering students changed the university's Suzuki Van from petrol to electricity. This van has consistently met the university's needs since that time. Twice it has been demonstrated at the annual Christchurch EV event. This is the third NZ electric vehicle that can be modified and marketed by NZ engineering companies from Mike's Waikato university Engineering School stable.

To date the cost of replacement batteries has been a media focussed deterrent in buying EVs. In 2009, second year BE electronics student, Peter Leijen, addressed this. New Prius Nickel Hydride battery packs cost in the order of $3K to $5K. He found a source of Prius batteries declared as "failed" by car workshops and started to break them down to measure the performance of each blade in the battery packs. His initial findings encouraged him to adopt it as his BE (Hons) major project. He researched and produced the specialist test criteria and procedures and equipment. From the initial sample of "failed" battery packs he was finding that, apart from blades that had obviously totally failed, the rest had variable degrees of loss of performance. By removing the totally-failed blades and inserting good blades from other rejected battery packs with the same design code and performance the remaining length of the pack's active life can be met. Over the ensuing years, he has found banks from Prius cars that have run 160,000 km and some over 2,000,000 km. By the time he finished his BE (Hons) his line of business was set. However, he did not finish there. He continued his research and now holds a PhD. Car workshops know where to find him, as the testing and balancing of blades process is highly specialist, but his story should change the media view that battery costs always limit the market standing of BEVs.

Editor's note – My friend drives an early Prius with 250,000 km on the clock. The hybrid battery system started malfunctioning. He had it fixed and it is now as good as new. He was pleasantly surprised to get a bill for only $1200; i.e. like an IC engine overhaul at 250,000 km.

This year Mike's challenge to the students is to research, design, develop and gain approval plus sponsors to build and test a small unique EV. The Engineering School October 2016 end of year students Design Show included the completed designs and a firm list of sponsors for the 2017 final year BE student's team to progress through manufacture and road testing. The market prospects are being kept close to the team's chest. Let us say "it is close to SEF members' dream!"

At the 2016 October Design Show was this year's petrol driven 2016 Waikato Engineering Students' Motors (WESMO) international Formula Student (FS) [10] single seater racing car on target to race against other Australian and NZ universities' cars in December, in Melbourne. However, alongside was designed, and under construction, its sister, the first Waikato 2017 EV WESMO to be ready to challenge the world, maybe alongside the petrol-fuelled 2017 WESMO.

For many years, this IMechE international high profile FS challenge, has been the most established educational motorsport competition. Backed by industry and high-profile engineers such Patron Ross Brawn OBE, the competition aims to develop enterprising and innovative young engineers and encourage more young people to take up a career in engineering[11]. It is notable that 3 years ago the electric cars beat the traditional gasoline fuel cars, to the extent that they, like frequently winning horses, have to carry an additional burden.

For decades NZ has been very short of engineering skills, which is well known to the large number of companies that have grown in the Waikato region. There is a very active Waikato Engineering Careers Association (WECA), formed during the 1990s by 15 of the largest companies, with the mission to bring the next generation into engineering.

In 2016, as a new initiative, WECA linked with *"Evolocity"*, which was created in Christchurch in 2013. This challenges high school student teams to build single seater racing electric cars to beat their rival schools. *Evolocity* has rapidly spread from Christchurch, which declared that it will be *"the first renewable transport city in the world"*.

This year we have seen Waikato high school students building *Evolocity* designed single seater cars and drag racing them. Media stories, include the year-13 students from St Johns College, which just happens to be next door to Waikato Engineering School, joining in the September car inspections, trials and drag racing events against the other 11 colleges' cars from the region. These challenges used many of the academic and practical skills gained in the essential foundation Science, Technology, English and Mathematics (STEM) subjects. The time pressure applied to meet each step in the Evolocity challenge provided the typical competitive work ethos met in any career. The enjoyment of the teams is very apparent in the media reports[12].

