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 81 July 2019

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

EDITORIAL

EVs - Good, but not that good

Recently, I have been the owner of a 2015 Nissan Leaf, which we bought as a second car to back-up our Prius-V hybrid. That gave me a first-hand opportunity to gather data and to gain experience and anecdotes of the pros and cons of using a sub-$20K EV in the real world in rural NZ.

Using our 100% Electric Vehicle (EV) instead of our Internal Combustion engine (ICE) hybrid vehicle for our regular 100 km round trip to Whangarei emitted 1.5 kg.CO_2 from NZ power plants[1] instead of 11.5 kg.CO_2 from the exhaust pipe. Furthermore, the round-trip cost me $2.40[2] for electricity rather than $10.50 for petrol.

However, the freedom of independent action provided by ownership of a personal vehicle is compromised by limited range and by the time it takes to recharge an EV. Both my own experience, and the experience of others, is that driving an EV involves an extra set of constraints on journey planning which limit freedom of action and the ability to cope with the unexpected events that occur in the real world.

Modern ICE technology gives the motorist the ability to drive all day and to go anywhere with certainty. A 5-minute visit to a filling station provides several additional hours of driving. In contrast, the affordable EV technology most commonly available in New Zealand (i.e. a used 24 kWh Nissan Leaf) gives the ability to drive for no more than 1.5 hours on the open road. A half hour fast charge then provides up to a further one hour of driving.

My wife and I lived in rural Waipu. We drove over 30,000 km per year and we needed one and a half cars. The Leaf met our need for half a car. However, we have now downsized to a retirement apartment in urban Warkworth, where we only need one car. The range, economy and capacity of our PriusV, rather than the Leaf, meets that need. We have therefore sold the Leaf to our son and his partner. Our contribution to reducing NZ's CO_2 emissions will arise from greatly reducing our annual motoring requirements.

[1] At 100 kgCO2/kWh – NZ average for 2018
[2] Ripple circuit interruptible supply from Contact Energy @ 17.9 c/kWh

In this issue of EW I point out that fast charging is fast, but not that fast. The claimed 50 kW charging rate turns out to be half that power on average to charge a series 2 Leaf battery up to 80% of capacity, due to the car protecting its battery. Although public fast chargers are planned with up to 150 kW capacity, the EV controls its actual charging rate. The rate of energy transfer from a 50 kW ChargeNet fast charger.is about 50 times less than the rate of energy transfer at the petrol pump.

Journey planning is a critical aspect of EV use. I include some cautionary tales of people who have gotten in a mess with the limitations of EV charging. I describe our experience of delivering our Leaf from Warkworth to our son in Wellington.

Because of the reducing charging current as the battery fills, the ChargeNet fast-charging network, which includes a per-minute rate, has a high c/kWh cost. Whilst necessary for range extending, my use of the ChargeNet service worked out to more expensive per km than putting petrol in my PriusV. A friend with a plug-in hybrid shuns the ChargeNet fast chargers because for him they work out more expensive per km than letting his PHEV default to its petrol engine.

The current absence of Road User Charges makes the apparent cost of operating an EV artificially low. For the typical New Zealander buying electricity at regular retail tariffs, the cost of routine slow charging of an EV overnight is about half of the cost of buying petrol for a conventional car. That is three times the "*30c/litre*" myth, which is heavily promoted in NZ's official EV promotional propaganda. Running an EV in NZ is currently cheap, but not that cheap. It will get more costly with the RUC, as EV uptake evolves.

Free fast-charging facilities provided by Lines Companies distort the market by bypassing electricity retailers. But current electricity market legislation prohibits Lines Companies from selling power directly to consumers.

My EV purchasing budget was $20K. I got a good one for $19,900 with a 12/12 battery state of health. My plan was to buy an older EV with the intent of replacing or upgrading the battery after a few years. However, I found that there was little by way of EV battery replacement services available in New Zealand. As the battery ages the effective range reduces. The common rationale is to sell the car, as is, to someone with less range demand as a second car and focus investment on replacing the car with a newer EV.

In provincial New Zealand, car ownership is a necessity not a luxury. A second-hand EV with limited range at an affordable price, whilst desirable in an ideal world, is not a practical option for a one car household in the real world.

The $50K+ new battery EVs on the market in NZ, and PHEVs, are outside of the scope of this review and are probably also outside the budget of the NZ car buyer needing just functional, reliable and affordable personal transport.

The 2019 SEF AGM was held in Wellington on 4th July, with a guest speaker from SEANZ and further discussion of EVs in NZ.

Alastair Barnett contributes a perspective on the prospects for pumped storage in New Zealand.

Molly Melhuish made a submission on the Electricity Price Review. Some of her comments are included as the ongoing debate on electricity.

This issue ends with the usual review of oil prices.

Steve Goldthorpe, Editor of EnergyWatch

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Fast charging is not that fast

Practical experience of using fast chargers

By Steve Goldthorpe

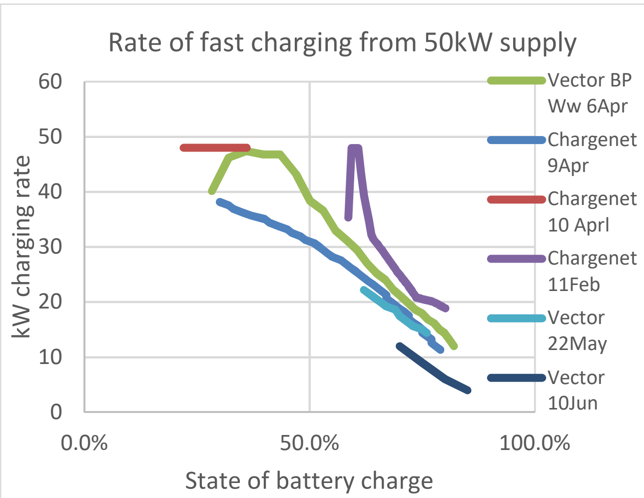
When the average motorist fills up his ICE car with petrol or diesel, he is operating an energy transfer system with a capacity of about 4 Megawatts. He buys traveling capability at a rate of about 7,500 kilometres per hour of refuelling. The same rate of electrical energy transfer would require the operator to be a highly qualified industrial electrical engineer using some grunty equipment.

In contrast, the fast-charging equipment made available to EV users for re-fuelling their vehicles is typically rated at 50 Kilowatts. The ChaDeMo Fast charging port available on the Nissan Leaf is supplied by a heavy-duty cable from the charger unit, which is about 32 mm diameter.

