ENERGY FOUNDATION
能源基金会

CTP Strategy Part II: Deep Dive on Transport System & Off-Road Sector

Energy Foundation China

This strategy was presented to EF China board in Jun 2021, and subjects to regular updates.

Outline

1. Context
2. Key policymakers
3. Overall goals
4. Theory of change
5. Barriers and drivers
6. Key intervention prongs

Context: Focus of Part II Strategy and Rationale

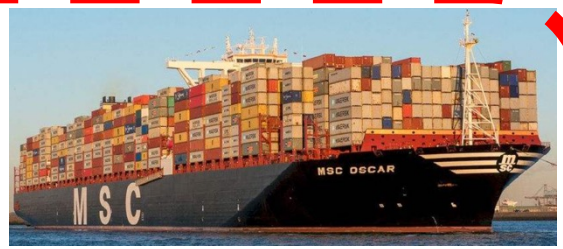
Transport CO_2 emissions

Road Transport




Off-Road Transport





Part II strategy

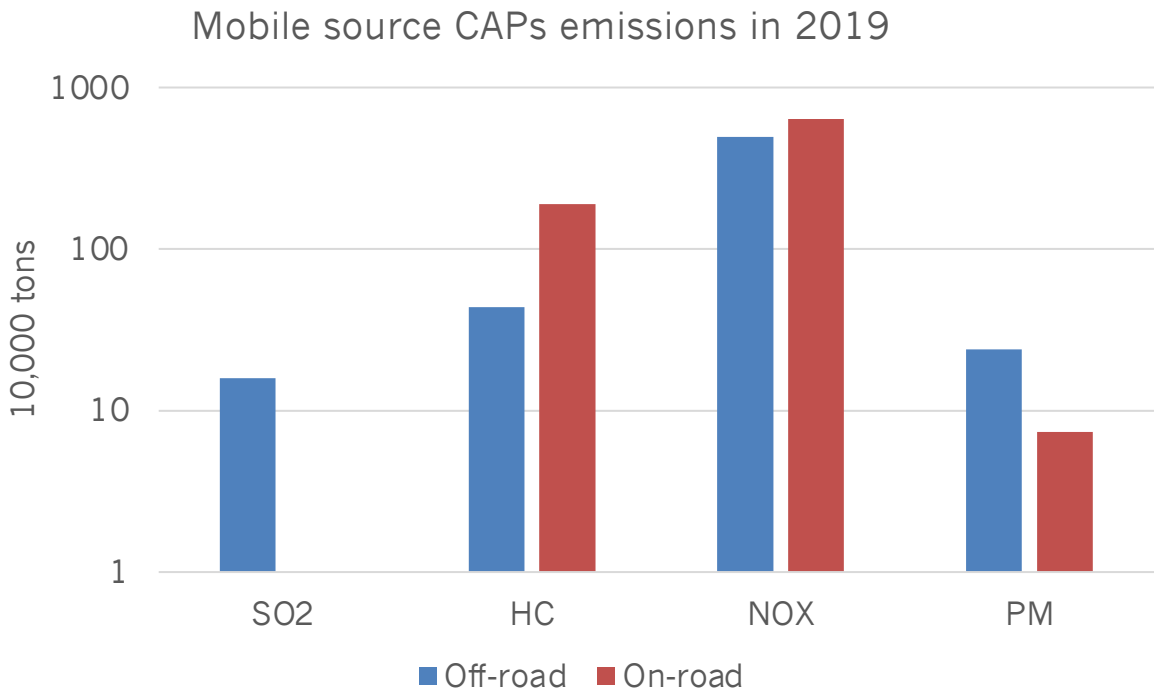
Off-Road Machineries

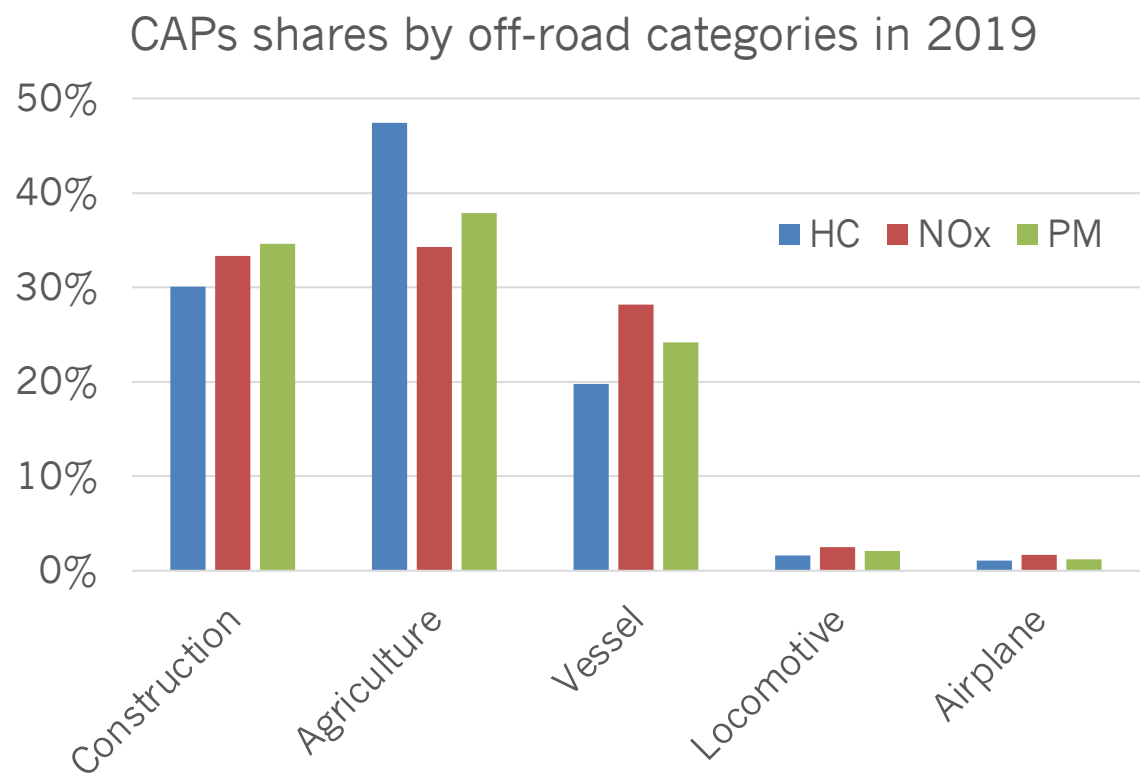


Mobile source criteria air pollutants (CAPs) emissions

Off-Road Sector

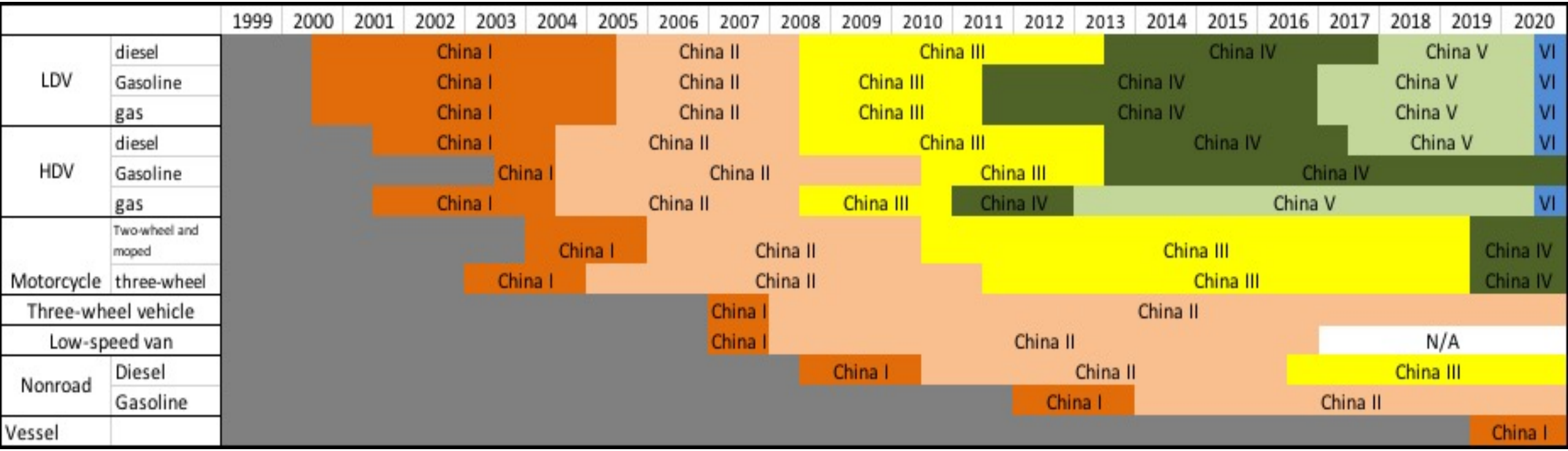
Off-road mobile sources accounted for 44% and 76% of total NOx and PM emissions respectively from mobile sources in 2019





Source: 2020 Mobile Source Environment Management Annual Report

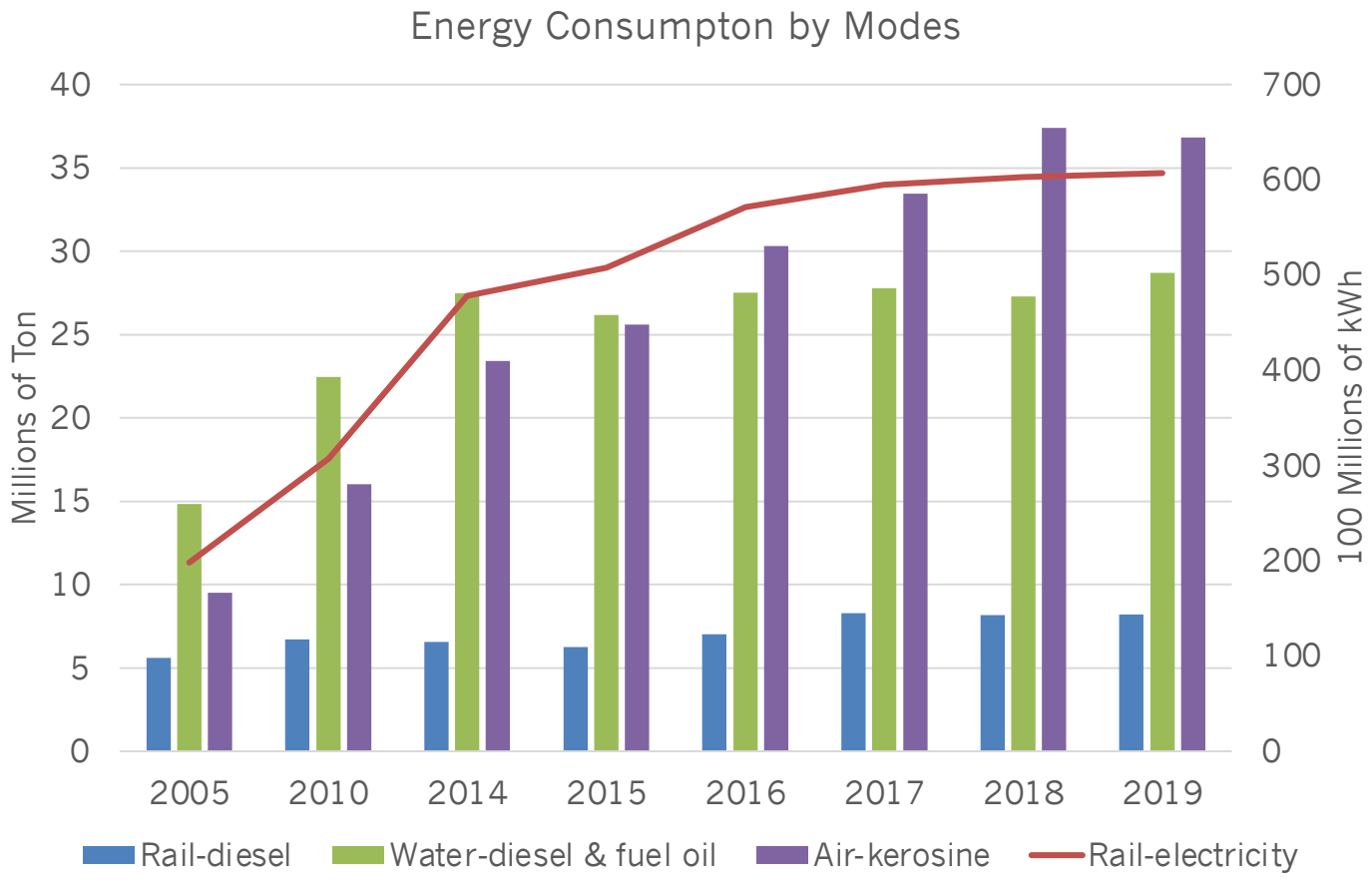
Off-road mobile sources are lagging far behind on criteria pollutants (CAPs) emissions reduction



Emissions standards implemented by dates for different mobile sources

Source: 2020 Mobile Source Environment Management Annual Report

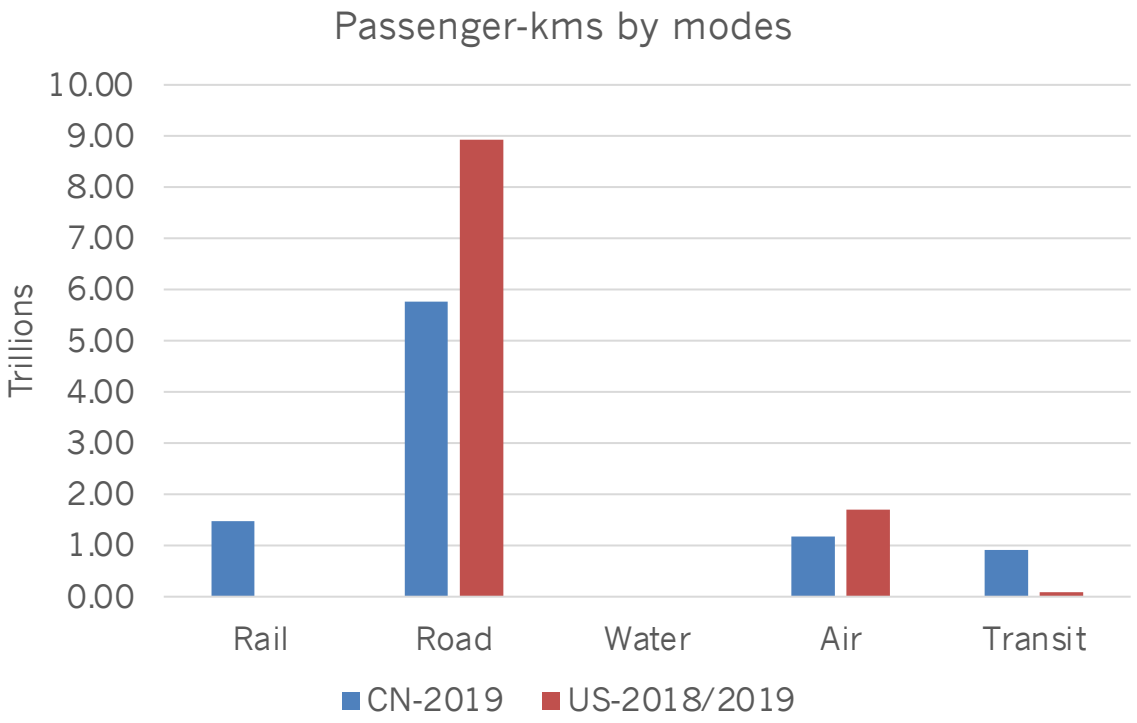
Fuel consumption from off-road transport (aviation, water, rail) was about 20% of total transport energy consumption, excluding electricity.

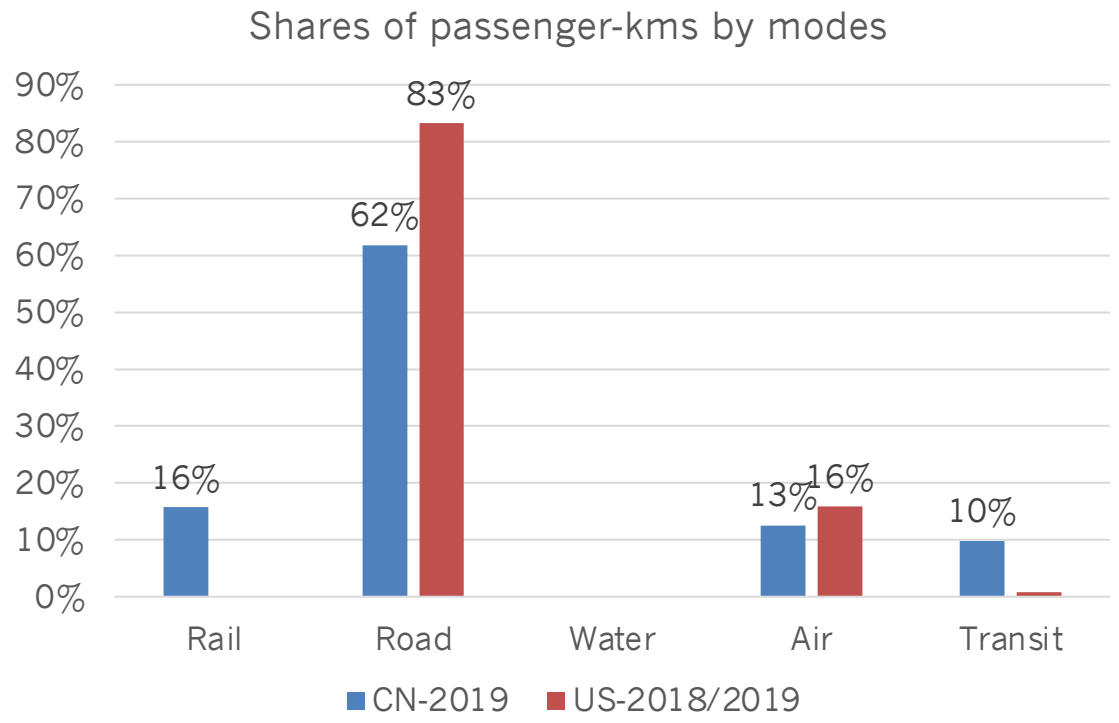


Source: 2020 Energy Data Annual Report by Qingyi Wang

Transport System

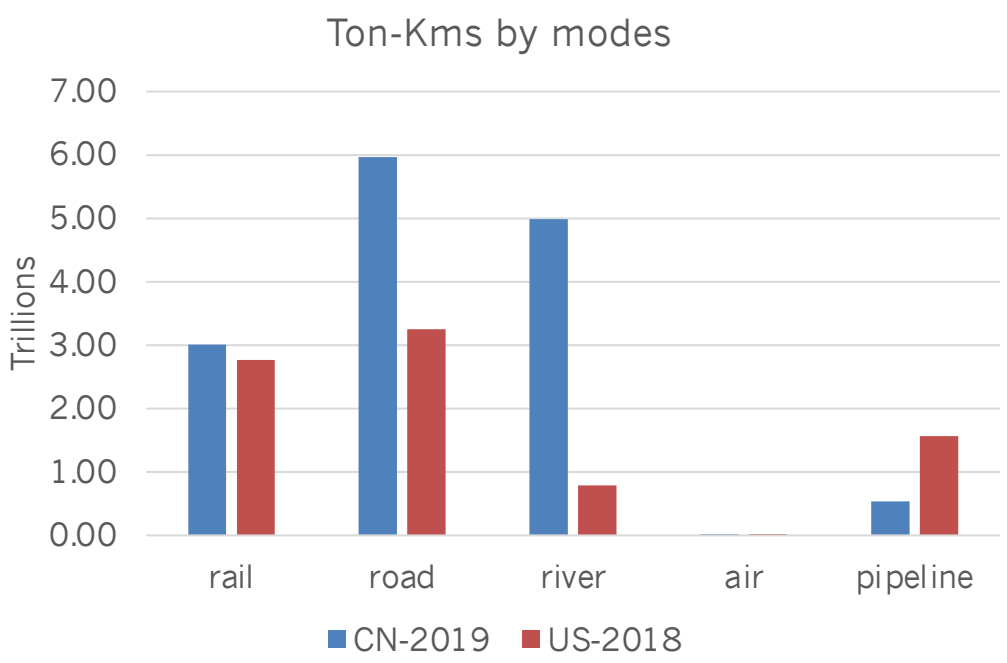
China needs to avoid relying too much on road and aviation (as the U.S. does) for passenger transportation

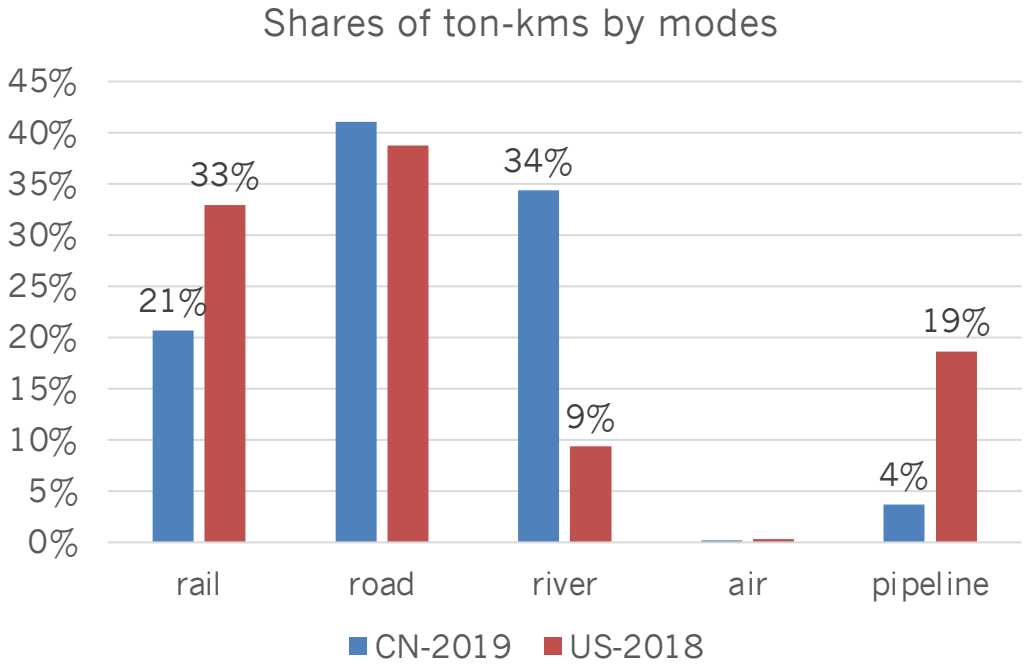




Source: China Statistic Bureau; BTS in U.S.

China could learn from U.S. to increase railway freight market share

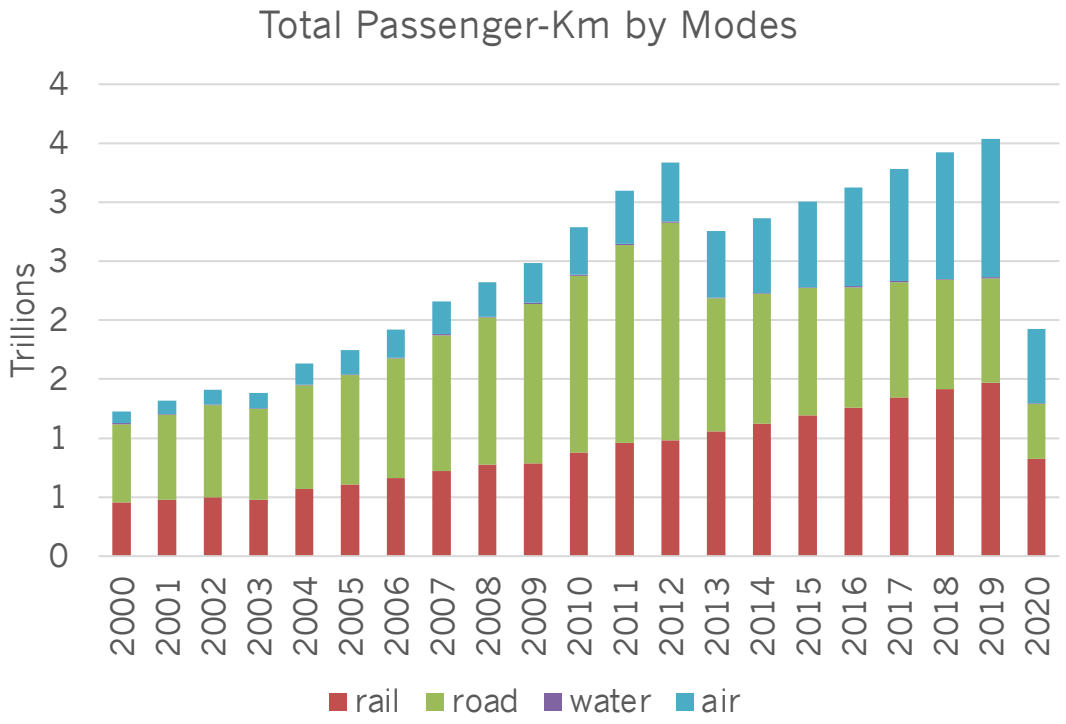


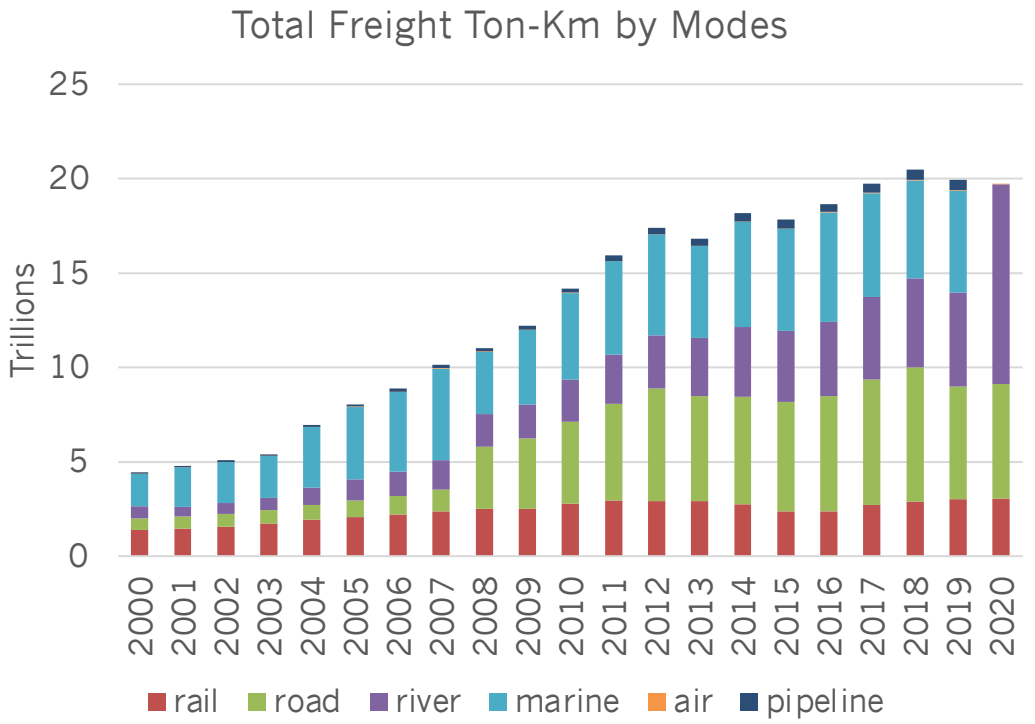


Note: excluding international marine

Source: China Statistic Bureau; BTS in U.S.

