NEW MOBILITY IMPACTS

URBANISM NEXT EUROPE 2021

The impact of vehicle automation on public transport

Future of public transport in the era of emerging modes

Maaike Snelder, TNO and Delft University of Technology

TNO innovation for life

TU Delft

@UrbanismNextEU #UNextEU

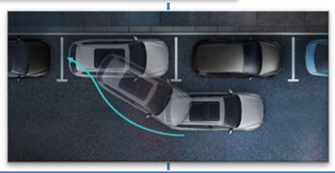
Outline

- Vehicle automation: cars and public transport
- Impact on public transport usage
- Mobility system design
- From pilots to implementation
- Conclusions

Vehicle automation: cars and public transport

Automated vehicles: New concept?

Private transport



1925 | 1970s | 1983 | 1999 | 2000s | 2014 | 2016 | 2019

Public transport

Automation levels

	SAE L0	SAE L1	SAE L2	SAE L3	SAE L4	SAE L5
	 **NO AUTOMATION**	 **DRIVING ASSISTANCE**	 **PARTIAL AUTOMATION**	 **CONDITIONAL AUTOMATION**	 **HIGH AUTOMATION**	 **FULL AUTOMATION**
Automation technologies	NO	SOME	YES	YES	YES	YES
Driving tasks	DRIVER	DRIVER	DRIVER/VEHICLE	DRIVER / VEHICLE	VEHICLE	VEHICLE
Driver's attention	YES	YES	YES	YES	NO	NO
ODD	/	/	/	LIMITED	LIMITED	COMPLETE

Driverless shuttles

Low operating speed
- 15 – 25 km/h

Small passenger capacity
- Between 6 and 12 pax

SAE automation level 4+
- Driver-less operations
- No user interfaces
- No driver engagement
- Limited ODD

