28 October 2021

Carbon Analysis of the LGWM Programme

Revision History

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0.2		Further draft	18 Oct 2021
0.3		Quantitative analysis	21 Oct 2021
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Prepared by			18 Oct 2021
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On behalf of			

Introduction

Background

In January 2021, Councillors from Wellington City and Wellington Region revised the objectives of Let's Get Wellington Moving (LGWM) to account for a strengthened focus on reducing carbon emissions, enhancing mode shift, and boosting the liveability of the city. Councillors weighted the objectives as:

- Carbon emissions and mode shift: 40%
- Liveability: 20%
- Safety: 15%
- Access: 15%
- Resilience: 10%

A range of tools and approaches have been used to consider the impact on carbon reduction that might be expected from the investment proposals in LGWM. None of the tools, by themselves, are able to provide a complete view of all the benefits and all the costs that accrue to the LGWM programme. Transport modelling has been used to guide and inform the analysis and decision making. Multi-criteria analysis (MCA) undertaken by subject matter experts applying their best judgement to consider qualitative benefits and costs also provides a part view. Finally, analysis against the region's headline target for transport emissions reduction, set out in the Regional Land Transport Plan 2021 guided by statutory requirements, provides another lens with which to view the LGWM programme.

The ability of LGWM to deliver on regional and city climate change goals is fundamental to the success of the programme. Modelling in this area is complex and has limitations at an Indicative Business Case (IBC) stage, which is discussed in more detail later. Nevertheless, there is a wealth of existing knowledge that can supplement the modelling and provide a level of comfort that what is being proposed will deliver on emissions reduction aspirations.

When it comes to reducing carbon emissions there are a couple of basic principles which are not only common sense but have been validated through local and global experience over many decades. We do not need new modelling to confirm what we already know which is that:

- Quality investment in active and public transport modes will have a positive impact on reducing emissions.
- Cities that maintain and build on a compact urban form when accommodating growth will also have a positive impact on reducing emissions.

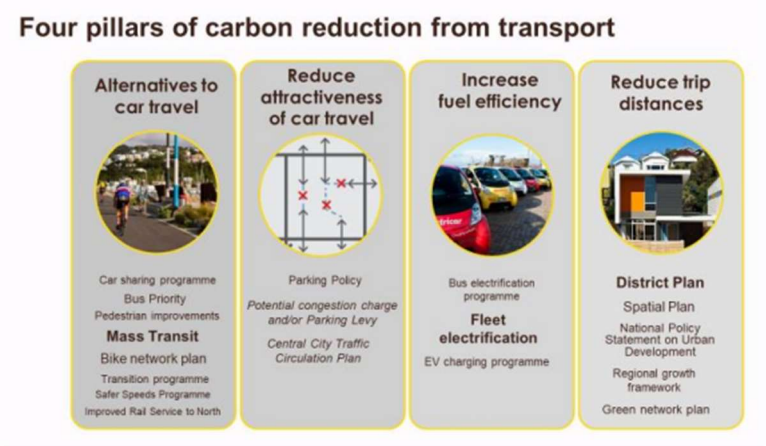
The LGWM programme focuses on investment that delivers strongly on these principles, so we can say with a high level of certainty that we will see positive carbon benefits whichever option is eventually progressed. These principles are easy to understand and are broadly accepted by the public so they should form the most basic, but fundamental, platform of the carbon narrative.

The pathway to meeting our carbon targets

Through the Regional Land Transport Programme, the Wellington region has a target of a 35% reduction in transport generated emissions by 2030. On our current trajectory, and business as usual, we will not achieve this. A range of activities and interventions are being planned across the region to contribute to our regional target. Investment in our regional rail network, increasing reliability, frequency, capacity and reach of train services to attract more users. Improving and encouraging access to train stations by active modes, public transport and shared modes. New active mode facilities, such as Te Ara Tupua, connecting our two largest cities, will enable more people to cycle between the Hutt Valley and Wellington City more often. Ongoing improvements to bus services around the region and trialling 'mobility on demand' services in areas where scheduled public transport services are less efficient. Travel behaviour change programmes, working with schools, workplaces and individuals across the region to identify and address barriers and support behaviour change and mode shift. The LGWM Programme forms an important part of this regional picture and action to reduce emissions as a key multi-decade investment in Wellington City's transport network.

When you break down emissions by local authority Wellington City has by far the largest share of emissions due to population size. This reinforces the value of the LGWM investment in the city in terms of maximising emissions reduction benefits for the entire region.

In the shorter term, emission reduction potential is likely to come through rapid roll out of safe and attractive walking and cycling facilities, bus priority lanes and measures, and travel behaviour change programmes focused on reducing single occupant vehicle trips and supporting mode shift. However, meeting regional growth needs while continuing to reduce our transport emissions longer term will require changes to land use and urban form within Wellington City and across the wider region. We'll need both transformative urban regeneration stimulated by the LGWM programme, together with intensification in and around sub-regional centres and around commuter rail stations. The more housing we can provide within Wellington City's central and southern suburbs along a future MRT corridor, the higher the number of trips we can expect to be easily made by walking and cycling and public transport given the proximity to the region's largest centre and employment hub, Wellington City CBD.



Driving down carbon emissions through LGWM

There is growing public and political understanding of both climate change and the need to make significant changes to the way we live to protect our future way of life. Significant weather events are increasingly impacting communities, forcing us to confront what until now has been a nebulous future threat.

To combat climate change, Wellington City Council has set targets to reduce greenhouse gas (GHG) emissions by 57% by 2030, using 2020 as the baseline year, and become a net zero carbon city by 2050. Reducing emissions from transportation will play a significant role in achieving these targets.

LGWM is set to deliver infrastructure that facilitates the movement of Wellingtonians safely and efficiently through providing low carbon and resilient public and active transport options. An important driver of LGWM is the reduction of carbon emissions. Transport infrastructure contributes to carbon emissions both directly (i.e. through materials, construction activities, etc. referred to as ‘embodied’ or ‘embedded’ emissions) and indirectly (i.e. through vehicles driving on it, referred to as ‘enabled’ emissions).

The assessment of carbon emissions associated with transport has traditionally focused on improving the design of infrastructure and systems. This approach is useful, however, the largest opportunities to reduce carbon emissions are found in the initial decisions of which projects to invest in that can result in the greatest reductions in enabled emissions.

Internal combustion engine (ICE) vehicles using the transport infrastructure (i.e. enabled emissions) are the most significant source of emissions across the lifecycle of the infrastructure, typically making up 80 – 95% of total emissions. Focussing on investments in infrastructure that enable and encourage people to take public or active forms of transport will have a significant potential to reduce carbon emissions and tackle climate change.

Layering upon this, there is a significant need to appreciate the carbon emissions reduction power of development targeted around Mass Rapid Transit routes. The increases in development bring communities closer – encouraging active modes and lower-emission living that multiplies the impact of the transport investments alone.

Why we need mode shift, not just electric vehicles, to address climate change

There is an ongoing transition to electrify vehicles. According to a 2021 Waka Kotahi modelling report[1], it is estimated that electric vehicles will comprise approximately 3-4% of the light duty vehicle fleet by 2030 and approximately 10% by 2035. Noting that this modelling was completed prior to the Clean Car Package being introduced by the NZ Government in June 2021. Meanwhile, the Climate Change Commission's final report, *Ināia tonu nei*: a low emissions future for Aotearoa, estimates electric vehicles will comprise approximately 10% by 2030 and 30-40% by 2035 of the light vehicle fleet. However, even under the Commission's higher electric vehicle uptake estimates, this transition on its own will not achieve our significant ambitions.