Alternatively, the domestic scale slow charger systems run at about 2-3 kW through the slow charging port on a Leaf and a 20 mm cable.

A ChaDeMo fast charger does not necessarily deliver 50 kW. That is the maximum rating of the equipment. The car regulates the actual rate of electricity drawdown so as to ensure that the battery is protected and not over-heated.

This chart shows various actual charging rate for my Nissan Leaf, which now has 21 kWh capacity. E.g. a Vector ChaDeMo fast charger, took 30 minutes to charge my car from 20% to 80% full to give me an additional 70 km of driving range. The average charging rate was 25 kW (i.e. 140 km/hr). Other EVs may be less conservative than mine.



This chart shows that after the battery is about 50% full the rate of charging declines rapidly. The rate of charging is controlled by the car, not the charger. At 80% full, the rate of charging is less than 30% of the nominal 50 kW rate. By default, the ChargeNet fast chargers stop at 80%. If additional range is needed, charging beyond 80% state of charge is slow, expensive and heats up the battery.

The opposite figure also shows that at a low state of charge the car limits the rate of charging. Users are recommended not to operate the battery less than 20% full to maintain good battery health. It is also wise to keep 20% of battery capacity (i.e. 25 km for my Leaf) in reserve in case of a road diversion, an unexpected deviation, a charger not being available as required or a change of plans. I was happy for my car to automatically protect its battery by limiting the fast charging rate, because the battery was the main feature of my capital investment in the electric car. I am told that a lot of fast charging tends to make the battery deteriorate more quickly.

The time required for fast charging has a significant impact on journey planning. For example a 240 km return trip from Waipu to North Shore took 4 hours in our Leaf, with 2 stops to fast charge, compared with 3 hours in our Prius V. Reliance on fast chargers also introduces uncertainty into journey planning because the charger units may be under maintenance or may be in use charging other EVs.

I recently arrived at a 50 kW fast charger to find a new Tesla hooked up. It had already been feeding for half an hour and was 70% full. The Tesla continued feeding at 25kW for a further half hour until it was 96% full before it released the charging cable. That cost $25 for 37 kWh. (68 c/kWh).

As the range of EVs increase with bigger batteries the time taken to fast charge an EV will increase. For example, that new Tesla with a 75-kWh battery (375 km) might take 90 minutes to charge from 20%-full to 80%-full at the real-world charging rate of about 150 km of range per hour of refuelling.

Cautionary tales

A man arrived at our place recently asking if he could charge his Leaf. It was 10.00.a.m. He had found my slow charger listed on the PlugShare website. We put his car on charge using my lead. His was at home.

It turned out that he was medical consultant from Auckland who had a clinic in Whangarei and was running late. His usual car had had a problem, so he had decided to use his wife's Leaf, planning to fast charge it on the way. The time taken to charge the car had taken longer than he estimated, compounded by other vehicles already using the two fast chargers that he had planned to use for his journey. So his plans had gone awry.

After climbing over the Brynderwyn hills, he got to our place with only 18 km of range left for the 38 km trip to the next fast charger in Whangarei. I estimated that it would take 2 hours to put enough charge into his car with my slow charger to give him that 20 km of additional driving range. He had a problem, since his clinic was already due to start.

As it happened, my Leaf was fully charged, and I had no need for it that day. So I loaned him my Leaf to get to Whangarei hospital and back, whilst we left his Leaf on charge all day. He returned that evening, very grateful for my assistance, which had enabled him to complete his clinic and see all his patients.

This example illustrates that in the real world the limitations and uncertainty of fast chargers can result in people with important time-critical commitments getting in a mess by reliance on EV fast-charger systems.

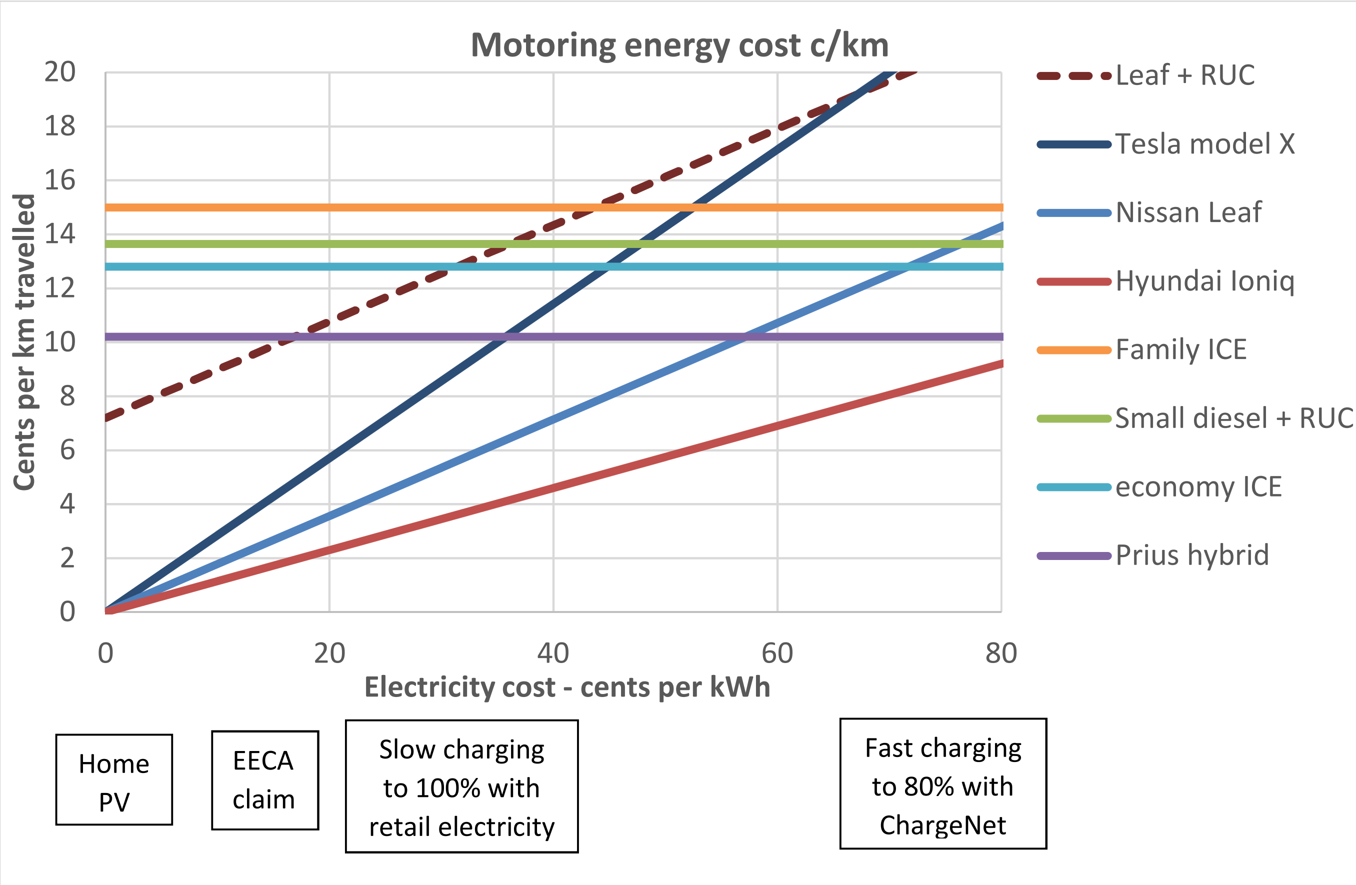
A lady and her teenage daughter arrived a while ago at our place at about 4.00.p.m. asking if she could charge her Leaf, which was running low on power. She was taking her daughter to a 7.30 p.m. event in Auckland. She had a plan of picking up power at various chargers on the way, but she had little appreciation of the time it would take to deliver charge into her car at each stop. She had previously only driven locally with overnight charging. We discussed her charging options and eventually it became clear to her that that car was not going to get to Auckland by 7.30 p.m.; nor was it feasible to pick up enough charge from my slow charger to enable her to return back up north that evening. They were effectively stranded.

