Cost, Carbon, Comfort and Convenience

– a 2 hour journey by bus, train or plane versus taking a diesel or electric car.

Ralph E H Sims

Professor Emeritus, Massey University R.E.Sims@massey.ac.nz

This article compares several transport mode options for travellers over a 150 km journey and return. It offers guidelines for policymakers aiming to encourage people out of their cars on to public transport. A small diesel or petrol car and driver costs around double for one person making the journey compared with catching a bus or train. It also emits around three times the carbon dioxide per passenger. However, for many people the slightly shorter overall journey time for a car, plus the door-to-door convenience, will outweigh the higher costs and emissions. Carrying one or more passengers in a car would share both costs and emissions per person making it a more viable option than public transport. Using an electric car significantly reduces emissions but not costs. The multi-benefits of travelling by train are evident where the "first and last mile" issues can be resolved.

Note: Details of all the assumptions made are given in the Appendix below.

Background

Achieving New Zealand's climate target of net zero emissions by 2050 will not be possible without decarbonising the transport sector. This will entail investment in infrastructure, the rapid uptake of low-carbon fuels and vehicles, and encouraging changes in behaviour – which won't be easy. Moving around cities without depending on a car is a growing trend and well documented. More people are now using public transport or walking, cycling, E-biking, scooting etc.

By way of contrast, this article analyses a return journey of 300 km. It compares travelling by a small diesel hatchback car, electric car, diesel bus, diesel train, or plane. The pros and cons of each of these transport modes are presented to enable travellers to better compare the options available. In addition, the limitations identified for each mode, particularly the infrequency of public transport services and the often poor "first-and-last-mile" connections, will help policymakers better understand the challenges involved when aiming to discourage our ever-growing reliance on the car.

Infrastructure development and improving the interactions needed between different transport modes in order to enable a hassle-free journey will help encourage travellers to consider the alternatives to taking the car.

Transport accounts for around one third of New Zealand's carbon dioxide emissions and over one fifth of total greenhouse gas emissions. Annual transport emissions have nearly doubled since 1990. Light duty vehicles (cars, utes and vans less than 3t) now account for around two thirds of total transport emissions that have continued to increase in spite of the NZ Emissions Trading Scheme being in place for 14 years. The ETS has added a "carbon levy" of around 6-7 cents per litre to petrol and diesel fuels but few people even realise they are paying it since it does not show up on the receipt. Even for those who do know, it is far too small to have any impact on minimising fuel use by choice of vehicle purchase or on driver behaviour.

Reducing carbon emissions

The Climate Change Commission (CCC) has recommended that the Government should:

1) "*Reduce the reliance on cars (or light vehicles) and support people to walk, cycle and use public transport*."
2) "*Rapidly adopt electric vehicles (EVs)."*
3) "*Begin work now to decarbonise heavy transport and freight*."

With regard to item 1) the Commission also states that "*Local government plays an important role in changing how people travel, and it needs more support from central government to do the job well*."

As detailed in the IPCC 5th Assessment Report's Transport chapter (ipcc_wg3_ar5_chapter8.pdf) a person's choice of transport mode for a journey is based on a mixture of cost, comfort, convenience, as well as speed and safety. However, the choice for most people on whether to take the car or not is usually based on habit and gut-feeling rather than on any analytical reasoning.

The amount of carbon dioxide emitted is rarely a factor that travellers include in their choice of transport mode. Indeed, although most people now agree that climate change is happening, that it results from human activities, and we need to do something about it, very few people have taken any real action to significantly reduce their personal carbon footprint.

Folk I know will proudly tell me they have bought a new hybrid car (but often a large petrol or diesel SUV); most will be recycling some of their waste (though few are aiming to minimise it at source); some are eating less meat products (mainly for health reasons); and many have reduced their international travel (but somewhat begrudgingly due to COVID-19 restrictions rather than from trying to reduce their C footprint). So is it realistic to expect national and local governments to "*change how people travel*" and "*reduce their reliance on cars*" as recommended by the CCC? Education is perhaps the key.

Transport mode comparisons for a given scenario

This comparison of a number of travel options when undertaking a return journey of 300 km is based on the author's personal experiences when travelling between his house on the outskirts of the city of Palmerston North and Wellington's CBD. The analysis can be related to any other similar journey with a choice of transport modes, even though the details will vary depending on the specific circumstances.

The scenario used is that he has to attend a meeting in Wellington starting at 9.30am on a Thursday during a typical school day when the traffic is busy. The meeting finishes at 4.30 pm after which he makes the return journey home.

A 1500cc diesel car owned for 10 years is compared with an electric vehicle (EV) that has a 220 km range. The EV is mainly charged using rooftop solar. The airport is 8km away from the house; railway station 7km; and 5km to the city centre from where the bus departs. "First and last mile" options are included for each of these modes. The total journey time, cost, carbon emissions, comfort and convenience are summarised for each option assuming one person is travelling (Table 1). Should more than one person travel using the car, the costs and carbon emissions will be shared and therefore much less per passenger.