Reducing transport emissions will require a combination of factors. These include reducing the distance people have to travel, modal shift towards public and active transport, and the transition to electric vehicles[2]. LGWM will not only facilitate modal shift by providing safe and efficient alternative options to driving but will also facilitate denser residential and commercial land use. Denser land use can result in people living closer to employment opportunities and other amenities, which decreases the distance travelled on a daily basis to commute to work, get groceries, go to the park, travel to school, sports, and social activities.

The benefits of mode shift are numerous and desirable – less traffic circulation opens up more opportunity for drivers to get to their destinations in a smoother way; more space is available for reallocation to people whether pedestrian or cyclist; amenity and liveability is noticeable in impact as more and more people shift to sustainable modes; lastly but most significantly health outcomes are profoundly improved by reshaping the city.

[1] Vehicle Emissions Prediction Model: VEMP 6.2 update technical report, Waka Kotahi, 2021

[2] The 2015 EECA report, *Life Cycle Assessment of Electric Vehicles*, compared the lifecycle carbon emissions of electric vehicles (EVs) vs. petrol / diesel vehicles (lifecycle assessments include all emissions from material extraction, manufacturing, use and operation, through to end of life of the vehicle). This assessment showed EVs reduce lifecycle emissions by approx. 60% compared with petrol / diesel vehicles.

Quantified carbon analysis

Background

The LGWM Partners collectively control the urban planning, road transport, public transport, vehicle fleet standards, and various funding mechanisms around transport and urban development that allow significant influence on carbon outcomes. Each has declared a Climate Emergency and each has passed a significant piece of legislation or policy relating to carbon reduction – the Zero Carbon Act, Regional Climate Emergency Declaration and Action Plan, the Regional Land Transport Plan, and Te Atakura: First to Zero. The commitment is there, and the action is beginning to flow. Seven key opportunities to deliver carbon reduction have all come on the scene at once, with the Eighth and most critical being Let's Get Wellington Moving. They are:

- The Wellington City Spatial Plan and new District Plan
- The Wellington City bike network plan and transitional programme
- The Greater Wellington Bus Electrification Programme
- The Wellington Regional Growth Framework
- The Clean Car Programme, and
- Commitment to investigating priced Travel Demand Management
- The Regional Mode Shift Plan

Each initiative provides a significant amount of emissions reduction – noting the overlap between the Spatial Plan/District Plan and Regional Growth Framework – and they represent a significant step in the right direction. The Let's Get Wellington Moving options will serve to unlock each of these to a degree and integrate them into a better whole. All the programme options perform well and also deliver transport benefits, carbon reduction, and urban development uplift over and above what would happen under business as usual. They also provide many benefits including liveability and the opportunity for urban transformation that would otherwise not be realised. The Let's Get Wellington Moving programme enables all of the Partners' existing commitments to be achieved faster.

This is not to forget the many small actions that Partners are taking to address emissions – Travel Behaviour Change programmes, incentives like e-bike and subsidy schemes, PT fare integration and adjustments, and much, much more. This will all contribute further to the decarbonisation of Wellington.

Two of the eight significant moves are as yet unmodelled – the Wellington Regional Growth Framework and Regional Mode Shift Plan. These should not be minimised in their impact but for this analysis will not be quantified.

The Seven Initiatives

The Wellington City Spatial Plan and new District Plan
The new District Plan gives effect to the Spatial Plan, and focuses on urban density - more people living and working closer together. The aim is to maintain and build on our compact urban form facilitating this close-knit vibrancy. This reduces travel distances, leading to more travel on foot, by bike or by public transport, and overall lower carbon from moving differently around the city.

Impact: Tonnes of carbon (City): -6,603 tonnes per annum
Wellington City Carbon Impact Expected: -1.86%
Impact: Tonnes of carbon (Region): -53,180 tonnes per annum
Wellington Region Carbon Impact Expected: -4.59%
Source – Wellington Analytics Unit

The Wellington City bike network plan and transitional programme
The bike network plan has received LTP funding of $226 million, including transitional projects in the next 3 years to get improvements faster. This will transform cycling infrastructure in Wellington, integrating with City Streets to introduce a step change in active transport in Wellington – and address underinvestment in that space.

Impact: Tonnes of carbon(City): -1,497 tonnes per annum
Wellington City Carbon Impact Expected: -0.42%
Impact: Tonnes of carbon (Region): -1,497 tonnes per annum
Wellington Region Carbon Impact Expected: -0.13%
Source – WCC cycling model outputs
(Modelling note– Included in Programme due to City Streets influence)

The Greater Wellington Bus Electrification Programme
The Greater Wellington Regional Council's bus fleet upgrade programme aims to have a fully electric fleet before 2030 for Wellington, an achievement that will transform both the air quality and noise along all bus routes

Impact: Tonnes of carbon(City): -6,864 per annum
Wellington City Carbon Impact Expected: -1.93%
Impact: Tonnes of carbon (Region): -13,200 per annum
Wellington Region Carbon Impact Expected: -1.14%
Source – GWRC / Metlink

The Clean Car Programme
The Government's Clean Car Programme, through Waka Kotahi, will boost the speed of our transition to a zero carbon fleet. The programme provides standards and incentives to get safer, more carbon- and air quality-friendly vehicles on the road. If we are to reach our goals for the transition to a zero carbon future, the Clean Car Programme will be part of how we arrive there.

Impact: Tonnes of carbon(City): -5,015 tonnes per annum
Wellington City Carbon Impact Expected: -1.41%
Impact: Tonnes of carbon (Region): -12,446 tonnes per annum
Wellington Region Carbon Impact Expected: -1.07%
Source – Ministry of Transport

Priced Travel Demand Management
Congestion charging is on the table for discussion in Auckland and across New Zealand. In Wellington, the impact of a parking levy is now well-understood in terms of how it might influence outcomes – even more so than congestion charging. In either case, modelling for congestion charging shows significant potential to decrease carbon.

Impact: Tonnes of carbon(City): -18,000 – -58,000 tonnes per annum
Wellington City Carbon Impact Expected: 5-15% of total carbon emissions can be expected depending on form and settings.
Impact: Tonnes of carbon (Region): -53,000 – -174,000 tonnes per annum
Wellington Region Carbon Impact Expected: 5-15% as above
Source – TDM Workstream, WAU Modelling and Auckland Congestion Question

