India Urban Mobility Model
A Tool for Identifying Low-Carbon Pathways for the Urban Mobility Sector in India

Presentation
22 February 2019

INTRODUCTION

- **A policy simulation tool to identify cost-efficient urban mobility pathways for mitigating CO_2 emissions in Indian cities.**
  - **Excel-based tool**
- **Policies that can be tested with the tool:**
  - **Transport infrastructure investment**
  - **Urban area growth**
  - **Demand-management measures**
  - **Vehicle technology**
  - **Shared mobility**
- **Joint work between the World Bank and the International Transport Forum with local data and technical support provided by TERI.**

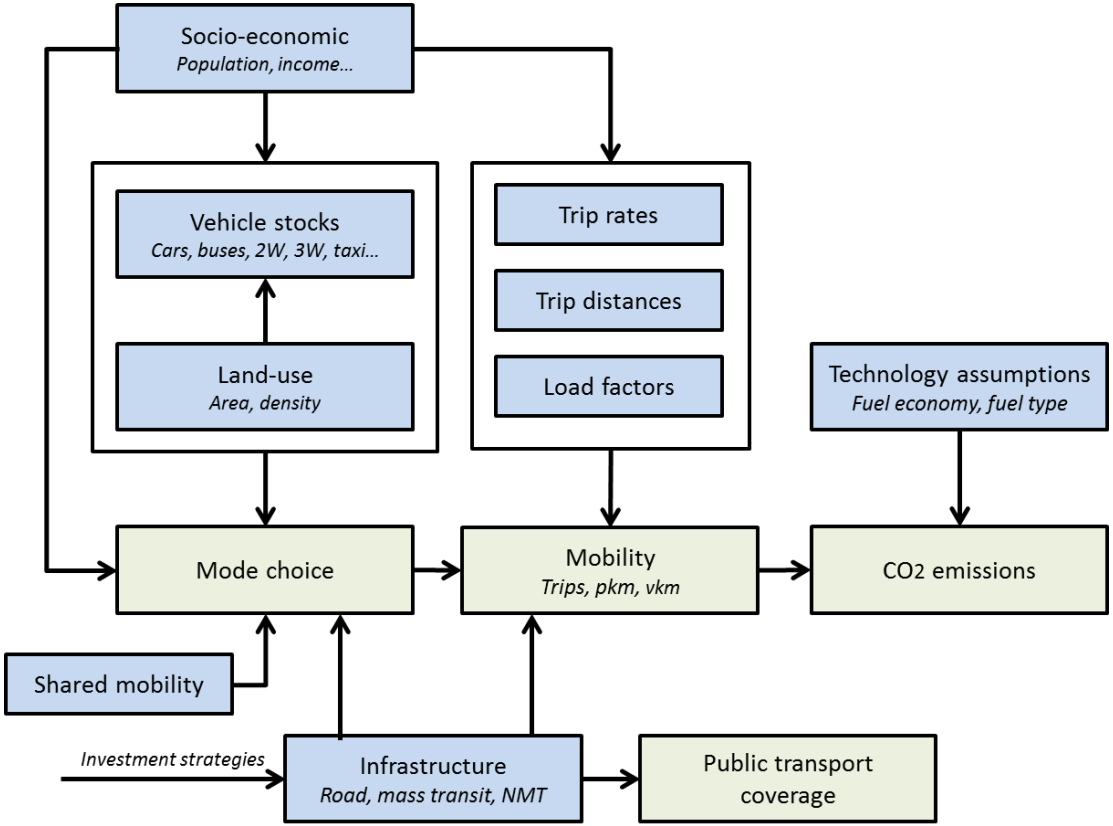
MODEL SCOPE

- **Analysis carried out for all cities (population >500K) in India**
  - Exhaustive city-specific data collection by TERI for 108 cities

UA pop (2011)	City Tier	NO. of Cities	Cities Included
>8 Million	I	5	Mumbai, Delhi, Bangalore, Kolkata, Chennai
4 - 8 Million	II	4	Hyderabad, Ahmedabad, Pune, Surat
1 - 4 Million	III	44	Jaipur, Lucknow, Vijayawada, etc.
0.5 -1 Million	IV	55	Amaravati, Mathura, Bhubaneswar, etc.

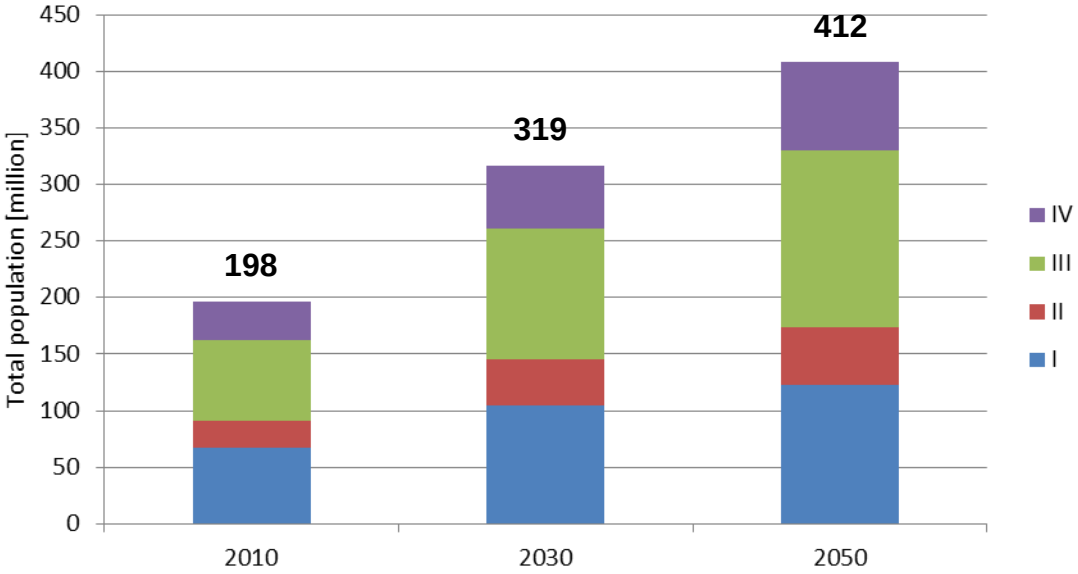
- **The model captures aggregate relationships** (not a projection model for each city)

