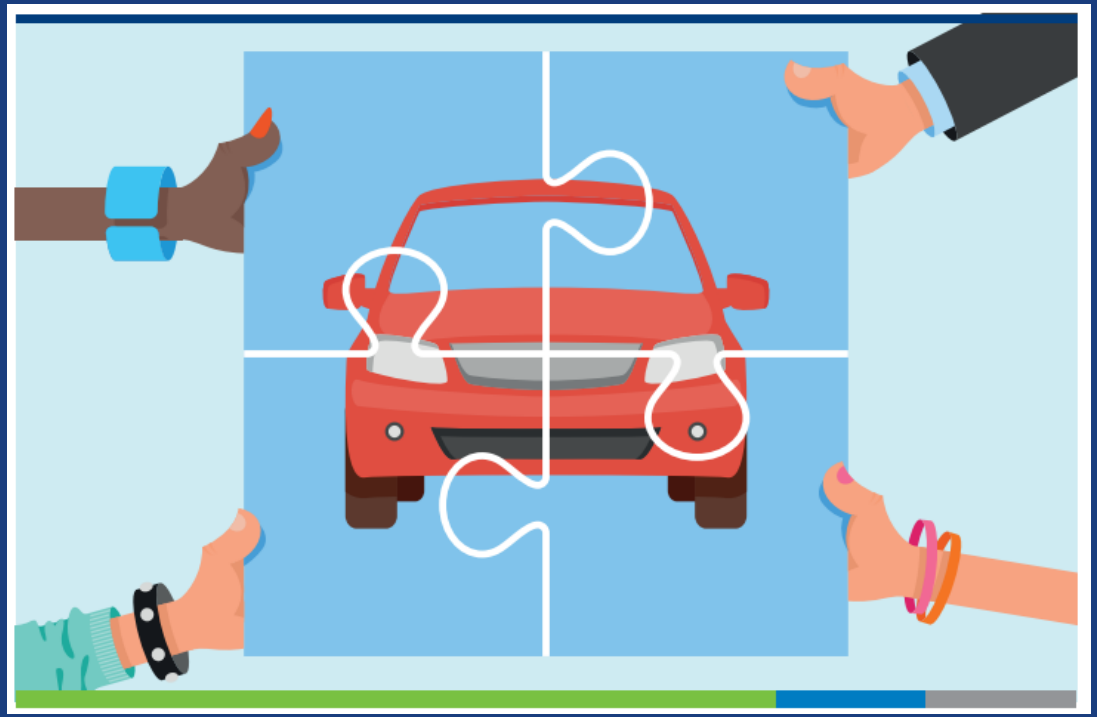
International Transport Forum

Introducing results from micro-simulation models on shared mobilityfor cities (Helsinki, Auckland, Dublin, Lisbon and Lyon) into the ITF urban passenger model

Luis Martinez
(with Olga Petrik, Francisco Furtado and Jari Kauppila)

ITEM4 Workshop,
IIASA, Laxenburg, Austria



OECD

What is the shared mobility concept we are exploring?

Not current TNC's solution…

International Transport Forum

Shared modes specification

Mode	Booking	Access time	Max. waiting time (depending on distance)	Max. total time loss (depending on distance)	Vehicle type
Shared Taxi	Real time	Door-to-door	5 minutes (≤ 3 km), up to 10 minutes (≥ 12 km)	Detour time + waiting time, from 7 minutes (≤3 km), up to 15 minutes (≥12 km)	Minivan of 8 seats rearranged for 6 seats, with easy entry/exit
Taxi-Bus	30 minutes in advance	Boarding and alighting up to 400 m away from door, at points designated in real time	Tolerance of 10 minutes from preferred boarding time	Minimum linear speed from origin to destination (15 km/h)	Minibuses with 8 and 16 seats. No standing places

OECD

Shared modes specification

Mode	Booking	Access time	Max. waiting time (depending on distance)	Max. total time loss (depending on distance)	Vehicle type
Platform carpooling	15 to 30 minutes in advance	Walk to a carpooling stop or drive to a carpooling dedicated parking lot	Tolerance of 15 minutes from preferred departure time	10 minutes access (walking or driving) + five extra minutes waiting at stop or depot + 10 minutes walking at destination	Regular private car (owner by the assigned driver)