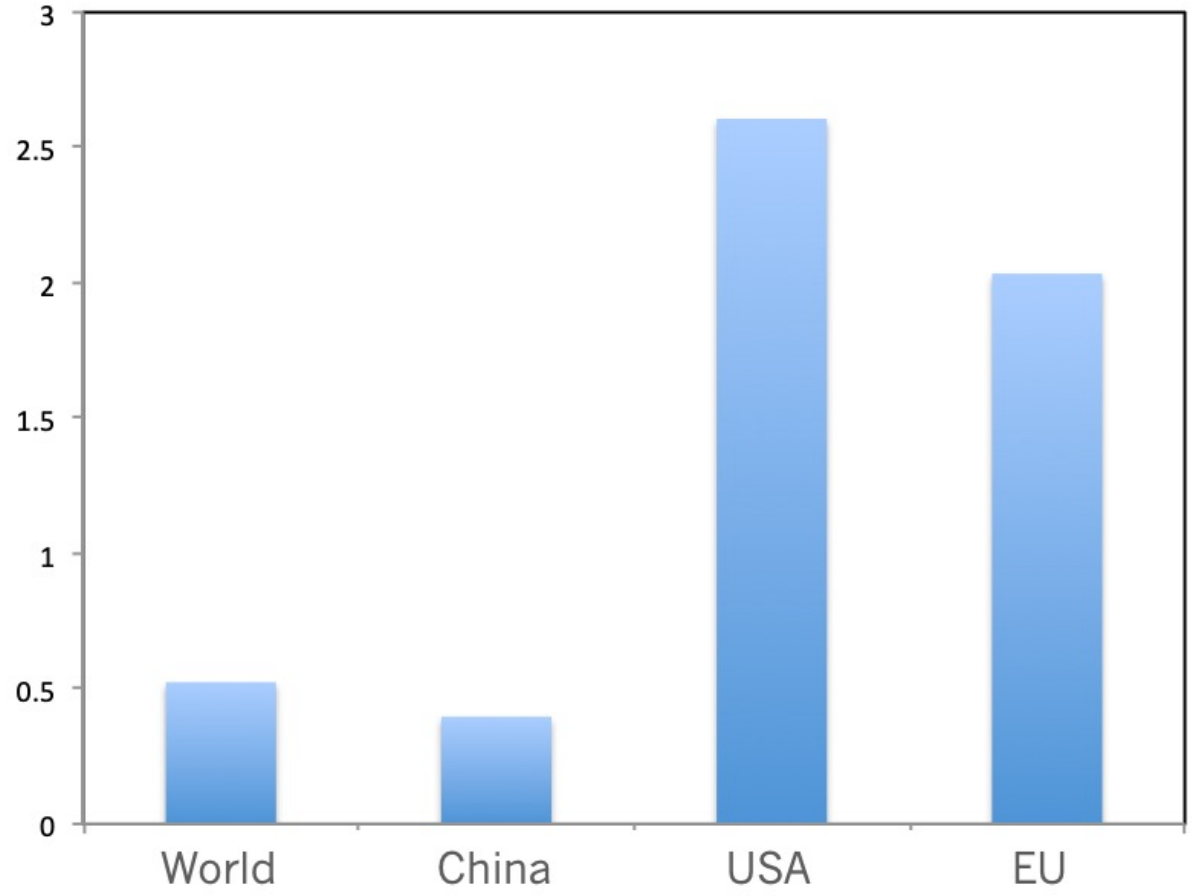
Inter-city passenger-kms significantly declined while ton-kms was relatively stable due to Covid-19 in 2020 in China





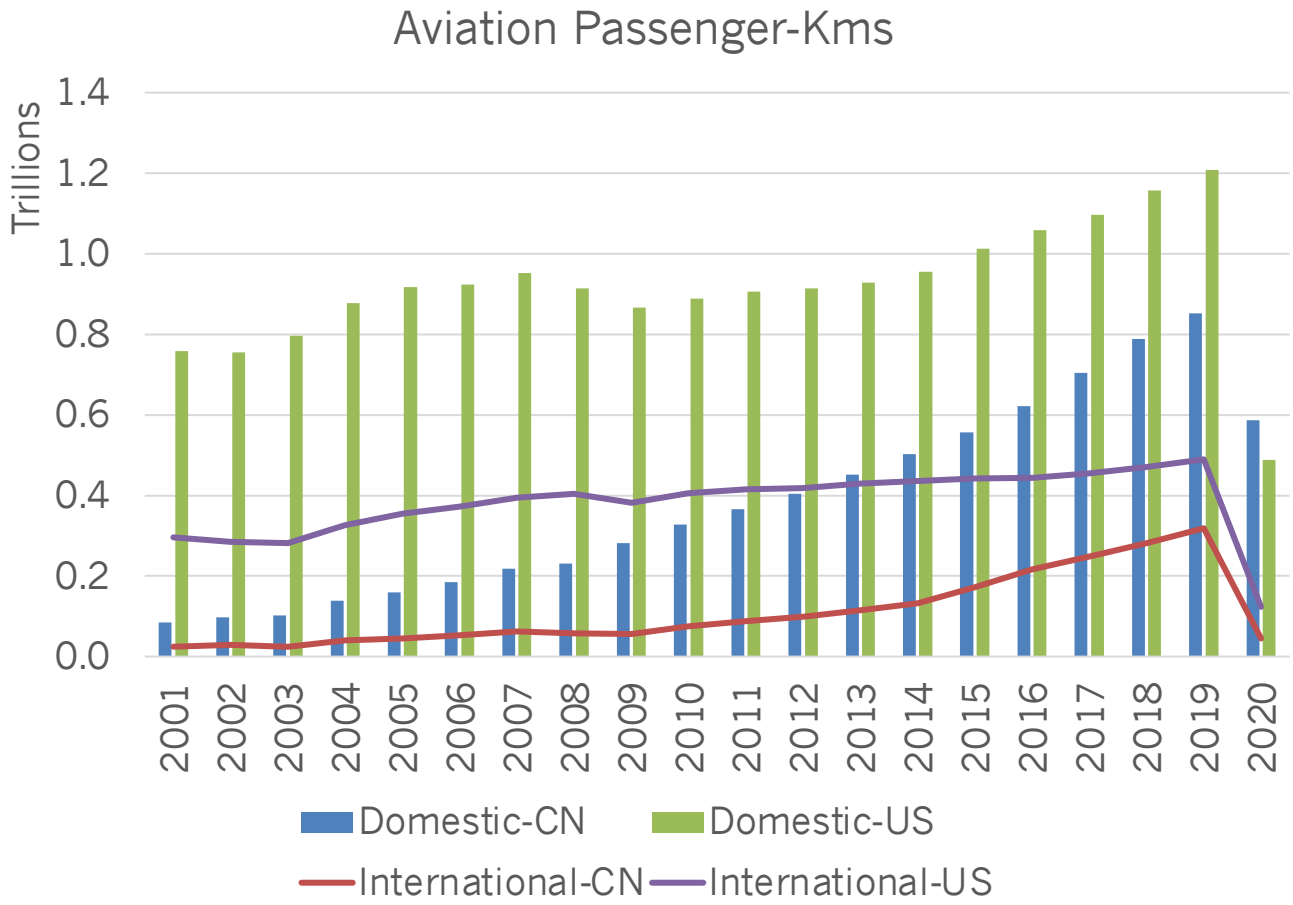
Source: China Statistic Bureau

However, China has huge potential for more aviation trips

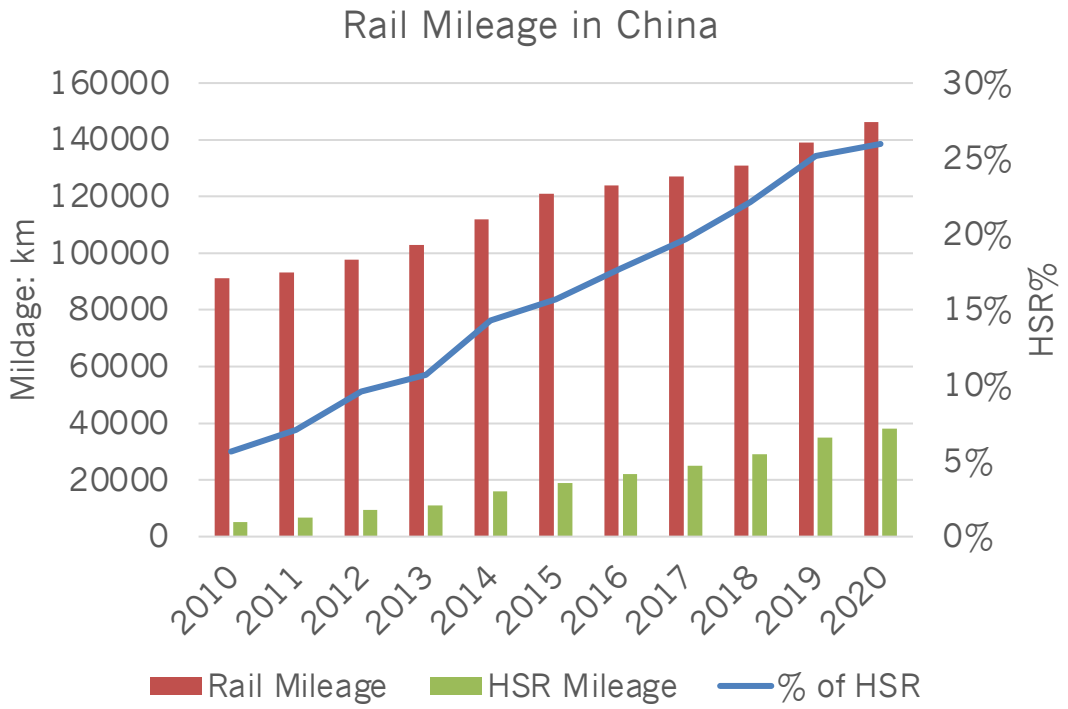


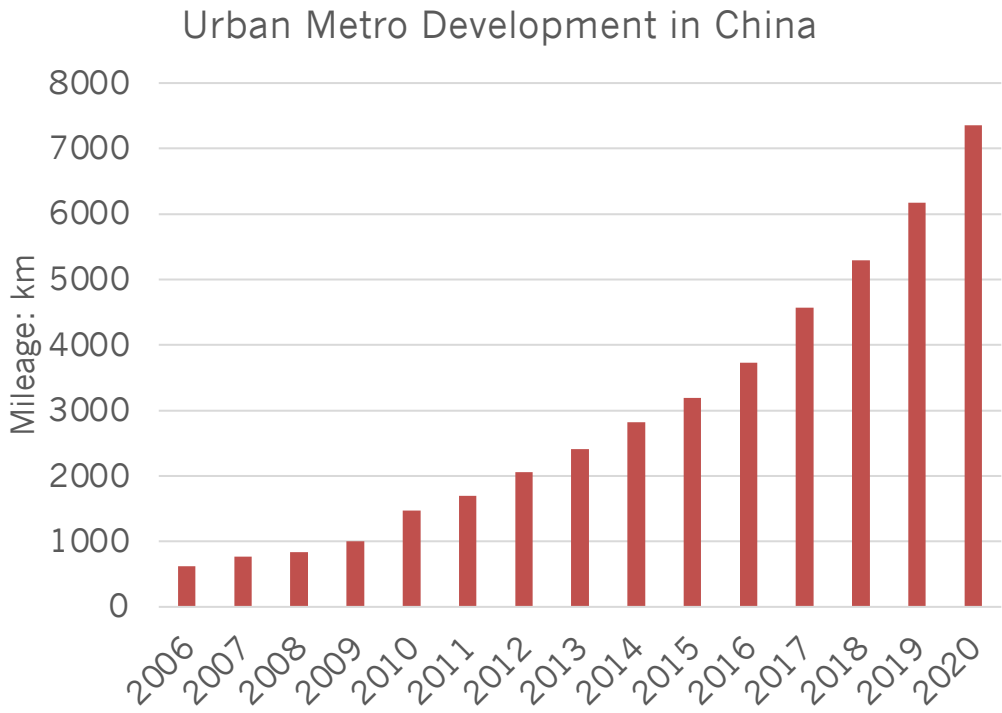
Flights per capita by region

Source: China Statistic Bureau; BTS in U.S.



Prioritizing HSR and metro development could help reduce inter-city aviation and private car trips





Source: China Statistic Bureau; Ministry of Transport

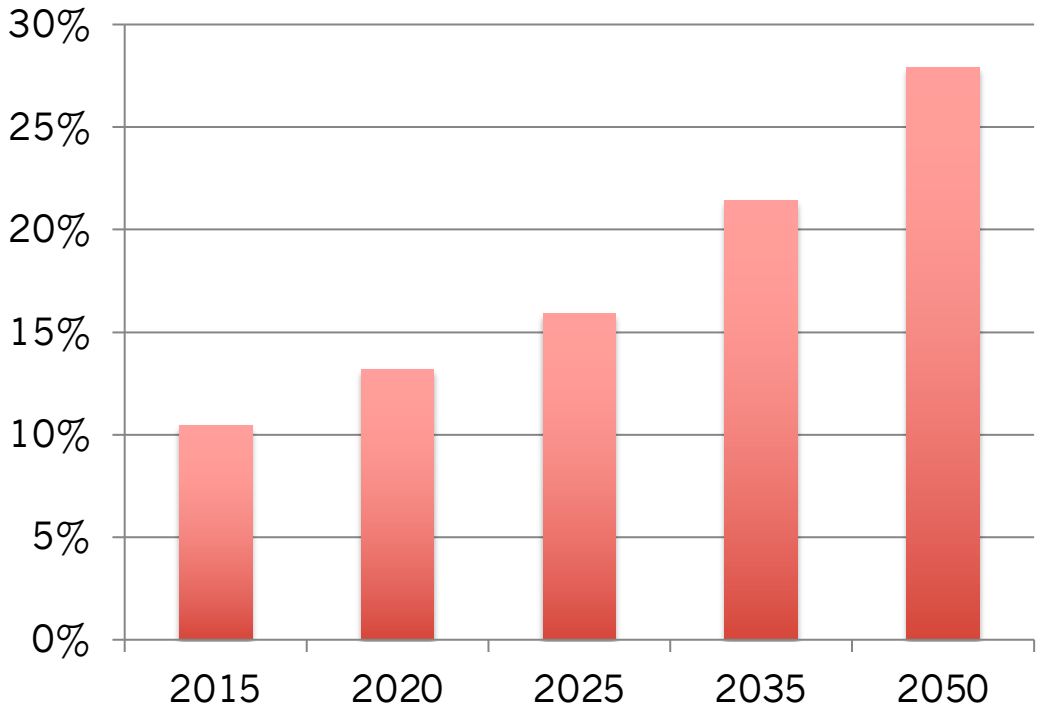
Different cities and regions need different mobility strategies

City Category

(population range)

Small	Medium	Large	Very Large	Super Large
$(P < 0.5\,m)$	$(0.5m \leq P < 1.0m)$	$(1.0m \leq P < 5.0m)$	$(5.0m \leq P < 10.0m)$	$(P \geq 10m)$
I $(0.2m \leq P < 0.5m)$		I $(3.0m \leq P < 5.0m)$		
II $(P < 0.2\,m)$		II $(1.0m \leq P < 3.0m)$		

Mobility for vulnerable groups needs more attention



% of people above 65 years

More than 85 million disabled persons

Source: China Statistic Bureau, China Disabled Persons' Federation, LTS project supported by EFC

Future Mobility

Electric 2- & 3-wheelers are feeding into public transportation and reduce the last mile demands for cars and urban delivery trucks

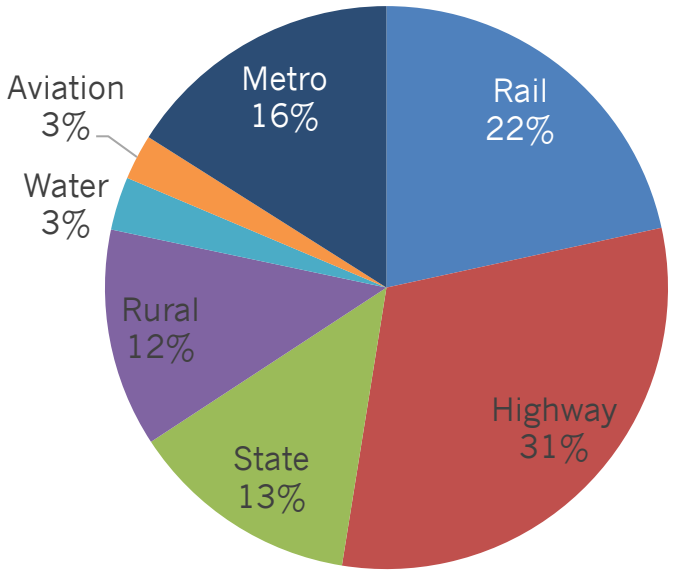
Shared mobility is reducing the demand for owning a car

- Maximize the utilization of a car for resources efficiency
- Benefit vehicle electrification
- Delay the demand for purchasing a car before mature EV
- Reduce mobility cost for vulnerable groups
- Help jobless
- Might reduce the attractiveness of buses

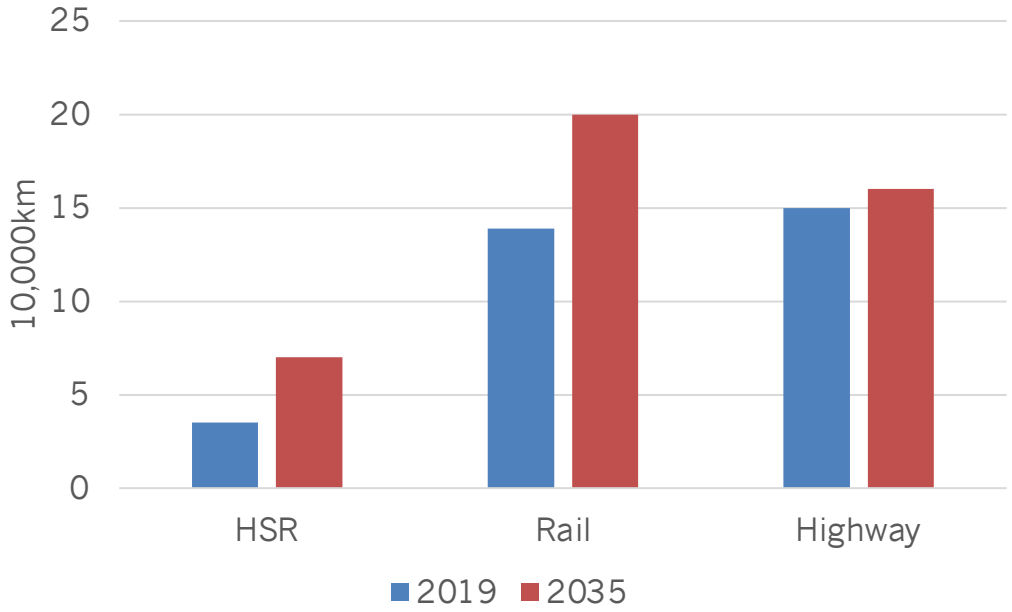
Key issues in summary

- No or poor CAPs and CO_2 regulations for off-road transport and machineries
- Aviation is increasing fast & trucks dominate the freight market while there are uncertainties on their zero emissions technology pathways
- Lack of differentiated mobility strategy based on city and region difference
- Lack of clear strategy and plan to embrace micro and shared mobility
- Poor attention to mobility demands from vulnerable groups

China invested 3.9 trillion RMB to improve transport infrastructure in 2019, & has an ambitious infrastructure plan by 2035



Transport Infrastructure Investment by Modes in 2019

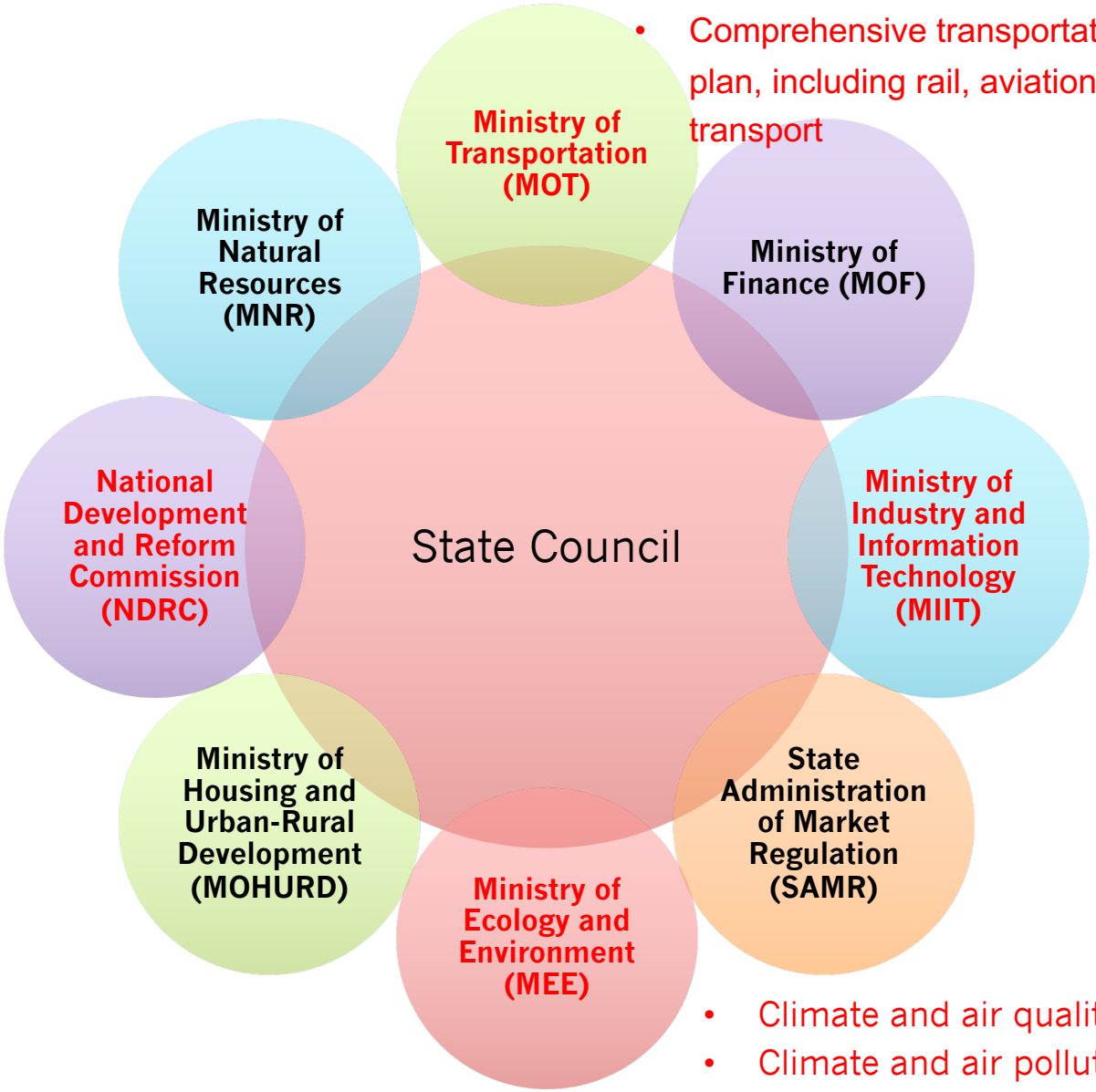


Transport Infrastructure Development Targets by 2035

Source: Ministry of Transport,《国家综合立体交通网规划纲要》

Key policymakers

- Public transportation and green transportation development plan
- Comprehensive transportation development plan, including rail, aviation, water, and road transport



- Transport infrastructure development, including metro
- Carbon peaking action plan

- Manufacturing of vehicles, vessels, airplanes, etc.
- Energy efficiency promotion and new energy vehicle industry development

- Climate and air quality targets
- Climate and air pollution control action plan
- Tailpipe emissions standards

Theory of Change

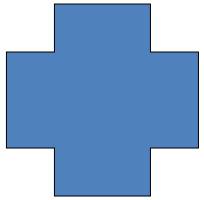
structure

Increase rail competitiveness to reduce trucks, inter-city car trips, and aviation

Accelerate metro development in Tier I & II cities to reduce urban car driving

Encourage 2 & 3 wheelers in Tier I & II cities to feed public transport & reduce short-distance car trips

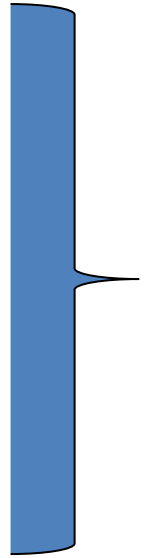
Improve bus services in Tier III & IV cities to provide choices other than private cars



technology

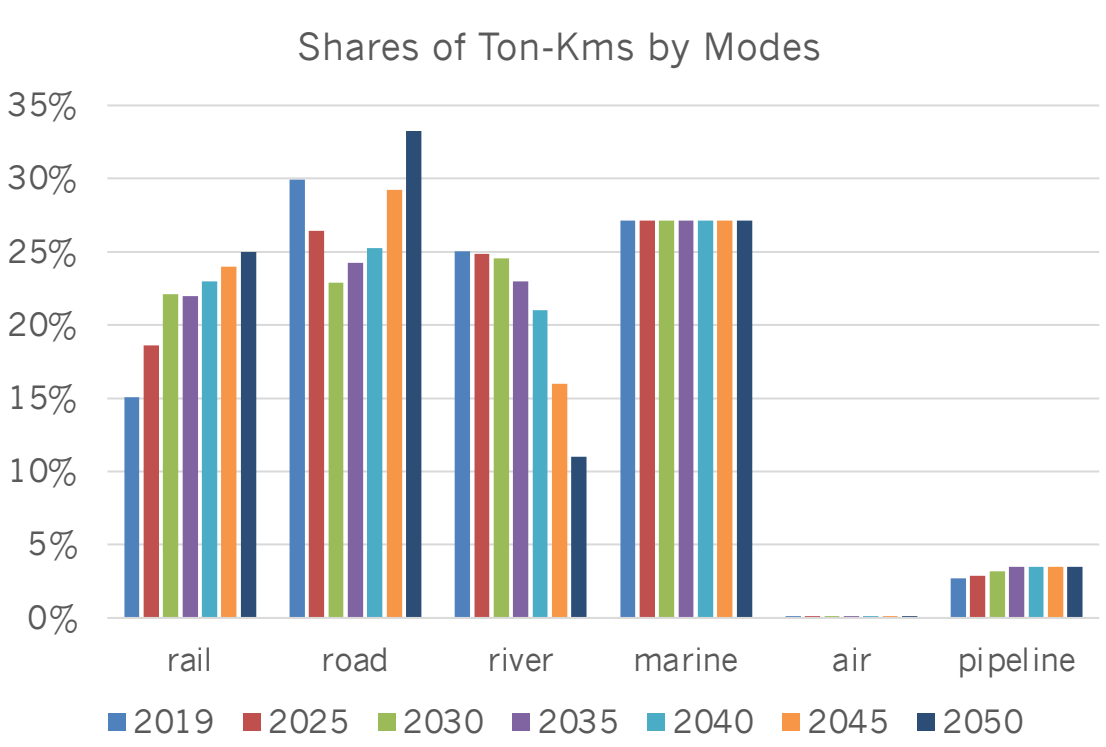
Electrify equipment, vessels, & airplanes where possible

