十四五及中长期中国交通部门碳减排的机遇与潜力
Opportunities and potential of transportation decarbonisation during the 14th FYP period and long-term

交通碳达峰碳中和政策与技术研讨会

NDC Transport Initiative for Asia 2021 Event Series – China Annual Workshop

November 23, 2021

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项目背景和研究范畴
Context and Scope

- 本研究为国际清洁交通委员会（ICCT）和生态环境部机动车排污监控中心（VECC）分工合作完成
- **项目背景**：旨在为中国近、中、长期的交通部门碳减排目标提供量化的技术依据
- **研究范畴**：
  - 气候污染物：从油井到车轮排放的二氧化碳(CO_2)、甲烷(CH_4)、氧化亚氮(N_2O)、黑碳(BC) 以及空调系统泄漏的氢氟碳化合物(HFC)
  - 20年时间框架下的全球变暖潜能值(GWP20)
  - 主要交通方式和细分部门：乘用车、公交和长途客车、轻型和中重型货车、内河、沿海和远洋船舶、货运铁路和非道路移动机械；本研究不包括客运铁路和民用航空器
  - 适合中国国情的五大减排策略：能效标准或温室气体排放标准、尾气排放标准、低GWP制冷剂的管理要求、电动化、和货物运输调整

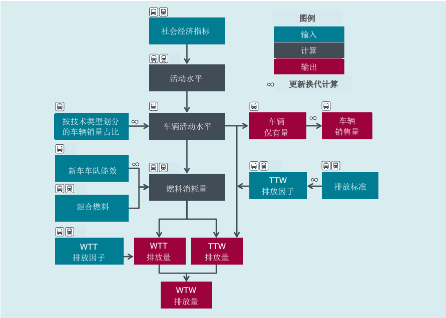
- A **joint** study between the ICCT and VECC-MEE
- **Context**: support China's near, mid-to-long term transportation climate pollutant targets
- **Scope:**
  - Focused on climate pollutant：well-to-wheel emissions of CO_2,CH_4,N_2O,BC due to fuel combustion and HFCs from the A/C refrigerants
  - Used GWP20 to better capture impact of short-lived climate pollutant.
  - Major transportation modes including passenger cars, buses and coaches, commercial trucks, shipping vessel, freight rail, and nonroad machines. Didn't include passenger rail or civil aviation.
  - Analyzed five major emission control strategies tailored to the China context – fuel efficiency or direct GHG regulations, emissions regulations, ban on high-GWP refrigerants, electrification and freight modal structure optimization.

研究方法概要
Methodology in brief

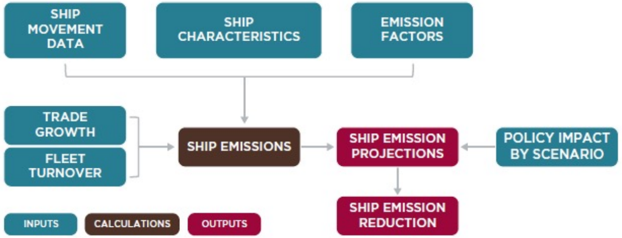
1. 识别中国上述7个交通细分部门的基准排放水平，以及上述5大减排策略范畴内已出台或正在规划中的政策措施
2. 对标国际先进的目标和政策要求
3. 基于国际对标和中国的可适用性，与合作伙伴共同制定上述领域未来政策管控情景
4. 通过ICCT和VECC开发的道路车辆、船舶、及非道路机械排放清单模型评估未来政策管控情景的减排收益

1. Identify baselines for the seven transportation modes and current and pipeline policies under the five strategies in China
2. Benchmark with world-class policies and programs for the various transportation modes
3. In collaboration with local partners, define future scenarios based on the benchmark analysis and applicability in China
4. Assess emission reductions of future scenarios using in-house emission models for onroad, marine and offroad sectors

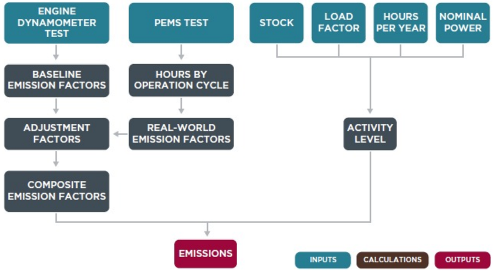
Onroad module



Marine module



Nonroad module (VECC)