This is a timely initiative given that there are 200,000 young New Zealanders without work, who have not finished school and are "lacking work skills" according to the Prime Minister[13]. Without consistent encouragement and funding to gain high school level qualifications in STEM subjects to start a career in science or technology, such youngsters struggle to compete with the flood of immigrants qualified, skills-trained and certified by overseas governments and industry. Instead of draining developing countries of these much-needed people, ethically NZ industry corporates and government should pay their dues and give our own young people careers. It was a NZ tradition, until this current generation, that senior engineers, having received their training and career starts in NZ accepted that it is their turn to front up with fostering and mentoring of the next generation. But it is not now happening across the board and should be an important issue in this election year.

[10] https://www.imeche.org/events/formula-student/about-formula-student

[11] https://www.imeche.org/events/formula-student/about-formula-student

[12] DEMM Engineering & Manufacturing September 2016

[13] Article quoting NZ PM 'Many New Zealanders…200,000 unemployed…lack work ethic…69,000 needed immigrants arrived in 2016…' The Guardian Weekly 16.09.16

EV International developments and plans for public transport

In 2016 China was claiming the lead in electric public transport production and operation.[14]

China's company BYD has manufactured more than 5,000 electric buses, which, as of April 2015, have logged more than 50 million miles of service. Altogether, the buses have been tested out in more than 150 cities. In March 2015, they reported they have an extended-length bus design under test that covers 190 km for each battery charge. While London's then Mayor Boris Johnson could always be seen picking up the latest transport technology to keep the global lead for the city, 800 London traditional shaped Route Masters in EV form will soon be seen on the bus routes around the CBD.[15]

Most likely, Mayor Johnson had been convinced that the BYD's proprietary iron-phosphate batteries, supported by energy recovery through regenerative braking is the leading proven technology.

The key outcome of the very recent "Bus Summit" (May 2015) involving 24 major global cities and associated manufacturers, committed to getting 40,000 ultra-low emission buses on the road by 2020.[16]

It is very noticeable that Hamilton City pollution is well below other like-size cities, because NOx levels are lower as their bus fleet remains CNG fuelled plus its operational and maintenance costs are lower. This is not the case in other NZ cities, so their economies and the health of their populations are still missing out.

Heavy transport EV and alternative zero emissions developments

A common misunderstanding in the media, as expressed by corporate interests and reflected by government advisers, is that heavy transport vehicles will always need diesel fuel.

However, in terms of heavy transport batteries capability, an example is the Chicago all electric garbage truck fleet started in 2012.[17][18] Each garbage truck carries a 9-ton load per route with no direct emissions from a diesel engine, thereby reducing the health hazard due to NOx and particulates. Given this example, retro fitting and operation of that weight of city truck use can make immediate reduction in greenhouse emissions and health cost savings and improvement in public life expectancies. As well, the vehicle retrofitting and maintenance work provides a new source of on-going local employment.

Waste Management Ltd is moving to electric garbage trucks in New Zealand.[19]. The use of EV in trucks is also developing widely in other countries.

Editor's note – The truck that collects our refuse in Waipu sounds like one of the new quiet electric fleet run by Waste Management NZ Ltd.

When I was a child in Manchester, UK a battery-powered milk float delivered our daily pint. Urban stop-start services are an obvious good fit to the features of EVs. Quietness is a co-benefit for early morning deliveries and collections.

[14] http://www.forbes.com/sites/eshachhabra/2015/07/20/can-london-build-the-cleanest-transport-system-new-double-decker-buses-go-electric/#5716ccd43092
[15] http://cleantechnica.com/2015/08/03/london-get-1st-large-scale-electric-bus-fleet-thanks-byd-alexander-dennis-limited-partnership/
[16] http://cleantechnica.com/2015/07/06/london-gets-worlds-first-double-decker-electric-buses-clean-bus-summit-starts-bang/
[17] http://www.forbes.com/sites/peterdetwiler/2015/03/04/electric-garbage-trucks-huge-energy-savings-and-they-wont-wake-you-up-in-the-morning/#204ff4fc4123
[18] http://cleantechnica.com/2014/09/16/first-electric-garbage-truck-in-us-hauls-9-tons-of-chicago-trash/
[19] https://www.wastemanagement.co.nz/blog/news/our-move-to-electric-trucks

Car market and alternative emissions developments

There are many companies in the automotive market sector but in the main their objectives are closely related. There are over 50 models of EV in the global market place ranging from slow economy cars; to city cars; to highway cars; to racing cars.[20] A sample of the strategies for three major car firms is discussed below.

