Transport GHG Emission Reduction Scenarios in Germany
德国交通运输业温室气体减排前景

Workshop on
“Potentials for Low Carbon Transport Development in China – Scenario Analyses and Promising Measures”
“中国低碳交通发展潜力-前景分析和减排措施”工作讨论会

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Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

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Oeko-Institut

Oeko-Institut is a leading European research and consultancy institute based in Germany which is working for a sustainable future.

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- Founded in 1977, non-profit association 成立于1977年,为非赢利协会
- Offices in Freiburg, Darmstadt and Berlin 在弗莱堡、姆施塔特和柏林设有办事处
- More than 140 staff, including 90 researchers 超过140名职员,包括90名研究人员
- More than 300 national and international projects per year 每年有300多个国内和国际项目
- Clients: European Union, ministries, industrial companies, non-governmental organisations
  客户: 欧盟、部委、工业公司、非政府组织
- Annual turnover: approx. 12 million Euro
  年营业收入:约1,200万欧元

Project team 项目团队

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Oeko-Institut, Berlin/Darmstadt/Freiburg
Oeko-Institut, 柏林/弗莱堡/姆施塔特
(Project management, material flow analysis / GHG emission calculation, scenario building项目管理,物料流分析/温室气体排放计算,前景构建)

DLR Institute of Transport Research, Berlin
柏林DLR交通研究院
(Transport demand, scenario building交通需求,前景构建)

Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe 弗劳恩霍夫系统与创新研究院 ISI，卡尔斯鲁厄
(Transport demand, economic impacts交通需求,经济影响)

Renewbility：可再生性：
Project objectives 项目目标

- Development of an integrated method for modelling policies and measures for sustainable mobility in passenger and freight transport
  开发综合性方法以制订旅客及货物的可持续性运输流动的政策模型及措施
- Taking into account interactions between transport and energy sector
  充分考虑运输与能源部门的互动
- Modelling of economic impacts of climate policies in the transport sector
  气候政策对交通行业的经济性影响模型
- Incorporation of a broad spectrum of stakeholders in model development at an early stage & development of a consistent climate protection scenario up to 2030 for the transport sector in Germany including stakeholder participation
  在模型开发的早期即融合广泛的股东, 联合股东的参与为德国交通业开发出直至2030年的连续气候保护前景

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Renewbility:可再生性:
Scope范围

- Time period时间跨度:
  - 2010 to 2030 2010至2030
- Considered modes of transport考虑的交通模式:
  - Inland passenger transport (road, rail, aviation) 内陆旅客运输(公路,铁路及航空)
  - Inland freight transport (road, railways, inland navigation)
    内陆货物运输(公路,铁路及内陆导航)

  Not considered未考虑的: international aviation & maritime navigation国际航空和海运导航
- GHG emission calculation includes 温室气体排放计算包括:
  - Fuel production 燃料生产(upstream emissions上游排放)
  - Vehicle production 车辆生产
  - Vehicle operation车辆行驶 (direct emissions直接排放)

Modelling concept 模型概念图

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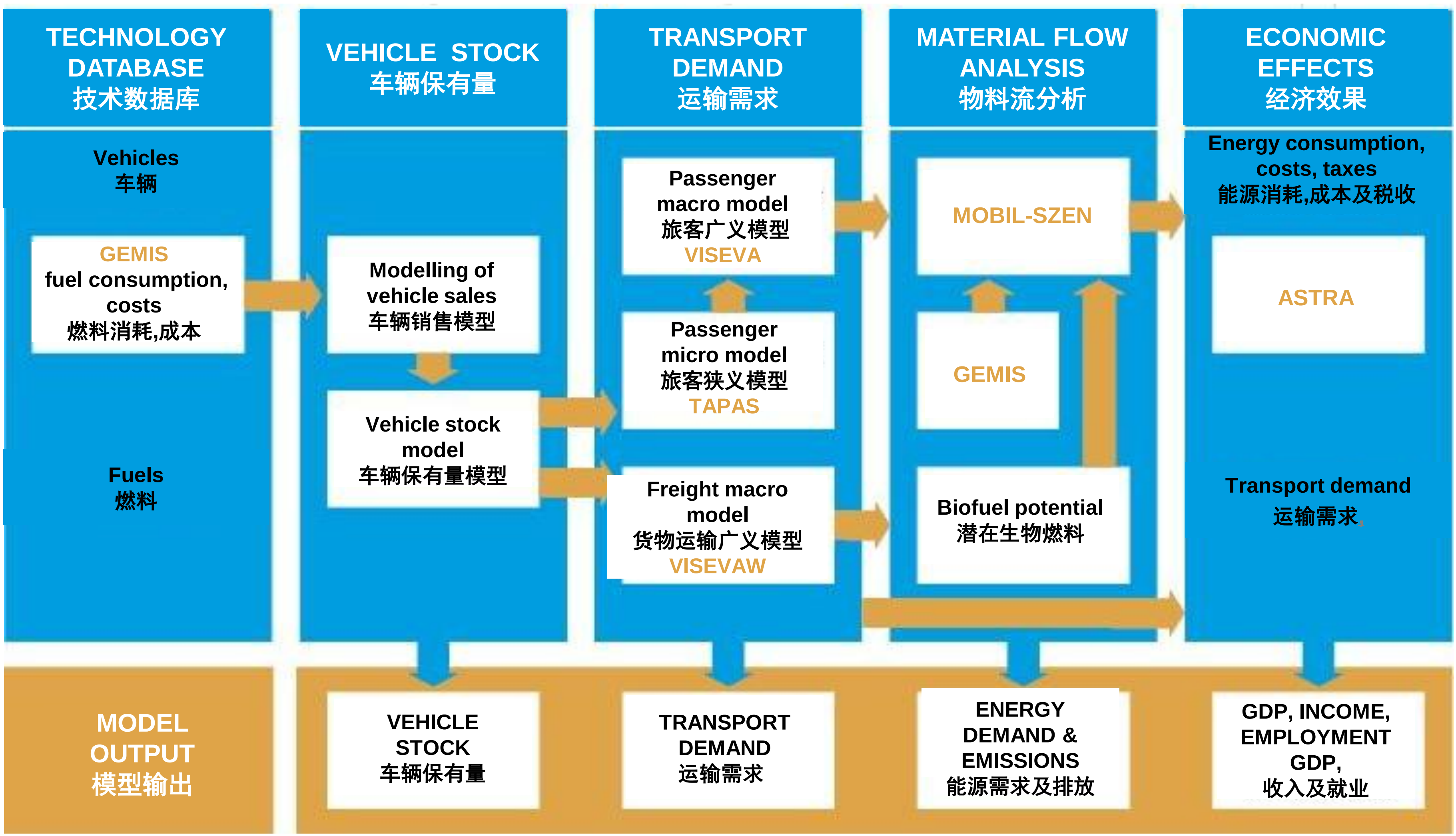

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Technology database技术数据库

- ***Vehicles车辆:***
  - Passenger cars, light and heavy duty vehicles, others (trains, aeroplanes, inland water vessels) 客车,轻重型车辆,其它(火车,飞机,内陆水上船舶)
  - different efficiency stages for 2010, 2020, 2030
  - 2010, 2020及2030年不同的能效阶段
  - Different propulsion technologies: conventional, plug-in hybrid, battery-electric and fuel cell
    不同的驱动技术: 传统驱动,接插式混合动力, 电力电池及燃料电池

- ***Fuels燃料:***
  - conventional and a large variety of renewable energy carriers
    传统的及大量多样的可再生能源(biofuels, Bio-CNG, H2, electricity 生物燃料,生物压缩液化气,氢气及电力)
  - including availability and upstream emissions
    包括可用性及上游排放