They decided to abandon the trip to Auckland and to stay in my backpacker's hostel whilst their car charged overnight. Although the lady was an EV enthusiast, her daughter was not impressed with that outcome.

A guy turned up at our place in the early evening in a second-hand Leaf, which he had just bought in South Auckland. His old 2011 Leaf had a maximum range of 85 km so, after fast charging to 80% on the way, by the time he got to our place he still needed an additional 20 km of range to get home. We plugged the car in, but it didn't charge. He then remembered that the salesman had said that he had set the automatic timer on the car to come on at 10.00 p.m. There was supposed to be an override switch, but we couldn't make it work. So he was stuck and needed to get back home to his family. I loaned him my leaf to get home and we left his Leaf plugged in. It started charging at 10.00.p.m. He returned, very grateful, the next morning to return my car and to pick up his charged car. He had learned a valuable first lesson of EV ownership in a rural area.

Fully utilising the reported remaining range of a Leaf is unadvisable. The unexpected can happen. The display starts flashing when the remaining juice gets down to 20%. The algorithm that estimates remaining range is based on recent driving history, takes no account of elevation, and is only a +/- 10% approximate guide. It can suddenly change by several km. When the remaining battery capacity gets down to the last 10% the remaining range prediction stops displaying an estimate range. When the remaining battery capacity gets down to 5%, that display also blanks out. Although my leaf typically estimated 130-140 km range from full, the actual maximum range was about 120 km. Keeping a safety reserve, the effective range of my car was 100 km.

Cheap to run - but not that cheap



EECA claims that the energy running cost of an EV[3] is the equivalent of paying 30 cents per litre, or approximately 15% of the cost of running an equivalent sized petrol vehicle.

The EECA calculation is based on:

- Fuel running costs of a 2018 Hyundai IONIQ EV (@11.5 kWh/100km), relative to a 2018 Toyota Corolla GX (6.4 litres/100km)[4];
- Residential off-peak electricity rate of 15 cents per kWh incl. GST (home overnight charging on special night rate).
- Petrol pricing at $2.00/litre.
- Costing excludes road user charges, as EVs are currently exempt from RUC charges

The above chart shows the dependence of comparative energy cost on electricity purchase price for various vehicle comparisons.

The widely publicised "30 cents per litre" myth promoted by EECA is grossly optimistic.

Firstly, the comparison of an Ioniq EV with a Corolla is comparing apples and oranges. By default, EVs include regenerative braking and other hybrid vehicle features. Therefore a fair comparison would be with a common hybrid car such as a Toyota Prius at 5.1 litres/100km.

Secondly, the 11.5 kWh/100km claim for a Hyundai Ioniq is remarkably low, but perhaps achievable in city traffic. The ubiquitous Nissan Leaf generally available in New Zealand has a higher energy consumption. My Leaf uses 18 kWh/100 km on open road rural use.

Thirdly, the RUC exemption until 2021, means that EV fuel is not taxed. The chart shows that a small diesel car (4.5 l/100km at $1.40/litre for diesel) with RUC would cost the same to run as a Leaf with RUC[5] and retail electricity at 35 c/kWh.

[3] www.energywise.govt.nz

[4] NZTA Right Car data

[5] RUC for a small car is 7.2 c/km from 1st July 2019

Fourthly, an electricity price of 15 c/kWh at night is not generally available throughout New Zealand. Retail electricity inc. GST typically costs about 25-30 c/kWh to the householder.

My house has a ripple-circuit interruptible supply, which costs me 17.9 c/kWh and is unavailable from 5 p.m. to 8.p.m. in the winter. I use that circuit for my EV charging socket. With that low-cost system my Leaf energy cost is 30% of the fuel cost for my Prius, not 15% (i.e. "*30c/litre*").

If I paid the full rate for a marginal kWh of retail electricity the EV would cost 50% of buying petrol for my Prius V.

However, when using the ChargeNet fast charging system to extend the range of my Leaf, my operating cost advantage goes negative.

When the RUC comes in for EVs in 2021, at the current RUC rate there would be no operating cost advantage for a Leaf using retail electricity.

Steve Goldthorpe

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The ChargeNet retailing model

"ChargeNet was started in 2015 by a few enterprising Kiwis with a dream of encouraging people to turn on to electric vehicles, and through a mix of imagination, determination, and some pretty clever software, is now the largest privately owned, fast charging network in the Southern Hemisphere! ChargeNet is New Zealand owned and has more than 100 conveniently located stations on its network for topping up on the go."[6]

For $6 the customer buys an identification key fob and registers a credit card. Monthly bills are then direct debited at the rate of 25c/kWh plus 25 cents/minute when a fast charger is used. A text message is also sent with the details each time a fast charger is used. It is a convenient and reliable system, which makes long trips possible.

My purchase history is show in the table opposite. The average cost is 76 c/kWh comprising one third electricity cost and two thirds the per minute charge for using the facility. The chart on Page 3 shows how the rate of charging reduces with the state of charge of the battery. If the initial state of charge is low or if charging is stopped before reaching 80% full then overall cost is less.

