中国乘用车生命周期温室气体排放
Life-cycle greenhouse gas emissions of passenger cars in China

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THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

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概述
Introduction

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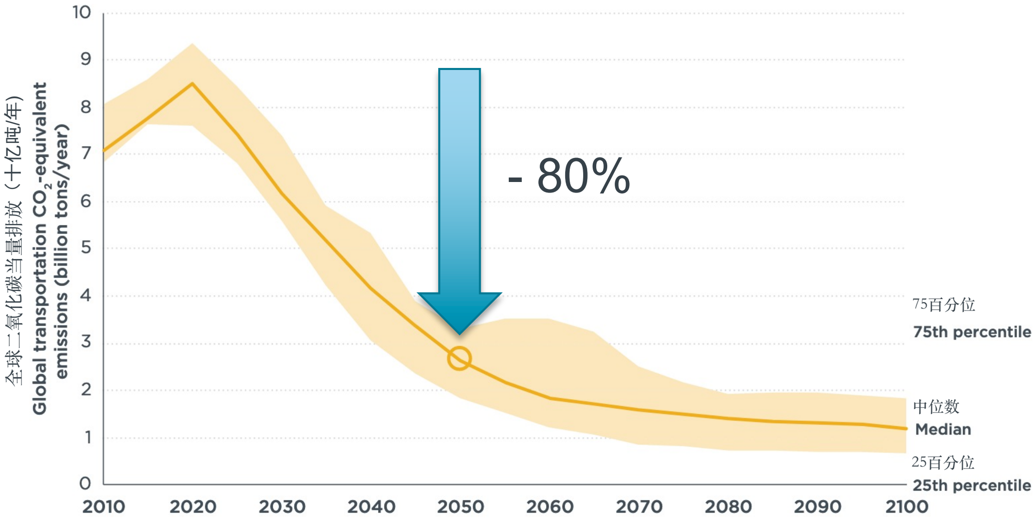
交通：到2050 年前需减排80%
Transport: 80% lower emissions by 2050

- 为了将全球变暖控制在1.5° C以内，需要在2050年前将全球交通排放的温室气体减少80%。
- *To limit global warming to 1.5 ° C, GHG emissions of global transport in 2050 need to be 80% lower.*

- 在乘用车数量不断增加的情况下，哪些技术可以使乘用车的排放大幅减少？
- *Which technologies can deliver this deep reduction in the passenger cars fleet despite a growing number of vehicles?*

全球交通运输温室气体排放影响控制在1.5° C以内的场景预测

Global transport sector GHG emissions in 1.5 ° C scenario



2050年愿景：在世纪中叶实现全球交通脱碳的策略

Vision 2050: A strategy to decarbonize the global transport sector by mid-century.

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范围：生命周期温室气体排放
Scope: Life-cycle GHG emissions

- 生命周期温室气体排放 / *Life-cycle GHG emissions:*
  - 二氧化碳、甲烷、一氧化二氮 / *CO_2, methane (CH_4), nitrous oxide (N_2O)*

- 车辆周期 / *Vehicle cycle:*
  - 车辆及电池制造（包括原材料） / *Vehicle and battery production (incl. raw material)*
  - 维护 / *Maintenance*
  - 使用寿命末期回收 / *End-of-life, recycling*

- 燃料周期(生产、使用周期) / *Fuel cycle (well-to-wheel):*
  - 燃料和电力生产/ *Fuel and electricity production*
  - 间接土地利用变化 / *Indirect land use change (ILUC)*
  - 燃料燃烧 / *Fuel combustion in vehicle*