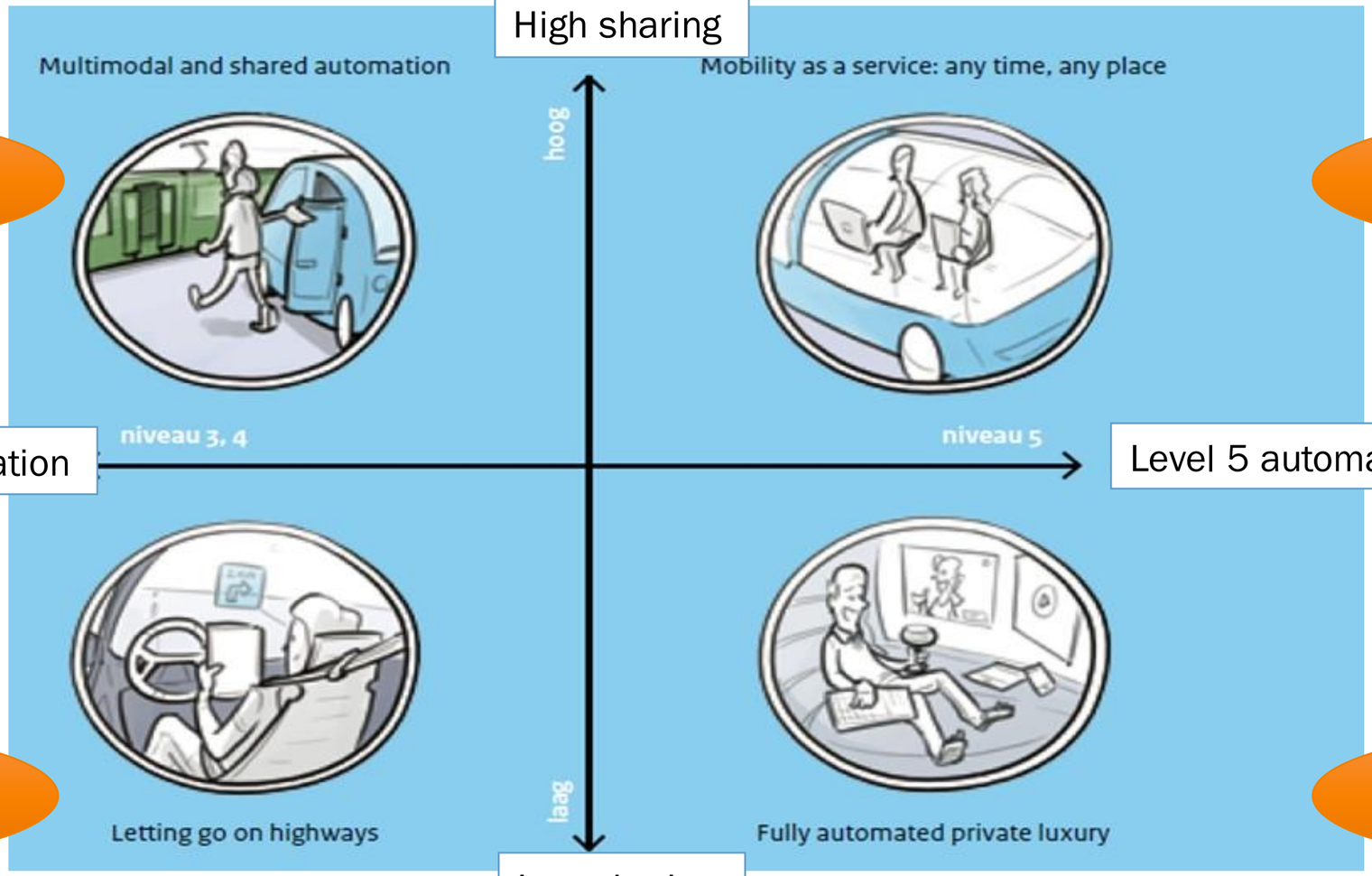
Impact on public transport usage

Scenario's

High sharing

L3/4 - sharing

L5 - sharing



Level 3/4 automation

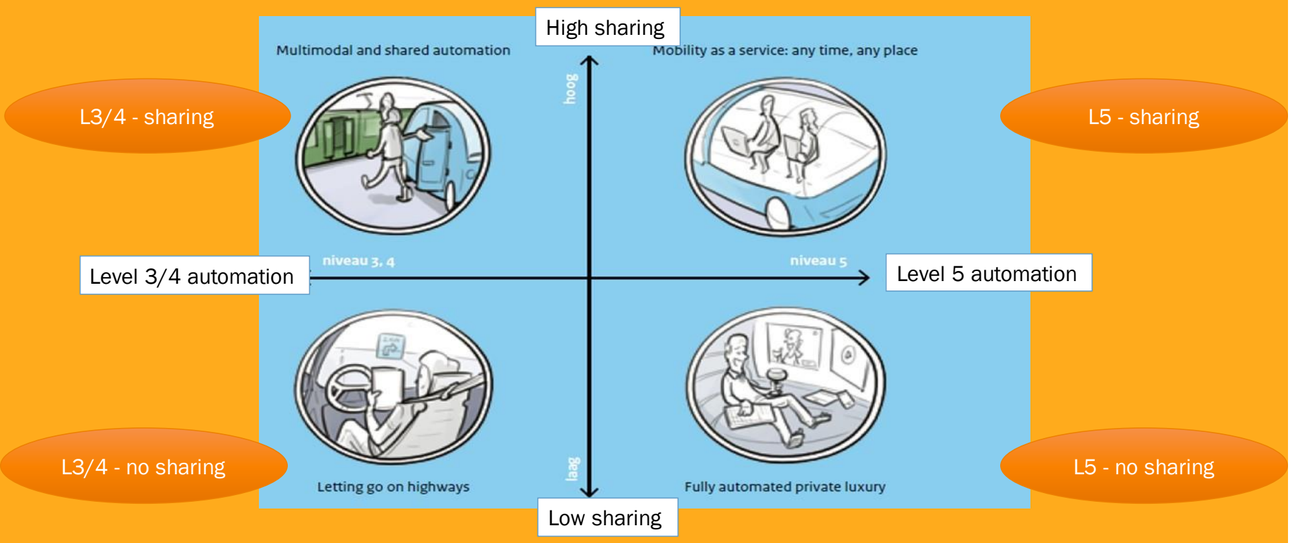