MODEL FRAMEWORK



DEEP CHANGES IN URBAN TRAVEL DEMAND

- **Population will double by 2050**
- **Tier I and Tier III constitute 70%**

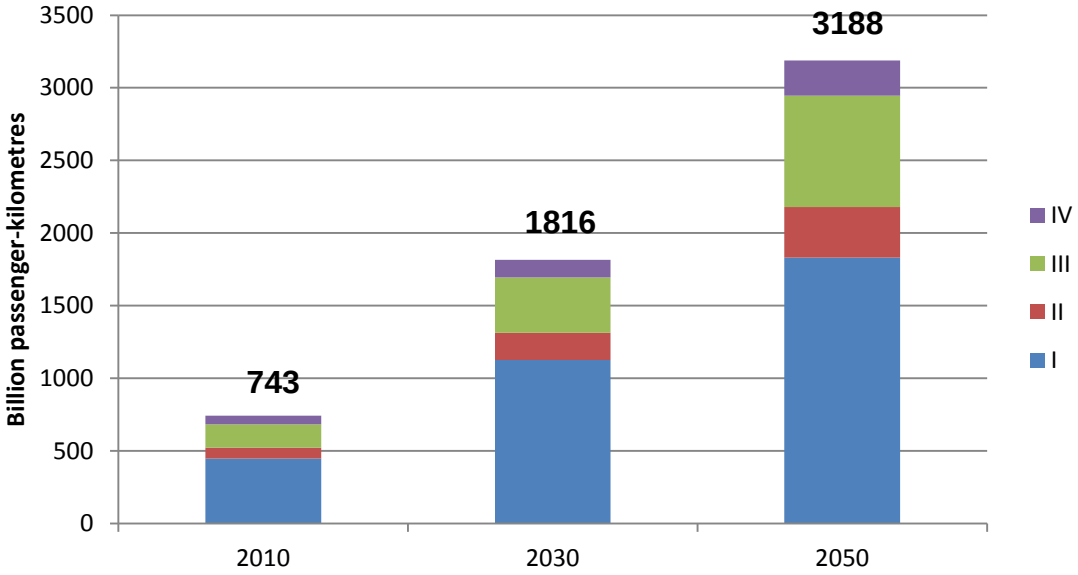


Number of cities in each Tier

	City class in 2050			
City class in 2010	I	II	III	IV
I	5	0	0	0
II	4	0	0	0
III	0	14	30	0
IV	0	0	53	0

DEEP CHANGES IN URBAN TRAVEL DEMAND

- **Passenger demand will quadruple by 2050**
- **Highest increase occurs in Tier I and Tier III**

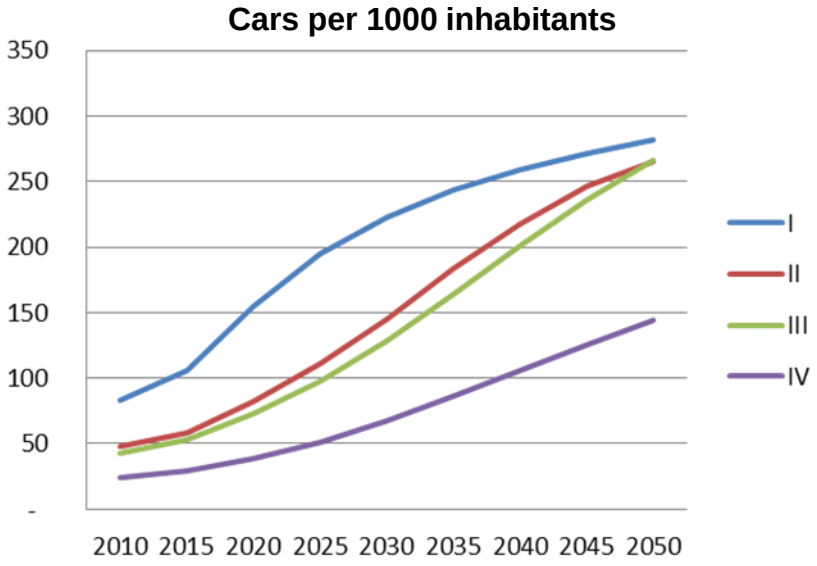


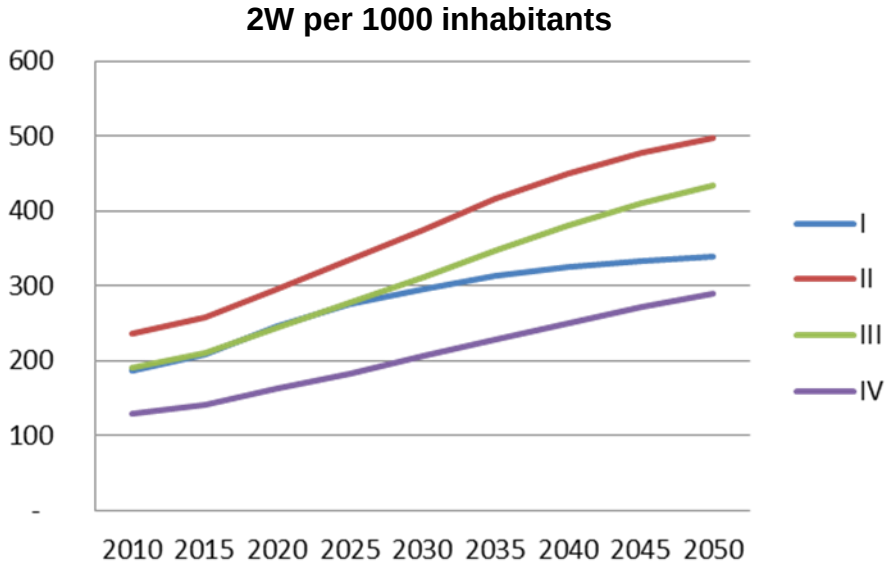
- **Share of PKM for each share**

City Tier	2010	2030	2050
I	60%	62%	58%
II	10%	10%	11%
III	22%	21%	24%
IV	8%	7%	8%

DEEP CHANGES IN URBAN TRAVEL DEMAND

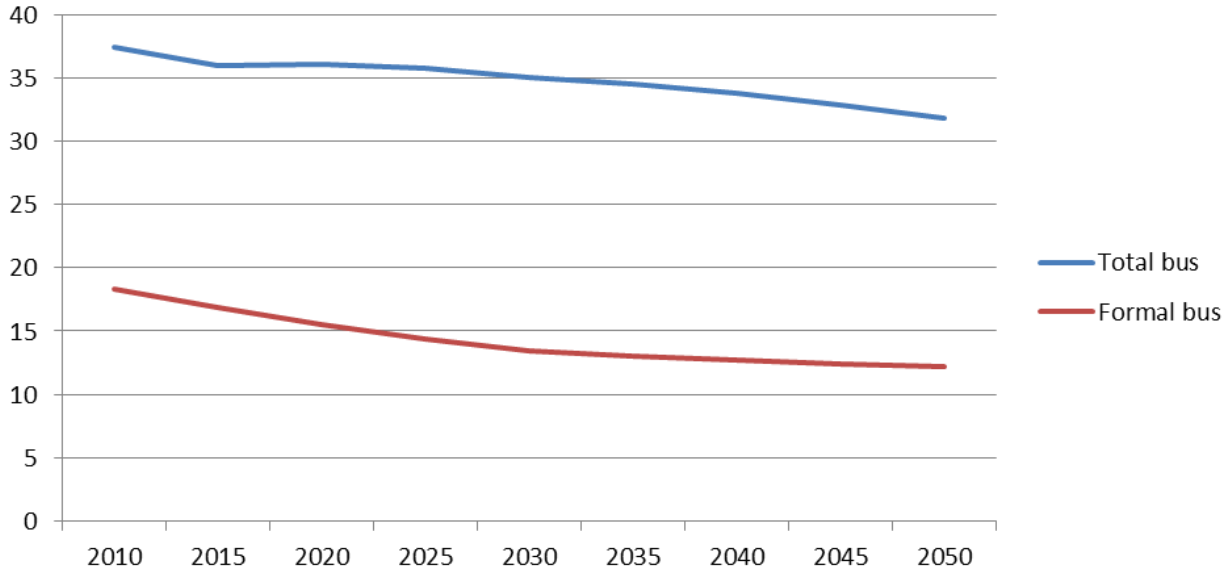
- Car ownership will grow from 52 to 231 per 1000 inhabitants
- 2W ownership will grow from 183 to 352 per 1000 inhabitants