Beyond battery EVs, the next reality being actively developed, and supported by the Japanese government, is the use of hydrogen as an automotive fuel in a fuel cell.

In the technology definitions, hydrogen fuelled cars remain electric vehicles. The key feature of difference being that within 3 minutes of the vehicle stopping at a hydrogen station the vehicle's two hydrogen storage cylinders can be charged with 365 miles worth of the gas, which goes on to produce electricity for the EV drive system, thus emulating conventional liquid fuel convenience. This overcomes the major charging time issue that is the Achille's heel of pure EVs.

The applied technologies of electrolysis and fuel cells convert hydrogen gas into electricity and vice versa. Internationally, the hydrogen-EV industry sector is rapidly coming into being.

To this end three major players Nissan, Toyota and Honda have combined and successfully convinced the Japanese Government to focus upon research, development and implementation of the infrastructure to achieve this mission.[21] They have agreed to work together to help accelerate the development of hydrogen fuel cell vehicles (FCVs) stations. Infrastructure companies are making strides to design, build and operate the mass of hydrogen stations. But they face difficulties while FCVs remain under development and marketing, and sales plus related production are not fully up to speed.

Consequently, to gain international market edge, the Japanese government is not only supporting the installation of hydrogen stations by means of subsidies, but has also resolved to introduce a range of additional policies aimed at promoting activities that generate new demand for FCVs, including partially subsidizing the cost of operating hydrogen stations. The three automobile manufacturers will consider concrete initiatives, such as underwriting a portion of the expenses involved in the operation of hydrogen stations.

> Editor's note – Last July in Paris, we took a late-night taxi back to our lodgings. To my amazement, the first cab on the rank was a Hyundai hydrogen fuel cell car. The bored French taxi driver just gave a classic Gallic shrug of the shoulders when I expressed my interest in this world-leading technology.

Honda

It has taken many years for Honda to develop and produce their first series of electric vehicles. They have worked jointly with battery companies to produce products that can best support the vehicles working through from the traditional zinc/acid types, through developments of cadmium, nickel and lithium. Currently lithium is considered the most reliable and the global corporates' money is directed at continuing its technology research.

From 2015 the EV hybrid is looked upon as an intermediate car for the next 15 years. The 2016 models' sales specifications state that their batteries are Nickel Metal-Hydride (Ni-MH). The concern over EVs batteries depleting natural resources particularly lithium may not be as trenchant as the media automatically assumes.

Ultimately the Honda corporation see all their vehicles as being hydrogen fuelled.

Toyota

The Australian and New Zealand new offering of hybrid has extended the Prius philosophy up to the Camry Hybrid and added small car sizes; the

[20] https://en.wikipedia.org/wiki/List_of_electric_cars_currently_available

[21] http://newsroom.toyota.co.jp/en/detail/6006916

Corolla Hybrid and Prius C. The batteries are Nickel Metal-Hydride with a 160,000km, 8-year warranty. Toyota performance data are: -

	IC Engine litres	Litres per 100 km[22]
Prius C	1.5	3.9
Corolla Hybrid	1.8	4.1
Prius Series 4	1.8	3.4
Prius V – 7-seater	1.8	4.4
Camry Hybrid	2.5	5.2

After nearly 20 years Prius remains the Toyota hall mark hybrid, with 8 million or so sold globally. They do not require additional national infrastructural services being non "plug-in" designs. The Ni-MH batteries have well proven their service capability, reliability and cost efficiency. (See Dr P Leijen's work above). Toyota does not have a lithium supply problem.

Of course, Toyota still must meet the Australian and NZ corporates' marketing market mindset and maintain their competitive product range. Therefore, they also offer large petrol and diesel SUVs, cars and trade vehicles.

