Transitioning to a low emissions economy in the Bay of Plenty

Santiago Bermeo[1], Sandra Barns, Stephen Lamb
Bay of Plenty Regional Council

Summary

How New Zealand transitions to a low emissions economy will challenge policy makers as the impacts of the national level target (net zero by 2050) become more apparent. Examples that deliver towards this goal are important to showcase and build understanding of what a low emissions economy could be. This paper presents three case studies of "low-hanging fruit" type emission-reduction initiatives in the Bay of Plenty:

1) impact investment for solar energy and clean heating;
2) electric buses; and
3) electric vehicles.

Keywords: climate change mitigation, electric vehicles, impact investment, energy efficiency

1. Introduction

The Bay of Plenty Regional Council (BOPRC) was one of a number of New Zealand local authorities that declared a climate emergency in 2019, committing to work with communities on transitioning to a low-emissions future and adapting to a changed climate. Initial actions in response to this declaration are set out in BOPRC's Climate Change Action Plan (2019a). Responding to climate change is a strategic priority for BOPRC, which is now considering how best to deliver on it over the next ten years, beyond initial actions already underway.

One key area to address climate change is the transition towards a low emissions economy. Understanding what this is can be assisted by considering examples that fit within the transition from the status quo to an economy that deliberately seeks to lower emissions. This paper presents the results of three case studies of BOPRC initiatives already adopted, or being considered, to reduce emissions in the Bay of Plenty:

1) impact investment for solar energy and clean heating;
2) electric buses for public transport; and
3) electric vehicles for a corporate fleet.

---

[1] Corresponding author (santiago.bermeo@boprc.govt.nz). This paper does not represent BOPRC policy.

Section 2 provides some context about the regional baseline of greenhouse gas emissions. Section 3 discusses emission-reduction initiatives and case study findings. Section 4 provides a summary and conclusions.

2. Regional context

StatsNZ (2020a) recently released regional greenhouse gas (GHG) emission estimates. These estimates show that Bay of Plenty emissions increased by 12% between 2007 and 2018 (Figure 1), the largest percentage increase among the five regions which did not decrease their emissions over that period. The Bay of Plenty also experienced the highest level of economic growth of all regions over that period (StatsNZ, 2020b). Although population growth in the region was also among the highest in the country, other regions with comparable population growth rates actually decreased their GHG emissions over the same period.

The StatsNZ's 2018 estimate of 3.35m tonnes of CO_2-equivalents shows that the Bay of Plenty is the 10th largest regional emitter, accounting for 4.3% of national emissions. The distribution of these emissions by industry is summarised in Figure 2. In comparison, the Bay of Plenty generates 5.6% of the national GDP.

Figure 1: Regional gross emission estimates for the Bay of Plenty by source, 2007-2018 (StatsNZ)

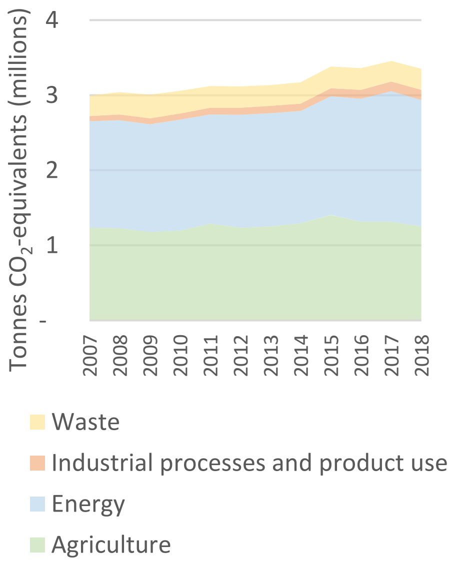
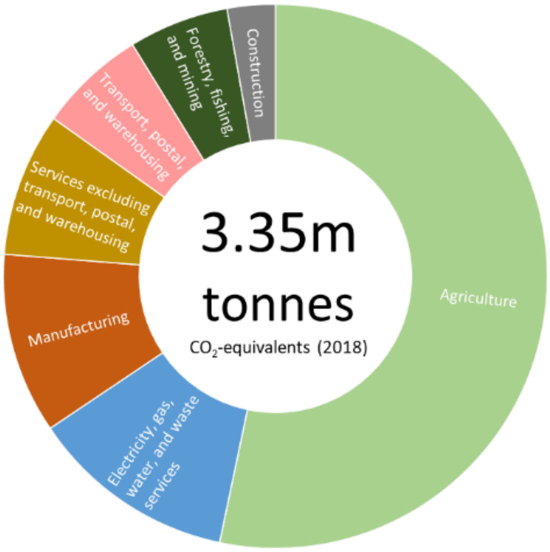


Figure 2: Regional gross emission estimates for the Bay of Plenty by industry, 2018 (StatsNZ)



Based on these estimates, the relatively large economic growth experienced by the Bay of Plenty in recent years has resulted in an increase in emissions. This is illustrated in Figure 3; the size of each bubble indicates the relative contribution of each industry to Bay of Plenty's GDP in 2018/19. This was not always the case for other regions and New Zealand generally, where some industries have experienced economic growth over that period yet also managed to reduce their emissions (i.e. their 'bubbles' were in the top left quadrant of Figure 3).