DEEP CHANGES IN URBAN TRAVEL DEMAND

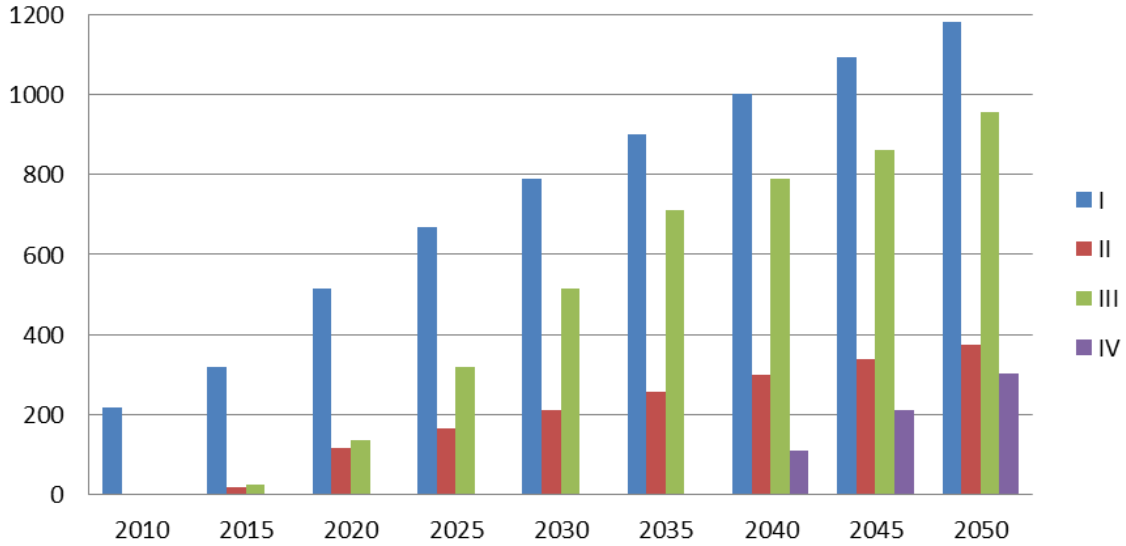
- **Formal buses per lakh decrease from 18 to 12 per lakh**
- **Share of private bus increases from 50% to 60%**



DEEP CHANGES IN URBAN TRAVEL DEMAND

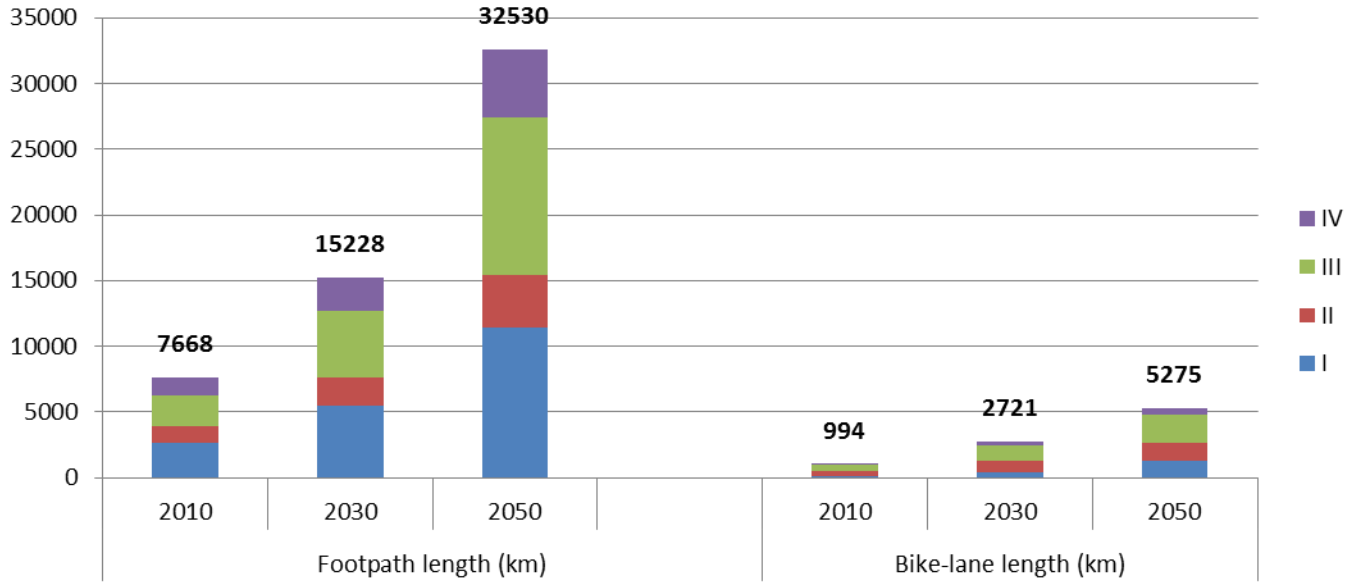
❑ Metro network length grows from 217km to 2813km

As planned, 250 000 million rupees per year are 100% spent on metro network construction and expansion, according to the existing and future plans.



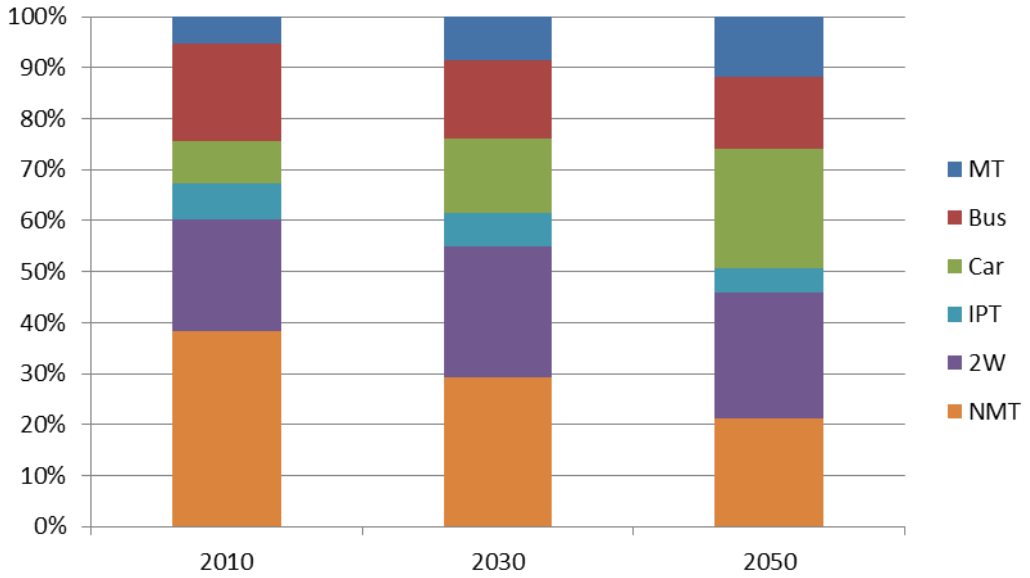
DEEP CHANGES IN URBAN TRAVEL DEMAND

- **Footpath length grows from 7668km covering 9% of the roads to 32530km covering 18% of the roads**
- **Bike-lane length grows from 994km covering 1% of the roads to 5275km, covering 3% of the roads**