Platform carpool

centralised private carpool dispatched

Qualitative comparison of transport modes

Service type	Service quality					
	Access	On-board time	Waiting	Transfers	Comfort	Price
Private Car	★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★
Public transport and/or	★★	★	★	★★	★★	★★★★★
Shared Taxi 	★★★★★	★★★★	★★★★	★★★★★	★★★★	★★
Taxi-Bus 	★★★	★★★	★★★	★★★★★	★★★★	★★★
Feeder service to rail, ferry or BRT 	★★★	★★★★	★★	★★★★	★★★	★★★★
Carpooling	★★★	★★★	★★★	★★★★	★★★	★★★

Assessing the range of quality of specification designed for shared mobility services
New services may emerge in this spectrum
(e.g. peer to peer ridesharing)

Legend:

Comparative modes performance rating

- ★ Very low performance
- ★★ Low performance
- ★★★ Average performance
- ★★★★ High performance
- ★★★★★ Very high performance

How to assess it?

International Transport Forum

Modelling Framework

Characterisation of the study area

Transport infrastructure and services
- Road network
- PT GTFS model

Spatial definition and resolution
- Study area boundaries
- Grid system definition

Mobility seed and transport mode preferences
- Travel survey
- Mode choice model

Transport performance by OD pair and mode
- Travel times by mode

Probability of trip production / attraction
Land use data (Grid)
- Population
- Employment
- Ameneties (POIs)
- Building footprint

Focus group and stated preference analysis
- Willingness to shift to SM

SM mode selection
Shared-Taxi, Taxi-Bus
Feeder service to rail, ferry or BRT

Synthetic mobility dataset
Household characterisation
(Residential location, family profile)

Individual data
(age, education level)

Mobility data
(trip sequence, each trip (origin, destination, schedule, purpose, transport mode))

Transport demand & supply scenarios
Demand (Scenario specification)
Private car trips,
(% modal shift to SM),
Bus trips (% modal shift to SM)

Supply (Scenario specification)
Private car (allowed: Yes/No)
Bus (preserved: Yes/No)
BRT (preserved: Yes/No)
Walking & biking (preserved: Yes)
Rail and Ferry (preserved: Yes)
Low Emission Zone (active: Yes/No)

Simulation (Outputs)
Service quality
- Waiting time
- Detour time

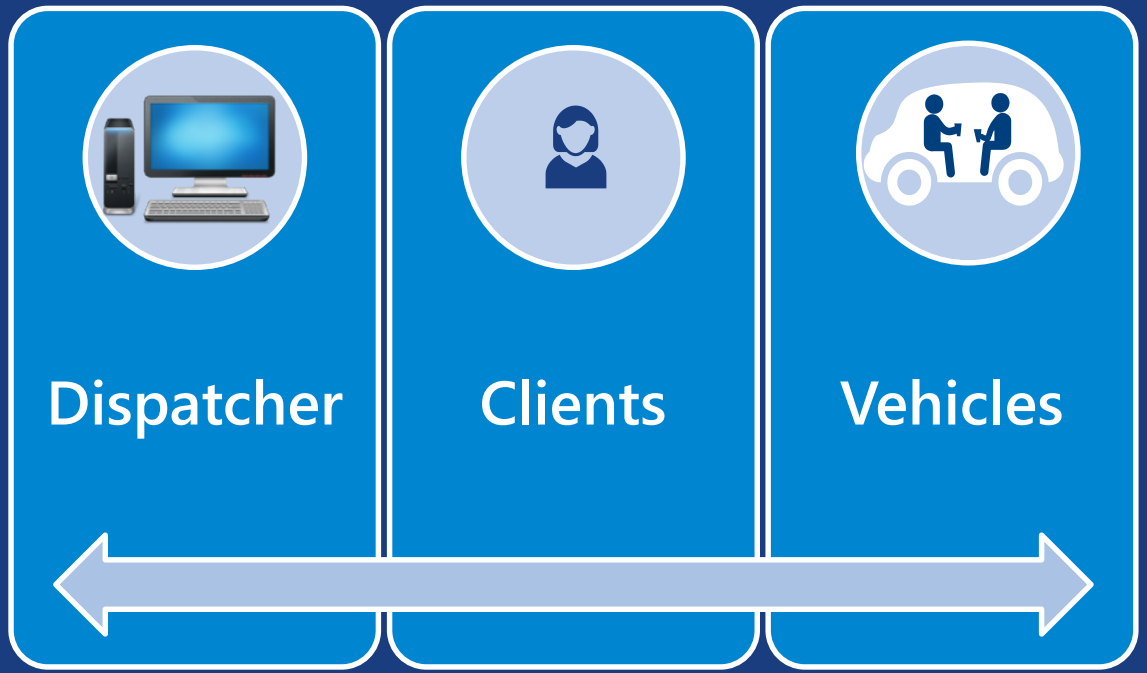
Operational Performance
- Average vehicle occupancy
- Fleet requirements
- Costs