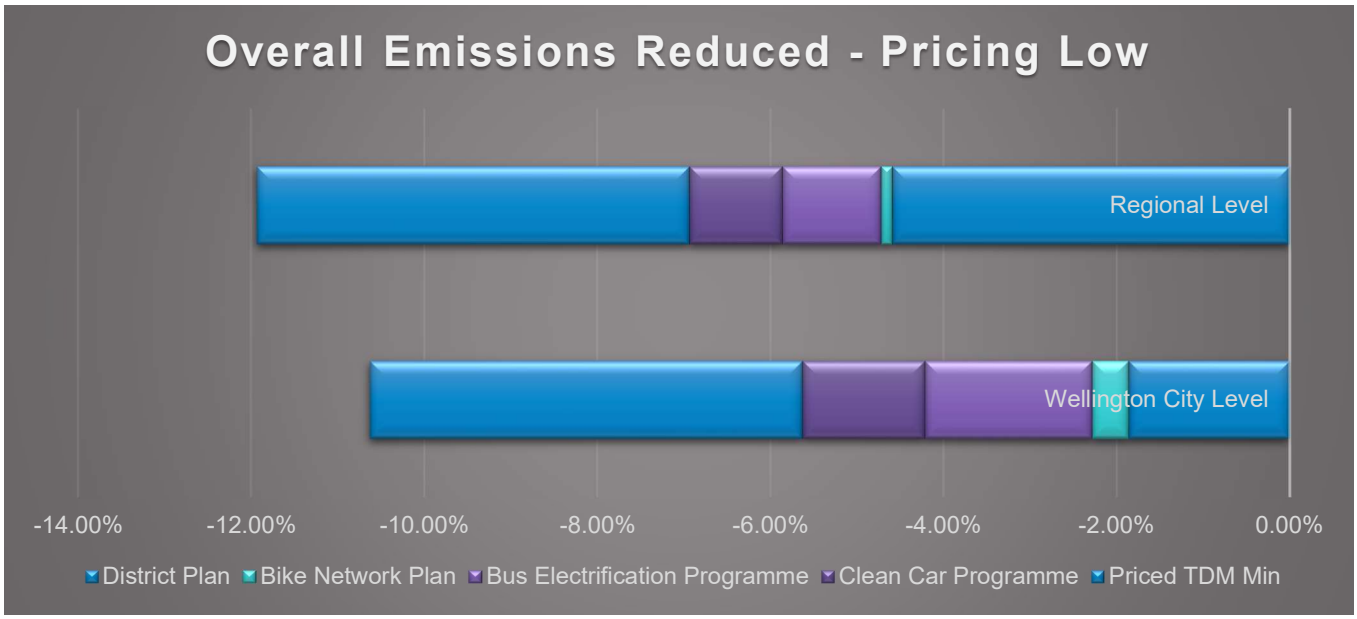
Let's Get Wellington Moving
Let's Get Wellington Moving represents the single largest potential transport investment in Wellington's history – and has the potential to transform the public and active transport networks across the city. The south and east would particularly benefit along the Mass Rapid Transit corridor, with City Streets, the Golden Mile and improvements to Thorndon Quay / Hutt Road are also key parts of the success of the transformation.

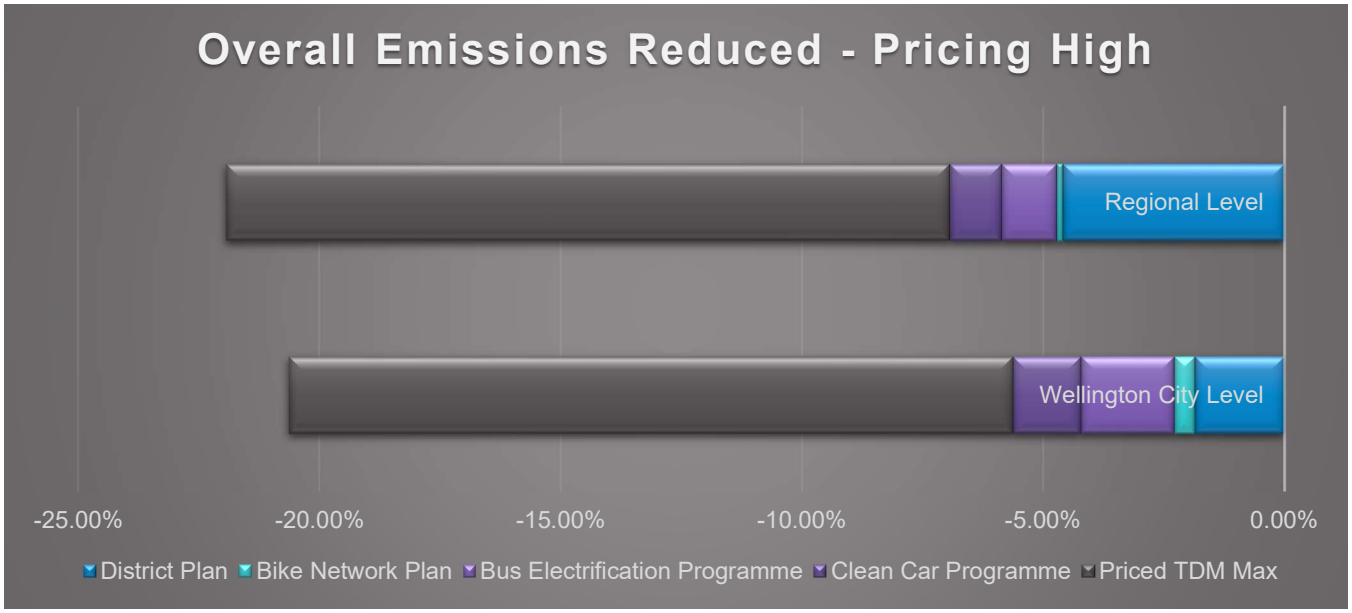
Impact: Tonnes of carbon(City): -5,721 tonnes per annum
Wellington City Carbon Impact Expected: -1.61%
Impact: Tonnes of carbon (Region): -5,271 tonnes per annum
Wellington Region Carbon Impact Expected: -0.45%
Source – Deloitte – MBCM Calculations

Integration is key

Integrating these initiatives will yield profound transformation for the city, and start us on our path to net-zero carbon – in fact the significant progress shown above is impossible without interactions between them. They should not, however, be viewed in isolation. They all need to be woven together to deliver the greatest benefit. That is – good decisions must be made on all initiatives to get the most out of each on its own.

Taking the example of the above, there are seven programmes yet all together their change within the Wellington City boundary adds up to about 10%-25% depending on the outcome of road pricing. This is not enough to meet the goals of the partners and not enough in isolation to do what is needed to reach our carbon goals. That is why each of the initiatives is important to get right – to make great decisions with for a zero carbon future.


Overall Emissions Reduced - Pricing Low
Regional Level
Wellington City Level
-14.00%
-12.00%
-10.00%
-8.00%
-6.00%
-4.00%
-2.00%
0.00%
District Plan
Bike Network Plan
Bus Electrification Programme
Clean Car Programme
Priced TDM Min

