The TX28 Fund

Preparing your application

Integrated transport emission modelling framework to decarbonise Australian transport networks

August 01, 2024

The Power of Commitment

1. Team details

1.1 Name(s) of any team members, collaborators, or external contributors

- *Your application may involve multiple Service Lines, but for the purposes of the application, please select the most closely aligned Service Line.*
- *TX28 Fund applicants should be registered members of a Service Line. To self-select your Service Line(s), follow **these instructions**. To see a list of current Service Line Leaders, click **here**.*

Team members	Role in the Project
Phil Guo	Lead Traffic Modeller
Ying Wang	Lead Research Analyst
Dr. Eleanor Short	Technical Reviewer – Transport Decarbonisation
Ravi Singh	Sustainability Lead

Supporting members	Role in GHD
Owen Peel	Business Group Leader – Traffic Engineering and Transport Planning
Mike O'Neill	Business Group Leader – Sustainability and Climate
Dr. Eleanor Short	Senior Technical Director – Transport Decarbonisation
Erin Jackson	Mobility Leader – Australian Transport Market
Rebecca Want	Market Leader – Transport
Charlotte French	Service Line Leader – Transport

2. Describe your project

Use this space to explain what the project is, the deliverables/outputs, resources required, each person's responsibilities and how you will track progress. Also, please provide evidence that you have consulted widely in preparing the request (e.g. with TSLs, SLLs, MLs, CRMs, Technical Directors).

*Applicants seeking to complete technical investigations or research studies may consider staging their application. Often applicants will complete an initial investigation during 'Stage 1,' with 'Stage 2' funding dependent on the successful completion of Stage 1. Stage 2 will build upon, detail or publish the work completed during Stage 1. **If your project would benefit from this approach, you may submit a single application**, but please be clear about work that will take place in each stage, and associated budget.*

2.1 Project Summary:

The structural decline of internal combustion engine (ICE) vehicles powered by fossil fuels in recent years along with a projected growth of A$260B in global autonomous market by 2030, indicates the enormous potential of Zero Emission Vehicles (ZEVs) to assist Australia to meet its climate targets as well as to provide a cleaner and safer future transport system. To estimate and quantify the impact of ZEVs in decarbonising our transport sector, an advanced transport emission modelling framework within a simulation environment is essential.

This study proposes developing a novel emission modelling framework that combines PTV Vissim with Bosch Environmentally Sensitive Traffic Management (ESTM) for emission modelling. The study will further investigate the applicability of the proposed framework considering two case studies.

The outcome of this study will establish the benchmark for transport emission modelling in Australia based on associated market penetration of ZEVs. The framework could be further enhanced towards evaluating different decarbonising strategies of fleets of electric public transport vehicles, shared mobility services and other future mobility options.

This project is strongly aligned with GHD's Future Communities initiatives, specifically both transport decarbonisation and mobility, with a focus on reducing emissions from transport and changes in how people travel in future. A series of extensive discussions were held during the preparation phase of this proposal through cross-regional and cross-role consultation with BGLs of related business groups (e.g. Traffic Engineering and Transport Planning, Sustainability and Climate), market leads, and other areas of the business.

To the best of the project team's knowledge, this would be the first integrated modelling framework that combines traffic model along with emission model for a transport network that considers ZEVs and ICE vehicles in an Australian context. Such integrated modelling frameworks will play a crucial role in evaluating different decarbonisation strategies in the transport sector and significantly contribute towards enabling Australia to reach the target of net-zero emissions by 2050.

2.2 Project Description and Objectives:

Transport emissions are the second largest contributor to greenhouse gas emissions in Australia, expecting to be the largest by 2030. We have more than 20 million registered vehicles for 18.7 million licensed drivers. This massive number of registered vehicles on road has cost more than 1,100 deaths due to crashes in 2021 along with contributing to 6,800 hospitalisations with respiratory issues and 66,000 cases of childhood asthma each year (Climate Council of Australia Ltd, 2023).

