

HOW AND WHY WE TRAVEL: IMPROVING REPRESENTATIONS OF TRANSPORT DEMAND MANAGEMENT AND MODAL SHIFT IN ENERGY SYSTEM MODELS.

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Improving representations of transport demand management and modal shift in energy systems models

Why is this important for the built environment?

Issues important to address when planning for the built environment:

- How much can public transport infrastructure reduce transport CO2 emissions?
- How much can cycling and cycling infrastructure reduce transport CO2 emissions?
- The reasons why we travel in to formulate purpose based policy to reduce traffic in the built environment
- The difficulty with decarbonization of longer journeys and the issues with decentralized planning and urban sprawl

Without proof for policy makers, “alternative ideas” get forgotten about!

Ireland's commitments to Climate Action

CLIMATE ACTION PLAN 2019

To Tackle Climate Breakdown



An Bille um Ghníomhú ar son na hAeráide agus um Fhorbairt Ísealcharbóin
(Leasú), 2021
Climate Action and Low Carbon Development (Amendment) Bill 2021

Mar a tionscnaíodh

As initiated

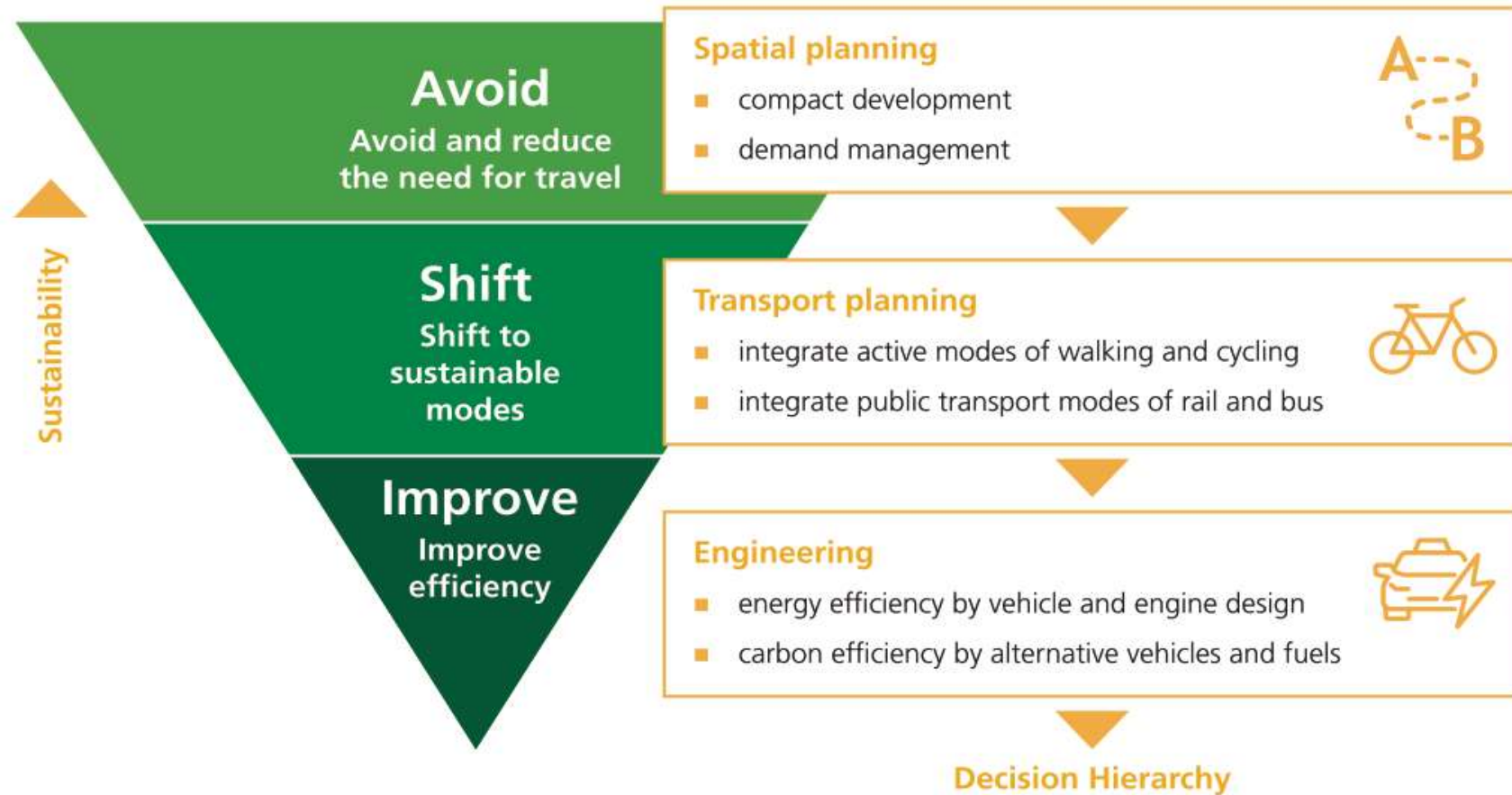
**Programme
for Government**
Our Shared Future

A legal obligation to a 51% reduction in GHG emissions for Ireland by 2030 compared to 2020.