The Toyota strategic direction is to be the global hydrogen vehicles leader along with Nissan and Honda as outlined above.

The Toyota Mirai

Toyota is a long way down the hydrogen track. Since September 2016 there have been two MIRAI cars on Australian roads supported by a mobile hydrogen refueling unit.[23]

Nissan

The well-known Nissan Leaf EV is the 21st century equivalent of the Volkswagen beetle; i.e. a mass production model aimed at the middle class. However, the Nissan Leaf has been withdrawn from sale in NZ because Nissan consider the NZ market is too small. Nevertheless, Nissan Leafs (Leaves?) can be found in the used import listings.

NISSAN only offers a hybrid in their top end luxury Infiniti brand.

Sources and Supplies of hydrogen:

The world's engineering industry sector is well into the challenges of producing bulk hydrogen with a view to supplying the transport sector.

A technological driving force product is a device, which converts electricity into hydrogen and water and back across the same change cell, known as "electrolysers". This was introduced by the Canadian Hydrogenics company[24], formed in 1948. This cell can take its sources from the likes of sewage, farm waste and industrial process gas emissions to create hydrogen. Their "electrolysers" are now in operation in over 500 plants covering over 100 countries. They have developed and have in commission their "electrolysers in motorway service stations alongside existing petrol and LPG supply cabinets, in Canada and Germany.

In addition, the mighty E-ON, the German electric power company, which bought the UK West Midlands power stations and associated grid supply networks from the CEGB, is now taking the lead in creating the German hydrogen network. The 24 hr/day supply of hydrogen is created from all sources of renewable energy, be

[22] ADR 81/02 combined cycle. The low fuel consumption figure for new Prius seems anomalous.

[23] https://ssl.toyota.com/mirai/fcv.html

[24] http://www.hydrogenics.com/hydrogen-products-solutions/energy-storage-fueling-solutions/hydrogen-fueling-stations/

it local sewage gas, spare wind, hydroelectricity, biofuels or landfill methane. The gas is injected into the city network including motorway service stations. The city gas network, with its storage systems, becomes part of the national fuel storage to cover electricity systems peak load, and cover for loss of generation at a power station, as the electricity grid requires spinning emergency or gas turbines cover.

Conclusions

Progress is now well advanced in terms of the transport sector. EVs with a constant supply of electricity, especially for long haul motorway situations, plus advanced battery technology, can now be considered a given. On board fossil fuels are not essential.

Internationally there have been considerable developments in electric drive vehicles, with rising numbers in operation. The debate on whether EVs will become a market reality is over. It is a reality. Historically it appear that the transport vehicles loop is closing, electricity is the means!.

However, remember the power of the vested interests of the corporates' board members and their shareholders. For example, in the late 90s GM produced EV1 that exceeded the capabilities of their current models. They killed it. The fear was that if EVs are allowed to progress into the bulk market, the motor industry and its many subsidiary industries would need to close and many millions would be unemployed.

However, in NZ we are a country where strategic infrastructural developments are rarely completed. For example, the major rail lines are only partially converted to electricity and, under current government policy, even those electric lines are being converted back to diesel.

The capital city had become well serviced with electric trolley buses, but, on commercialisation, these services are also being replaced by diesel.

Seizmic events in 2016 confirmed that we live in a long thin country where we even need international warships and helicopters to transport us out of climate and other extreme events.

But, as I finish this article, I observe that China is different. The Chinese government priority is to remove health-hazardous smog and to fight climate change. On 29 December 2016 Hydrogenics was chosen to supply their fuel cells for a major commitment to Chinese hydrogen fuelled transport [25] . Like ever-successful Singapore, the current Chinese leadership are people-focused engineers ensuring that needs are being met.

Strategically, to fight climate change and to address health hazards, a non-fossil transport fuel network for NZ is possible - a SEF topic for 2017?