构建未来减排路径情景

	乘用车	客车	轻型商用车	重型货车	船舶	铁路	非道路机械
能效/CO_2 标准	• 2030年新生产内燃机车辆的油耗达到4 L/100km； • 等效于油耗标准的新车CO_2排放标准； • 实际道路油耗：与较温和目标情景相同	• 2020-2030年期间新生产内燃机车辆的油耗降低30%； • 等效于油耗标准的新车CO_2排放标准。	• 2020-2030年期间新生产内燃机车辆的油耗每年降低4%； • 等效于油耗标准的新车CO_2排放标准。	• 2020-2030年期间新生产内燃机车辆的油耗降低30%； • 等效于油耗标准的新车CO_2排放标准。	• 新生产沿海和内河船舶：2025年以后燃油能效每五年提升约10%（与2025年水平相比）。	/	/
排放标准/政策	• 与较温和目标情景相同		• 到 2025 年，国IV之前的所有车辆替换为国VI或新能源汽车； • 到2030年，所有国IV车辆替换为国VI或新能源汽车。	• 到 2025 年，国IV之前的所有车辆替换为国VI或新能源汽车； • 到2030年，所有国IV车辆替换为国VI或新能源汽车。	• IMO 排放控制区(ECA)扩大到专属经济区； • 实施中国第III阶段排放标准， 等效于欧盟第V阶段标准。	• 2021年对柴油铁路机车实施等效于欧盟第V阶段的排放标准	• 2020年实施第IV阶段排放标准； • 2027年实施第VI阶段排放标准。
低GWP车用空调制冷剂	• 到2022年禁止新车使用高GWP制冷剂(HFCs)				/	/	/
新能源汽车和非道路源	• 2030年新生产车辆中新能源汽车占比70%； • 2035新生产车辆中新能源汽车量占比100% • 2025年纯电动汽车的能效达到11.1kWh/100km。	• 2025年新生产长途客车中新能源汽车占比100%； • 城市客车中新能源汽车占比与较温和目标情景相同。	• 2025年新生产物流车中新能源汽车占比100%； • 2035年新生产整体式卡车中新能源汽车占比55%。	• 2030年新生产环卫及邮政车中新能源汽车占比100%； • 2035年新生产自卸卡车中新能源汽车占比75%； • 2035年新生产半挂牵引车中新能源汽车占比40%。	• 远洋船舶：除游轮（100%要求）和化学品运输船（自愿）外，有岸电接入条件的船舶停靠期间全部使用岸电；增加有岸电接入条件的中国籍船舶数量； • 沿海和内河船舶：与已出台政策情景相同。	• 2025年货运铁路电气化率达到90%	• 2030年新生产叉车100%电动化； • 新生产建筑机械电动化率从2030年开始逐渐增加，至2040年达到70%电动化。
清洁电网	• 2030年电网全生命周期碳排放比2017年基线减少60%，即 307 gCO_{2e}/kWh						
货运体系	/		•通过模式转变，到2020年铁路货运活动量在2017年基础上增长30%，到2025年增长50%； •从2025 年开始，3%的在用货车参与到绿色货运计划当中，参与车辆的能效提升15%。				

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Detailed strategies to decarbonize transportation in China

	Passenger Car	Bus	LCV	MH Truck	Marine	Rail	Non-road
Efficiency/CO_2 standards	• New ICE vehicle fuel consumption reaches 4L/100km by 2030 • Equivalent new fleet CO_2 standard • Real-world fuel consumption gap same as proposed	• New ICE vehicle fuel consumption reduces by 30% between 2020-2030 • Equivalent new fleet CO_2 standard	• New ICE vehicle fuel consumption improves 4% per year 2020-2030 • Equivalent new fleet CO_2 standard	• New ICE vehicle fuel consumption reduces by 30% between 2020-2030 • Equivalent new fleet CO_2 standard	• New coastal and river vessels: Fuel efficiency improves about 10% every 5 years after 2025 compared to 2025 level.	/	/
Emission standards/policies	• Same as Low Ambition		• All pre-China IV vehicles are replaced with China VI or NEV vehicles by 2025 • All China IV vehicles are replaced with China VI or NEV vehicles by 2030	• All pre-China IV vehicles are replaced with China VI or NEV vehicles by 2025 • All China IV vehicles are replaced with China VI or NEV vehicles by 2030	• IMO ECA expanded to exclusive economic zone • China Phase III emission standard, equivalent to EU Stage V	• Emission standard equivalent to EU Stage V for diesel locomotive in 2021	• Implementation of Phase IV standard in 2020. • Implement Phase VI standard in 2027
Low-GWP refrigerants	• Ban the use of high-GWP refrigerants (HFCs) in new vehicles by 2022				/	/	/
New energy vehicles and engines	• 70% NEV in new fleet by 2030 • 100% NEV in new fleet by 2035 • BEV energy consumption 11.1kWh/km in 2025	• 100% NEV in new coach fleet by 2025 • Same as proposed for NEV urban bus	• 100% NEV in new logistics truck fleet by 2025 • 55% NEV in new rigid truck fleet by 2035	• 100% NEV in new sanitation truck fleet by 2030 • 75% NEV for new dump truck by 2035 • 40% NEV for new tractor trailer by 2035	• Oceangoing vessels: Other than cruise ships (100% required) and chemical tankers (voluntary), 100% at-berth plug-in rate for shore power equipped ships; Increasing number of China-flagged shore power equipped ships • Coastal and river vessels: Same as adopted	• Freight rail electrification rate reaches 90% by 2025	• 100% electric forklift in new fleet by 2030 • Increasing share of new electric construction equipment from 2030, 70% by 2040.
Clean grid	• 60% lifecycle carbon reduction from 2017 baseline in 2030, which is 307 gCO2e/kWh						
Freight systems	/		•Railway freight activity increases by 30% from mode shift compared to 2017 level by 2020 and 50% by 2025. •3% of in-use trucks participate in green freight program starting from 2025, where their energy efficiency improves by 15%				