Given the accelerating pace of climate change, there has never been more urgency to dedicate our time and resources to swiftly counteract this trend and limit global warming. One effective approach is to adopt informed decarbonisation strategies within the transportation sector. To determine the viability of such strategies, it is crucial to establish robust evaluation frameworks that can assess the potential impact of various future mobility options on our transport networks. The purpose of this study is to contribute to the development of such evaluation frameworks by utilising transport emission modelling techniques that incorporate Zero Emission Vehicles (ZEVs), Connected Autonomous Vehicles (AVs), and traditional legacy ICE vehicles.

Based on the review of existing body of literature in transport emission modelling, the following gaps have been identified to be crucial:

– Transport emission models involving upcoming future mobility options such as ZEVs combined with legacy ICE vehicles have not been developed for transport networks in Australia.
– Evaluation frameworks for assessing fleet decarbonisation strategies are non-existent for multi-class transport networks with ZEVs in Australia.

With an attempt to bridge these gaps, the following objectives are proposed for this study:

1. Develop a multi-class traffic flow model involving ZEVs and ICE vehicles to assess the impact of mixed vehicular interactions in transport networks.

2. Establish a transport emission modelling framework to estimate the environmental impact of ZEVs with respect to their market penetration.
3. Investigate the applicability of the developed framework considering two case studies.

2.3 Research Methodology:

In this study, we propose to develop a multi-class microscopic (fine scale) traffic flow model involving ICE Vehicles and ZEVs. The ICE vehicles are regular fossil-fuelled vehicles whereas ZEVs are zero emission electric vehicles. The traffic flow will be modelled using PTV Vissim, a microscopic multi-modal traffic flow simulation software.

We proposed to undertake this project in the following two technical streams.

2.3.1 Technical Stream 1: Model Development

In this Technical Stream, a multi-class microscopic traffic flow model will be developed along with a framework for assessing emissions in the Australian context. We will assess the emission measurement (e.g., relative CO_2 per km per vehicle) in two case studies (two different locations) of urban road network in New South Wales based on the following:

– Existing vehicle class and fleet (e.g. based on traffic surveys)
– Assumed electric vehicles and connected autonomous vehicle penetration rates up to two horizons within the scope of work.

The study will further include:

– Projection of the realisation and penetration of ZEVs in Australia, based on the existing literature (e.g. Austroads and the NSW Government's Future Transport Strategy)
– Literature review on the international research on ZEV operational characteristics, concerning driver behaviour and operational traffic modelling, including the key modelling parameters tested in CoEXist Project funded by the European Union's programme (PTV 2020).

This Technical Stream will involve two steps as described below.

2.3.1.1 Traffic performance assessment

In this step, the traffic performance will be assessed with different ZEV percentages in the network. GHD has previously undertaken research on the transport network performance with assumed penetration rates, including average vehicle speed, vehicle travel time and number of stops etc. This could be used as a basis for this project.

Figure 1 and Figure 2 present the outcome of the previously developed Proof of Concept study at GHD.