Technology database for passenger cars
客车技术数据库

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- Technology database is the result of技术数据库来自:
  - Several expert consultations 数个专家咨询(⇨German OEMs德国OEM)
  - Literature review专业资料阅审
- Documents efficiency improvement and related costs and material demand of conventional efficiency measures & alternative propulsion technologies
  记载能效提高及传统能效措施的相关成本和材料需求以及替代的驱动技术
- Different efficiency measures are combined, resulting in several technology packages that allow a specific efficiency improvement
  结合了不同的能效措施,产生了数个可带来有针对性能效提高的技术方案
- Assumption: technology costs decrease with increasing market penetration (learning curve)
  假设: 技术成本随着市场渗透(学习曲线)的增加而降低
- Costs of efficiency measures are basically derived from TNO 2006
  能效措施成本基本来自TNO2006

Maximum potential of efficiency technologies and related technology costs (Source: TNO 2006)
能效技术的最大潜力及相关技术成本(来源: TNO 2006)

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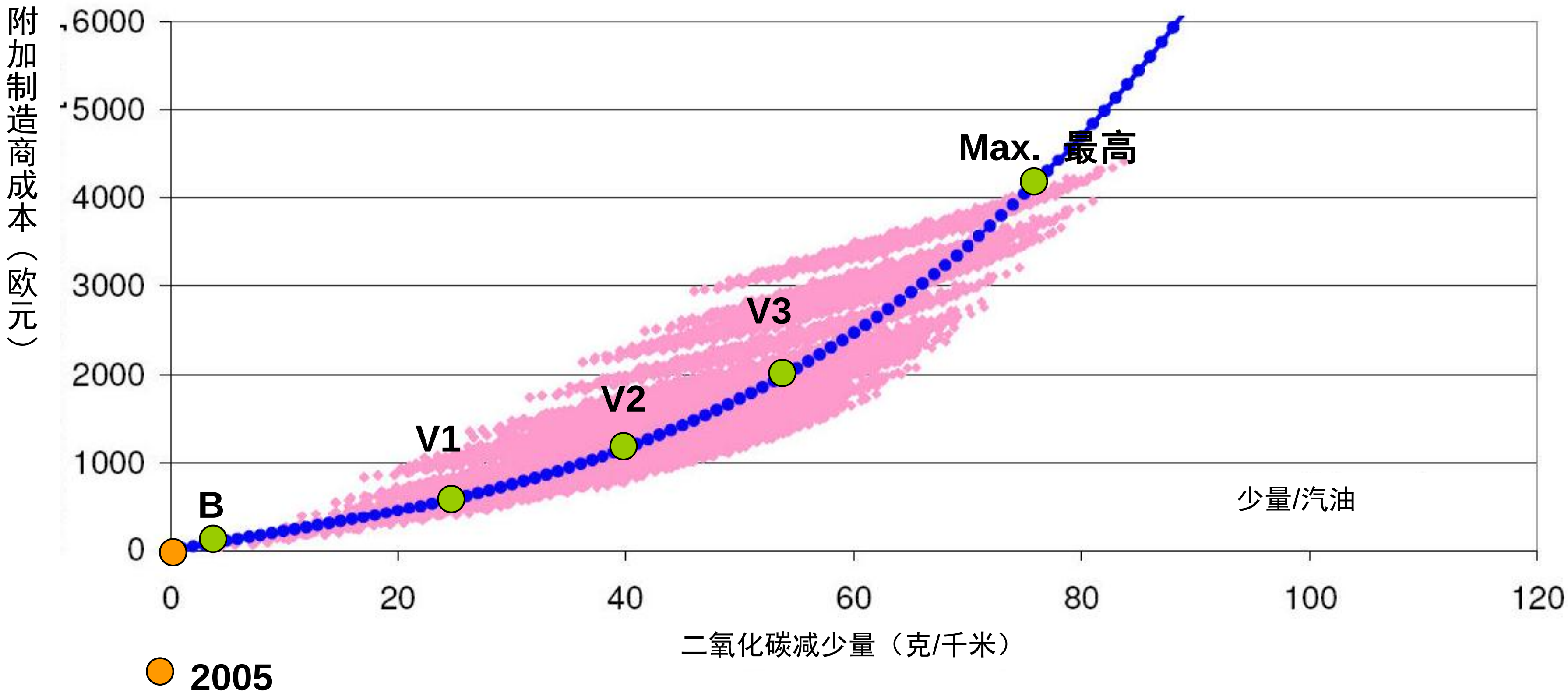

Scenario process前景进程

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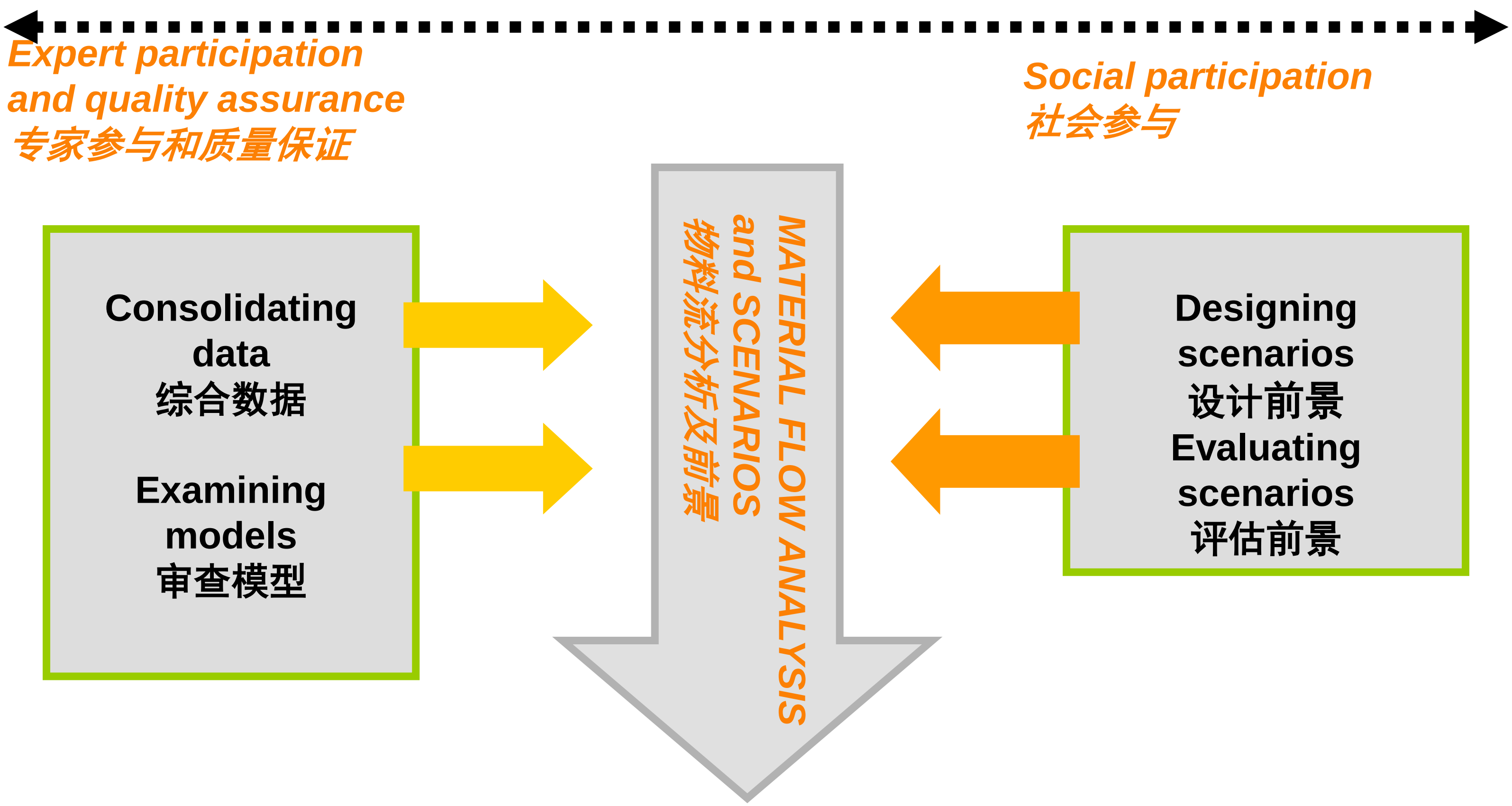
Participatory material flow analysis 参与式物料流分析