The average cost in c/km of travel works out for my car to be 13.5 c/km. That compares with 10 c//km for my Prius at 5.1 l.100km and $2.00 for petrol; including excise duty.

My ChargeNet purchase history (Jan to Apr)

kWh	mins	$	c/kWh	c/km*
4.0	9	3.38	84	15.1
6.0	12	4.85	81	14.4
4.3	9	3.51	82	14.6
9.2	22	7.90	86	15.3
3.8	5	2.22	58	10.4
2.5	4	1.76	70	12.6
11.1	18	7.39	67	11.9
40.9	**79**	**31.01**	**76**	**13.5**

*A kWh of purchased electricity gives me 5.6 km of travel on average. The battery capacity is now about 21kWh.

The high cost of fast charging with ChargeNet reflects the valuable enabling service provided to NZ's EV users, particularly in rural areas. However, in Auckland and Hamilton, free fast chargers, provided by local lines companies, trump the ChargeNet model.

Steve Goldthorpe

[6] https://charge.net.nz/about/

The Vector, WEL and other Lines Company fast chargers

In the Auckland region there are 9 50 kW fast chargers provided by Vector shown on the ChargeNet map. Likewise in the Waikato there are 6 fast chargers provided by WEL networks. There are a further 15 fast chargers in the Power Co., Horizons, Unison and Eastland Lines Company areas on North Island. There are also 7 fast chargers in South Island provided by Lines Companies EA Networks and Network Waitaki.

These fast chargers can typically refill a Leaf battery from 20% to 80% at up to 50kW (see chart on page 3) via a ChaDeMo plug in half an hour.

All Lines Company chargers are initially free to use. The Vector fast chargers in Auckland are still free. The only Lines Company website to describe a payment regime is Unison, which charges a flat 40c/kWh for fast charging, which is administered and billed via ChargeNet.

The Vector fast chargers in Auckland are very popular with EV owners because they are currently free, which is, of course cheaper and faster than charging at home. That presents a problem for the commercial ChargeNet model, which would charge about $10 to charge a 24kWh Leaf from 20% to 80%. EV drivers are very mobile and they will obviously choose to use a local network free charger to rather than a commercial ChargeNet charger, where feasible, to obtain up to an 80 km boost in range.

Electric vehicle production and popularity is on the rise. It's an exciting prospect and a great time to encourage uptake of electric vehicles among locals here in Mid Canterbury.

On 18 April 2017, we installed Mid Canterbury's very first Electric Vehicle Charging station on Rolleston Street, Rakaia (picture opposite). Set within a visitor-friendly carpark and close to dining outlets and other amenities, the Rapid Charge Station has proven popular with locals and travellers alike.

Equipped with a solar panel to power its LED lighting, the charging station is used often and is a valued stopping point between Christchurch and Timaru for vehicle top ups.

EA Networks also installed an EV charging station on West Street in Ashburton CBD. Once again, we chose this location in collaboration with the Ashburton District Council because of its proximity to SH1, local amenities and the high profile and visibility the site gives the station.

With plans to complete installation of our 3rd EV Charging station in Methven in the near future, it's an exciting time to be a catalyst to the electric vehicle movement. *EA Networks*[7]*

In rural areas fast chargers of either type are widely spaced out so the EV driver has little choice between the free chargers and the paid chargers. However, in the urban areas of Auckland and Hamilton a choice is available.

[7] https://www.eanetworks.co.nz/services/electric-vehicle-charging/

For example, in Warkworth (in Greater Auckland) there is a ChargeNet fast charge at the New World supermarket. But it is less than 2km to the free Vector fast charger at the BP station on SH1. The free Vector fast charger is usually busy. The paid ChargeNet fast charger in town is not. When I travelled between Waipu and Auckland I could hop between free Vector fast chargers and pay nothing for the energy that I used.

Of course, Lines Companies giving free energy to EV users gains a lot of "likes" on social media. The downside is that free introductory handouts of energy are so popular that often EV users have to queue to get onto a free fast charger.

However, that model is not sustainable or expandable. It distorts the local energy supply market and conflicts with the competitive electricity market. As the uptake of electric vehicles increases, the introductory free fast chargers supplied by Lines Companies, will surely have to be phased out – won't they?

It is not that easy for Lines Companies to charge for the valuable service that they provide. Collecting small amounts of money securely in remote locations is not easy. Unison has solved that problem by using ChargeNet as their billing agency. Unison charges a flat rate of 40c/kWh (7c/km for my Leaf) administered by the ChargeNet accounting system, which requires the EV user to be registered with ChargeNet.

However, is that legal? Charging for electricity supply direct to consumers is clearly an electricity retailing activity. The NZ electricity market structure does not permit Lines Companies to retail electricity. Changing the electricity market law to allow Lines Companies to retail power to EVs would give them a local monopoly position which would directly conflict with the principles of NZ's competitive electricity market.

The NZ competitive electricity market design is based on electricity consumers being supplied through a fixed Installation Control Point (ICP) at specific locations supplied by local Lines Companies. However, when the electricity consumer becomes mobile that commercial electricity supply infrastructure model falls over.

Likewise, the EV users do not currently pay for their use of the roads, via either excise duty or Road User Charge (RUC). An RUC on EV use may be introduced from the start of 2022.[8]

> *"As of January 2019, there are 175 DC rapid charging stations across New Zealand. The NZTA approved goal is to encourage the installation of a rapid charger every 75 km along NZ's main State Highways so that even a low-range vehicle can travel inter-city."* (www.leadingthecharge.org.nz)

Steve Goldthorpe

The SEF Annual Meeting

On July 4th the SEF AGM was held at The Sustainability Trust in Wellington, followed by a talk by Iain Jerrett, director of the Sustainable Energy Association of New Zealand.

The AGM confirmed the continuance of the existing Executive Committee (none of whom had completed a 3-year term) and identified the need for a subscriptions campaign. The AGM also agreed that SEF should support the sustainable transport objectives of the Wellington-based International Climate Safe Travel Institute, which is campaigning against a second Auckland Airport runway.