This roughly translates to 7% per year reduction in GHG emissions

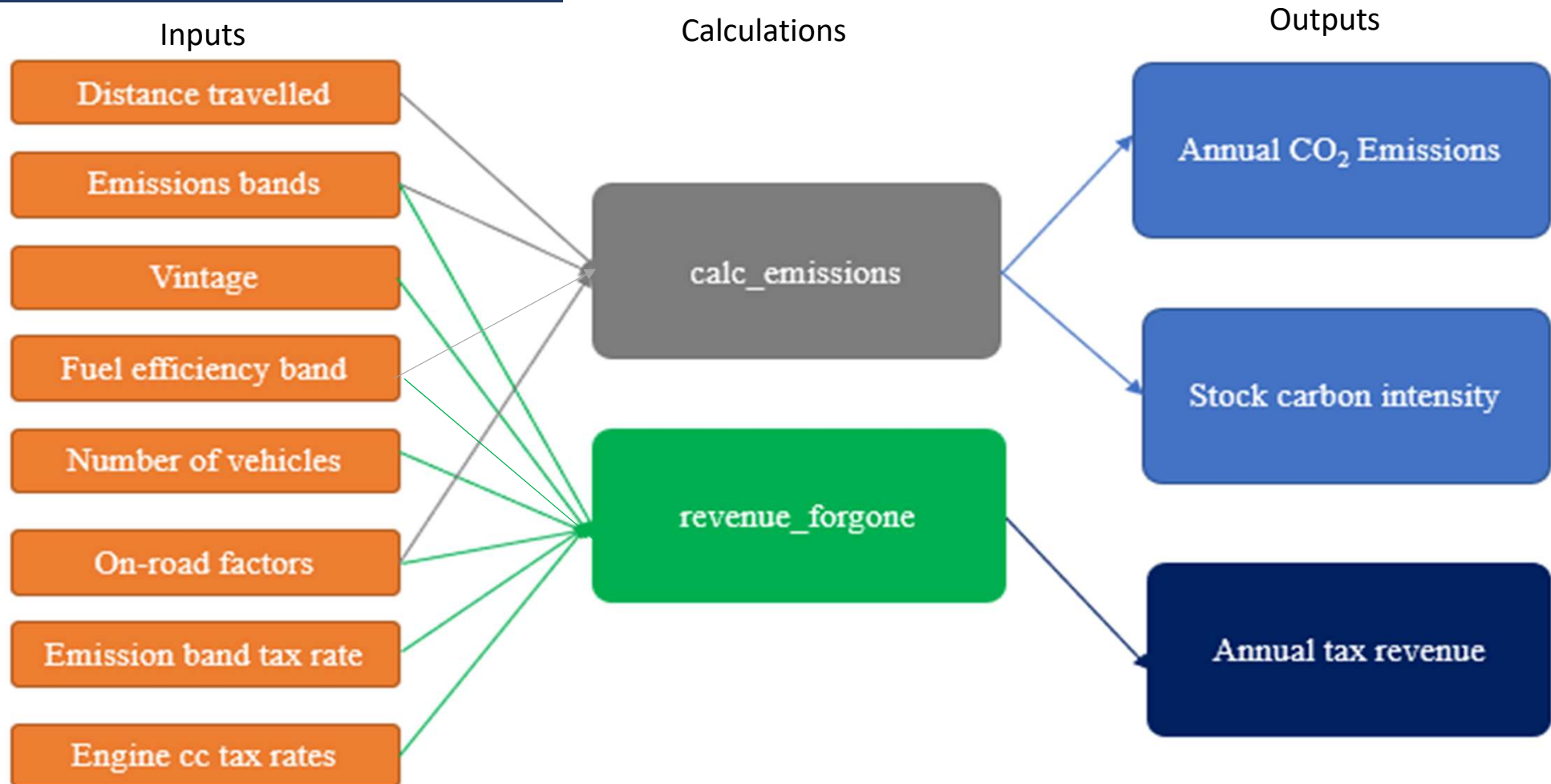
Targets for sustainable technologies, public services and low carbon schemes

Avoid-Shift-Improve Framework for Transport



[1] Environmental Protection Agency, 2020. *Ireland's Environment - An Integrated Assessment 2020*. [online] Available at: <<https://www.epa.ie/media/EPA-Ireland's-Environment-2020-Chapter11.pdf>> [Accessed 26 March 2021].

Irish Car Stock Model



Irish Passenger Transport Emissions and Mobility Model



[2] Daly, H., Ó Gallachóir, B.P., 2011. Modelling private car energy demand using a technological car stock model. Transp. Res. Part D Transp. Environ. <https://doi.org/10.1016/j.trd.2010.08.009>

[3] Central Statistics Office, National Travel Survey, <https://www.cso.ie/en/statistics/tourismandtravel/nationaltravelsurvey/>

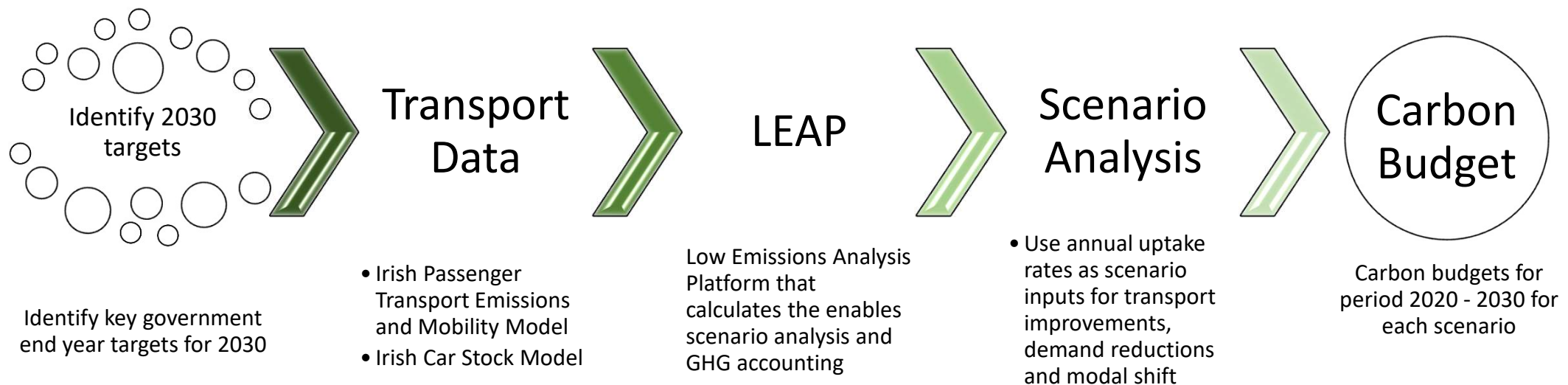
[4] Bus Éireann Annual Reports Available at: <https://www.buseireann.ie/inner.php?id=680> (Date accessed: 16th December 2020)

