



Professor Heikki Liimatainen

# THE NEEDS AND DRIVERS FOR TRANSPORT TRANSFORMATION

Why do we need a transport transformation?

## The dilemma:

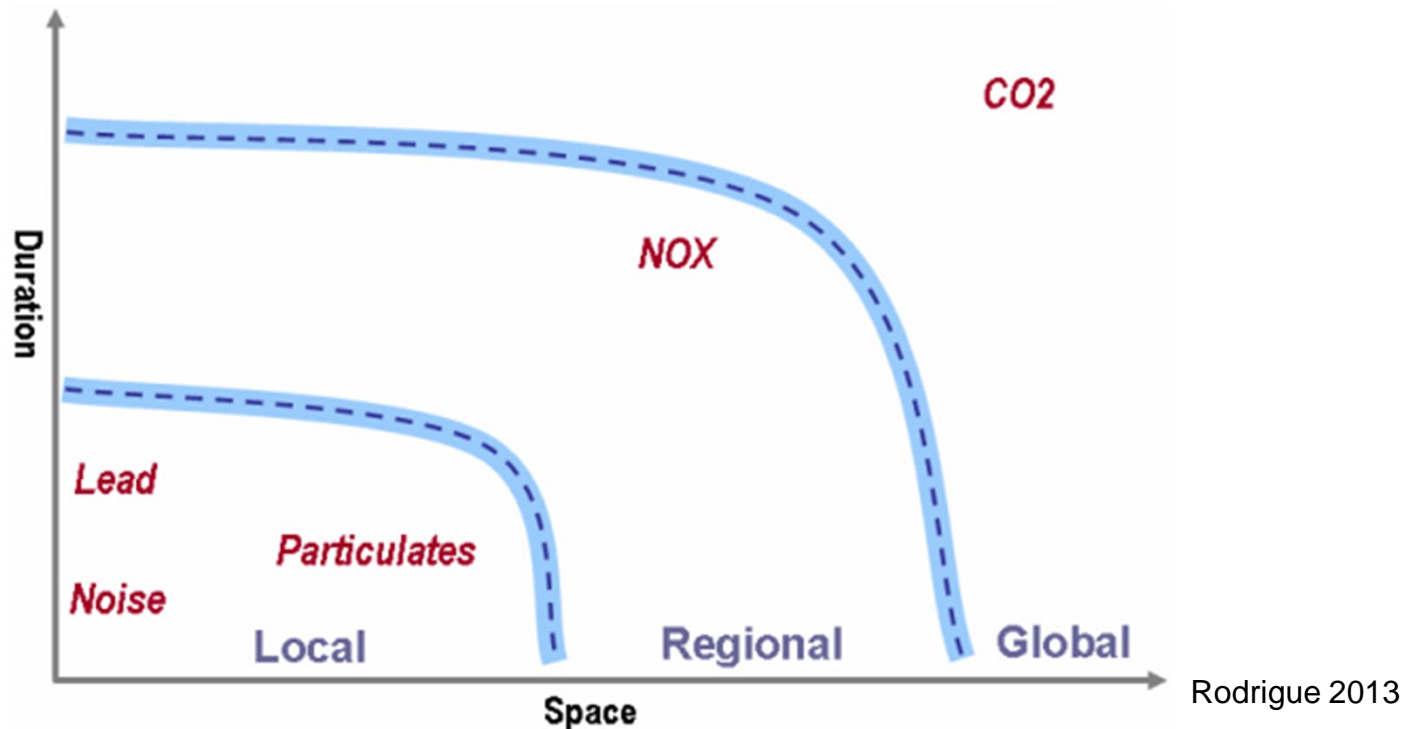
- On the other hand transport is a prerequisite for economic development and social equality,
- but
- on the other hand transport inevitably(?) causes negative environmental and social impacts

# The social problems of transport

- **Globally 1.35 million people killed every year**
  - 9th leading cause of death, close to HIV/AIDS and diabetes
  - the leading cause of death for children and young adults aged 5-29 years
- **In Finland 3000 killed and 79000 injured in ten years (2005-2014)**
  - Roads are a working place for hundreds of thousands of drivers. What other working place would allow such occupational hazard?

# The environmental problems of transport

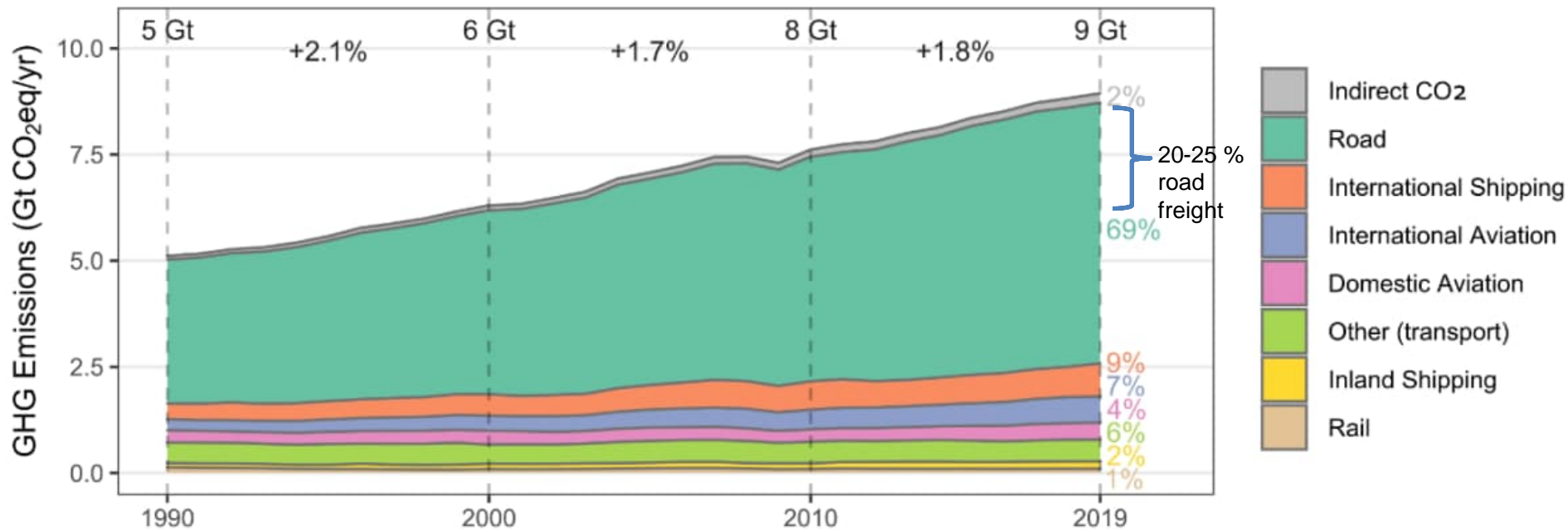
- Exhaust gases cause respiratory and heart diseases which kill as much or even more people than accidents (Yim & Barrett 2012)