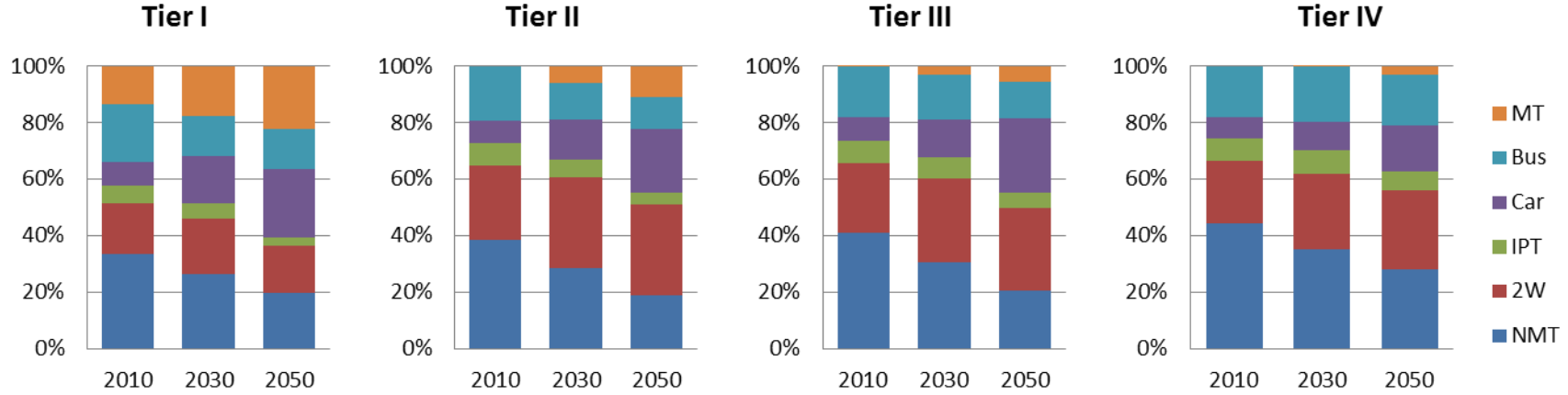
DEEP CHANGES IN URBAN TRAVEL DEMAND

- Private mode share will increase from 30% to 48%
- NMT mode share will decrease from 38% to 21%



DEEP CHANGES IN URBAN TRAVEL DEMAND

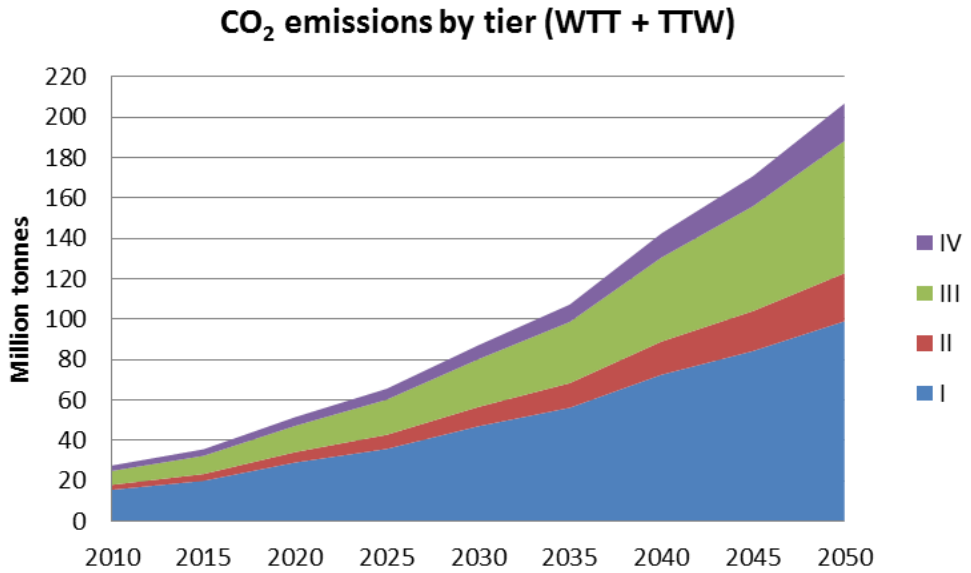
❑ Differences in transport supply lead to distinct mode share patterns



- NMT shares decreases in all tiers, with a shift to motorised modes
- Bus shares decrease in all tiers but tier IV, due to the negligible increase in mass transit supply and lower growth in personalised modes
- 2W share continues to grow in all tiers, despite much slower than car. It started to stabilises or declines after 2035
- Increasing car share for all tiers, most notably in tier III, due to the combination of high income growth and limited plans for PT supply expansion

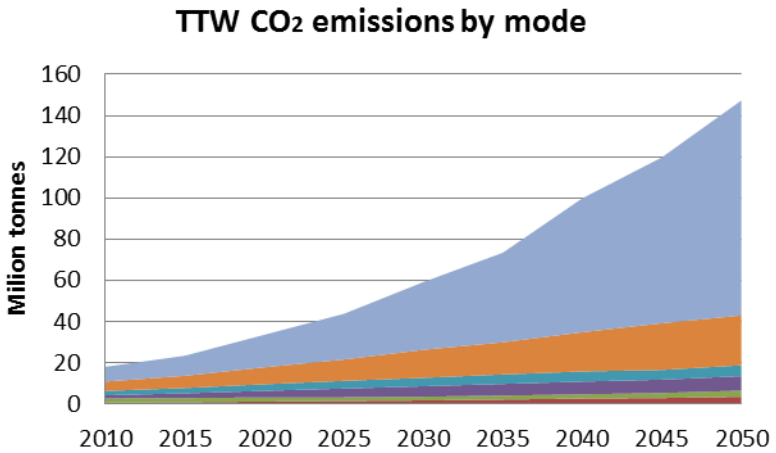
TRANSPORT SECTOR EMISSIONS

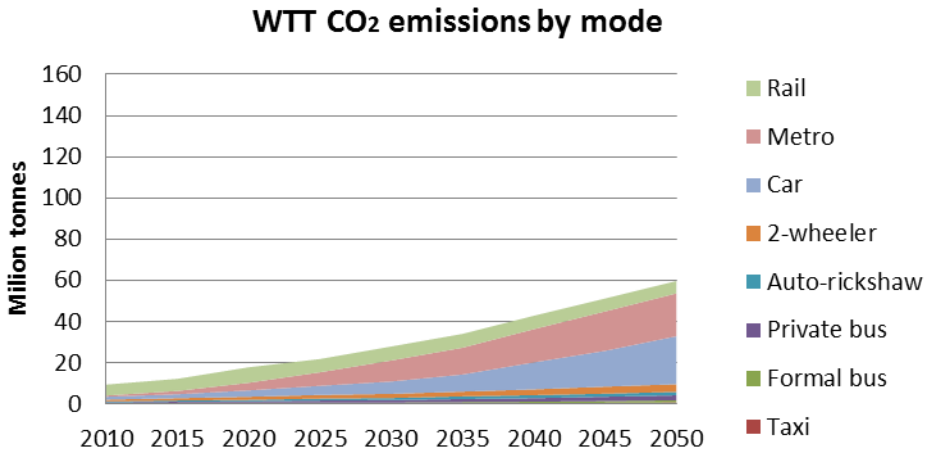
- CO_2 emissions in 2050 is nearly <u>EIGHT</u> times the 2010 level.
- Larger cities emit much more due to the prevalence of cars
- 80% of the emissions comes from Tier I and Tier III



DEEP CHANGES IN URBAN TRAVEL DEMAND

- Private car is the main contributor to the increase in TTW CO2 emissions.
- Metro and rail are the main contributor to the WTT emissions, representing more than 60% in 2010 and decreases to 45% in 2050.