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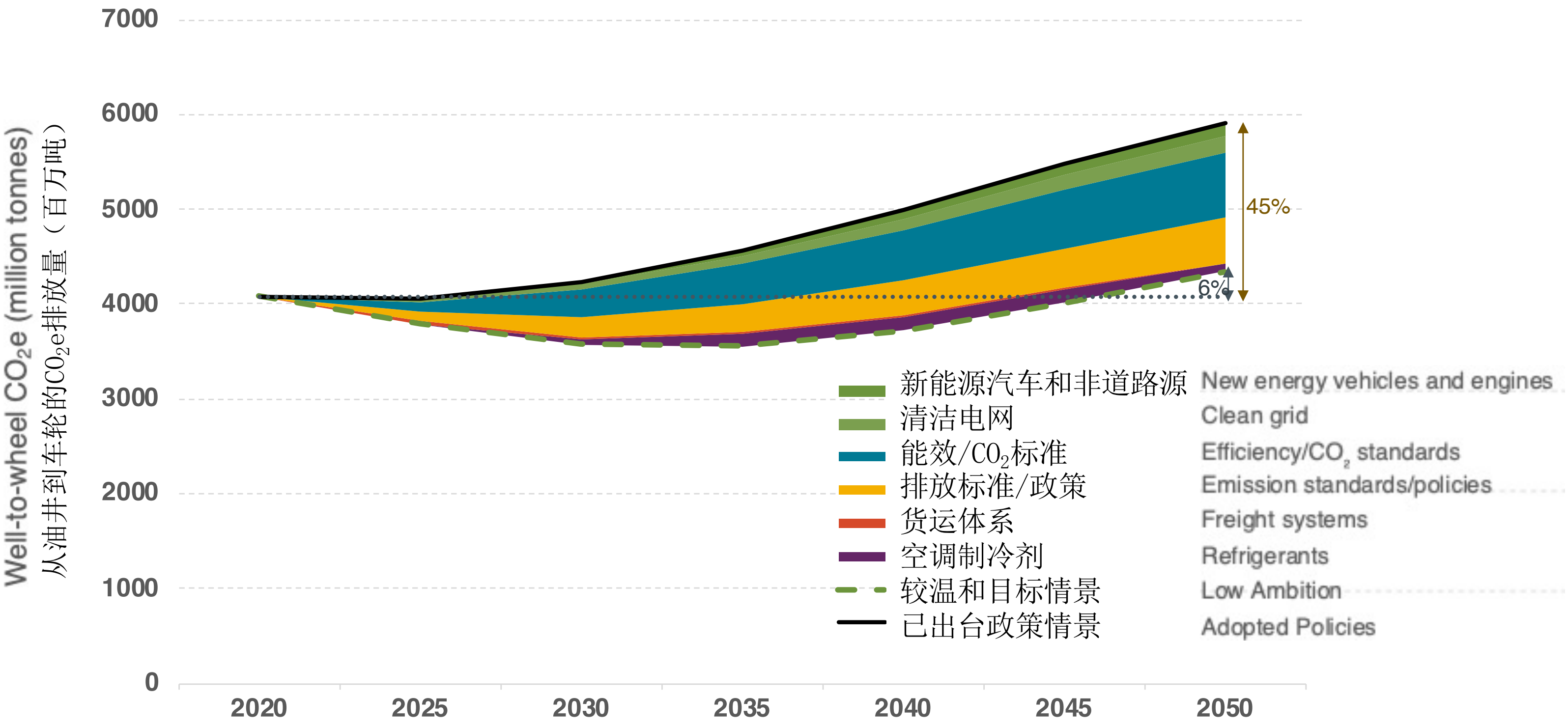
核心结论1: 当前政策不足以实现可持续、长期减排
Key finding 1: current policies are insufficient to achieve mid- and long-term emission reduction targets



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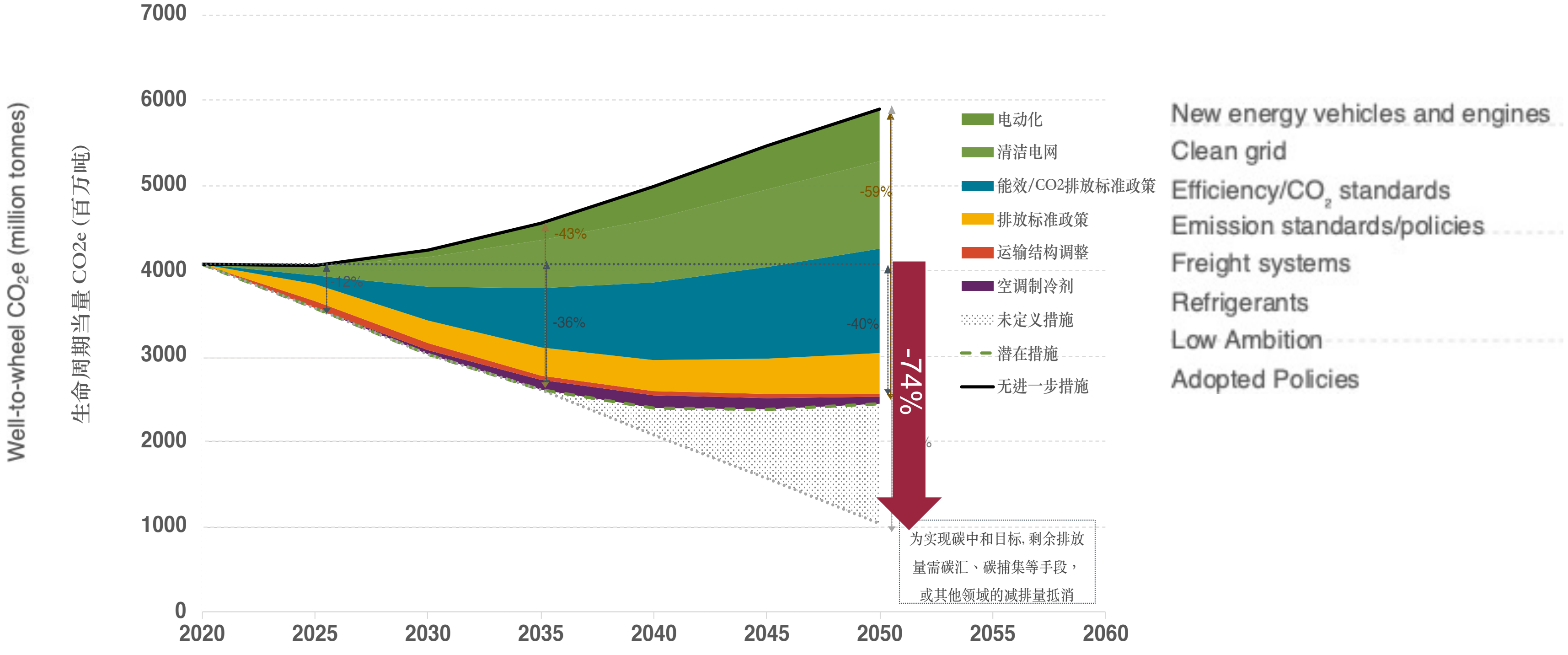
核心结论2: 先进政策组合可在2050年实现交通部门约74%的减排
Key finding 2: Advanced policies may reduce about 74% climate pollutant emissions from the transport sector by 2050