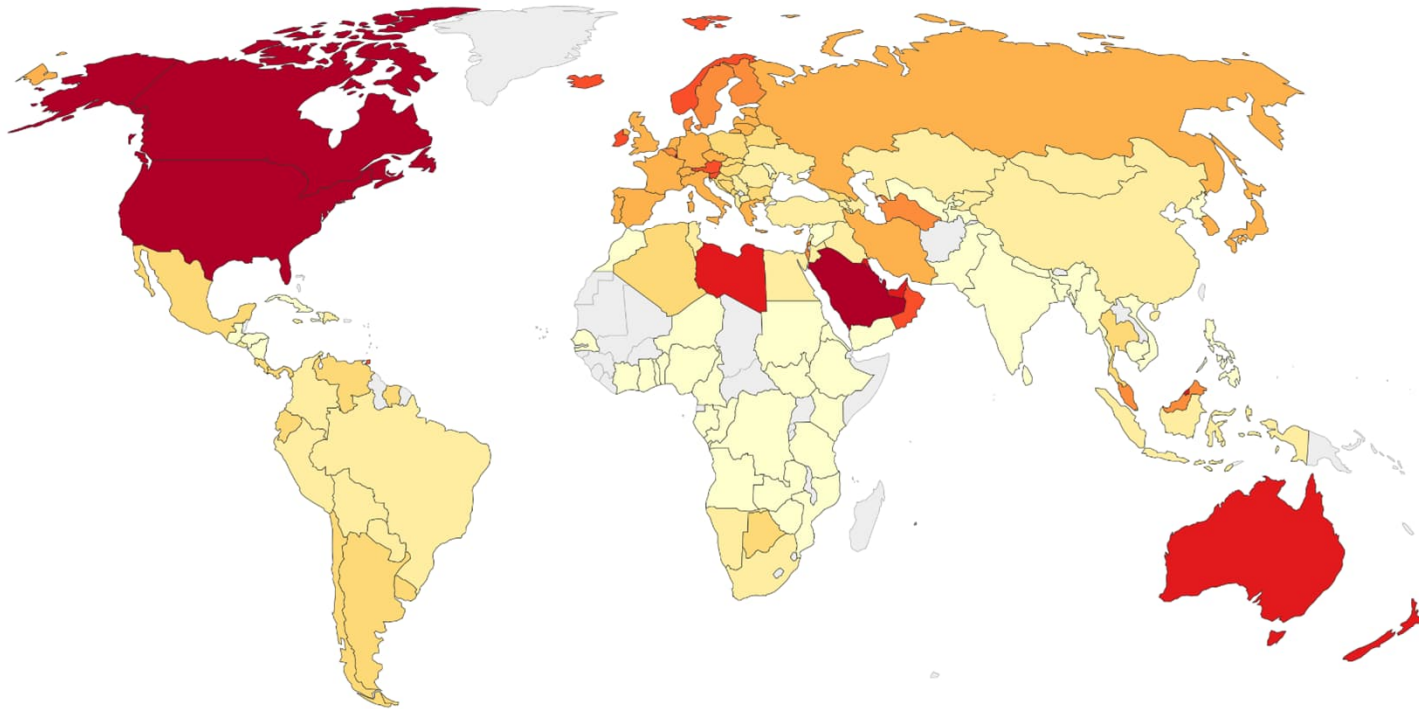
# Roughly 15% of total GHG emissions and about 23% of global energy-related emissions

a. Transport global GHG emissions trends

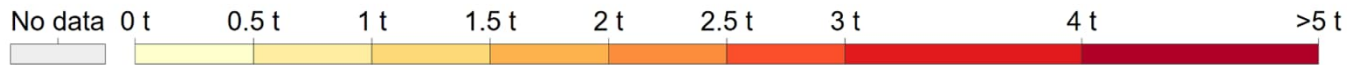


# Per capita CO<sub>2</sub> emissions from transport

Our World  
in Data



USA:	5,3
Canada:	4,7
Finland:	2,3
Germany:	2,0
Russia:	1,7
Mexico:	1,3
China:	0,6
India:	0,2



Source: CAIT Climate Data Explorer via. Climate Watch  
Note: International aviation and shipping emissions are not included.

OurWorldInData.org/transport • CC BY

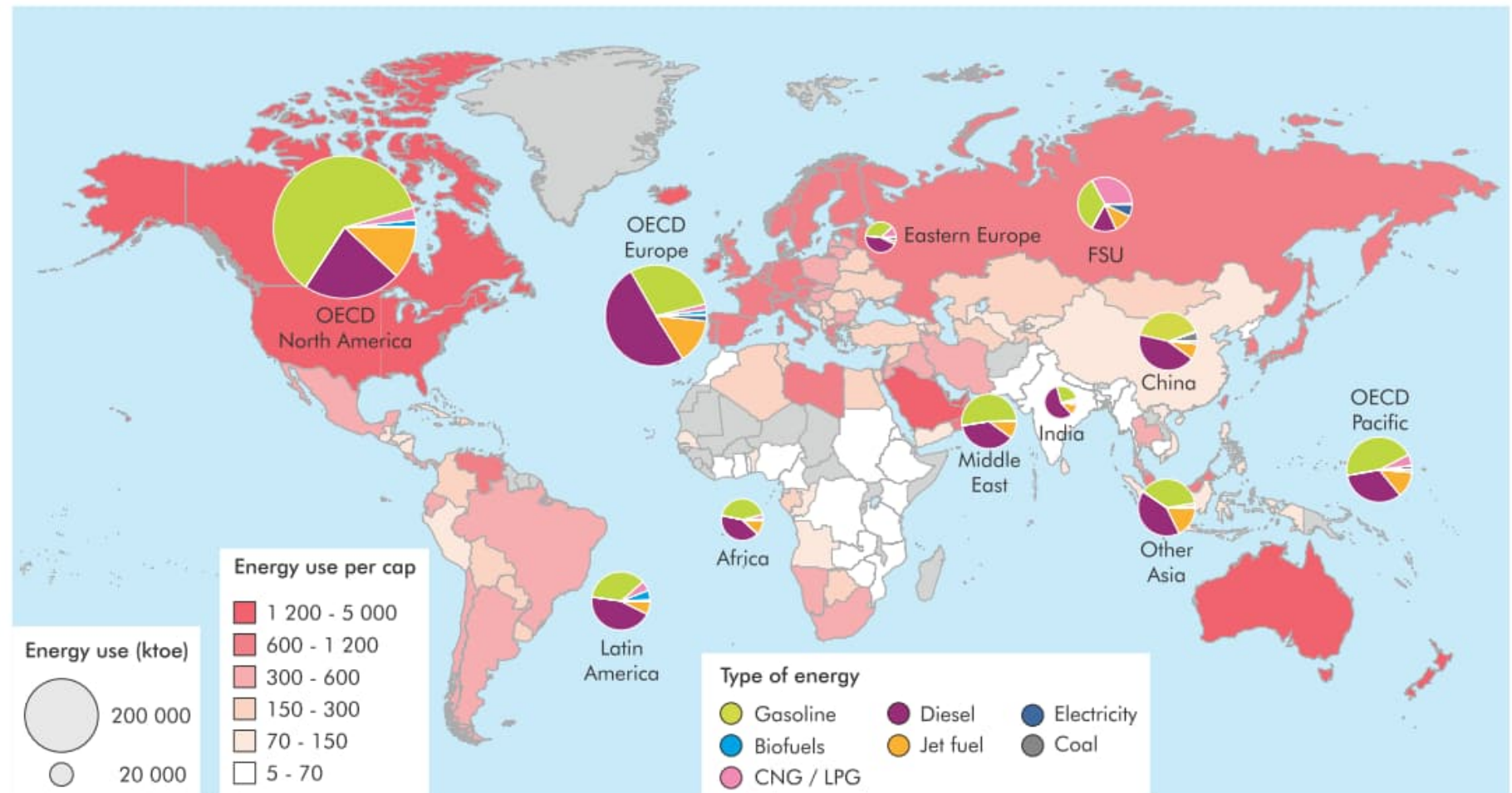
# The economic problems of transport

- **Transport is almost entirely dependent of fossil oil**
  - EU countries spend 200 billion € annually on imported oil (EC 2011)
- **Current car-based transport system is inherently inefficient:**
  - Average car in motion only 30 min/day and
  - while in motion, only carries on average 1.8 persons,
  - furthermore, internal combustion engines only have the efficiency ratio of about 20 %
- **Transport poverty**
  - a situation where people are struggling or unable to make the journeys they need, due to e.g. lack of transport infrastructure or services or high costs of transport