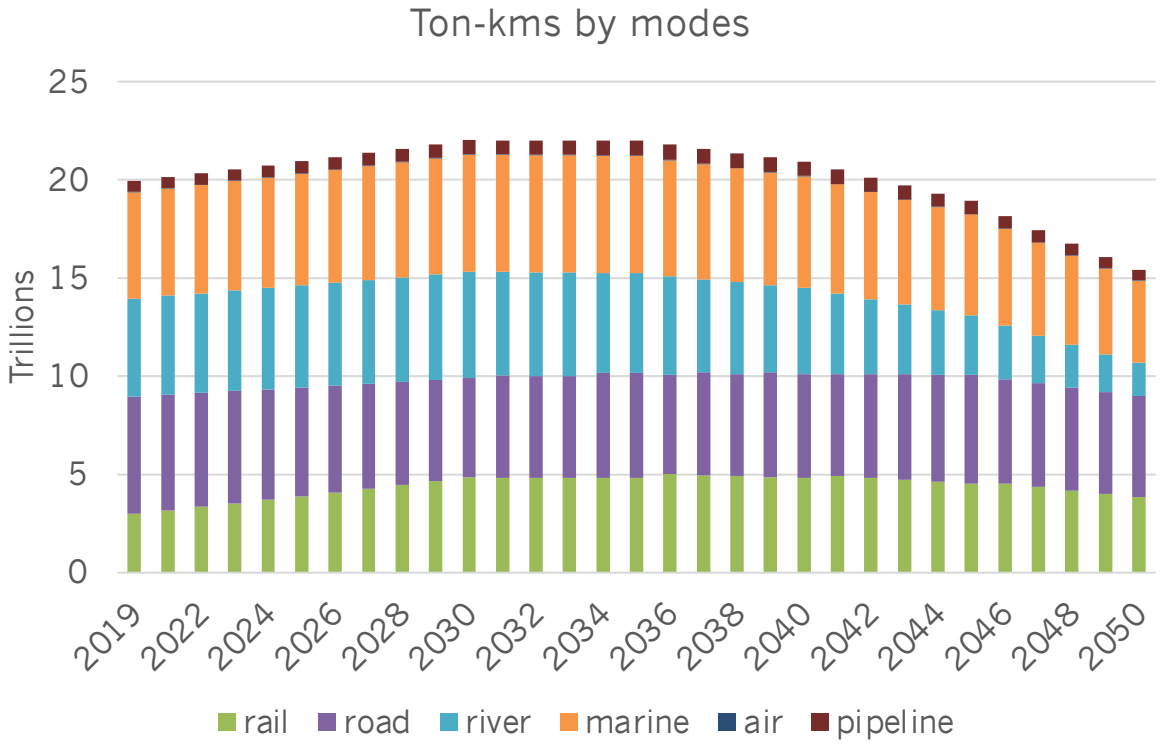
Tighten off-road emissions and fuel efficiency standards



- Safe
- Economic
- Low-carbon
- Clean
- Fast
- Convenient
- Reliable
- Comfortable

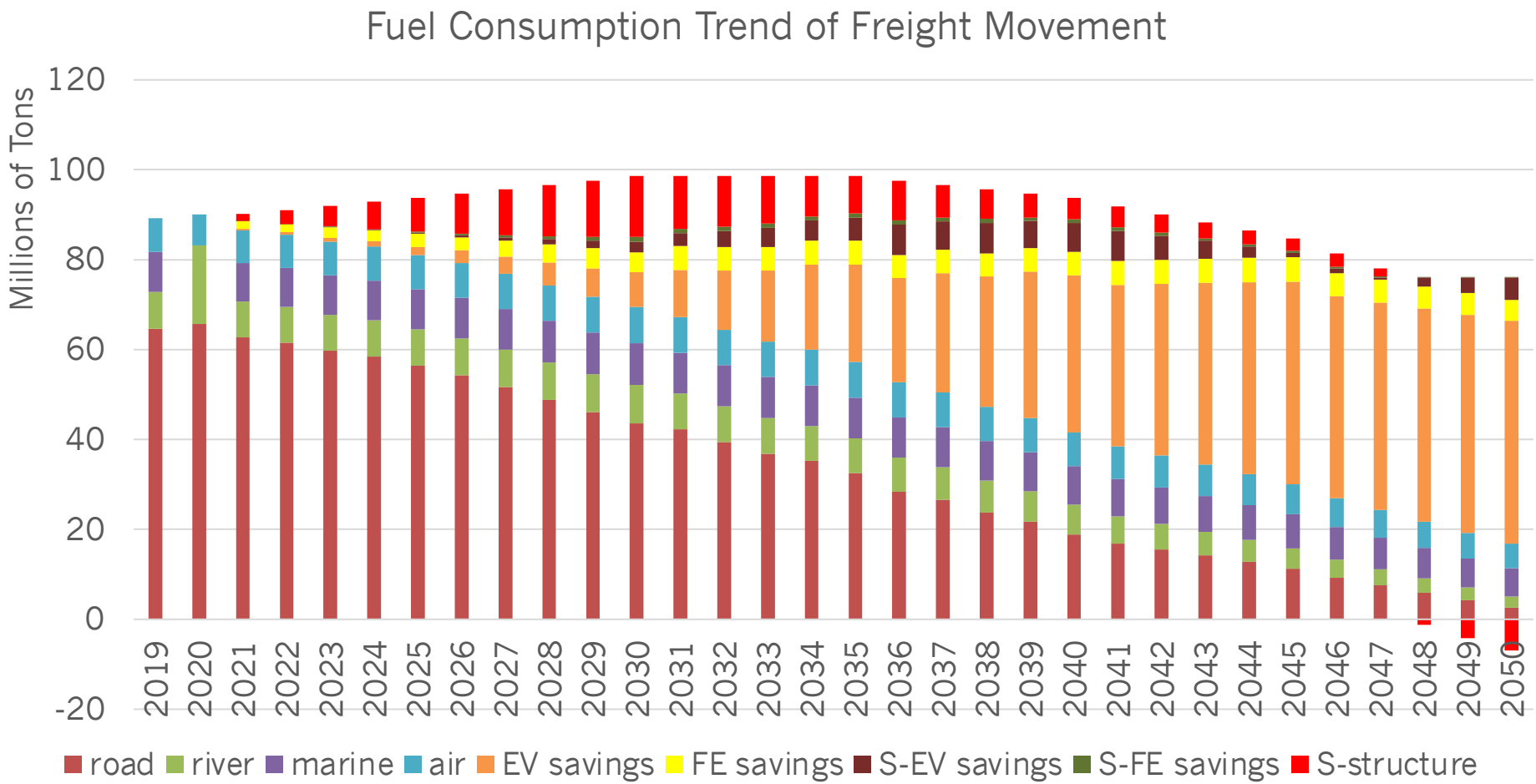
Increase railway freight market to 25% by 2050 from 15% in 2019





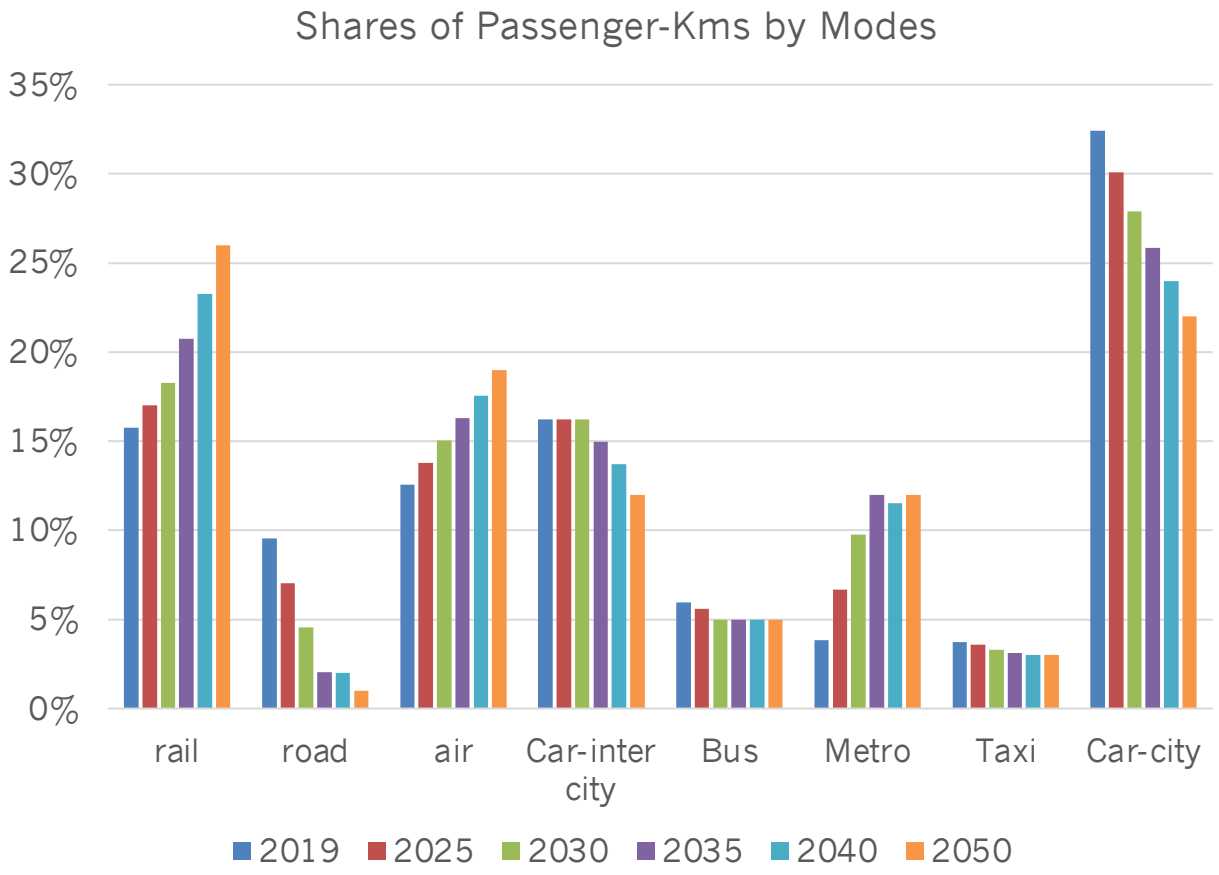
Source: EFC internal modeling and analysis, excluding urban freight

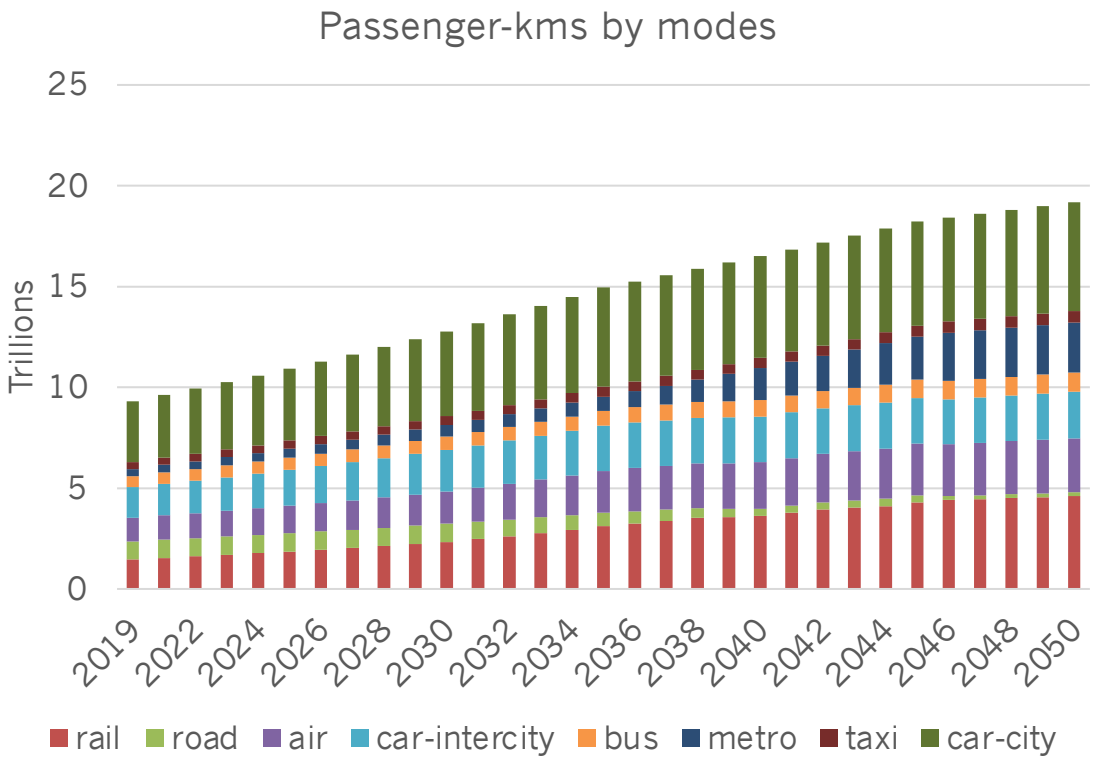
Shifting trucks to rail could account for more than 50% of total freight fuel consumption savings before 2030



Source: EFC internal modeling and analysis

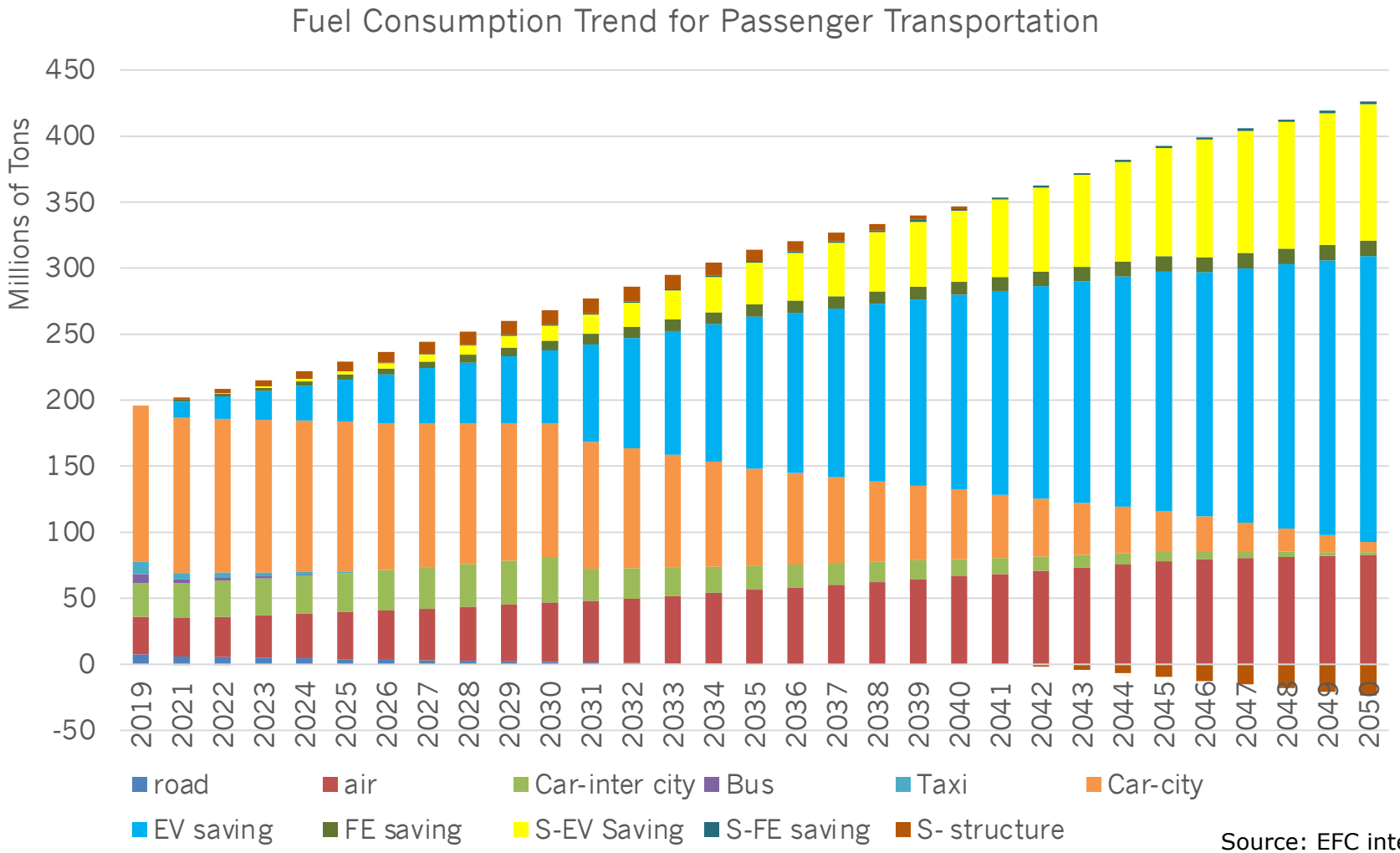
Increase rail and metro passenger market to 38% by 2050 compared to 20% in 2019





Source: EFC internal modeling and analysis

Electrification dominates the fuel savings for passenger transportation, with aviation as the remaining hard bone by 2050



Source: EFC internal modeling and analysis

Key barriers & drivers

Barriers:

- Lack of the law to mandate the integration of different transport modes, including infrastructure development and service supply
- Railway operates like a government and lacks the market competitiveness
- The government is not used to innovative market-based mobility service, such as sharing
- Lack of data on urban logistic and national and local commodities flow
- Immature zero emissions technologies for vessels and airplanes
- Lack of enough attention to vulnerable groups' mobility

Drivers:

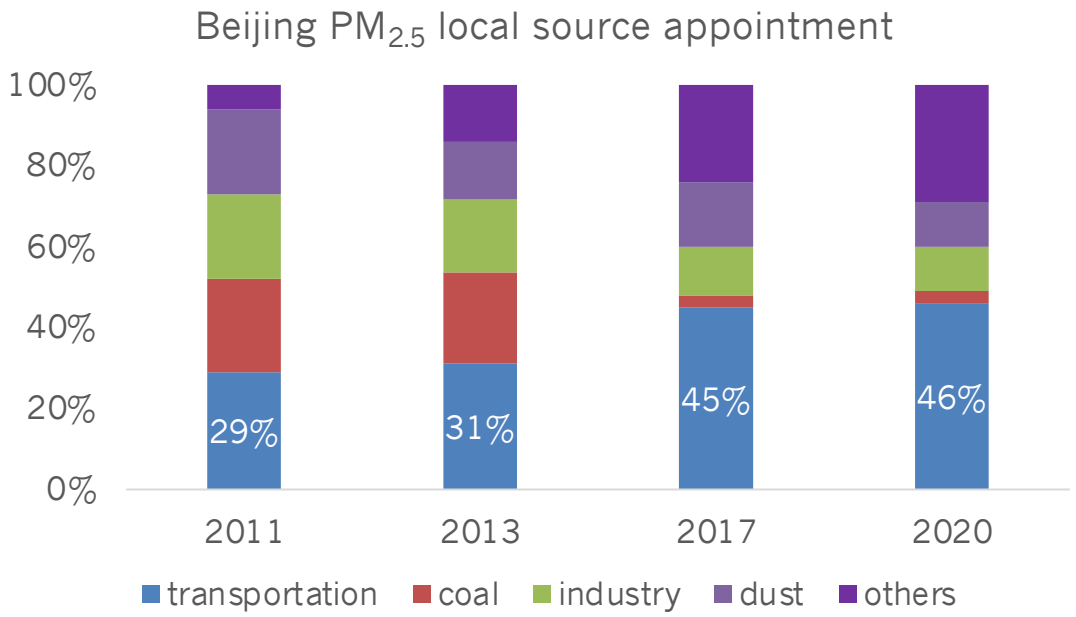
- Air quality improvement and health protection
- National and urban carbon peaking and neutrality
- International requirements to reduce emissions from international aviation and marine vessels
- Transportation cost and economic development
- National and city operation efficiency and attractiveness
- Transportation safety and fairness

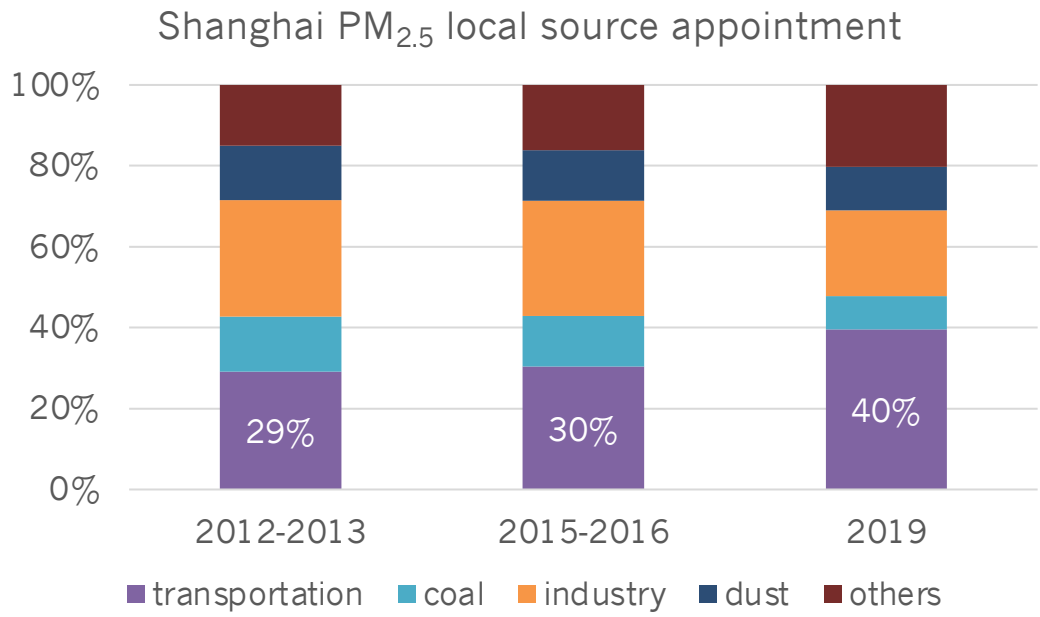
Key intervention prongs

THANK YOU

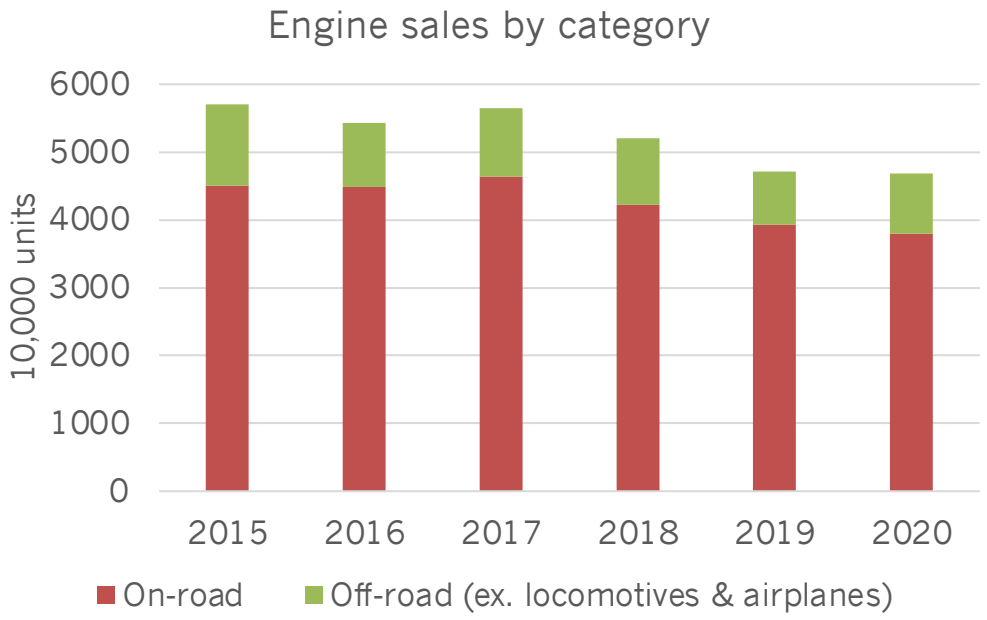
Annex

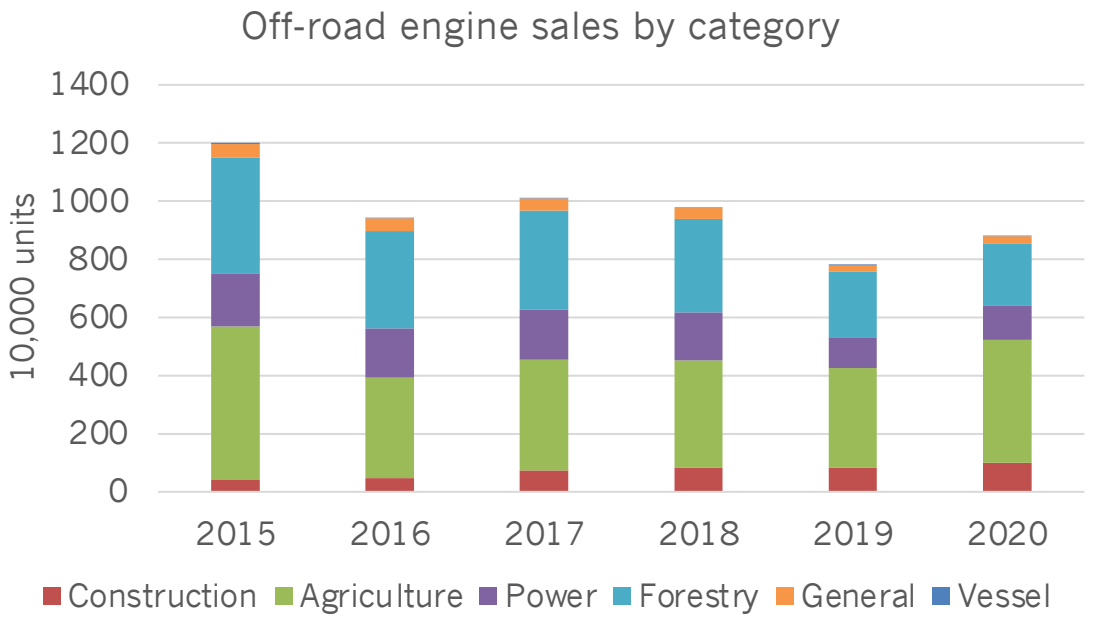
Transport is accounting for growing local $PM_{2.5}$ pollution in both Beijing and Shanghai