[5] Sweeney, E.. "Research Into Options for Reducing Energy Consumption Across the Luas Network." (2015).

[6] Irish Rail Annual Reports, Available at: <https://www.irishrail.ie/about-us/company-information/iarnrod-eireann-annual-reports> (Date accessed: 16th December 2020)

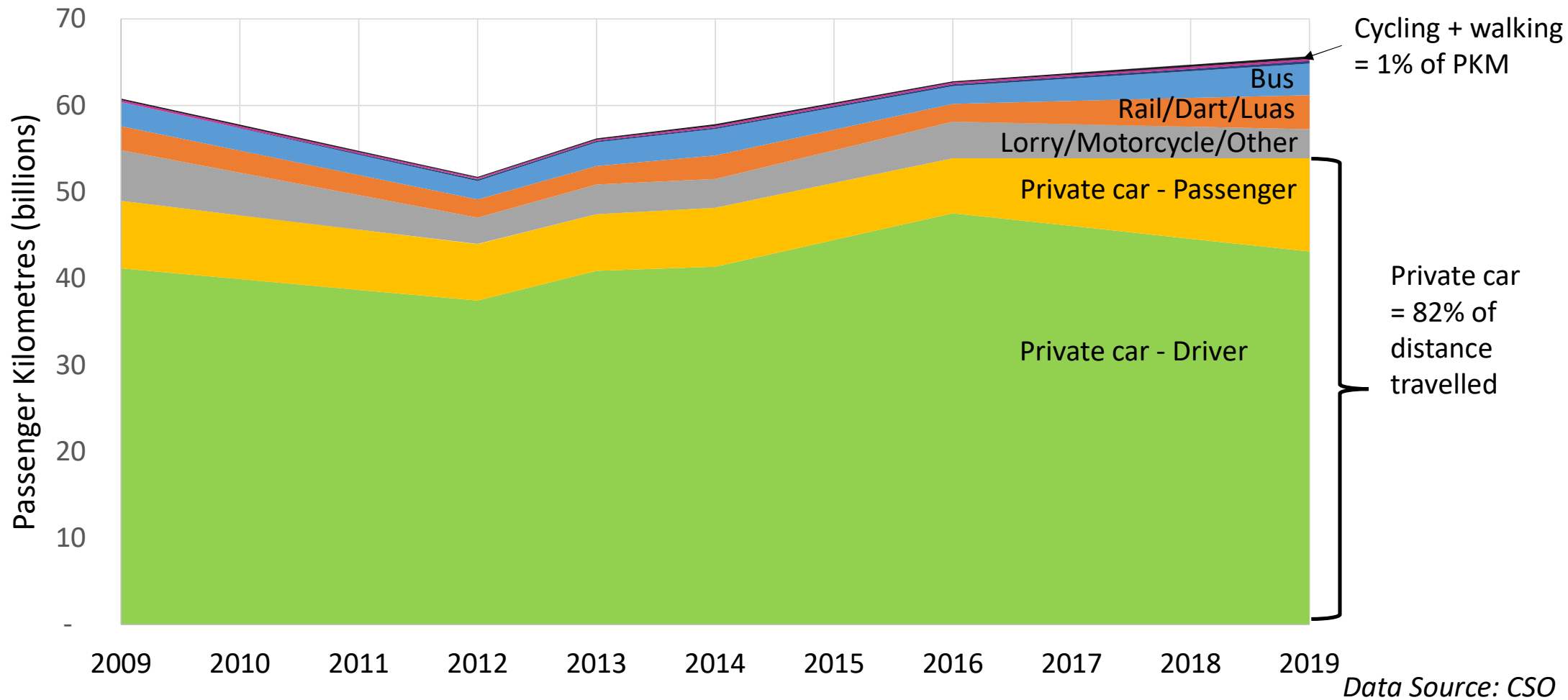
Low Emissions Analysis Platform - LEAP

Exploratory climate action targets are applied using the LEAP simulation model and scenario analysis. This allows the construction of pathways to low carbon transport and the estimation of carbon budgets for the period 2020 – 2030 [7].