An earlier set of estimates from AECOM's regional carbon footprint (Martin & Marquardt, 2017) indicated 2015/16 net GHG emissions from the Bay of Plenty region were 5.98m tonnes of CO_2-equivalents, while gross emissions were 4.08m tonnes. The difference between gross and net emissions is explained mainly by the amount of exotic forestry harvesting and planting/growth which occurred that year. The distribution of these emissions by industry is illustrated in Figure 4 below.

Figure 3: GDP growth vs. percentage change in emissions by industry in the Bay of Plenty, 2007-18 (StatsNZ)

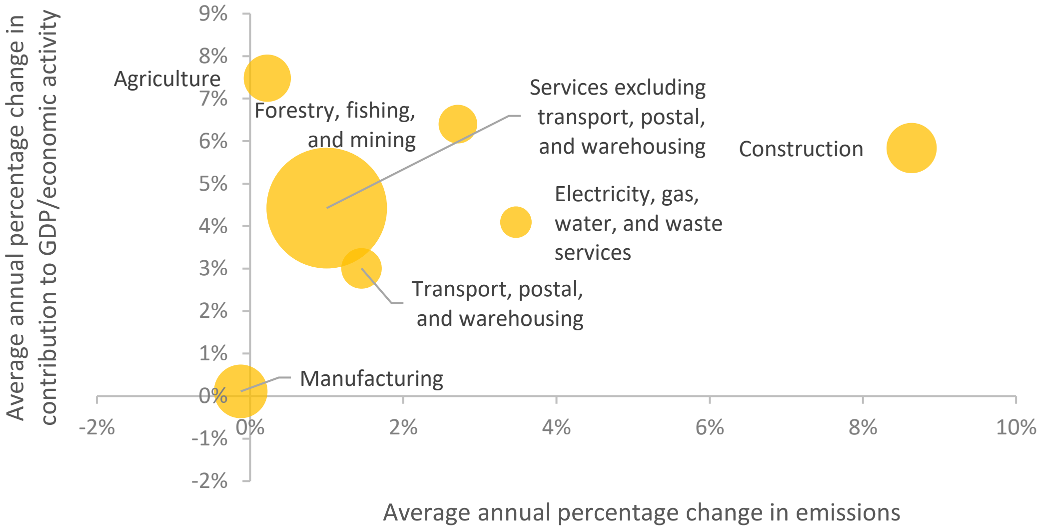
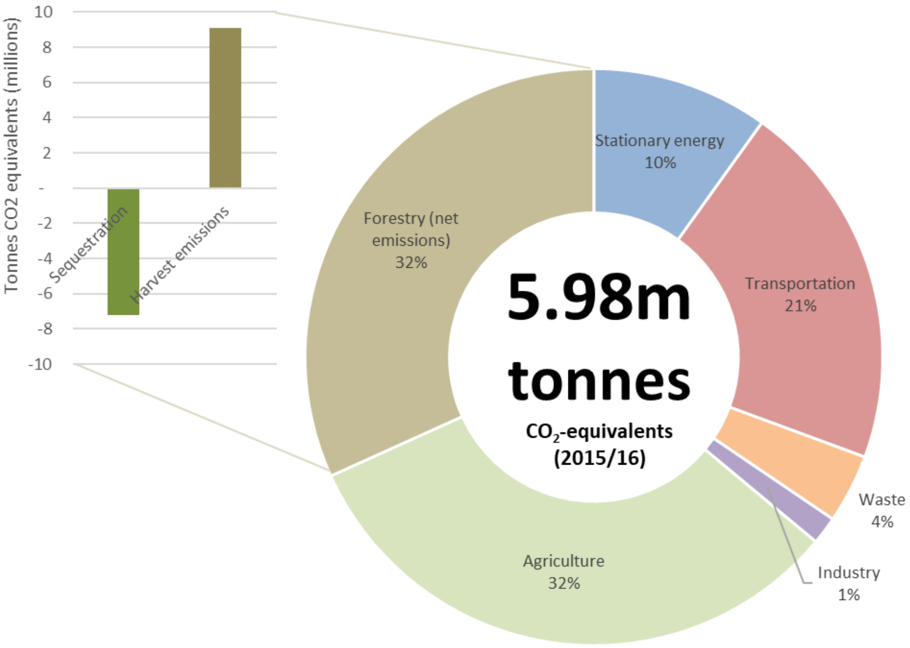