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研究方法论
Methodology

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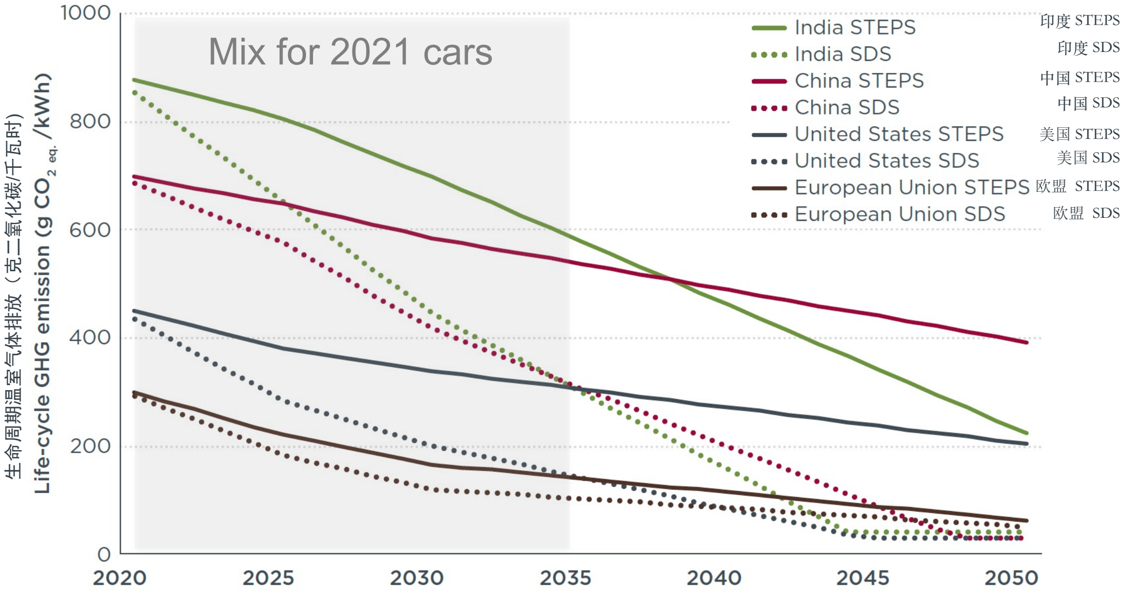
使用寿命期平均电力结构
Lifetime average electricity mix

1. 车辆使用寿命期燃料和电力结构的平均碳强度 / *Vehicle lifetime average carbon intensity of the fuel and electricity mixes:*
   - 电力结构和生物燃料份额的预期变化/*Projected change of electricity mix and biofuel shares*
   - 依据目前政策/*Based on current policies*
   - 与巴黎协定一致的发展相比/*Compared to Paris Agreement-aligned development*

电力消耗生命周期温室气体排放
Life-cycle GHG emissions of electricity consumption



数据来源：Bieker (2021). 内燃机和电动乘用车生命周期内温室气体排放的全球对比

Source: A global comparison of the life-cycle GHG emissions of combustion engine and electric passenger cars.

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电池生产
Battery production

2. 电池生产 / *Battery production:*
   - 最新工业规模数据/*Most recent data on industrial-scale battery production*
   - 地区电池生产的市场平均结构/*Market average mix of regional battery production*

电池生产温室气体排放
Battery production GHG emissions

千克二氧化碳 / 千瓦时 kg $CO_{2\ eq.}$/kWh	欧洲 Europe	美国 United States	中国 China	韩国 South Korea	日本 Japan
NMC111-graphite NMC111-石墨	56	60	77	69	73
NMC622-graphite **NMC622-石墨**	**54**	**57**	**69**	**64**	**68**
NMC811-graphite NMC811-石墨	53	55	68	63	67
NCA-graphite NCA-石墨	57	59	72	67	70
LFP-graphite LFP-石墨	34-39	37-42	51-56	46-50	50-55

数据来源：Argonne国家实验室的GREET模型（2020年版本）
Based on Argonne National Laboratory's GREET Model (2020 version)

燃料/电力消耗
Fuel/electricity consumption

3. 燃料和电力消耗 / *Fuel and electricity consumption:*
   - 使用实测平均值而不是官方测试值（对充电式混合动力电动车尤其重要）

     Average real-world usage instead of official test values, especially important for PHEVs.

4. 甲烷的20年全球变暖潜势 / *20-year global warming potential (GWP) of methane leakage:*
   - 甲烷的前20年全球暖化潜势是其100 年全球暖化潜势的 3 倍。

     Methane contributes 3 times more to global warming in the first 20 years than indicated by the 100-year GWP.
   - 天然气及天然气或煤制氢