Society (Sustainability)
- Emissions
- Congestion
- Accessibility indicators
- Parking requirements

OECD

International Transport Forum

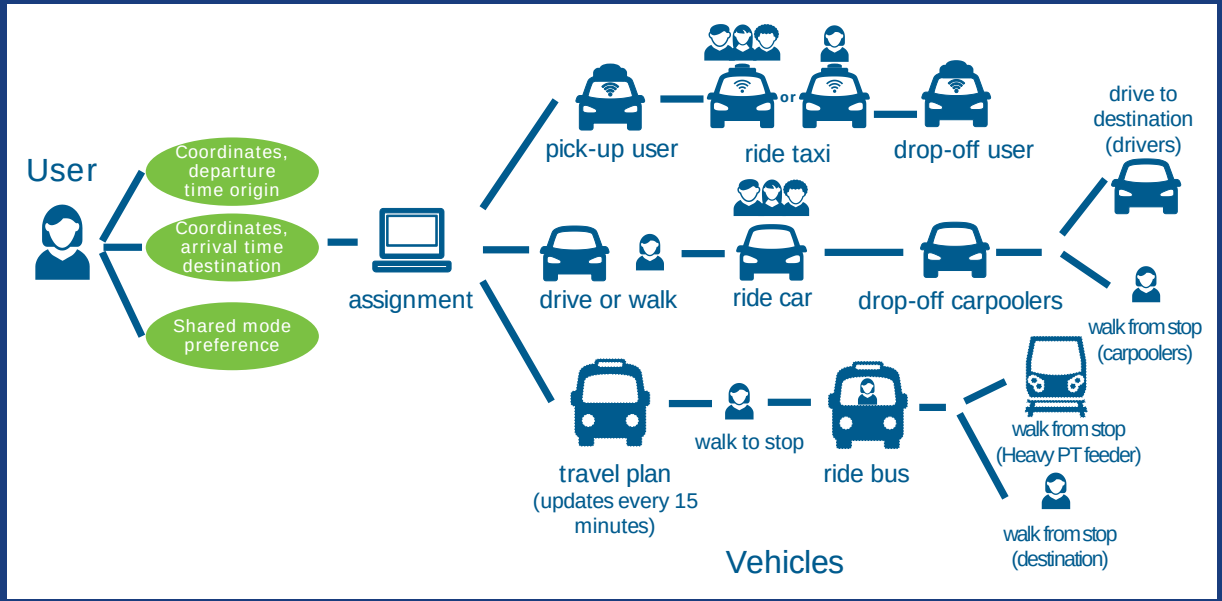
Agent-based Simulation framework



OECD

International Transport Forum

Agent-based Simulation framework



OECD

Current mobility

Land use patterns

Transport supply characterisation

Mode choice and car ownership

CO_2 intensity per inhabitant

Land use patterns

City	Highways network density (km/sqkm)*	Heavy PT infrastructure (km / 1000 inhab.)	PT service provision (seat-km heavy PT / 1 million inhab.)	Connectivity PT (avg. linear speed for trips > 1km) **	PT / PC travel time ratio (trips > 1km)
Auckland	0.2	0.1	3.7	8.0	2.8
Dublin	0.4	0.07	4.9	6.7	2.7
Helsinki	0.7	0.21	16.2	16.1	1.0
Lisbon	0.5	0.14	6.7	7.9	3.1
Lyon	0.8	0.15	9.8	12.1	1.9