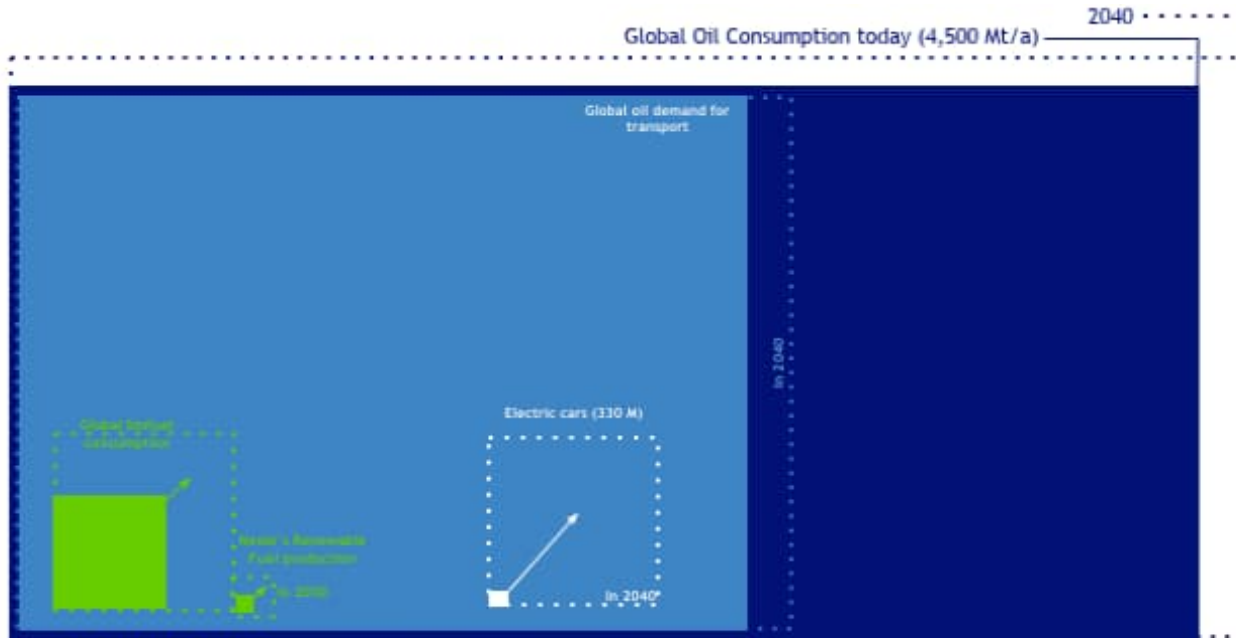


# Energy – the ultimate problem (IEA 2009)

Figure 1.2 ▶ Transport sector energy use per capita, 2006



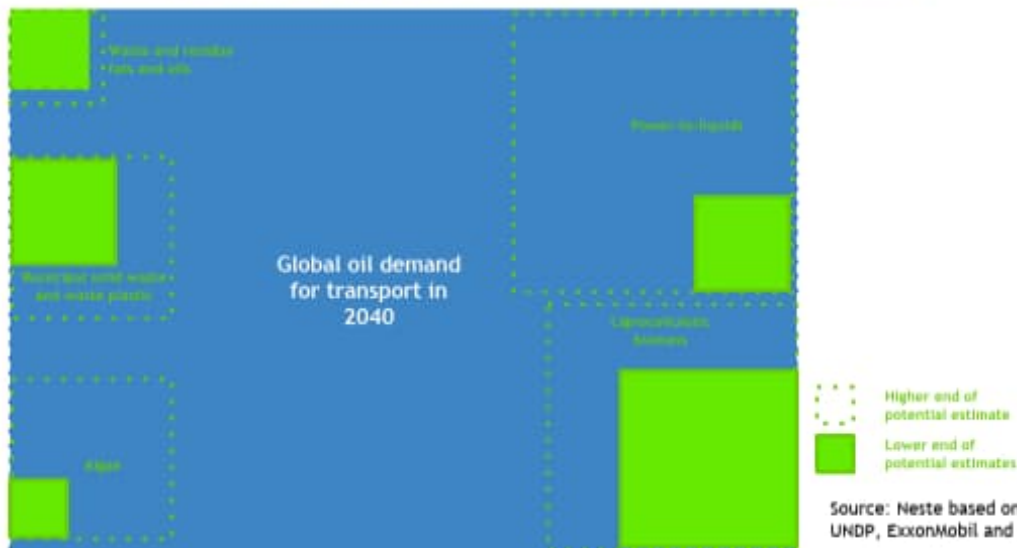
# Limited potential of renewable fuels



Source: Neste based on IEA World Energy Outlook 2019, Stated Policies Scenario

NESTE

Estimated potential for different liquid fuel feedstocks beyond 2040 (Mt fuel equivalent)



Source: Neste based on IEA, UNDP, ExxonMobil and others

NESTE

## Sustainable transport should:

- contribute to GHG reduction, meet air quality and noise standards and minimise waste and impacts on biodiversity (***environmental target***),
- promote growth, secure jobs, reflect costs of transport, ensure fair competition and cheap mobility of people and supply of goods through efficient system (***economic target***) and
- improve road safety, protect health, minimise the impact of noise, promote good access to goods and services and provide efficient distribution service to all (***societal target***).

(adapted from DETR 1999)

## In other words: triple vision zero 2050!

- **0** individuals or companies affected by transport poverty
- **0** deaths in accidents
- **0** emissions

How do we achieve the transport transformation?



# Framework of transport and logistics transformation

## NEEDS / DRIVERS

**50% emission reduction**  
in transport by 2030

**5 bn€** maintenance backlog  
of transport networks

- LIVI 2,5 bn€
- Cities etc. 2,5 bn€

### Transport revolution

- Automation,
- Electrification,
- Servitization

### Transport system attributes

- Sustainable
- Safe
- Resource efficient
- Resilient

### Y-Generation mindset

- Own vs. shared car
- Carpooling
- Active lifestyle

## ENABLERS

### Technology strengths

- Communication (5G etc.)
- Ambient perception & remote sensing
- Low-carbon fuels
- Energy storages
- Block chain

### Flexible legislation

- Automated driving
- Data collection
- Innovative procurement

### Demanding conditions and diverse test sites.

### EU-projects + large scale piloting

### Finnish PPPs and co-creation

### Smart allocation of extra funding to transport network

- 1 billion €/year
- (Liikenneinfra 2040 report: scenario Huima 2018-40)

## GROWTH & EXPORT OPPORTUNITIES

### Digital transport network & infrastructure

- ICT and smart energy grids
- Asset management and maintenance
- Arctic road and weather excellence

### Clean and attractive public transport

- Low-carbon and electric vehicles
- Smart fleet management and maintenance
- Smart charging systems
- IoT & smart services

### Digital travel agency - MaaS++

- Seamless travel chains, Mobility-on-Demand, first/last mile connections
- Value added mobility services