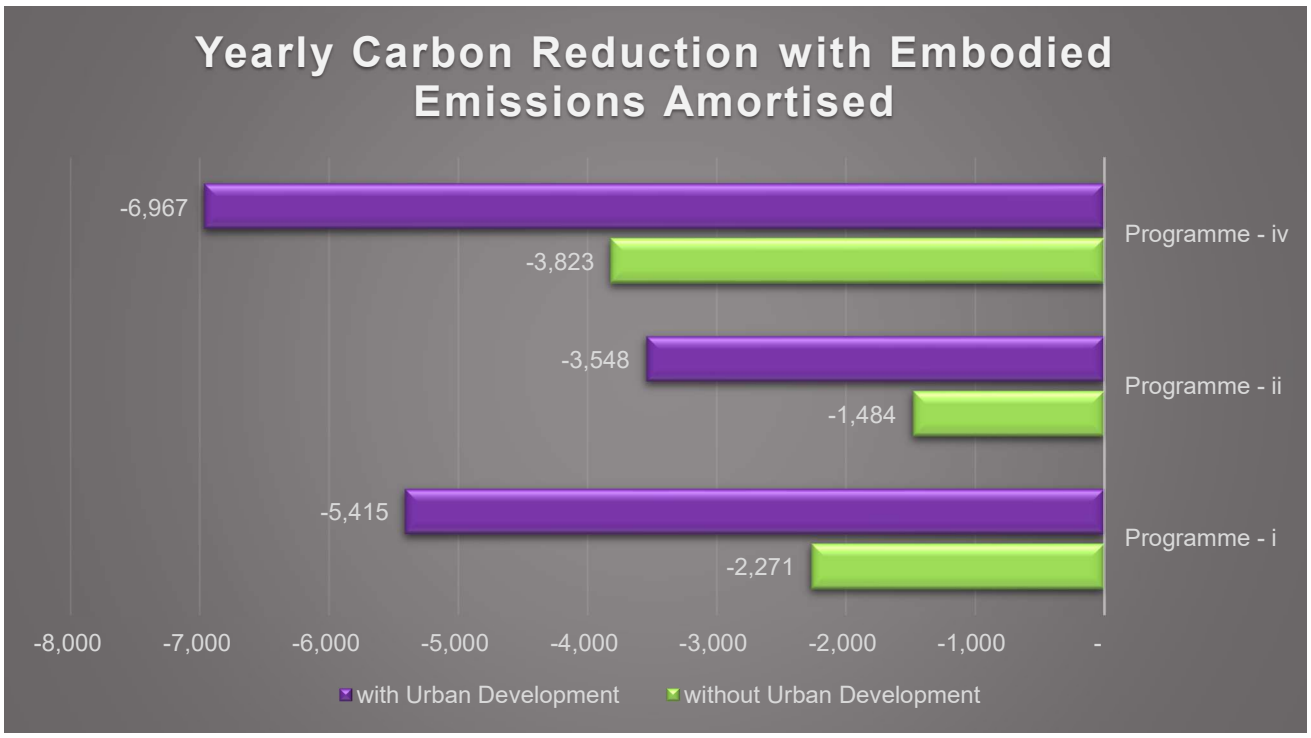

Overall Emissions Reduced - Pricing High
Regional Level
Wellington City Level
-25.00%
-20.00%
-15.00%
-10.00%
-5.00%
0.00%
District Plan
Bike Network Plan
Bus Electrification Programme
Clean Car Programme
Priced TDM Max

The Programme's Impact

NOTE: For the next section of analysis one thing must be kept in mind. Due to time limitations option 3 has not been analysed in as much detail as the other 3 options, because it scored lowest of the four options in the Multi-Criterion Analysis conducted for the Indicative Business Case

Below the annual carbon impacts for three of the four programme options as at FY2037 are presented with emissions from our transport model combined with embodied emissions amortised over 40 years. Alongside is presented the carbon impact provided the portion of urban development attributable to the programme option is realised, bringing the impact of the programme up to double what it is without urban uplift in two of three cases.

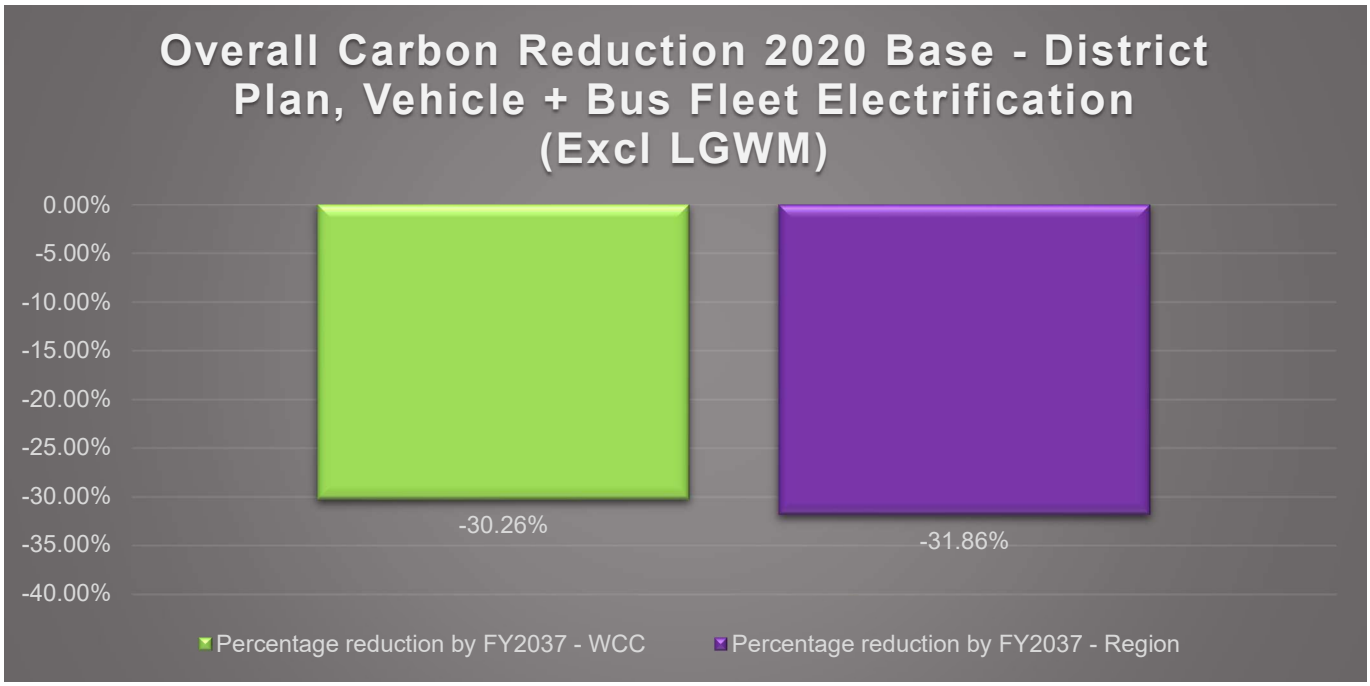
The programmes are expected to deliver meaningful annual carbon reductions.



Sources: Deloitte, Aurecon, WAU and WCC

Carbon reduction without the programme

Taking into account the transition in electric vehicles and the other key programmes we know will make a difference to emissions – the Bus Fleet Electrification Programme, the new District Plan in Wellington and the transition of the vehicle fleet along the lines predicted by Waka Kotahi's Monetised Benefits & Costs Manual with the Clean Car Programme factored in, we can expect a significant change in the carbon output of Wellington's transport system. Both regionally and locally, the emissions are expected to reduce by FY2037 to around 30% below FY2019 levels (As reported in AECOM's greenhouse gas inventories for the respective Councils done in 2020) as shown below.