Iain Jerrett described SEANZ, which is primarily focussed on the electricity industry. In particular, the prospects for expansion of electric vehicles were discussed. There is substantial scope for advances in battery technology internationally to service the evolving electric vehicle market. When questioned about the limited EV battery replacement services in New Zealand, Iain identified that large lithium batteries are identified as Class 9 DG and are more expensive and specialised to ship than normal freight. *Editor*

[8] https://www.transport.govt.nz/multi-modal/climatechange/electric-vehicles/

A 700 km EV road trip Auckland to Wellington

By Steve Goldthorpe

I have now sold my Leaf to my son. That deal involved delivery of the car from Auckland to Wellington. My wife and I combined that road trip experience with my journey to the SEF annual meeting. The road trip, with the use of fast charges, took 5 hours from Auckland to Taupo on Day 1, twelve hours from Taupo to Wairarapa on Day 2, and 1.5 hours to Wellington on Day 3.

Careful planning was essential. We aimed to arrive at each charger with at least 20% battery capacity remaining and preferably enough to also get to the following fast charger, but that was not always possible. In addition to distance estimation, the major changes in elevations had a significant impact on range. The estimated remaining range is unreliable because it predicts future range based on recent history and can't account for elevation.

The original intent was to drive 468 km from Taupo to Wellington via Napier on Day 2. We started at 6.00.a.m. However, multiple fast charges resulted in the battery temperature increasing to 90%[9]. of the operating range by the time we got to Masterton, so we arranged to stay overnight with a friend in the Wairarapa and to continue the next day after the battery had cooled.

Although all the nine fast chargers that we used all worked OK, it was a bit nerve-wracking to drive into a strange town with the "low-battery" warning flashing, trying to locate the unsignposted fast charger, in the knowledge that progress was absolutely dependent on that single piece of equipment. Since the State Highways bypass many towns, there was the additional complication of making a detour off the main road into town and then getting back on the main road again after re-charging both the car and driver.

In contrast, on the early morning leg from Taupo over the hill to Napier, the two charging points were well signposted. That was essential because there was no phone signal up there. Those two fast chargers were in the middle of nowhere, so we just had to sit and wait whilst the car charged with no coffee or toilets until we got to Napier.

The use of Google maps via the ChargeNet map app was generally essential; particularly the ability to identify where we were in a strange town relative to the location of the charging unit. For example, the free fast charger at Te Kauwhata is well out of the village centre.

As we approached Greytown, traffic came to a stop because of a serious accident ahead of us. Some vehicles turned around. Google Maps advised us to return to Carterton and take a different route to our friend's place. That would have been a 40 km diversion. We only had about 40 km remaining range, so we decided to wait until the accident was cleared. If not range-limited we would have taken the diversion.

We were fortunate not to be making the journey 8 days later. At 8.00a.m. I received a text saying *"ChargeNet scheduled maintenance: Masterton unavailable today, plan your trip accordingly"* At 8.00 a.m. on Day 2 we were already on the road and committed to the SH2 route. Without the Masterton charger, the leg from Woodville to Featherston (114km) would be impossible.

The total ChargeNet bill for our trip was $45[10]. One fast charge was free, and we had three overnight full slow charges that were free. At regular ChargeNet rates for all charges, the cost would have been about $85. If we had done the same 700 km journey in our PriusV, the petrol cost (including excise duty) would have been about $80. That illustrates that EV use is not cheap for long-distance travel and will be uncompetitive when an RUC on EVs comes in.

I conclude that EV fast charging infrastructure in NZ is barely fit for purpose at present.

[9] The battery temperature got up to 80% of operating range on Day 1

[10] The three Unison Lines Co. charges cost a flat rate of 40c/kWh, administered by ChargeNet. Is that legal?

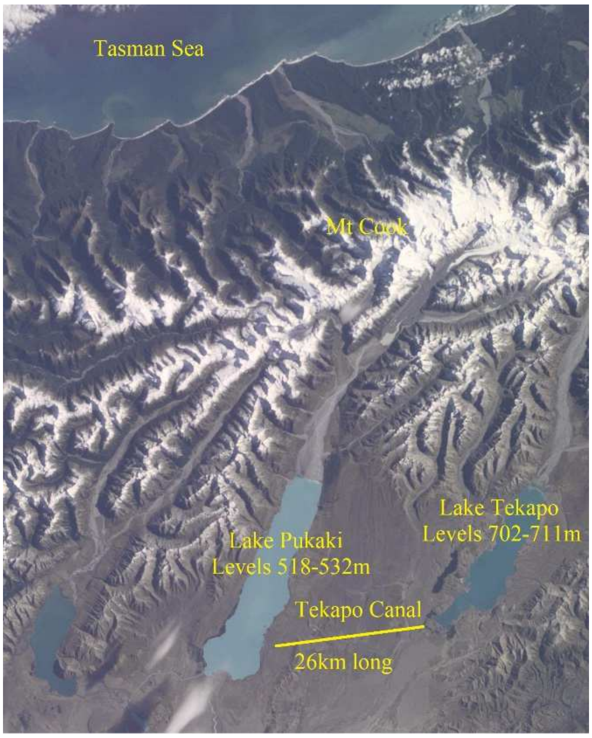
A Case for Pumped Storage in New Zealand

Editor's note:-

In this Article Alastair Barnett explains how the structure of the NZ competitive electricity market conflicts with principles of co-operation required for the design of pumped storage to address security of electricity supply in NZ.

He cites the example of the Tekapo scheme in the Upper Waitaki in which water from the 83 km² Lake Tekapo, at 702-711 metres elevation, drops through the 25MW Tekapo A power station into the 26 km long Tekapo canal, which takes it to the 160 MW Tekapo B power station from which it discharges directly into the 179 km² Lake Pukaki at 518-532 metres.

The addition of a facility to use surplus off-peak electricity to pump water from Lake Pukaki up into the Tekapo Canal and then from the other end of the canal back up into Lake Tekapo would create a pumped storage facility for NZ.



By Alastair Barnett

Introduction

All recent studies of security of electricity supply assume our hydro storage will dry out under certain conditions. Reliance on this assumption appears to coincide with the development of the competitive market model for electricity generators. This model relies on unverified econometric hypotheses at an extremely crude national scale, in stark contrast to the intensive evidence-based analysis used for the original design of each turbine and generator in our distributed hydropower system.

Example: The Tekapo-Pukaki Storage System

The Upper Waitaki power scheme includes by far our largest storage resource, with Lakes Tekapo and Pukaki together capable of storing over 50% of our total national hydropower reserves. These two huge reservoirs were conceived as interlinked, with exchange of stored water initially one way, but ultimately two way through the billion-dollar 26 km Tekapo canal.