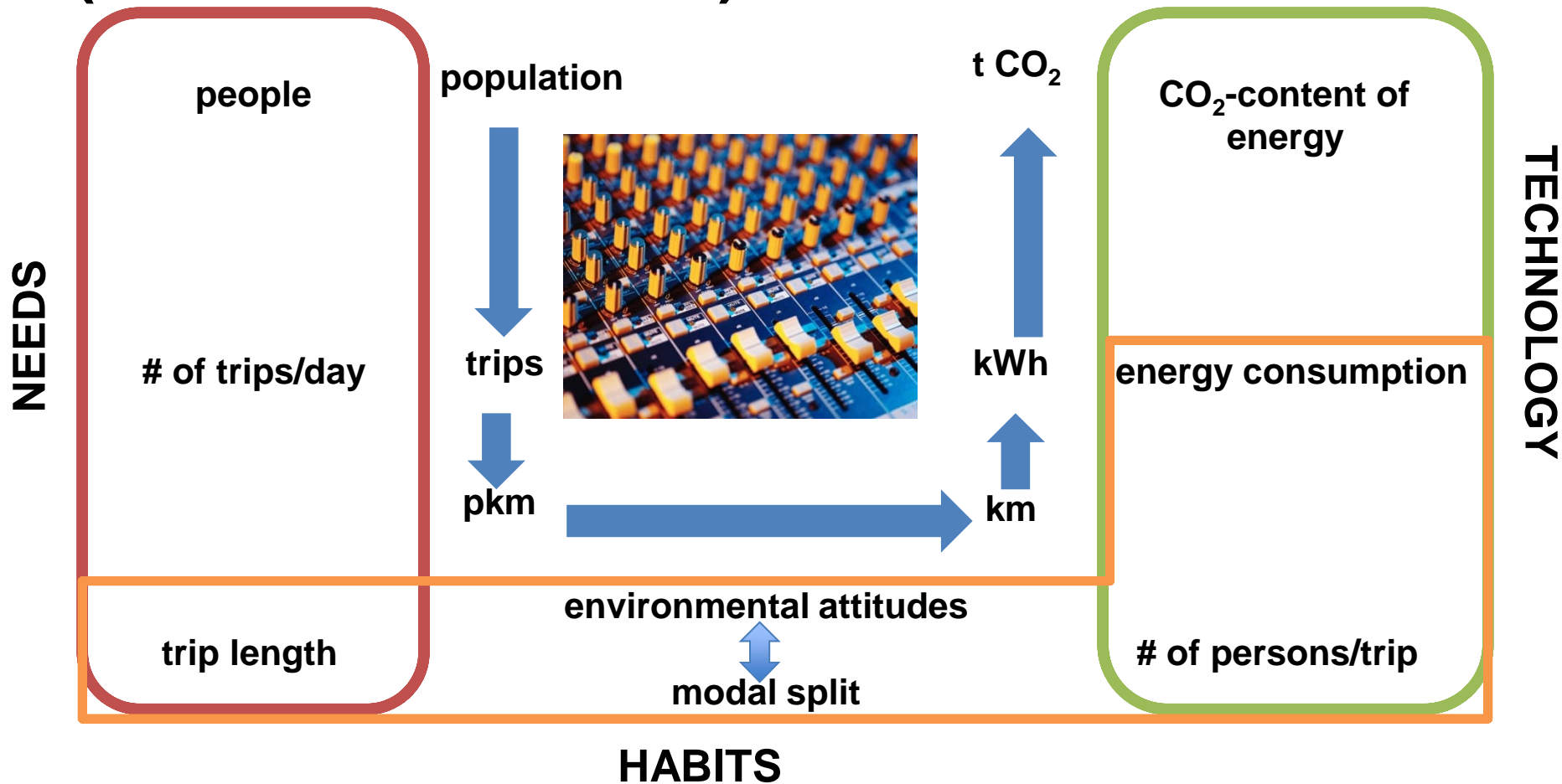
### Automated vehicles

- Connected Automated Driving
- Arctic conditions as a speciality
- Automated vessels and mobile machinery

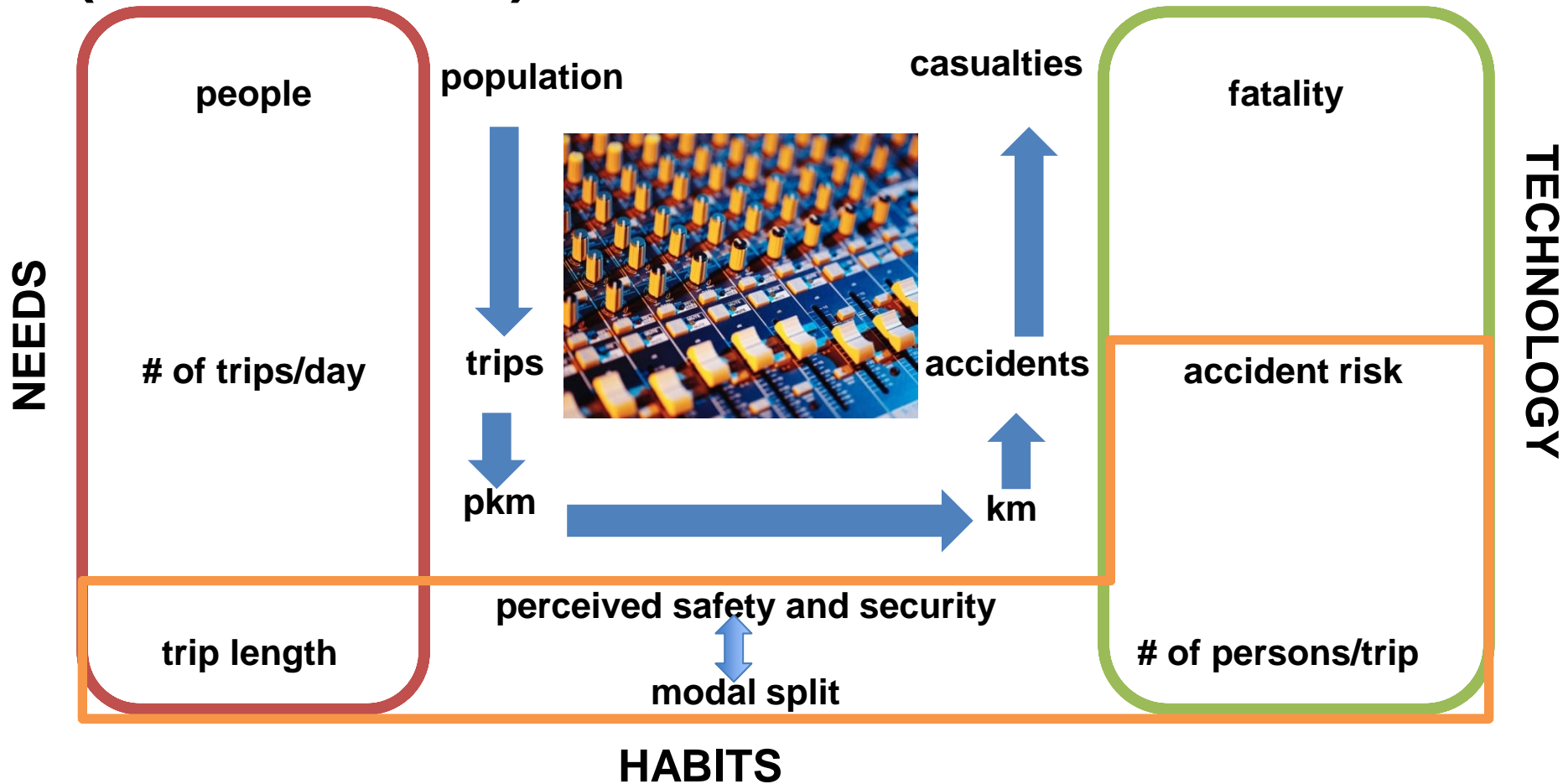
### Smart intermodal logistics

- Modular intermodal combined transport
- Smart first/last mile delivery
- Automated loading and ports
- Digital supply chains