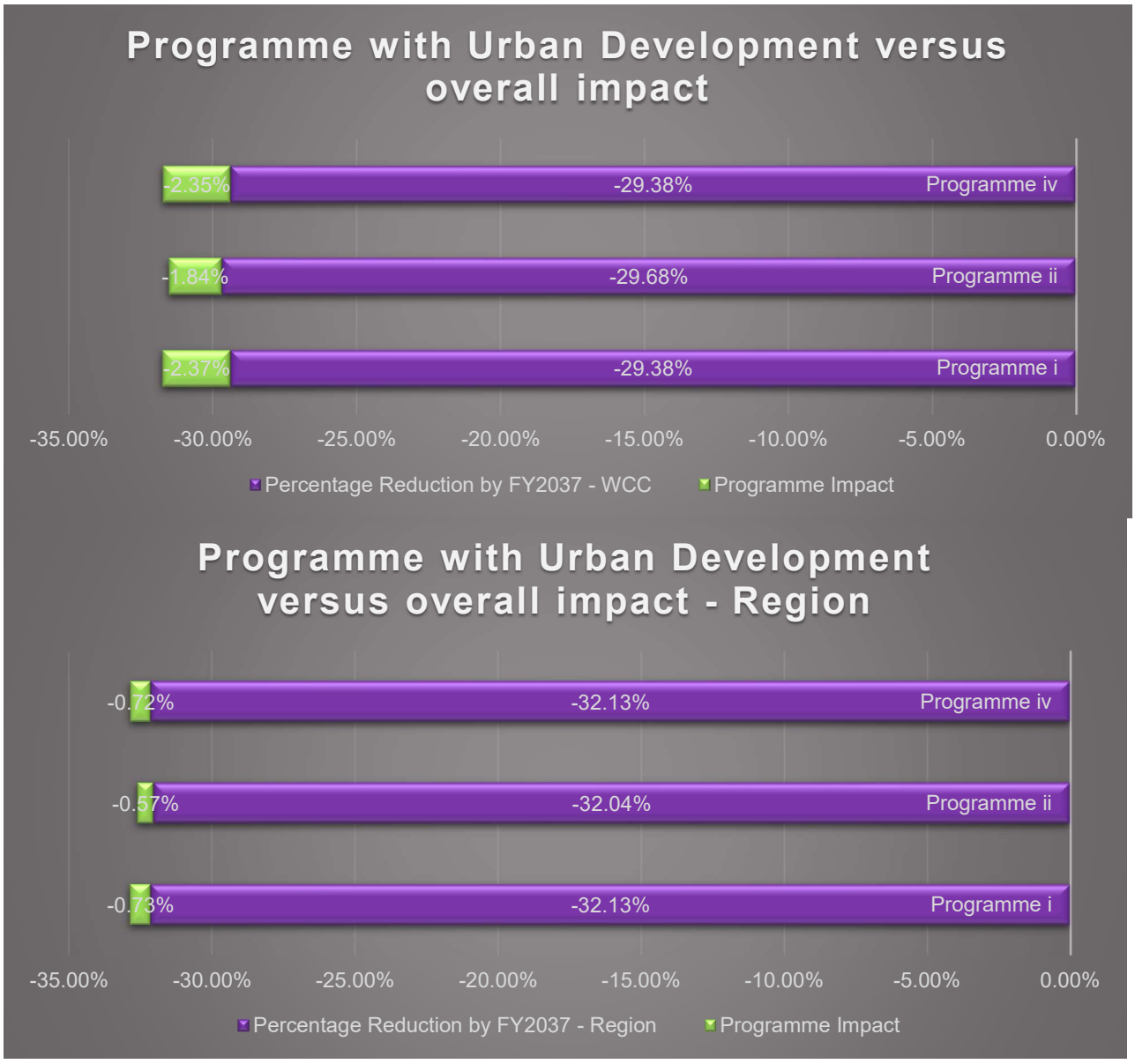
Sources: AECOM, WAU, Deloitte plus all indicated among initiatives.

This represents a very substantial reduction in emissions, however it does not indicate that in the transport sector Wellington City will meet its 2030 target of a 57% reduction in emissions. 2040 targets for Wellington City are also in question given the current trajectory.

Note: For this and the following graphs there are a number of key projects that are not accounted for. Rail to the north, Te Ara Tupua, public transport access and potential land use change across the region are among them. This should be kept in mind when considering regional emissions reduction progress without the programme.

The Programme

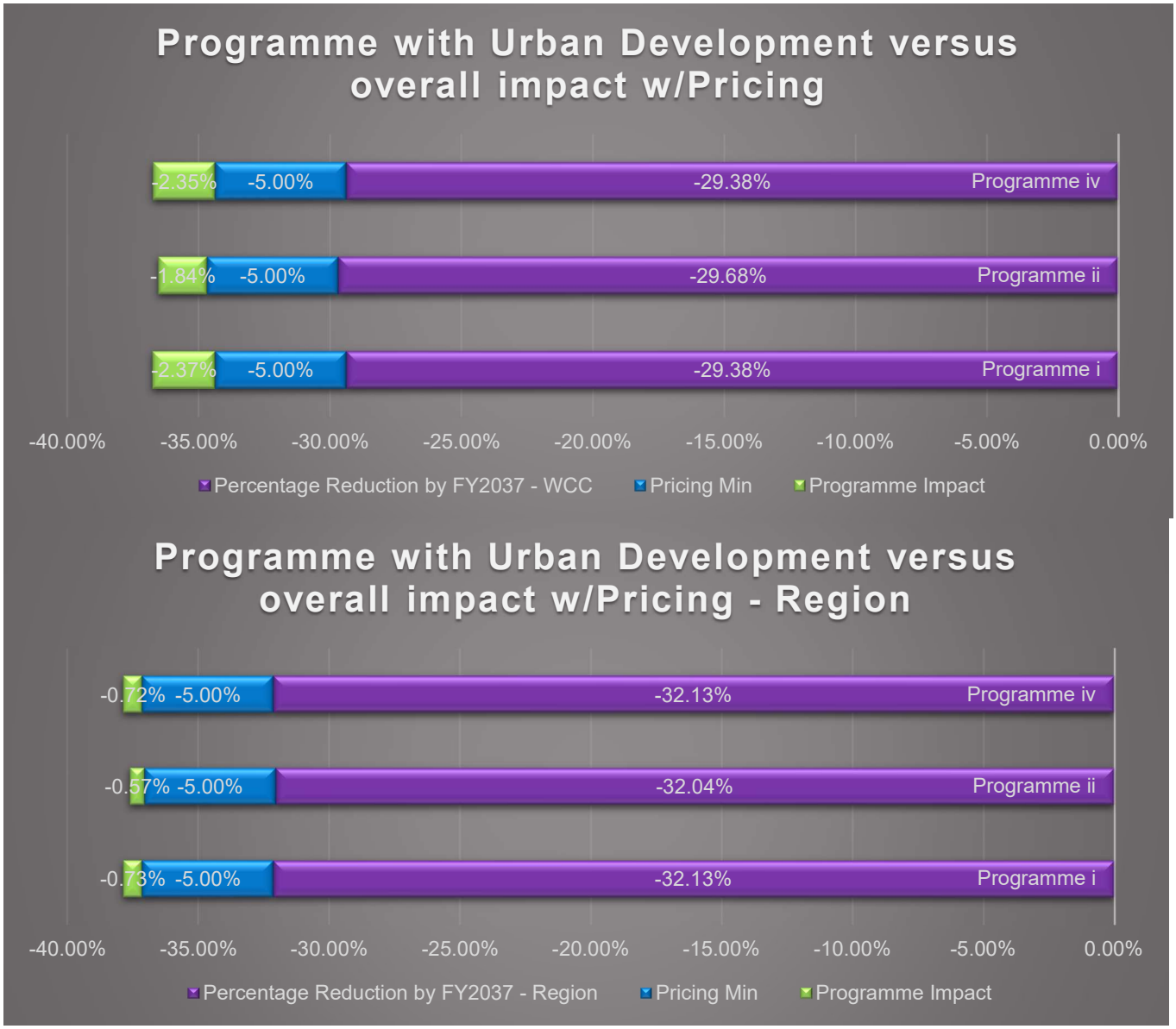
Layering upon this, for options i, ii and iv, the net impact of the programme is a further reduction in emissions, with option i delivering more than option iv, which in turn delivers noticeably more than option ii. The impact is somewhat limited but this should be read with the limitations section fully in mind – dynamic land use change, dynamic active transport modelling, and behaviour change are not accounted for in the model underlying these graphs. In addition, the impact without the programme largely accounts for a series of other programmes including the Bus Fleet Electrification, the electrification of the vehicle fleet, the new District Plan and others. Without a doubt, though, with the programme in place, emissions reductions are further enhanced.