as a basis for discussion of sustainable mobility 作为可持续流动性的讨论基础



Stakeholders: Scenario group
股东:前景组

- ADAC e.V. – A major German automobile club 一家主要的德国汽车俱乐部
- BBE – Federal Association for Bioenergy 联邦生物能协会
- BEE – Federal Association for Renewable Energies 联邦再生能源协会
- Dachser GmbH & Co KG – A major German logistics company 一家主要的德国物流公司
- Deutsche Bahn AG – German rail company 德国铁路公司
- Deutsche BP AG – German branch of British Petroleum 英国石油公司德国分部
- Deutsche Post – German postal service + DHL 德国邮政服务和DHL
- E.ON AG – The leading German energy supplier 领先的德国能源供应商
- Shell Germany – German branch of major oil company 壳牌德国- 大型石油公司的德国分部
- VCD – An environmental NGO for transport 一个交通行业的非赢利性环保组织
- VDA – German Association of Automotive Industry 德国汽车工业协会
- VDV – Association of German Public Transport Companies 德国公共交通公司协会

Baseline scenario
基准前景

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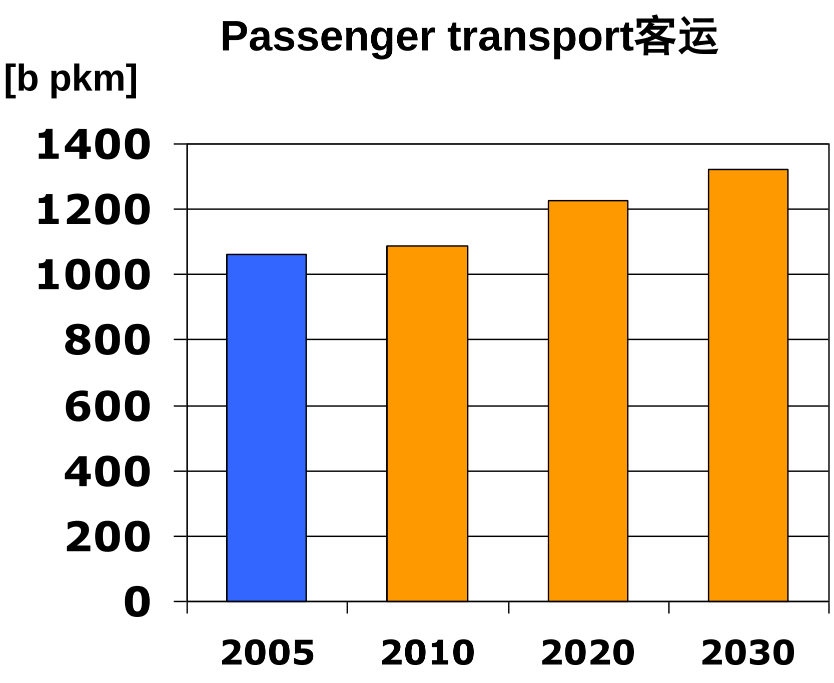
- Basis for comparing impacts of measures
  对比措施影响的基础= not a forecast不是预测

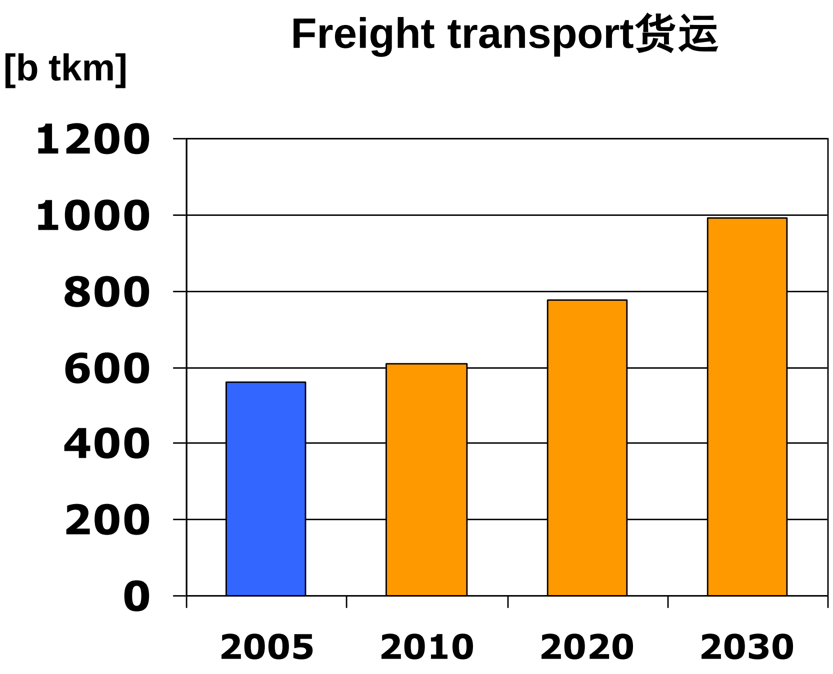
The basics基于:

- Transport section contains only (political) measures that reflect prevailing law (e.g. CO_2 emission standards for passenger cars)
  交通业只顾及反应现行法律的(政治)措施(例如:客车的二氧化碳排放标准)
- Transport demand: Transport forecast of the German Federal Ministry for Transport
  运输需求:德国联邦交通部的运输预测
  - Adaptation to new socio-economic forecast data适应于新的社会经济预测数据
  - Consideration of higher fuel efficiency of passenger cars考虑更高燃料能效的客车
- Energy demand (electricity, heat): “Leitstudie 2010” – Renewable Energy Scenario of the German Federal Ministry of the Environment
  能源需求(电能和热能): “Leitstudie 2010”- 德国联邦环境部的可再生能源前景
- Updates on trend development (economy, population, mobility budget)
  发展趋势更新(经济,人口及流动性预算)
- Fuel prices increase to 1.66 $€_{2010}$/l petrol and 1.53 $€_{2010}$/l diesel up to 2030
  2030年燃料价格预测为汽油1.66 €2010/升,柴油为1.53 €2010/升

Transport demand in baseline development in Germany 德国运输需求基准发展

- Parameters: income, population growth, costs and freight volume
- 参数：收入,人口增长,成本及运输量
- Passenger kilometres travelled increase by approx. 25% 客运里程增长约25%
- Freight kilometres travelled increase by approx. 75% 货运里程增长约75%





"Climate protection scenario"
"气候保护前景"

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- Structural framework data remains unchanged 结构框架数据保持未变
- In-depth **discussion in the scenario group** on model and scenario development
  对模型和前景开发的**前景组深入讨论**
- Objective: development of a consistent and feasible scenario with the aim of a considerable GHG-emission reduction in the transport sector
  目标: 在交通行业内开发出一套统一且可行的温室气体减排前景
- Result: Package of measures and assumptions on the development of framework conditions
  结果:框架条件开发的一揽子措施及假设

→ "Climate protection scenario"
"气候保护前景"