WTW GHG (CO_2e) emissions (GWP20) under strong policies, 2020-2050

https://theicct.org/publications/decarbonize-china-transport-14th-5-year-plan-oct21
https://theicct.org/publications/decarbonize-china-transport-14th-5-year-plan-CH-oct21

核心结论3: 并同时带来可观的空气污染物减排协同收益

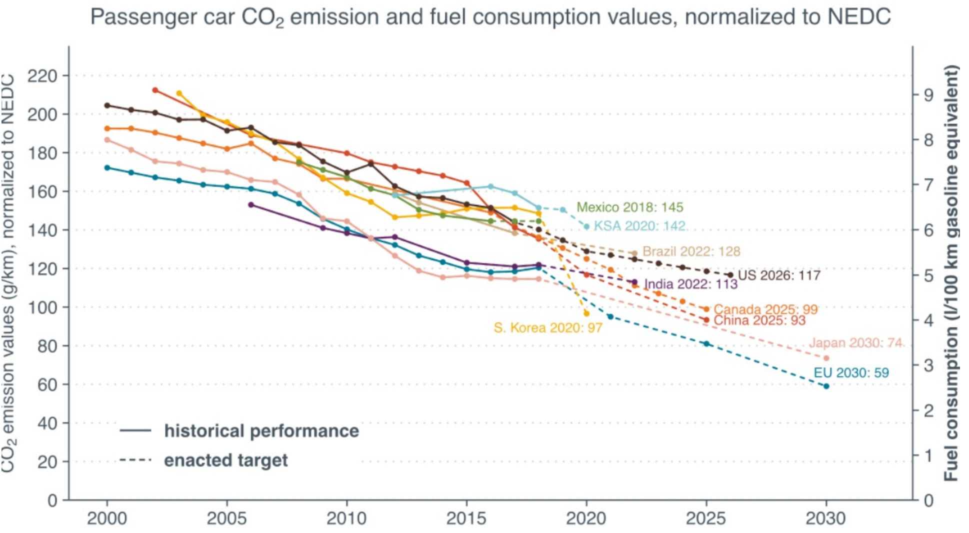
Key finding 3: At the same time achieve substantial reduction in air pollutant emissions as co-benefit

NOx	2025	2035	2050
LDV	947	1,554	1,795
HDV	4,611	6,614	6,643
Rail	453	642	737
Non-road	1,173	2,507	2,574
Marine	372	1,635	3,362
Total	**7,556 (45%)**	**12,952 (77%)**	**15,111 (87%)**

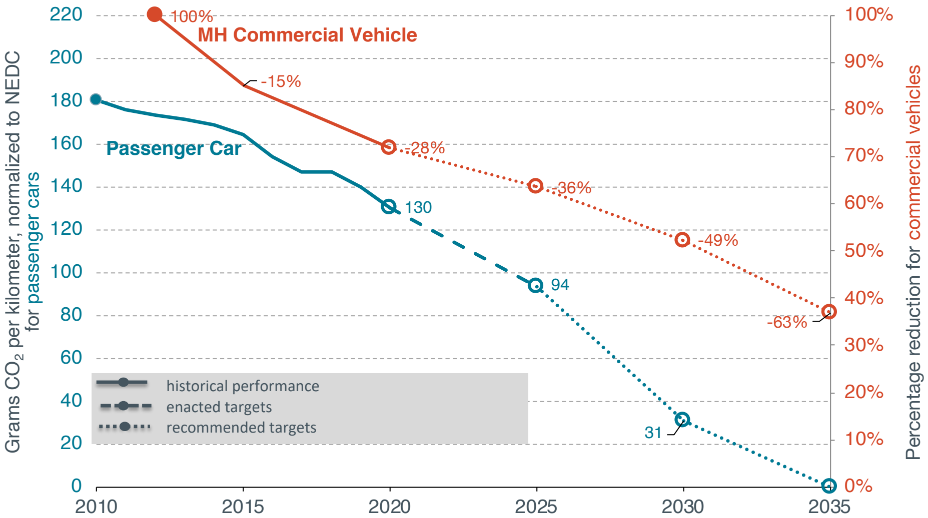
PM	2025	2035	2050
LDV	21	37	57
HDV	117	175	178
Rail	9	17	21
Non-road	62	114	117
Marine	119	163	242
Total	**328 (47%)**	**506 (72%)**	**615 (81%)**