# Mixing table for transport transformation (environmental view)

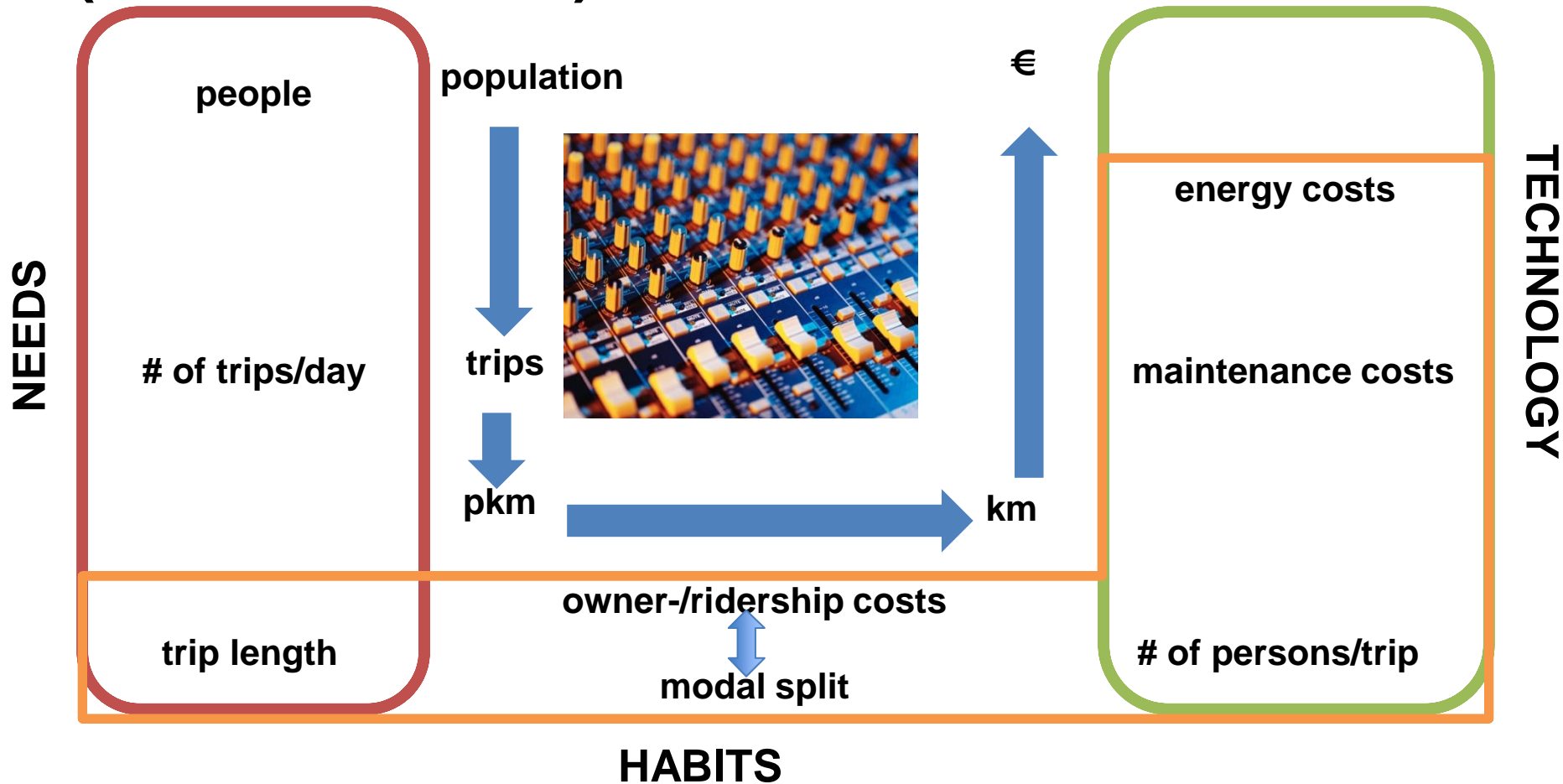


# Mixing table for transport transformation (societal view)





# Mixing table for transport transformation (economic view)

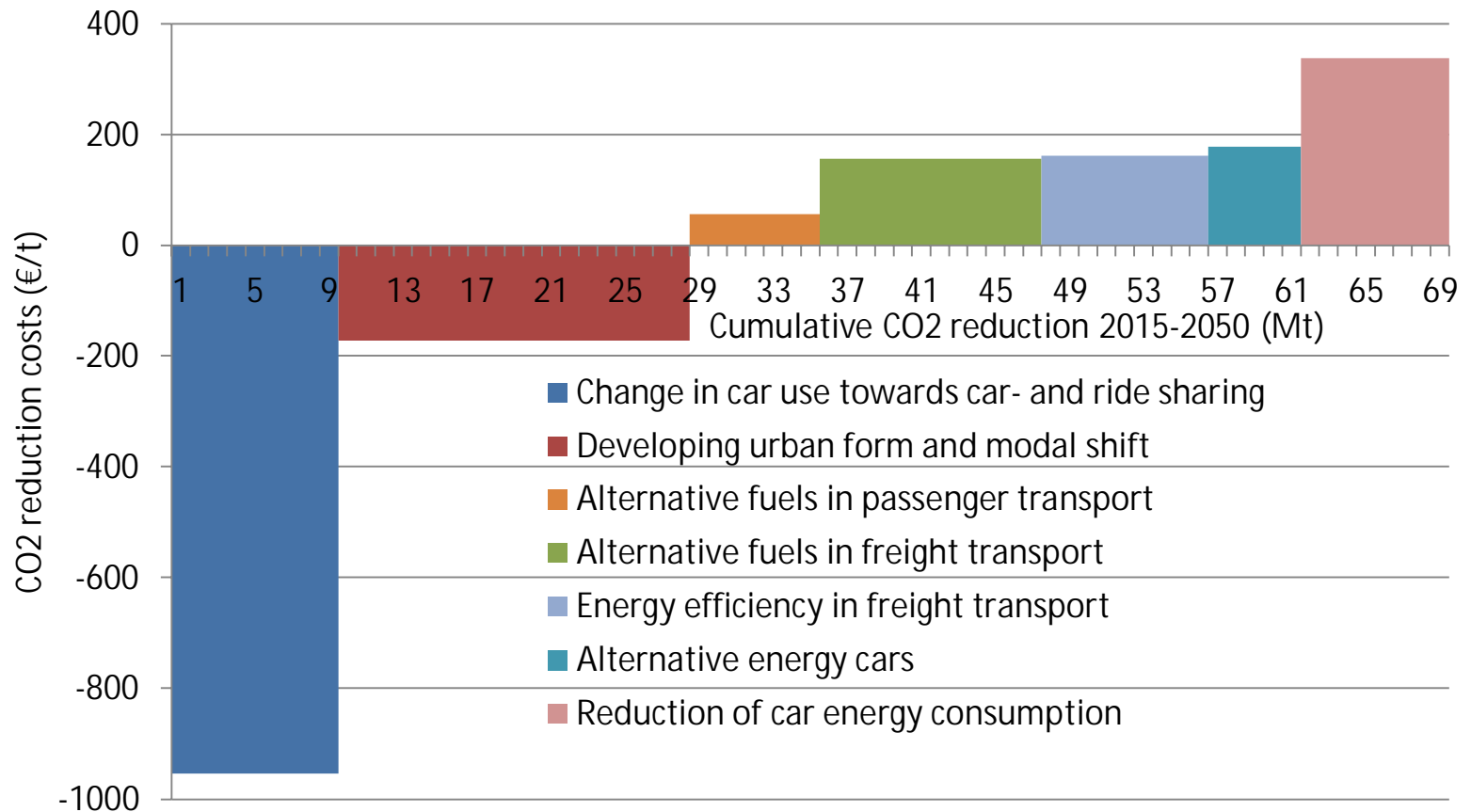


# Decisions for transport transformation

	Decision making level			Timeframe		
	Municipality	Finland	EU	2020-2025	2025-2035	2035-2050
Urban form	land use planning	land use legislation		street plan	city master plan	regional master plan
Promoting walking and cycling	infrastructure investments	mobility management		comfort of traffic environment	high quality cycling network	car free zones
Promoting public transport	infrastructure investments, increasing level of service	infrastructure, national payment and information system		payment and informations systems, bus lanes	park-and-ride, public transport streets, rail public transport	rail public transport, automated demand responsive public transport
Changing car use habits	parking policy	taxation, subsidies	legislation of automated vehicles	car and ride sharing	Mobility as a Service (MaaS)	automated vehicles
Technologies to decrease environmental effects of cars	infrastructure for alternative energy	taxation, infrastructure for alternative energy	emission standards	taxation	standards, infrastructure for electric vehicles	standards, infrastructure for hydrogen vehicles
Technologies to improve road safety	traffic calming	taxation, road infrastructure	vehicle approval criteria	active collision avoidance systems, eCall	vehicle to vehicle and infrastructure communication	automated vehicles