Main assumptions and measures of the “Climate protection scenario”
“气候保护前景”的主要假设及措施

Expansion of public transport service
公共交通服务的扩展

- Increase of ***operational performance*** by a maximum of ***25% 运营绩效最大提高25%***
- ***Shorter journey times*** through individual optimisation of service according to region type, e.g. higher frequency, extended hours of operation
  根据各地区情形各自优化服务，如更高的频率，延长运行时间，以实现**更短的旅行时间**
- Awareness of public transport service is increased
  公共交通服务认知度提高

Emission standards for new passenger cars
新客车排放标准

- ***95 g CO_2/km in 2020 & 60 g CO_2/km in 2030***
  2020年为95 g CO_2/km, 2030年为60 g CO_2/km
- segment shift compared to baseline development
  与基准发明相对比的行业转移
- Emission standards for new PCs are achieved on basis of efficient conventional vehicles and an increasing share of electric cars (approx. 6 million by 2030)
  新客车排放标准的实现以节能的传统汽车和电动汽车的份额增加为基础 (至2030年为约600万)

Emission standards for light commercial vehicles
轻型商业车辆排放标准

147 g CO_2/km in 2020 & 110 g CO_2/km in 2030
2020年为147 g CO_2/km, 2030年为110 g CO_2/km

Emission standards are achieved on basis of efficient conventional vehicles and an increasing share of electric vehicles
排放标准的实现以节能的传统汽车和电动汽车的份额增加为基础

Efficiency improvement of other modes of transport
其它运输模式的能效提高

Improvement of HDV :**15%** (2020), **30%** (2030), compared to 2005
HDV的提高： **15%** (2020), **30%** (2030)，相对于2005年

Improvement of bus & rail: **8%** (2020), **20%** (2030)
巴士及轨道车辆的提高： **8%** (2020), **20%** (2030)

Increases in fuel prices and mineral oil tax
燃料价格及矿物油税的增长

Fuel prices increase to **2.0 €$_{2010}$/l** (2020) and **2.5 €$_{2010}$/l** (2030) for petrol 汽油价格至2020年涨至**2.0 €$_{2010}$/升** (2020)，2030年涨至**2.5 €$_{2010}$/升** (2030)

Calculation of mineral oil tax considering GHG intensity and energy content of fuel ⇨ diesel price in 2030: **2.69 €$_{2010}$/l** 考虑到温室气体浓度及燃料中能量含量而计算出的矿物油税⇨2030年柴油价格为**2.69 €$_{2010}$/升**

Biofuels – quota and criteria 生物燃料- 份额及准则

- Quota as in baseline: **10%** 2020 and及 **20%** 2030
基准份额： **10%** 2020 及 **20%** 2030

- Additional: More ambitious social and environmental sustainability criteria – leads to a limited variety of biofuels being used
此外, 对社会及环境可持续性的准则要求更高- 导致可使用的生物燃料的多样性受到限制

Optimisation of logistics 物流优化

- Improved trip patterns
改进的物流行程模式

- Optimised vehicle load through improved transport logistics
通过改进的物流来优化车辆负载

- Further reduction of the “empty run” share
进一步降低”空载”率

- Using telematics systems in freight transport
货物运输中应用移动车载信息系统

Fuel-saving behaviour behind the wheel 车轮背后的省油行为

- Vouchers for fuel-saving training when buying a new vehicle
购买新车时的省油培训证书
- Broad use of gear shift indicators in vehicles
车辆中更多的档位提示
- Cheaper insurance premiums when participation in fuel-saving training can be proven
若有证明参与了省油培训,则可享受更低的保险费
- Implementation of corresponding directives for the public sector
公共部门推行相关指令

Telematics systems移动车载信息系统, I&C technologies I&C技术公司

- Use of telematics systems and I&C technologies leads to improved transport management
使用移动车载信息系统, I&C 公司提升了运输管理
- Dynamic navigation systems which take up-to-date traffic news into account = reduced congestion on German motorways and reduced fuel consumption
吸收最新交通信息的动态导航系统=德国高速公路上得到缓解的拥挤状况及更少的燃料消耗

German lorry toll 德国卡车过路费

- Lorry toll extended to all road types and all lorries with a total permitted weight of >3.5 tons
卡车过路费推广至所有路况,所有卡车允许的总重量>3.5吨

- Toll increase to **0.50 €$_{2010}$/km** in 2030
至2030年, 过路费增至**0.50 €$_{2010}$/km**

Promotion of intermodal freight transport 推动货物联运

- Public investment in the promotion of intermodal transport and financial support for railway sidings
公共投资以推动联运交通及为铁路专线给予财政支持

Mega trucks 超级卡车

- Increasing use of mega trucks (total length of 25 metres) in particular for transport of high-volume goods
增加使用超级卡车(总长25米)运输，特别是大体积货物

Increasing use of renewable energies in rail transport
轨道交通中增加使用可再生能源

- Share increases to 30% in 2020; additional energy demand after 2020 is provided by renewable energies
至2020年,该份额增至30%; 2020年后新增的能源需求来自可再生能源

Speed limit on motorways 高速公路车速限制

- Speed limit on motorways (120 km/h) reduces average fuel consumption
- 高速公路限速(120公里/小时)减少平均燃料消耗

Additional measures 其它措施

- Lower average speed of lorries on motorways
卡车在高速公路上更低的平均速度
- Abolishment of commuter lump sum 废止通勤车一次性补助
- Promotion of cycling 提倡自行车出行

Scenario assumptions & measures lead to demand reduction and modal shift
导致需求减少和模式转化的前景假设及措施

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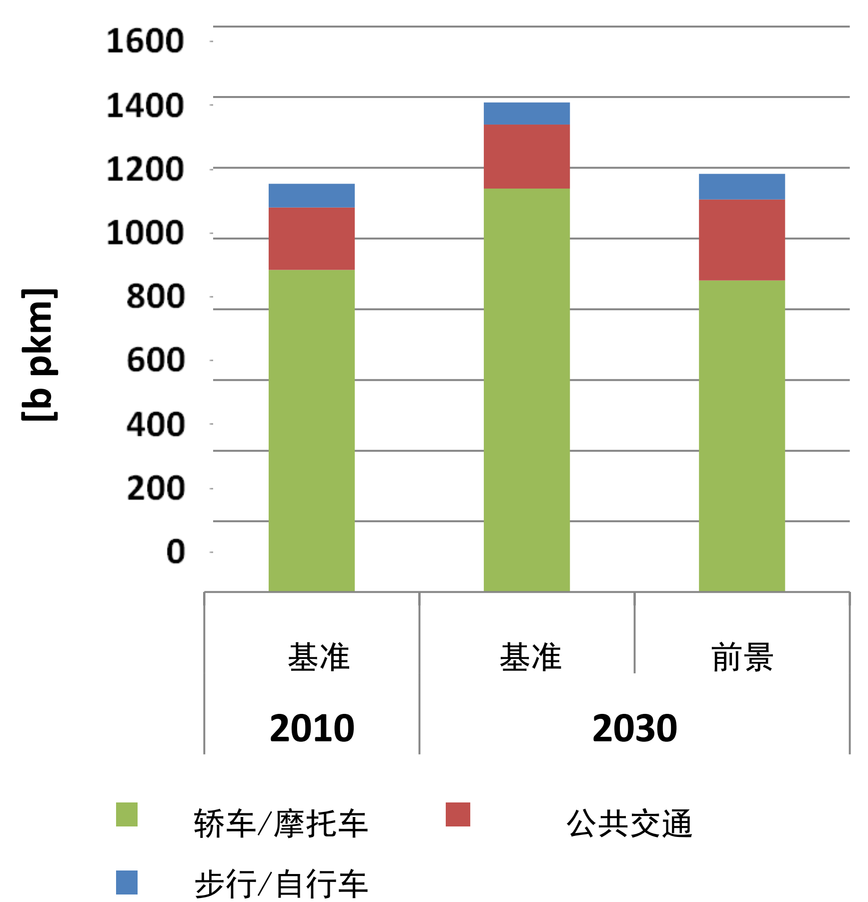
Passenger transport 客运