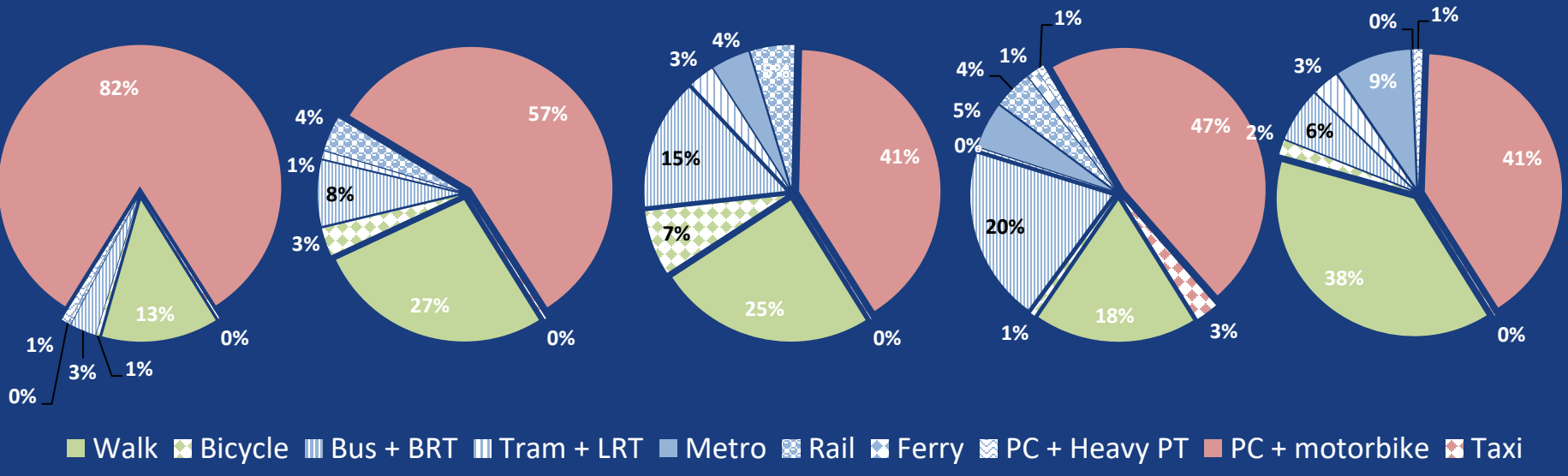
Transport supply characterisation

City	Study area size (total / active)	Population density (inhab. / sqkm – total / active surface)	Land use mixture (avg. entropy index)	CBD influence radius*
Auckland	2 233 / 986	582 / 1 318	0.32	17.5
Dublin	6 988 / 1 047	258 / 1 720	0.36	16.8
Helsinki	770 / 639	1 414 / 1 703	0.29	20.6
Lisbon	3 015 / 999	929 / 2 802	0.53	8.9
Lyon	532 / 512	2 518 / 2 616	0.48	12.6

* Highways are all road links with speed greater than 80 km/h.

** It includes 10 minutes penalty in the calculation for each transfer by public transport

Mode choice and car ownership



(Auckland) (Dublin) (Helsinki) (Lisbon) (Lyon)

Mode choice and car ownership

City	GDP per capita (USD/inhab.)	Car ownership (cars / 100 inhab.)	Non-motorised transport (%) *	Heavy public transport (%) **	Light public transport (%) ***	Private car (%) ****
Auckland	54 178	680	14	1	3	82
Dublin	56 971	350	30	5	8	57
Helsinki	49 364	320	32	12	15	41
Lisbon	32 434	217	19	12	20	49
Lyon	32 213	400	40	13	6	41

* includes walking and bicycle.
** includes rail, metro, bus rapid transit (BRT), light rail transit (LRT) and ferry.
*** includes bus and tram.
**** includes car, taxi and motorcycle, both as a driver and as a passenger.