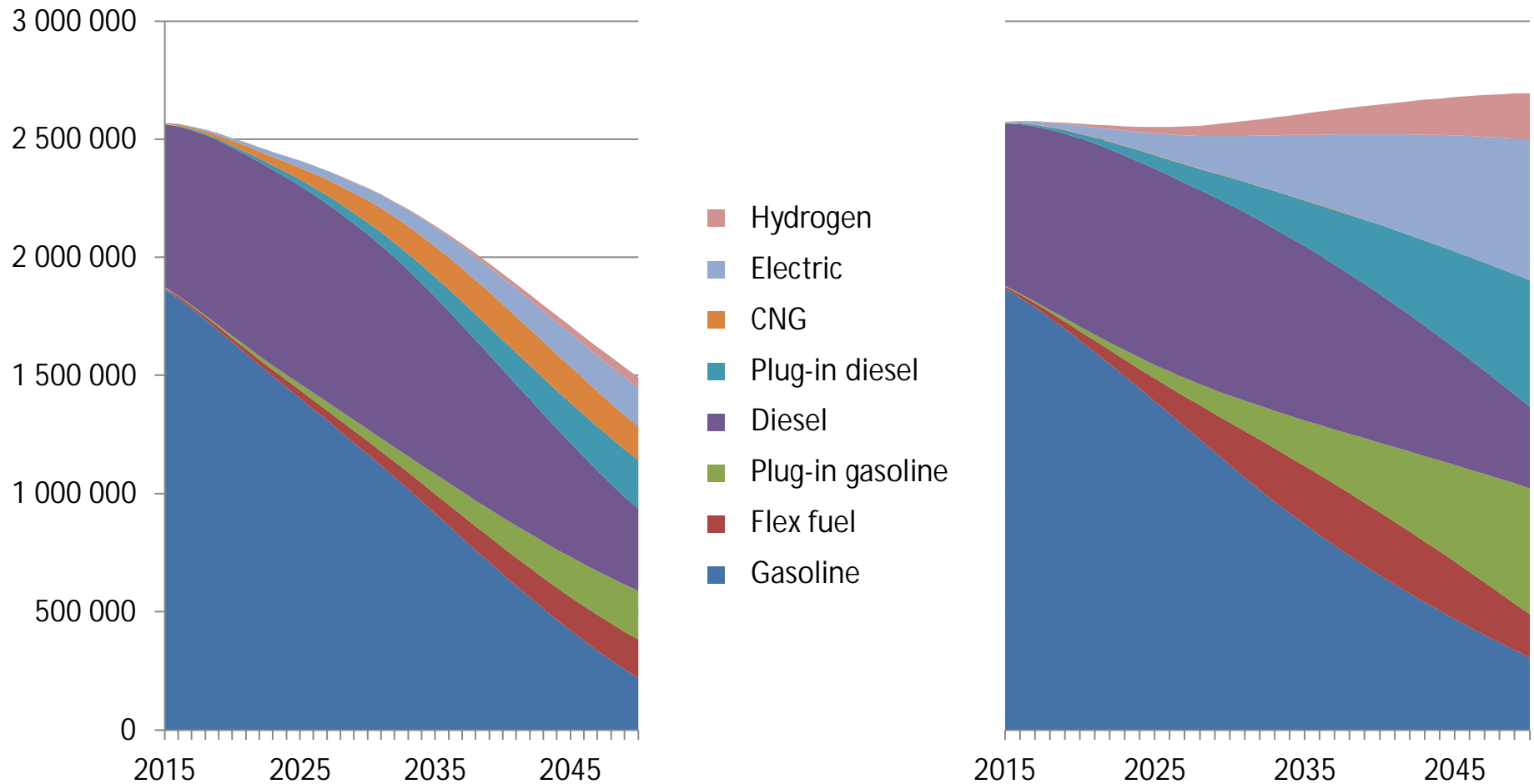


# Cost efficiency of CO2 reduction measures



# If there is no change in needs and habits:

*Finnish car pool in Recommendation (left) and Technology scenario (right)*



**If only technological measures are used, the costs are 19 billion € and benefits 4 billion €. Unit costs for CO<sub>2</sub> reduction are 225 €/t.**

**With measures affecting transport needs and habits the costs are 21 billion € and benefits (health, decreased vehicle costs) 25 billion €. Unit costs for CO<sub>2</sub> reduction are -52 €/t.**

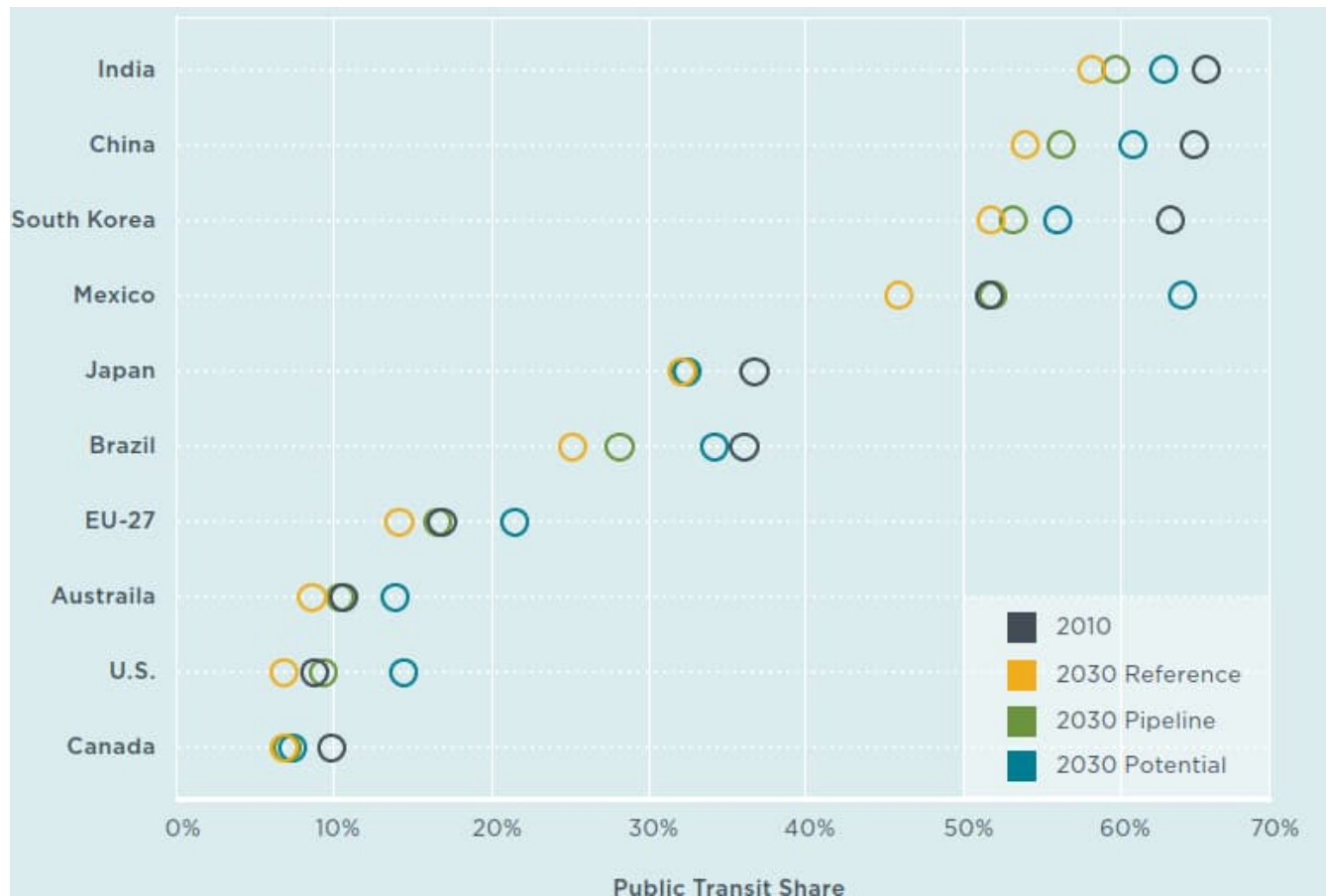
Research Article | [Open Access](#) | Published: 21 December 2018

## CO<sub>2</sub> reduction costs and benefits in transport: socio-technical scenarios

[Heikki Liimatainen](#), [Markus Pöllänen](#)  & [Riku Viri](#)

[European Journal of Futures Research](#) **6**, Article number: 22 (2018) | [Cite this article](#)

# Status and potential of modal shift (ICCT 2012)



How can digitalisation and electrification help to achieve the transport transformation?



# Transport transformation toolbox provided by digitalisation and electrification

- **Big data from transport for better transport system planning, infrastructure construction and maintenance and dynamic traffic management**
  - IF privacy issues are resolved
- **Tailor-made mobility solutions for people**
  - IF transport service providers cooperate with travel information and payment systems
- **Smart grid with electric vehicles as power storage units**
  - IF consumers benefit from it
- **Cost efficient publicly purchased transport services**
  - IF the organisational silos are removed
- **Efficient logistics through cargo status data, dynamic routing, cargo exchange, loading scheduling, automated reporting and billing**
  - IF the solutions are easy to use and cost efficient enough for small hauliers

# Digitalisation and transport habits

- **People are happy with current mobility – but it could be cheaper**
- **BUT are people aware of the actual costs of alternatives?**

## Characteristics of good mobility

		Importance		Current state
Smoothness	1	4.6	3	4.3
Ease of use	2	4.5	2	4.3
Safety	3	4.5	1	4.3
Low costs	4	4.4	8	3.3
Healthiness	5	3.6	7	3.4
Privacy	6	3.5	4	4.0
Environmental	7	3.5	5	3.4
Progressiveness	8	3.3	6	3.4
Experience	9	2.8	9	3.1
Community	10	2.6	10	2.9

# Digitalisation and transport habits

- **How to make transport cheaper? Do anything but own a car!**
- **Why don't we sell our cars? Alternatives are not convenient enough.**

Mode	Number of trips (million)	Transport volume (billion pkm)	Costs (billion €)	€/trip	€/pkm
Walking	1110,2	1,7			
Cycling	426,9	1,3	0,2	0,37	0,12
Car	3066,6	53,9	15,1	4,94	0,28
Bus	243,8	4,3	0,7	2,70	0,15
Train	110,1	4,5	0,4	3,51	0,09
Plane or ship	21,1	20,1	2,0	92,95	0,10
Total	5190,9	88,9	19,0	3,66	0,21