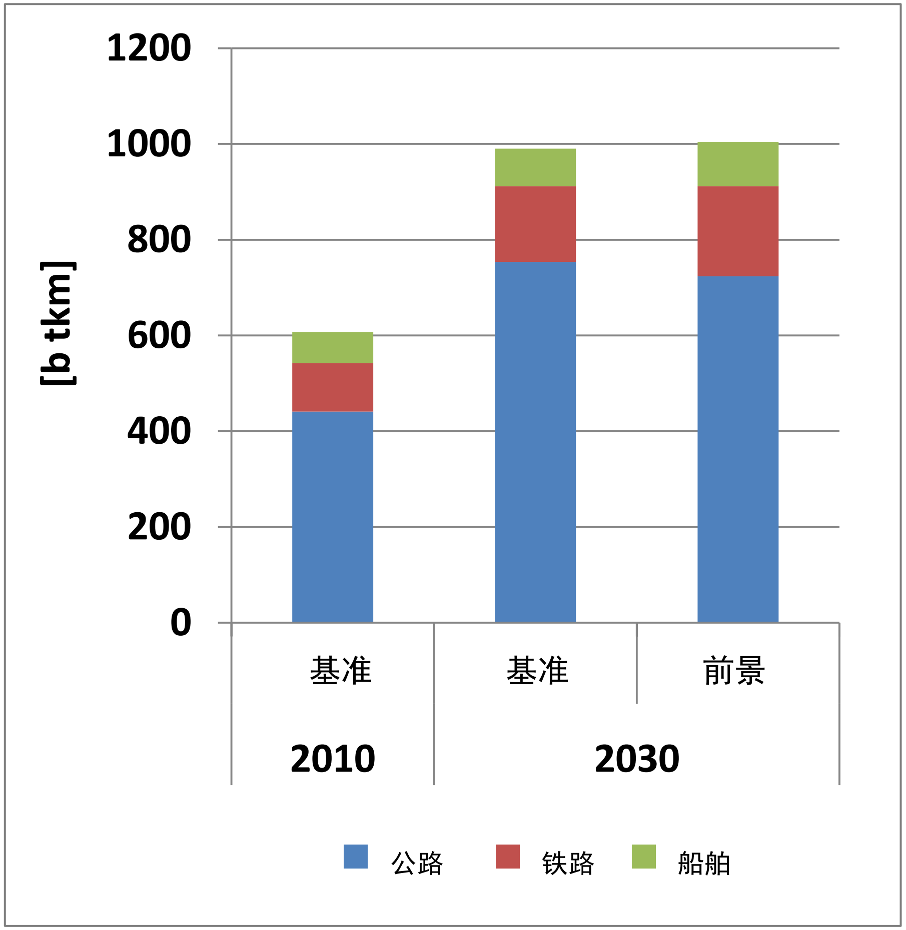


Compared to baseline 2030 与2030年基准相比:

- 15% reduction of passenger transport demand
  客运需求减少15%
- Reduction of car/motorcycle transport by 23%
  轿车/摩托车交通减少23%
- Increase of public transport by 26% and walk/cycle by 15%
  公共交通增加26%,步行/自行车出行增加15%

Scenario leads to decrease of road freight transport and modal shift
导致公路货运减少和模式转换的前景

Freight transport 货运



Compared to baseline 2030 与2030年基准相比:

- Increase of road freight transport is lowered by 4%
公路货物运输的增加降低4%
- Considerable shift from road to rail and ship
从公路转化为铁路和船舶的较大模式转化
- Increase of rail transport by 19%
铁路运输增加19%
- Increase of inland water transport by 18%
内陆水运增加18%

Energy consumption can be lowered by 31% in 2030 compared to 2005. Share of fossil fuels decreases and share of renewable energy increases
与2005年相比，2030年能源消耗降低31%。 化石燃料份额下降且可再生能源份额上升

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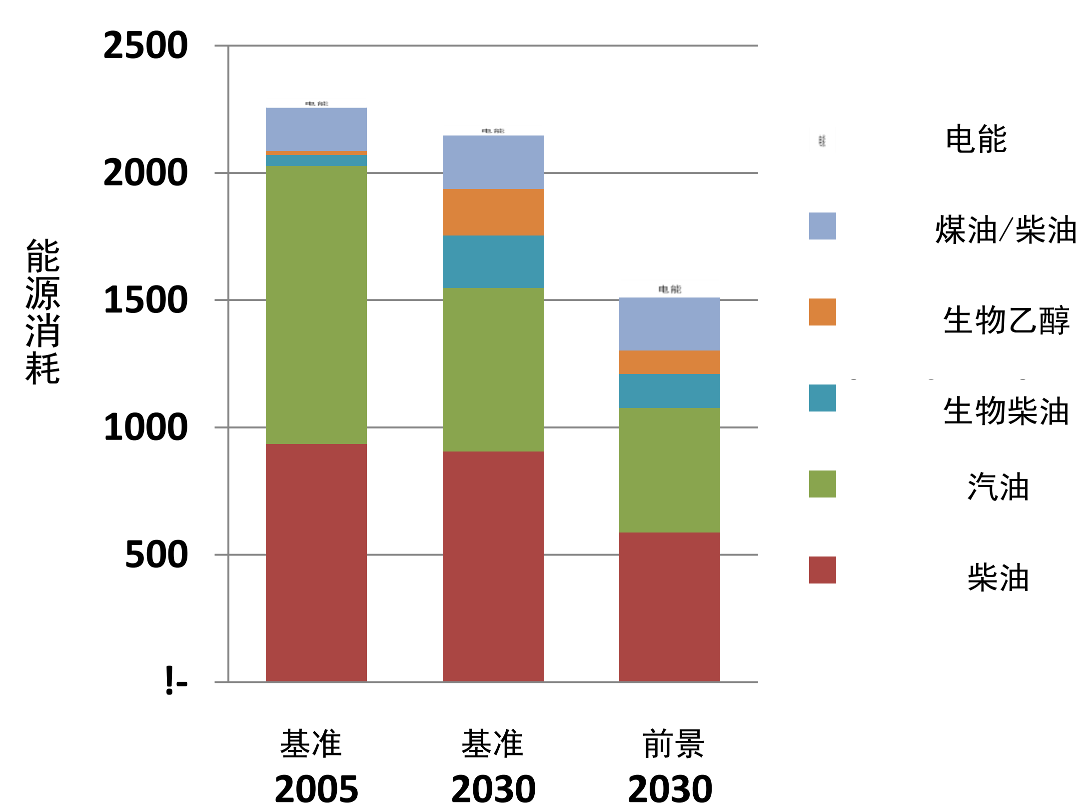
Energy consumption of the transport sector
交通业能源消耗