Figure 4: Estimated net GHG emissions from the Bay of Plenty by source, 2015/16 (AECOM)



StatsNZ’s and AECOM’s estimates are not directly comparable due to a number of methodological differences. StatsNZ estimates are based on a residency production approach while AECOM’s estimates are based on a consumption approach. For example, AECOM’s estimate includes emissions associated with electricity from non-renewable sources consumed in the region but generated elsewhere, while StatsNZ’s estimates do not. Likewise, AECOM’s estimate includes emissions and sequestration associated with forestry harvesting and growth while StatsNZ’s estimates do not.

Regardless of the yardstick used, these estimates highlight that the Bay of Plenty faces a significant challenge ahead in reducing emissions while accommodating some economic growth.

3. Emission reduction initiatives

3.1 Impact investment for clean heating and solar energy

There are three parts to this case study. The first is a summary of BOPRC's Hot Swap Programme in Rotorua, the second evaluates the experience of seven Bay of Plenty households with solar energy systems and the third sets out a proposal to extend the Hot Swaps Programme to other parts of the region and to cover other forms of energy efficiency.

Hot Swap Programme for clean heating and improved air quality in Rotorua

Driven by air quality issues in Rotorua, the Hot Swap Loans Programme encourages householders to replace inefficient wood burners with more efficient forms of heating (e.g. low-emission wood burners or heat pumps). Rotorua has traditionally had relatively high use of wood burners, and in the cold weather an inversion layer sits over the airshed, trapping the warm smoke-laden air under a layer of cold air.

The Programme provides a loan to households to replace their inefficient wood burners. The loan is repayable at an interest-free or preferential interest rate over 10 years through targeted rates. A $500 grant is also available for insulated households, which can be achieved through Energy Efficiency and Conservation Authority (EECA) incentives if necessary. The Programme is designed to be cost neutral for ratepayers, except for where grants are provided to householders. For example, low-income owner-occupiers may qualify for a low income heating grant, in which case their inefficient burner is replaced free of charge.

The Programme has been in place since 2010 and, as of early 2020, had resulted in 2,376 inefficient wood burners and open fires being replaced with more efficient alternatives through $5 million worth of loans. It is estimated that emissions amounting to more than 3,500 tonnes of CO_2-equivalents per year could have been reduced as a result of the programme.[2]

Aside from reducing GHG emissions, the Programme has resulted in improved air quality (Bay of Plenty Regional Council, 2019b) and a range of other improved socio-economic and cultural outcomes. This is a successful example of impact investment.

Solar energy

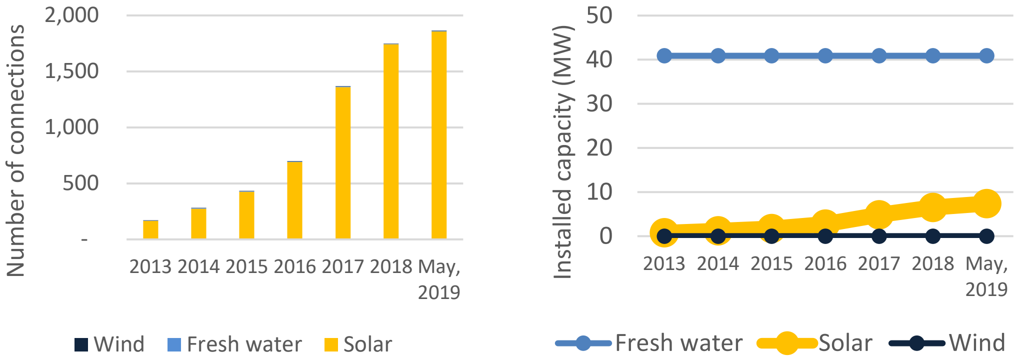
Use of grid-tie solar energy systems (including photovoltaic panels, inverters, timers, import/export meters, and in some cases batteries) is becoming more popular in the

---

[2] It is inherently difficult to estimate GHG emissions from heating due to the range of variables (e.g. weather, insulation, house size, heating behaviour, fuel type and quality, etc.). Nonetheless, this estimate is based on Hot Swap Programme registry data, average fuel use for home heating in Rotorua reported by Wilton (2005), the Ministry for the Environment's *Measuring Emissions: A Guide for Organisations – 2019 Interactive Workbook* and the *Running Costs Calculator* on EECA's Energywise website.