Sources: National travel survey 2010–11,  
Household expenditures 2012

# Digitalisation and transport habits

Transport spendings in Finland 19,0 billion € annually, 3500 €/ capita, 80% car related, 17% of total household spendings  
**→ Huge market potential for all transport services!**

Car maintenance and spare parts; 2.75 billion €

Autojen huolto ja varaosat; 2,75 mrd. €

Other car costs (parking, taxes...); 2.94 billion €

Muut autojen kustannukset (pysäköinti, vakuutukset, verot, ym.); 2,94 mrd. €

Fuel and lubricants; 3.68 billion €

Poltto- ja voiteluaineet; 3,68 mrd. €

Car purchase; 5.76 billion €

Autojen hankinta; 5,76 mrd. €

Other transport; 3.89 billion €

Muu liikenne; 3,89 mrd. €

Lento- ja laivaliput ja valmismatkat; 1,96 mrd. €

Polkupyörien hankinta; 0,16 mrd. €

Moottoripyörien, -kelkkojen ym. hankinta ja varaosat; 0,55 mrd. €

Taksimatkat; 0,17 mrd. €

Linja-automatkat; 0,66 mrd. €

Junamatkat; 0,39 mrd. €

Bus trips; 0.66 billion €

Train trips; 0.39 billion €

Plane and ship trips and group travel; 1.96 billion €

Bike purchase; 0.16 billion €

Motorcycle, etc.; 0.55 billion €

Taxi trips; 0.17 billion €

# Digitalisation and transport habits

- There is a large potential for ride-sharing and car-sharing
- **BUT ONLY IF the alternative is as smooth and easy to use as own car**
- → critical mass

What is your attitude towards the following statements?

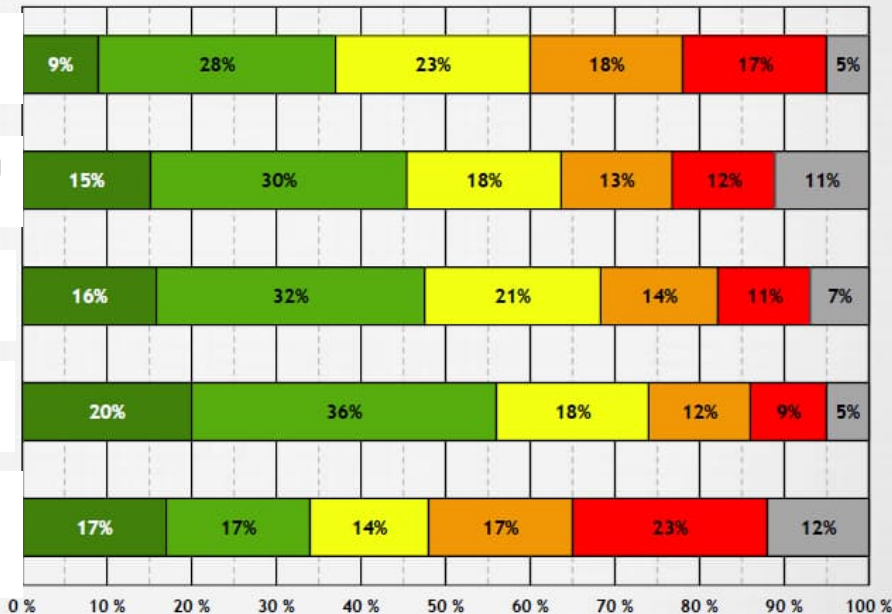
Willing to give personal information for personal services

Willing to driving habit monitoring for lower insurance costs

Willing to use ridesharing if I'd know who would come along

Willing to use ridesharing if it reduces costs

Willing to give up own car if the same costs would cover taxi rides



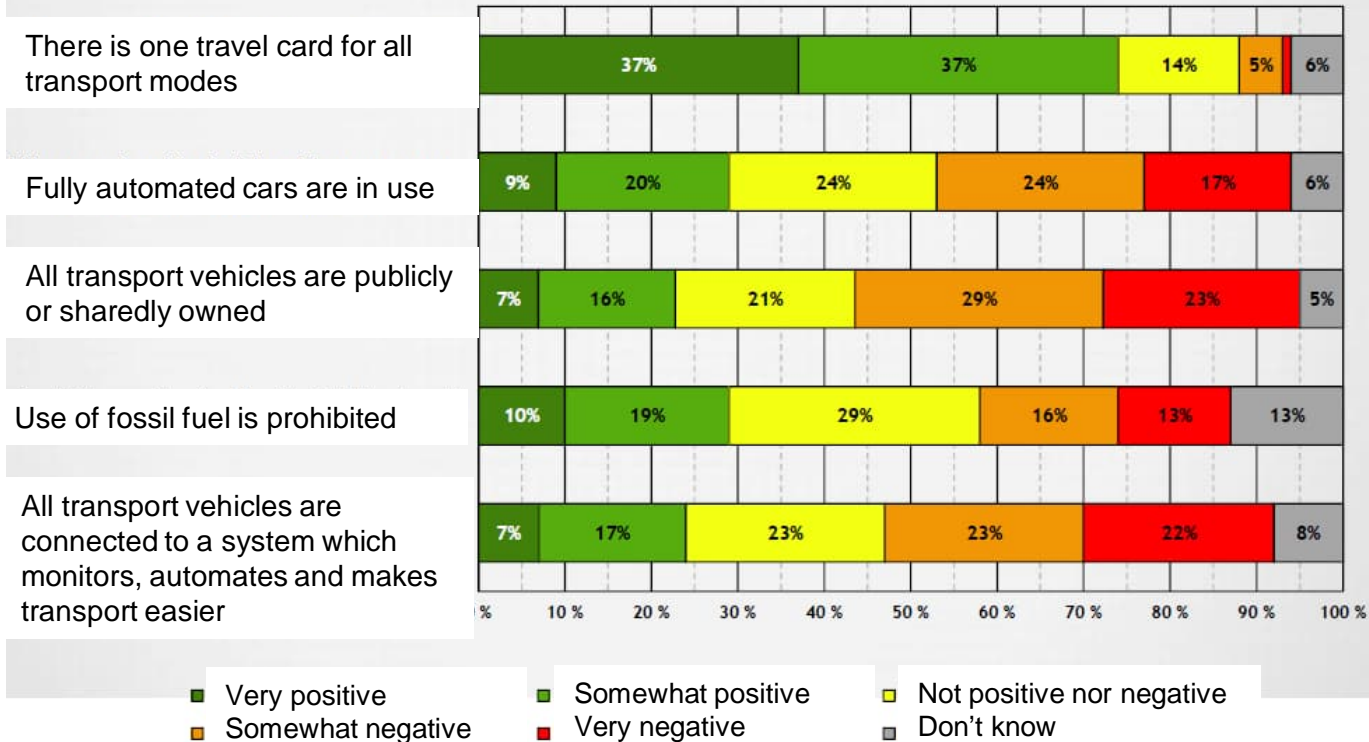
■ Fully agree  
■ Not agree nor disagree  
■ Fully disagree  
■ Somewhat agree  
■ Somewhat disagree  
■ Don't know