     For natural gas and for natural gas or coal hydrogen

主要结论
Key results

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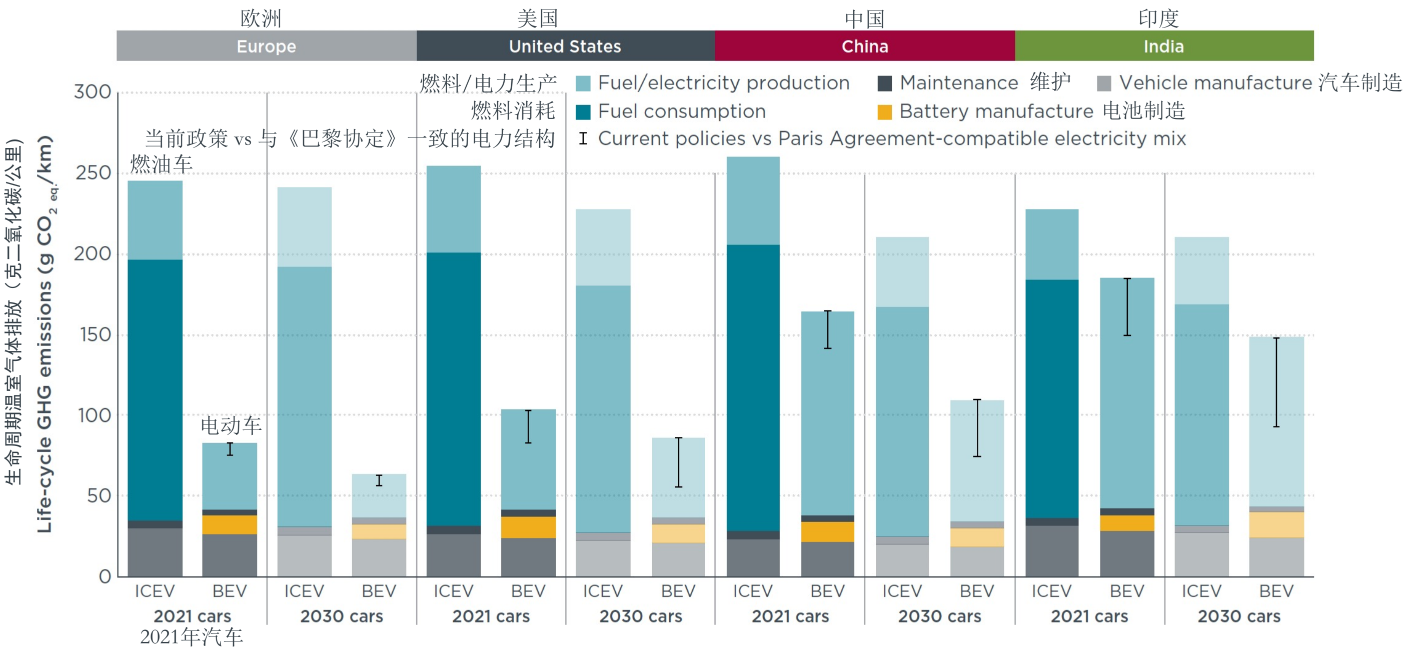
全球：电动车的排放量最低
Global: Battery EVs have lowest emissions

- 电动车的排放全球最低
  Battery EVs have lowest emissions
  - 2021年注册的车辆 / *For cars registered in 2021*
  - 四个地区 / *In all four regions*
- 未来电动车的温室气体排放效益会增加
  The GHG emission benefit increases for future BEVs.

2021年及2030年注册的中型汽油车和电动车在生命周期的温室气体排放对比
Life-cycle GHG emissions of medium-size gasoline cars and battery EVs registered in 2021 and in 2030



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Source: A global comparison of the life-cycle GHG emissions of combustion engine and electric passenger cars.

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中国：2021年A级车
China: Cars registered in 2021, A segment