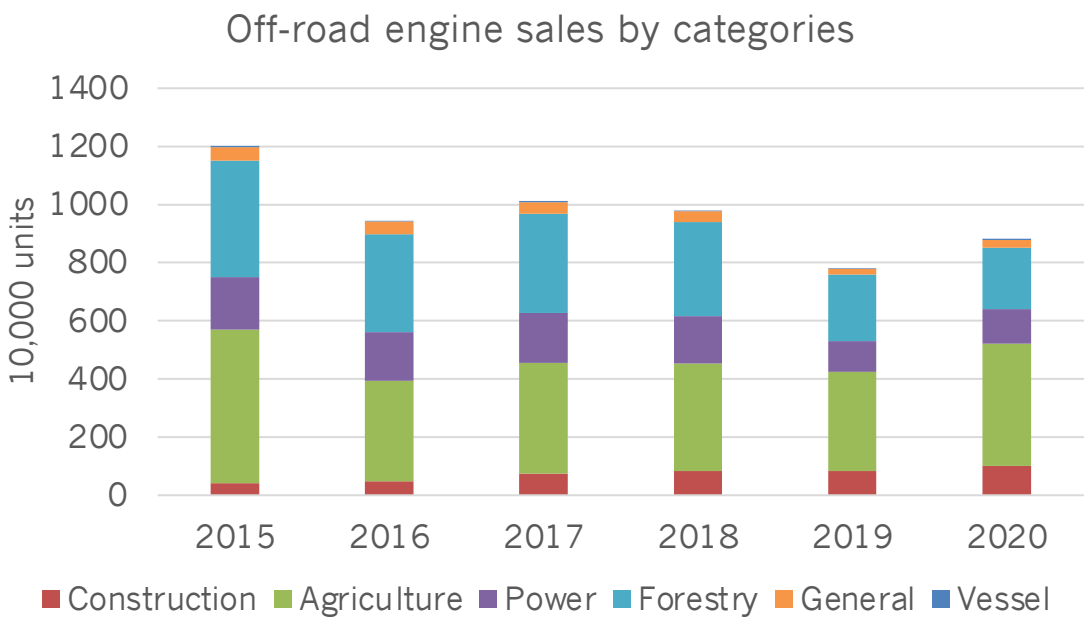
Off-road engines account for ~18% of total engine sales

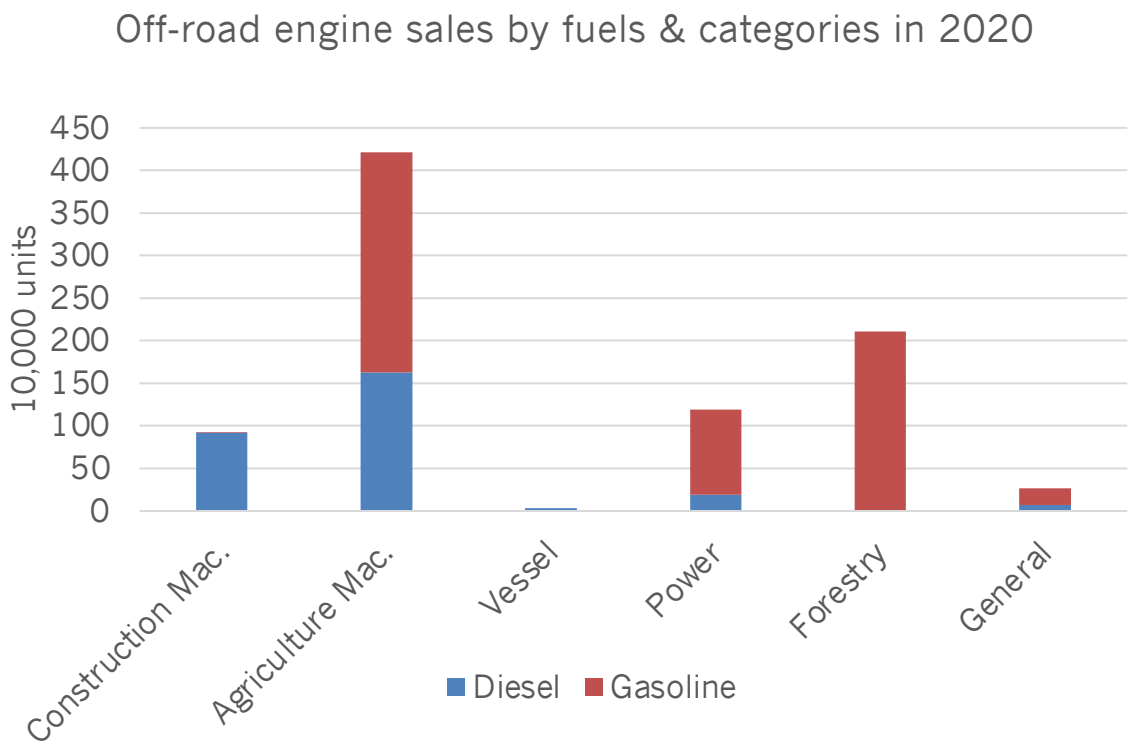




Source: China Internal Combustion Engine Industry Association

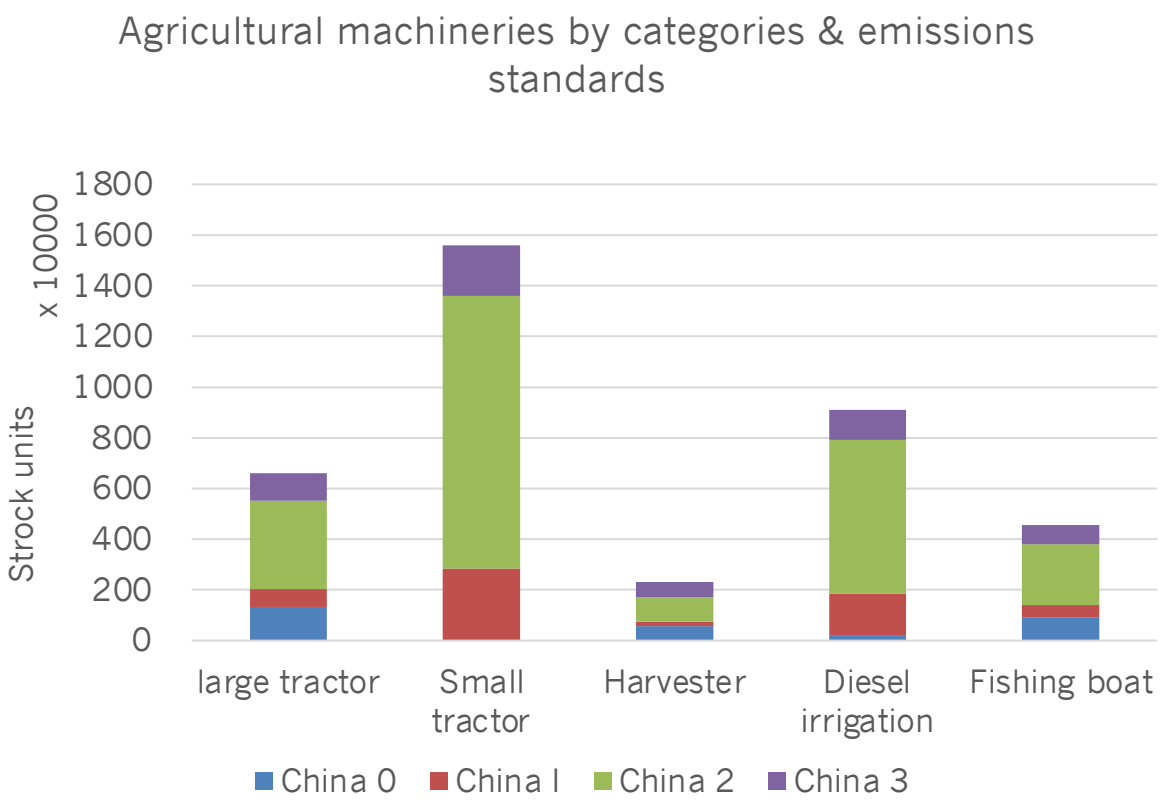
About 8m off-road engines are sold each year without strict emissions standards and no fuel efficiency regulation

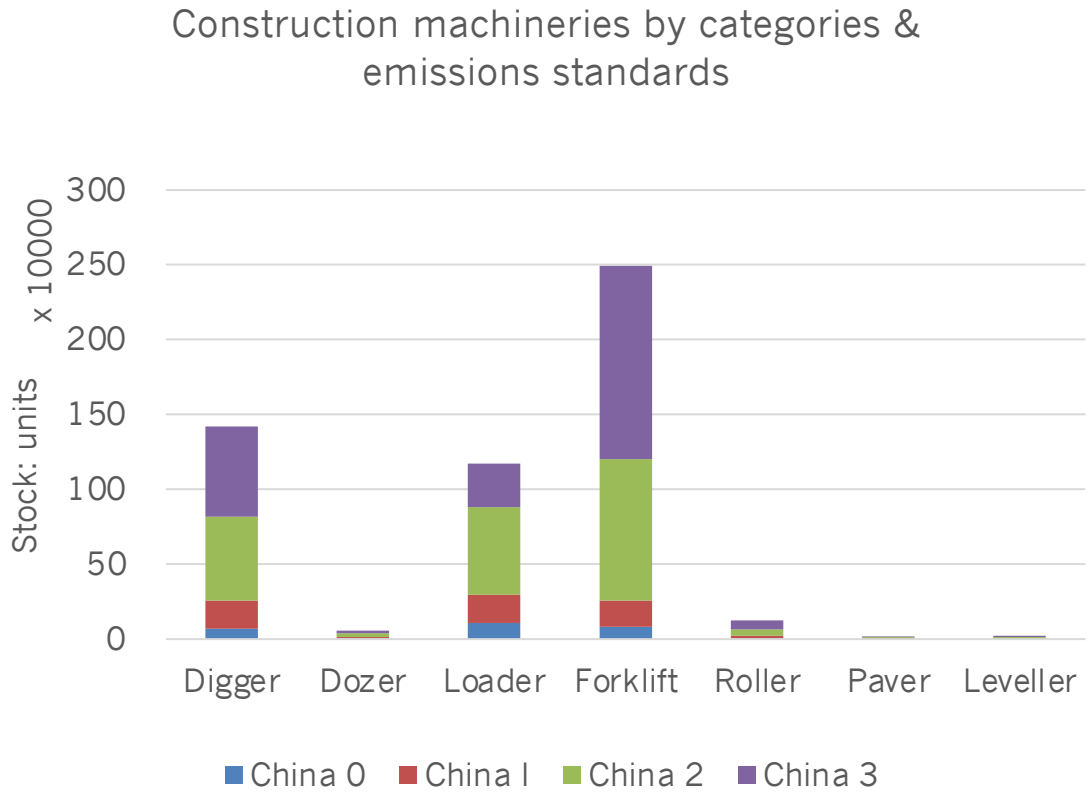




Source; China Internal Combustion Engine Industry Association

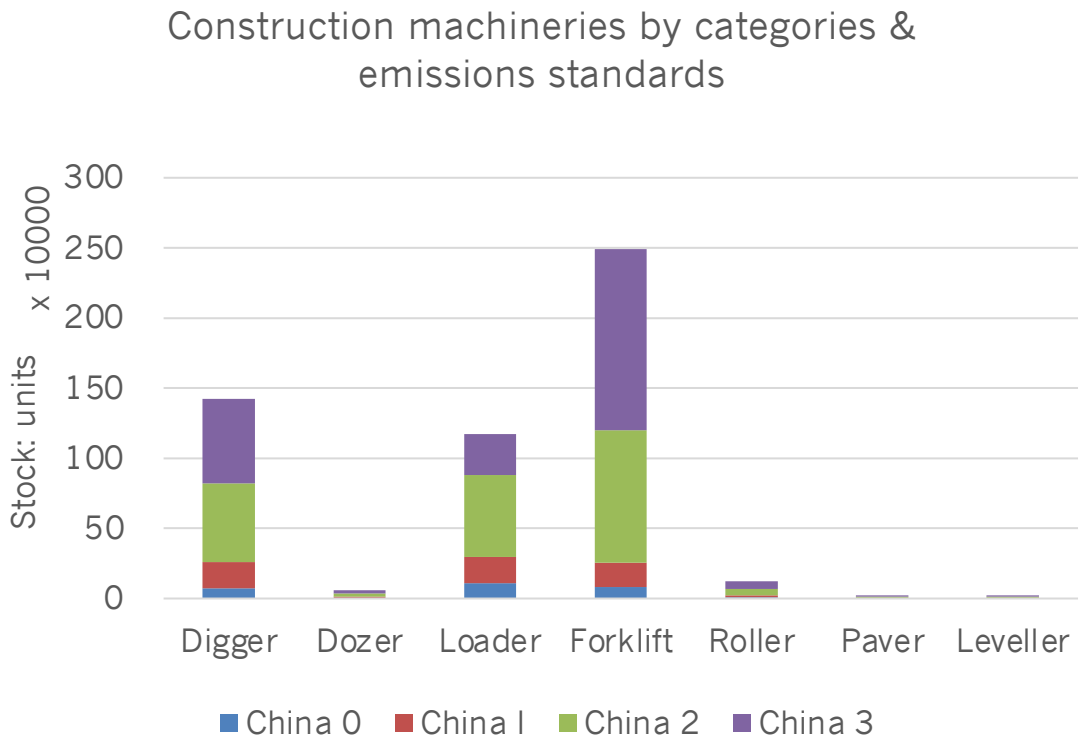
As of 2019, 43m agricultural & construction machineries are operating in the field, with largest fraction meeting China 2 emissions standard

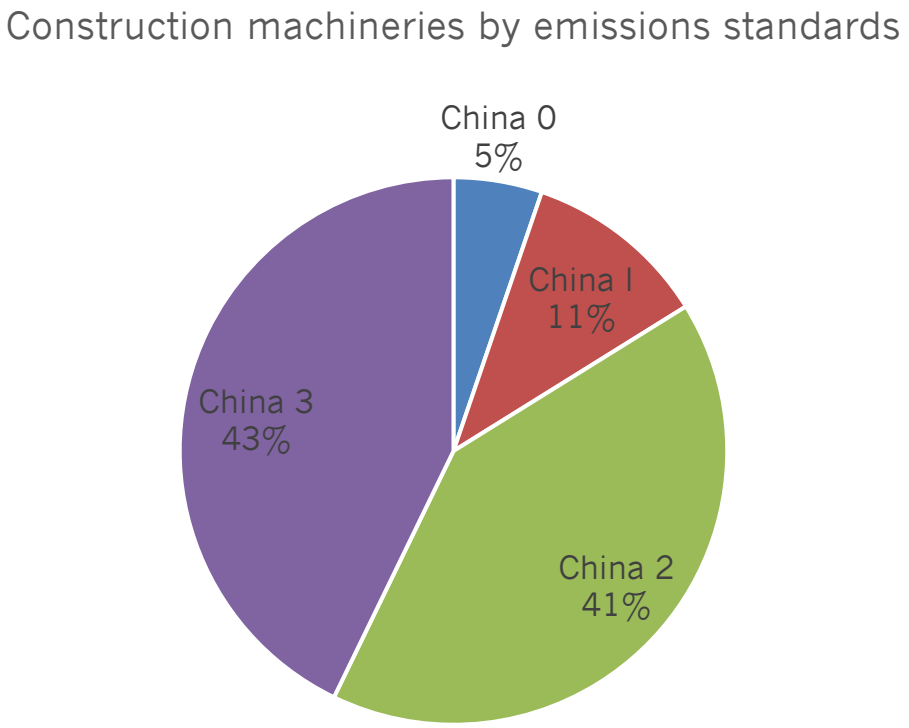




Source: Vehicle Emissions Control Center

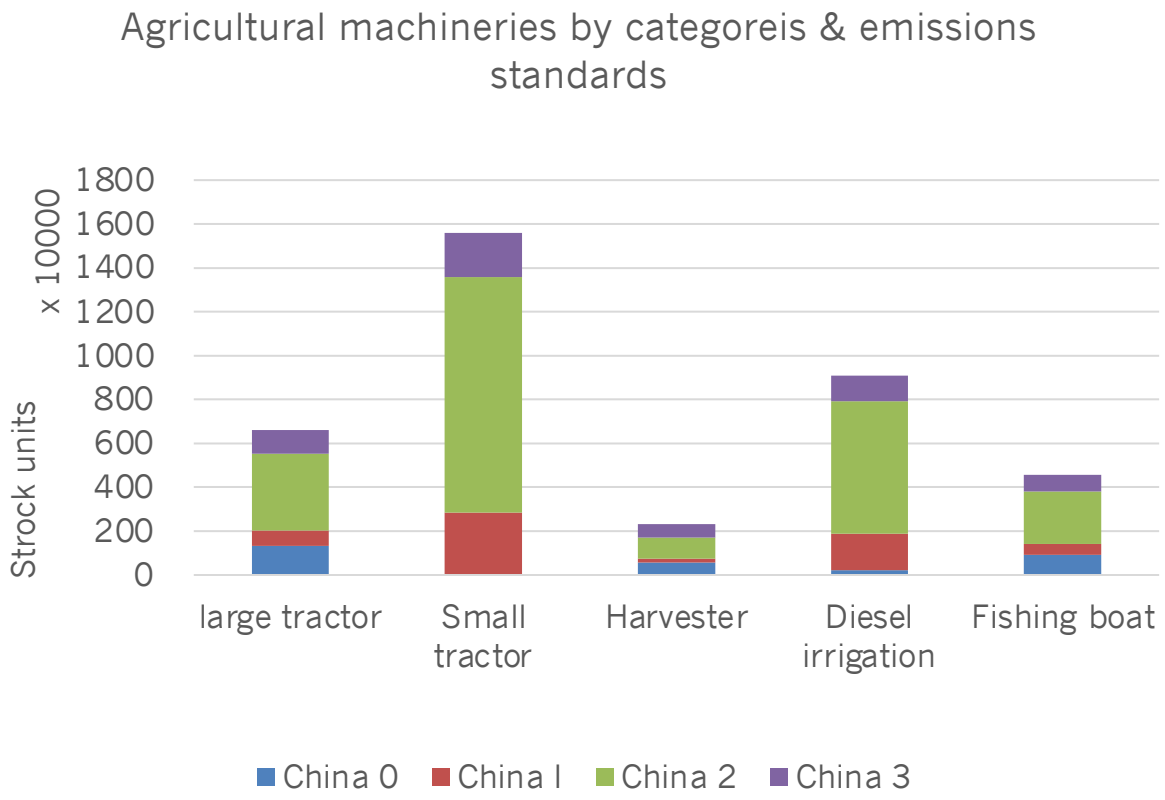
As of 2019, 5.3m construction machineries are operating in the field, mostly meeting China 2 & 3 emissions standards

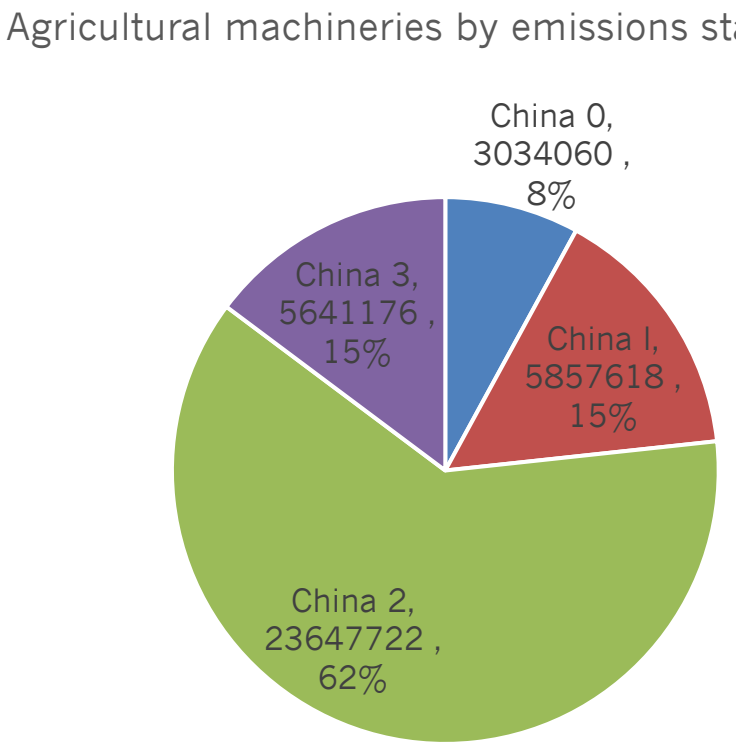




Source: Vehicle Emissions Control Center

38m agricultural machineries, mostly meeting China 2 emissions standards





Source: Vehicle Emissions Control Center

In addition to vehicles, off-road transport is also critical

River-going: 119,500
Costal: 10,364
International marine: 1,664

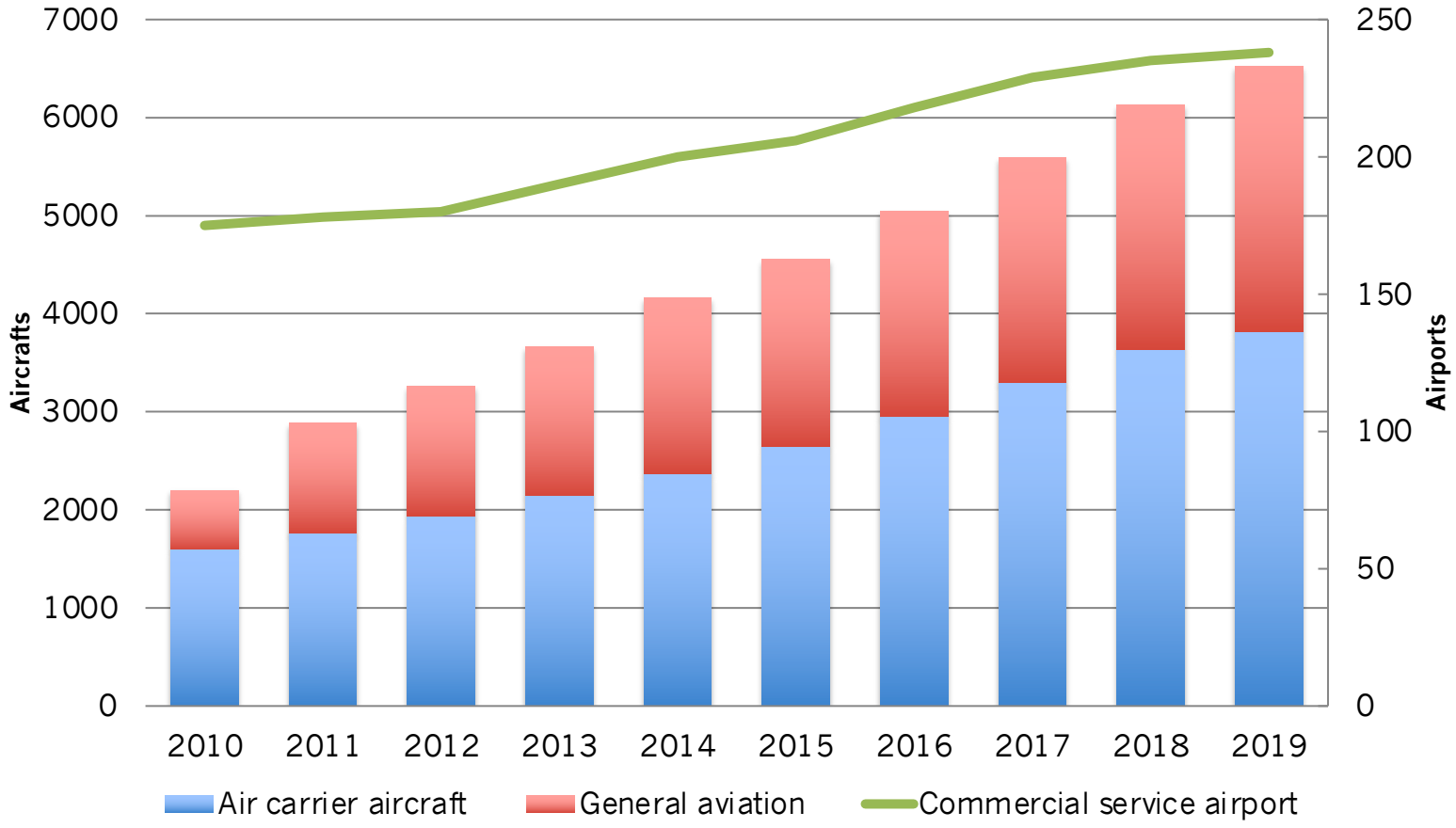
Electric locomotives: 13,700

ICE locomotives: 8,000

Air carrier: 3,818

General aviation: 2,707

Both the number of airports and aircrafts are increasing quickly in China



Source: Civil aviation development statistics

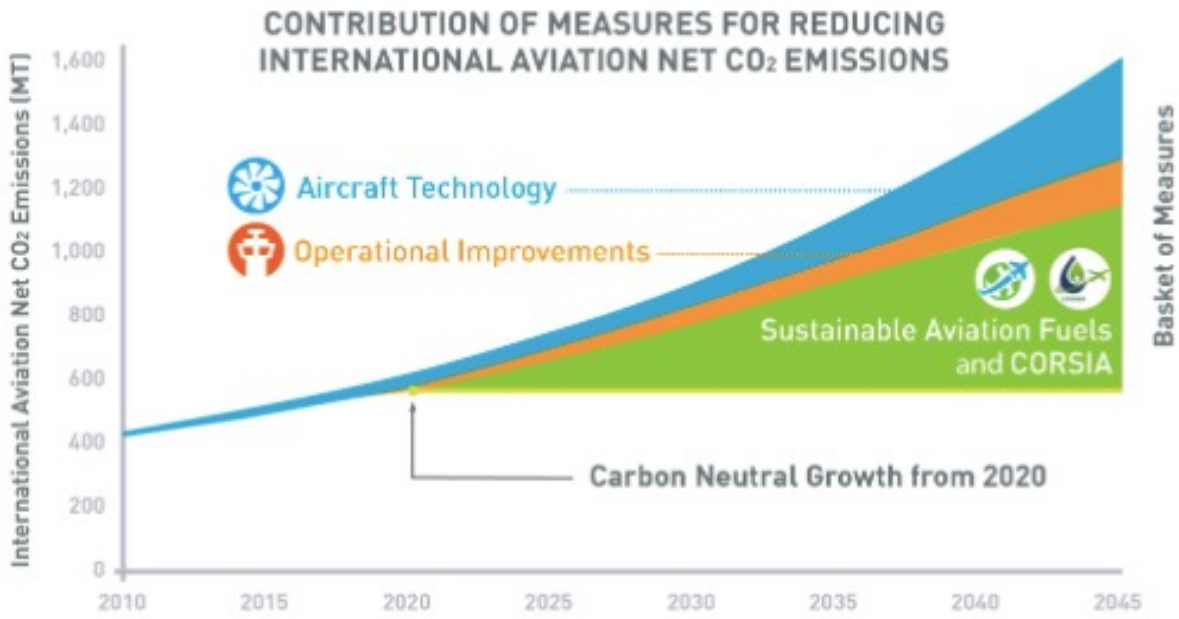
Enable China to proactively support and advocate more stringent environment targets and actions at ICAO

