

重塑能源：中国



REINVENTING FIRE: CHINA



ENERGY FOUNDATION CHINA
TRANSPORTATION FORUM

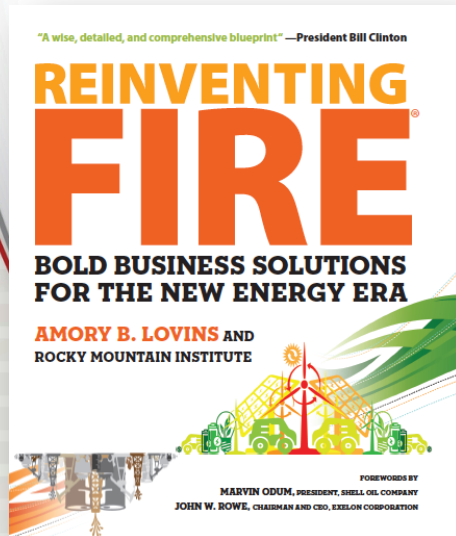
14TH NOVEMBER, 2013

能源基金会 中国

交通论坛

2013年11月14日

REINVENTING FIRE MAPS A PATH TO A CLEAN ENERGY FUTURE 重塑能源描绘清洁能源未来



Roadmap to a U.S. energy transformation

一张美国能源变革的路线图

- No oil, coal, nuclear 实现石油、煤炭、核能零消耗
- Cheaper than business-as-usual (\$5 trillion savings)
相比基准情景节约5万亿美元
- Transition led by business for profit 以商业界营利驱动变革
- Includes 2.6-fold bigger economy by 2050
可满足2050年时2.6倍的经济体总量的能源需求
- Uses existing technologies 完全基于当前技术水平

Clear, open-source analytics support all conclusions

基于清晰而开源的分析得出结论

- Addresses 4 energy-related sectors: buildings, transportation, industry, and power
关注四大能源消费领域：建筑、交通、工业和电力
- Integrated economic and technology analysis
深度整合经济与技术分析
- Practical case examples illustrating ways to achieve results
以真实案例佐证可行途径



OUR TWO-STEP ANALYSIS APPROACH

分析框架包括两大步骤



Use integrative design
to minimize new
system capital needs

使用整体设计思路将新
系统资本需求最小化

- 1. Maximize capture of cost-effective energy efficiency**
最大化利用经济上可行的能效提升机会

- 2. Maximize deployment of economic renewables to meet remaining demand**
最大化使用经济上可行的可再生能源满足剩余需求