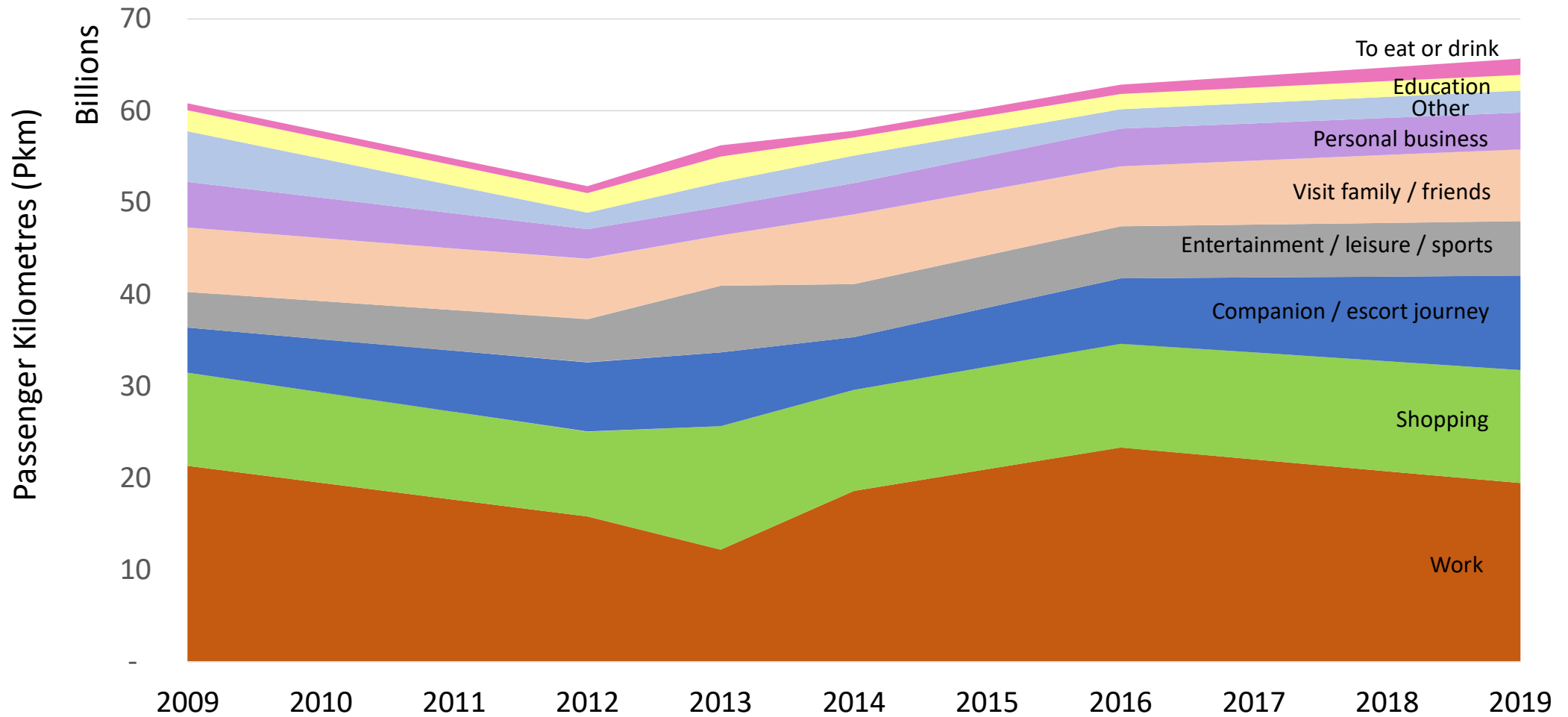


[7] Mac Uidhir, T., Rogan, F., Gallachóir, B.Ó., 2020. Develop a LEAP GHG Ireland Analytical Tool for 2050 Report No. 349. Available at: https://www.epa.ie/pubs/reports/research/climate/Research_Report_349.pdf (Date Accessed: 16th December 2020)