Goals:

2% annual fuel efficiency improvement through 2050

carbon neutral growth from 2020 onwards

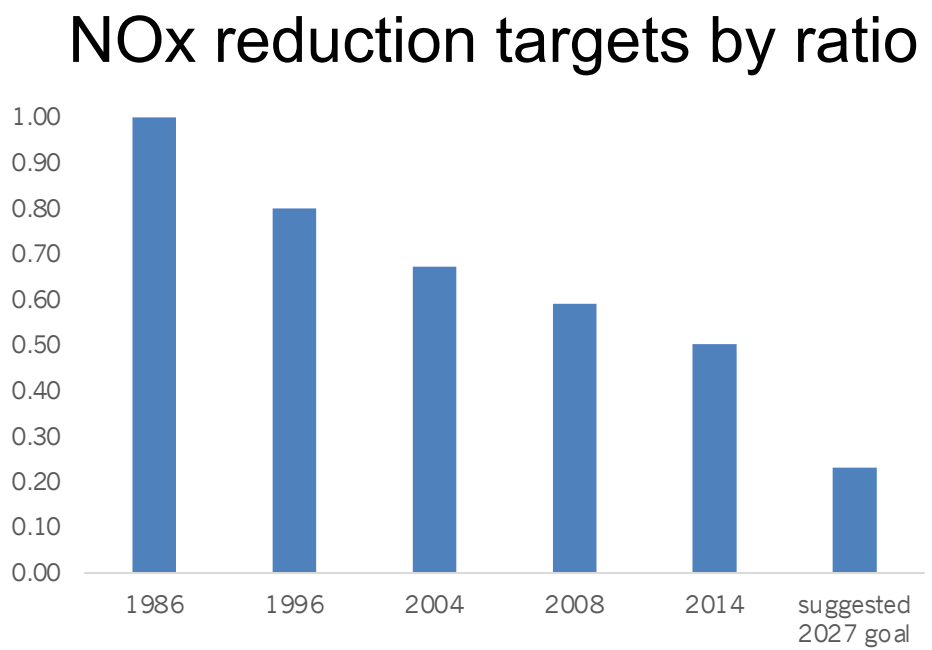
- aircraft technology improve-ments (Airplane CO_2 Standard (2017))
- Opera-tional improve-ments
- Sustain-able aviation fuels
- market-based measures (CORSIA)



ICAO technical standards on engine emissions

Standard	ICAO ANNEX 16 VOL II， 4th Edition, July 2017
Targeted pollutants	NOx, HC, CO, liquid fuel venting, smoke*

*Smoke is expected to be superseded by the nvPM Standard to be approved in 2020

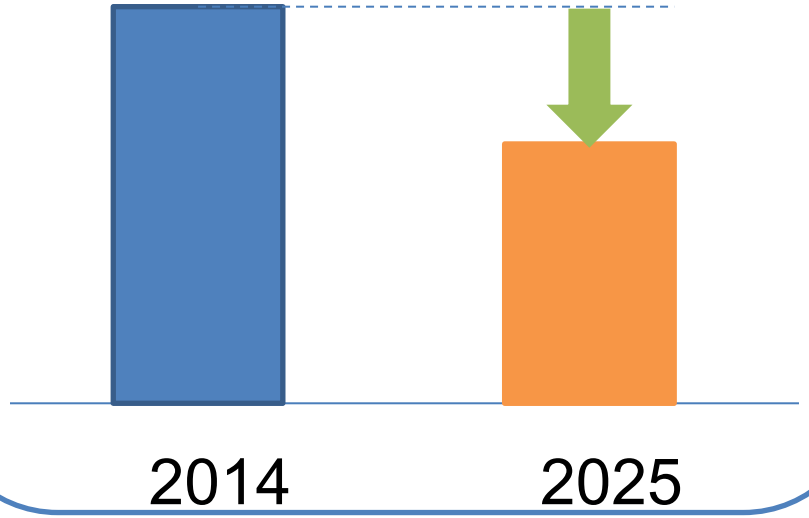


Source: EPA and ICAO

Enable China to proactively support and advocate more stringent environment targets and actions at IMO

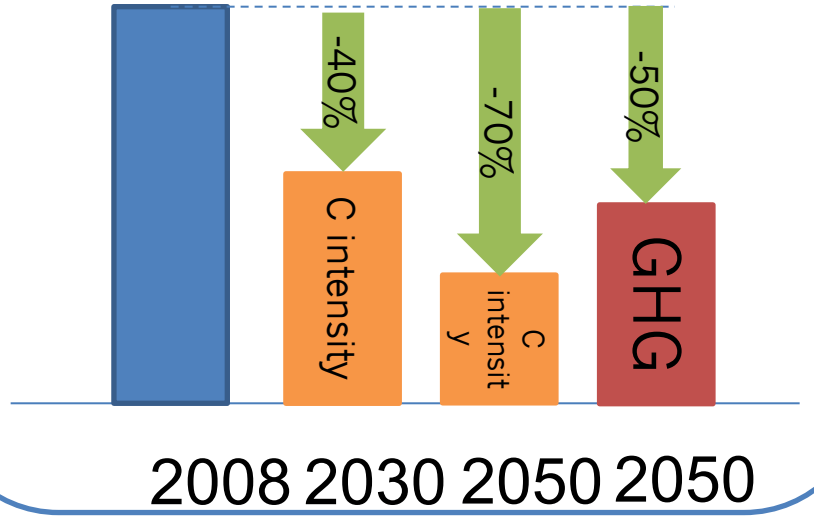
MARPOL Annex VI EEDI & SEEMP

Carbon intensity reduced by 30%



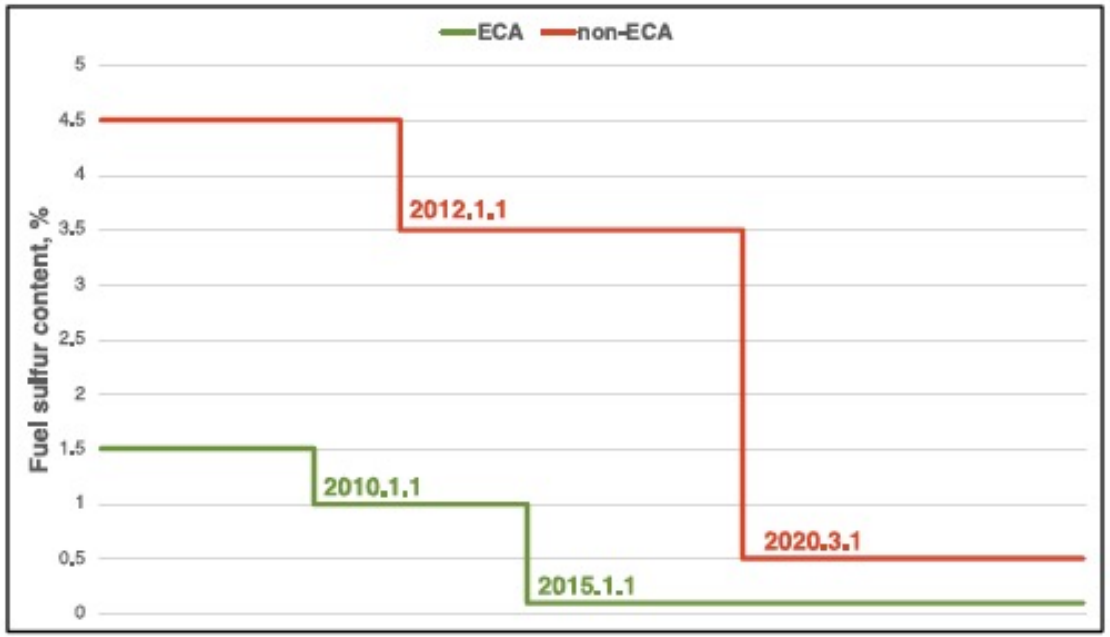
Initial GHG Strategy

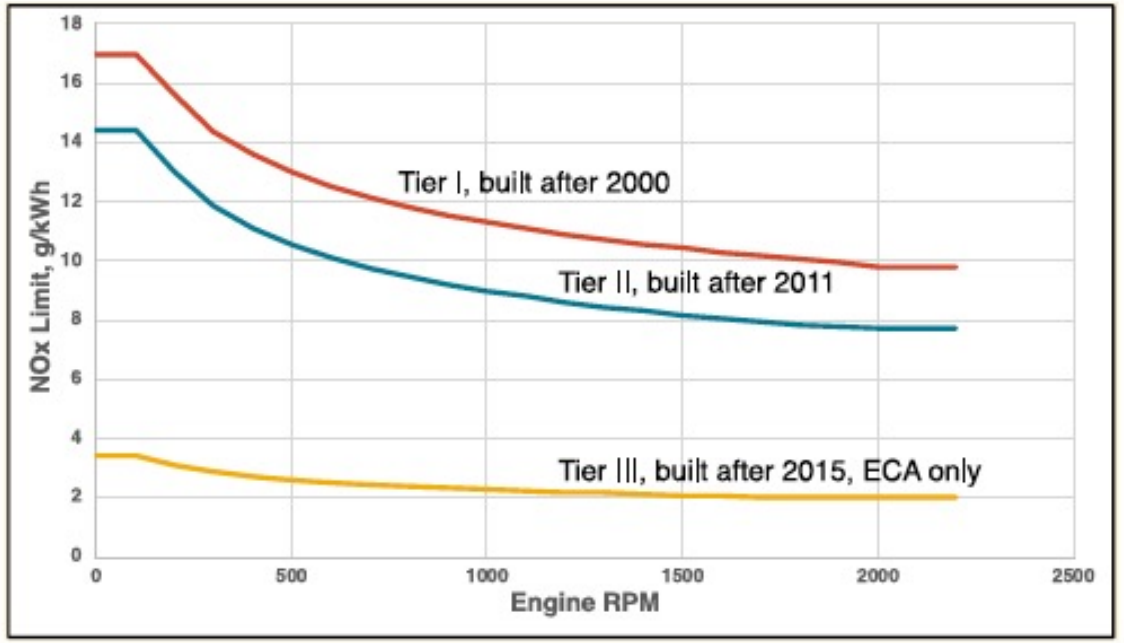
Carbon intensity reduced by 70%
GHG emissions reduced by 50%



EEDI: Energy Efficiency Design Index
SEEMP: Ship Energy Efficiency Management Plan (SEEMP)

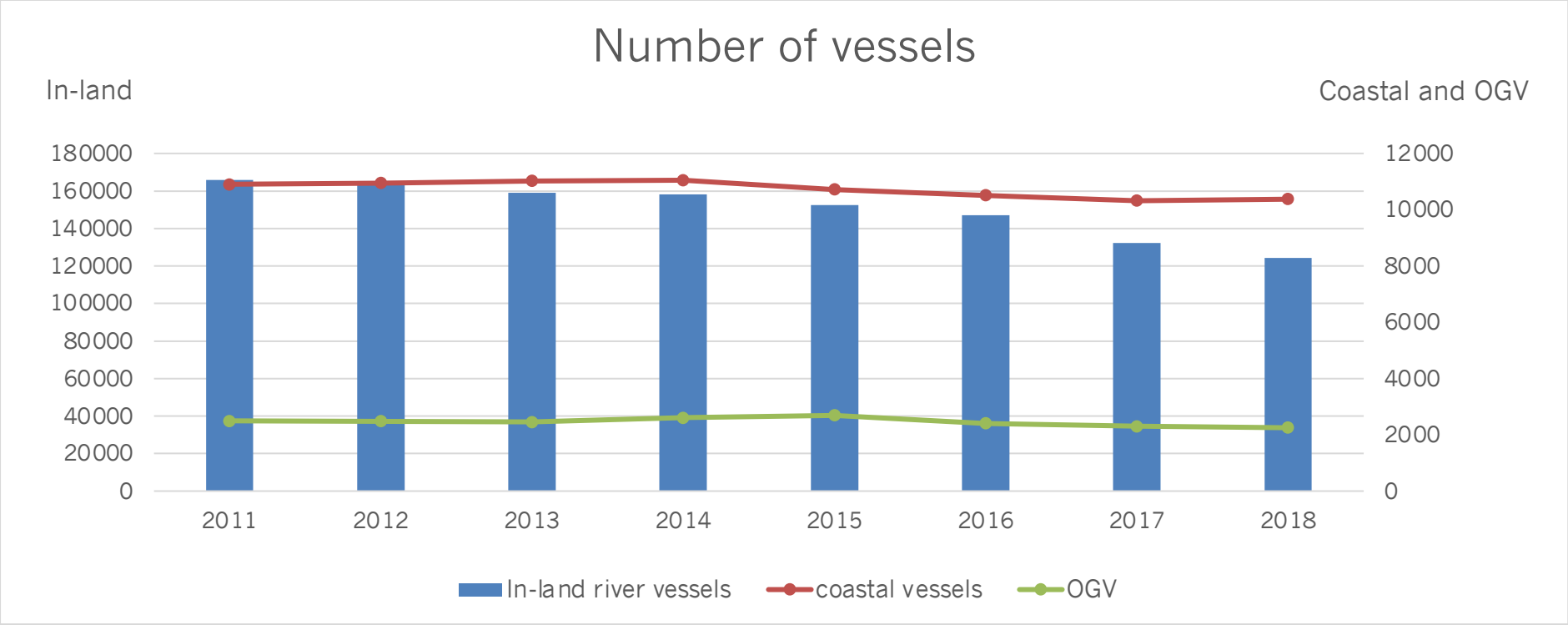
Fuel quality improvement and engine emissions standards are the key approaches to reduce SOx and NOx emissions for international marine in MARPOL VI





Source: ICCT

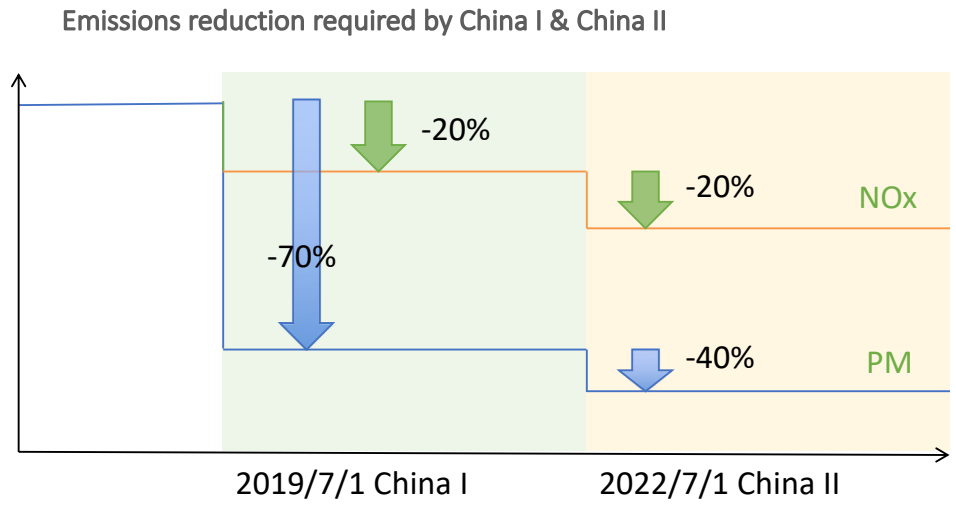
The number of vessels in China is decreasing, but the total available tonnage capacity is increasing

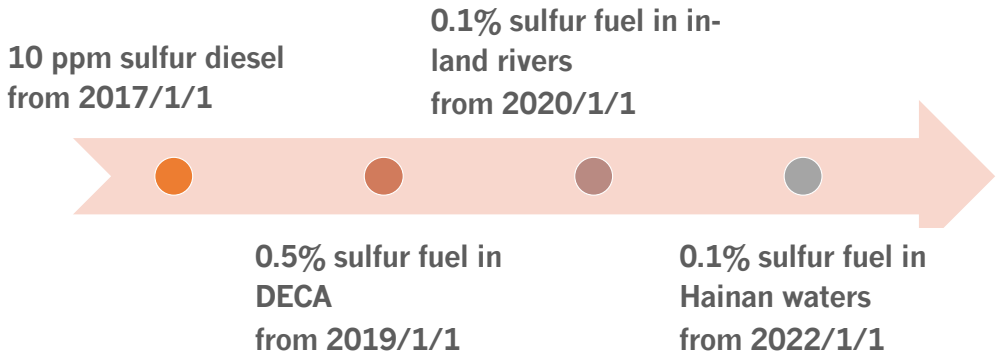


Source: Transportation statistics from MOT

China has made first step to regulate vessel emissions but still need to do more

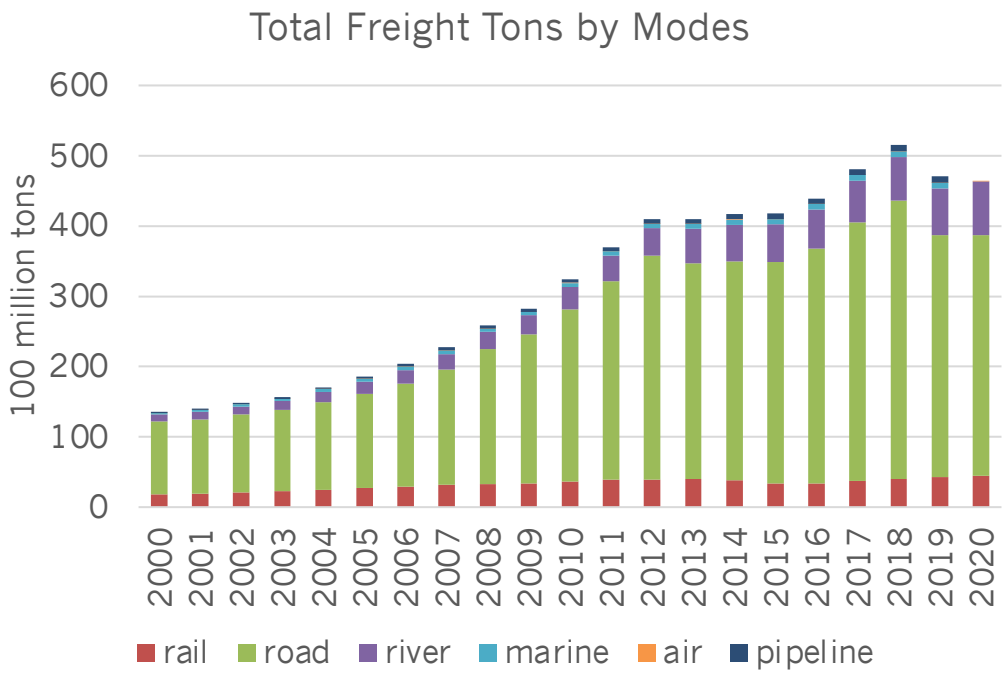
- Vessel SOx, NOx, and PM emissions reduced by 65%, 20%, and 30% in Bohai Rim Waters, Yangtze River Delta, and the Pearl River Delta by 2020
- Commercial ships energy and carbon intensity reduced by 6% and 7%, and port energy and carbon intensity reduced by 2% in 13th FYP period

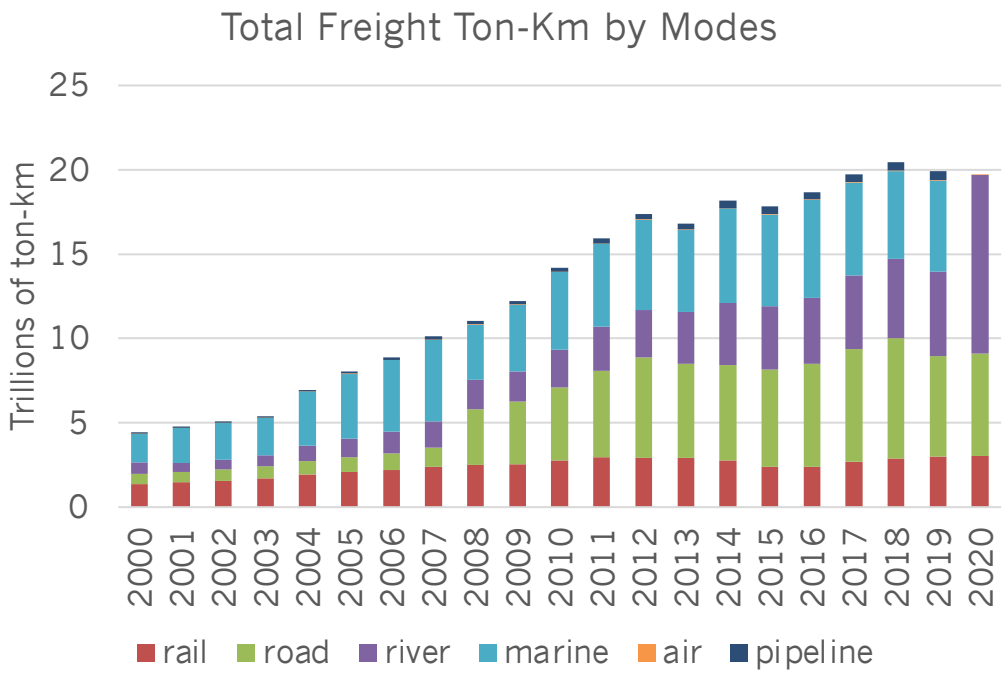




Leapfrog domestic off-road sources towards zero emissions where possible together with more stringent emissions standards

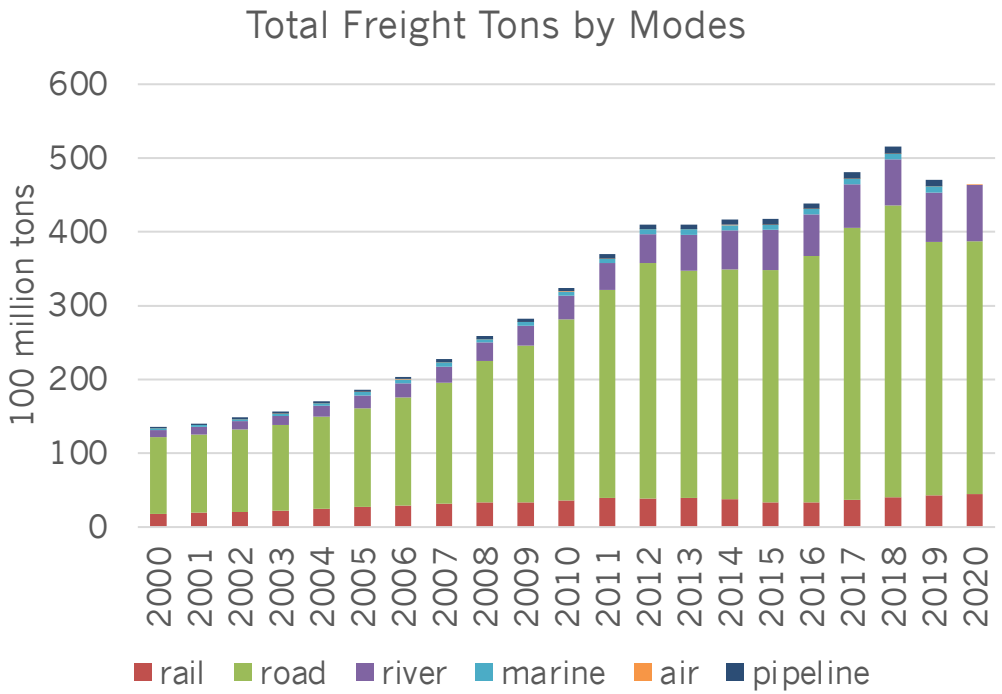
Freight ton-kms might have stabilized in China

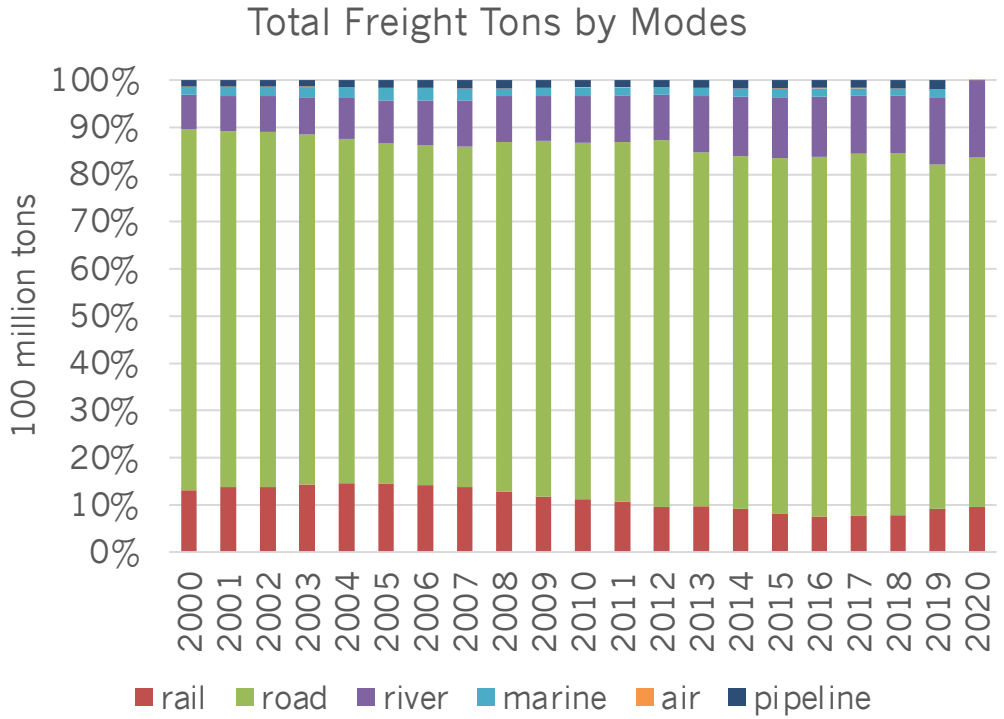




Source: China Statistic Bureau, excluding urban logistics

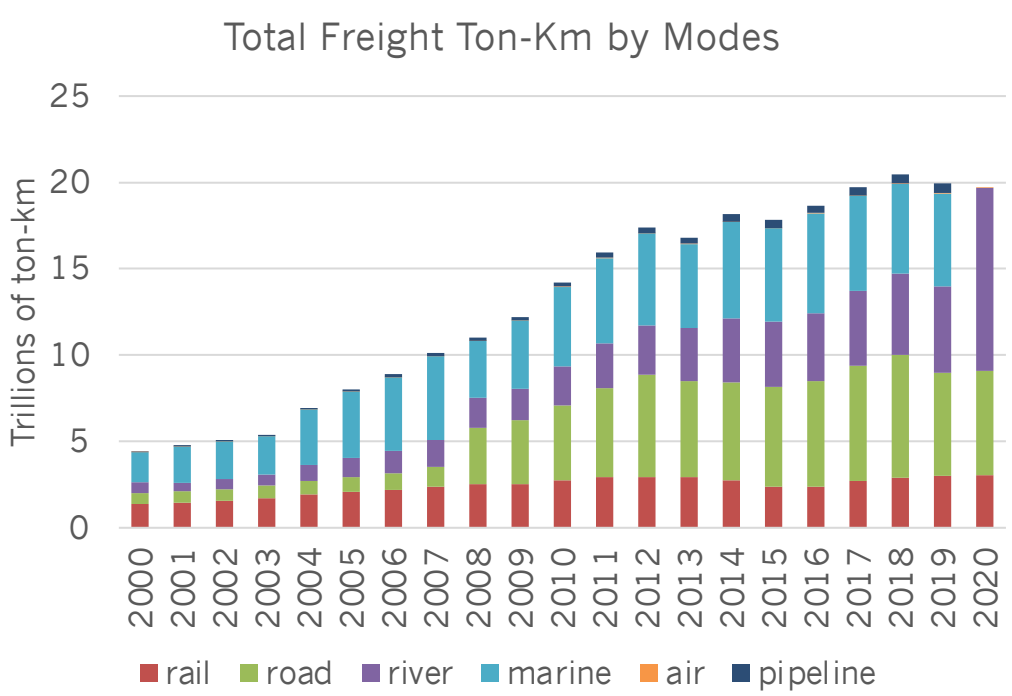
Road dominates the total tons of freight movement