CO2 intensity per inhabitant

6.0	3.1	2.5	3.5	2.9
(Auckland)	(Dublin)	(Helsinki)	(Lisbon)	(Lyon)

kg of CO_2 per inhabitant.day

Urban policy testing

Impacts Full adoption scenario
Factors affecting outcome
Testing targeted policies
Transition

International Transport Forum

Impacts (Full adoption scenario)

2.7	2.1	1.8	1.6	1.5
(Auckland)	(Dublin)	(Helsinki)	(Lisbon)	(Lyon)

CO2 /inhabitant

OECD

kg of CO_2 per inhabitant.day

Factors affecting outcome

Current modal share

Public transport quality

Density of the area

Trip patterns

International Transport Forum

Carbon intensity model

City layout (land use characteristics and mobility patterns)	Transport supply (public transport and road provision)	Shared mobility market adoption (private car and bus users adoption)
Average trip distance (km)	Highways network density (km/sqkm)	Share of users of conventional bus * (%)
Case study area size (skm)	Service provision (seat-km heavy PT per 1 million inhabitants)	Share of users of high performance bus (%)
Non-motorised transport (%)		Share of remaining car users ** (%)
Population density (inhab. / sqkm)		

* High performance is considered either a BRT or buses with a high level of service (BHLS) or bus service with headway lower than 7.5 minutes. The remaining bus is considered conventional.
** This variable measures the resulting car modal share after the adoption of shared mobility by part of the original demand defined in the input scenario.

International Transport Forum

Carbon intensity model

Urban context factor analysis

Variable	PA1	PA2
Highways network density (km/sqkm)	**-0.66**	**0.75**
Service provision (seat-km heavy PT per 1 million inhabitants)	**1.04**	-0.07
Population density (inhab. / sqkm)	0.21	**0.77**
Non-motorised transport (%)	**-0.67**	**0.68**
Average trip distance (km)	0.55	**-0.68**
Case study area size (skm)	0.54	-0.03

PA1 is characterised by strong public transport provision and low non-motorised transport and private car infrastructure provision. This factor was designated "*public transport centred mobility*"

PA2 is explained by strong non-motorised mobility in a dense urban context with shorter trips but in presence of good motorway network. This factor was named "*dense urban context*"

International Transport Forum

Carbon intensity model

Urban context factor analysis

Variable	PA1	PA2
Highways network density (km/sqkm)	**-0.66**	**0.75**
Service provision (seat-km heavy PT per 1 million inhabitants)	**1.04**	-0.07
Population density (inhab. / sqkm)	0.21	**0.77**
Non-motorised transport (%)	**-0.67**	**0.68**
Average trip distance (km)	0.55	**-0.68**
Case study area size (skm)	0.54	-0.03

PA1 is characterised by strong public transport provision and low non-motorised transport and private car infrastructure provision. This factor was designated "*public transport centred mobility*"

PA2 is explained by strong non-motorised mobility in a dense urban context with shorter trips but in presence of good motorway network. This factor was named "*dense urban context*"

International Transport Forum

Carbon intensity model

Regression model

Explanatory variable	Coefficients	Standard Error	t-stat	p-value
Intercept	1.626	0.506	3.211	0.006
Share of remaining car users (%)	3.379	0.272	12.413	0.000
Share of users of conventional bus (%)	0.322	1.761	0.183	0.858
Share of users of high performance bus (%)	-1.766	1.854	-0.953	0.356
PA1 (“public transport centered mobility”)	-0.112	0.121	-0.925	0.369
PA2 (“dense urban context”)	-0.269	0.145	-1.857	0.083
Car ownership	0.001	0.001	1.244	0.233