主要减排举措 1: 严格的中、长期能效或温室气体排放标准
What needs to be done 1: Stringent, mid-to-long term efficiency or GHG standards

Status Quo (cars only)



Potential



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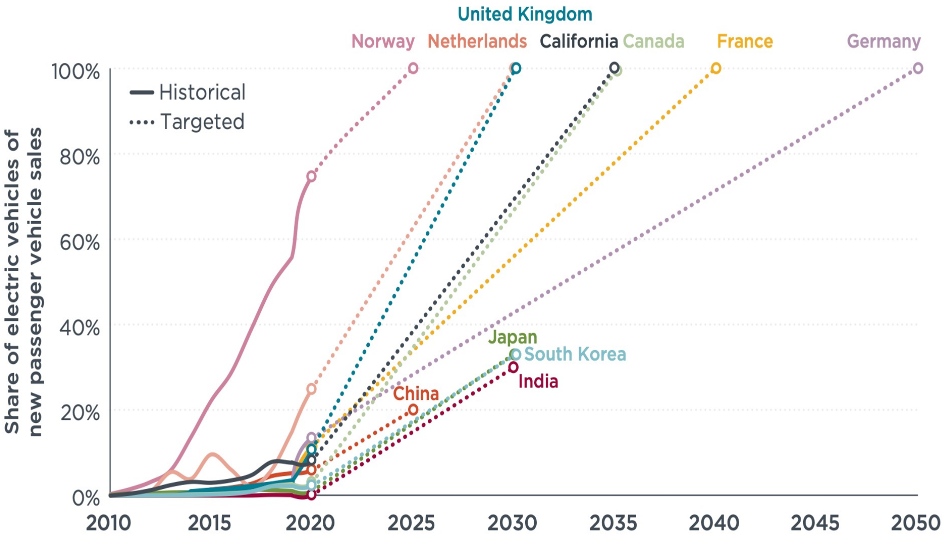
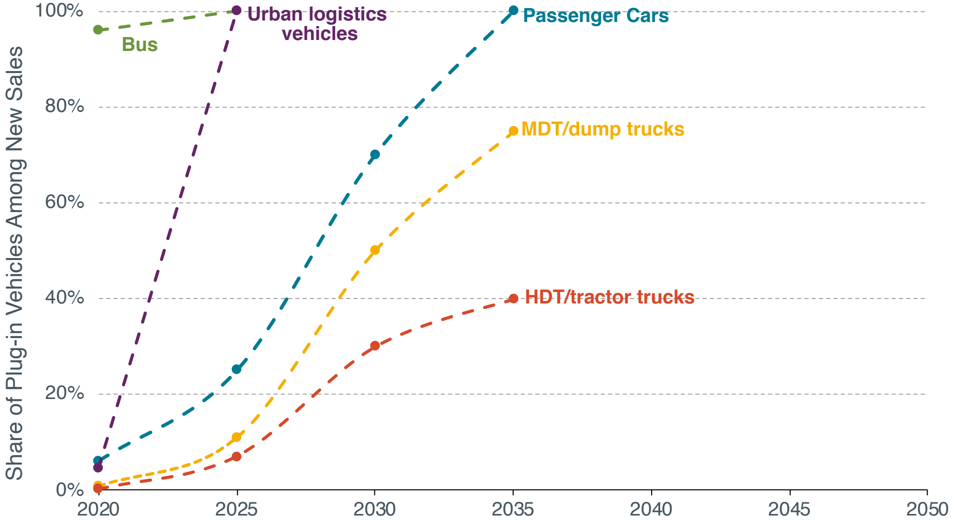
主要减排举措2: 加速零排放化进程

What needs to be done 2: Accelerate the electrification of major road transportation modes

Status Quo



Potential



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对中国的思考和建议
Final thoughts for China

- 中国可以适时考虑制定交通领域气候污染物减排的近、中、长期目标，到 2050 年实现 70% 以上的减排是可行的。
- 根据国际经验，能效和温室气体标准是交通部门减碳的有力政策工具。
- 电气化是实现长期脱碳目标的最具成本效益的途径。
- 道路车辆、船舶和非道路机械的下一阶段近零排放标准在减排短寿命气候污染物同时实现空气质量提升方面至关重要。
- 货物运输模式战略的优化可以带来额外的减排量。

- It is time for China to establish near- to long-term vision and targets for transportation GHG reduction; >70% of reduction is achievable by 2050.
- Based on international evidences, GHG standards are powerful policy instrument to decarbonize the transport sector.
- Electrification is a highly cost-effective way to achieve long-term, ambitious carbon reduction targets.
- Next-phase near-zero emissions standards for on-road vehicles, marine, and non-road equipment play an important role in reducing short-lived climate pollutant and at the same time achieve better air quality.
- Optimalization of transport modal strategies brings additional reduction.