Level 5 automation

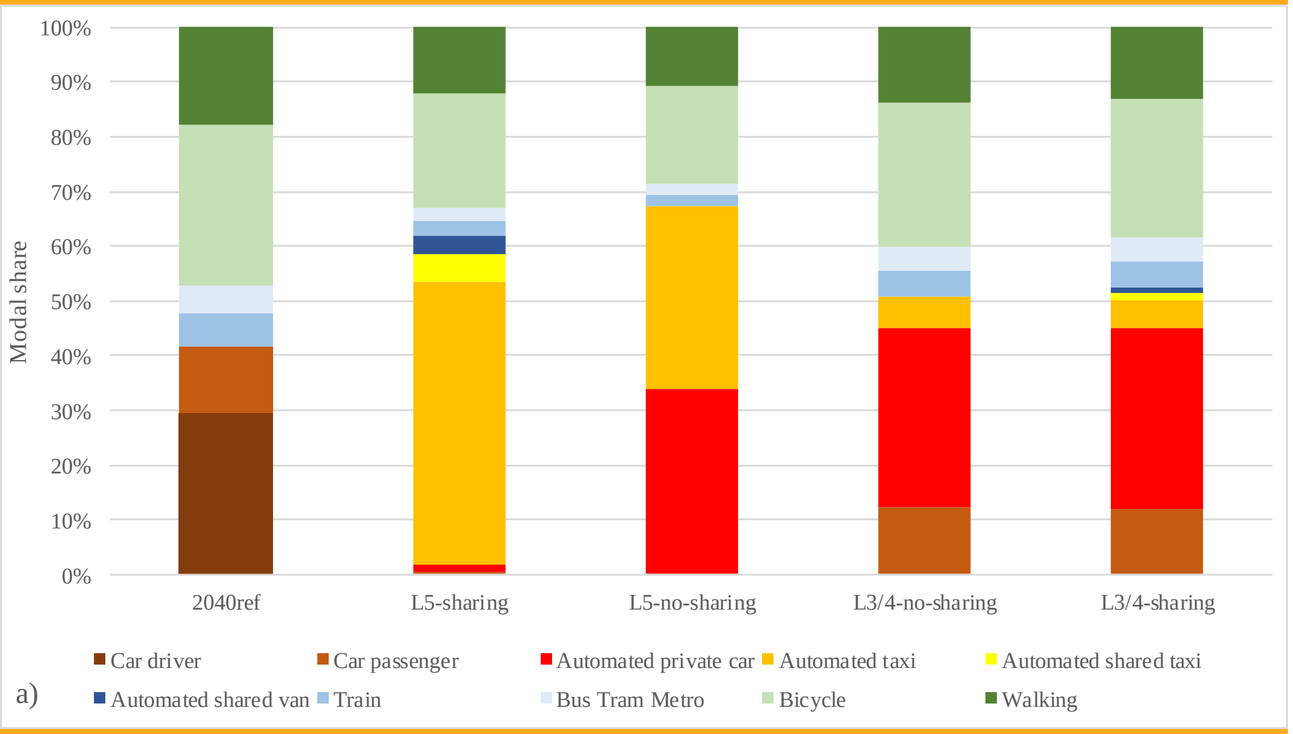
L3/4 - no sharing

L5 - no sharing

Low sharing

Source: KIM, Chaueur aan het stuur? Zelfrijdende voertuigen en het verk,, 2015)





