Global Energy Demand Intelligence

Road Transport/Future of Mobility

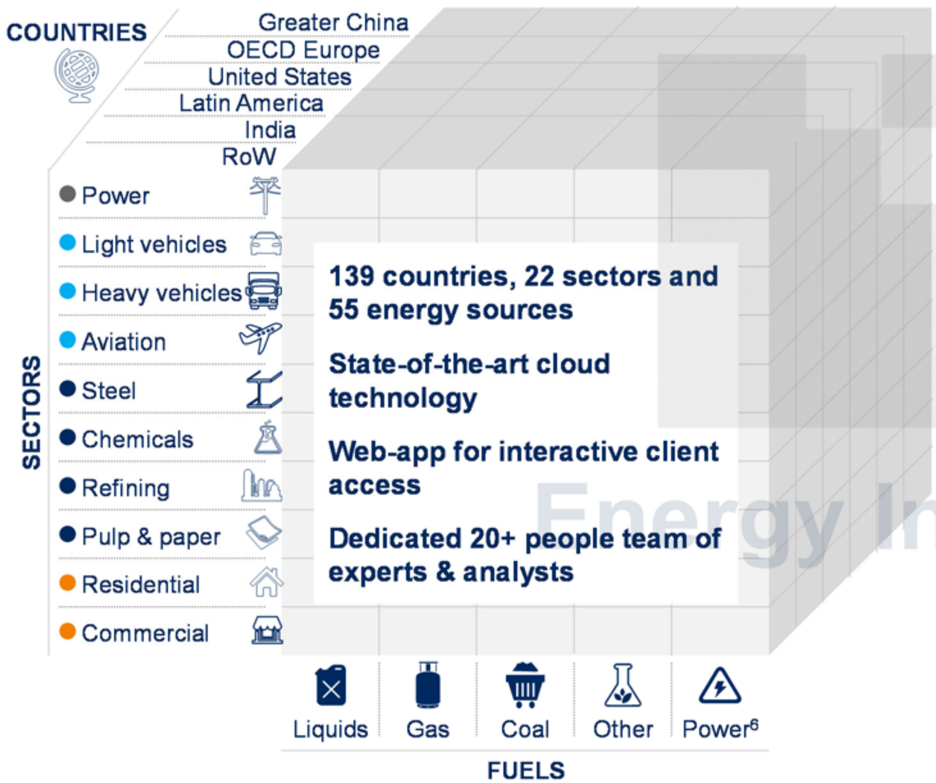
McKinsey&Company Inc.

Asilomar Conference Session II -- Is Global Oil Demand Peaking?

Energy Insights
By McKinsey

We are building a fundamental energy demand outlook

We developed a cloud-based data cube…



… to develop our understanding of fundamental demand drivers

POWER:
What will be the impact of **improving economics of renewables** on the generation mix in 2030?

TRANSPORT:
Will increasing **EV penetration** trigger a **peak in global oil demand** for transport in the coming decade?

INDUSTRY:

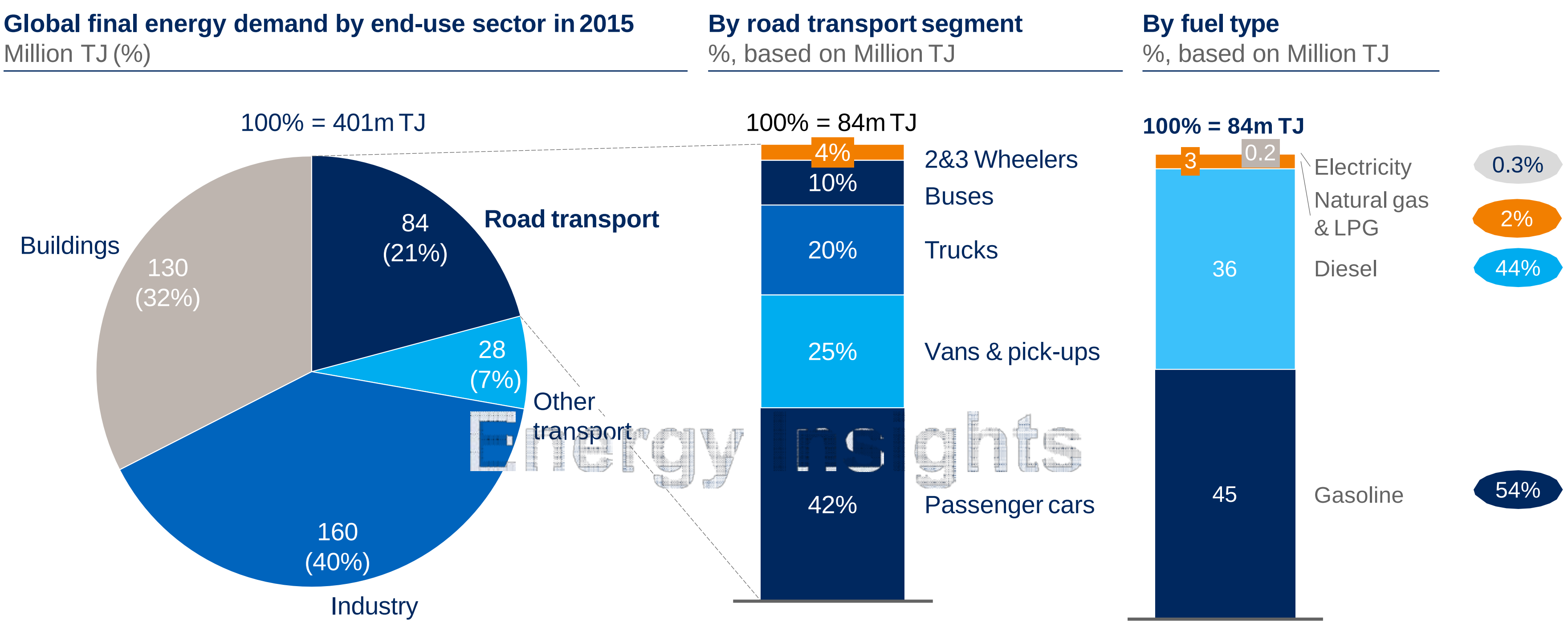
What will be the scale and magnitude of **electrification in industry**?