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Backup slides

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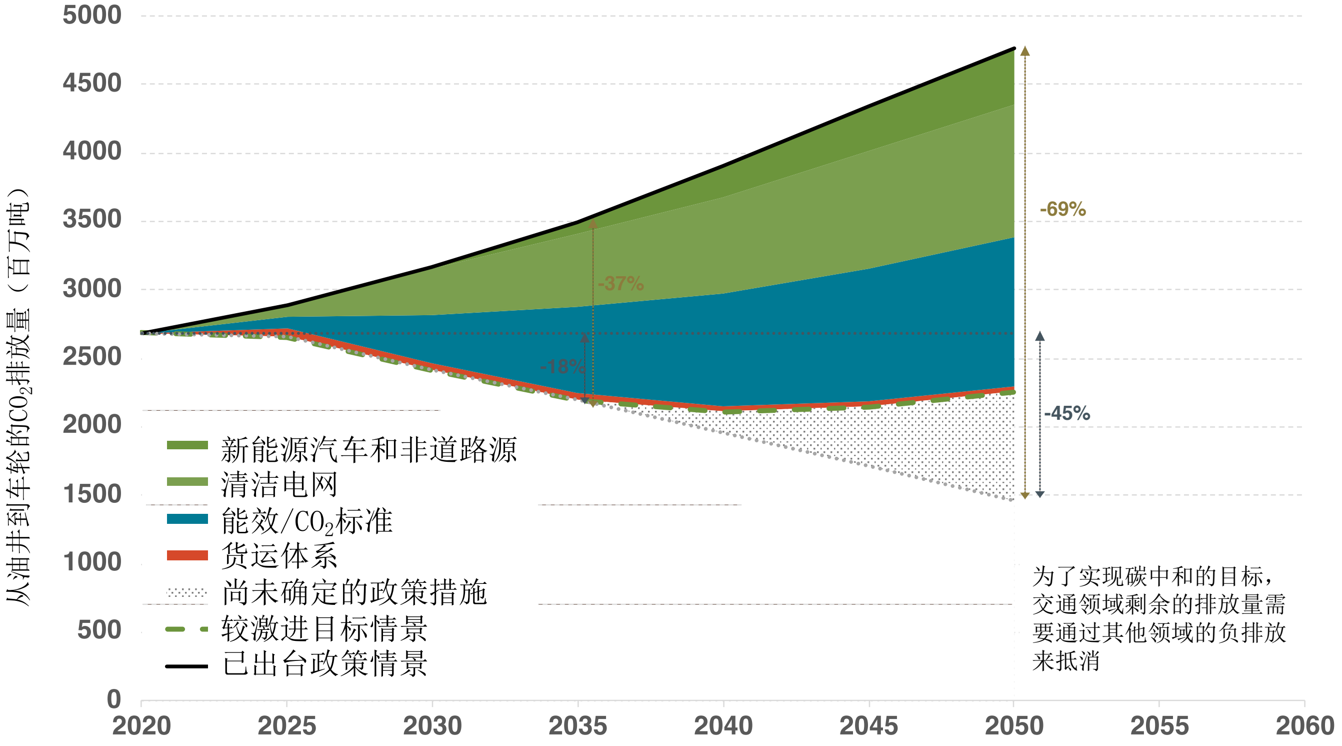
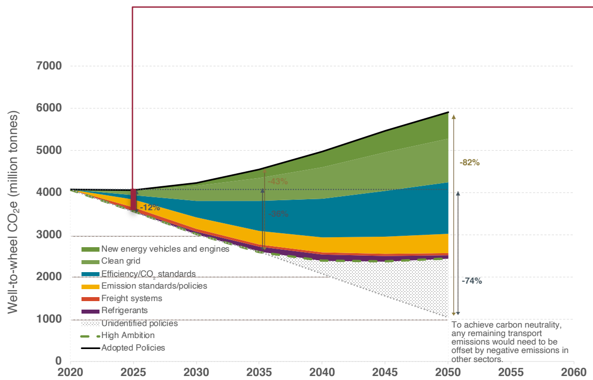
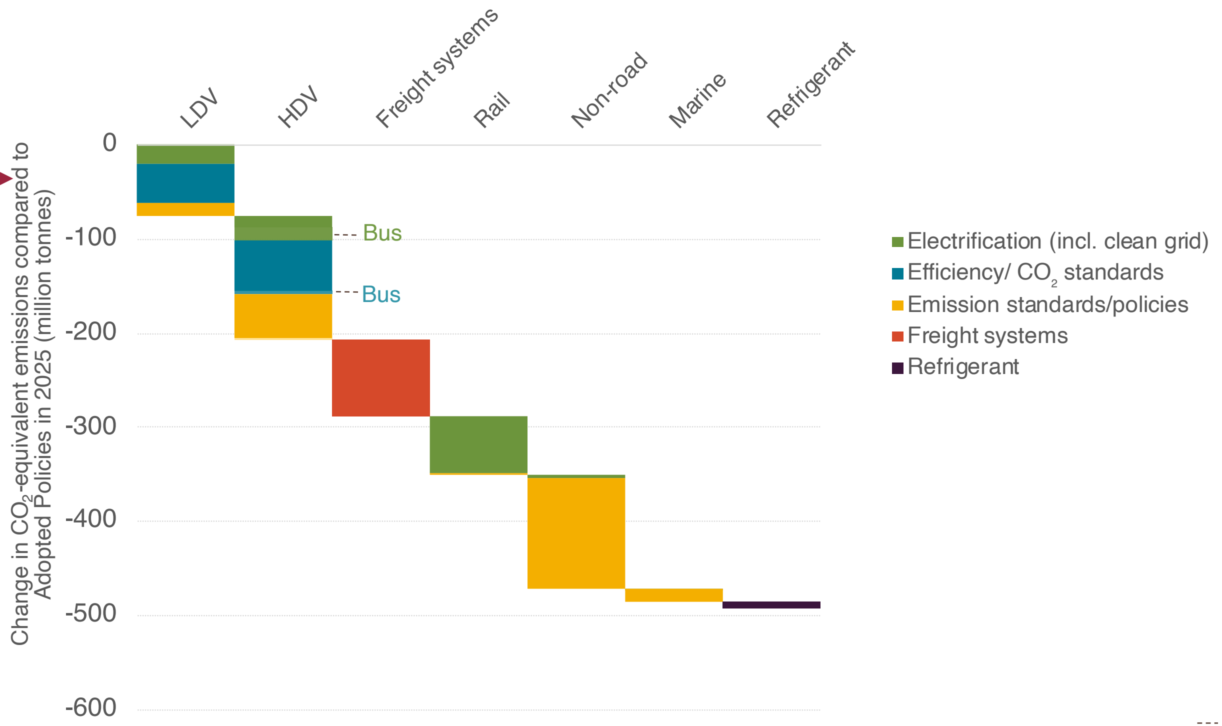
二氧化碳减排潜力
CO_2 emission reduction potential