Impact

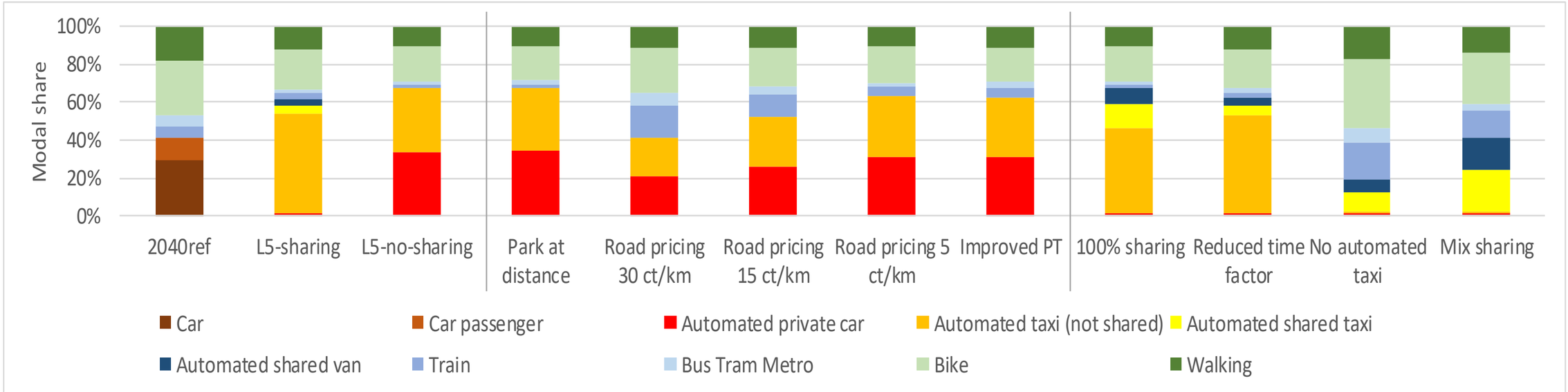
- Modal shift from walking, cycling and public transport to automated private cars, (shared) taxi’s
- User acceptance has a large impact on results
- A strong mix of interventions is needed to keep areas accessible and liveable and to maintain a high share of ‘traditional’ public transport →

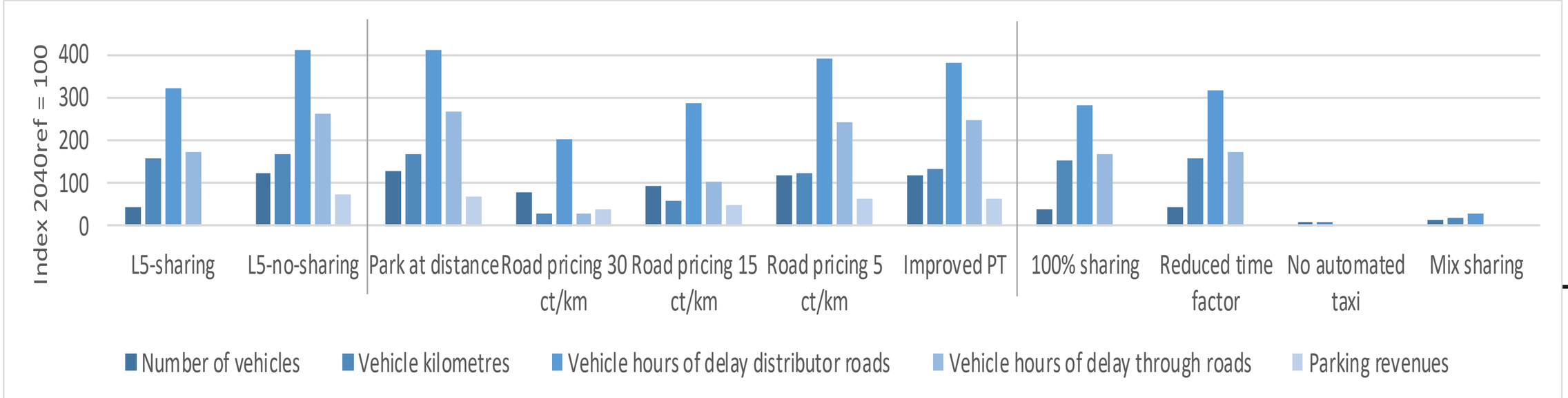
Mobility system design

Interventions

- Car less attractive
  - Road pricing
  - Parking rates
  - Parking capacity → car free cities
  - Higher car ownership tax
- Public transport more attractive
  - Higher frequencies
  - Shared cars/bikes
  - Hubs
  - Shuttles