Bay of Plenty, although installed capacity is still significantly lower than for other energy sources (Figure 5).

Figure 5: Number of renewable energy grid connections and installed capacity in the Bay of Plenty from December 2013 to May 2019 (SOLGM Data Service)



For this case study, we looked at the experience of seven BOPRC staff and friends (“Chris”, “Cheryl”, “Jane”, “Greg”, “Matt”, “Sally” and “Tom”) with solar energy at their homes.

Tom was the first to have a system installed in 2013, followed by Cheryl in 2015, and Chris and Sally in 2016. Greg, Jane and Matt had their systems installed in 2019. Taking into account differences in system capacity, there appears to have been an overall reduction in upfront set up costs over this period. As a result of this, estimated payback timeframes for Jane and Matt are much shorter, between 5 and 12 years, depending on the discount rate applied. Jane will also be receiving a $2,000 rebate from Kiwibank, which further shortens her payback time. Sally got her system free of charge as a prize in a competition.

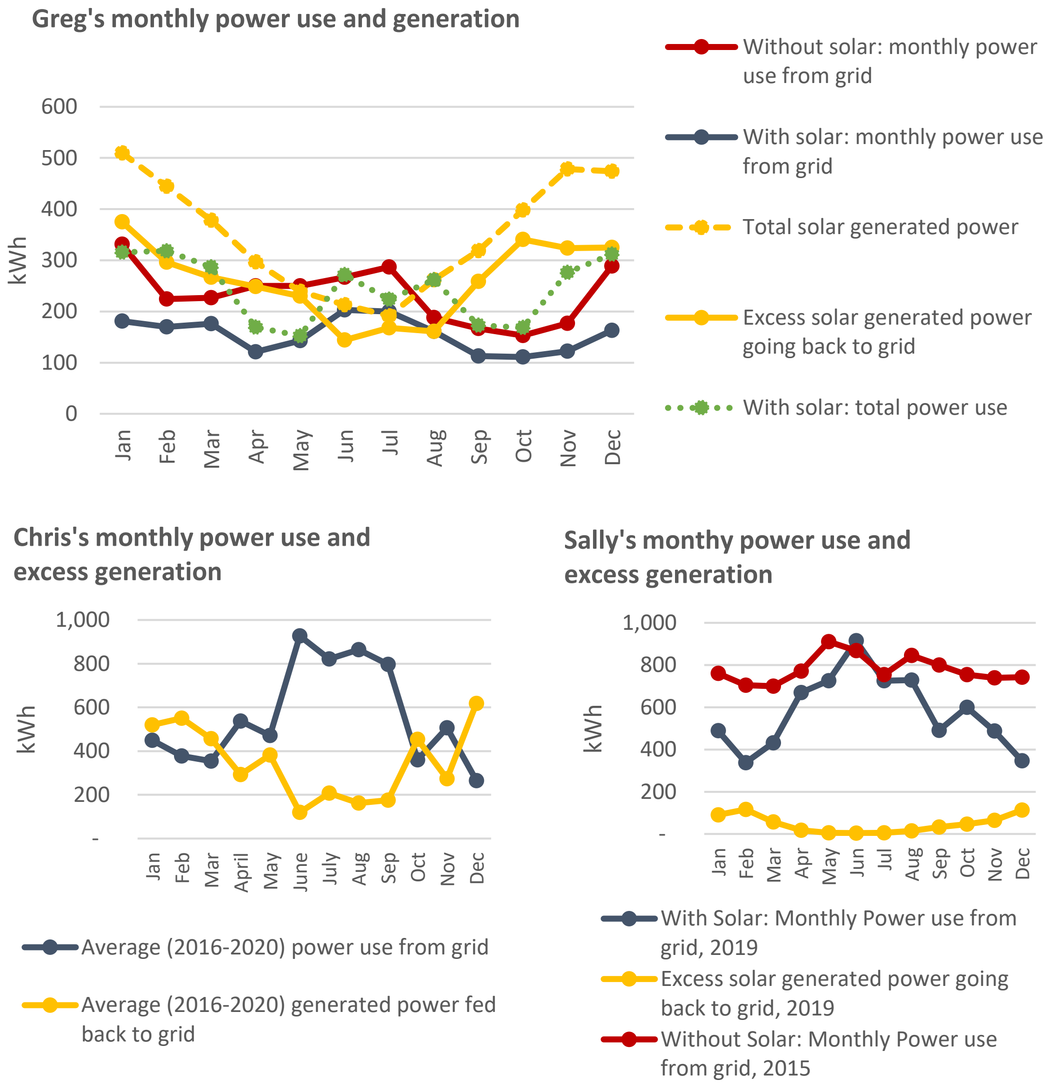
Chris’s power use is somewhat unusual in that it covers two separate households and also the operation of a pump for a bore which appears to draw a significant amount of electricity. This may help explain the longer estimated payback time, although it is shared between two households. Likewise, Greg’s power use pattern is also unusual with higher consumption over the summer months. It is understood this could be due to regular use of air conditioning for cooling. This also increases his estimated payback time, potentially to more than 30 years, and makes the financial viability of his system questionable.