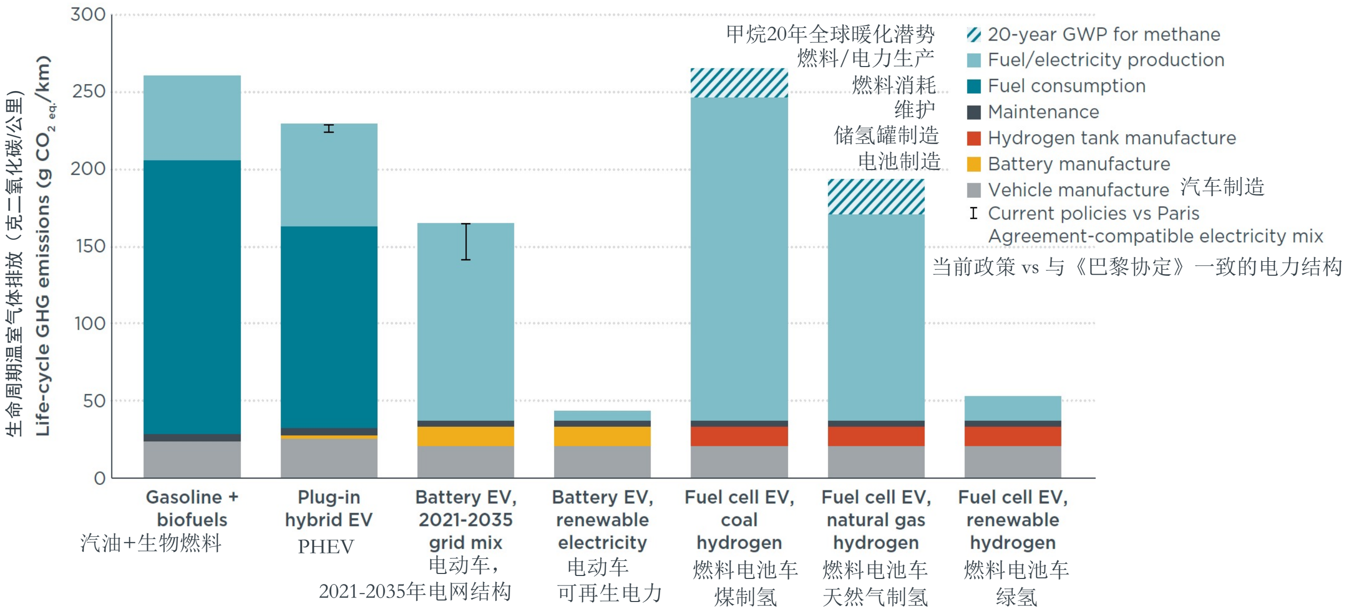
- 汽油车：最高排放
- *Gasoline cars: highest emissions*

- PHEV：小幅减排
- *Plug-in EVs: small reduction*

- 电动车: 现今使用车型中最低排放
- *Battery EVs: lowest emissions, already for cars registered today*

- 燃料电池汽车：排放因氢气来源而异，煤制氢具有很高排放
- *Fuel cell EVs: emissions vary with hydrogen source, very high for coal*

A级车平均生命周期温室气体排放
Life-cycle GHG emissions of average A segment cars



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中国：2021年注册SUV
China: Cars registered in 2021, SUV segment

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- 电动车：现今使用车型中最低排放
- *Battery EVs: lowest emissions, already for cars registered today*

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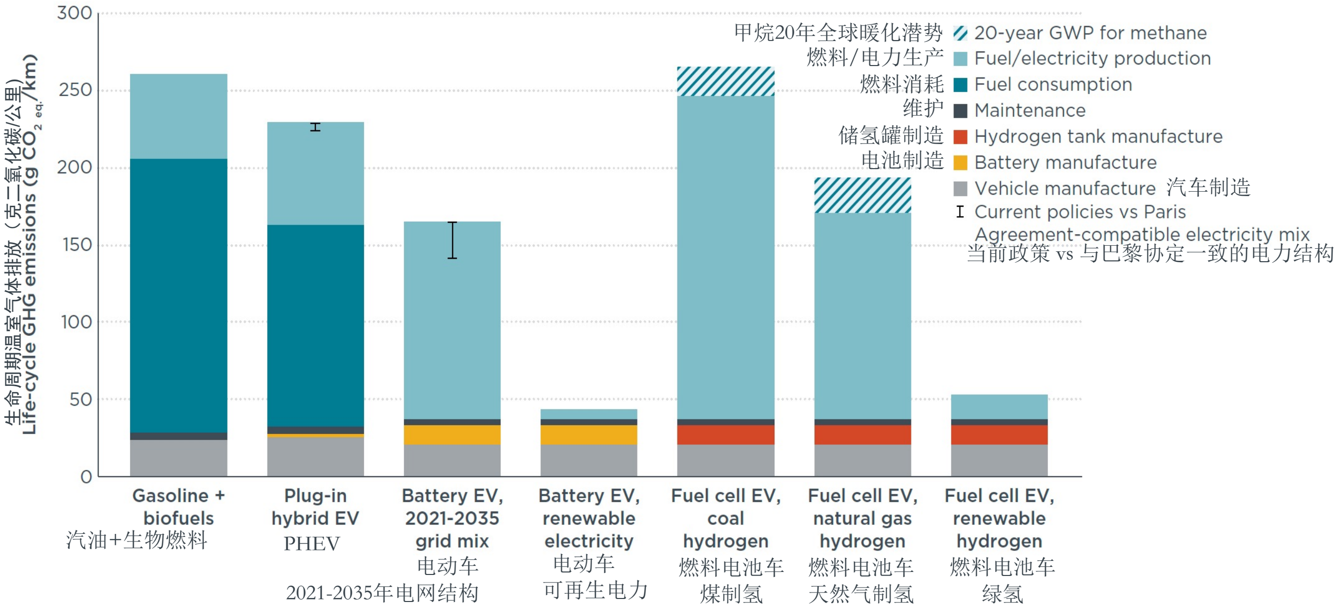
- *Fuel cell EVs: emissions vary with hydrogen source, very high for coal*