How will the circular economy affect demand for **chemicals** feedstocks?

BUILDINGS:
Will uptake in use of **heat pumps** lead to a decline in gas demand?

SOURCE: Energy Insights, a McKinsey Solution – Global Energy Perspective

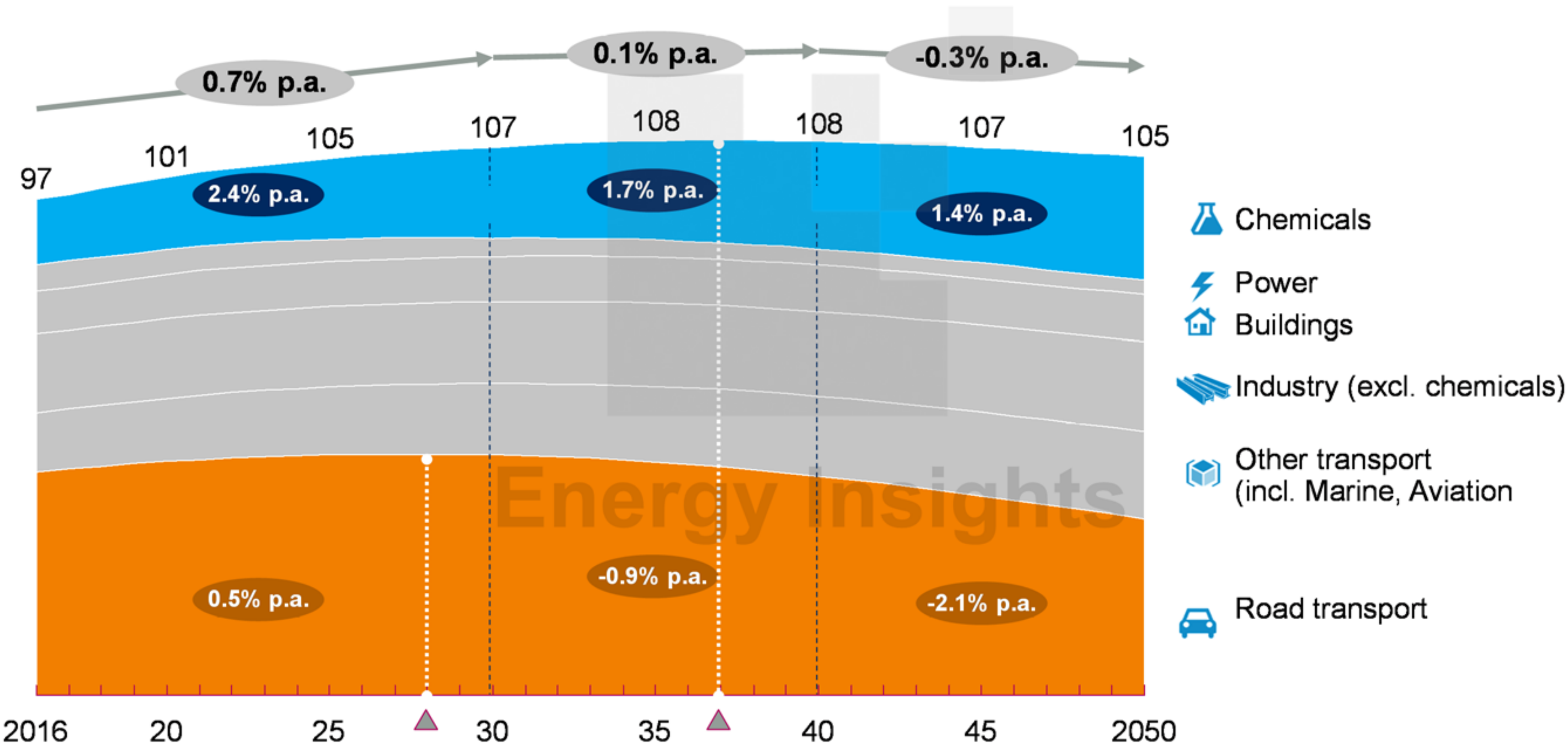
Road transport accounted for 20% of global final energy demand in 2015, with passenger cars being the largest segment



SOURCE: McKinsey Energy Insights' Global Energy Perspective, BAU Scenario, July 2017

We see a peak in global liquids demand by 2037, while road transport peaks already in 2028