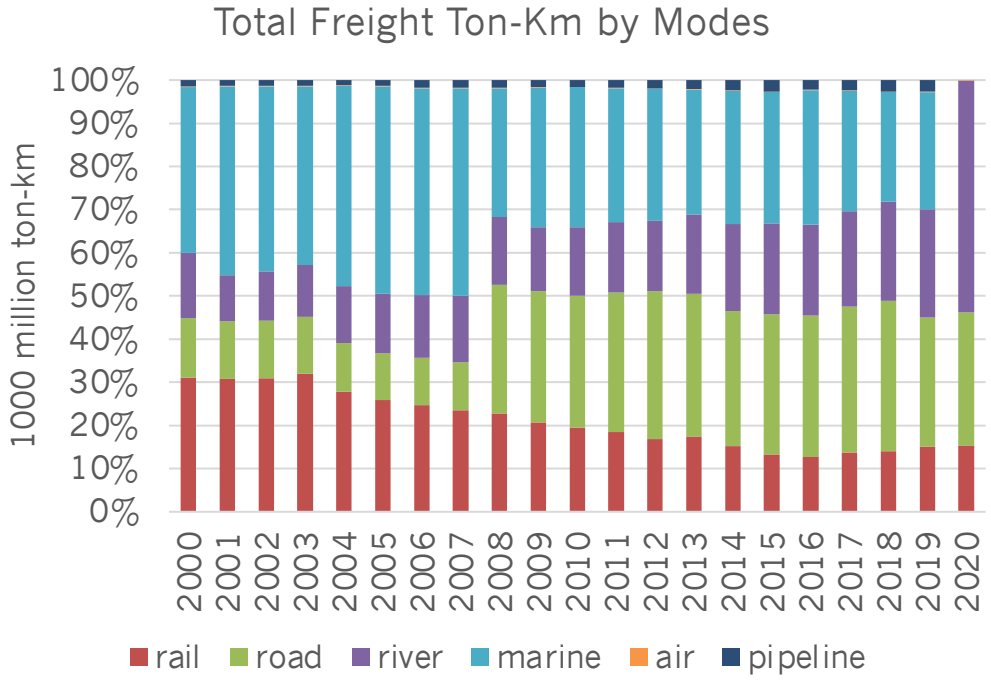




Source: China Statistic Bureau, excluding urban logistics

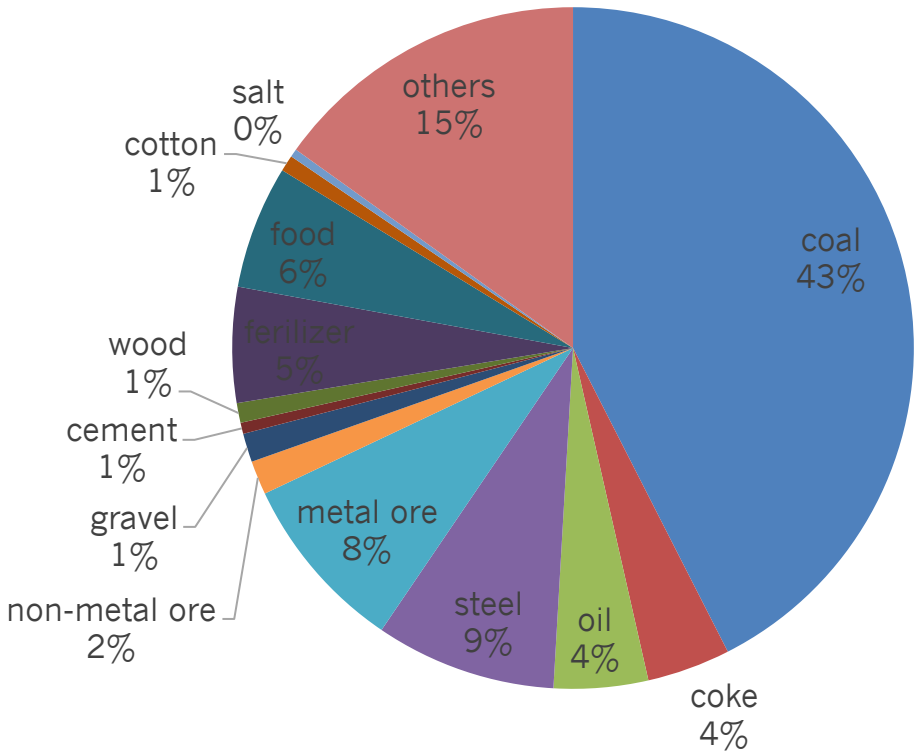
Water accounts for about half of total ton-kms of freight in China, and railway has slightly increasing market recently



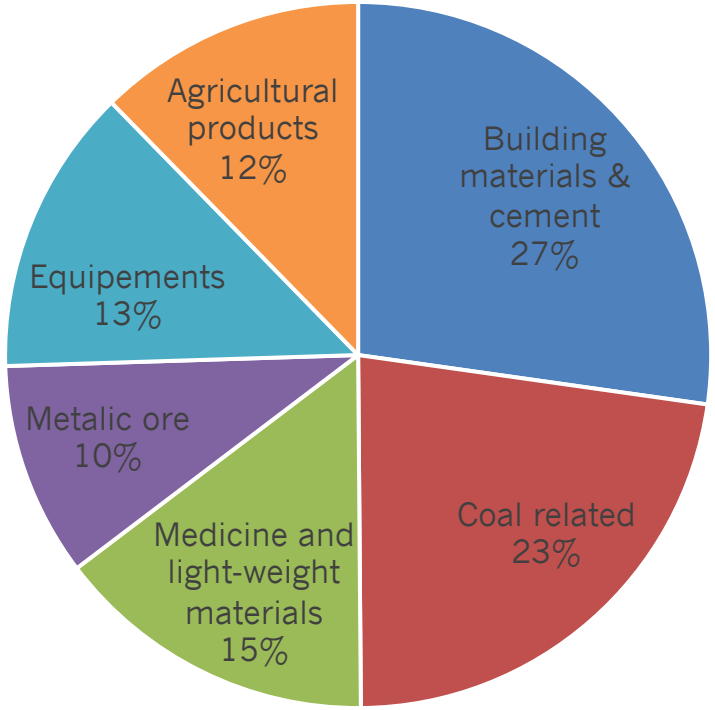


Source: China Statistic Bureau, excluding urban logistics

With the economy upgrading and shifting away from coal, China is expecting decreasing freight movement demand



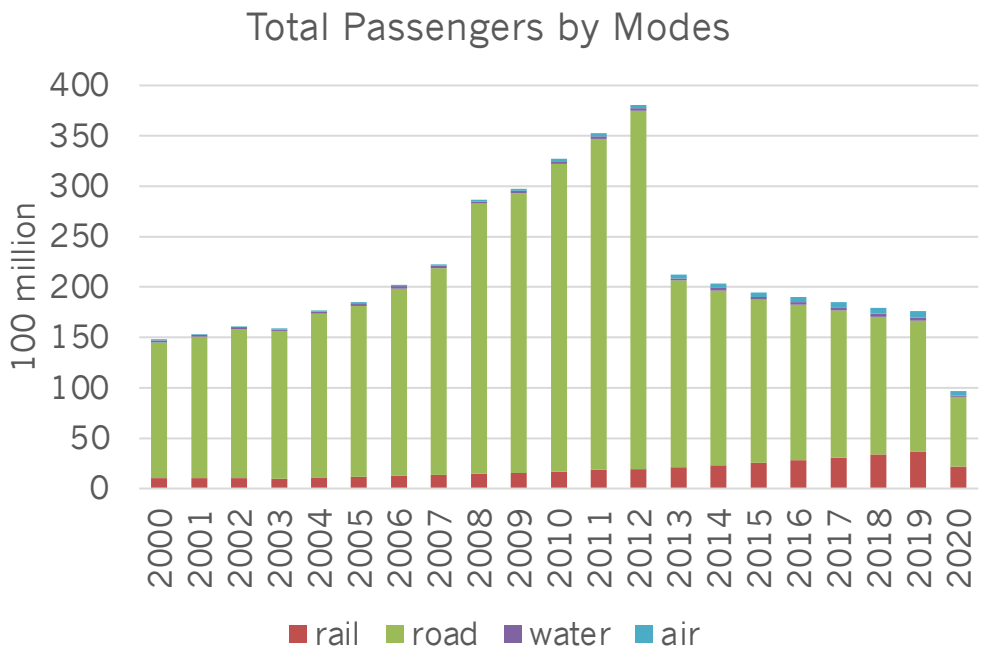
Shares of ton-miles by commodities by rail in 2014

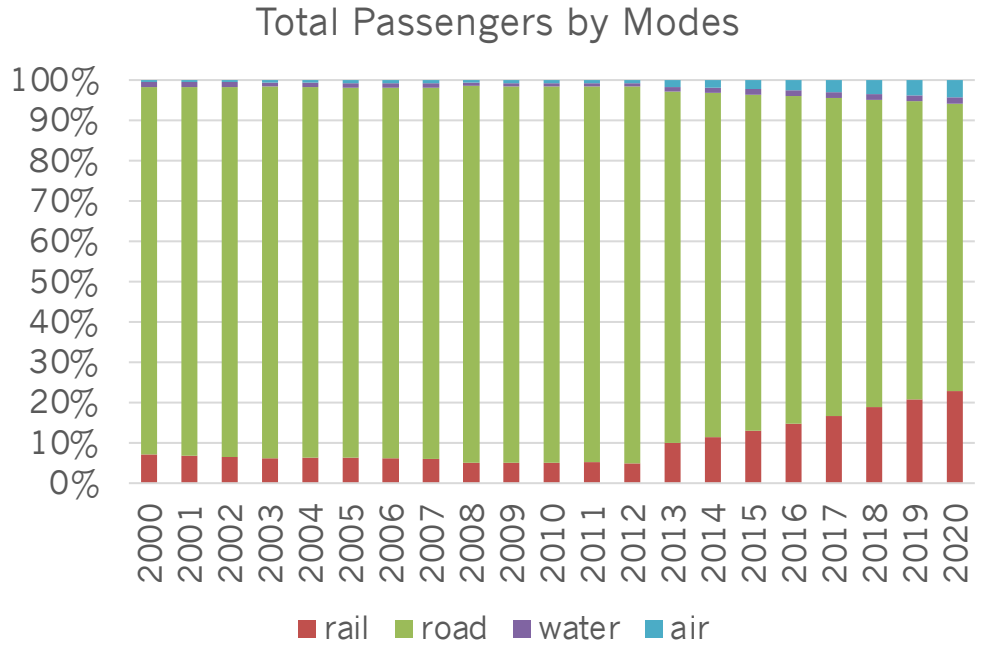


Shares of ton-miles by commodities by trucks in 2019

Source: China Statistic Bureau; Ministry of Transport

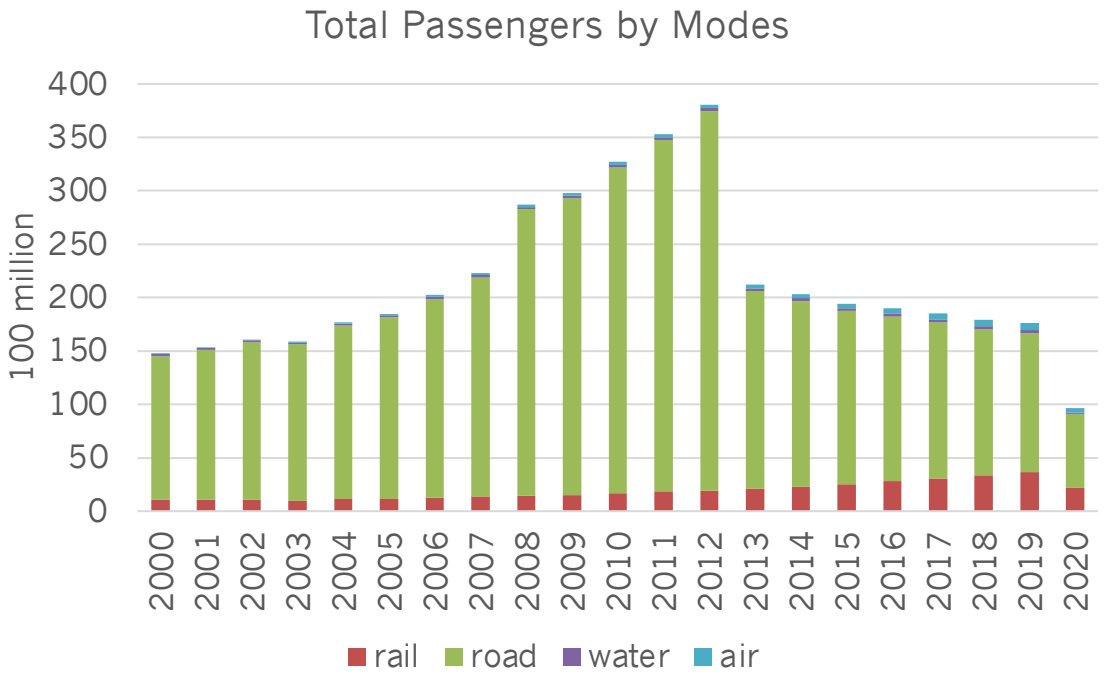
Similarly, road dominates the inter-city passenger movement

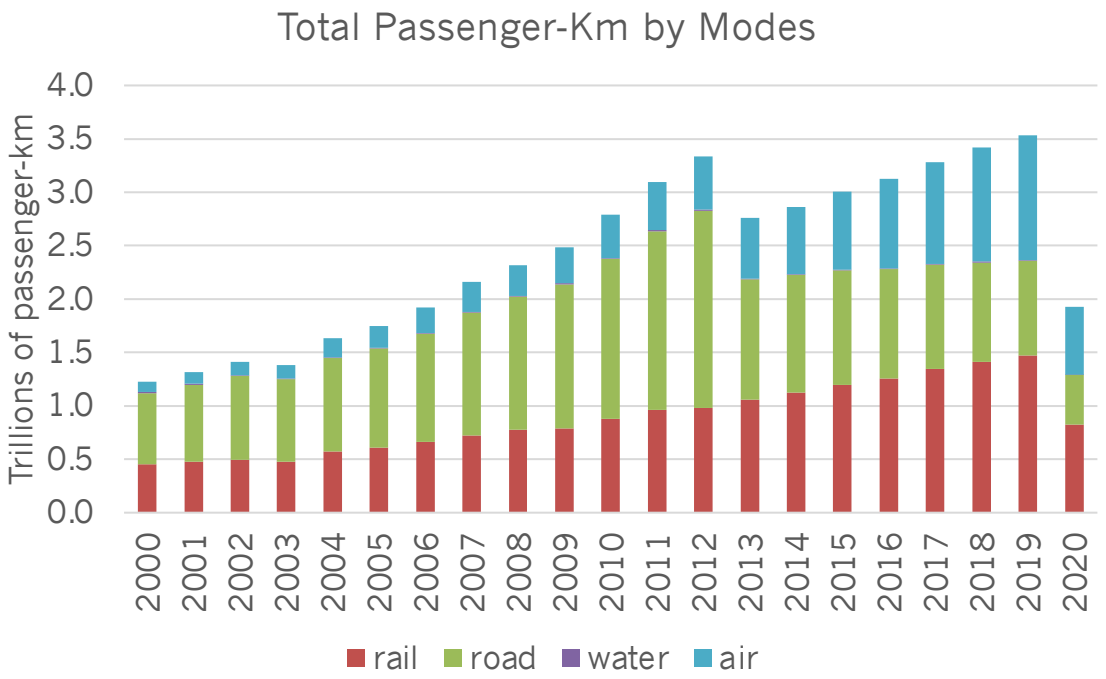




Source: China Statistic Bureau

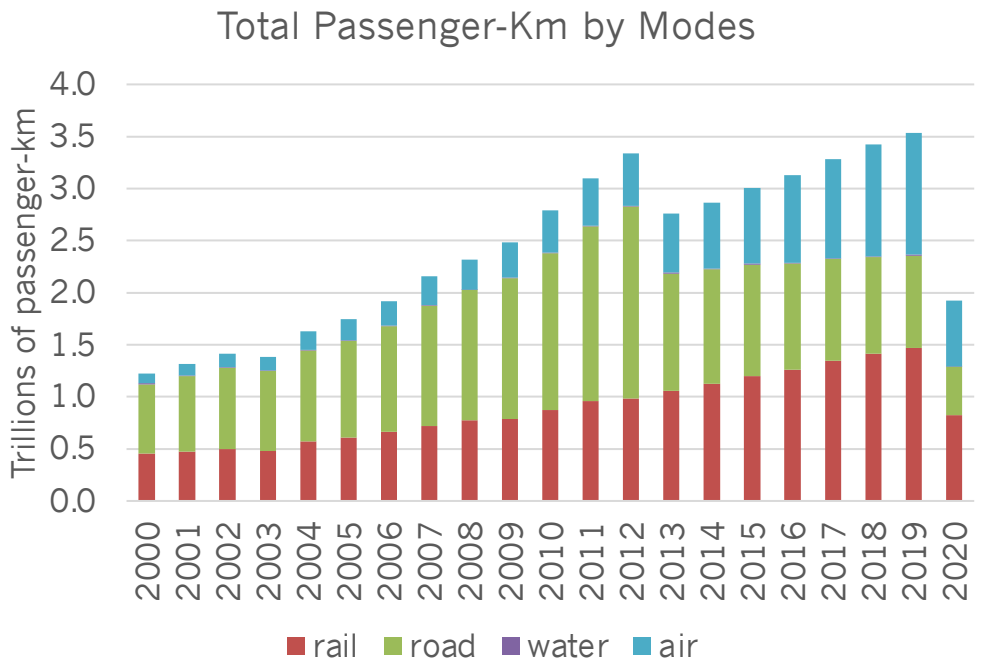
However, road is losing its inter-city passenger-kms market quickly, while both rail and aviation are increasing significantly

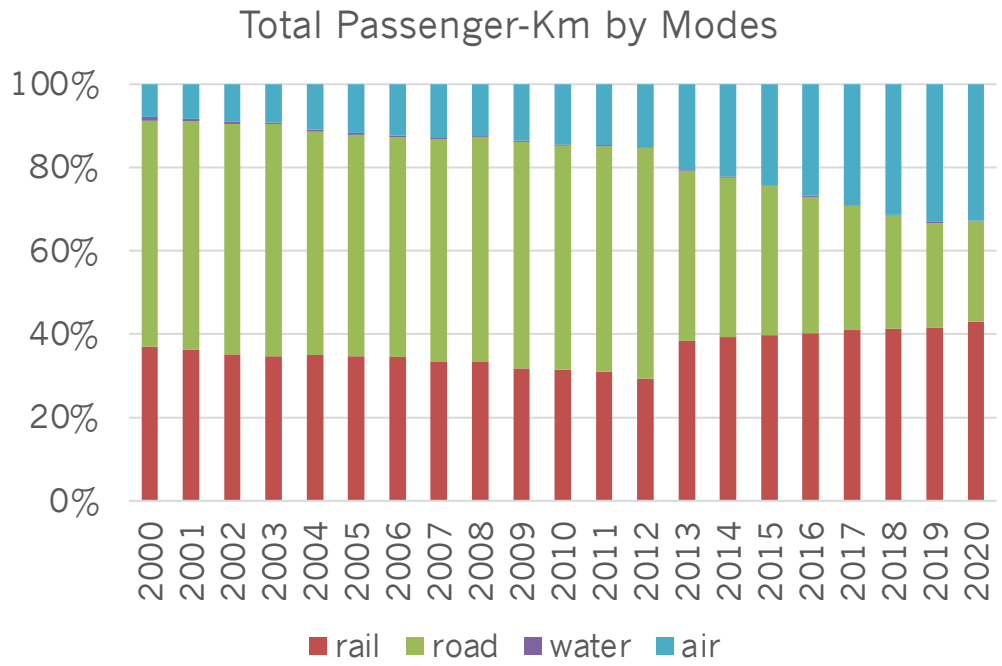




Source: China Statistic Bureau

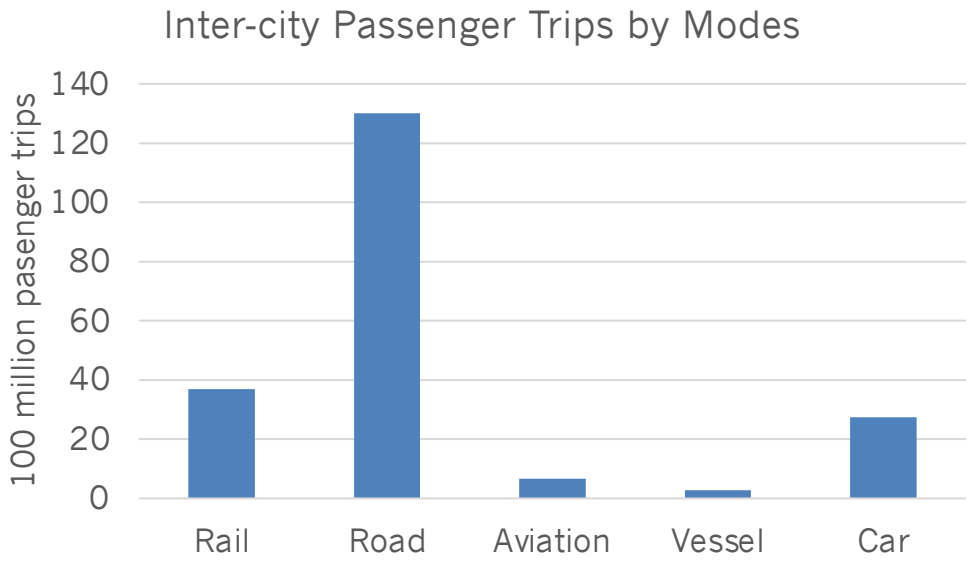
Aviation is increasing its passenger-kms market share quickly

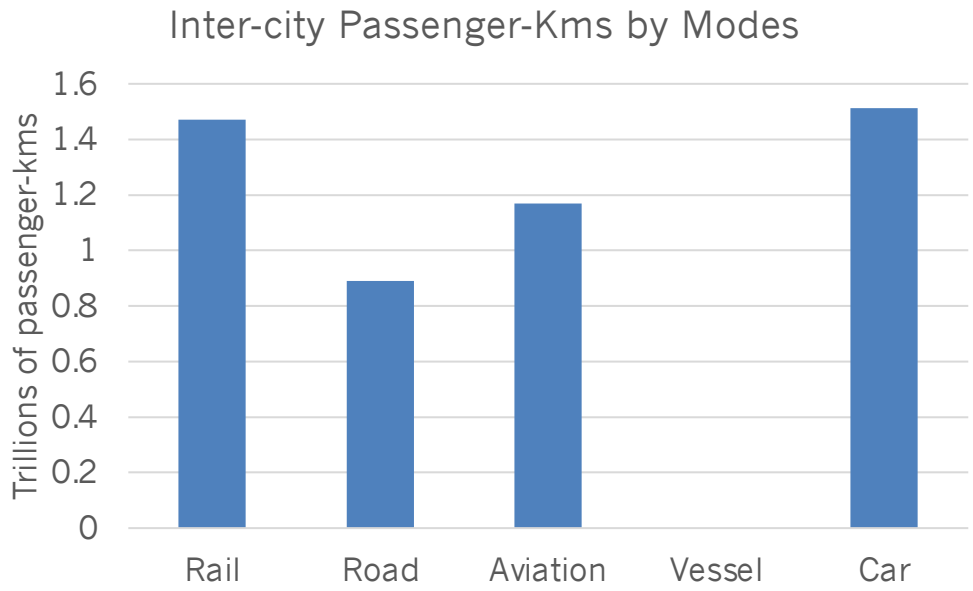




Source: China Statistic Bureau

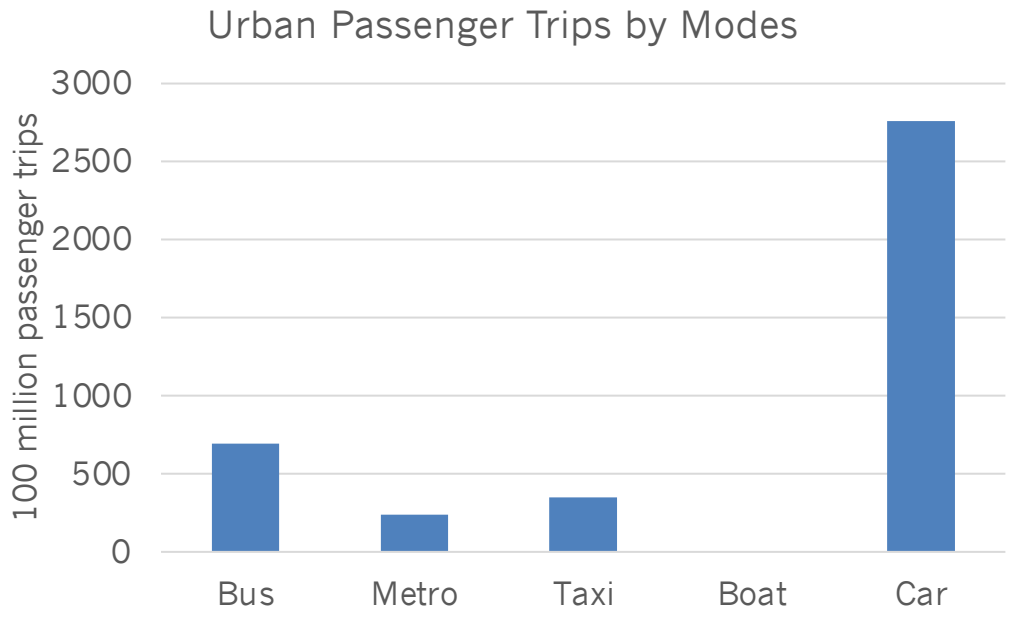
Inter-city passenger-kms accounted for 54% of total passenger-kms in China