- Without clean electricity, mode shift to metro will not transform into CO_2 savings
- Share of WTT in the total emissions goes down from 35% in 2010 to 29% in 2050

ALTERNATIVE POLICY SCENARIOS

Investment policies

Land use policies

Demand management

Shared mobility

Vehicle technology

INVESTMENT POLICIES

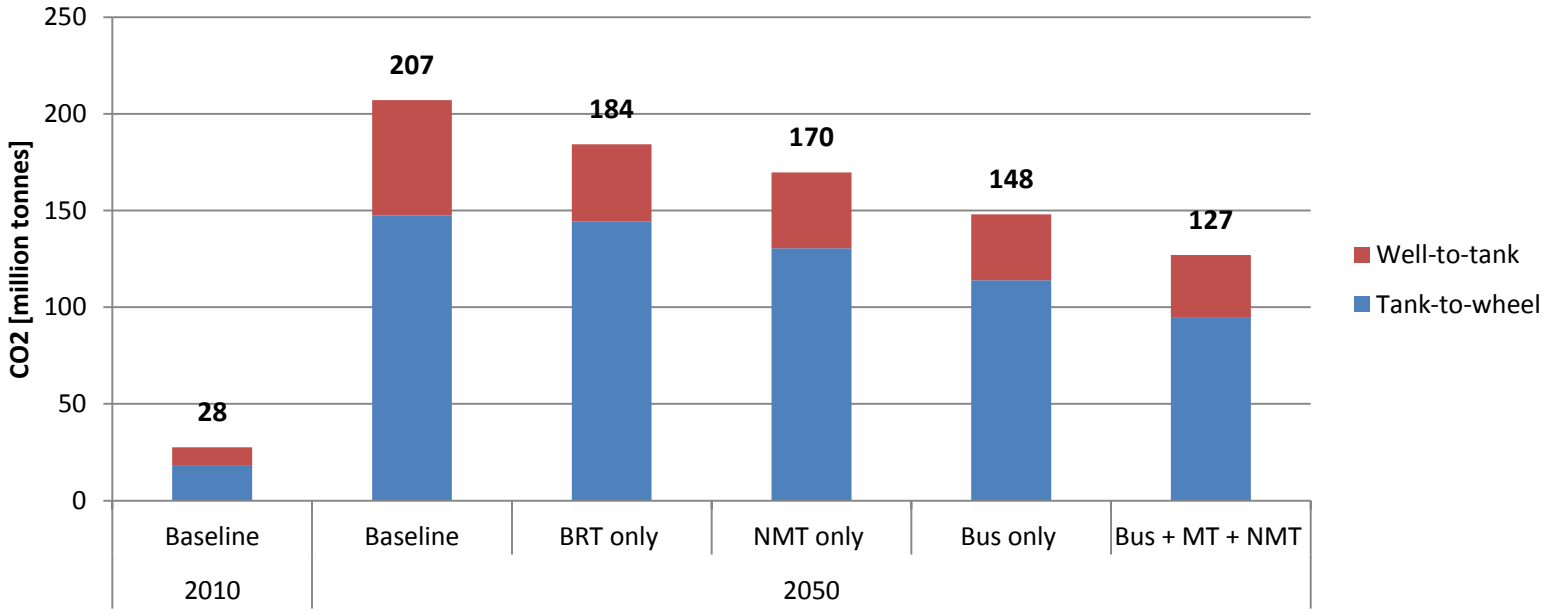
❑ Indicative strategies of allocating available funding

Available money per year (million rupees)	250 000

Scenarios	Pop > 4M	Pop 1M - 4M	Pop < 1M	% of funding allocated	% of funding utilised
Bus only scenario	37%	40%	21%	98%	87%
BRT only scenario	10%	22%	13%	45%	45%
NMT only scenario	15%	9%	4%	28%	27%
Bus + MT + NMT scenario	10% MT, 20% Bus, 6% NMT	12% MT, 25% Bus, 5% NMT	0% MT, 20% Bus, 2% NMT	100%	91%

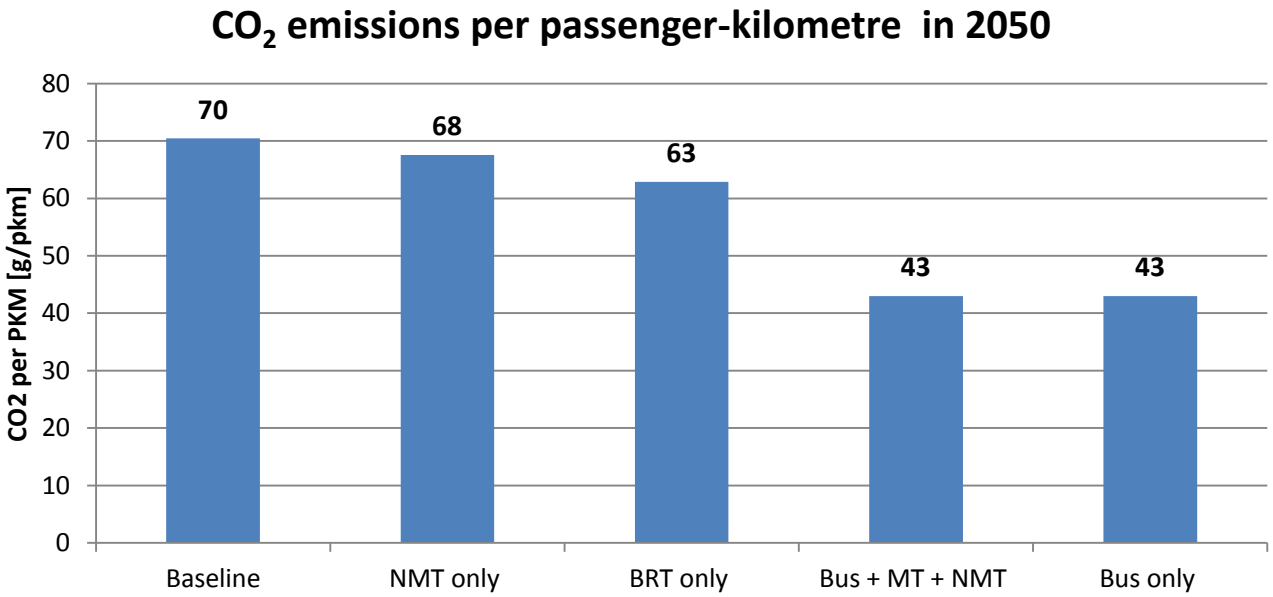
INVESTMENT POLICIES

- **Mixed investment strategy has the highest CO_2 mitigation potential in cities**