SUV平均生命周期温室气体排放
Life-cycle GHG emissions of average SUV segment cars



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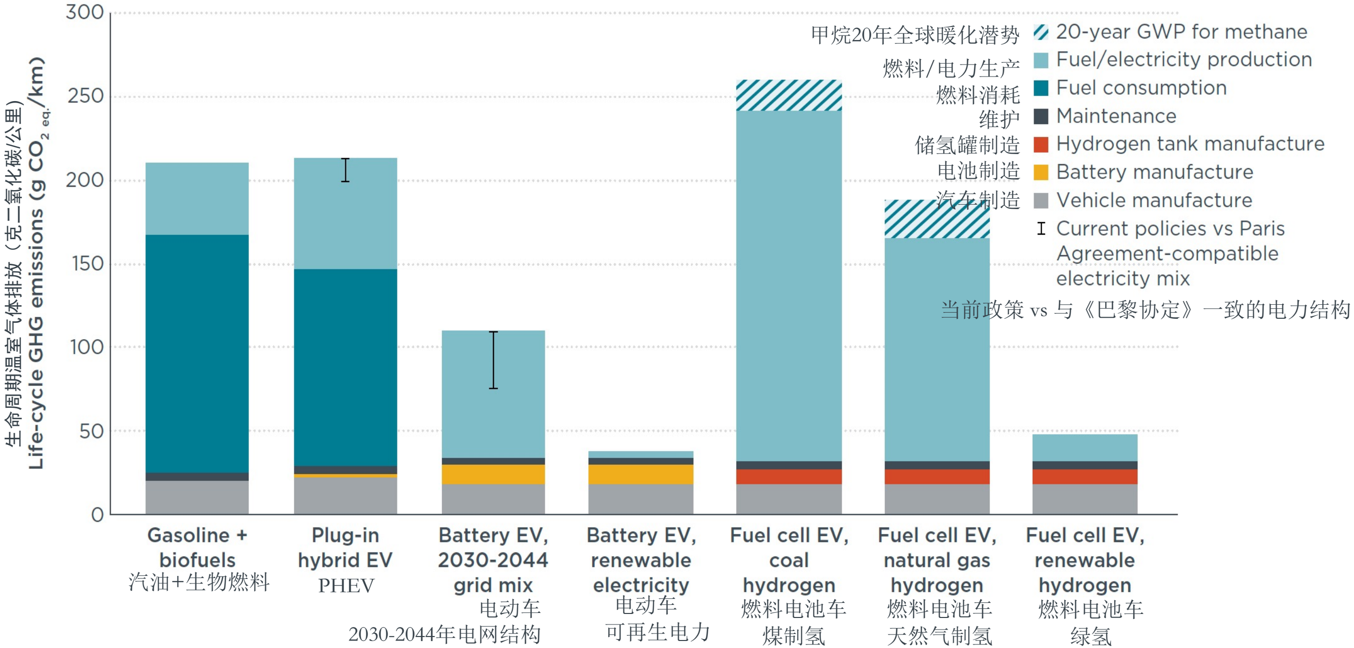
中国：2030年注册A级车
China: Cars registered in 2030, A segment

- 汽油车：比2021年减少20%油耗
- *Gasoline cars: 20% lower fuel consumption than 2021 cars*

- PHEV：续航里程提高 20%，但仍然无效益
- *Plug-in EVs: 20% higher range, but still no benefit*

- 电动车：排放很低，低于《巴黎协定》的电力结构情况
- *Battery EVs: very low emissions, even lower for Paris Agreement electricity mix scenario*

A级车平均生命周期温室气体排放
Life-cycle GHG emissions of average A segment cars



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China: Cars registered in 2030, SUV segment