Near-term (2025) emission reductions impact





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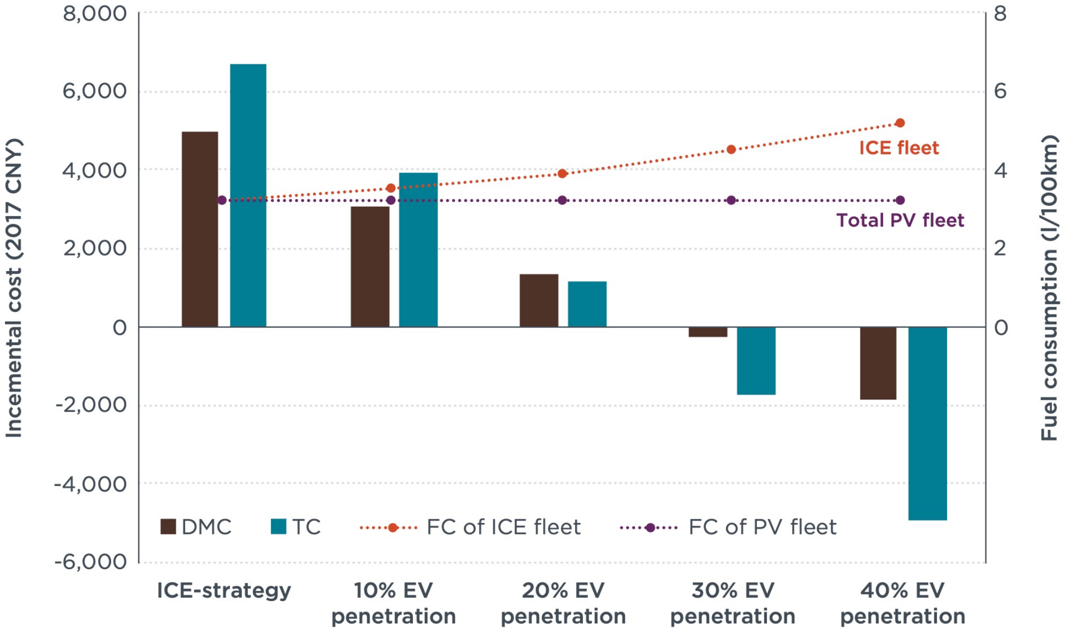
The efficiency/CO_2 regulation pathway: the future perspective