Sally is the only one of the five to have a battery as part of her system. Consumer NZ (2016; le Page, 2018) and anecdotal comments suggest the cost of batteries is prohibitively expensive, although it is also decreasing over time. Luckily for Sally, this was not an issue for her since her system was provided for free. Sally’s battery allows her to store some excess generation from daylight hours for later use at night, reducing the overall amount of power that she needs to draw from the grid and therefore her power costs. For everyone else, excess generated power is fed back into the grid and any power use in excess of instantaneous generation (i.e., at night) has to come from the grid. This also means that Sally feeds much less excess power back into the grid, as illustrated by the yellow line in her graph (Figure 6) below, and therefore also receives less revenue from the power company for that.

Power companies currently pay for generated power fed back into the grid at a rate of $0.08 per kWh. Although this is much less than the cost of power derived from the grid ($0.25-$0.35 per kWh), it does provide a monthly revenue stream which reduces overall power bills, and occasionally has resulted in negative power bills (or credits) for some of the case study households.

As illustrated in Figure 6, generation is greater over the sunnier summer months, and power use is generally higher during the winter months. Obviously there is no generation outside of sunlight hours and peak power use is typically early in the mornings and evenings, although this varies according to different households' routines.

Figure 6: Case study households power user before and after solar system installation



There are a number of peculiarities with individual systems, individual power use patterns and all necessary information for each of the seven households above was not available so a number of simplifying assumptions have been made. In particular, Jane's and Matt's systems were in place for less than a year (as of early 2020) and just over the summer months when performance is better and power use generally lower. Although some adjustments were made to account for this, the benefits of their systems may be over (or under?) estimated.

Furthermore, this analysis does not consider whether the systems were paid through loans or from savings. This could also make a significant difference to the financial viability of a solar system. There are a range of other variables which can also affect financial viability including system capacity relative to power demand, grid power costs, power buyback rates, location and power use patterns.

Consequently, the results below (Table 1) should be considered broadly indicative only. Nonetheless, this information suggests that use of solar energy for a household can make environmental as well as financial sense, particularly in the case of the more recent systems. For solar power to make financial sense, upfront costs should be able to be paid-off within the system's warranty period and taking into account any additional costs like finance. Strictly speaking, the net present value of the investment must be positive and the rate of return on the original investment must be higher than any discount or interest rate applied. This was the case for all case study households, except Greg's. EECA and the Sustainable Energy Association provide online calculators to help with these assessments.

Table 1: Evaluation of household grid-tie solar system

	Chris	**Cheryl**	**Jane**	**Greg**	**Matt**	**Sally**	**Tom**
Installation date	2016	2015	2019	2019	2019	2016	2013
System capacity	5.2 kW	2 kW	2.7 kW	2.68 kW	5.6 kW	3 kW + 6.4 kWh battery	4.5 kW
Upfront cost	$16,095	$10,451	$8,000 - $2,000 rebate	$10, 850	$ 9,756	N/A	$15,000
Estimated payback time	18-28 years	14-20 years	9-12 years	21-30+ years	5-7 years	N/A	13-18 years
Estimated average annual savings	$900	$723	$673	$506	$1,800	$633	$1,115
Estimated emissions reduction[3] (kg CO_2-e/year)	656	318	234	400	975	290	1,093
Net present value (Rate of return)*	$458 (3.73%)	$2,841 (6%)	$6,234 (10%)	-$1,549 (2%)	$23,350 (15%)	N/A	$5,512 (6%)

**Over 30 years, assuming a discount rate of 3.5% per annum and no finance.*

More impact investment for energy efficiency

Bearing in mind the context described above, BOPRC is now considering extending the use of small scale loans, repayable through targeted rates, to encourage uptake of a range of energy efficiency initiatives and beyond Rotorua. The proposal is set out in detail in Barns (2020).

---

[3] Based on reduced power use from grid, excess generation going back to the grid and MfE's Interactive Emissions calculator.