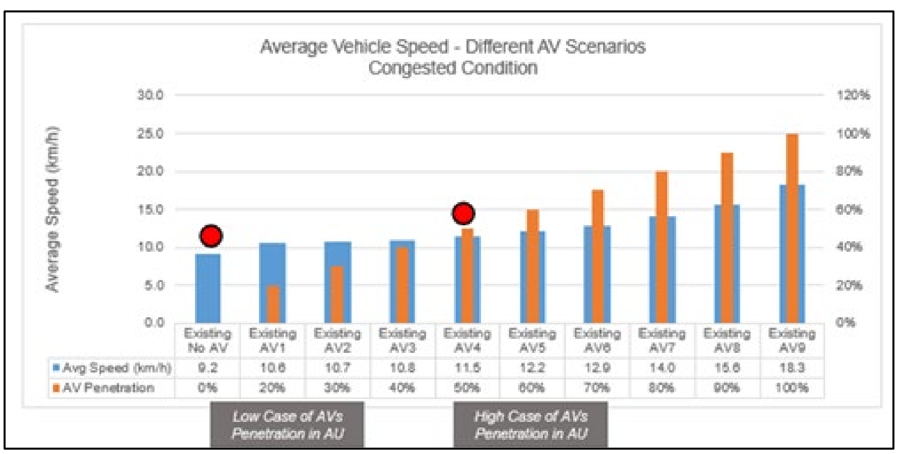

Figure 1 *Average vehicle speeds in congested conditions in different AV scenarios (Source: GHD)*

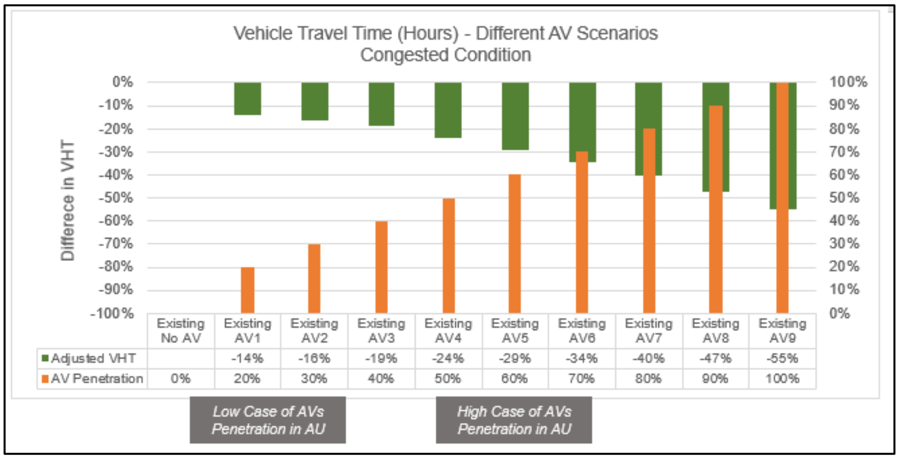

Figure 2 *Average vehicle travel times in congested conditions in different AV scenarios (Source: GHD)*

2.3.1.2 Calibration of Emission Class Distributions

In this step, the model developed in the previous step will be calibrated to refine the existing Emission Class Distributions to fit Australian fleet parameters. The existing emission class module provided in PTV Vissim is based on the European fleet composition and features (refer to Figure 3).

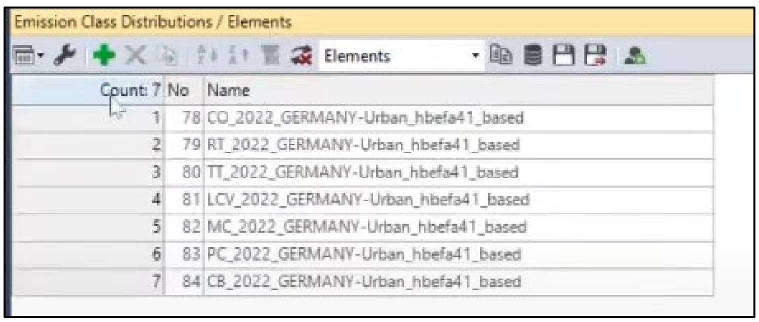

Figure 3 *Existing Emission Class Distributions in PTV Vissim*

Prior to assessing emissions savings through PTV Vissim, our traffic and sustainability specialists in the team would undertake research to refine the fleet parameters to fit Australia local traffic conditions and align with the recently announced national New Vehicle Efficiency Standards (NVES).

2.3.2 Technical Stream 2: Case Studies

In this technical stream, two case studies will be developed to demonstrate the commercial value of the integrated traffic and emissions model. We will further expand the microsimulation traffic modelling (with detailed interactions between vehicles) with the impact on the emission using the BOSCH module embedded in PTV Vissim with the updated Australian fleet characteristics.