Norm Stannard

Additional links

https://en.wikipedia.org/wiki/Electric_car

https://en.wikipedia.org/wiki/Nissan_Leaf

https://en.wikipedia.org/wiki/General_Motors_EV1

https://en.wikipedia.org/wiki/UltraCommuter

http://www.hybridcars.com/history-of-hybrid-vehicles/

http://www.worldsolarchallenge.org/about_wsc_2015/overview

http://www.theguardian.com/environment/2014/nov/21/toyota-hopes-to-recreate-prius-success-with-hydrogen-powered-mirai

http://www.theguardian.com/environment/2015/jul/18/chinese-built-zero-emissions-electric-bus-prepares-for-service-in-london

http://www.fuelcellcars.com/celebrating-fuel-cell-day-with-energy-department-support-and-new-northeastern-campaign/

25 http://www.hydrogenics.com/2016/12/29/hydrogenics-chosen-for-fuel-cell-award-in-china/

The contribution of EV's to NZ's CO_2 emission reduction

By Steve Goldthorpe

In May 2016, the NZ government set a target of annual doubling of electric vehicles, operating in NZ to reach 64,000 by 2021. This includes plug-in hybrids. This exponential growth in the use of electricity in the transport sector is to be exempt from the Road User Charge until EVs comprise 2% of the light vehicle fleet[26], i.e. about 70,000 vehicles. By the end of 2016 there were 1,900 EVs registered in New Zealand.[27]

If, despite Nissan's refusal to sell their Leaf EV in NZ, the uptake of pure EVs and plug-in hybrids somehow captures 2% of the light vehicle fleet over the next 5 years, then what is the impact on the transport sector greenhouse gas emissions?

If half of the NZ EV's are plug in hybrids and if 60% of their energy needs are met by electricity, then the overall reduction in light vehicle fuel consumption would be about 1.6%. That minor saving of greenhouse gas emissions could be fully negated by an increase in the maximum speed on NZ's motorways, as discussed below.

Notwithstanding the advent of EVs in NZ, the growth in population compounded by the increase in per capita vehicle ownership means that the growth in greenhouse gas emissions from the NZ light vehicle sector is set to continue to increase for the near future, moderated only by improvements in vehicle energy efficiency.

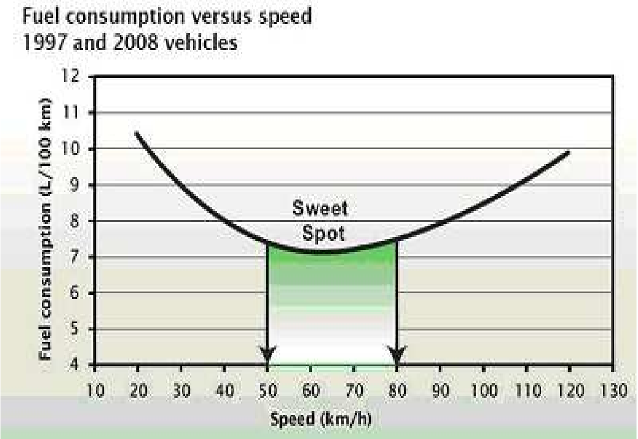
In the long-term, hydrogen is viewed as the Holy Grail for automotive transport; but what is the primary energy source? The route of renewable electricity via electrolysis, compression and storage losses, and conversion back to electricity in on-board fuel cells, suggests compounding inefficiencies worse than battery technology. Alternatively, if the hydrogen is made from natural gas, then the overall greenhouse footprint of the hydrogen car could be little better than the petrol car.

Steve Goldthorpe

Going the wrong way on NZ's motorways

The recent announcement that the speed limit on New Zealand's better motorways will be increased by 10 kph has been generally received as a sensible move, with the only concern being the consequence of any crashes occurring at higher speeds.

However, another downside to higher speeds is the higher fuel consumption and hence the higher carbon footprint from transport. This chart[28], based on Canadian data, indicates that an increase in speed from 100 kph to 110 kph would typically result in a 9% increase in average fuel consumption.