Interventions





Combined scenario

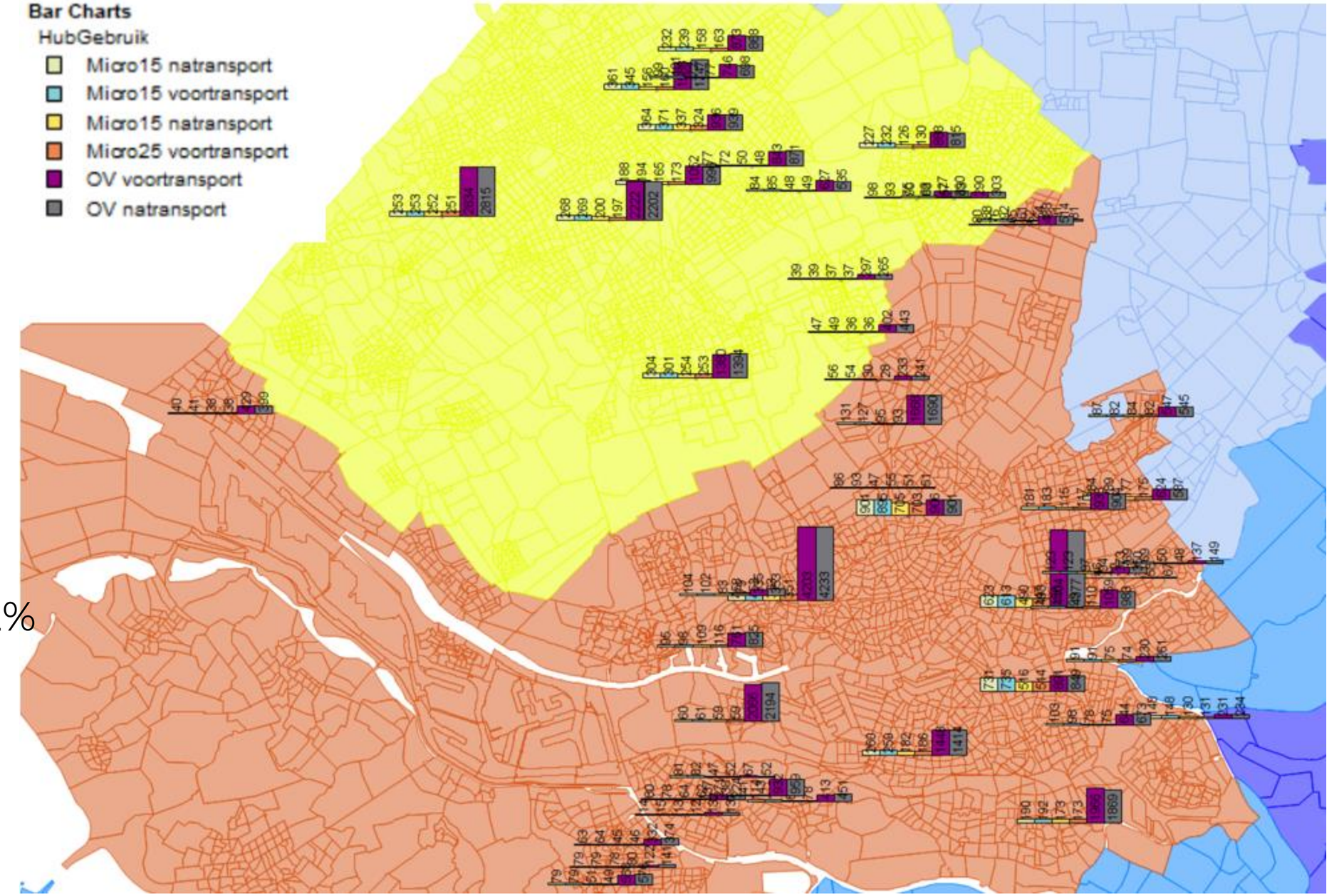
- Reduced parking capacity in the city centres of Rotterdam (-30%), The Hague (-30%) and Delft (all street parking locations)
- Extra hubs
  - Close to the centre + shared bikes
  - Further away from the centre + shared bikes

Modal split	Reference	Scenario
Car	55%	47%
Bike	36%	34%
E-Bike		9%
Traditional Public Transport	9%	10%