It is estimated that capturing solar energy could result in emission reductions over 25 years costing about $1,290 per tonne. Aside from reducing emissions associated with grid power from non-renewable sources, increased solar generation can lower power bills and increase resilience in supply. This is particularly relevant as future demand is predicted to increase due to electrification of the vehicle fleet for example.[4]

Solar hot water was another initiative considered, with an estimated cost of $3,750 per tonne of emissions reduction. Due to its upfront cost, installing a solar hot water system would only be viable for new builds or when replacing a broken alternative system. Solar hot water systems also have a shorter expected life of 10 years.

Insulation is estimated to result in emission reductions at a cost of $880-$2,380 per tonne, with a range of benefits over the long term including reduced power costs and improved health outcomes. Bearing in mind upfront costs and other existing incentives for insulation, uptake is expected to be higher than for solar systems.

As noted above, it is tricky to estimate the emission-reduction potential of efficient heating. Yet, improving the efficiency of home heating by replacing small plug-in heaters and/or aging wood burners with heat pumps can help to keep families warmer (particularly when combined with good home insulation), providing a range of individual and public benefits.

This initiative is also expected to contribute to BOPRC's strategic priority to support the region to recover from the impacts of COVID-19 by creating additional employment.

3.2 Electric buses for public transport

In 2019, five electric buses joined the Tauranga public transport network, out of a total of 100 buses in the network. The buses are owned by NZ Bus, under contract to BOPRC. They have a range of 200km and fully recharge in 3 hours. The indicative figures in Table 2 below compare the GHG emissions, upfront and running costs of electric buses relative to the diesel alternatives which they replace (excluding costs of recharging infrastructure).

The five electric buses currently in service are estimated to result in direct emission reductions of between 363 and 418 tonnes of CO_2-equivalents per year. Over the expected years of service of buses in the public transport network, the overall costs of electric and diesel buses are very similar. As technology develops, the cost of electric buses is expected to decrease over time.

Public transport generally is also expected to result in significant indirect emission reductions by replacing the use of private vehicles. However, patronage in public transport services across the Bay of Plenty was reducing every year from 2015/16 to 2018/19. Nonetheless, it was encouraging to see an increase in patronage in the first two quarters of 2019/20. Patronage in January and February 2020 was also higher

---

[4] The electrification of the vehicle fleet will be a challenge for New Zealand, and one that is recognised by in long term planning by Transpower (2018). Transpower anticipates increasing competitiveness in the electric vehicle (EV) market, with EVs having a 40% market share by 2030, and 85% by 2050. Such a change though would require an additional 60+TWh of new generation. For context, 9 windfarms with ~60 turbines each would supply about 4 TWh.

than in previous years however it decreased sharply in March 2020 due to the introduction of COVID-19 restrictions (S. Berry, pers. comm.).

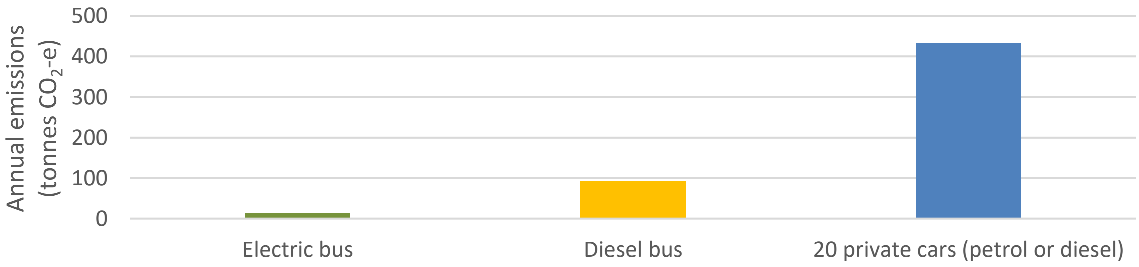
Table 2: Indicative comparison of an electric and a diesel bus

	Electric Bus	**Diesel Bus**
Purchase cost (new)	\$920,000	\$650,000
Annual maintenance cost	\$3,000	\$5,000
Mileage per year	80,300 km	80,300 km
Road user charges per year	NA[5]	\$22,300
Fuel/power costs	\$0.18 per kWh	\$1.06 per litre
Litres per 100 km	NA	40
kWh per 100 km	150	NA
Total annual running costs	\$24,681	\$61,371
Annual emissions	9-14 tonnes CO_2-e[6]	87-92 tonnes CO_2-e
Emissions per km	0.11-0.18 kg CO_2-e	1.08-1.15 kg CO_2-e
Discounted ownership costs over 10 years	-\$1.1m	-\$1.1m

Source: J. Metcalfe, pers. comm.; Auckland Transport (2018); MfE Interactive Emissions Calculator workbook.