Sources: Deloitte, WAU, AECOM, GWRC and WCC

User Pricing

Pricing adds another important layer to the emissions reduction story. With estimates as low as 5% of its impact and as high as 15% it is important to note that depending on the way you price, outcomes will change. We take a low estimate below to characterise how pricing might fit into this context. Clearly pricing will push the emissions reduction achieved further, even with the low end of impacts assumed. Combined with the programme pricing, it will produce a more noticeable impact that pushes the context into a range where it may make a significant contribution towards the 2030 RLTP target if pricing is implemented as part of construction management as opposed to implementing it at the end of the process. In either case – pricing goes hand in hand with the programme and will complement the emissions outcomes the programme delivers, whatever type of pricing is chosen.



Sources: WAU, Deloitte, AECOM, GWRC and WCC

Predicting enabled emissions through transport modelling

Enabled emissions are forecasted using Vehicle Kilometres Travelled (VKT) identified through transport modelling. Using VKT, carbon emissions from road users can be estimated based on assumed fleet composition, vehicle efficiencies and emission factors.

Based on the forecasted VKT in 2036, from the transport model, the LGWM programme on its own is estimated to reduce emissions by 1.5% relative to the do minimum option in Wellington City. When coupled with high land use, there is an additional 1% reduction.

Limitations of transport modelling

It is worth noting transport models – and in fact all approaches to understanding transformational infrastructure, thus our view that we must use them in combination rather than isolation – give an indication of "what might happen" based on a series of assumptions and historical travel behaviours that make them inherently conservative on what might change. Therefore, there are inherent uncertainties in the model relating to future changes in technologies, attitudes and behaviours, and policies and regulations[3]. Some examples of future changes that could lead to a step change in modal shift to active and public transport, and greater reductions in enabled emissions are provided below.

- City wide electric micro-mobility as a service (i.e. bikes, scooters, etc.) programmes providing greater accessibility and flexibility of active transport options.
- People's growing understanding of climate change and how their own behaviours play a part. Historically, carbon emissions may not have been a factor in human behaviours and travel decisions.
- Policy interventions like congestion charging.
- Passing the cost of carbon from driving ICE vehicles onto end users.

Although, to best enable the examples given above and drive significant changes in peoples travel patterns and habits, the supporting transport infrastructure needs to be in place. This is what LGWM will deliver.

How does Wellington compare with similar cities?

Internationally, cities have experienced mode shift success through the provision of supporting transport infrastructure. Prior to the LGWM MCA process, the Wellington City Council (WCC) team explored 15 European cities (with roughly Wellington's population and density, and many with similar terrain challenges) for their relative active and public transport investment per mode split[4]. One of the output graphs from this analysis is shown in Figure-1 and presents the mode shift potential achievable by Wellington city if mode shift supporting infrastructure is prioritised.

[3] Draft LGWM MRT and SHI Modelling Programme and Package Modelling Report, MRT and SHI Team, Wellington Analytics Unit, 2021

[4] Comparing Cities: Greenhouse Gas Emissions and Transport Realities, Wellington City Council, 2021. For more information on this work please contact Tom Pettit at WCC.

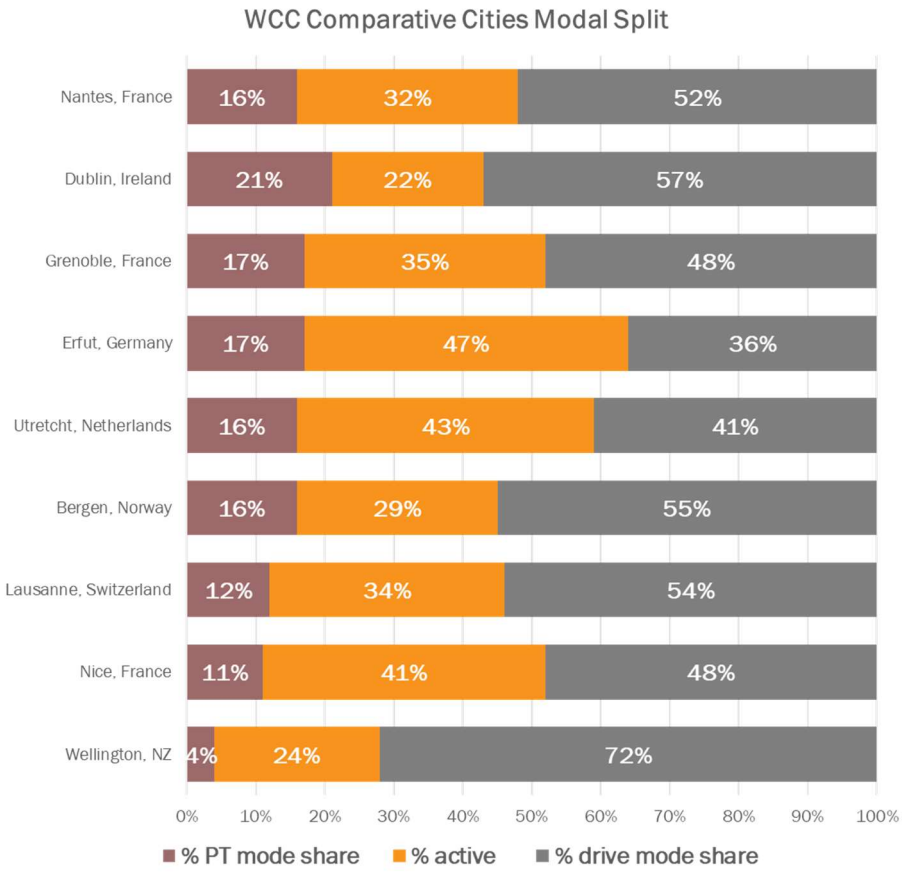


Figure-1 Wellington City Council's Comparative Cities Research Findings

Assessing the impact different LGWM programme options could have on carbon emissions from an investment point of view

Transport interventions have different emissions-enabling or emissions-reduction potential. For example, Mass Rapid Transit (MRT) systems provide opportunities for mode shift and behaviour change. It is proactive infrastructure that policy enablers can then further enhance.

There needs to be investment in this enabling, proactive infrastructure first; to then generate mode shift, urban form development, and behaviour change. LGWM will deliver proactive infrastructure.