International Transport Forum

Carbon intensity model

Carbon intensity elasticity

Explanatory variable	Elasticity
Share of remaining car users (%)	0.39
Share of users of conventional bus (%)	0.04
Share of users of high performance bus (%)	-0.05
Highways network density (km/sqkm)	-0.07
Service provision (seat-km heavy PT per 1 million inhabitants)	-0.15
Population density (inhab. / sqkm)	-0.16
Non-motorised transport (%)	-0.14
Average trip distance (km)	0.08
Case study area size (skm)	-0.09
Car ownership	0.15

International Transport Forum

Carbon intensity model

Adaptations to the model for forecasting

1. The intercept of the equation has to be adjusted proportionally to the vehicle.km weight CO_2 intensity of different countries when compared to current European standards used in the model calibration. This is true both for different world regions and for estimated future vehicle fleets

2. In three input variables related to motorised vehicles (Share of remaining car users (%), Share of users of conventional bus (%) and Share of users of high performance bus (%)) , the input shares should also be corrected proportionally to the equivalent 2015 CO_2 intensity of European fleet composition standards to account for differences in vehicle fleet across countries and periods

International Transport Forum

Carbon intensity model

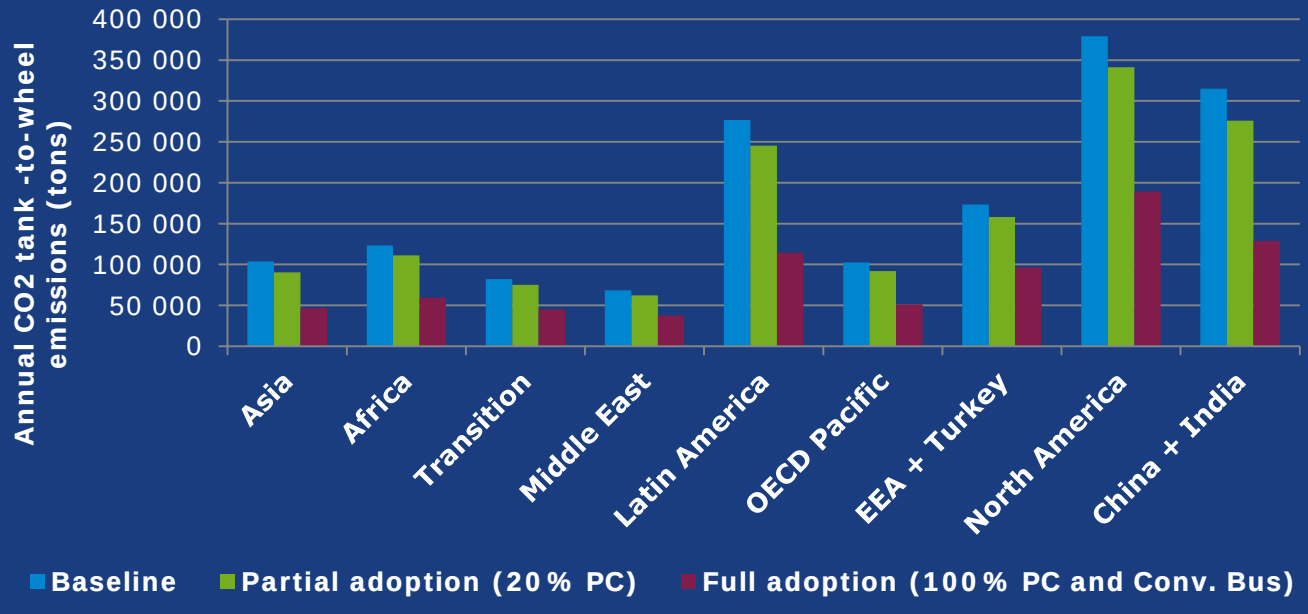
Model testing – Scenarios (Baseline year 2015)