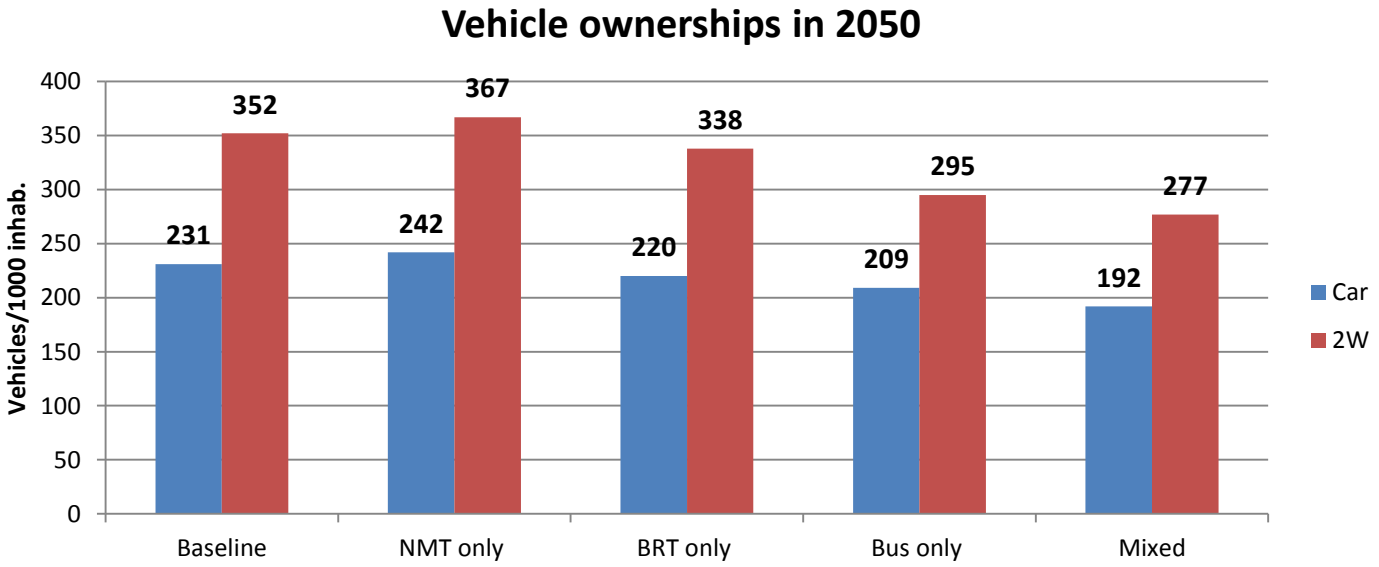
INVESTMENT POLICIES

- **Bus and mixed investment strategy have the highest efficiency (CO_2 per PKM)**



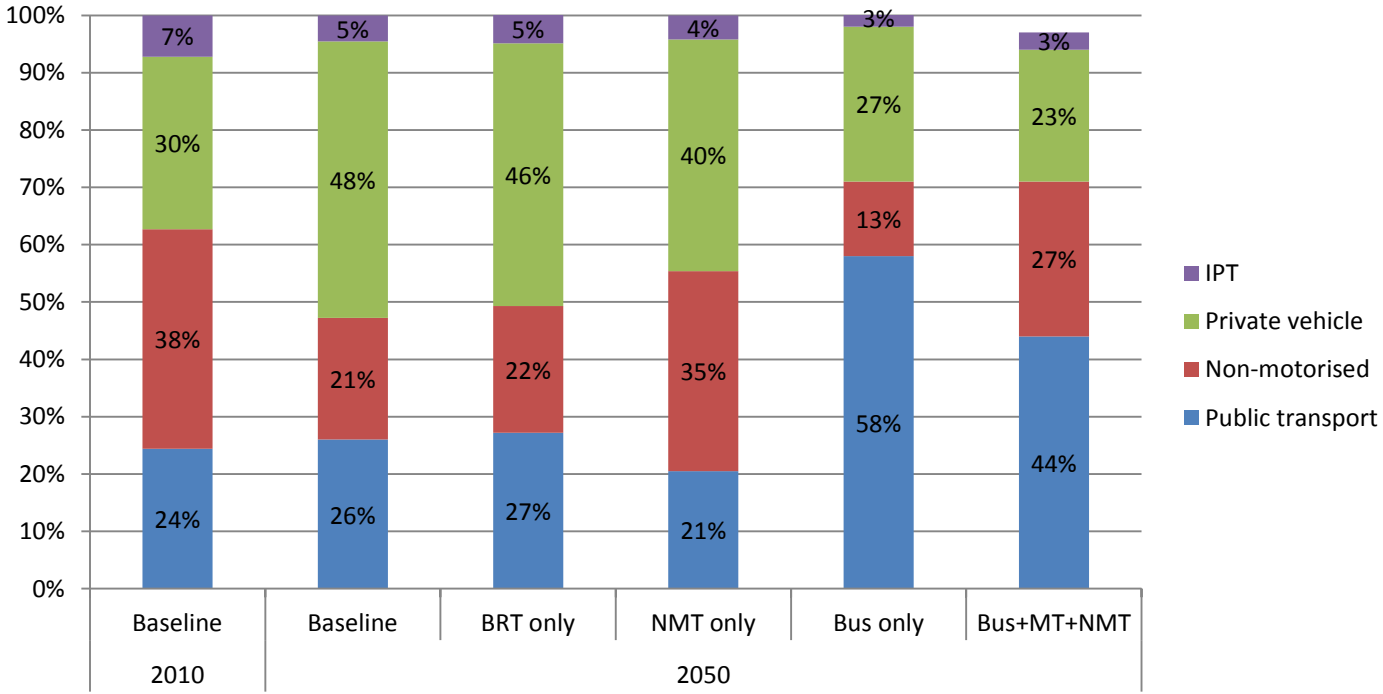
INVESTMENT POLICIES

- **Mixed and bus only investment strategy have the highest impacts on containing the growth of private vehicle ownership**