A tool developed by Waka Kotahi was used to assess how the LGWM programmes might impact enabled emissions. Waka Kotahi's qualitative Carbon Assessment Tool for investments (CATi) classifies investment by its potential to influence transport related carbon emissions as outlined in Figure -2. Investments are classified as either climate positive (has potential to reduce emissions), climate neutral, or climate negative (has potential to increase emissions).

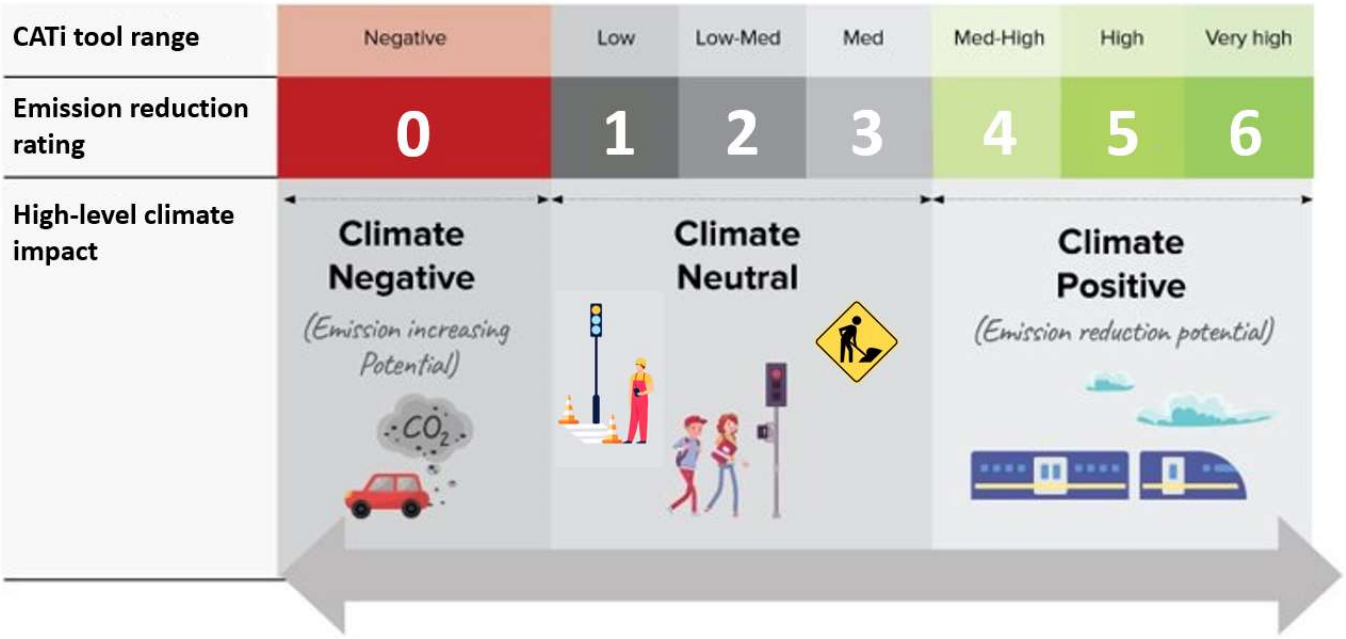


Figure -2 Kotahi's Carbon Assessment Tool for investments (CATi): Investment classifications

Assessing LGWM with the CATi tool found all four shortlisted programme options have high proportions of the overall spend going towards climate positive infrastructure as shown in Figure-3 and summarised below. Appendix 2 presents a summary of the LGWM MCA Carbon Assessment Results.

- **Climate Positive** investments that could reduce emissions by enabling behaviour change and mode shift to lower emission forms of transport. For the LGWM shortlisted programme options, this includes light rail or bus rapid transit, network wide active transport infrastructure, and improvements to public transport service (through frequency, efficiency, and reliability).
- **Climate Neutral** investments to maintain current emissions through supplementary transport infrastructure that is neither likely to increase emissions through greater private motor vehicle (PMV) use or reduce emissions by enabling behaviour change at scale. For LGWM, this includes improvements to localised walking and cycling facilities, enhanced bus services, and road safety.
- **Climate Negative** investments that could increase emissions by further enabling PMV use, through the development of new roads, enhancing of existing roads, or any increase in road capacity. For LGWM, this includes the enhancing of existing roads around the Basin Reserve and through the Mt Vic Diagonal tunnel. Despite relatively equal PMV capacity, there will be benefits to PMV road users, including new infrastructure, more direct route, and improved experience. This is also a limitation of the CATi tool, which is further explained in Appendix 2.

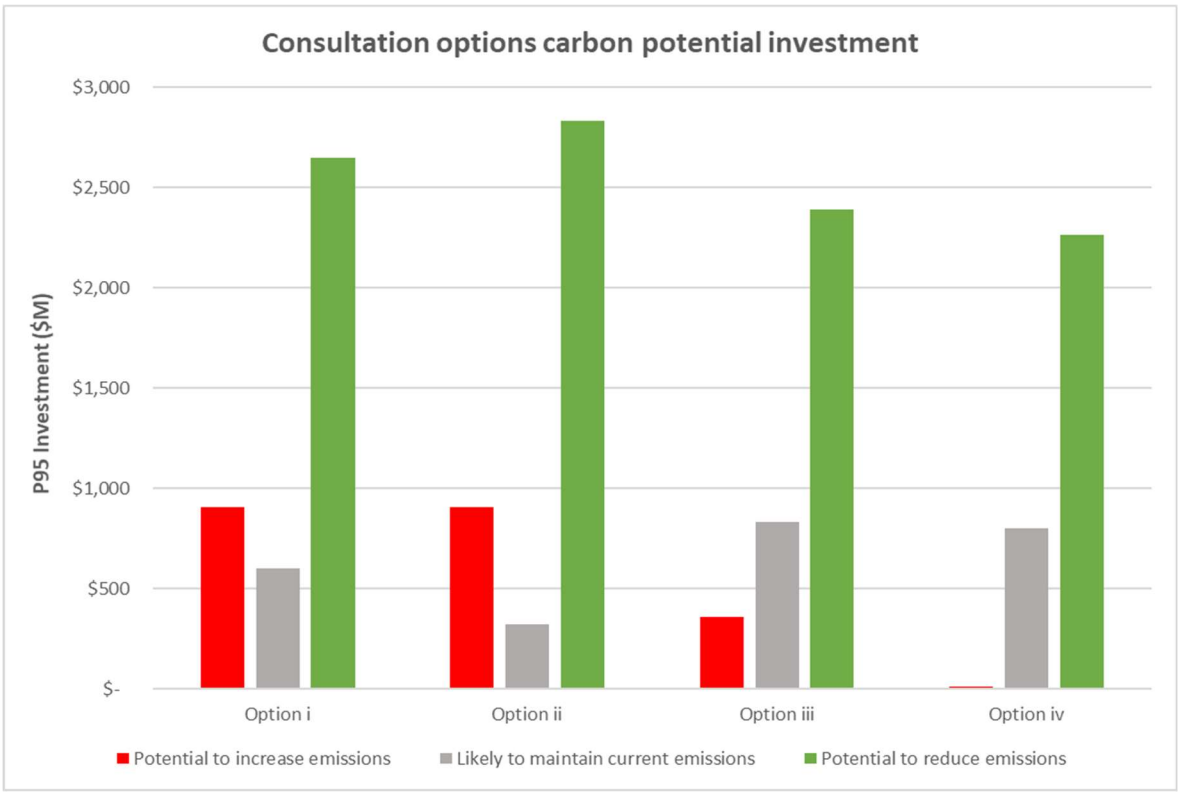


Figure-3 – Assessment of LGWM shortlisted programme options using CATi tool

How could an uplift in urban form impact emissions?