The difference in emission impact will be estimated based on a single confined network (e.g. urban road corridor with traffic controls including traffic signal), for each of the case study. The emission parameters would include CO_2, NOx, small particulates etc. The locations of the network where the emission impact has been captured would be highlighted, through different vehicle driving behaviours changes and network schemes that may result in emission reduction. These changes in driving behaviours and network schemes might include:

– higher ZEV penetration rates
– reduced acceleration requirement due to ZEV technology
– network schemes e.g. safe speed zone and coordination of traffic signals.

Figure 4 and Figure 5 present the outcome of a transport emission modelling study in Stuttgart, Germany using PTV Vissim with Bosch module.

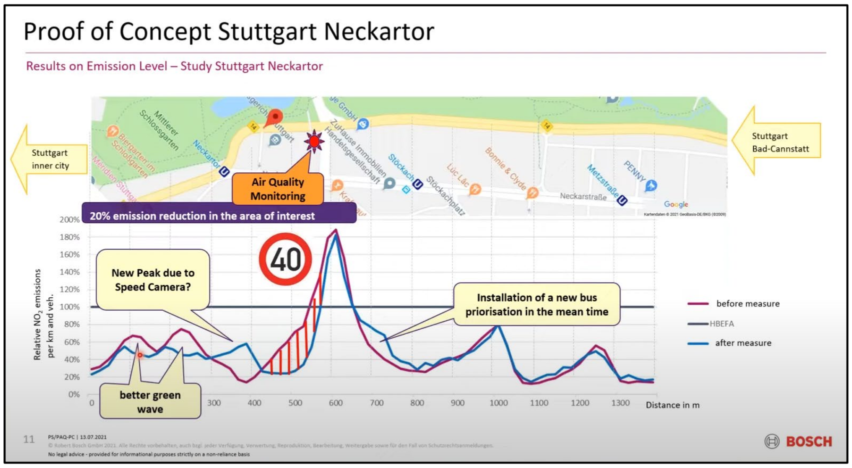

Figure 4 *Example case study using PTV Vissim with BOSCH – Stuttgart*

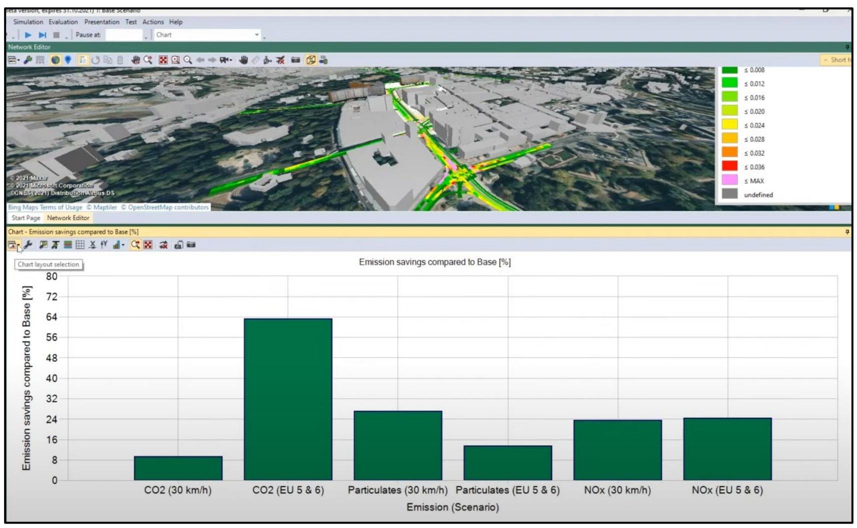

Figure 5 *Emission modelling simulation environment using PTV Vissim*

The outputs from both Technical Streams would enable the policy makers (e.g., Transport for NSW) to have evidence-based information on how the ZEV take up in Australia would relate to sustainability (e.g., climate change) based on emission reduction measurements. We will also consider how the outputs from this Technical Stream could be utilised for market opportunities with state agencies (e.g. TfNSW, DTP) and research partners (e.g., iMOVE) to undertake further related work.