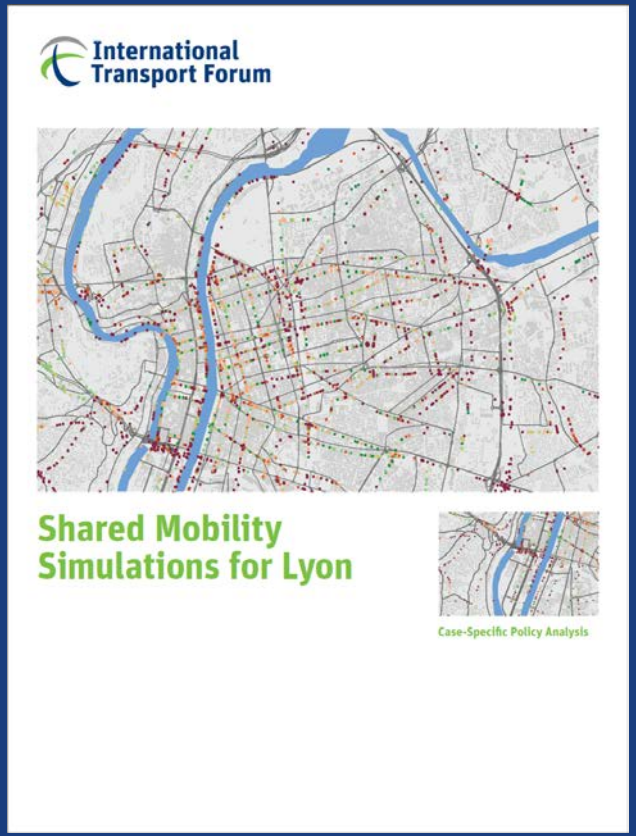
1. • **Baseline scenario:** The CO2 emissions are obtained directly from the ITF urban mobility model
2. • **Scenario partial adoption:** 20% of private car mobility is replaced by shared mobility services in all cities of the world
3. • **Scenario full adoption:** All private car conventional bus trips are replaced with trips by shared mobility services in all cities of the world;

International Transport Forum

Carbon intensity model

Model testing – Results

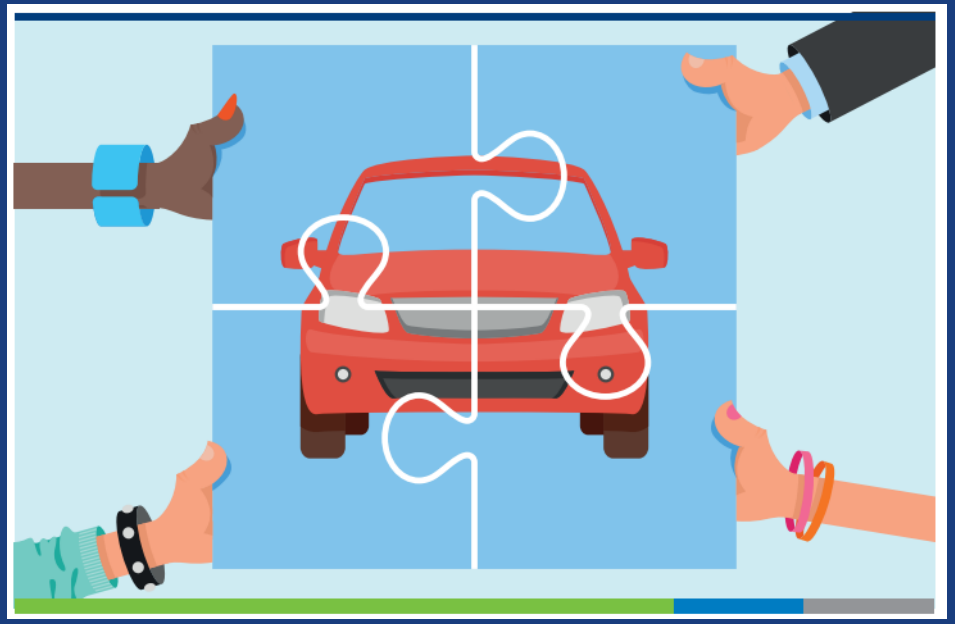




Next reports

1. Shared Mobility Simulations for Lyon
2. Shared Mobility Simulations Methodology

International Transport Forum



Thank you!

Luis.MARTINEZ@itf-oecd.org

Francisco.FURTADO@itf-oecd.org

Olga.PETRIK@itf-oecd.org

Jari.KAUPPILA@itf-oecd.org

Latest reports available at
https://www.itf-oecd.org/itf-work-shared-mobility

OECD