Hubs usage

Egress modes

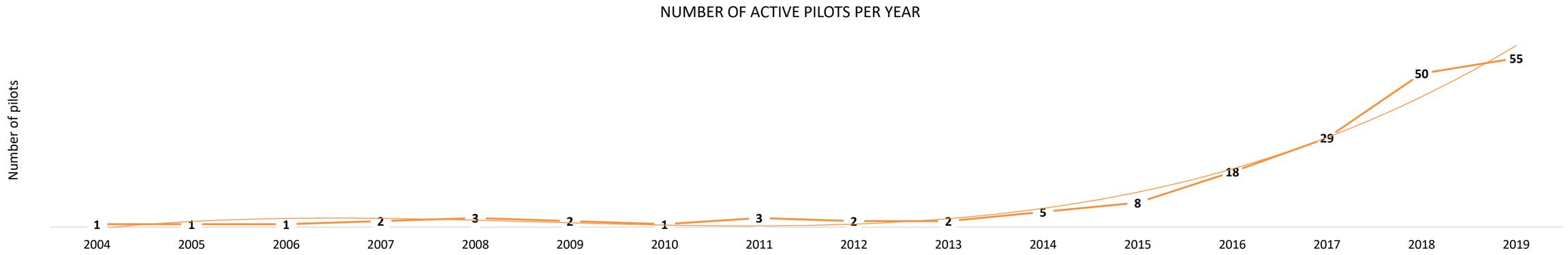
- Bike 11%
- E-bike 8%
- Traditional PT 82%

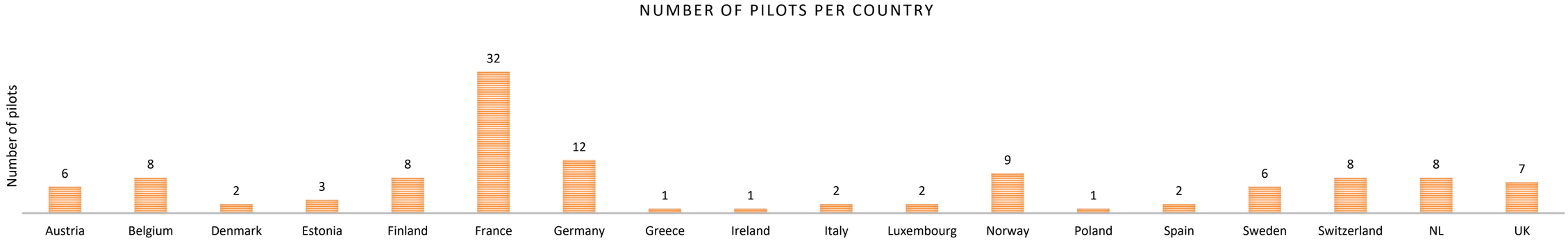


Source: TNO, Urban Tools Next, 2021)

From pilots to implementation

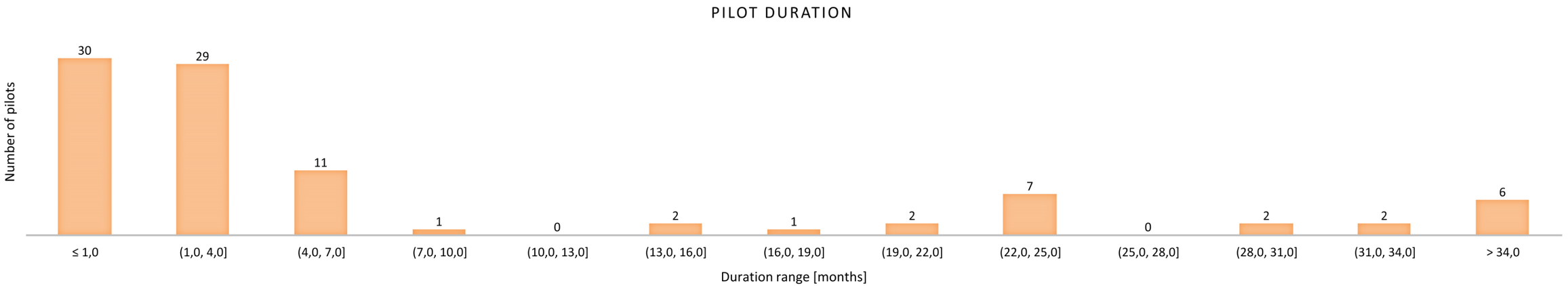
From pilots ...example shuttles





https://www.researchgate.net/publication/339916105_Automated_Buses_in_Europe_An_Inventory_of_Pilots_version_10