Table 1. Comparisons of journey time, cost, CO_2 emissions, comfort and convenience for different transport modes when travelling 150 km between Palmerston North and Wellington and return*.

Mode	Total journey time – one way, door-to-door	Total cost for return journey	kg CO_2 per passenger for return journey	Comfort ***** = good *** = OK * = poor	Convenience ***** = good *** = OK * = poor
Diesel car	**1 h 55 mins**	**$144.80** *If 4 people = $38.20*	**42.0** *If 4 people = 10.5*	***	****
Electric car	**2 h 10 mins** (need time to recharge)	**$131.43** *If 4 people = $32.86*	**6.2** *If 4 people = 1.6* *If using solar PV = ~0*	***	***
Diesel bus	**2 h 30 mins**	**$62.60**	**13.3** *If electric bus = 4.3*	****	**
Diesel train	**2 h 25 mins**	**$76.88**	**11.2** *If electrified rail = 3.7*	*****	***
Plane	**2 h 35 mins**	**$386.60**	**26.8**	***	*

*Details of assumptions used are shown in the Appendix below

Conclusions

Travel by car, either diesel or electric, is relatively costly, but overall has good door-to-door convenience so often quicker than the bus, train or plane. Comfort is reasonable but the driver cannot read or relax as on public transport.

Few car-owners include the costs of depreciation, tyre wear, repairs and maintenance etc. and only consider fuel costs when taking a journey. Renting a car includes these costs so would be around $300 for the journey, with time needed for picking up and dropping off.

Taking a short-haul flight over this distance is relatively costly, the journey is no quicker, and there is considerable inconvenience getting to and from the airports at either end, needing to arrive well before boarding, plus going through security. The CO_2 emissions per passenger km are actually lower than for a diesel car with driver only, assuming the plane has around 80% occupancy.

Taking a bus or train can be significantly cheaper than taking a car for just one person, and also offers lower carbon emissions. However, the longer journey time and the hassles getting to and from the station are deterrents. Infrequent bus and train services, often at inconvenient times, can also be disincentives to using these modes.

The very low carbon emissions of an electric car, especially if charged from a domestic solar PV system, coupled with reasonable comfort and convenience and the lowest journey cost per person when carrying 2 or 3 passengers, confirms that the Government's policy to encourage the deployment of EVs, such as through the feebate scheme, is sound. However, it will take many years to replace the existing fleet of petrol and diesel cars.

Travelling by train is perhaps the best option overall for this journey. The total cost is less than half that of taking a car; emissions per passenger are around one third of a diesel car); comfort is good with the opportunity to read, snooze, connect to wifi, buy refreshments etc. Making the journey more convenient will help encourage more people to travel by train and help reduce transport emissions.

This will involve national and local governments:

- encouraging Kiwirail to provide more frequent services;
- electrifying the line (already in place between Palmerston North and Hamilton but no longer used);
- providing cheap and efficient “first-and-last-mile” services to railway stations; and
- undertaking a major education campaign to illustrate all the cost, carbon, comfort and convenience benefits from leaving the petrol or diesel car at home.

Reference:

IPCC, 2014. Figure 8.3, *Transport chapter*, 5th Assessment Report, Intergovernmental Panel on Climate Change, Working Group 3.
https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter8.pdf

APPENDIX. Details of assumptions used for comparing transport modes when travelling a journey of 150 km (between Palmerston North and Wellington) and return.

[Scores used for *Comfort* and *Convenience* categories:

***** = good; **** = reasonable; *** = OK; ** = below average; * = poor]

1) Travel by 1500cc diesel car (driver only).

Journey time one way: **1 hour 55 minutes**

Costs: Fuel ($1.40/l; 5 l/100km = $21.00) plus road user charge ($0.076 /km = $22.80) = $43.80

Variable costs for depreciation, tyres, repairs and maintenance calculated from records kept over 10 years of ownership; 160,000km = 29c/km = $87.00

(Note: fixed costs for annual licence, insurance, warrant of fitness etc., not included).

Parking in long-stay car park per day (cheaper than on a parking meter) = *$14.00*

Total $144.80

Carbon: 140g CO_2/km (IPCC, 2014) from tailpipe only, excluding extraction, refining etc. **42.0 kg CO_2**

[Note: If the car has a driver plus 3 passengers, then per person the journey cost will reduce to ~ $37.00 and CO_2 emissions drop to ~ 11kg, allowing for slightly higher fuel consumption.]

Comfort: *** Can listen to radio and communicate by car phone, but have to concentrate and unable to read or use laptop, internet, social media etc.

Convenience: ***** Door-to-door but have to find parking. Time taken for a single trip is around 1 hour, 50 minutes (longer at peak traffic times), plus time to park and walk to meeting venue. Time to refuel vehicle not included.

2) Travel by electric vehicle (driver only).

Journey time one way: **2 hours 10 minutes**
(including 30 minute recharging time spread between the two journeys)

Cost: Charged using grid power imported at 24c/kWh. Energy consumption 13.7kWh/100km = $4.93

[If charged at home using surplus power from solar PV system that would otherwise be exported to the grid for 7c/kWh = $ 1.44. Depreciation of PV system not included as 90% of power generated used for house.]