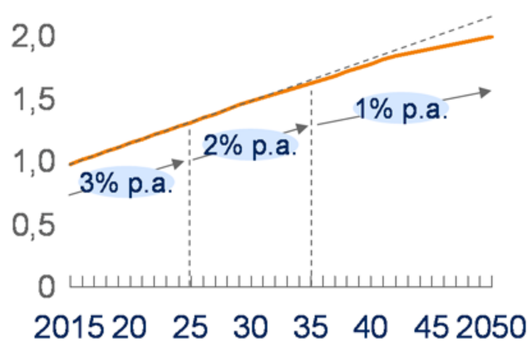
Global oil demand, Million barrels per day



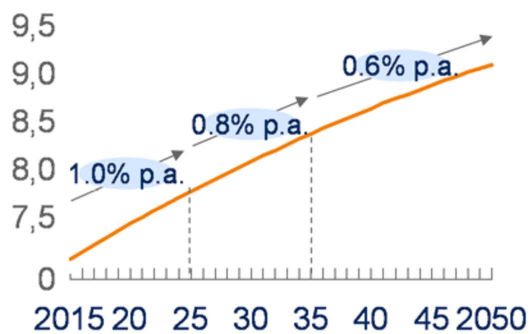
SOURCE: McKinsey Energy Insights' Global Energy Perspective, July 2017

A Growth of car parc slows down as peak car ownership is expected between 2025 and 2035 in developed world

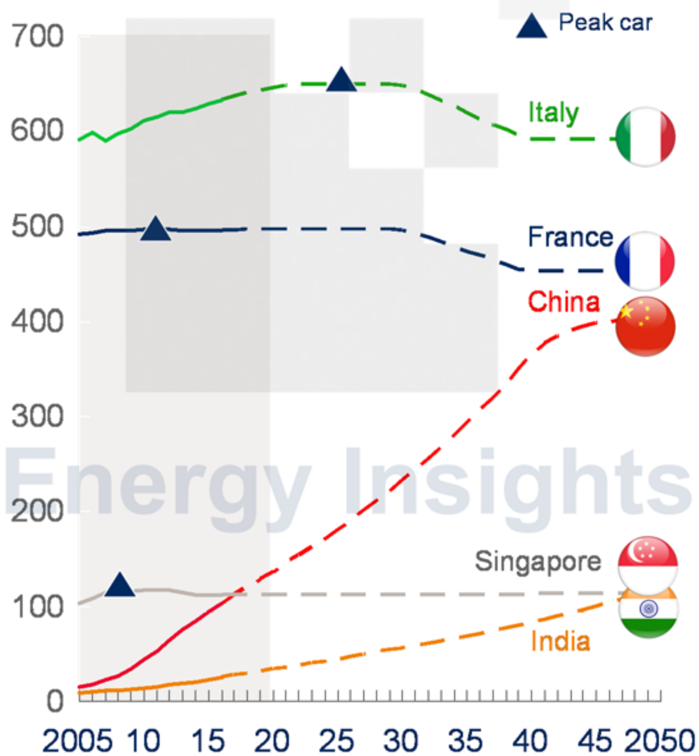
Global car parc, bn passenger cars



Population, bn people



Passenger car ownership for selected countries, #/1000 capita



Peak car drivers

- Drivers for reduced ownership include **urbanization**, **car sharing**, **e-hailing**, better public transport alternatives and regulation

Peak car already reached

- France showed peak ownership in 2011
- Singapore has shown declining ownership since 2008 driven by regulations

Peak car expected

- Remaining developed countries have nearly reached saturation and expect to peak between 2025 and 2035
- Developing countries will follow peak trend (China)

SOURCE: McKinsey Energy Insights' Global Energy Perspective, BAU Scenario, July 2017

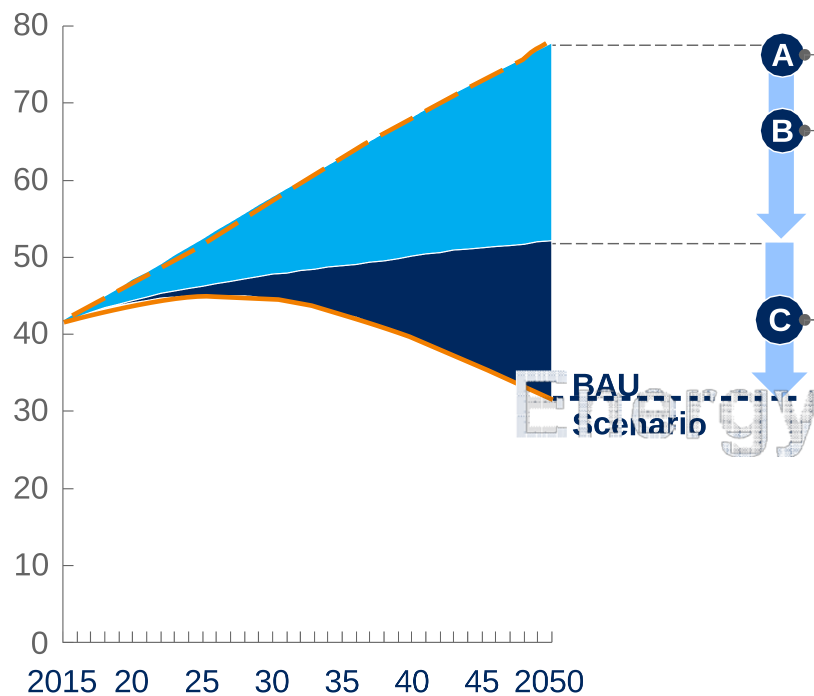
B Increasing regulatory pressure is driving efficiency improvements and electrification