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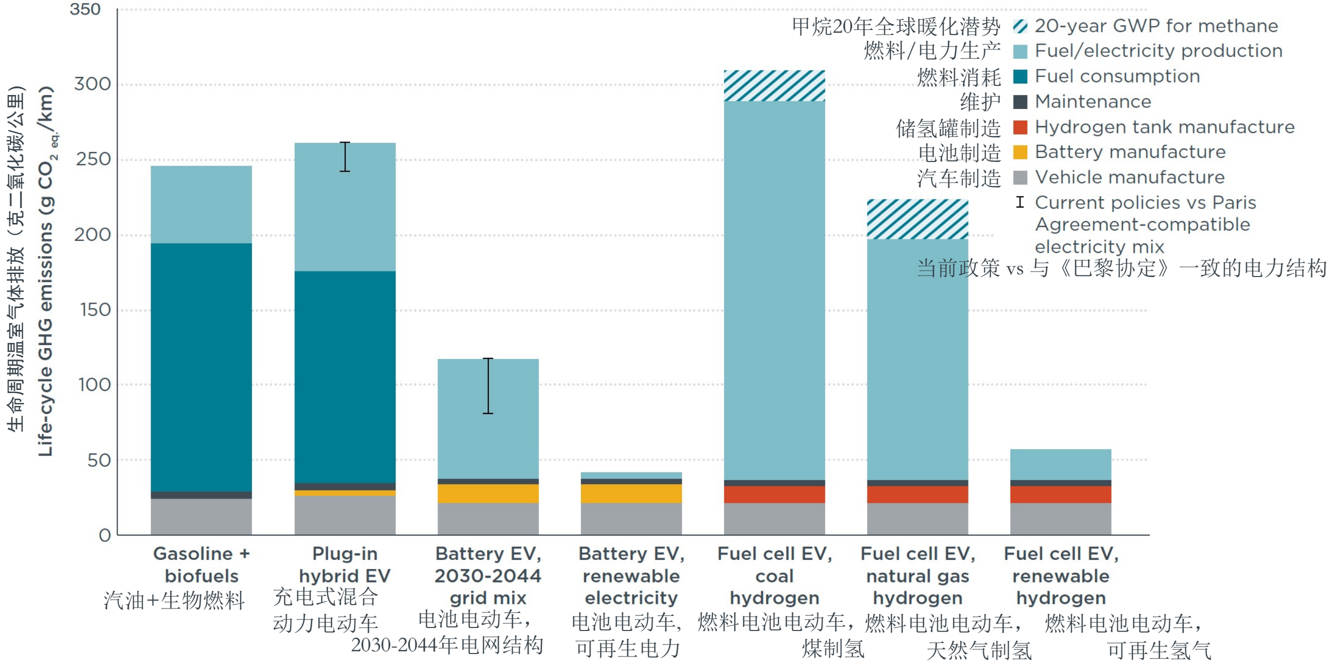
SUV平均生命周期温室气体排放
Life-cycle GHG emissions of average SUV segment cars