From pilots … to implementation

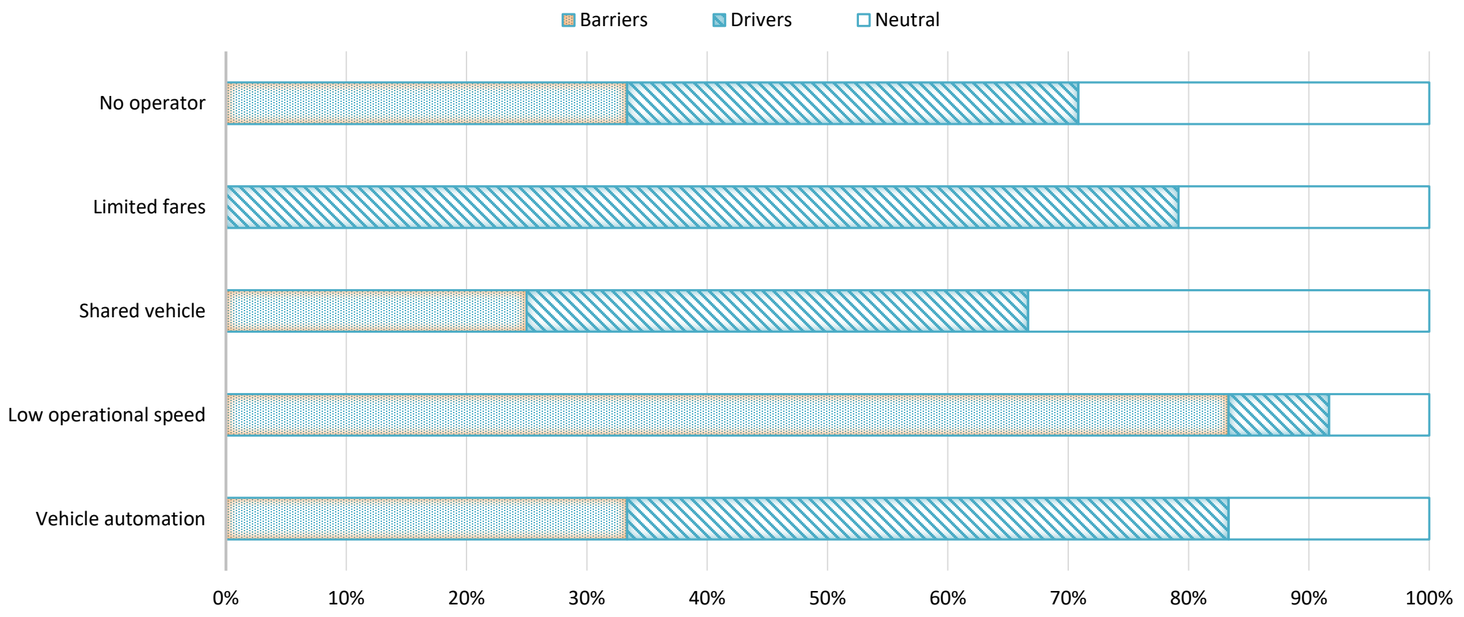


- Short average duration
- Very few become actual operative systems
- Interest in bringing forward these pilots

https://www.researchgate.net/publication/339916105_Automated_Buses_in_Europe_An_Inventory_of_Pilots_version_10

Development directions: Experts opinion from stakeholder survey

- Drivers and barriers for driverless shuttle integration



Biggest drivers
- Limited fares
- Vehicle automation

Biggest barrier
- Low operational speed

Not relevant
- No operator
- Shared vehicle

Credit: Irene Zubin, PhD candidate TU Delft

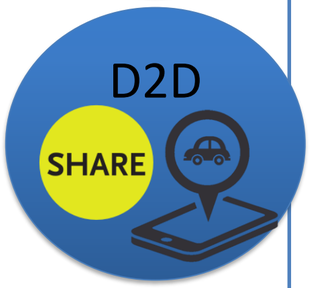
Deployment scenarios: Experts opinion from stakeholder survey

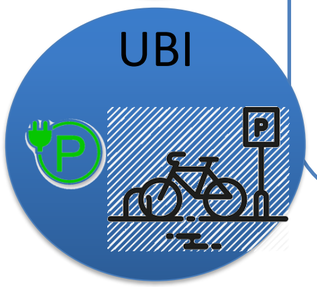
	Supervision	Area	Infrastructure	Operations
Scenario A	Remote control	Urban	Dedicated lanes	Schedule-based
Scenario B	Remote control	Urban	Dedicated lanes	On-demand
Scenario C	Remote control	Rural	Mixed infrastructure	On-demand
Scenario D	Remote control	Urban	Mixed infrastructure	On-demand
Scenario E	On-board steward	Urban	Mixed infrastructure	On-demand