Figure 7 compares the estimated annual emissions of an electric bus, a diesel bus and 20 private internal combustion engine (ICE, petrol or diesel) cars, for the expected annual average mileage of a bus. The difference in emissions between public transport and private ICE vehicles is much greater than the difference between an electric and a diesel bus. While there are clear benefits from electric buses, in terms of emission reductions, significant gains would be achieved by encouraging/ compelling more use of public transport (regardless of its fuel source) and less use of private ICE vehicles.

Figure 7: Estimated annual emissions



Per capita transportation emissions are larger in the Bay of Plenty than the national average. 2018 Census data for the Bay of Plenty shows that private vehicle use to get to work and education is a lot more prevalent than using other forms of transport, when compared to other regions. The Tauranga/Western Bay of Plenty area in particular has ‘one of the highest rates of private vehicle use among New Zealand cities’, partly due to the design of the area and location of workplaces relative to where people live (Waka Kotahi NZTA, 2018).

---

[5] Heavy electric vehicles are currently exempt from RUC until December 2025. After that, the costs would be the same as for heavy diesel vehicles, should the exemption not be extended.

[6] Based on the average emissions from grid electricity used to charge these buses.

3.3 Electric vehicles for a corporate fleet

BOPRC has initiated a process to replace part of its corporate fleet with electric vehicles (EVs). As of early 2020, there were 156 vehicles in BOPRC's fleet, of which 53 were compact cars/SUVs and the rest were utes. Five of these cars were Hyundai Ioniq EVs. BOPRC intends to continue replacing the cars in its fleet with EVs as current diesel cars come up for replacement. There are currently no viable alternative fuel options to replace diesel utes, which make up the majority of the corporate fleet. However, there would be merit in re-assessing if that many utes are actually required.

Based on the analysis summarised in Table 3, the five EVs in BOPRC's fleet will result in an estimated emissions reduction of about 17 tonnes of CO_2-equivalents per year. Replacing all current fleet diesel cars and SUVs with EVs would result in an estimated emissions reduction of 180 tonnes of CO_2-equivalents per year.

Table 3: Comparison of electric and diesel compact car

	Electric vehicle Hyundai Ioniq	**Diesel vehicle Hyundai i30**
Upfront costs	$47,000	$31,000
Litres of fuel per 100km	NA	4.5
kW per 100km	12.2 - 20	NA
Fuel/power costs	$0.18 per kWh	$1.40 per litre
Average annual mileage per year	20,000km	20,000km
Road user charges per year	NA[7]	$1,442
Annual maintenance costs	$156	$398
Total annual running costs	$595-$876	$3,100
Emissions per year	0.2 tonnes CO_2-e[8]	3.85 tonnes CO_2-e
Discounted ownership costs and re-sale value over 5 years	-$33,924	-$33,773

A common barrier to uptake of EVs is "range anxiety". BOPRC's EVs have a range of 180-200km on a full charge, enabling return journeys to the most common destinations within the region. BOPRC has also installed charging facilities at its office buildings.

Another barrier to adoption of EVs is uncertainty about battery life and replacement costs (Girvan & Hearnshaw, 2018). In the case of BOPRC's EVs, Hyundai provides a 10 year warranty on its batteries, acknowledging there is some uncertainty about battery life and replacement cost. The warranty is more than twice as long as the expected years of service of these vehicles in the corporate fleet. The analysis above has not considered whole life cycle costs and emissions associated with EVs and batteries, nor installation of charging infrastructure.

Assuming a depreciation rate of 15% per year for both types of vehicles, re-sale after 5 years and the upfront, running and maintenance costs described above, the overall costs of both vehicles for the expected years of service with BOPRC are very similar. The difference in upfront cost between the EV and its diesel equivalent would be

---

[7] Light electric vehicles are currently exempt from RUC until December 2021. After that, the costs would be the same as for light diesel vehicles, should the exemption not be extended.

[8] Based on the average emissions from grid electricity used to charge these vehicles.

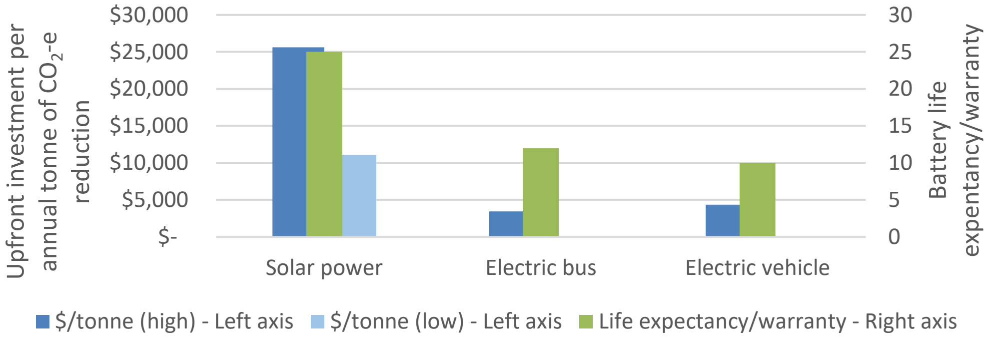
"paid back" through lower EV running costs in between 6 and 8 years, subject to mileage and the discount rate applied.