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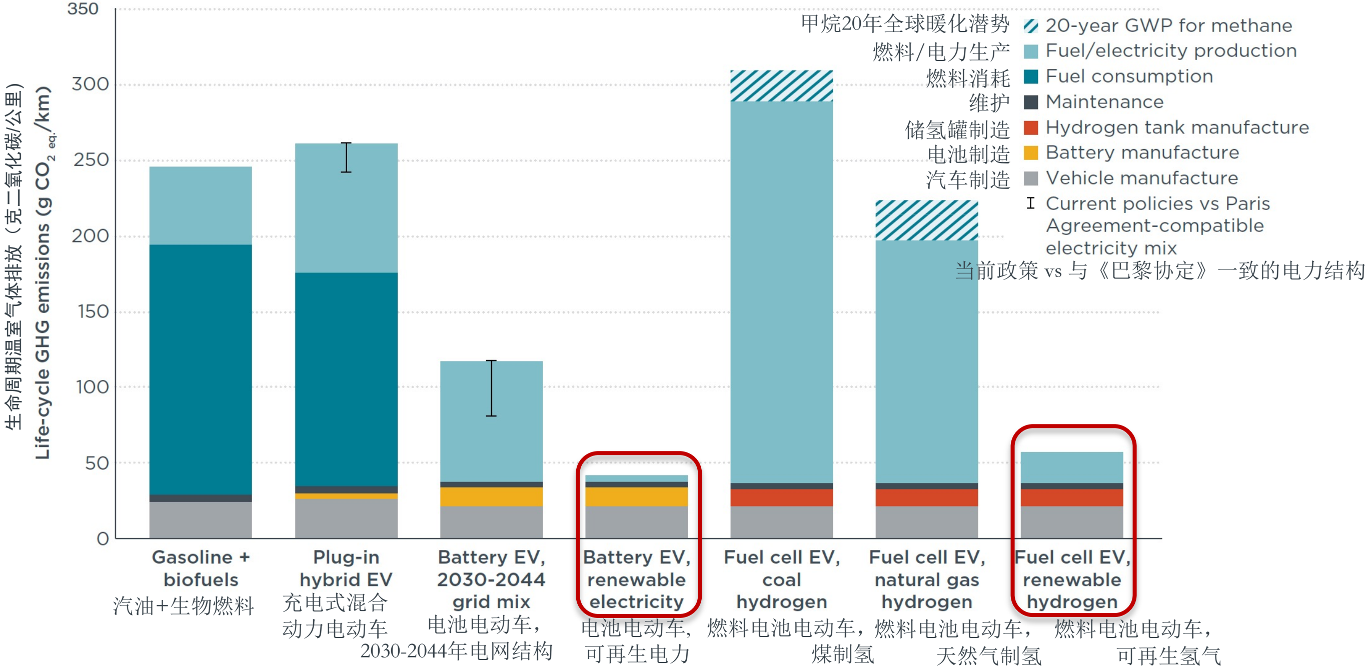
中国：2030年注册SUV
China: Cars registered in 2030, SUV segment

- 相比于汽油汽车，由可再生能源驱动的电动汽车和燃料电池汽车的生命周期温室气体排放要低 80%
- *With renewable electricity/hydrogen battery EVs and fuel cell EVs have 80% lower life-cycle GHG emissions than gasoline cars.*

SUV平均生命周期温室气体排放

Life-cycle GHG emissions of average SUV segment cars



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Source: A global comparison of the life-cycle GHG emissions of combustion engine and electric passenger cars.

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电力、绿氢和合成燃料
Electricity, green hydrogen and e-fuels

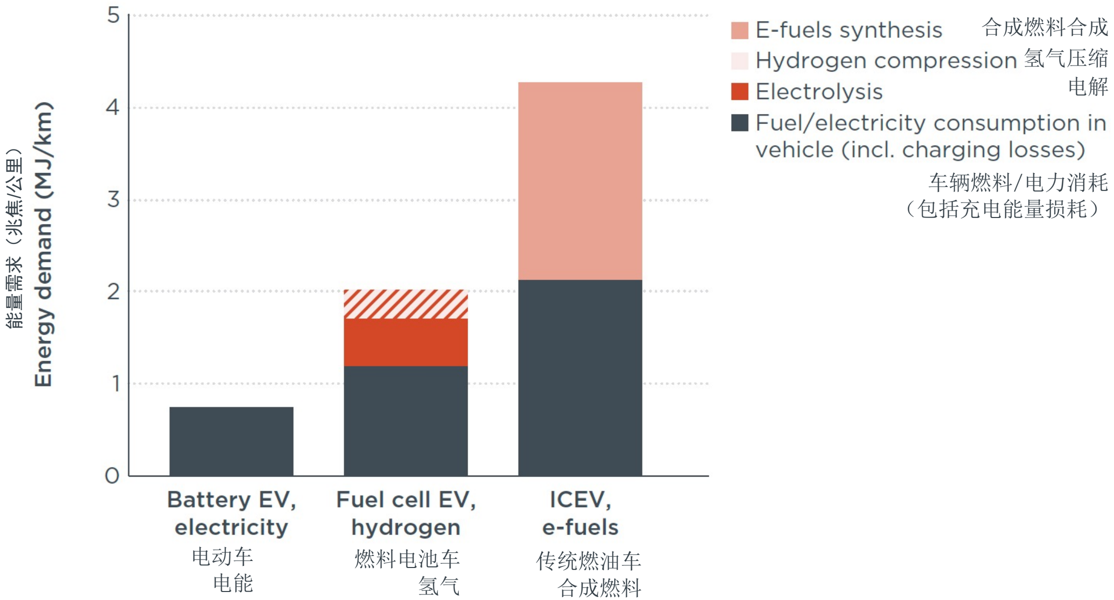
- 驾驶可再生氢能汽车的能源消耗是驾驶电动汽车的3倍。
- *Driving on renewable hydrogen is three times more energy intensive than driving battery EVs.*