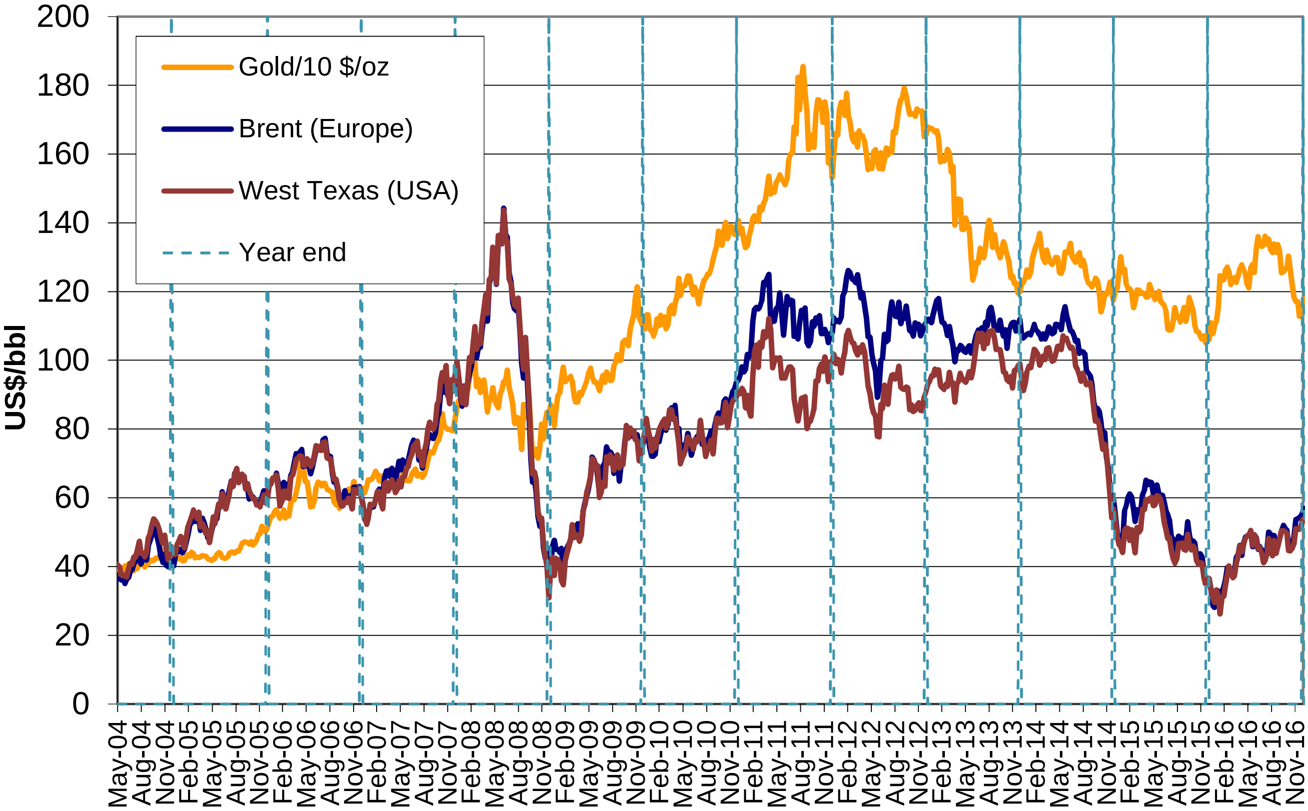
6.6% of my car's mileage is on the Northern Motorway between Albany and the Johnson Hill tunnels. That high-quality road would be a prime contender for the new speed limit. If that statistically invalid sample of one matches all NZ vehicle use, then the new speed limits would increase NZ transport fuel use by 1.6%. That would increase NZ's greenhouse gas emissions by a quarter of a million tonnes of CO_2 per year *Steve Goldthorpe*

[26] http://www.transport.govt.nz/ourwork/climatechange/electric-vehicles/

[27] www.drivelectric.org.nz

[28] http://www.nrcan.gc.ca/energy/efficiency/transportation/cars-light-trucks/fuel-efficient-driving-techniques/7513

Neil's Oil Price Chart



Oil Gains 14% on OPEC Deal – Analysts see further Gains

Oil and Energy Insider4 - 2nd December 2016

"The two-and-a-half-year oil bust could be coming to an end, thanks to OPEC. The oil cartel pulled off a surprise agreement, snatching victory from the jaws of defeat. The deal calls for collective cuts from 13 members (Indonesia suspended its membership), reducing output by 1.2 million barrels per day to 32.5 mb/d. Also, non-OPEC countries will cut output by 600,000 barrels per day, including 300,000 bpd from Russia. The deal will take effect in January.