2.4 Program

We propose that the Technical Stream 1 would take around 8 weeks and Technical Stream 2 would take around 4 weeks to complete. Including an overall review process of 2-3 weeks, we propose a timeframe of 14 weeks to drive this project to completion (20% - 30% FTE of project team). The following program provides detailed timeline of this project with associated deliverables.

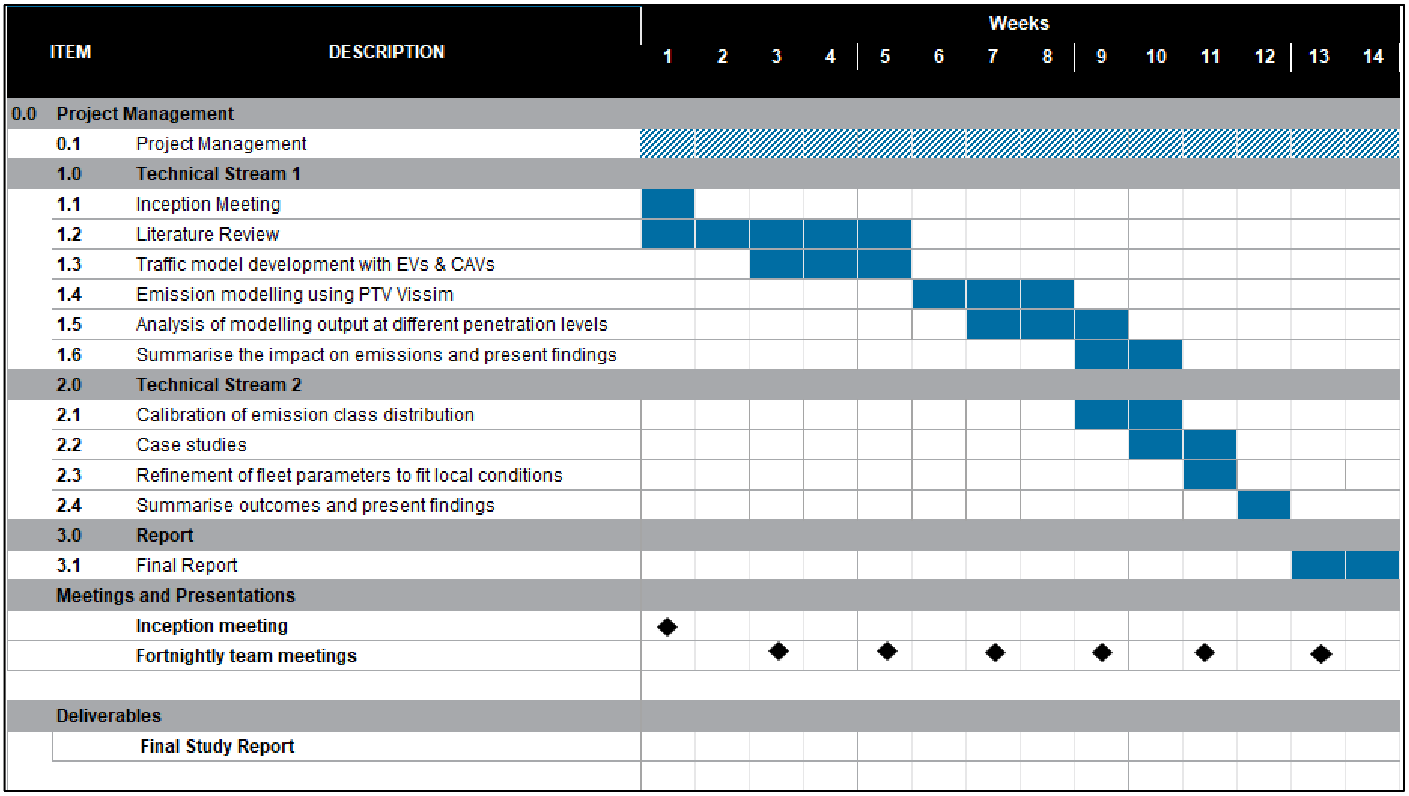

Figure 6 Project program

2.5 Project participants and resources

Our project team has the skills to deliver the project. We have supported the delivery of several projects with transport authorities across Australia, using the similar approach of microsimulation modelling which enabled vehicle-to-vehicle interaction within a simulated environment. We have also undertaken the assessment of transport network impact with autonomous vehicles fleet in PTV Vissim.

Phil Guo | Lead Traffic Modeller | Project Manager

Phil will oversee all day-to-day project activities and will be responsible for the overall success of the project.

Phil has over 15 years' traffic engineering, planning and modelling experience including major corridor traffic study, motorway operational assessment, precinct traffic study, local traffic impact assessment and toll road forecast. Phil specialises in the application of a variety of modelling packages and has undertaken the case studies regarding the impact on network congestion. He has been seconded to RMS and TfNSW for traffic model review and assurance of major projects including Western Sydney Harbour Tunnel and F6. Most recently, he undertook the PM role of Road Network Strategy for Northwest Growth Area and Western Sydney Employment Area, including the detailed traffic modelling on Richmond Road, Townson Road and Southern Link Road.

Phil is passionate about assessing the future impact of autonomous vehicles and have undertaken research and published the findings on Modelling of Autonomous Vehicles impact on congested urban road network with PTV User Group Meeting.

Ying Wang | Lead Research Analyst

Ying will drive the research component of the study and will be the key contributor for developing the emission modelling framework.