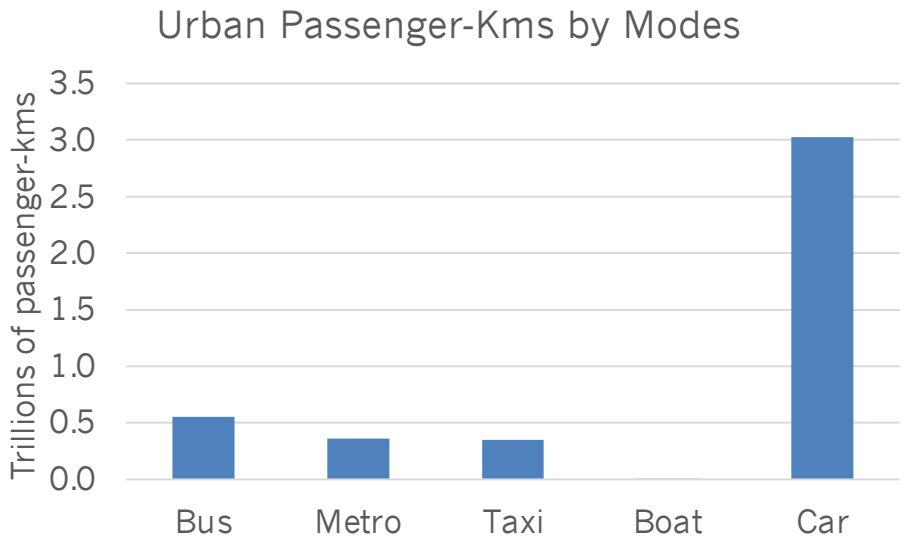




Source: China Statistic Bureau; EFC internal analysis, excluding walking and bicycling

Cars dominated the urban passenger transportation at about 70% of total urban passenger-kms





Source: China Statistic Bureau; EFC internal analysis, excluding walking and bicycling

High-speed rail has strong competition capacity with private driving and aviation

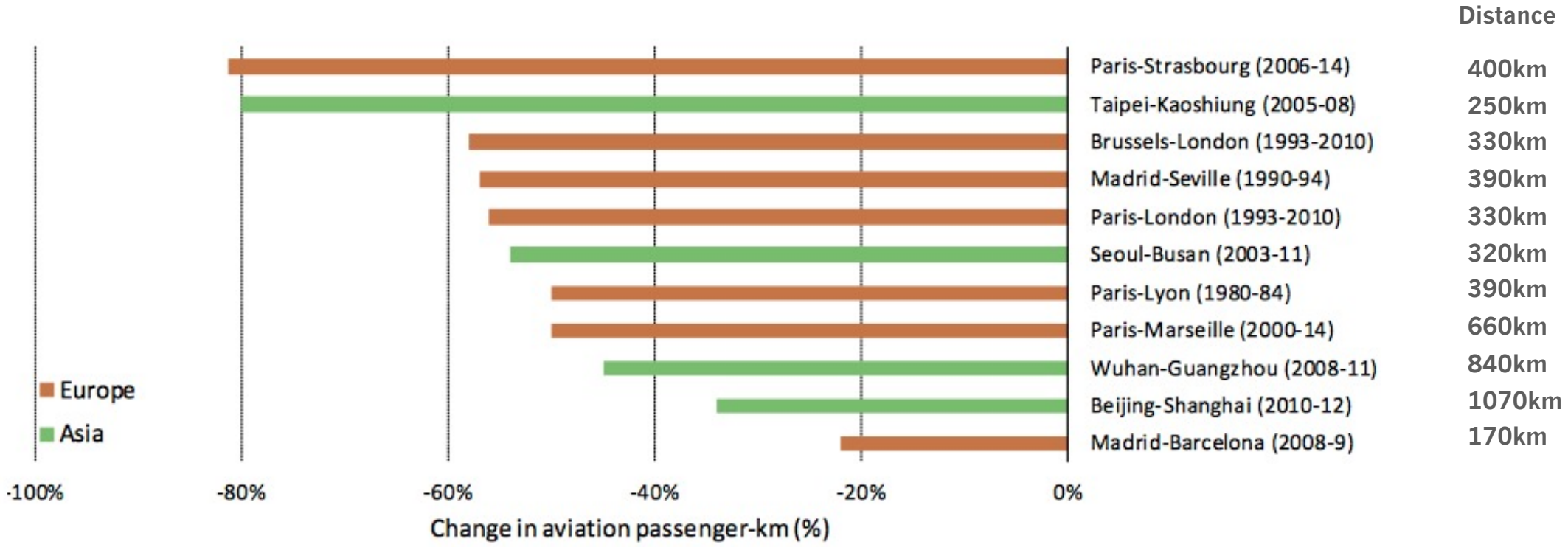
Unit: %

Distance	Less than 100 km	Around 100-300 km	Around 300-500 km	Around 500-800 km	Around 800-1200 km	More than 1200 km
Driving	64	40	15	6	4	3
High-Speed Trains	17	43	68	73	57	42
Inner-City Buses	13	14	11	6	4	3
Taxies	6	2	1	1	1	1
Airplanes	-	1	4	15	34	51

Source: Market survey done by IPSOS with the supported from EFC

HSR significantly reduces the demand for aviation

Average change in passenger activity on selected air routes after high-speed rail implementation

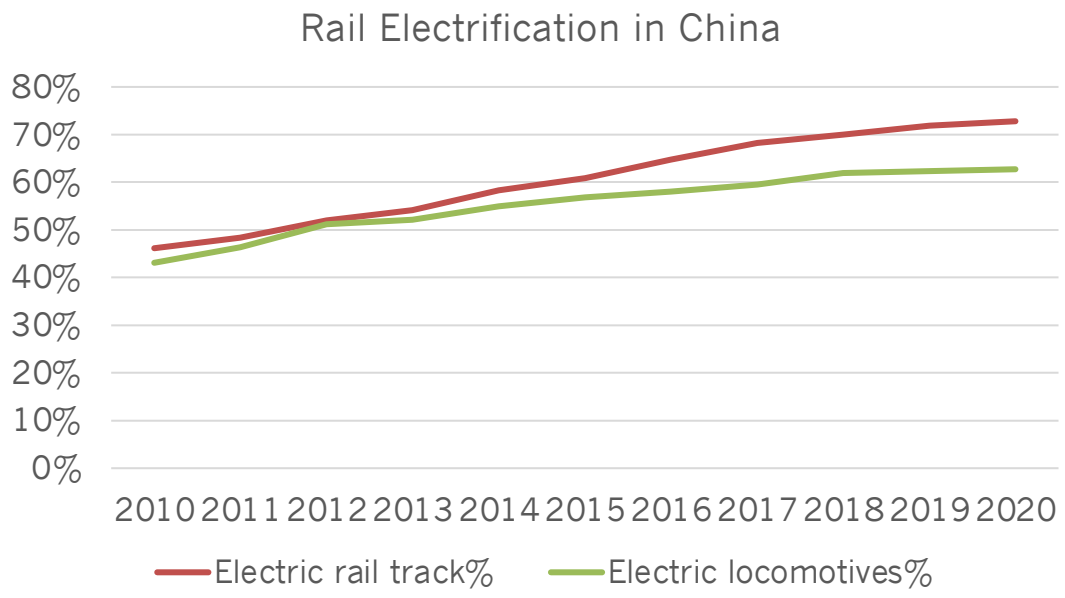


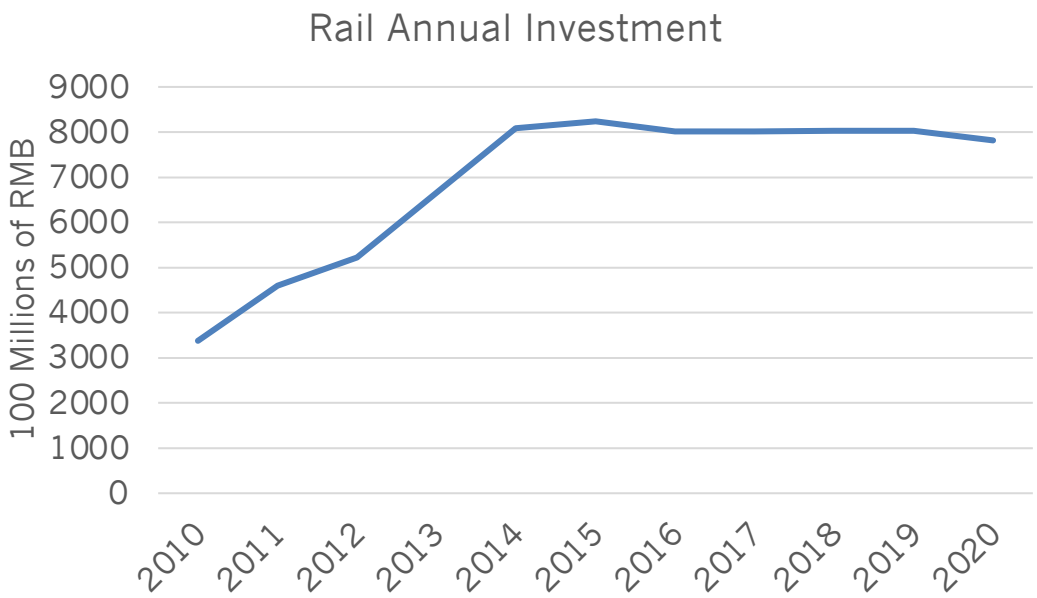
Sources: Xia (2016); Börjesson (2014); Givoni (2013); Chen (2017); Commissariat Général au Développement Durable (2016).

Note: The periods of time vary from line to line in this figure, which needs to be taken into account when comparing these elements.

Source: IEA, The Future of Rail

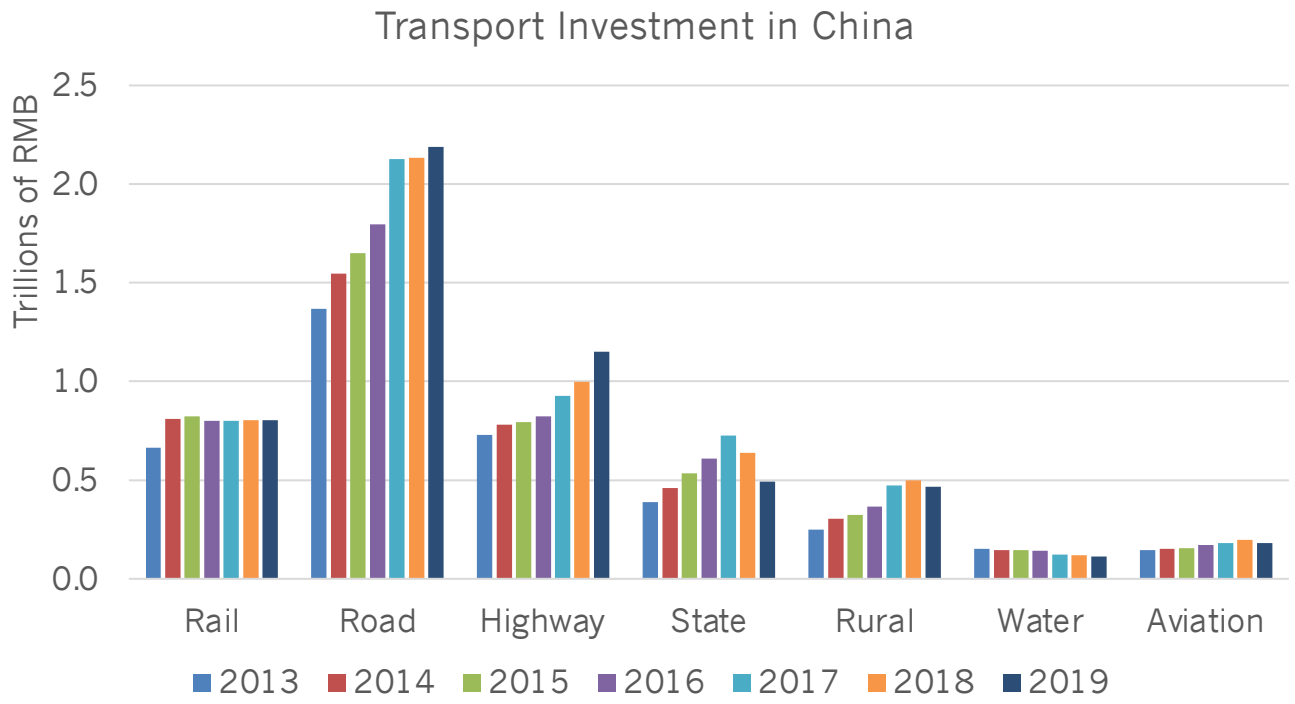
73% of rail tracks and 63% of locomotives are electric in 2020 in China, and railway development continues with significant annual investment



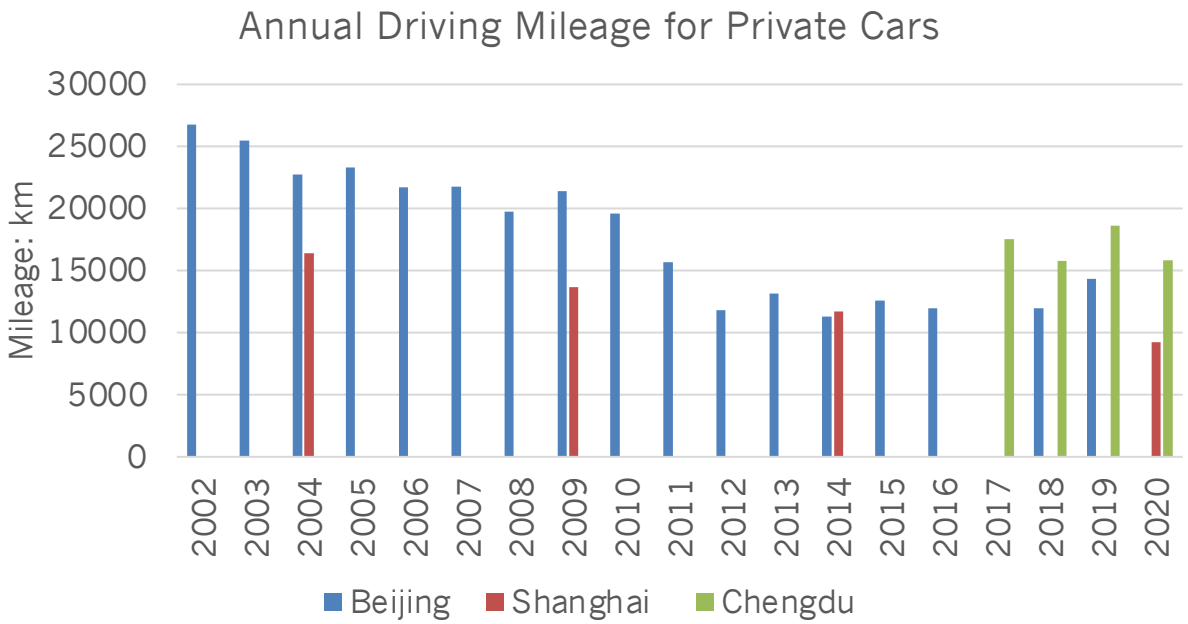


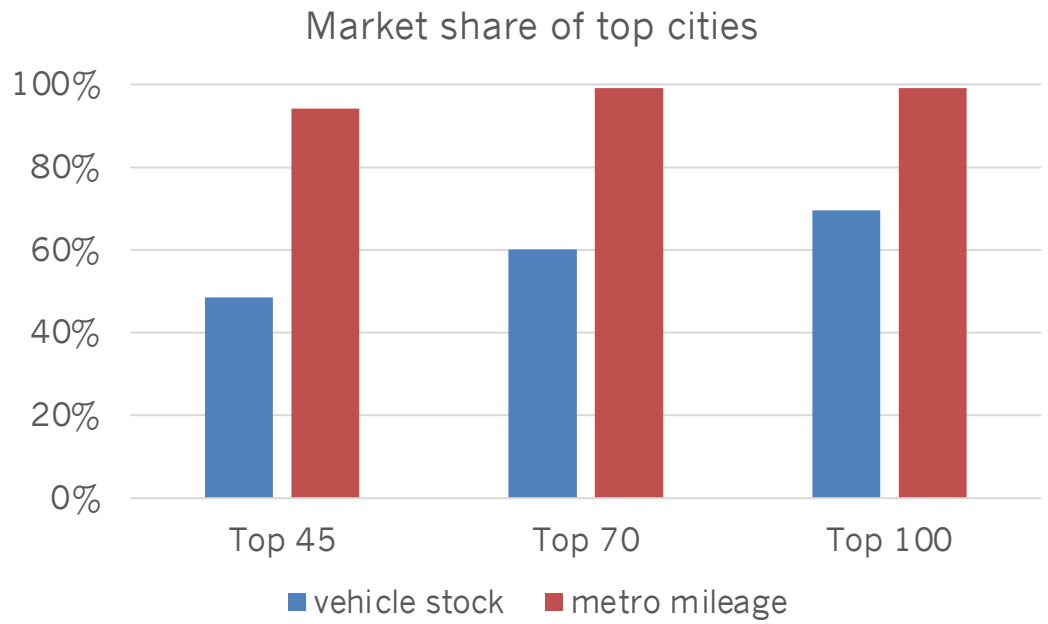
Source: China Statistic Bureau; Ministry of Transport

The transport investment increased 20% annually on average from 2013 to 2019 in China mainly due to road construction



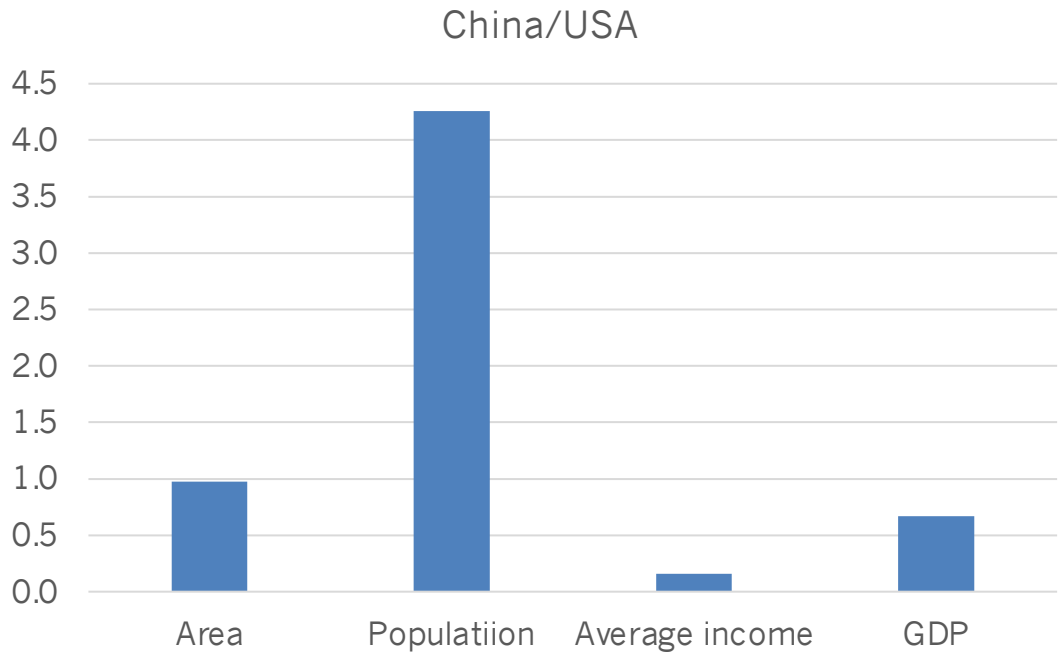
With good public transportation, private car mileage is decreasing steadily in mega cities, which might become a trend in top cities if with rapid metro development

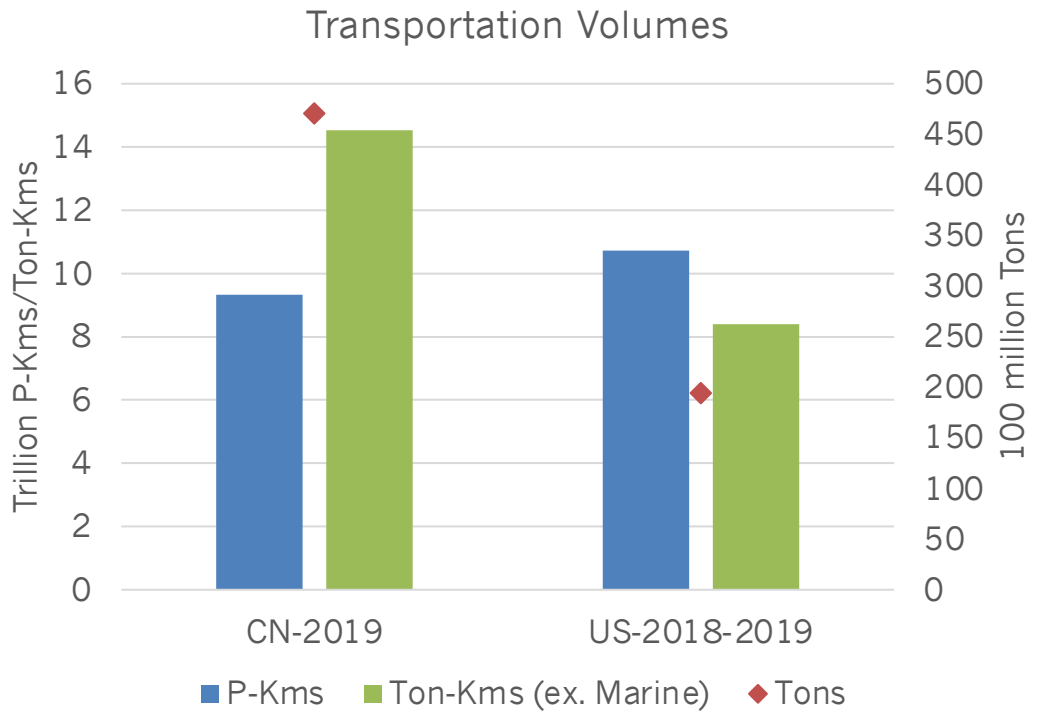




Source: EFC internal analysis, Vehicle Emissions Control Center, Beijing Transport Institute, Shanghai Urban-Rural Transport Research Institute, Chengdu VECC

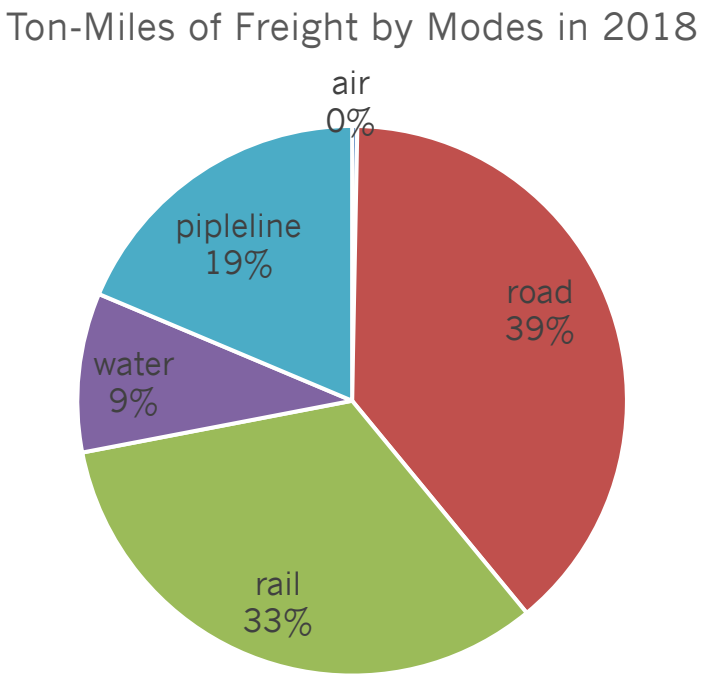
Passenger & freight transportation are determined by population and land area, and the amount & structure of economy & energy

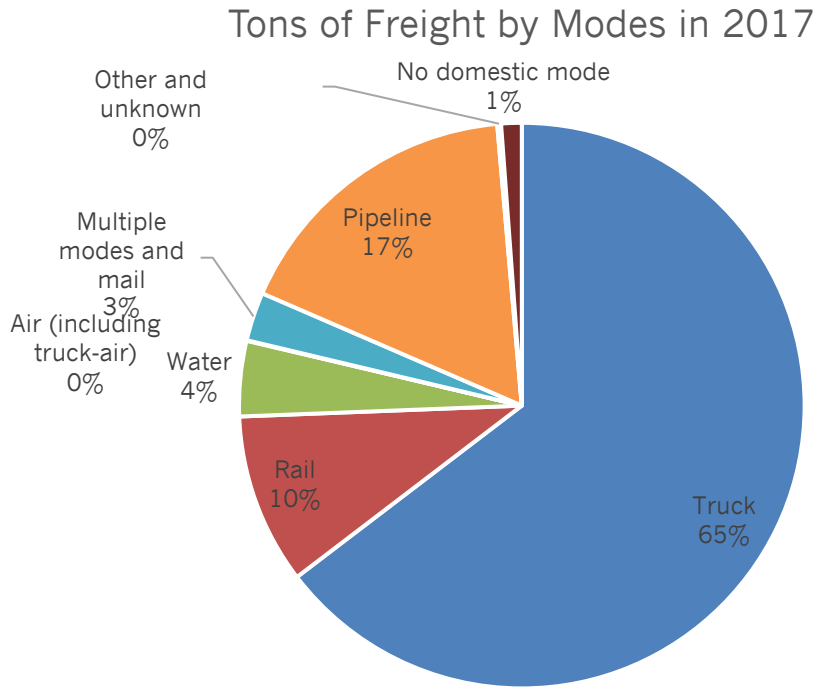




Source: China Statistic Bureau; BTS in U.S.; https://www.worlddata.info/country-comparison.php?country1=CHN&country2=USA