	Description of policy	Target group: OEMs	Target group: Users
Regulation			
Emission limits	▪ Strict **exhaust emission** and fuel economy limits (e.g., Euro 6 and Renewable Energy Directive) aimed to **improve ICE vehicle fuel economy** (engine technology, aerodynamics, light weight) and **promote electrification** (super-credits)	✔	
Access regulation	▪ **Access Regulation** and **low emission zones** (LEZ) promote sales of newer and **cleaner vehicles** by restricting access for polluting vehicles in urban areas	✓	✔
	▪ **Diesel bans** as communicated for Madrid, London and Paris (2025) or entire country (Norway, France)	✔	✔
Incentives			
Acquisition subsidies	▪ **One-off discount** on acquisition price via VAT and import tax exemptions or direct subsidy, to compensate buyers for higher acquisition cost of clean vehicles	✓	✔
Operational subsidies	▪ ***Feebates*** encourage clean & discourage polluting technologies – **Encourage:** toll exemption, fiscal discounts, free charging – **Discourage**: Fuel (excise) tax		✔
Non-financial perks	▪ Dedicated **driving lanes** (e.g., bus lanes) ▪ Dedicated **parking spots or free/fast parking permit**		✔
Technology push	▪ **Remove barriers for electrification** – **R&D subsidies** for OEMs and suppliers to develop technology – **Charging infrastructure** investments	✔	✓

SOURCE: European Commission, McKinsey Energy Insights' Global Energy Perspective, team analysis

Electrification and fuel economy gains reduce road transport liquids demand by ~60% in 2050

Impact of road transport drivers on liquids demand
(mb/d)



SOURCE: McKinsey Energy Insights' Global Energy Perspective, BAU Scenario, July 2017

Three global trends reduce energy demand

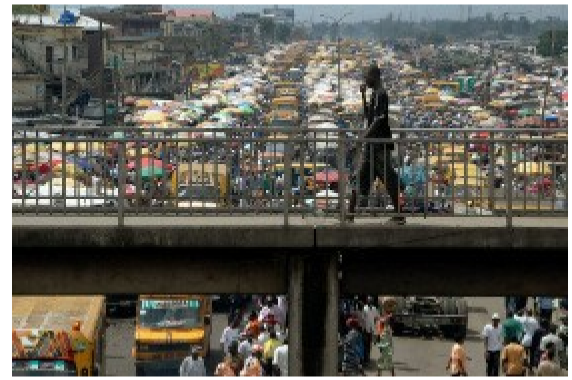
Growth of vehicle parc slows down	Population and GDP growth continue increase in fuel consumption, but growth is slowing down thanks to **peak car** in developed regions
Increasing fuel efficiency	Regulation enforces improvements in **fuel efficiency** of ICE-vehicles and drives electrification
Move to electric vehicles	**Electrification** of cars and other segments is accelerating driven by financial benefits as well as regulation

Cities are increasingly congested and polluted on the current unsustainable path

San Francisco

Beijing

Lagos



Los Angeles

Delhi

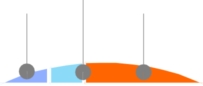
Tokyo

Privately owned vehicles

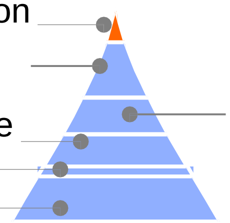
Massive waste in the current transport system – car example

Productive use

Car utilization rate

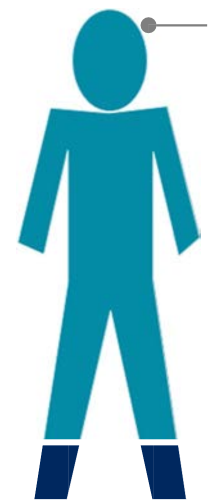


Tank to wheel energy flow - Gasoline



Deaths and injuries per year on road

More than 33,000 in US
$300B annually in cost



Land utilization rate

- A road reaches peak throughput only 5% of the time... ...and even then, it is only 10% covered with cars
- 50% of most city's land area is dedicated to streets and roads, parking lots, service stations, driveways, signals and traffic signs