"Oil prices surge. WTI and Brent shot up on the news, rising by more than 14 percent since Tuesday. On Friday, investors took a breather, pocketing some profits. WTI and Brent hovered at $51 and $53 per barrel, respectively, during early trading hours. Brent crude is on track for its biggest weekly increase since 2009.

Oil analysts around the globe see further price gains in the next few months. "

Weekly bulletin from Oilprice.com

"OPEC deal almost didn't happen. Bloomberg reports that the negotiations came down to the wire. With a gulf still between several OPEC members, the breakthrough came from a 2 a.m. phone call on the eve of the final meeting from Russian energy minister Alexander Novak to Saudi energy minister Khalid al-Falih. Novak told his Saudi counterpart that Russia was not only willing to freeze but to actually cut output, a surprise concession that jolted the talks back to life. Al-Falih then went to his colleagues in OPEC and demanded concrete reductions. With Russia on board, others were willing to play ball."

(A 14% increase in selling price for a 3.5% reduction in production looks to me like an easy decision for the OPEC cartel. *Editor*)

Join our sustainable energy news & discussion group

SEF Membership provides a copy of our periodic Energy Watch magazine. In addition, many members find the SEFnews email news and discussion facility an easy way to keep up to date with news as it happens and the views of members. The discussion by the group of sustainable energy "experts" who have joined the SEFnews service offers an interesting perspective.

Non-members are invited to join the SEFnews email news service for a trial. To do this send a blank email to: <SEFnews-subscribe@yahoogroups.com>. To help us stop spammers, non-members need to supply a name and contact details, and a brief statement of their interest and/or involvement in sustainable energy issues, before their trial is approved.

As with all Yahoo groups, SEFnews emails can be received "individually" (as they are sent) or as a "daily digest" (grouped into one email per day). If you have a Yahoo ID you can also switch emails on and off, or read the news on the web – a handy option for travelling Kiwis. YahooGroups saves all our text emails for later reference, and there is a search function so that you can review the thousands already stored over the last 6 years.

Some busy people using a work address prefer to use the Rules function in their email software to automatically save SEFnews emails to a separate folder for later reading. If you do not want a Yahoo ID, the administrator <office@sef.org.nz> can select the 'daily-digest' option for you.

EnergyWatch

Publication is now periodic, and EnergyWatch is posted on the SEF website (www.energywatch.org.nz) as a PDF file, shortly after individual distribution to SEF members.

Contributions Welcomed

Readers are invited to submit material for consideration for publication.

Contributions can be either as Letters to the Editor or short articles addressing any energy-related matter (and especially on any topics which have recently been covered in EnergyWatch or SEFnews).

Material can be sent to the SEF Office, PO Box 11-152, Wellington 6142, or by email to editor@sef.org.nz, or by contacting the editor, Steve Goldthorpe, at PO Box 96, Waipu 0545.

SEF membership

Memberships are for twelve months and include four copies of EnergyWatch.

Membership rates are:

Low income/student	$30
Individual	$50
Overseas	$60
Library	$65
Corporate	$250

Mail the form below, with your payment or order, to The Sustainable Energy Forum Inc., P O Box 11-152, Wellington 6142. Bank transfers, with your name, can be sent to the SEF account at 03-1538-0008754-00, with a confirming email to office@sef.org.nz.

A receipt will be sent on request.

Name: ....

Organisation:...

Address: ....

....

Home Phone:............................... ....

Work Phone:.................................. ....

Mobile Phone:..

E-mail:... ....

Membership type:..

Amount enclosed: $...