The majority of passenger kilometres are met with car transport

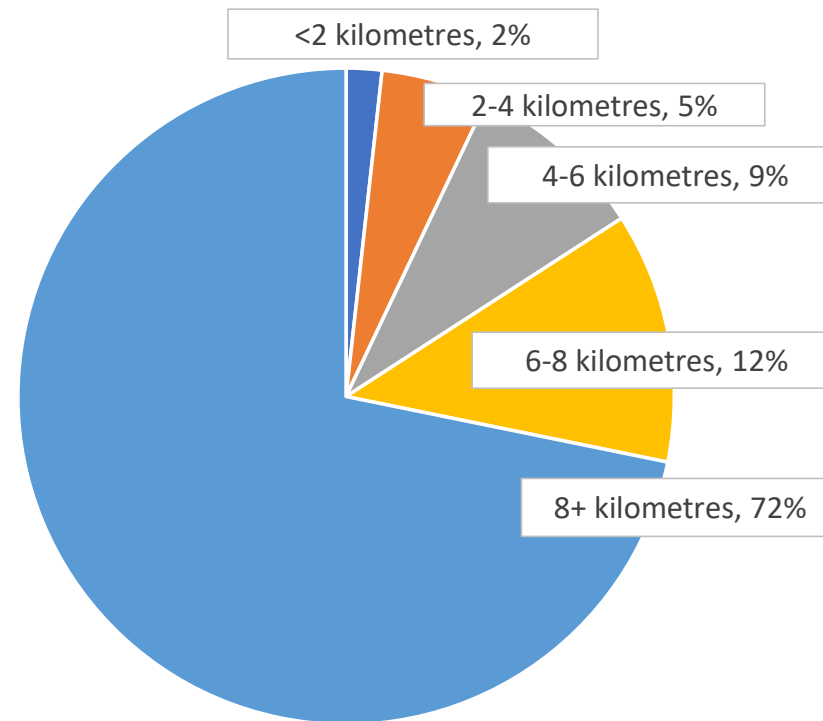


Passenger transport demand by trip purpose

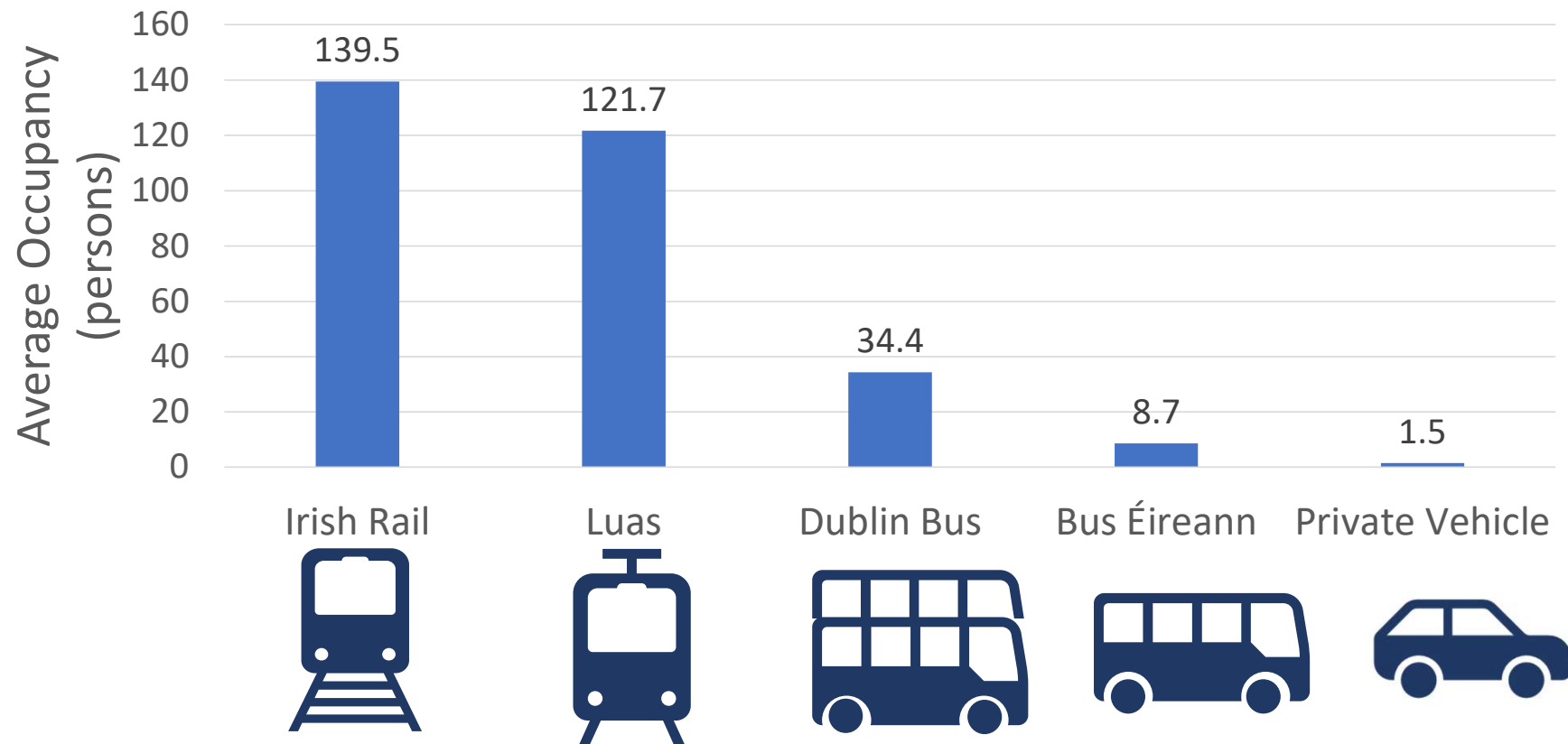


Many short journeys (for work & education) could be active modes

Proportion of passenger travel demand by overall
journey distance, 2019



Occupancy rates of transport modes in Ireland



Occupancy is the average number of people travelling in a mode of transport. It is based on an estimation from recorded passenger numbers from Bus Éireann, Dublin Bus and Irish Rail Annual Reports [5], [6], [7]. Private vehicle occupancy estimates are based on Eurostat figures [8].

Currently, no clear active modes targets exist – we explore 7 possible pathways

Scenario	Description
Reference	<ul style="list-style-type: none">Assumes no change in share of transport modes from 2019 levels
Cycling accounts for 10% of the shortest trips	<ul style="list-style-type: none">Share of cycling passenger kilometres increases until it reaches the value of passenger kilometres that represents 10% of the shortest trips
Cycling and walking 450k trips per day	<ul style="list-style-type: none">Walking and cycling trips increase proportionally to their current shares until 450k trips per day are either by walking or cycling
Cycling accounts for 10% of work passenger kilometres by 2030	<ul style="list-style-type: none">Cycling rate increases for work related travel until 10% of passenger kilometres for work is by cycling
Cycling is 10% of work and education passenger kilometres	<ul style="list-style-type: none">Cycling rate increases for work and education related travel until 10% of passenger kilometres for work and education is by cycling
Cycling accounts for 10% of trips of typical cycling journey length	<ul style="list-style-type: none">Cycling accounts for 10% of trips of typical cycling length
Cycling accounts for 10% of ALL passenger kilometres	<ul style="list-style-type: none">Cycling services 10% of ALL passenger kilometre demand each year.

Public Transport scenarios based on Ireland's Climate Action Plan

Scenario	Description
Reference	<ul style="list-style-type: none"> Assumes no change in share of transport modes from 2019 levels, demand growth in line with population and economic growth drivers
Bus Connects	<ul style="list-style-type: none"> Bus Rapid Transit for Dublin - assuming 20% of car rider-ship in Dublin switches from car to bus, based on studies from past success of mode switching with BRT from studies [8], which indicate mode share potential of between 5 - 70%. The "Medium uptake" scenario suggests a 25% switch from current private car use to bus in the Dublin area.
Electrification of Rail	<ul style="list-style-type: none"> Electrification of all railway in Ireland by 2030, an ambition set out by the Irish Climate Action Plan
Hybrid Rail Fleet	<ul style="list-style-type: none"> CAP 92 Hybrid fleet for rail, with hybrid fleet, with full hybridization by 2030, linear increase from 2023 to 2030. (20% electric, 80% diesel hybrid as per findings [9]).
Extension of Luas line	<ul style="list-style-type: none"> Addition of Luas in Finglas to city centre, a 4km Luas line expansion. The scenario assumes that the increase in passenger kilometres will increase Exploratory scenarios using NTS modality shares for Dublin (using other red & green lines as a guide). Method will increase Luas passenger kilometre proportion, using past usage patterns with respect to line length as a guide for usage patterns with increased rail line length.