INVESTMENT POLICIES

❑ Bus and mixed scenarios give more sustainable mode shares

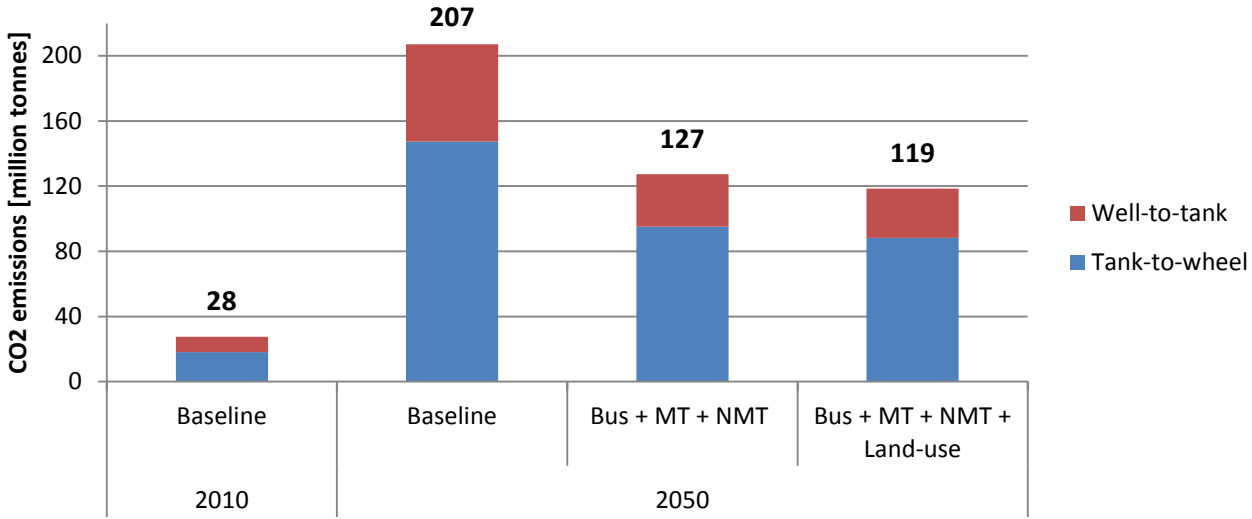


KEY TAKEAWAYS FOR MAXIMUM IMPACTS

- **Combination of mode investments yield superior outcomes - Integration**
- **Encourage low cost high impact Bus and NMT investments in combination with or without mass transit**
- **Investing in mass rapid transit in isolation is suboptimal**
- **Focus on Tier 3 cities with differentiated strategies compared to Tier 1 & 2**

LAND-USE SCENARIO

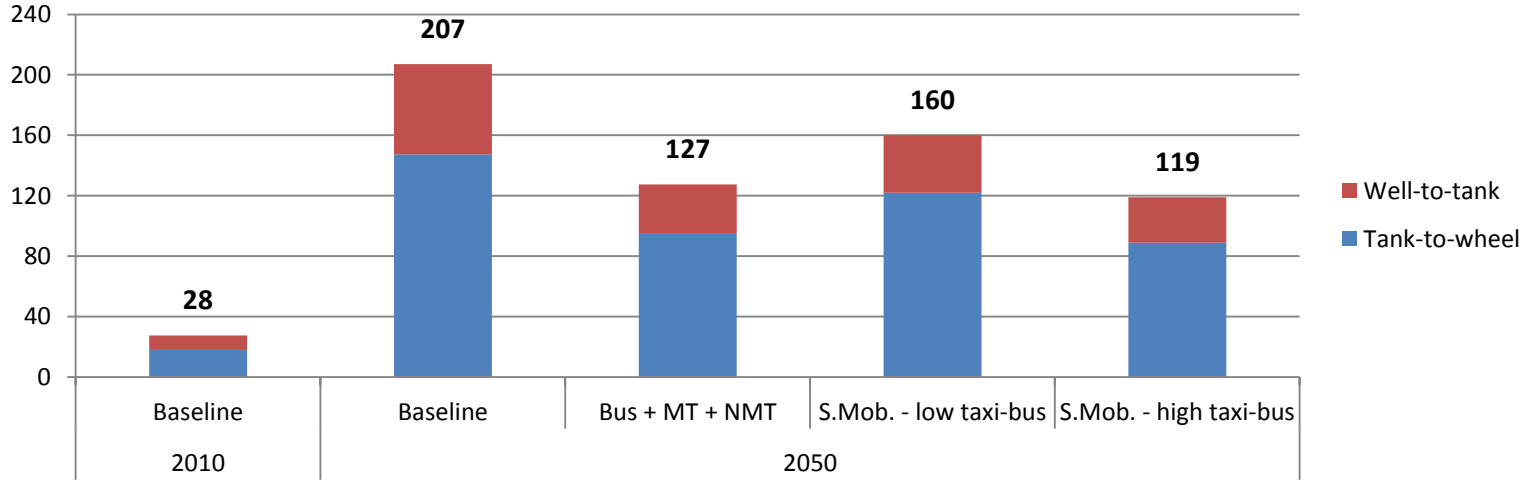
- **Limiting urban area growth from 2025 onwards can further reduce the CO_2 emissions by nearly 8mt in 2050.**



- **Limiting urban sprawl reduces the investment need**

SHARED MOBILITY SCENARIO

- **Introducing only the shared-taxi (4 pax) service has the risk of increasing CO_2 emissions, because the current car share is low.**
- **CO_2 benefits can be achieved when taxi-bus (16 pax) service takes high percentage of the shared vehicle fleet.**
- **The messages is consistent with ITF's shared mobility studies.**



VEHICLE TECHNOLOGY SCENARIOS

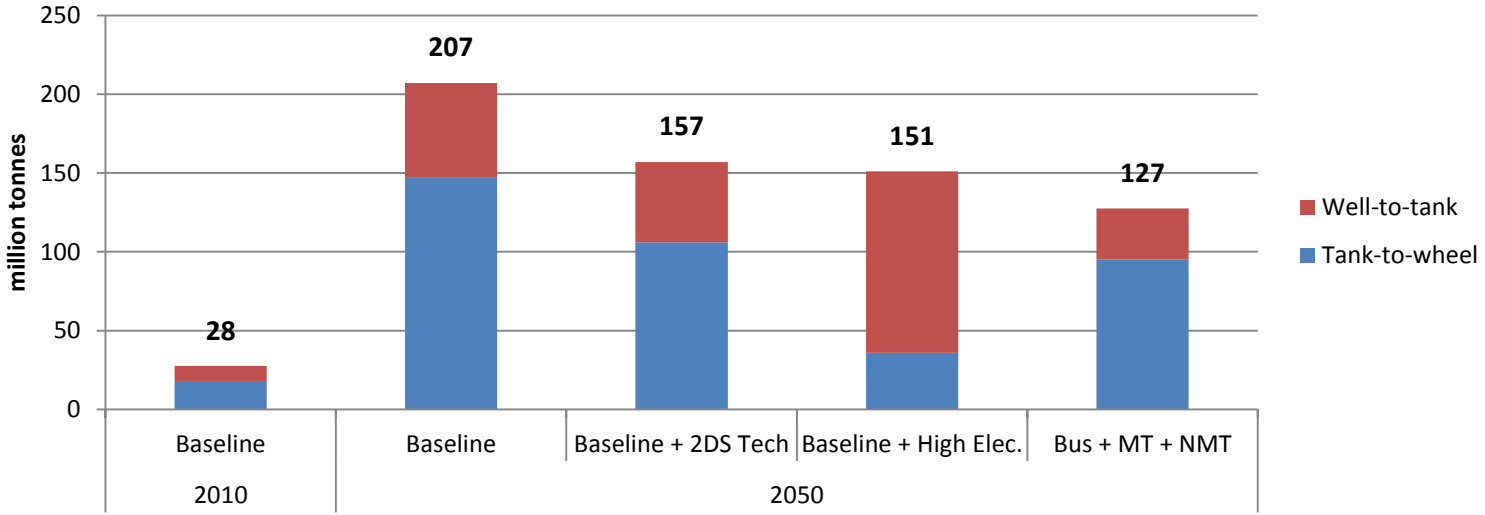
- **Introducing alternative vehicle technology pathway on top of the most effective scenario "Bus + MT + NMT"**

Scenarios	Bus, BRT	2W, 3W	Car
2DS Tech Path	2DS Fuel Eco, 2DS Fuel Share	2DS Fuel Eco, 2DS Fuel Share	2DS Fuel Eco, 2DS Fuel Share
High Electrification	40% elec. by 2030, 70% elec. by 2050, 4DS WTT	60% elec. by 2030, 100% elec. by 2050, 4DS WTT	40% elec. by 2030, 70% elec. by 2050, 4DS WTT