Before commissioning the new canal in 1977, the operating authorities required to understand the conditions under which the canal would overflow or run dry, as experience in other countries had shown that either condition can require the complete shutdown of the canal link for repairs taking months if not years. This meant that during commissioning tests we needed to be able to develop accurate predictions of such damaging conditions at a rate faster than data accumulated from the test runs as observed in real time. Even on the, then, fastest computer in New Zealand, the Vogel computing centre mainframe operated by the Ministry of Works and Development, computing speeds were not adequate during commissioning tests to generate warnings in time from information technology then internationally available. However, in New Zealand we were able to improve both the speed and accuracy of canal wave modelling using numerical techniques based on asymptotic expansions.

This world first technology enabled the 26km Tekapo canal to be modelled significantly faster than real time on the Vogel computer, remotely linked to the commissioning control centre on the canal. On modern computers this same high-speed technology enables long term simulations of the whole national hydropower network, as is essential to identify major potential canal damage events during analysis of dry year conditions.

Or at least that will apply until the asymptotic expansion technology is permanently lost during the next few years. At that time a search must begin to develop a replacement solution approaching the internationally verified computing speed and accuracy of the 1970s analysis. If this is not done, critical canal links will be at risk of catastrophic failure whenever conditions require operation near capacity flows.

Econometric Analysis

In contrast, current econometric analysis assumes that storages in Lakes Tekapo and Pukaki cannot be interlinked because the 1970s concept of linking by a canal has been superseded by linking within organisational structures. In the 1970s both lakes were co-operated by the New Zealand Electricity Department (NZED) with advice on hydraulic engineering from the, then, Ministry of Works and Development (MWD). This common management structure passed from NZED to the Electricity Corporation of New Zealand (ECNZ) and then to Meridian Energy, only to be disrupted by government intervention in 2010-2011 when the Tekapo assets (lake storage, canal and power stations) of the Waitaki scheme were transferred to Genesis Energy over the strong objections of the Meridian Board. Since then, co-operation of the Tekapo and Pukaki storages has been possible only under conditions in which both Genesis and Meridian separately see a commercial market advantage. In the light of recent declarations by Genesis management that Huntly continues to be their preferred backup in dry years, a Genesis veto of any Tekapo pumped storage development seems likely unless Government removes that possibility by rescinding their 2011 transfer of Tekapo assets from Meridian to Genesis.

Australian Strategy

In 2016, serious instability in the South Australian power supply led to the commissioning of the world's largest storage battery, capable of developing 100MW and storing up to 129MWh. This was duly delivered at a cost of A$90.6 million, apparently solving at least short-term stability problems in the South Australian grid.

This cost was somewhat greater than the NZ$76 million currently being spent by Mercury on upgrading the four generating units at the Whakamaru hydropower station. Since the generating capacity of the new units in this upgrade compares closely with the total capacity of new pump/turbine units required to set up pumped storage in Lake Tekapo, and since Whakamaru and Tekapo are comparably remote from large settlements, the construction costs of both upgrades should be similar.

But at Lake Tekapo, the total energy storage available is nearly 8600 times as great as in the South Australian megabattery. Of this, the part rechargeable by pumping would be nearly 2900 times as great as the battery technology, enough to run the 185MW capacity of the Tekapo stations for 2000 hours without recharge! Therefore, provided there is enough renewable energy generation surplus to continually recharge Lake Tekapo even in dry years, there is no reason why the Tekapo/Pukaki system should ever dry out.

This explains why the Federal Australian government are commissioning detailed feasibility studies of pumped storage in the Snowy Mountains, where hydropower storage is much more feasible than in South Australia. This even though the likely scheme involves a 27km tunnel, making this far more costly than the Tekapo upgrade, where the corresponding 26km link has already been constructed years ago.

Conclusion

Here in New Zealand we continue to rely on our market-based system to determine our development strategy. Unfortunately, we will have to wait a long time before all the competitors in a market agree on anything, let alone something as vital as a national strategy for energy security. What rewards does the market offer for reaching any such agreement? How much confidence can there be that unverified econometric model projections are even moderately accurate, especially with respect to canal failures?

Submissions to the Electricity Price Review 2018-19

Editor's Note:

In February the Electricity Price Review Panel, appointed by the Government, published an "Options Paper for discussion" as a stage in the 2018-19 Electricity Price Review process[11]*. Molly Melhuish made the following submissions on topics and options in that document, as a part of that consultation process. The final report of the Electricity Price Review Panel has been sent to the Minister of Energy, but the report has not yet been made public.*

Submissions by Molly Melhuish

A1 Establish a consumer advisory council

A consumer advisory council is needed, to monitor power prices and advise on ways to protect mass-market consumers from excessive pricing, and to find the best ways to offset the harm done to low-income and vulnerable consumers. That is not enough.

Electricity pricing today is designed to guarantee revenues and support asset values of the centralised electricity businesses in the face of falling demand. Industry support for increasing the fixed charge is an attempt to limit the ability of consumers to invest in energy efficiency and distributed energy. That is simply wrong.

Many overseas electricity markets incorporate "prosumer" investments and actions to reduce costs including CO_2 costs. In NZ, market rules and industry practices to promote these are being opposed by many or most electricity companies.

A separate "sustainability advisory council" is therefore also needed, to work with electricity regulators to overcome the many market barriers to a low carbon future. This would enable a launch of a new era of consumer choice and technology adoption.

A2 Ensure regulators listen to consumers

Mass-market consumers – residential and small-business – need regulatory protection, as do businesses that offer distributed energy and energy efficiency. Many large consumers are Market Participants, and most others have sufficient market power to look after themselves. Currently, only the Market Participants have the resources to participate in the consultation programmes run by the Electricity Authority. Mass-market electricity consumers do not have the resources to have a voice or effective influence on policy processes run by the EA. No such consumer groups are represented on the EA committees; the EA has no effective input from them. It is therefore unsurprising that domestic electricity prices have increased. Yes, we need regulators to be required to listen to consumers. The question that needs answering is "How can consumers and distributed energy businesses be given an effective voice in EA policy-making?"

B2 Define energy hardship

Agree. A definition needs to recognise that many or most financially constrained households prioritise the power bill over budget items such as food and medical expenses [comment from Salvation Army at the conference]. Quality of housing could have more impact on quality of life than either the power bill or the family income. Adequate housing is a human right, and electricity pricing impacts on that. In many cases hardship can be reduced by own-sourcing of non-electric fuel – wood heating and solar energy stand out. However if you can't cut back the trees that shade the house or roof, or split your kindling, you can get into hardship. So energy hardship must be precisely but broadly enough defined.

B3 Establish a network of community-level support services to help consumers in energy hardship

Agree strongly. Over and above that, community energy organisations are increasing the resilience of a region's energy supply, and providing meaningful employment, especially in low-carbon energy options.