Ying has over 14 years of experience in transport modelling, planning and traffic engineering with expertise in travel demand prediction and forecasting, transport network analysis & traffic flow optimization and statistical analysis. She is an experienced transport modeller and has been seconded to TfNSW for providing his expertise in delivering robust reviews of their strategic and operational models. Ying also specialises in the application of a variety of modelling packages (micro-, meso- and macroscopic) such as Aimsun, Vissim. She provides data-driven insights to optimize transport networks and promote sustainable, low-emission mobility solutions.

Dr. Eleanor Short | Technical Reviewer – Decarbonisation and Sustainability

Eleanor will be the Technical Reviewer of the project providing technical guidance to the project team.

Eleanor is a highly capable and adaptable manager with 18 years' experience combining both technical transport planning and Zero Emission Vehicle (ZEV) expertise, with skills in successfully leading a wide range of multi-disciplinary projects and teams. She led the development of the Zero Emission Bus (ZEB) Transition Plan for Transport Canberra and recently worked on a project for Austroads looking at the impact of future ZEV freight and ZEBs on the road network to provide an evidence base to support road managers in their decision making. Eleanor has a background in multi-modal and place-based transport planning, and a strong focus on travel demand management and modal shift to sustainable modes.

Ravi Singh | Sustainability Lead

Ravi will lead the sustainability component of the project providing his technical expertise in identifying the impact of the emission modelling framework towards a sustainable transport future.

Ravi has over 6 years' experience in sustainability and decarbonisation across the UK, Europe, and Australia. Ravi is specialised in greenhouse gas emissions modelling and forecasting, techno-economic analysis of decarbonisation options, net-zero roadmap and implementation planning, policy development and action plans, and feasibility and market assessments. He has worked with private and public sector clients to develop and advise on low carbon and renewable energy decarbonisation projects across a range of sectors including the hydrogen, built environment, agriculture, transport, sustainable finance, mining, and smart energy networks. He also has experience in climate resilience analysis, and non-carbon related sustainable design including water, waste, biodiversity, and materials for the built environment.