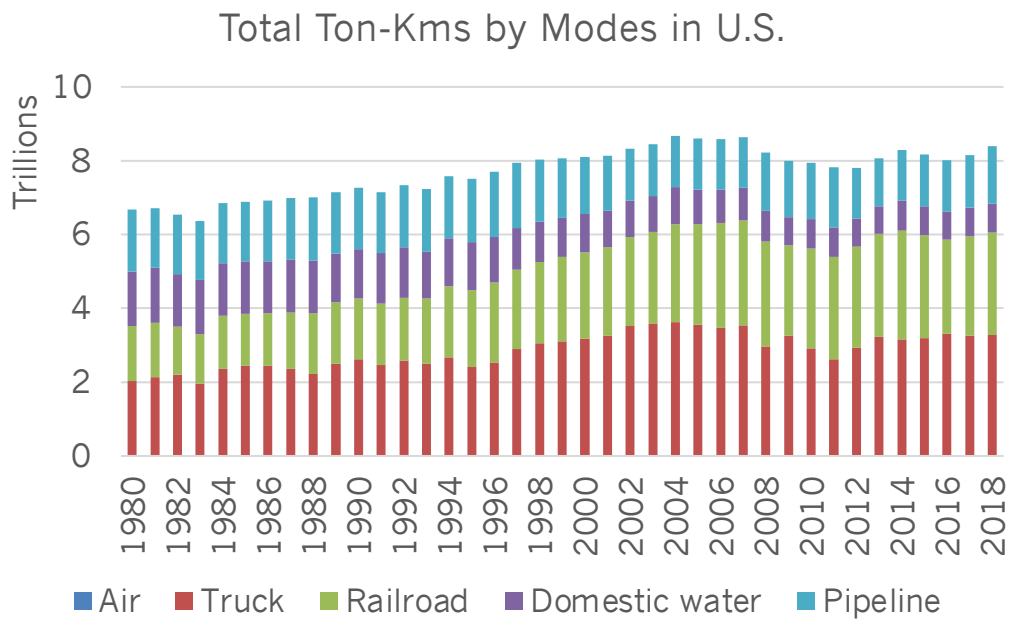
Rail and pipeline accounted for 33% and 19% of domestic ton-miles in 2018 in USA

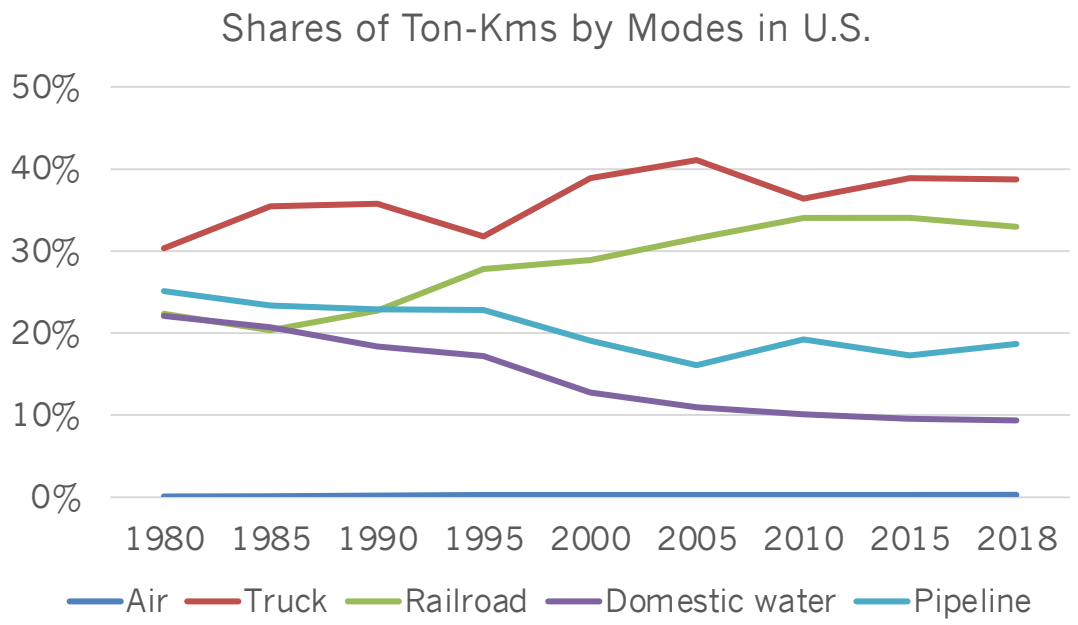




Source: BTS in U.S.

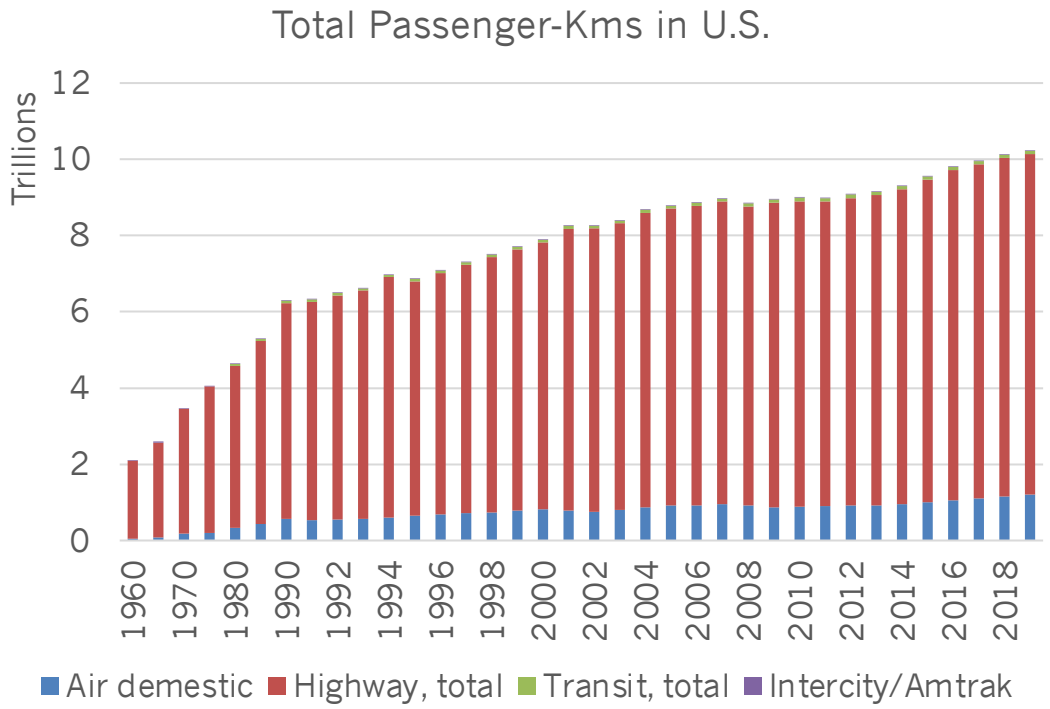
Freight ton-kms grew only 26% since 1980 in U.S.

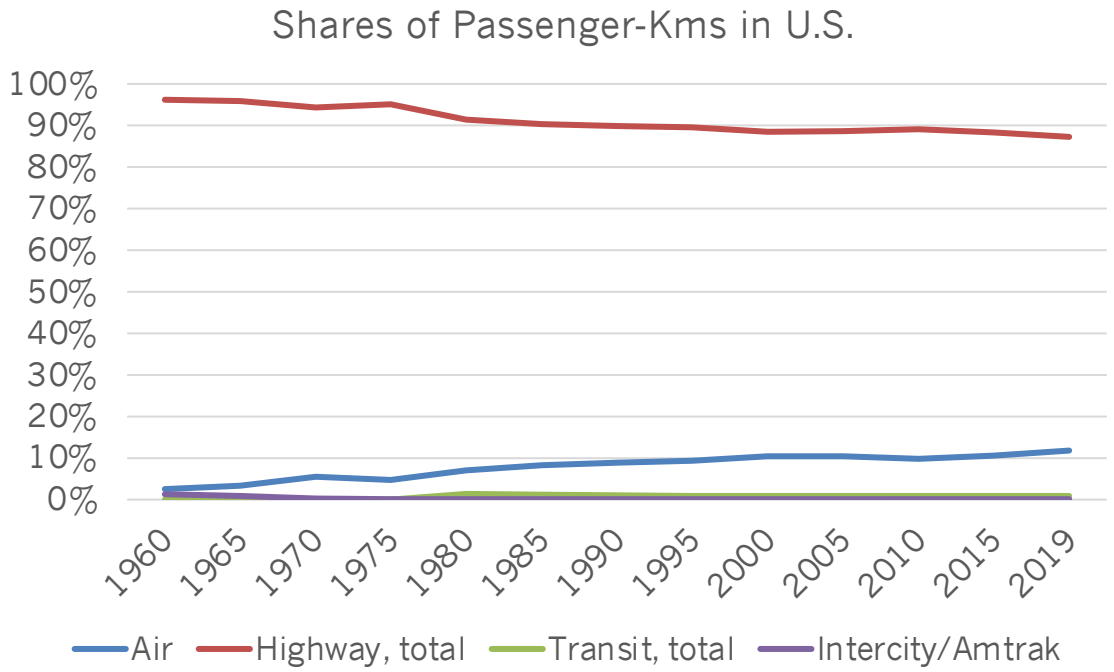




Source: BTS in U.S.

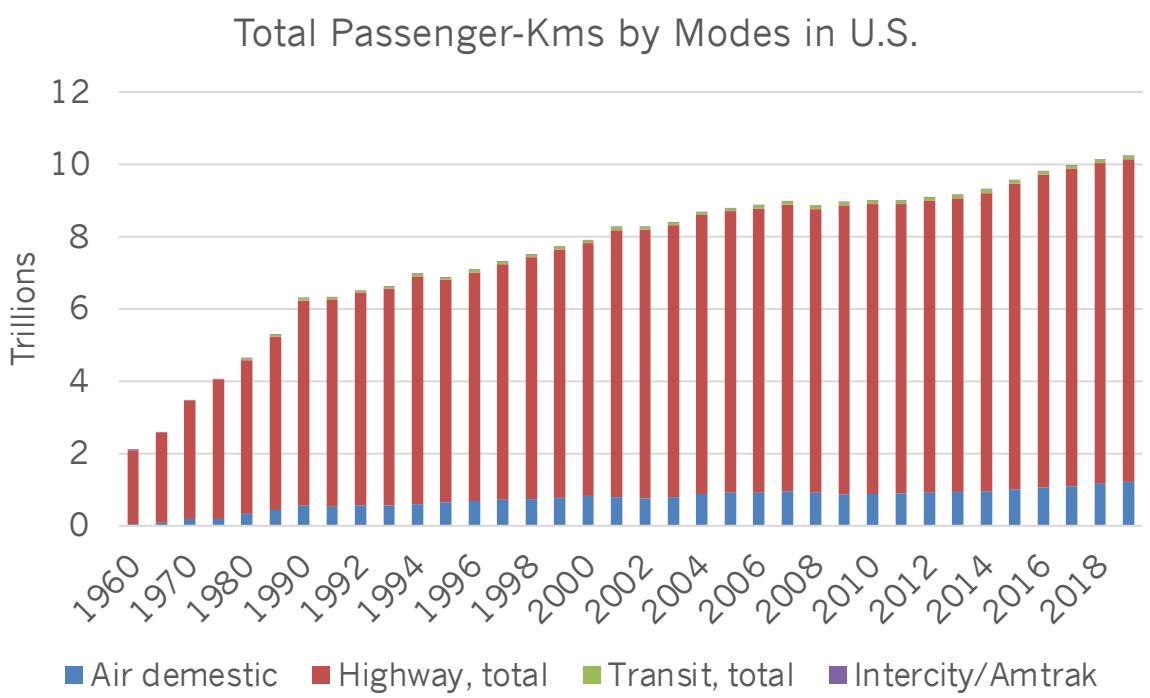
However, passenger-kms grew 120% since 1980 in U.S.

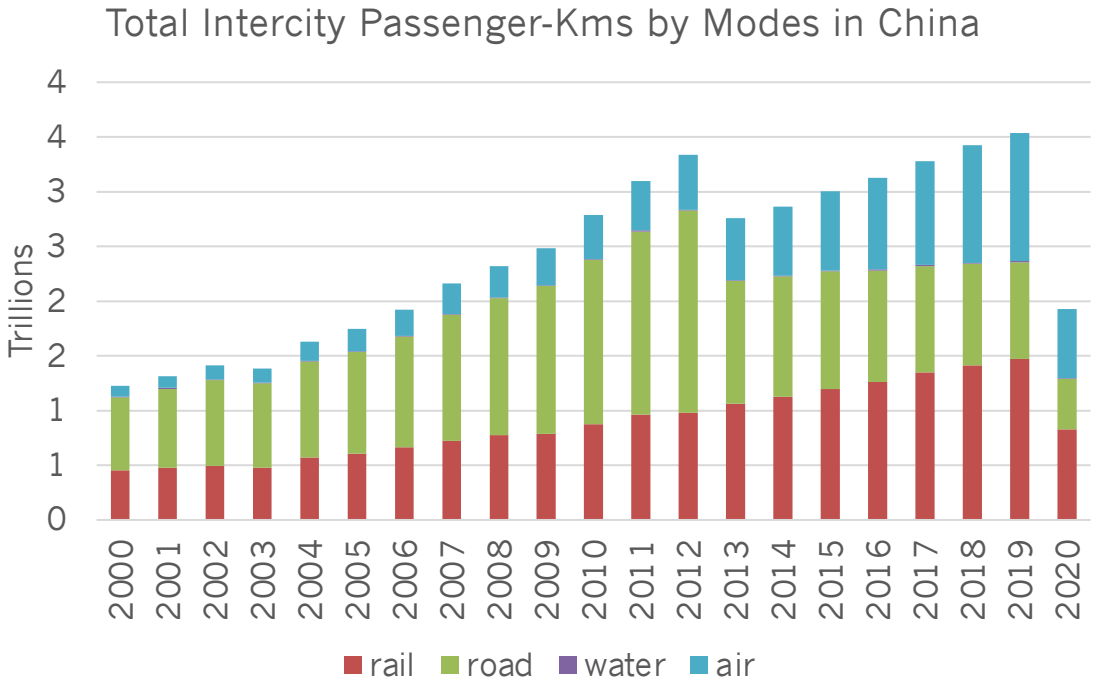




Source: BTS in U.S.

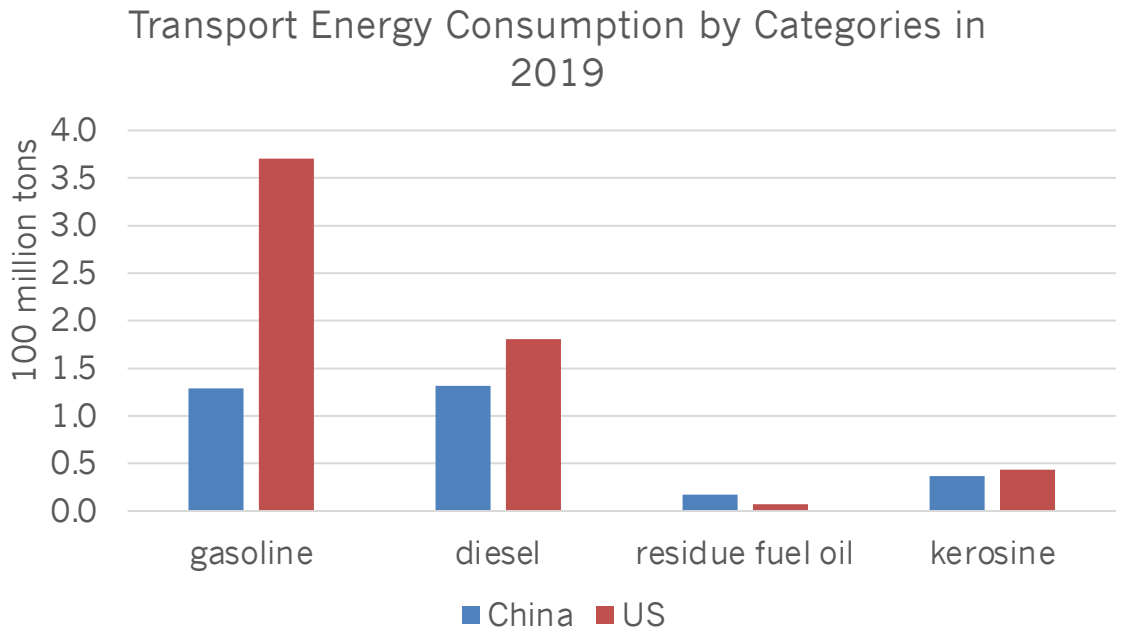
Passenger-kms keep increasing in both countries

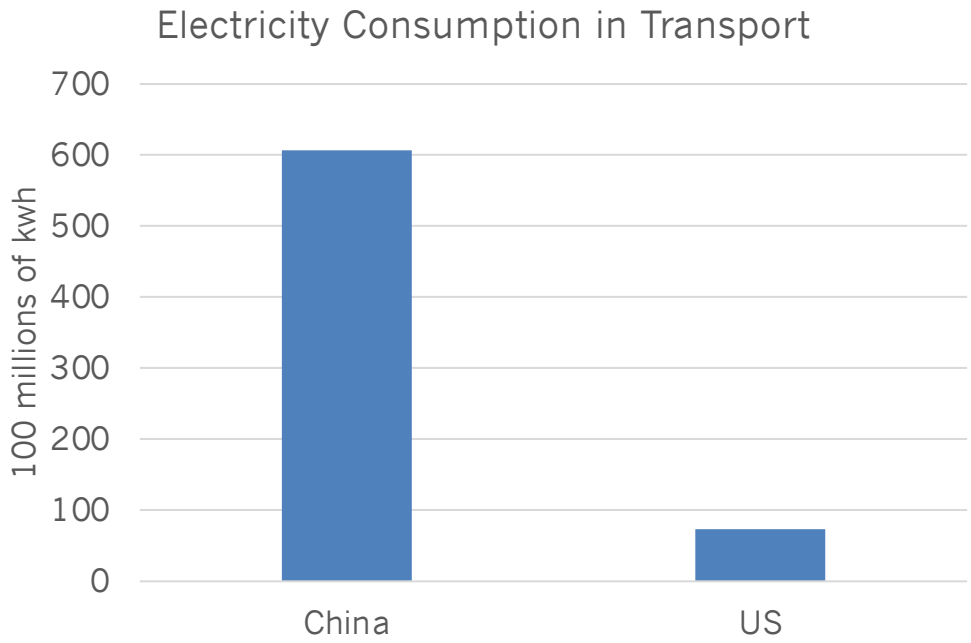




Source: China Statistic Bureau; BTS in U.S.

U.S.'s transport sector consumed twice as much fuel as China, while China consumed much more electricity in 2019

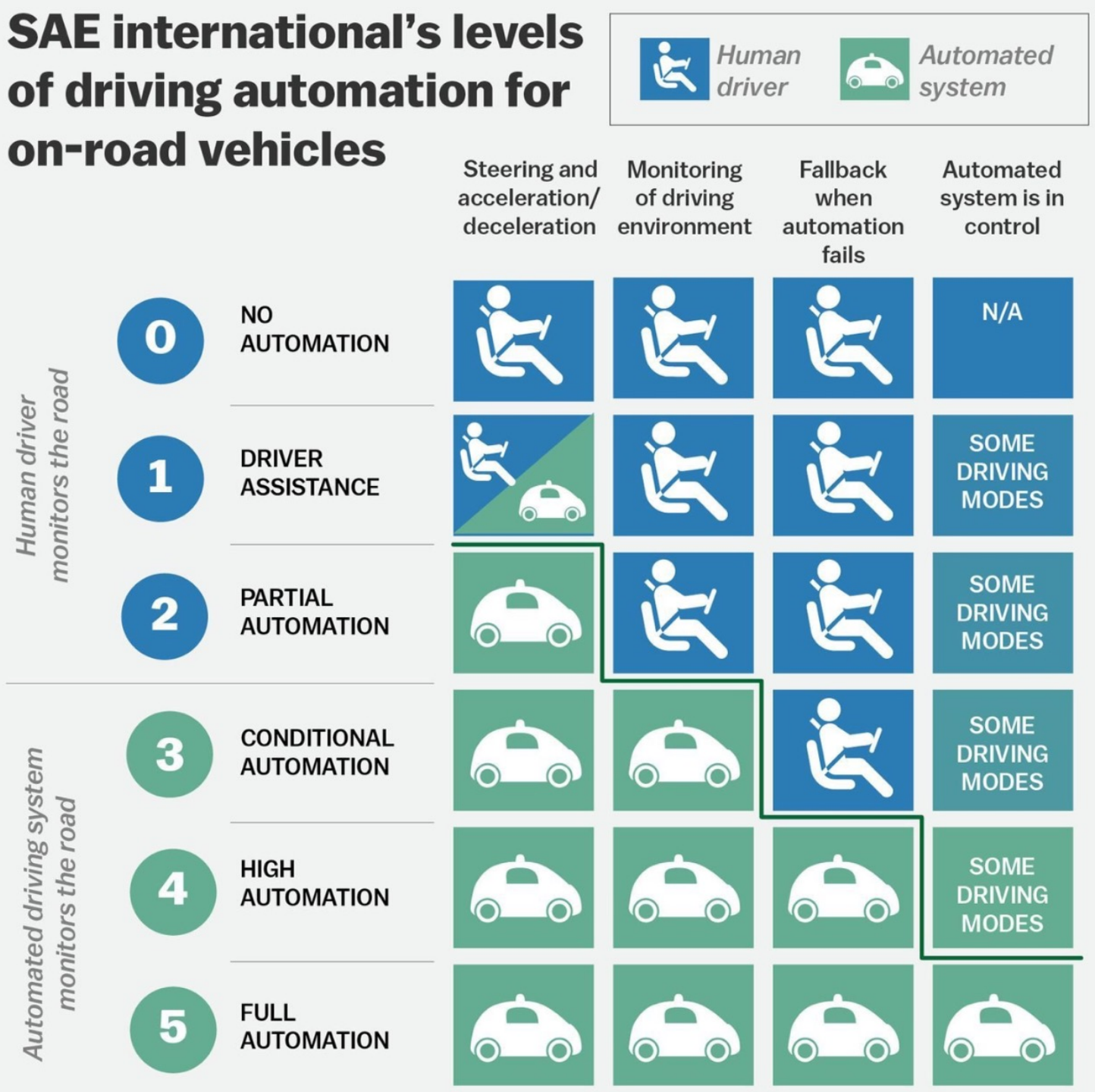




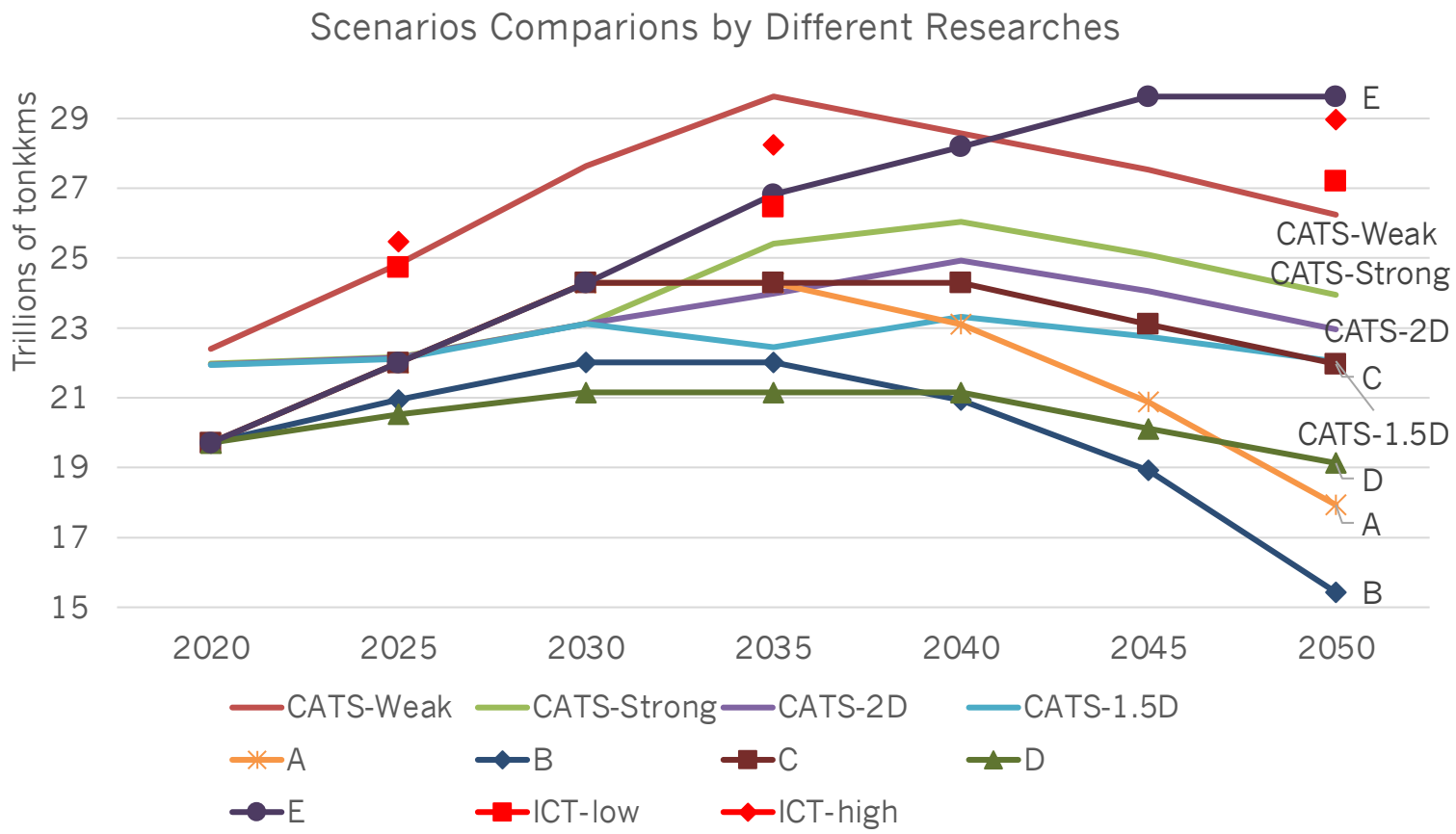
Source: 2020 Energy Data Book from Qingyi Wang, China Statistic Bureau, BTS, the 2nd National Pollution Census Report in China; excluding electricity for EVs

Autonomous vehicles?

- How soon? BEV-based or ICE-based?
- How smart? Smart vehicle & Smart city?
- How to use? Private owned or shared mobility?



In order to reduce the risks for carbon neutrality, freight ton-kms in China need to decrease quickly after 2035 with structure continuously improving



Source: CATS, ICT, EFC's internal analysis