[9] T. Satiennam, S. Jaensirisak, W. Satiennam, and S. Detdamrong, "Potential for modal shift by passenger car and motorcycle users towards Bus Rapid Transit (BRT) in an Asian developing city," IATSS Res., vol. 39, no. 2, pp. 121–129, 2016, doi: 10.1016/j.iatssr.2015.03.002.

[10] Rail-car hybrid trains to reduce fuel consumption and emissions, 2006, R. Cheli et al. https://www.researchgate.net/publication/266493285_Rail-car_hybrid_trains_to_reduce_fuel_consumption_and_emissions

Remote working scenarios based on Ireland's Climate Action Plan

Scenario	Description
Reference	<ul style="list-style-type: none">Assumes no change in share of transport modes from 2019 levels, demand growth in line with population and economic growth drivers
Civil Service – Working from Home	<ul style="list-style-type: none">Based on the Program for Government target to have 20% of the civil service remote working by 2023.
2-day Work from Home	<ul style="list-style-type: none">Assumes that any workers that can complete tasks from home, as specified by Crowley and Dornan and calculated using CSO employment figures by sector work 2 days per week at home [11, 12].
5-day Work from Home	<ul style="list-style-type: none">Assumes that any workers that can complete tasks from home, as specified by the OECD and Crowley et al. work 5 days per week at home [11, 12].

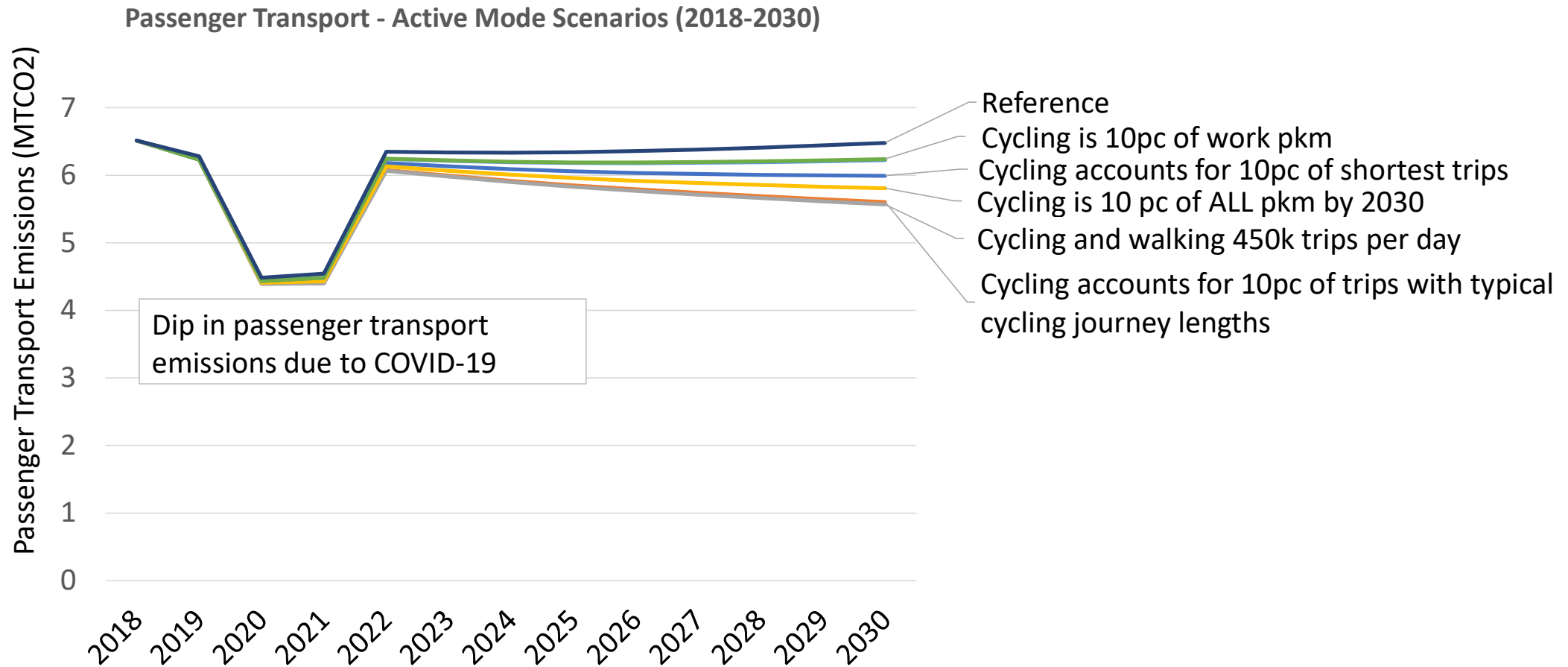
[11] Crowley et al. "Covid-19, Occupational Social Distancing and Remote Working Potential in Ireland" Working Paper, available online at: https://www.ucc.ie/en/media/projectsandcentres/srerc/COVID19_FC_JD_2020_website.pdf Date accessed: 26 May 2021

[12] Central Statistics Office, Labour Market Principal Statistics 2020, available online at: <https://www.cso.ie/en/statistics/labourmarket/principalstatistics/> Date accessed: 26 May 2021



For carbon budgeting, what are the potential GHG emissions savings from these measures?