3. Project Benefits

Use this space to describe the benefits to GHD, to the Technical Services portfolio, to your Service Line, to your own professional development and broader industry.

3.1 Market Opportunity and Impact

The global sale of fossil fuel-powered vehicles is in structural decline, having peaked at 86 million sales in 2017. In 2022, one in every seven passenger cars sold around the world was an electric vehicle, up from one in every 70 in 2017. Automation in the transport sector is gaining more attention than ever to minimise human inputs and exploit transport resources in an efficient and sustainable manner. This growing attention in automation translates to a projected growth of A$260B in global autonomous driving market by 2030. These unprecedented developments in transport industry in recent years, coupled with Australia Government's set target of net-zero emissions by 2050 have created a huge market opportunity for transport researchers/professionals to contribute to the expedition towards a cleaner and safer future transport.

Through advanced transport emission modelling of our transport networks with ZEVs, this study will establish the feasibility of combining two modelling platforms: traffic flow modelling and emission modelling, in decarbonising our transport sector.

The outcome of this study will be impactful as follows:

1. This study will provide a platform to evaluate how transport emission levels are impacted based on market penetration of ZEVs in Australia.
2. The two case studies, tailored for the Australian transport network context, will determine the applicability of the modelling framework in real transport networks.
3. The proposed transport emission modelling framework can be further extended into areas such as fleet decarbonisation of electric buses and other shared mobility services.

3.2 Pathway to Impact

One of the key challenges of decarbonisation is understanding the various pathways towards net zero and how these apply in the Australian context. The emission modelling framework proposed in this study would equip policy makers with a tool to assess pathways corresponding to ZEV adoption. The policy makers would include Transport for New South Wales, Department of Planning, the Federal Government (especially in the context of freight) and various organisation that requires to make decision on transport related decarbonisation.

Analysis completed in the UK shows that even with accelerating rates of ZEV uptake, there is still a significant gap which needs to be addressed to reach net zero by 2050, and that a wide range of other actions need to be taken in the short and medium term to decarbonise transport. This project will be critical in helping illustrate the impact of ZEVs in the journey to net zero and highlight any gaps which will need to be considered and addressed by policy makers.

The primary outputs of the project are a new modelling framework as well as case studies that practitioners can use to apply to future analyses. Communication of the progress and result of the project are essential to ensuring access of the novel tool for practitioners. This will be achieved through several meetings with key stakeholders and clear documentation and guidance on the new technology that is developed within the study. The project team will aim to present the findings of the study at national conferences (e.g., AITPM, iMOVE).

The outcome of the study would also be presented to Future Communities, Future Energy and GHD Sustainability Way through the following activities such as GHD's newsletter, lunch and learn, and a bespoke writing of the findings to be used in relevant tenders, to enhance the cross-sector and external business development.

In addition, our project team will further focus on publishing the findings in the academic domain providing greater rigour to the established framework. This demonstrates that we have both modelling expertise and a network for the distribution of the technology creating an environment to maximise impact throughout industry. Ultimately, this progress will yield better decision making related to Climate Change policy and lead to a more sustainable society.

3.2.1 Addressing user emissions in transport infrastructure projects

Transport emissions are considered in terms of embodied emissions (from construction and disposing of infrastructure), operational emissions (from energy) and user emissions (from vehicles). User emissions account for the vast majority of transport emissions. Whilst progress is being made in consistently measuring and seeking to manage embodied carbon, user emissions are further behind in many cases. For example, a recent tender from the Department of Climate Change, Energy, Environment and Water (DCCEEW) in NSW included Phase 1 focused on operational emissions but did not include user emission until Phase 2 in 2025/6, and then at a much-reduced scale. A better understanding of user emissions and the transition to ZEVs is an area which will need further work to reach decarbonisation targets, and the longer actin us delayed, the stronger it will need to be.