B4 Set up a fund to help households in energy hardship become more energy efficient

[11] https://www.mbie.govt.nz/assets/42ac93a510/electricity-price-review-options-paper.pdf

This assumes it is mainly Government's job to alleviate energy hardship. A stronger focus on energy efficiency would often lead to lower power bills at a lower cost to the economy and the taxpayer. Consumers in hardship may be in debt, facing massive interest rates, can invest nothing, and/or cannot shift the timing of their electricity use. Many are in rental accommodation. Energy efficiency is beyond the reach of these people. A hardship fund is one requirement to address these issues – community support is also required.

B5 Offer extra financial support for households in energy hardship

Yes, for the reasons above. "Equal access to capital" would be a great principle for an energy efficiency fund. Rolling funds such as the Crown Energy Loans Scheme could address this inequity.

C1 Make it easier for consumers to shop around

No. Few if any individual consumers enjoy having to "shop around" for retailers as they change prices to undercut rivals. Competing pricing offers must add a lot to the cost of retailing, a cost that ends up on every power bill. Instead, we want fair power prices, and tariffs that offer choices that include different levels of convenience, access to finance for big-ticket investment, and/or ability to save money by shifting demand.

C3 Make it easier to access electricity data

Yes indeed! Access to data is mission-critical to a more efficient and fair power system that enables new technology. A cleaner, cheaper, smarter power system requires full access to data by consumers and competitive distributed energy suppliers.

D1 Toughen rules on disclosing wholesale market information

Yes, this is critical. Real-time pricing is usual in overseas electricity markets; the RTP project of the Electricity Authority has dragged on for almost as long as Transmission Pricing Methodology. Withholding gas-fired generation has for years driven brief, or long, periods of high spot prices.

D2 Introduce mandatory market-making obligations

Yes. Right now, the hedge market is largely run on a 'handshake agreement' that assumes the generator-retailers will create a fair market for the other retailers. The hedge market does not really exist in practice. It is illiquid. A liquid market is a fundamental prerequisite for an effective wholesale market. In the words of the panel the hedge market is 'fragile' and unsteady, which is what we saw last year. In practice the hedge market is simply is not working, as demonstrated by the small-retailer complaint on the "Unacceptable Trading Situation" of last spring.

D3 Make generator-retailers release information about the profitability of their retailing activities

Yes, but where is the requirement to release information about profitability of wholesaling activities? The long-term forward price in mid-winter 2018 stood at about 7.5c/kWh; it has risen steadily since, and now stands at 10c/kWh. What profits have resulted? Does it mean retail prices will eventually settle at 2.5c/kWh higher than they are now?

E5 Phase out low fixed charge tariff regulations

Disagree. "Fixed charges drive higher costs for everyone. Network tariff design is critical for both the efficient short-term usage and long-term evolution of the grid. It sets the prices consumers pay for their use of the network infrastructure and influences their consumption and investment choices. Fixed charges take the power of choice out of consumers' hands. Because they are unavoidable, they undermine economic efficiency, in both the short and long run. (http://www.raponline.org/wp-content/uploads/2018/01/rap-ck-mh-ajnetwork-tariff-design-for-smart-future_2018-jan-19.pdf)

The majority of New Zealand consumers now have annual demands that qualify them for low fixed charges. Removing the regulations would increase their power bill. More important, the accompanying reduction in unit charges would make any investment intended to reduce their demand take longer to pay back. The industry now claims that low fixed charges make low-income high-use consumers subsidise rich consumers who can afford solar and house retrofits. This claim is rejected by most consumers – we require clear evidence of it.

E6 Ensure access to smart meter data on reasonable terms

This is essential to enable mass-market participation in network (also energy) investment and operation. Mass-market participation is more than a "benefit"– its absence creates a false market, like one hand clapping. It requires real-time pricing that rewards either or both investment and behaviour change. Access to data is the route to a cheaper, cleaner, smarter power system. Barriers to data access must be removed – the gains in efficiency will be large as they always are when data are made readily available.

F2 Transfer the Electricity Authority's transmission and distribution-related regulatory functions to the Commerce Commission

Probably not. The Commerce Commission does not have the focus, or resources, required to design or implement electricity market rules. However their control of overall revenue levels is still essential.

F3 Give regulators environmental and fairness goals

Yes. It's the job of a regulator to balance competing objectives. Environmental sustainability, fairness and energy efficiency should be made key objectives for the Electricity Authority, and every other agency that has a role in regulating electricity pricing and planning. The "energy efficiency first" principle has been embraced in principle by the European Parliament. It is bizarre that the electricity regulators do not have climate change objectives when their regulatory efforts are central to New Zealand achieving a zero-carbon economy.

F4 Allow Electricity Authority decisions to be appealed on their merits

Disagree. Merits appeals incur huge legal costs - residential and other small consumers could not pay for that. Legal decisions set the outcomes into concrete – as shown by the 1990s decision that confirmed that, in effect, rights to monopoly profits override common law rights to an essential service at reasonable price.

F5 Update the Electricity Authority's compliance framework and strengthen its information-gathering powers

Yes, effective competition of distributed energy against centralised electricity requires the former to have full information on what the electricity market is doing – spot prices, reserves prices, futures prices at different times-ahead. Probably also information on contracts. This needs to be interpreted by experts to form a sound decision base for small players in the electricity market. Evidence of market power needs to be analysed and reported on by experts independent of today's electricity Market Participants.