SOURCE: team analysis; Resource Revolution by Heck and Rogers

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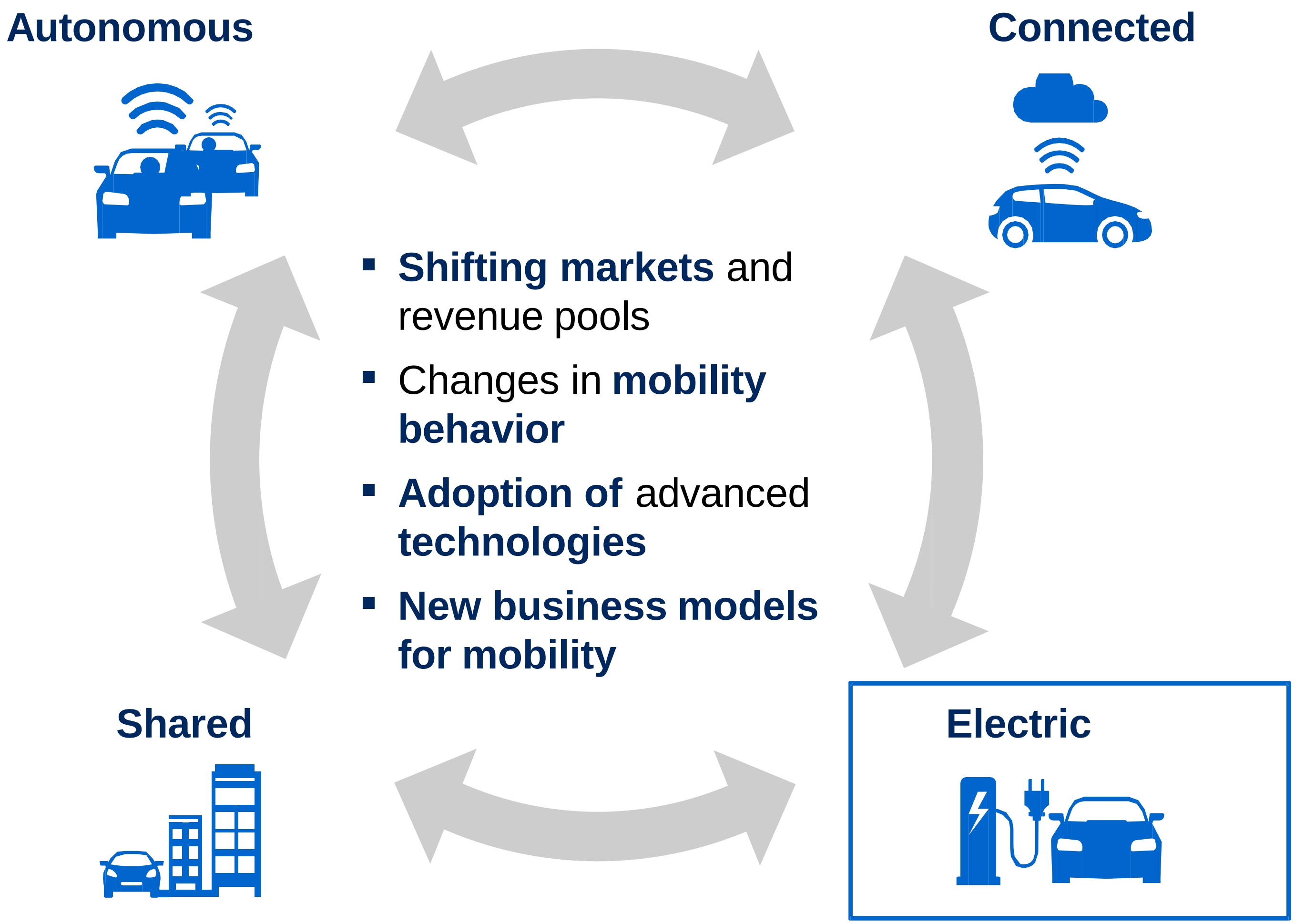
Global megatrends that are impacting the automotive industry and will likely drive significant change to mobility

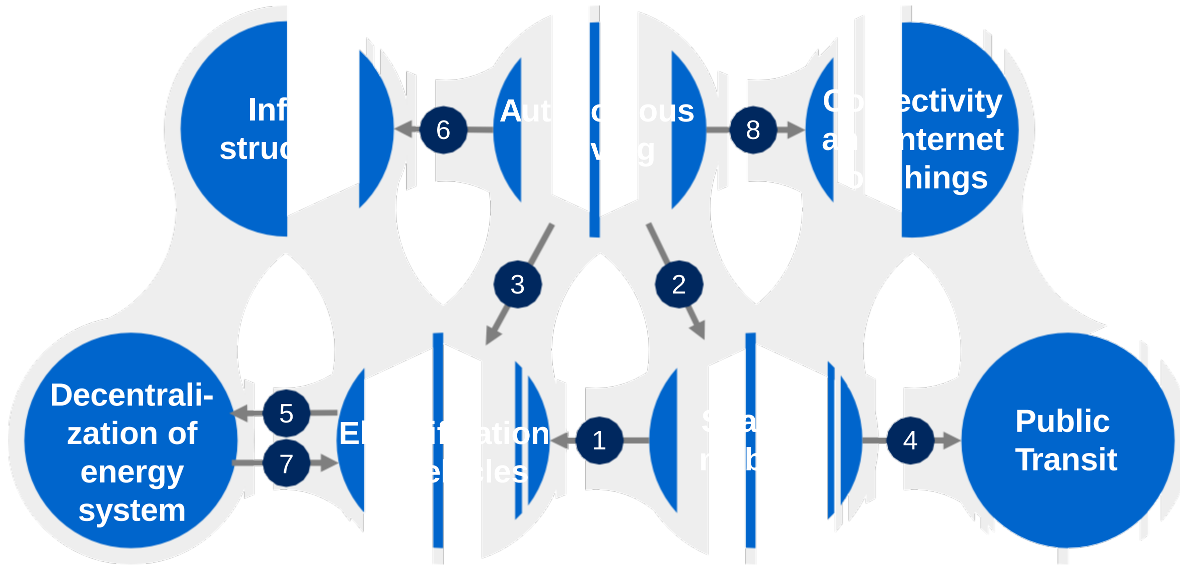
4 disruptive technology-driven trends will impact the industry