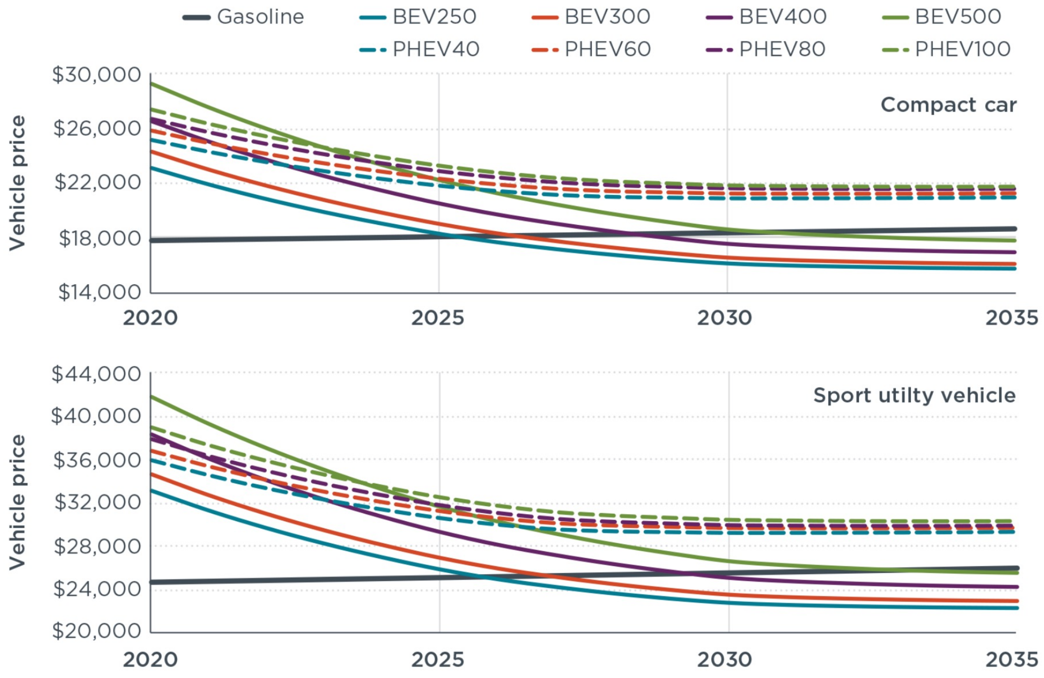
- There are different strategies to achieve a fleet average 3.2L/100km (~75g/km) of new passenger cars in 2030, with different implication to compliance costs
- Electrification is a lower-cost strategy



https://theicct.org/sites/default/files/publications/China-cost-curves-oct2020.pdf

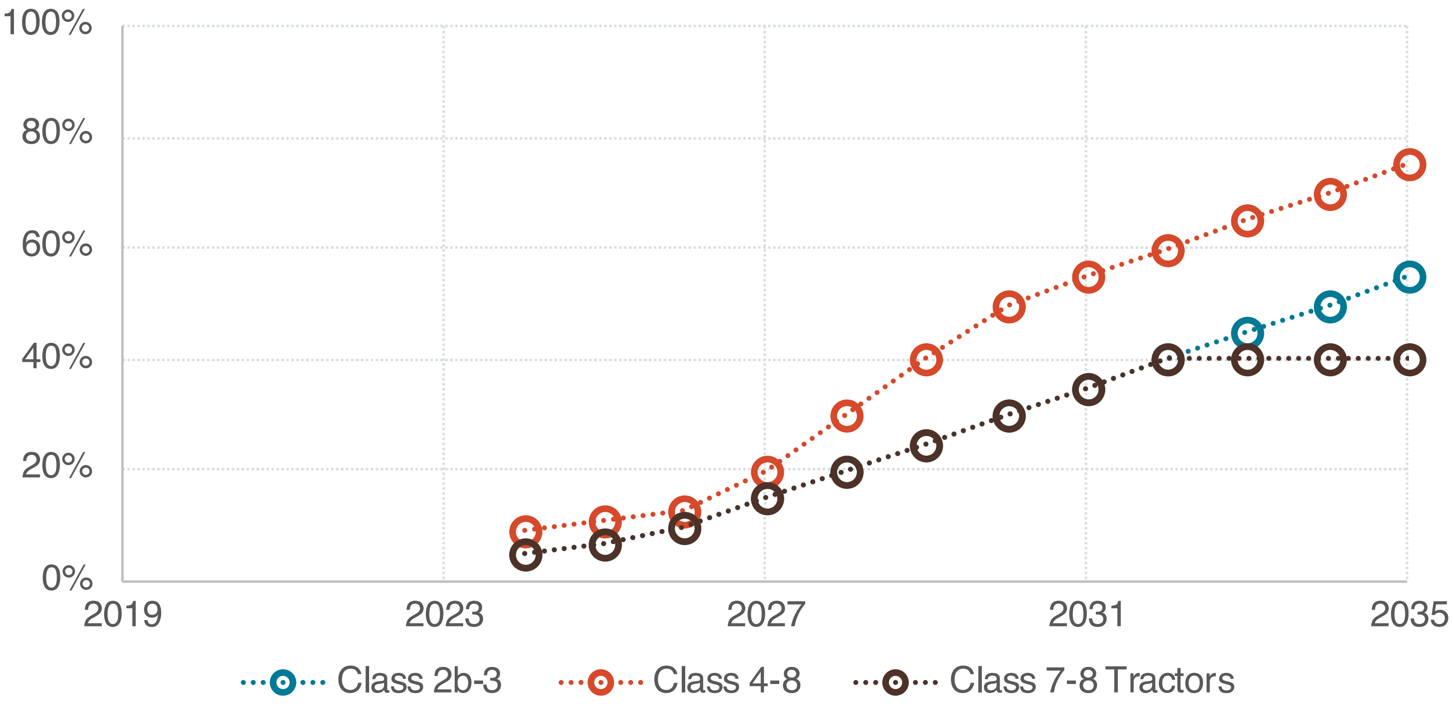
The zero-emission vehicle mandate pathway: the future perspective

- Electric cars, big or small, will achieve cost parity against fuel counterparts by 2030. It is ripe for China to consider ambitious EV uptake targets for the next 5-10 years



https://theicct.org/publications/ev-costs-benefits-china-EN-apr2021

California's Advanced Clean Truck Rule



EV leading cities: new-energy commercial vehicle top runners by type

Leading EV cities by various commercial vehicle types, based on 2020 annual data