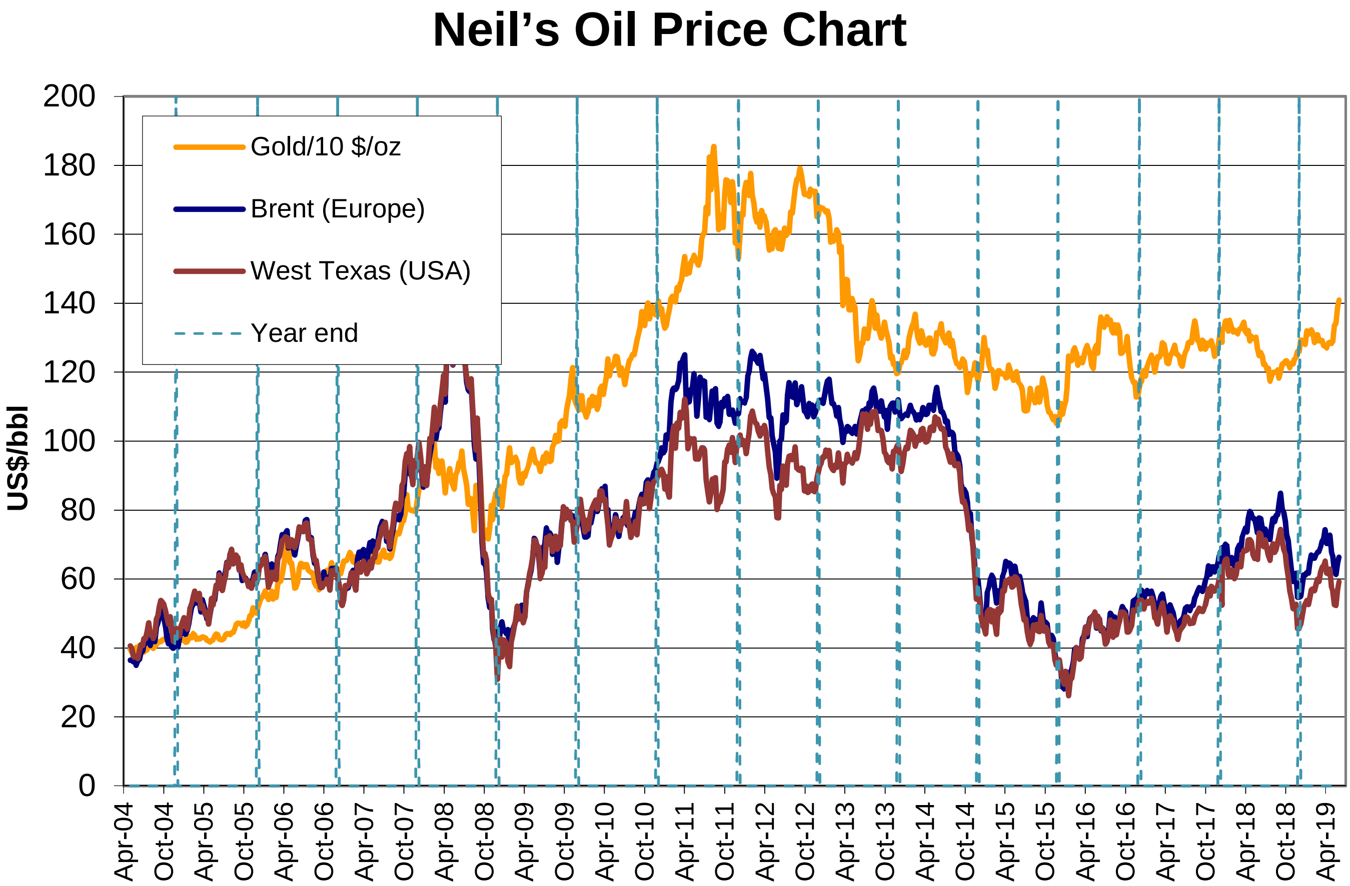
G2 Examine security and resilience of electricity supply

Again this shows the electricity-centric nature of current regulation – and of this Review. Secure and resilient electricity supply is most important for low-income and vulnerable residential consumers; other consumers are more able to create their own resilience through alternative energy systems. Using the right spread of technologies, whole communities can become far more resilient to the challenges of climate change.

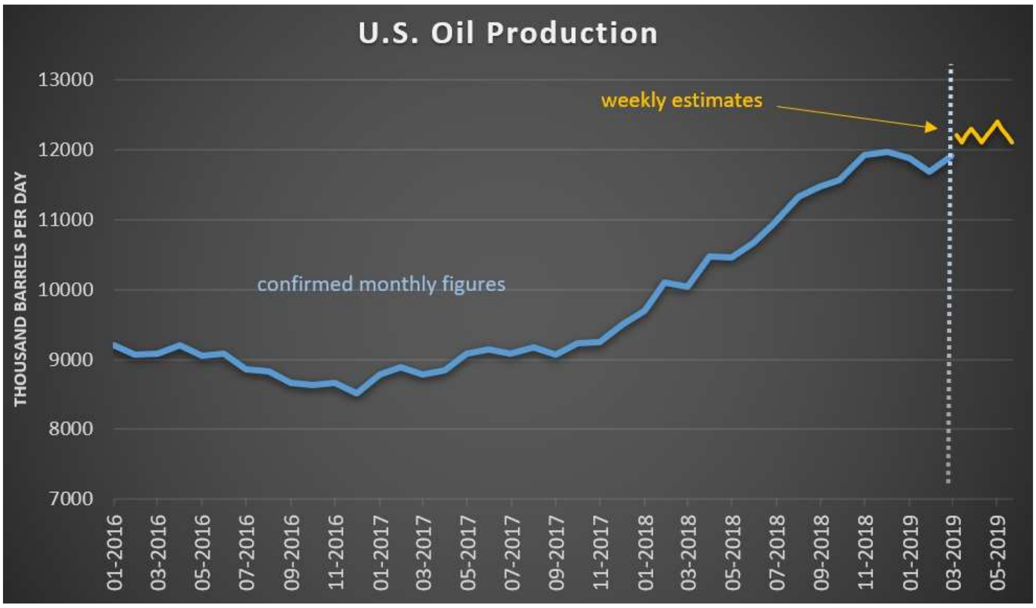
G4 Improve the energy efficiency of new and existing buildings

Probably the most cost-effective means of reducing carbon emissions from the electricity sector is through investment in buildings' energy efficiency, solar energy and clean wood burning. New buildings have the potential to sequester significant carbon, but their main contribution would be use of solar and/ or wood energy as appropriate. The 600,000 or so houses that are poorly insulated urgently need to be retrofitted, to reduce both energy poverty and carbon emissions.

Molly Melhuish



Despite geopolitical turmoil in the Middle East, the oil price is not showing signs of heading back towards the game changing price of $100/barrel. Even the attacking of tankers in the Strait of Hormuz has not yet created a sustained impact on oil prices. It seems that the oil industry is continuing with business-as usual. However, the gold price has increased to over US$1400/oz, the highest value for 6 years.



This chart from Oil and Energy Insider (28 June 2019) shows that US Oil production (probably including fracked natural gas calculated as oil-equivalent) increased from 9 to 12 million barrels per day over the last 2 years; i.e. the term of the Trump presidency.

Whilst the US oil and gas industry producers do not seem to see the writing on the wall for their sunset industry, Keith Shaeffer's Oil and Gas Investment Bulletin is talking more about lithium and silicon than it is about fossil fuels these days. That illustrates that people concerned only with making money from share trading are losing confidence in the oil and gas sector to be the cash cow it once was. *Editor*

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