Emissions impact of active modes of travel targets



Active Mode Scenarios - Results

Scenario	Reduction in 2030 compared to 2020
	MtCO ₂
Active modes = 10% of shortest trips	0.5
Cycling = 10% of trips with typical cycle journey length	0.9
Active modes = 450k trips per day	1
Active modes = 10% of all PKM by 2030	0.7
Active modes = 10% of work and education PKM	0.3
Active modes = 10% of work PKM	0.2



Overview of Transport Sector Scenarios for emissions reductions

Scenario	Reductions in 2030 (MTCO ₂)	Policy Reference
Active Modes (range of targets)	0.2 - 1	Smarter Travel
Electrification of all rail by 2030	0.3	Climate Action Plan
Hybrid fleet of trains by 2030	0.2	Climate Action Plan
Dublin Bus Connects	0.04	Climate Action Plan
Extension of Luas to Finglas	0.001	Climate Action Plan
20% of Civil Service working from home	0.0003	Program for Government
2 day work from Home	0.4	Program for Government
5 day work from Home	1	Program for Government
Gap to target (50% reduction by 2030)	2 – 4	Climate Action Bill



Transport Sector – Additional mitigation for increased 7% p.a target

- Significant additional measures are required to meet the higher mitigation ambition The current measures in the Climate Action Plan (2019) do not achieve a significant reduction in emissions.
- Private car is the most common transport mode in Ireland - many more journeys could be via public transport or active modes
- E-bikes may extend the potential for longer car trips to be replaced [11]
- When combined together, the impact of these policy-measures will be less than the sum of the emission savings, due to the “interaction effect” – this is an area that needs further research
- Demand reduction scenarios – the Irish Passenger Transport Modelling Framework could investigate the impacts of remote work on passenger transport emissions

[13] J. E. Bourne et al., “The impact of e-cycling on travel behaviour : A scoping review,” J. Transp. Heal., vol. 19, no. August, p. 100910, 2020, doi: 10.1016/j.jth.2020.100910.

Improving representations of transport demand management and modal shift in energy systems models

Why is this important for the built environment?

The Irish Passenger Transport Emissions Modelling Framework can show :

- How much can public transport infrastructure reduce transport CO2 emissions
- How much can cycling and cycling infrastructure reduce transport CO2 emissions
- The reasons why we travel in to formulate purpose based policy to reduce traffic in the built environment
- The difficulty with decarbonization of longer journeys and the issues with decentralized planning and urban sprawl

Without proof for policy makers, “alternative ideas” get forgotten about!

Questions & suggestions welcome!

Thanks for listening!



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References

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- [2] Daly, H., Ó Gallachóir, B.P., 2011. Modelling private car energy demand using a technological car stock model. Transp. Res. Part D Transp. Environ. <https://doi.org/10.1016/j.trd.2010.08.009>
- [3] Central Statistics Office, National Travel Survey, <https://www.cso.ie/en/statistics/tourismandtravel/nationaltravelsurvey/>
- [4] Bus Éireann Annual Reports Available at: <https://www.buseireann.ie/inner.php?id=680> (Date accessed: 16th December 2020)
- [5] Sweeney, E.. “[Research Into Options for Reducing Energy Consumption Across the Luas Network.” \(2015\).](#)
- [6] Irish Rail Annual Reports, Available at: <https://www.irishrail.ie/about-us/company-information/iarnrod-eireann-annual-reports> (Date accessed: 16th December 2020)
- [7] Mac Uidhir, T., Rogan, F., Gallachóir, B.Ó., 2020. Develop a LEAP GHG Ireland Analytical Tool for 2050 Report No. 349. Available at: https://www.epa.ie/pubs/reports/research/climate/Research_Report_349.pdf (Date Accessed: 16th December 2020)
- [8] European Environment Agency, accessible at : <https://www.eea.europa.eu/data-and-maps/indicators/occupancy-rates-of-passenger-vehicles/occupancy-rates-of-passenger-vehicles>
- [9] T. Satiennam, S. Jaensirisak, W. Satiennam, and S. Detdamrong, “Potential for modal shift by passenger car and motorcycle users towards Bus Rapid Transit (BRT) in an Asian developing city,” IATSS Res., vol. 39, no. 2, pp. 121–129, 2016, doi: 10.1016/j.iatssr.2015.03.002.
- [10] Rail-car hybrid trains to reduce fuel consumption and emissions, 2006, R. Cheli et al. https://www.researchgate.net/publication/266493285_Rail-car_hybrid_trains_to_reduce_fuel_consumption_and_emissions
- [11]
- [12]
- [13] J. E. Bourne et al., “The impact of e-cycling on travel behaviour : A scoping review,” J. Transp. Heal., vol. 19, no. August, p. 100910, 2020, doi: 10.1016/j.jth.2020.100910.
- [14] A. Milamoff, J. D. Brown, and H. J. Maclean, “Electrification of light-duty vehicle fleets alone will not meet mitigation targets,” Nat. Clim. Change, 2020, doi: 10.1038/s41558-020-00034-7



Assumptions

- Passenger kilometre demand for rail is proportional to the capacity factors throughout various stages of the pandemic (may be an overestimation)
- Passenger kilometre demand for bus is a factor of bus traffic volumes **and** the capacity factors throughout various stages of the pandemic
- Demand for private vehicle transport is proportional to car traffic volume flow
- “No-COVID” Reference scenario assumes passenger transport demand and mode share is the same as 2019 values
- 40% increase in cycling passenger kilometre demand based on rough estimation from Grove Road bicycle counter data. More information: [How the pandemic led to a cycling renaissance](#)