Improved infrastructure – particularly new forms of infrastructure – increase the accessibility of the land around it, which tend to make it more attractive to more people, and therefore, more valuable. More valuable, more accessible land is more likely to change in use, with denser development of residential and commercial space.

LGWM is expected to unlock urban development and increase housing densification in Wellington. Densification of brownfield central locations can drive an even greater decrease in carbon emissions. This is because a greater proportion of Wellingtonians can live, work and play in smaller geographical areas, which also have safe and convenient active and public transport options to access:

- Employment opportunities.
- Social infrastructure (i.e. childcare facilities, libraries, sporting facilities, schools, parks, cafes, etc.).

By providing the right built environment up front, LGWM can provide Wellingtonians with housing choice in locations that support new travel habits and mode shift. This results in reducing carbon emissions.

How much does the construction of the infrastructure contribute towards emissions?

As mentioned above, enabled emissions (i.e. vehicles using the transport infrastructure) are the most significant source of emissions across the lifecycle of the infrastructure. 'Embodied' or 'embedded' emissions are those 'locked in' during the construction of the asset. These emissions come from three main sources:

- Material creation / manufacturing process.
- Transport / delivery to the project site.
- Construction fuel and energy use.

Embodied emissions tend to make up approximately 5 – 20% of the total emissions of the asset's lifecycle. While carbon intensive materials such as concrete and steel are responsible for a large proportion of these embodied emissions. Construction fuel use is commonly the second highest contributor of embodied emissions.

Therefore, transport interventions with large volumes of concrete, steel, and/or intensive construction methodology will have higher embodied emissions. For example, projects involving tunnels require large amounts of concrete, steel, and construction fuel use, and will tend to have embodied emissions closer to 20% lifecycle emissions. Whereas, a standard road with minimal concrete and steel (comparatively) will have embodied emissions closer to 5% lifecycle emissions.

Calculating embodied emissions requires accurate data from the materials manufacturing process, delivery method and distance, and construction fuel use. These parameters are unknown in the business case stage of a programme. Therefore, the calculation of the LGWM embodied emissions are very high-level estimates based on industry assumptions and previous project knowledge. The order of magnitude estimates of the embodied emissions from each of the four shortlisted programme options are presented in Figure-4. Because of the high-level nature of these estimates, they were only used to provide a relative scale between the programme options. Appendix 2 presents a summary of the LGWM MCA Carbon Assessment Results.

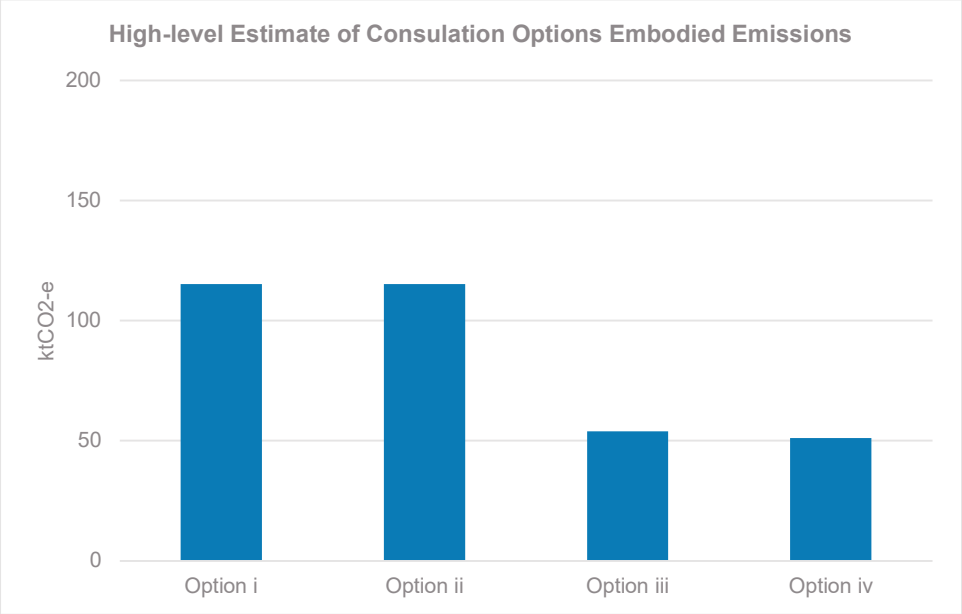


Figure-4 – Order of magnitude estimates of embodied emissions for the four shortlisted options

Limitations

Constraints of Analysis

All of the tools we have used to analyse carbon emissions for the Indicative Business Case stage are sufficient to give us a general direction of travel – we know that carbon emissions outcomes will improve with LGWM in place. However, they each are subject to certain assumptions and limitations. These include how they handle information that is not Wellington-based, whether they focus on outcomes or inputs, and other assumptions that stretch the reaches of the possible for these tools and models.

It is important to note that all of these tools and models provide insight but are inherently constrained in a way that likely makes them conservative (transport modelling) or optimistic (comparative cities modelling) when it comes to understanding transformative investments like LGWM.

Further work will be required to enhance our understanding at the Detailed Business Case stage, but the current stage has yielded a number of useful insights. The key insight is that carbon will be reduced by hundreds of thousands of tonnes over the 40 years after the project opens, with potential for more if the transport model is conservative as predicted.

Appendix One

LGWM MCA Carbon Assessment Methodology

The carbon analysis was split into Enabled carbon (user emissions) and Embodied carbon (construction and materials emissions) for the high-level MCA of programme options.

Enabled emissions

Enabled Carbon emissions have been assessed using the Waka Kotahi Carbon Assessment Tool for investment (CATi). The extent to which the different components of each Programme Option contribute to emissions increases or reductions has been identified. This is a sifting tool, based on the InterAmercian Development Bank transport infrastructure investment categories and services that align with Waka Kotahi project categories.

By comparing the relative investment options spend between negative 'potential to increase emissions', neutral 'likely to maintain current emissions growth', and positive 'potential to reduce emissions', it is possible to understand the emissions implications of different option configurations and support better investment decision making.

CATi is being used as the primary evaluation of the Programme options. This primary evaluation is moderated by influencing factors for options in 2036:

Fleet Emissions – including modelled Vehicle Kilometres Travelled (VKT), proportion of electrification of fleet, and fuel consumption impact of congestion

Active Transport Enabled – including spend on active transport and cars off local city streets increasing active transport safety

These influencing factors have been used as a sensitivity test using existing modelling and assessment to inform expert judgement.

Embodied emissions

The embodied carbon analysis was high level estimation of Programme options using estimation of quantities of key high emissions materials such as concrete and steel. The proportion of the emissions for each programme option was reviewed against industry standards and similar projects to sense check the high-level estimation. The proportional difference in embodied emissions was used to complete the assessment.

The three elements of embodied carbon considered for this assessment include:

- Material creation / manufacturing process,
- Transport to the site, and
- Construction methodology (high level estimation of fuel/energy usage during construction).

WAKA KOTAHI
NZ TRANSPORT AGENCY

Greater Wellington
Te Pane Matua Taiao

Absolutely Positively
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