Recharged to 80% in central Wellington at Chargenet; 20.5kWh taking 31 mins =$13.50

Variable costs estimated for depreciation over 10 years, tyres, repairs and maintenance (less than for a diesel vehicle); 16,000 km per year = 33c/km =$99.00

(Note: fixed costs excluded. EVs are exempt road user charge under current policy)

Parking in long-stay car park =$14.00

Total $131.43

Carbon: 150g CO_2/kWh from home grid charge plus from using Chargenet DC **6.2 kg CO_2**

[0g CO_2/kWh if charged from solar PV and excluding embedded emissions in solar PV system that are very low /kWh generated.]

[Note: If the car has a driver plus 3 passengers, then per person the journey cost will reduce to ~$34.00 and CO_2 emissions drop to ~1.7 kg allowing for slightly higher fuel consumption.]

Comfort: ***** - as for diesel car above.

Convenience: ***** - as for diesel car above, but there is also time taken for recharging.

3) Travel by diesel bus.

Journey time one way: 2hours 30 minutes

Cost: Fare - $27.00 one way (or $61 for Gold bus service with extras) = $54.00

Drive 5km to bus station - dropped off and collected to avoid parking charge; (or taxi for ~$20 one way; or walk 1.5km to catch public bus, $5 fare; or cycle taking 20 minutes each way).

4 * 5km @ 43c/km = $ 8.60

Total $62.60

Carbon: Diesel bus, 40 passenger occupancy. 35g CO_2 per passenger km (IPCC, 2014) = 10.5 kg
[For an electric bus at 5g CO_2 / passenger km this would reduce to 1.5 kg CO_2]

Diesel car to and from bus station (or 0.2kg for electric car) 4 * 5 km = 2.8 kg

13.3 kg CO_2

Comfort: ******** Possible to read unless get travel sickness; wifi only on more costly Gold bus. Some buses have no on-board toilet.

Convenience: ****** Need to travel to bus station (as outlined above). Bus times inconvenient: 4.15am arriving 6.30am ($51) with next service at 10am arriving 12.15 ($29); return departure times 3.30pm arriving 5.35 ($29) or 7.00pm arriving 9.20pm ($51).

Bus conveniently arrives in Wellington at central railway station near CBD.

4) Travel by diesel train.

Journey time one way: 2 hours 25 minutes

Cost: Fare - $35 one way (discount for 10 ticket purchase) = $70.00

Drive 8 km to station and return @43c/km = $ 6.88

Free parking – but no security. **Total $76.88**

There is no bus service to the station and if my wife needs the car, a taxi costs ~$30 one way. I have cycled on occasions but there is nowhere to park and lock the bicycle securely.

Carbon: Diesel locomotive. Train 20% full at start of journey at Palmerston North but becomes fairly full by the last station at Paraparaumu after ~100km.

30 g CO_2/passenger km (IPCC, 2014) = 9.0 kg

[Note: When the rail track becomes electrified as being proposed, this will drop to 1.5 kg.]

Diesel car to and from station (or 0.16 kg for electric car) 2 * 8 km = 2.2 kg

11.2 kg CO_2

Comfort: ***** Passengers can choose to sit at a table, read, plug-in laptop, connect to wifi etc. Refreshment bar available. Easy to find a seat in the morning but it fills up on route. Is usually full when departing for the return trip in the evening but many get off at first stations. A seat is always available (no reservations).

Convenience: *** Wellington station is near the centre of the CBD. Palmerston North station is on the edge of the city, the rail and station having been moved from the city centre in 1963 – in hindsight, a poor decision. No bus service goes to the station.

Only one train per day during the week departing at 6.15am and arriving 8.20am - if not delayed. Return trip departs 5.15pm and arrives 7.20pm so makes it a long day. Are plans in progress to run more frequent services in the future.

5) Travel by air

(Note, Air New Zealand have cut this service so assumptions were based on when direct flights from PMR to WGN were available)

Journey time one way: 2 hours 35 minutes

Cost: Fare - $140 one way (with discount fares available on occasions) = $280.00

Drive 10km to airport, (or taxi ~$40 one way, or cycle taking 25 minutes each way but no cycle park available). 2 * 10km @ 43c/km =$ 8.60

Car park = $ 18.00

Taxi from and to Wellington airport to CBD (airport bus no longer available) = $ 80.00

Total $386.60

Carbon: Short haul flight on ATR 72; 60 passenger occupancy; 80g CO_2/passenger km (IPCC, 2014) 24.0 kg

Diesel car to and from airport (or 0.2 kg for electric car) 2* 10 km 2.8 kg

Total 26.8 kg CO_2

Comfort: *** Once on plane can read, use laptop, but no wifi. Limited refreshments available.

Convenience: * No bus service to Palmerston North airport. Check-in at least 30 minutes before departure. Departure time 7.30am arriving 8.10am. Travel to and from Wellington airport and CBD only by taxi as airport bus service has recently been cut – or walk 2km to a public bus stop. Often traffic is congested on the route into the city, especially at these times of day.