Credit: Irene Zubin, PhD candidate TU Delft

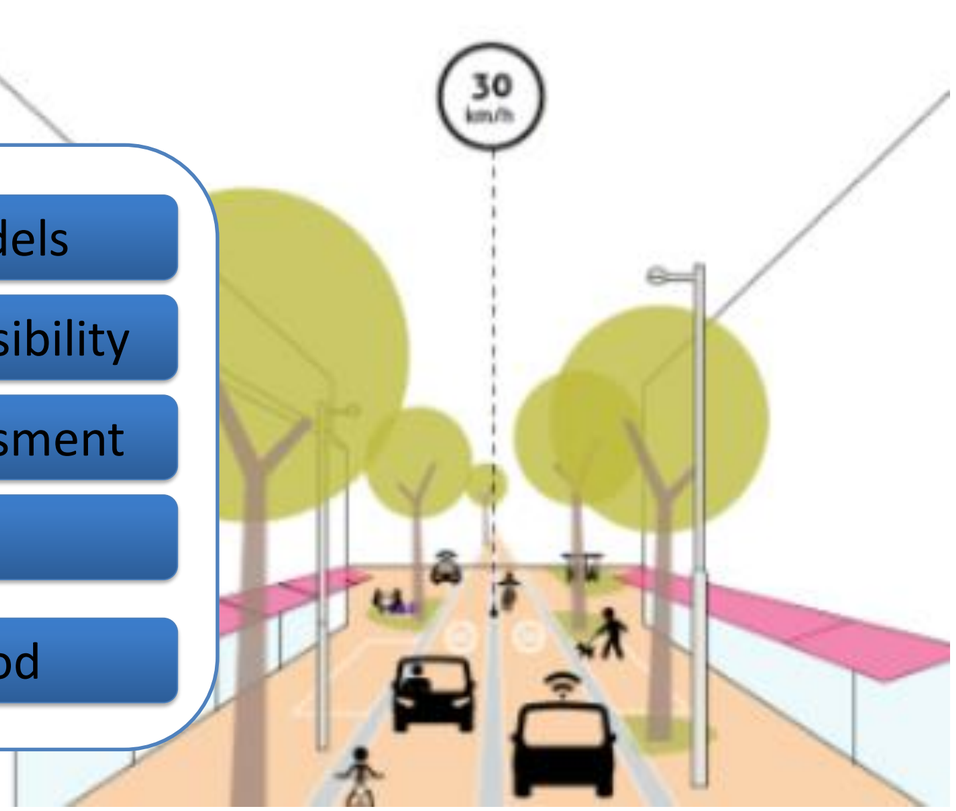
SUMMALab

Focus: accessible, sustainable, safe and livable urban areas





- Business models
- Technical feasibility
- Impact assessment
- Scalability
- Design method



Small scale pilots in protected environments → Full-fledged implementations in competitive settings.

Take aways

- Clear multimodal vision needed including emerging modes
- Important to steer towards societal goals
- From pilots to implementation
  - Business/value case
  - Technical feasibility and monitoring
  - Mobility and environmental impacts

More information

- Snelder, M., Wilmink, Isabel, van der Gun, J., Bergveld, H.J., Hoseini, P., van Arem, B. (2019) Mobility impacts of automated driving and shared mobility – explorative model and case study of the province of north-holland, *European Journal of Transport and Infrastructure Research,* vol. 19, n. 4 Doi: https://doi.org/10.18757/ejtir.2019.19.4.4282.

- https://www.researchgate.net/publication/339916105Automated_Buses_in_Europe_An_Inventory_of_Pilots_version_10

- www.summalab.nl

- http://stad.tudelft.nl/

EUROPE.URBANISMNEXT.ORG

URBANISM NEXT EUROPE 2021

Thank you!

Do you have any question?

Maaike Snelder, maaike.snelder@tno.nl

@UrbanismNextEU #UNextEU