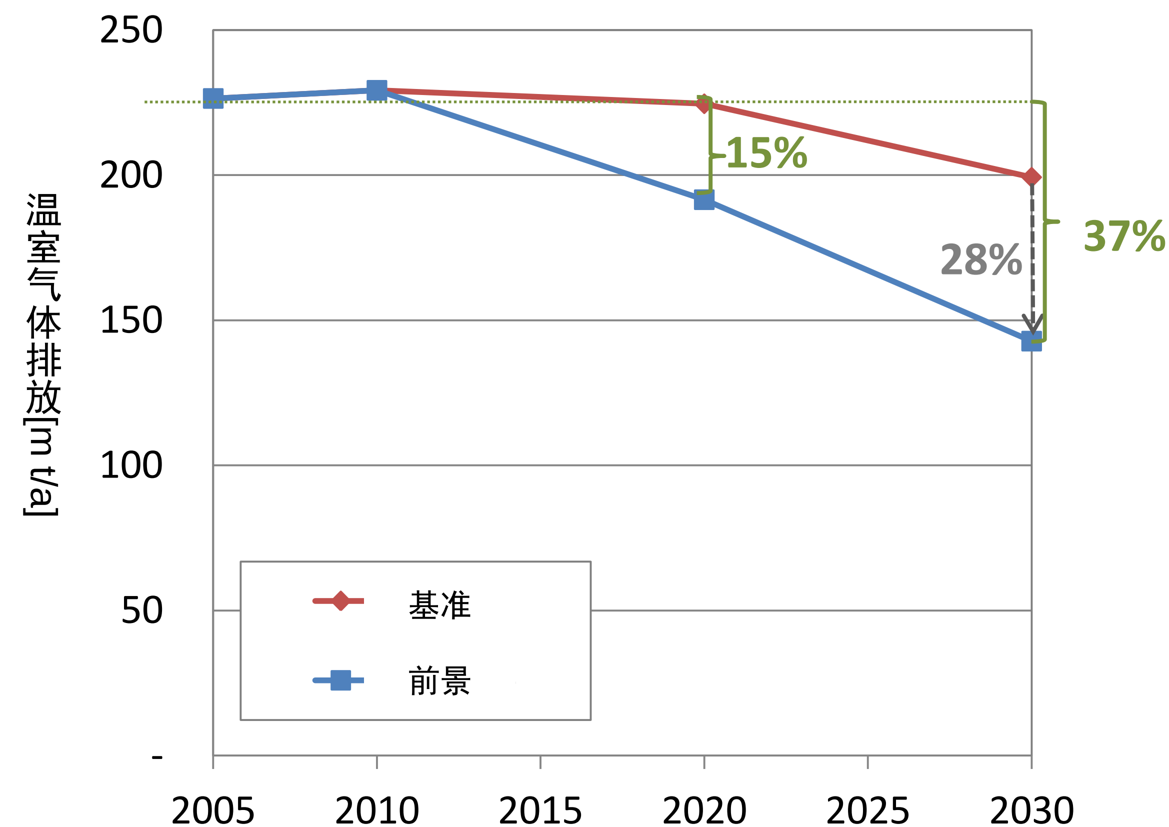
- Energy consumption 2030 is reduced by 28% compared to baseline and 31% lower than 2005
- 2030年的能源消耗比基准量减少28%,与2005年相比减少31%

- Share of fossil fuels decreases from 96% (2005) to 80% (2030)
- 化石燃料份额从96%(2005年)下降至80%(2030年)

- Share of biofuels increases from 3% (2005) to 15% (2030
- 生物燃料从3%(2005年)增加至15%(2030年)

Up to 2030 reductions in greenhouse gas emissions of 37% compared to 2005 are possible when all assumptions and measures are combined
与2005年相比，2030年的温室气体排放下降37%是可能的，前提是所有假设与措施相结合

GHG emissions of the transport sector
交通业温室气体排放



- Direct GHG emissions and upstream emissions from fuel and vehicle production are taken into account
  考虑到燃料及车辆生产的温室气体的直排及上游排放
- **Baseline scenario基准前景:** considerable reduction of GHG emissions – due to improved efficiency and increased share of biofuels
  由于能效的提高及生物燃料份额的提升而致温室气体排放发生较大下降
- **Climate protection scenario 气候保护前景:** 2005 to 2030 reduction of GHG emissions by 84 million tons (37%) is possible
  2005年至2030年,温室气体排放减少8,400万吨(37%)是可能的

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In freight transport a trend reversal can be achieved – GHG emissions can be reduced by 17% in 2030 compared to 2005
货物运输方面，逆趋势是可实现的 –与2005年相比，2030年的温室气体排放将减少17%

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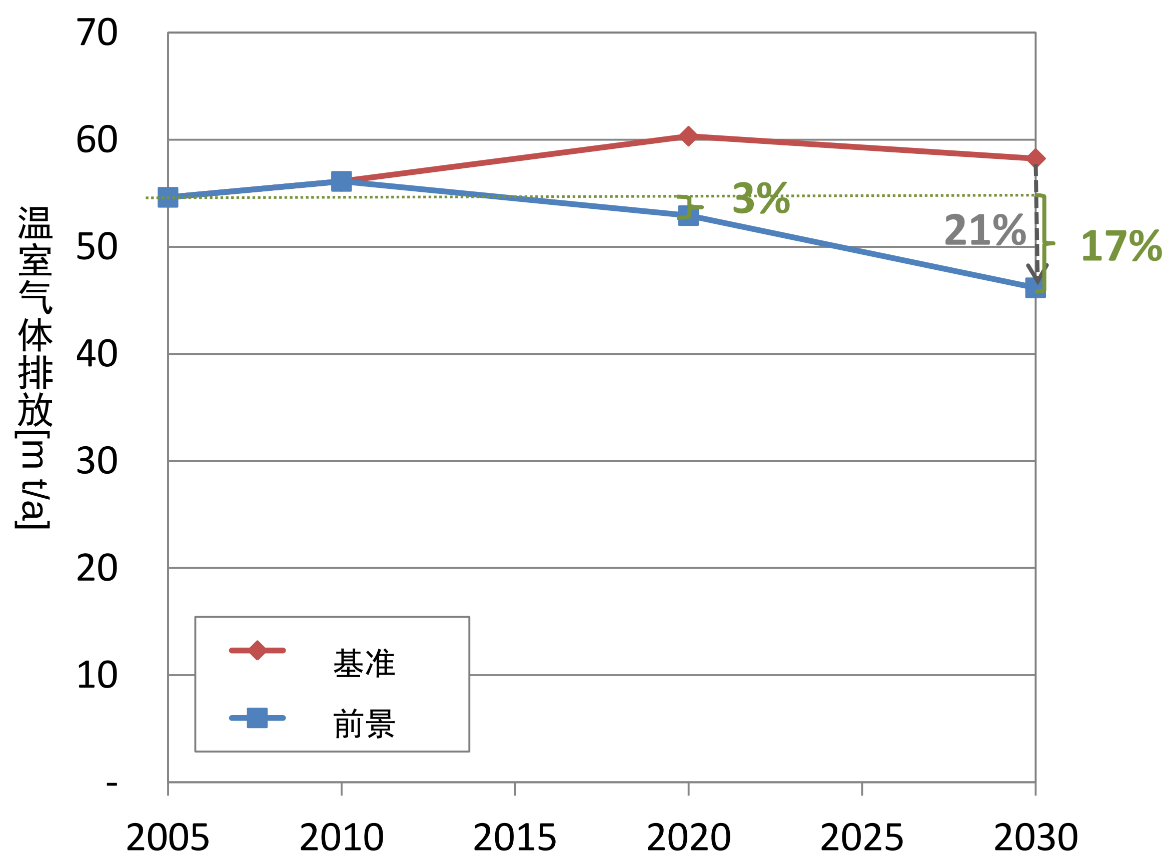
GHG emissions of freight transport
货物运输的温室气体排放



- **Baseline scenario 基准前景:** Despite strong increases in transport demand, GHG emissions increase by 4 million tons only
  尽管交通需求增长强劲，但温室气体排放只增加了400万吨