Glossary

Passenger kilometres:

Unit to measure transport demand for one person travelling

Vehicle kilometres:

Unit to measure transport by each kilometre travelled by a vehicle

Occupancy:

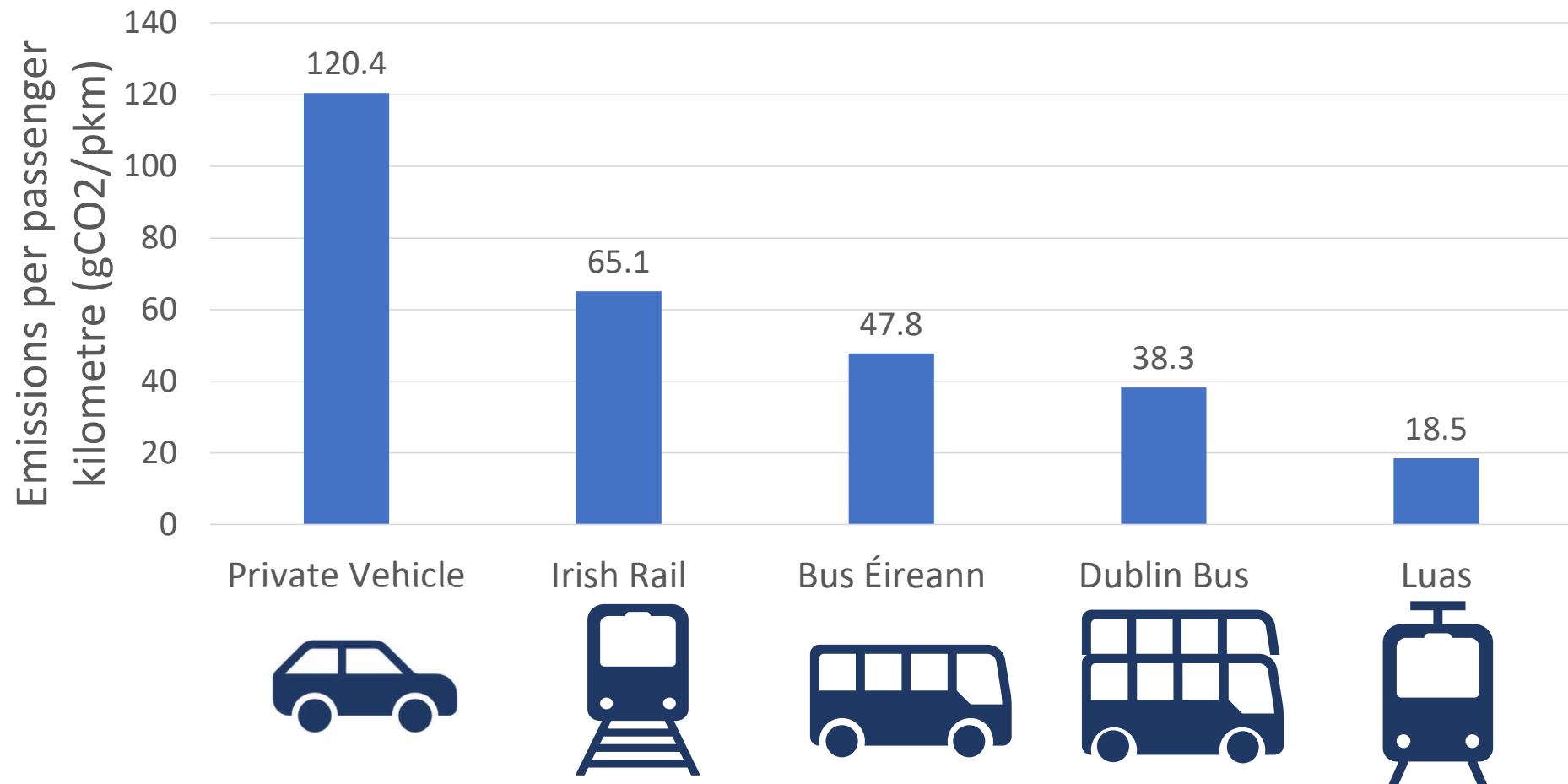
Total number of people travelling in a vehicle

Vehicle kilometre travelled x Occupancy of vehicle = Passenger kilometre serviced

Factors influencing total passenger kilometres

1. Trip frequency: how often the trip needs to be taken
2. Trip length: how far the trip is in kilometres

Emissions per passenger kilometres for transport modes in Ireland





Scenario Analysis

- Scenario analysis uses a simulation tool to compare a new target, which is quantified in a new scenario against the 'Business as Usual' or 'no target' scenario which is called the "Reference" scenario
- By comparing the relative difference in emissions, we can get an insight into the effectiveness of the policy target in reducing carbon dioxide emissions *if it is achieved by a given date.*
- More details about the LEAP Ireland 2050 model can be found [here](#) [7].

A final note on modal shift

“Climate change mitigation strategies are often technology-oriented, and electric vehicles (EVs) are a good example of something believed to be a silver bullet..... Improving average fuel consumption of conventional vehicles, with stringent standards and weight control, would reduce the requirement for alternative technologies, but is unlikely to fully bridge the mitigation gap. There is therefore a need for a wide range of policies that include measures to reduce vehicle ownership and usage.” [14]

[14] A. Milovanoff, I. D. Posen, and H. L. MacLean, “Electrification of light-duty vehicle fleet alone will not meet mitigation targets,” *Nat. Clim. Chang.*, 2020, doi: 10.1038/s41558-020-00921-7.