SOURCE: McKinsey

Some of these trends changing the future mobility systems will have reinforcing effects on each other

Key trends



Reinforcing effects

1 An uptake in shared mobility will accelerate electrification, as higher utilization favors the economics of electric vehicles

2 Self-driving functionality could lead to a competitive proposition for shared mobility

3 Self-driving – private and shared – vehicles are likely to increase mobility consumption in which case electric vehicles offer lower total cost of ownership

4 An uptake in shared mobility will affect public transit

5 Electric vehicle production at scale could accelerate the battery curve downward

6 Self-driving electric vehicles will have different usage and hence demand different requirements for charging infrastructure

7 Increasing renewable penetration could accelerate the attractiveness of electric vehicles

8 Self-driving vehicles might accelerate the uptake of IoT applications

SOURCE: BNEF and McKinsey

The end state of the new mobility system will bring significant benefits across all factors and is better than systems in place today

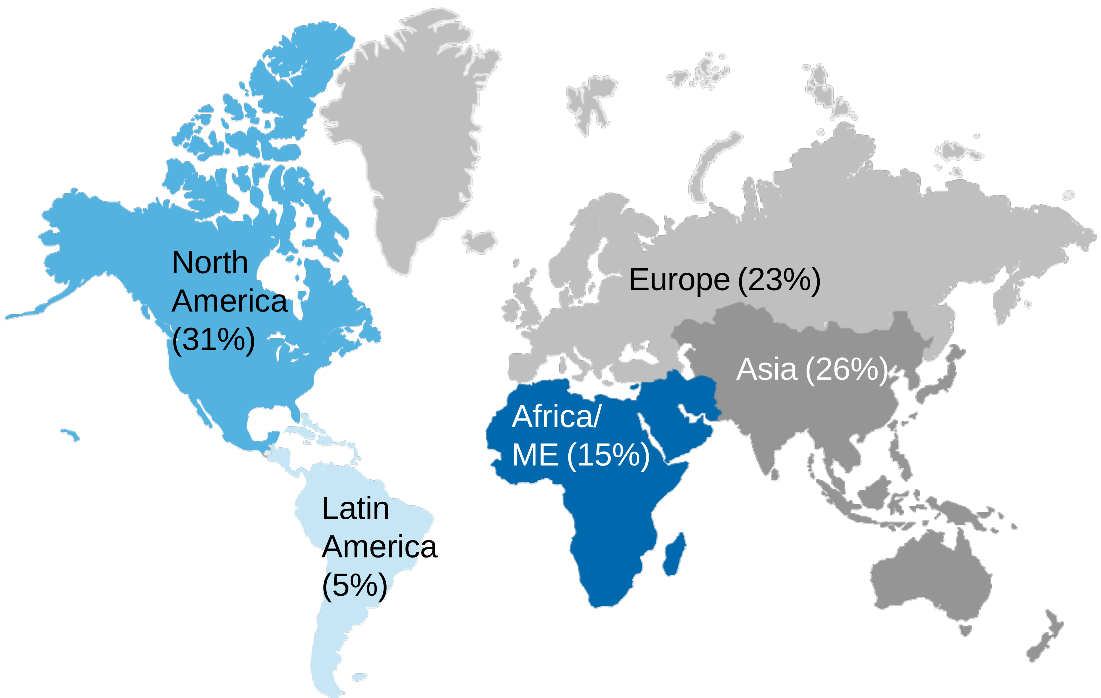
Key benefit	Description
Health and safety	▪ **Reductions in vehicle related deaths** due to both the safety benefits of autonomous vehicles and modal shifts away from private travel ▪ Many lives saved due to **reduced air pollution** from vehicles in dense urban environments
Cost and convenience	▪ **Lower cost of door to door travel** compared to existing public transport ▪ **More equitable access** to transport services, promoting income equality in urban environment ▪ Greater comfort while travelling and less wasted time in transport
Environmental impacts	▪ Significant **reductions in the CO_2** intensity of transport ▪ Opportunity to put public assets such as parking lots and excess road space to productive use as e.g., public parks
Benefits to the overall system	▪ More efficient transport systems which impose much **lower congestion costs** ▪ Enables smart investment in public transport and reduces the need for investment in expensive legacy assets such as metros ▪ Future-proofs public infrastructure for an entirely autonomous future
Ancillary benefits	▪ Stabilisation of the power grid through flexible demand from EVs ▪ Improve the attractiveness of the city to global expatriates

SOURCE: BNEF and McKinsey

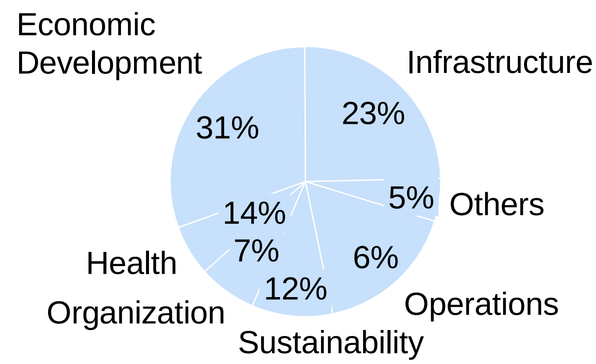
McKinsey has considerable expertise in cities work, having conducted 500+ projects around the globe over the past 5 years