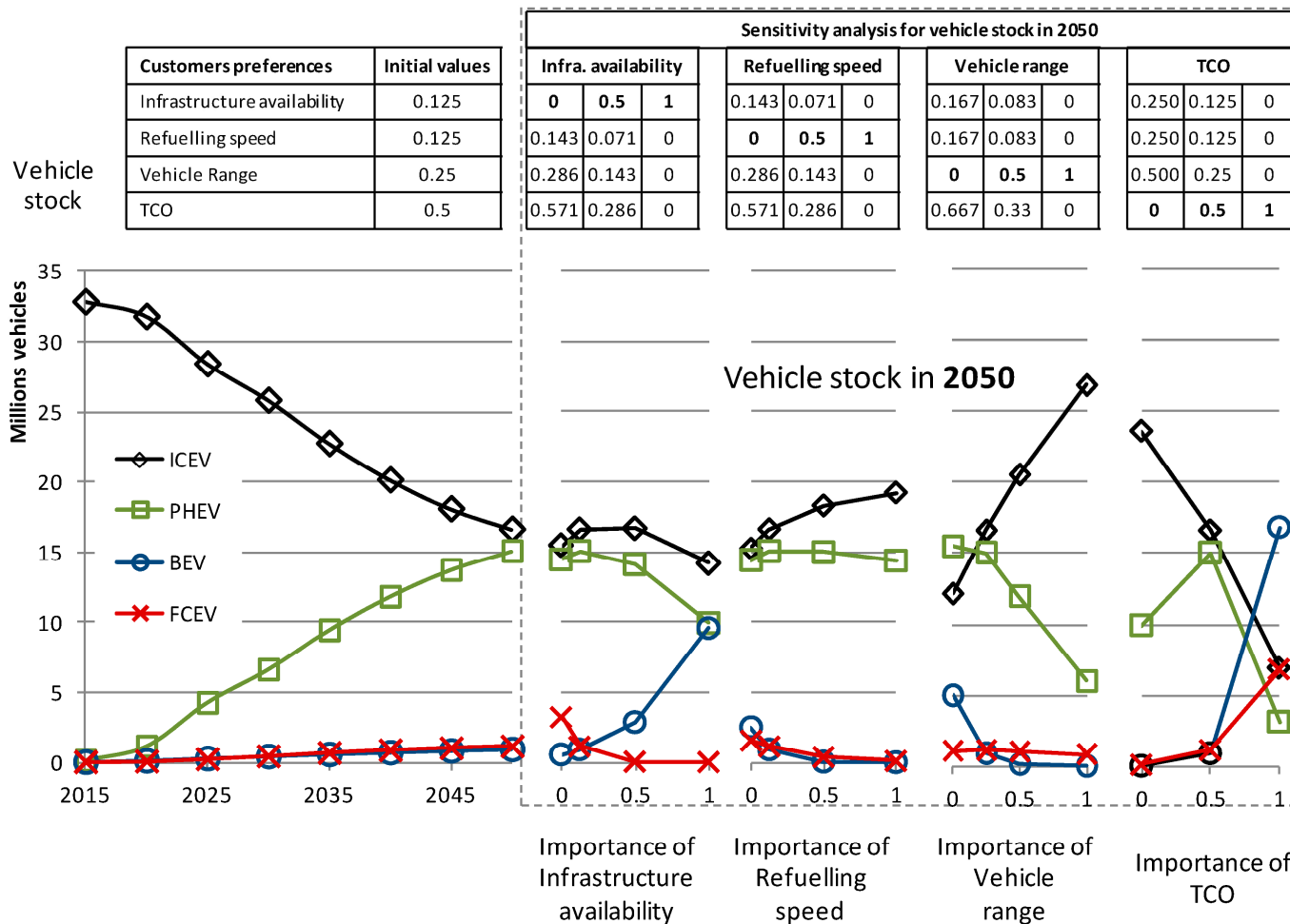
# Digitalisation and transport habits

- **Please implement a national, intermodal travel card, NFC credit/debit card payment or MaaS app immediately!**

What is your attitude towards the following statements?



**“Influencing car buyer’s preferences is the single most important measure on its own in the current paradigm. Adapting them in such a way that range anxiety and the fear of infrastructure availability are alleviated improves the position of both BEVs and FCEVs. If the full TCO is taken into account then BEVs are likely to become the dominant choice.” (Mazur et al. 2018)**



PHEV = plug-in hybrid electric vehicle

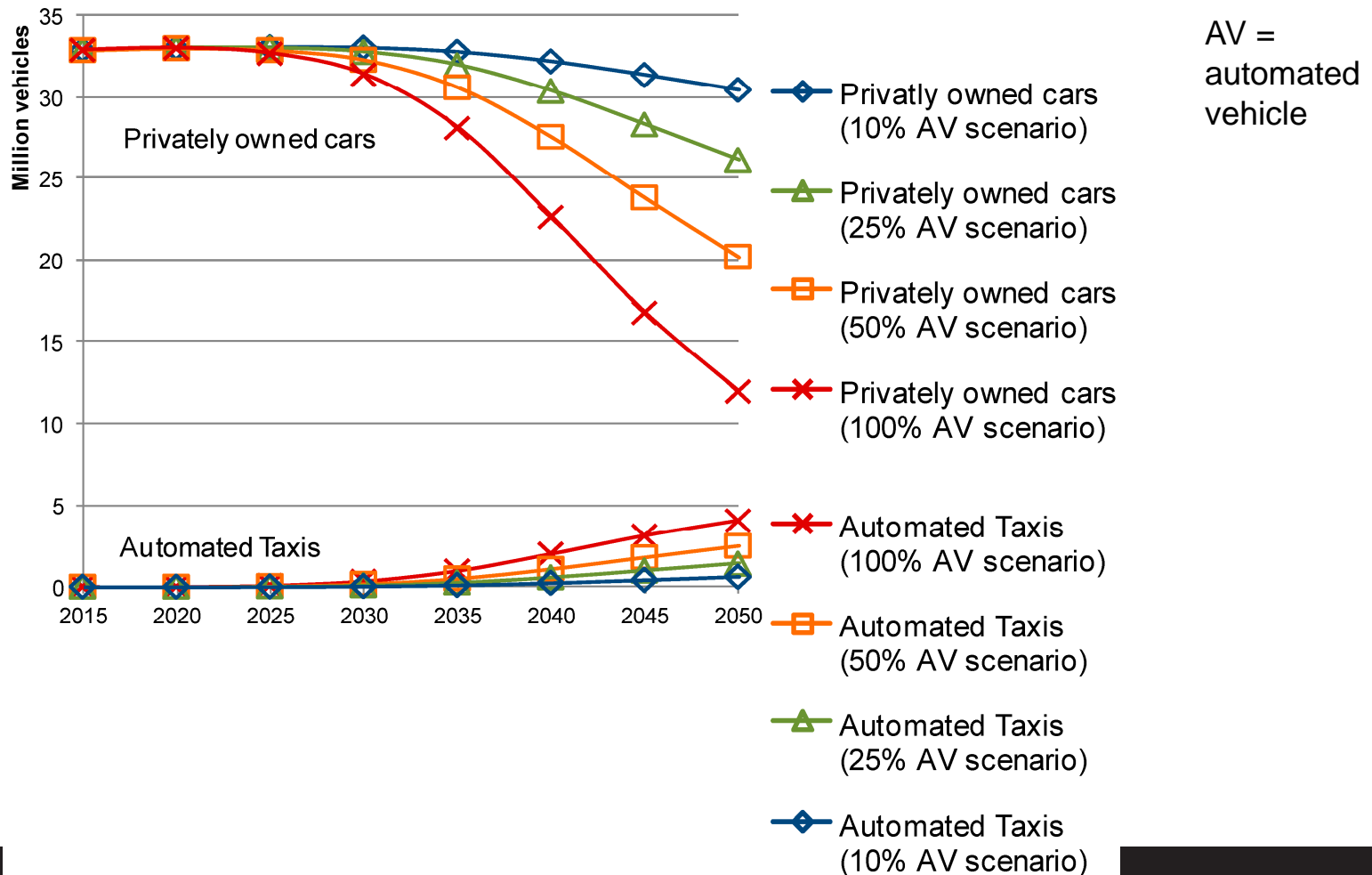
ICEV = internal combustion electrical vehicle

BEV = battery electric vehicle

FCEV = fuel-cell electric vehicle

TCO = total cost of ownership

**“the biggest reduction in GHG emissions from transport could be achieved by the introduction of automated vehicles as automated taxi services.” (Mazur et al. 2018)**





# Digitalisation and transport technology

- **Automated vehicles have the potential of reducing transport accidents, emissions and costs**
- **BUT will not solve these issues and have very little effect on energy use, noise and social equality if privately owned**
- **AND there is a risk of rebound effect towards more car use as it is even more comfortable than before!**
- **SO keep your priorities clear:**
  1. Walking
  2. Cycling
  3. Public transport
  4. Freight transport
  5. Cars



## **Key messages:**

- 1. Transport is a major cause of human and environmental suffering**
- 2. Measures to reduce environmental effects, accidents and costs are largely synergical**
- 3. Determined actions are required on all decision-making levels on both short and long term**
- 4. Digitalisation and electrification provide great tools for transport transformation, but are not THE solutions**

# Thank you!

Heikki Liimatainen  
Professor, D.Sc. (Tech.)  
Transport Research Centre Verne  
Tampere University