- **Climate protection scenario气候保护前景:** Significant decrease of 9 million tons (17%) is possible – due to higher transport and energy efficiency and lower GHG intensity of fuels
  由于更高的交通能源利用率及使用低浓度温室气体燃料，大幅下降达900万吨(17%)是可能的

In passenger transport a reduction of GHG emissions of 44% by 2030 compared to 2005 is achievable

与2005年相比，2030年客运的温室气体排放将减少44%

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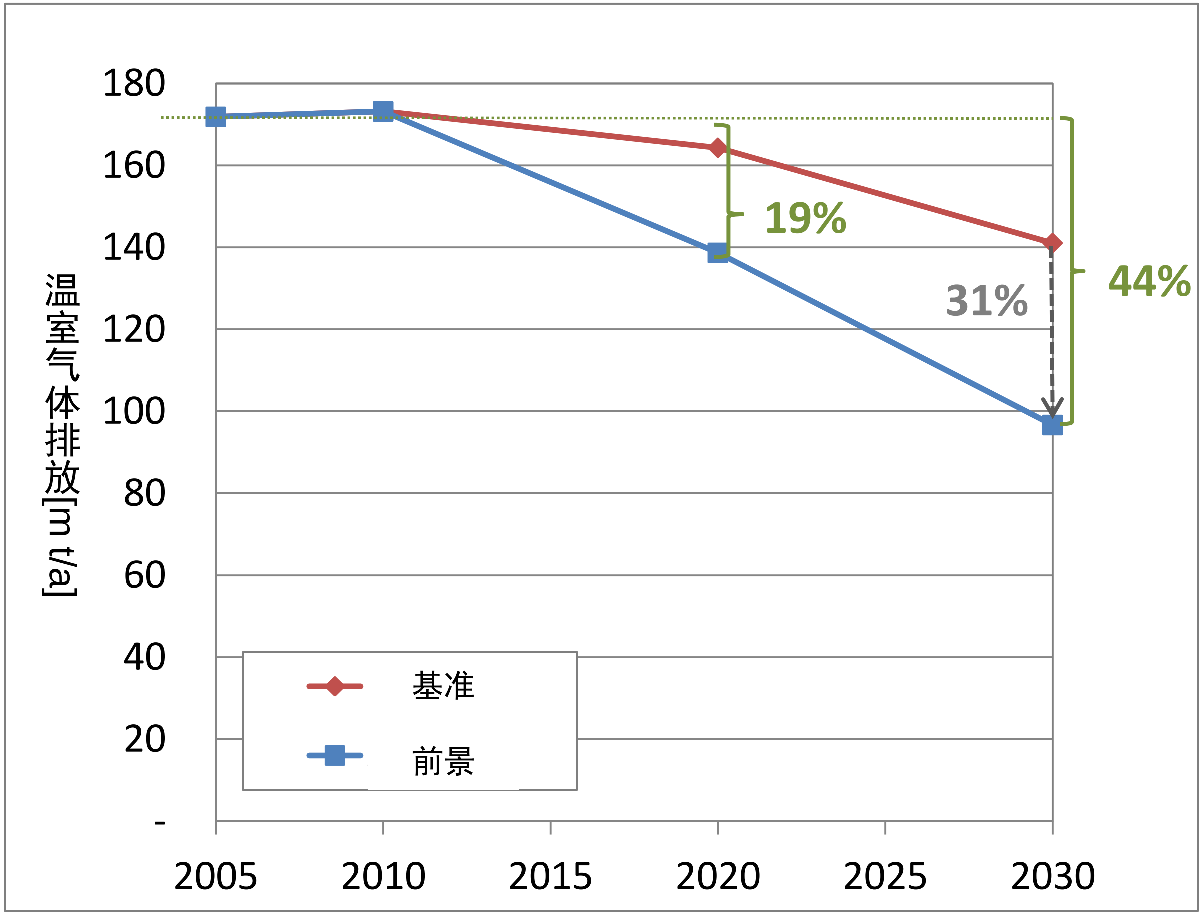
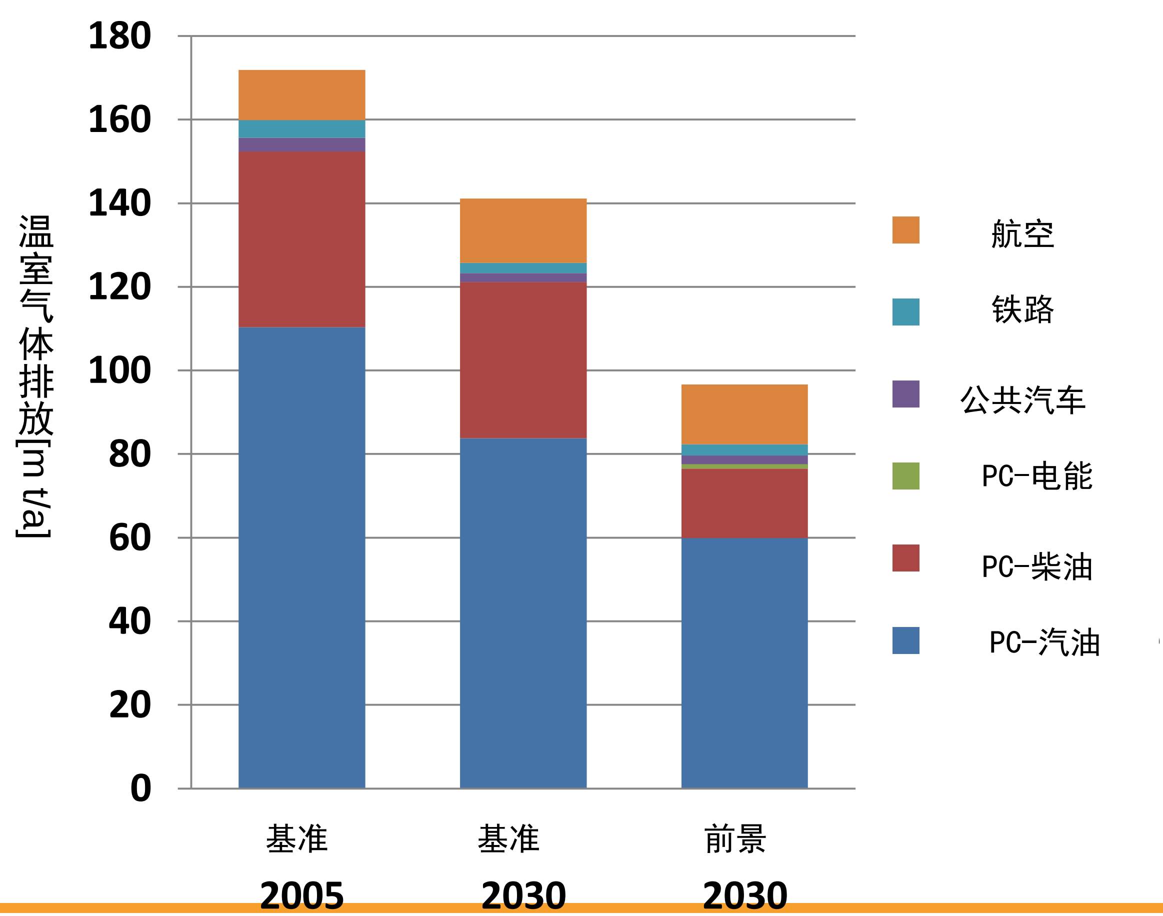
GHG emissions of passenger transport
客运的温室气体排放