Studies 2011 – 2016 (YTD)

Percent of engagements (n=524)

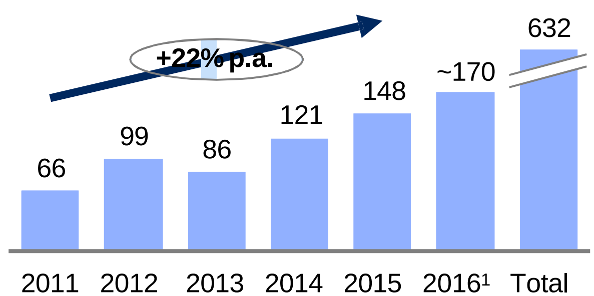


Type of engagements



Adds to 101% due to rounding

Engagements



1 forecast: 2016 figure subject to final reporting

SOURCE: PSSP client database, FPIS

We think mobility disruption in cities can happen along 3 major trajectories

Possible path for Pulse

Incremental based on population density and development stage

Seamless mobility

Rapid social change, system coordination and deployment of mobility solutions results in a **radically different mobility system**

Private autonomy

Technology change accelerates but social change is slow, resulting in **high uptake of EV/AV but** within current ownership models intact

Clean and shared

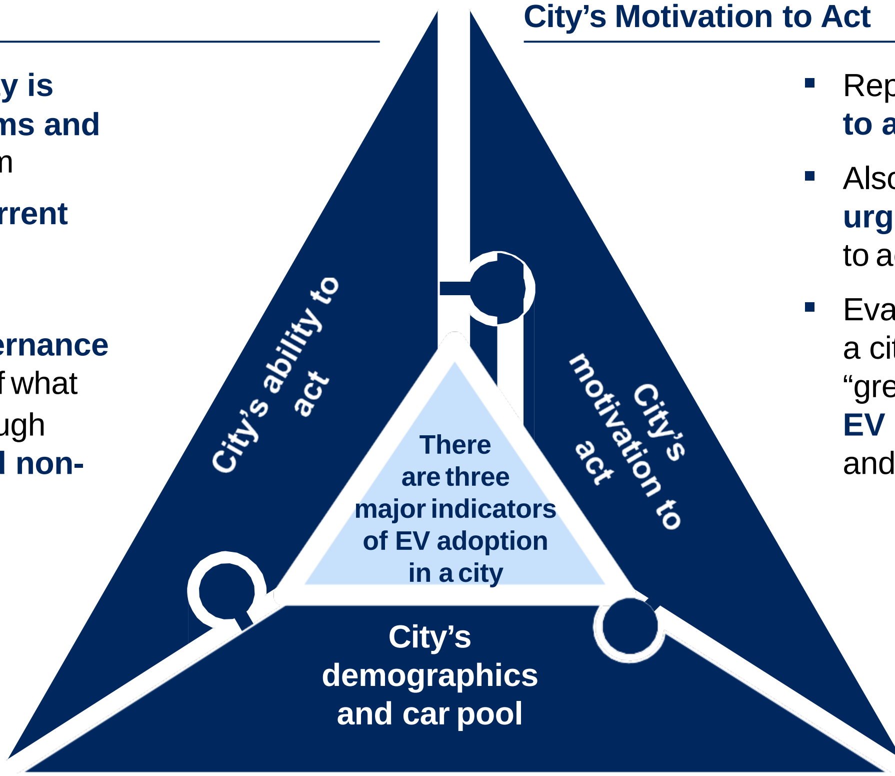
Despite technology readiness, **AV adoption remains very low while EV and shared mobility accelerate**

SOURCE: BNEF and McKinsey

We have evaluated the cities against 3 criteria most indicative of high EV adoption: a city's ability & motivation to act and its demographics and car pool

City's Ability to Act

- Represents **how well a city is able to recognize problems and take action** to resolve them
- Includes both **past and current** actions
- Delivers a comprehensive overview through the **Governance** index and understanding of what the city is doing today through evaluation of **financial and non-financial incentives**



City's Motivation to Act

- Represents **how motivated a city is to act** and solve its mobility problems
- Also includes the **pressures and urgency** that the city is experiencing to act
- Evaluates the motivation by looking at a city's **positioning** (innovative and "green") and at pressures related to **EV adoption motivation** (pollution and congestion)

City's Demographics and Car Pool

- Represents how well a **city itself** is positioned for high EV adoption
- Includes criteria that evaluate the **population** and EV and non-EV **car market**
- Consists of **KPIs** such as population, GDP PPP per capita, the wealth of the population, EV charging infrastructure availability, EV penetration projected 2025 car sales and average car age

SOURCE: McKinsey Future of Mobility Initiative

To the starting total of 2,600+ cities we have applied several macro criteria and an index model to derive a list of 30 top cities

City Archetype	Macro criteria applied						Resulting # of Top 30 cities
Developed, dense areas  **Seamless mobility**	All urban areas	Gover-nance effect-tiveness percent-tile >40	Car sales in 2025 > 100k	Popula-tion > 3m	All GDP classes	**Index model**	8
Developed, suburban sprawl  **Private autonomy**	All urban areas			Popula-tion > 1m	GDP PPP per capita above $35k		14
Developing, dense areas  **Clean and Shared**	All urban areas			Popula-tion > 3m	GDP PPP per capita above $6k		8
							30