4. Conclusions

It is difficult to directly compare the merits of different emission reduction initiatives. They occur in different contexts (e.g. transport vs. energy, local government vs. household decisions, etc.), in some cases there is a fair amount of uncertainty associated with them and they all have a number of co-benefits which are not always easily quantifiable. Key uncertainties in relation to electric buses and vehicles include battery life and replacement costs.

Nonetheless, Figure 8 compares the upfront investment per tonne of annual CO_2-equivalent emission reduction for household solar energy, an electric bus and an EV. While solar power costs have a wide range per tonne of emission reduction, the battery life expectancy/warranty of such systems is more than twice as long. Also, the lower total upfront cost makes it a lot more accessible to a household than an EV. However, the viability of both of these options for a household would still depend on their individual circumstances.

Figure 8: Upfront investment per annual tonne CO_2-e emission reduction and life expectancy/warranty of initiative



Transitioning to a low-emissions, and in turn a carbon-neutral economy by 2050 as required under the Zero Carbon Act, will be a significant challenge for the Bay of Plenty and New Zealand generally. Emission reduction pathways will need to be cognisant of different regions' emission profiles and sequestration or emission-reduction capacity. Thought leadership and initiatives at all levels of the economy will be required to enable the transition to occur.

A particular challenge for local authorities wishing to support this transition is the fact that the main tools to encourage behaviour change (e.g. the Emissions Trading Scheme and the alternative emissions pricing framework being developed for the agriculture sector) rest with central government.

Nonetheless, there are tools available for local authorities to increase accountability for emissions, and to provide leadership around behaviour change. For example, the use by local authorities of loans repaid through targeted rates has already proven to be a successful incentive in the Bay of Plenty and other regions. Public transport, a key responsibility of regional councils, will also play a significant role in reducing transportation emissions and ultimately local authorities may need to look towards mechanisms to discourage the use of private ICE vehicles (such as, for example, considering congestion charges/tolls).

References

Auckland Transport. (2018). *Auckland's low emission bus roadmap.* Auckland: Auckland Transport.

Barns, S. (2020). *Small scale loans for environmental goods: voluntary targeted rates (Discussion Paper).* Retrieved from https://infocouncil.boprc.govt.nz/Open/2020/08/SP_20200811_AGN_3315_AT.PDF

Bay of Plenty Regional Council. (2019a). *Climate Change Action Plan - Te Mahere mahi mo Te Huringa Ahuarangi.* Whakatane: BOPRC.

Bay of Plenty Regional Council. (2019b). *Science snapshot report: air quality monitoring.* Whakatane: BOPRC.

Consumer NZ. (2016, November 2). Considering solar? New calculator can help. *Consumer*.

Girvan, M., & Hearnshaw, E. (2018). *Reducing barriers to electric vehicle uptake.* Wellington: Ministry for the Environment.

le Page, J. (2018, August 3). Are solar panels right for your home? *ConsumerNZ.* Retrieved April 23, 2020, from https://www.consumer.org.nz/articles/grid-tied-pv-systems

Martin, R., & Marquardt, M. (2017). *Bay of Plenty Community Carbon Footprint 2015/16.* Wellington: AECOM Consulting Services (Report to BOPRC).

StatsNZ. (2020a, July 23). *Greenhouse gas emissions by region (industry and household): Year ended 2018*. Retrieved from StatsNZ: https://www.stats.govt.nz/information-releases/greenhouse-gas-emissions-by-region-industry-and-household-year-ended-2018

StatsNZ. (2020b, March 31). *Regional gross domestic product: Year ended March 2019*. Retrieved from StatsNZ: https://www.stats.govt.nz/information-releases/regional-gross-domestic-product-year-ended-march-2019

Transpower. (2018). *Te Mauri Hiko Energy Futures - Transpower White Paper*. Wellington: Transpower.

Waka Kotahi NZTA. (2018). *National Land Transport Programme 2018-21 - Regional Summaries - Bay of Plenty*. Retrieved from Waka Kotahi New Zealand Transport Agency: https://www.nzta.govt.nz/planning-and-investment/national-land-transport-programme/2018-21-nltp/regional-summaries/bay-of-plenty/

Wilton, E. (2005). *Warm homes Technical Report: home heating methods and fuels in New Zealand.* Wellington: Ministry for the Environment.