- **Baseline scenario基准前景:** GHG emissions reduced by 30 million tons by 2030 – in spite of increasing mileage due to improved efficiency and increased share of biofuels 尽管由于能效提高及生物燃料份额增加而致里程增加，温室气体排放到2030年将减少3,000万吨
- **Climate protection scenario气候保护前景:** Significantly higher reduction potentials (75 million tons): Emissions can be reduced by 44 % compared to 2005 – due to demand reduction, more energy efficient vehicles, biofuels and modal shift
- 更大幅的排放降低潜力(7,500万吨)：由于需求减少、更高能效车辆的使用、生物燃料及出行模式转换，与2005年相比排放可降低44%。

Passenger transport: GHG emissions of cars remain dominant, but its share decreases while aviation has the largest growth rate
客运: 轿车的温室气体排放仍占主导，但其份额随着航空运输的空前增长而下降

GHG emissions by mode and fuel
不同交通模式及燃料的温室气体排放



Baseline scenario基准前景:
GHG emission of passenger cars are reduced by 31 million tons (20%) – its share is reduced from nearly 90% to about 85%.
客车温室气体排放减少3,100万吨(20%)，其份额从近90%降至约85%。

Climate protection scenario 气候保护前景:
GHG emissions of passenger cars are reduced by 50% compared to 2005 – its share decreases to 80% while the share of aviation increases the most: from 7% (2005) to 14% (2030)与2005年相比，客车的温室气体排放下降50%，其份额下降至80%,而航空运输却空前增长，份额从7%(2005年)增长至14%(2030年)。

The use of sustainable biofuels and renewable energy for electric vehicles reduces GHG emissions by 26 million tons in 2030
可持续生物燃料及电动车辆的可再生能源使用将在2030年使温室气体排放下降2,600万吨

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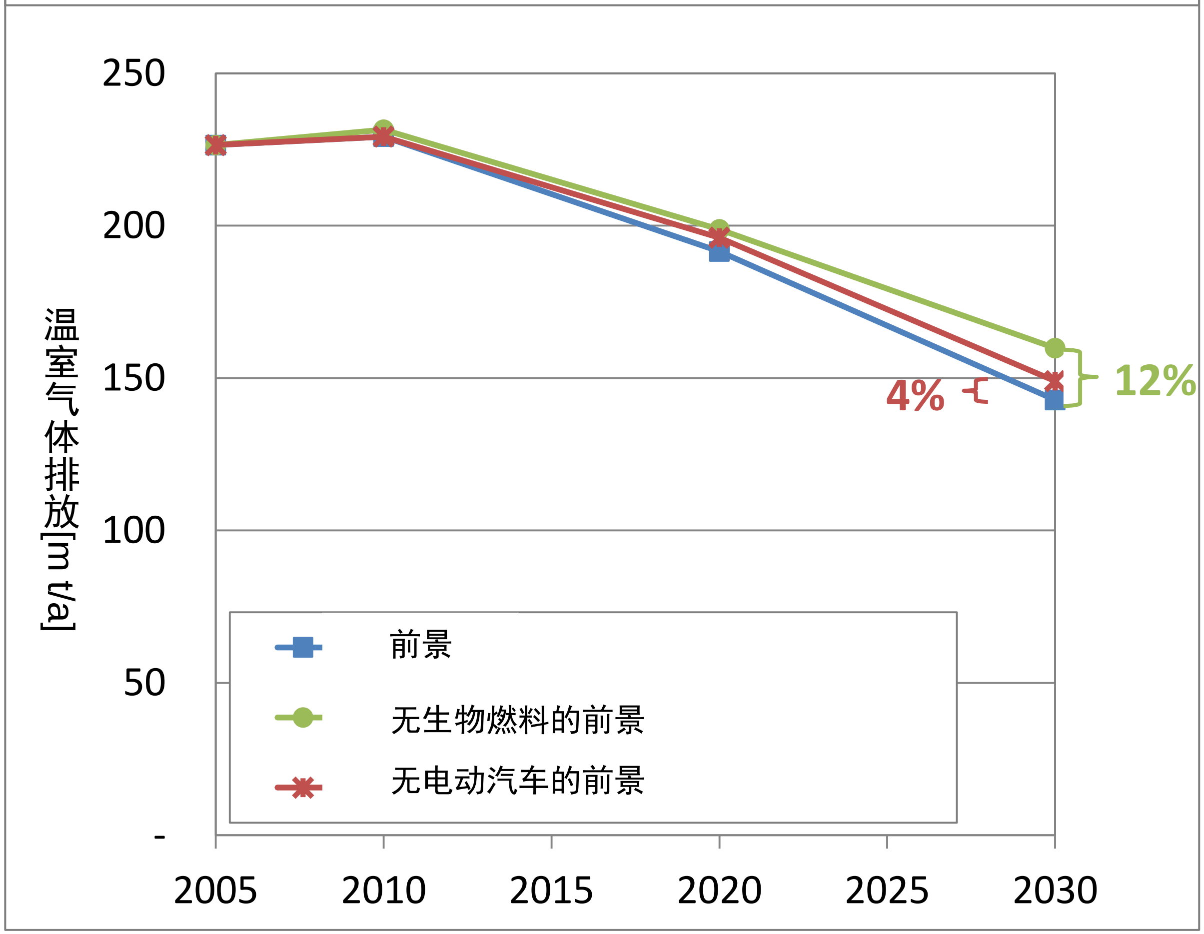
Impact of biofuels and electric vehicles
生物燃料及电动车辆的影响



- **Climate protection scenario气候保护前景:**
- 6 million BEVs and PHEVs with electricity from renewable energies reduce GHG emissions in 2030 by 6 million tons (4%)
- 600万BEV及PHEV使用再生能源的电动车辆将在2030年使得温室气体排放减少600万吨(4%)。
- The use of sustainable biofuels increases by a factor 4 compared to 2005 and leads to an additional GHG emission reduction of 18 million tons (12%).
与2005年相比，可持续生物燃料将增长4倍,使温室气体排放减少1,800万吨(12%)。

GHG mitigation measures with highest impact in Renewbility-scenarios
对可再生前景具最大影响的温室气体排放减缓措施

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GHG Mitigation Measure / Assumption 温室气体排放减缓措施/假设	Passenger transport 客运	Freight transport 货运
Fuel economy improvement (standards) 燃料经济性提高(标准)	XX	XX
Increase in fuel prices 燃料价格增长	XX	X
Expansion of public transport service 公共交通服务扩展	XX	
Promotion of intermodal freight transport 货物联运推广		XX
Use of sustainable biofuels 可持续的生物燃料使用	XX	XX
Renewable electricity production 可再生的电力生产	XX	X

Summary总结

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- The “Climate protection scenario” was developed by stakeholders in the form of a package of measures and assumptions on development of framework conditions.
  股东方开发的“气候保护前景”以框架条件开发的一系列措施和假设方式进行。
- Key results are
  关键结论为:
  - GHG emissions can be reduced by 37% by 2030 compared to 2005 – despite a further increase of transport demand.
    与2005年相比，温室气体排放可在2030年减少37%，尽管运输需求进一步增加。
  - Dynamics in passenger and freight transport are very different: GHG emission reduction in passenger transport is much higher (44%) than in freight transport (15%) by 2030.
    客运与货运的动态特征差别非常大： 至 2030 年客运的温室气体减排比货运的(15%)高许多(44%)。
  - Total energy demand in transport sector is reduced by 31% up to 2030 and share of renewable energies used in transport sector increases from 4% to 19%.
    至2030年,交通业总的能源需求减少31%，可再生能源在交通业的份额从4%增至19%。
  - The “Climate protection scenario” shows a large potential for emission reduction in the transport sector, but the underlying assumptions and measures are far more ambitious than current regulation in the transport sector.
    “气候保护前景”显示交通业的减排潜力巨大，但当前的交通业政策规定远跟不上其假设前提与建议的措施。

Thank you for your attention!
谢谢您的关注!

Florian Hacker

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