- **IEA's 2DS lays out an energy system deployment pathway and an emissions trajectory consistent with at least a 50% chance of limiting the average global temperature increase to 2° C.**

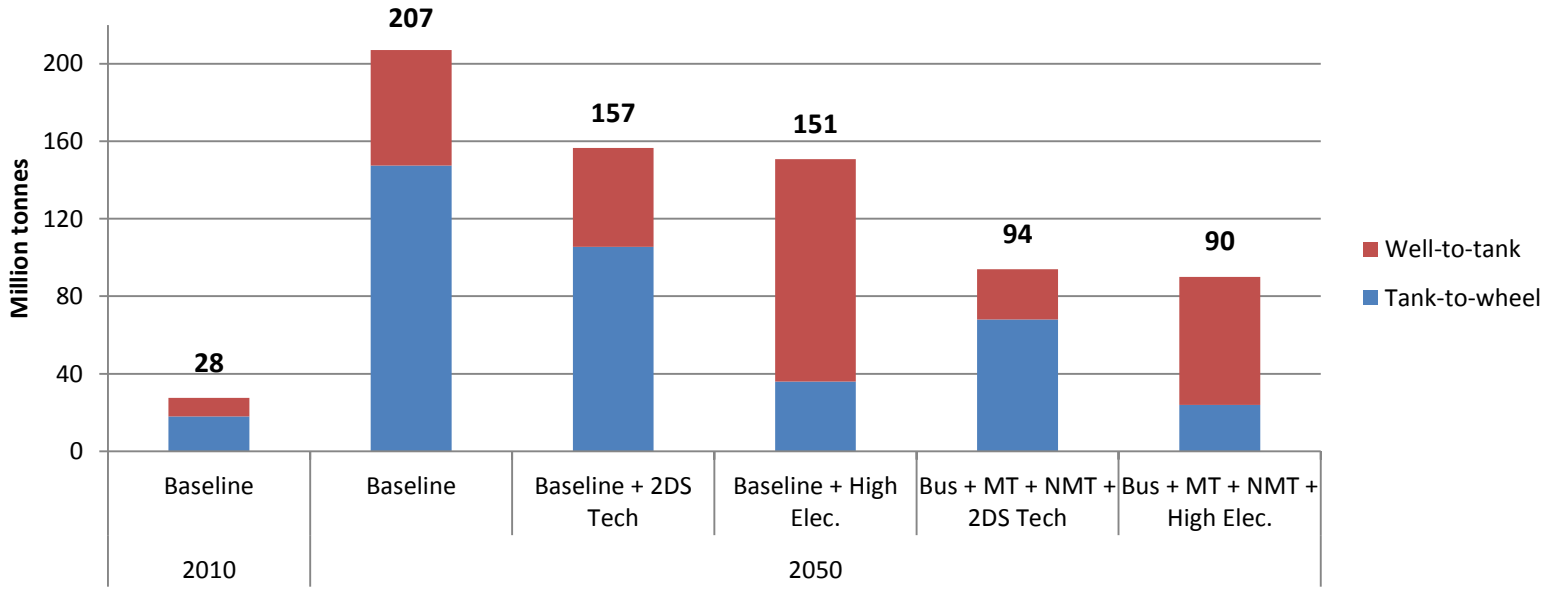
VEHICLE TECHNOLOGY SCENARIOS

- 2DS vehicle technology pathway, CO_2 emissions reduced further by 80mt
- High electrification scenario reduces CO2 emissions by 56mt
- But do not address sustainable mobility objectives (i.e. private vehicle use, congestion), in a way that the mixed strategy does

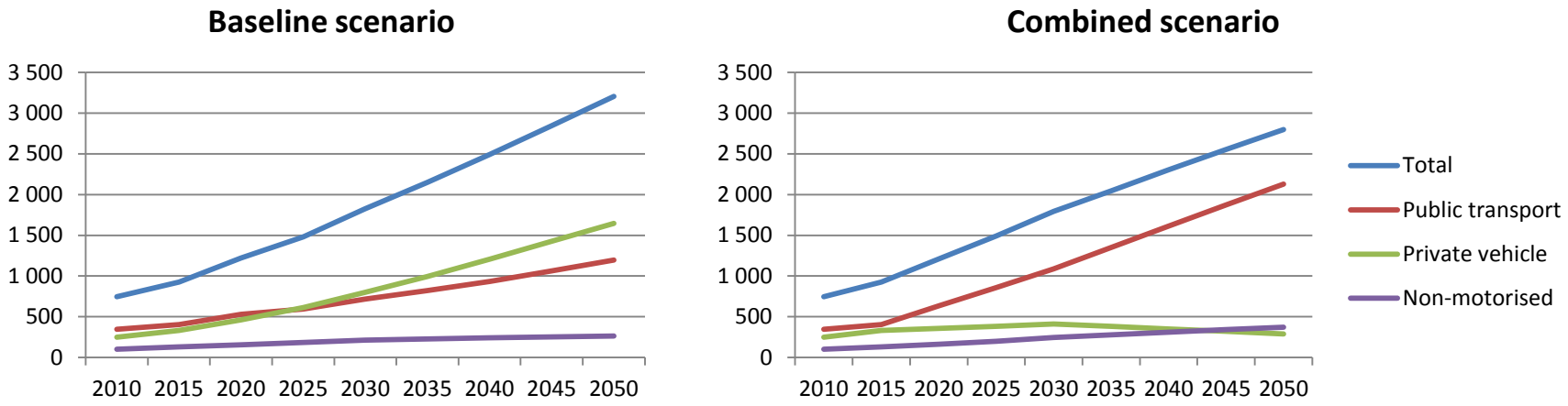


VEHICLE TECHNOLOGY SCENARIOS

- **Combining the mixed strategy with 2DS/High electrification can address both CO_2 and sustainable mobility objectives**
- **Focus next on clean source of electricity in high electrification scenario**



COMBINED IMPACT ON PASSENGER DEMAND



KEY TAKEAWAYS FOR MAXIMUM IMPACTS

- ❑ **Operationalize all policy levers together**
- ❑ **Focus on Tier 3 cities with differentiated strategies compared to Tier 1 & 2**
- ❑ **Controlling the urban footprint expansion for compact cities**
- ❑ **Encourage low cost high impact Bus and NMT investments in combination or without mass transit**
- ❑ **Emphasize high occupancy shared mobility**
- ❑ **Greening the Grid essential for realizing the electric mobility benefits**
- ❑ **Electric mobility strategy within the larger urban mobility strategy**

CURRENT LIMITATIONS

- Feedback from transport development to the land-use
- Dynamic interaction/equilibrium between travel demand and transport supply
- Congestion impacts of different types of transport infrastructures

Thank you

SHARED MOBILITY SCENARIOS

- **Introducing different levels of shared mobility services on top of the most effective scenario "Bus + MT + NMT"**

Scenarios	Target mode share of shared mobility services	% of taxi-bus in the shared vehicle fleet
S.Mob. – low taxi bus	20% by 2030, 30% by 2050	10% by 2030, 20% by 2050
S.Mob. – high taxi bus	20% by 2030, 30% by 2050	50% by 2030, 80% by 2050