SOURCE: City Selection Model, City Scope, World Bank Governance Index

There are clear indicators that the eTruck uptake will be significantly faster than the electric passenger car uptake

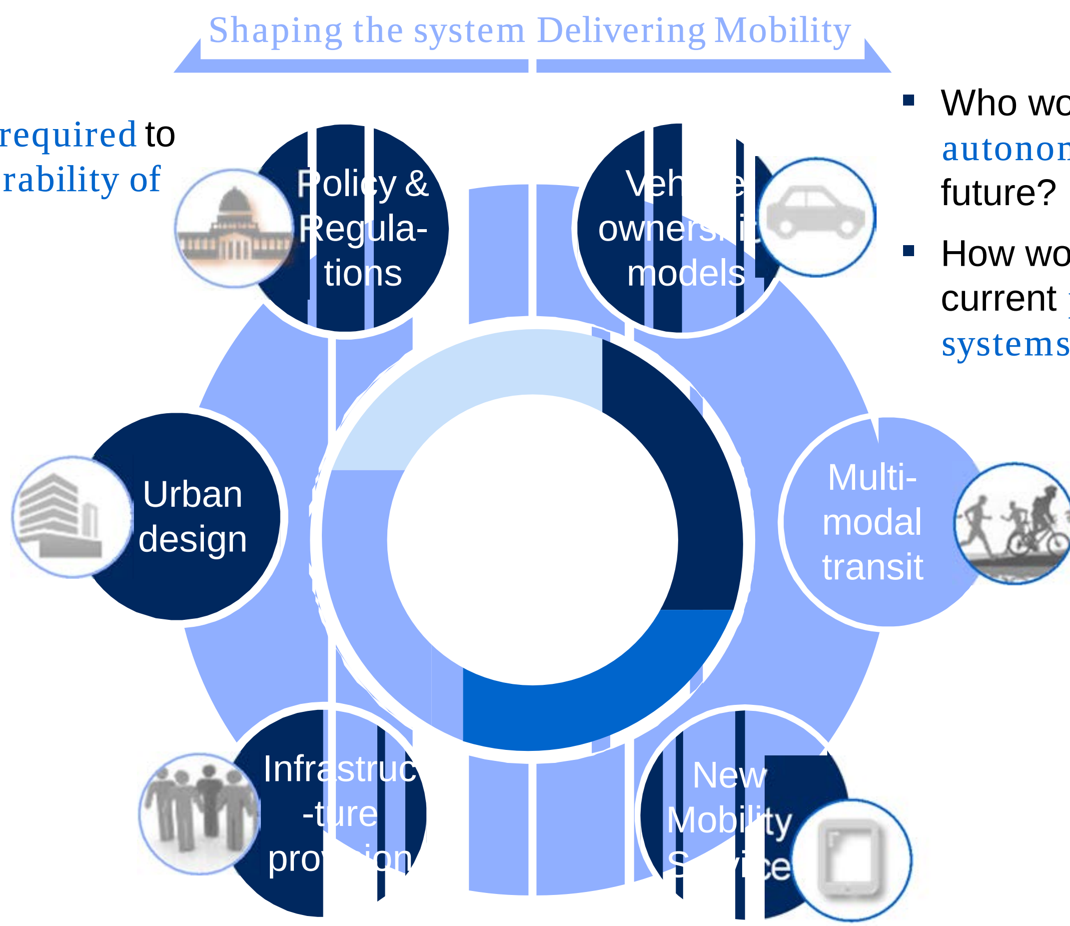
+ Faster than PC − Slower than PC

Perspective	Decision factors	Comparison to passenger cars (PC)
Customers	▪ Positive TCO business case for electric truck	+ Commercial vehicle owners are more TCO cost-conscious than emotional car owners
	▪ Technological maturity of fully electric powertrains	+ PCs have proven feasibility of electric vehicles
	▪ Fast turnover of trucks in fleets every 3-6 years depending on mileage	+ Commercial vehicle owners renew fleets at twice the rate as private owners
	▪ Green corporate image, emission free “green” delivery of goods	+ Commercial vehicles under higher corporate pressure
Regulation	▪ Diesel bans in cities (e.g. Paris 2025)	+ Diesel share within trucks much higher than for PC
	▪ Truck emission targets by 2030	− Less aggressive targets for trucks expected
Infrastructure	▪ Currently limited charging infrastructure for trucks, especially for long haul segment	+ Compared to early PC charging infrastructure already significant infrastructure today
	▪ Logistic centers can be easily equipped with charging infrastructure	+ On road parking limits access to charging
Product availability	▪ Very limited product availability before 2020	+ Compared to slow PC BEV OEM offering, large truck OEMs declared to bring eTruck trucks to the market

SOURCE: Energy Insights Road Transport team

Implications are identified through a systematic 6-step approach to urban mobility

Detailed further



- What standards are required to ensure the inter-operability of connected vehicles?

- Who would own the autonomous fleets of the future?
- How would they impact current public transit systems?

What is the impact on urban design themes (e.g. parking) as autonomous vehicles become popular?

How can Pulse deliver interconnected and interlinked multi-modal mobility?

What is the new infrastructure offerings that Pulse would need to provide?

What new mobility offerings are available at city level to augment mobility?

SOURCE: Mobility at a tipping Point, McKinsey Center for Business and Environment, 2015