- 驾驶合成燃料汽车的能源消耗是驾驶电池电动汽车的6倍。
- *Driving on e-fuels is six times more energy intensive than driving battery EVs.*

- 合成燃料昂贵且有限，难以促进道路运输脱碳。
- *E-fuels are too expensive and too limited to contribute to the decarbonization of road transport.*

分别驾驶电动、可再生氢气和合成燃料的中型汽车所需能源

Energy demand of driving medium size cars with electricity, renewable hydrogen, and e-fuels



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主要信息
Key messages

- 对于现已注册的车辆，电动车具有最低的生命周期温室气体排放。
- *Already for cars registered today, battery EVs show lowest life-cycle GHG emissions.*

- 只有电动汽车和氢燃料电池汽车有可能具有全生命周期的零碳排放。
- *Only battery EVs and hydrogen fuel cell EVs have the potential to be near zero-carbon, also on a life-cycle basis.*

- 目前还没有非常可行的传统燃油车辆脱碳途径：合成燃料和低碳生物燃料的产量较为有限，无法大幅减少排放。
- *There is no realistic pathway to decarbonize combustion engine vehicles: the availability of e-fuels and low carbon biofuels is too limited to substantially reduce the emissions of the fuel mix.*

- 为了控制全球变暖在 1.5° C内，2050 年前全球乘用车需要实现电动化。
- *To limit global warming to 1.5 ° C, the global passenger car fleet needs to be electric by 2050.*

- 由于车辆使用寿命为 15-18 年，全球需要在 2030-2035 年之前停止注册新传统燃油车辆。
- *With vehicle lifetime of 15-18 years, this requires that the registration of new combustion engine vehicles needs to be phased out by 2030-2035 - globally.*

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电动乘用车和电动商用车的不同之处
How are electric trucks and buses different than cars?

- 总质量 / *GVW: 1 - 2 t*
- 电池容量/ *Battery capacity: 30-100 kWh*
- 能耗/ *Energy consumption: ~0.2 kWh/km*
- 行驶总里程/ *Lifetime mileage: ~250,000 km*

- 总质量/ *GVW: 3.5 - 50 t*
- 电动容量/ *Battery capacity: 100 – 1,000 kWh*
- 能耗/ *Energy consumption: 1 - 2 kWh/km*
- 行驶总里程/ *Lifetime mileage: ~1,000,000 km*

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对于商用车有关研究的启示
Implications for trucks and buses

- ICCT已经开始着手针对商用车的LCA开展相应的研究，主要结论将于明年发布。本次演讲的主要结论仍然适用于商用车。只有电池和氢燃料电池商用车才有可能在全生命周期基础上实现低碳化。
- *ICCT has begun a detailed LCA for HDVs, to be published in 2022. Still the main conclusions from this presentation hold for HDVs. Only battery and hydrogen fuel cell HDVs have the potential to decarbonize the sector on a life-cycle basis.*

- 商用车与乘用车的一个关键的区别是商用车的全生命周期行驶里程更远，这意味着单位碳排放和能耗对全生命周期的温室气体排放有更大的影响。
- *One key difference is that HDVs are driven farther over their lifetimes. This means that the carbon intensity and the amount of energy they consume have a higher impact on the LCA GHG emissions.*

- 相应地，商用车整车和电池的生产排放也将被平摊至更长的行驶里程之中加以考虑。
- *Similarly, the HDV and battery manufacturing emissions are spread out over more kilometers.*

- 当考虑到甲烷的泄漏排放影响，天然气商用车相比于柴油车并没有很强的环境优势。
- *Considering methane leakage emissions, natural gas HDVs do not offer any GHG benefit vs. diesel.*

- 电动商用车的环境表现将会随着电网清洁度和氢能制备过程的低碳化而不断提升。
- *The climate performance of electric-drive HDVs will continue to improve as the electricity grid and hydrogen production gets greener in the coming years.*

- 商用车使用周期比乘用车更长久，因而使得电动化的转型显得尤为迫切。
- *HDVs stay on the road longer than passenger cars. There's urgency to beginning the transition to electric-drive buses and trucks.*

感谢关注！

Thank you!

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