Agencies such as DTMR in Qld and DTP in Vic have recently released tenders related to ZEV policy development but lack a clear understanding of the impact of increasing ZEV uptake on achievement of their overall emissions reduction targets. This project could help address this gap and offer a differentiator for GHD in tendering these and other ZEV opportunities.

3.2.2 Scalability

This study will be the first of its kind in Australian traffic conditions that involves muti-class traffic modelling with ZEVs and ICE vehicles within an emission modelling framework. The pilot study will be focussed on evaluating the applicability of such frameworks in case studies within NSW. Once the BOSCH module of PTV Vissim is calibrated based on the local case studies, the framework will be adapted to estimate transport emissions on transport networks around Australia and New Zealand followed by across the globe.

For example, New Zealand currently has a commitment to reduce net emissions to 50 per cent below gross 2005 levels by 2030.which is the first target under the Paris Agreement, a legally binding international treaty that New Zealand signed onto in 2015 along with 194 other countries. Currently, 49 per cent of New Zealand's energy-related emissions is from the transport industry. To reach net zero, the transport industry will play a crucial role in reducing the GHG emissions significantly with additional measures from the Govt. to offset any remaining emissions through removal of excess carbon dioxide from the atmosphere. The emission modelling framework developed in this study can inform New Zealand's Emission Reduction Plans enabling the nation to reach its legislated target to reach net-zero carbon emissions by 2050.

4. Potential risks

Write the potential risks here (consider technical risk, risks associated with timely completion or completion within budget).

Quality Risk	Likelihood	Impact	Combined	GHD's Mitigation Strategy
Availability of Project Management staff to lead the research process	Low	Medium	Medium	Each of GHD's key team members have sufficient capacity to undertake their respective project roles.
Ability to deliver project scope within the allocated funding, time over-runs, project scope increases	Low	Medium	Medium	GHD will ensure an effective project management approach by monitoring the project progress against the program. We have sufficient backup capability within GHD to accelerate the program.

Quality Risk	Likelihood	Impact	Combined	GHD's Mitigation Strategy
Ensuring the accuracy of data inputs and outputs for traffic model with AV/EV inputs	Low	Medium	Medium	GHD would adopt a methodical approach based on data interactions. We have deployed of a highly skilled team who will apply best practices and review all model inputs and assumptions in regard to the AV/EV inputs to model.
Achieving quality outcomes in the Calibration and Validation of the emission outputs	Low	Medium	Medium	GHD have outlined in the methodology including calibration of the emission outputs based on local fleet. We will ensure that a methodical approach based on data interactions is adopted. Our proposed Emission specialist will review the results and whether it is applicable to Australia.
Managing expectation for the overall model development	Low	Medium	Low	We will also discuss our approach, assumptions, limitations, scope of work at the inception meeting. We will ensure clear message is communicated and that the study process is well understood by all.
Scope of work is unable to be completed within the timeframe	Low	Medium	Low	GHD would adopt a methodical approach and would constantly monitor the progress of tasks and resources. Using the project program, we will identify all information required at the start of the project (as much as practical) and allow reasonable timeframe for response to data requests.

5. Deliverables

Use this space to describe the final results or deliverables expected from the completion of this project.

The outcome of this study will be documented in a report (accompanied by a deck of power point slides) that will establish a benchmark for transport emission modelling in Australia based on associated market penetration of ZEVs. The outputs from this project would enable the policy makers (e.g. state and federal government authorities (including Transport for NSW)) to have the information on how the ZEV take up in Australia would be connected with the sustainability (e.g. climate change) based on emission reduction measurements.

The framework could be further enhanced towards evaluating different decarbonising strategies of fleets of electric public transport vehicles, shared mobility services, active transport modes and other future mobility options.

The findings of this study would yield immediate advantages to the Australian Government's Future Transport Technology sector by strengthening their strategic leadership and coordination efforts. This support would facilitate the safe and sustainable implementation of future transport technologies, thereby enhancing transport accessibility, road safety, alleviating congestion, and improving the overall productivity for all Australians.

GHD

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