Capture system
feedbacks across
sectors

关注行业部门间的系统
性反馈



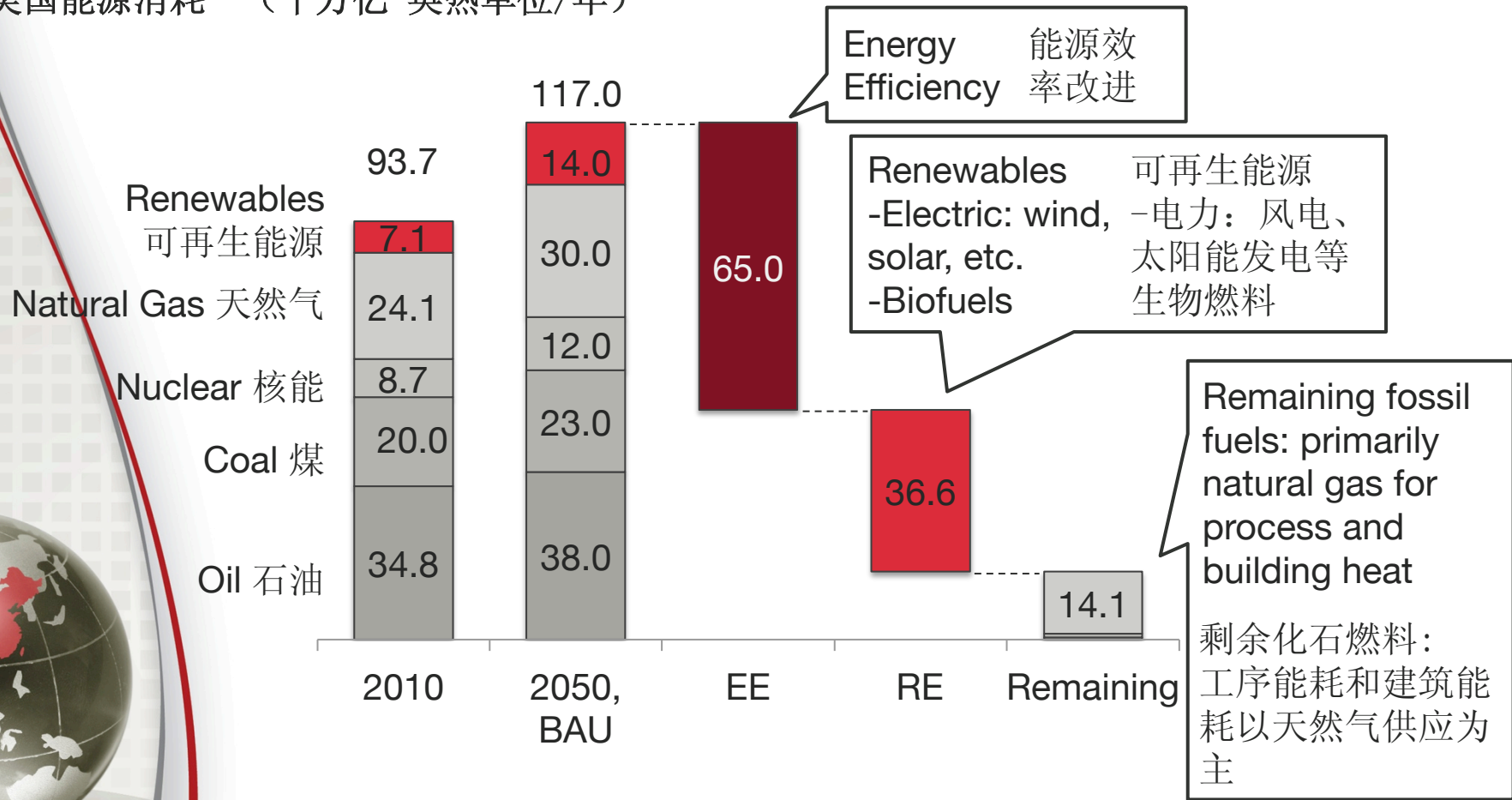
OUR APPROACH BEGINS WITH ENERGY EFFICIENCY, THEN ADDS RENEWABLES

分析框架：能源效率为先，可再生能源次之



U.S. Energy Consumption (quadrillion BTU/y)

美国能源消耗 (千万亿 英热单位/年)



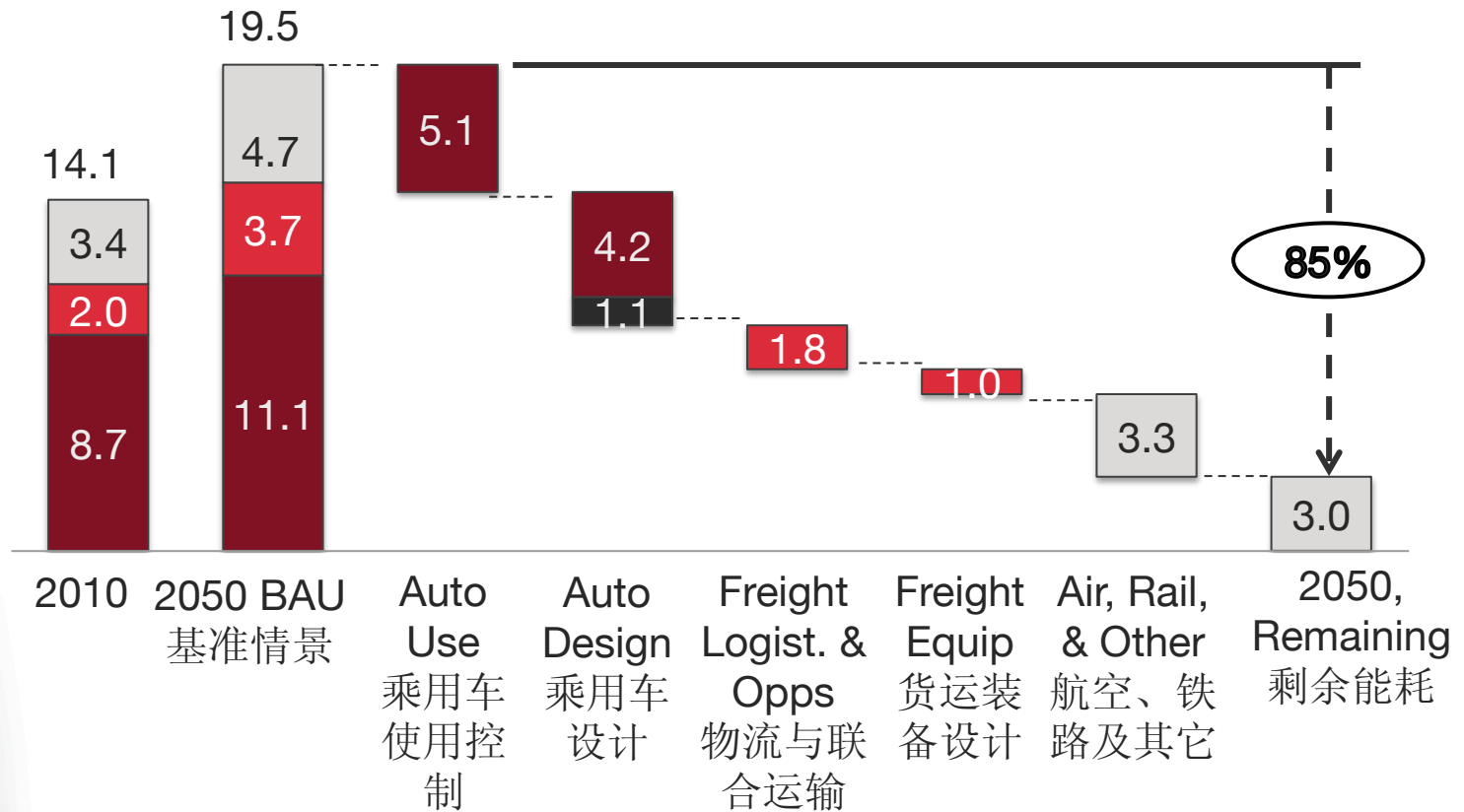
TRANSPORTATION OIL CONSUMPTION IS DRAMATICALLY REDUCED



重塑能源方案大幅降低了交通能耗

U.S. Transportation Sector Fuel Savings (million bbl per day)

美国交通部门石油消耗(百万桶/天)

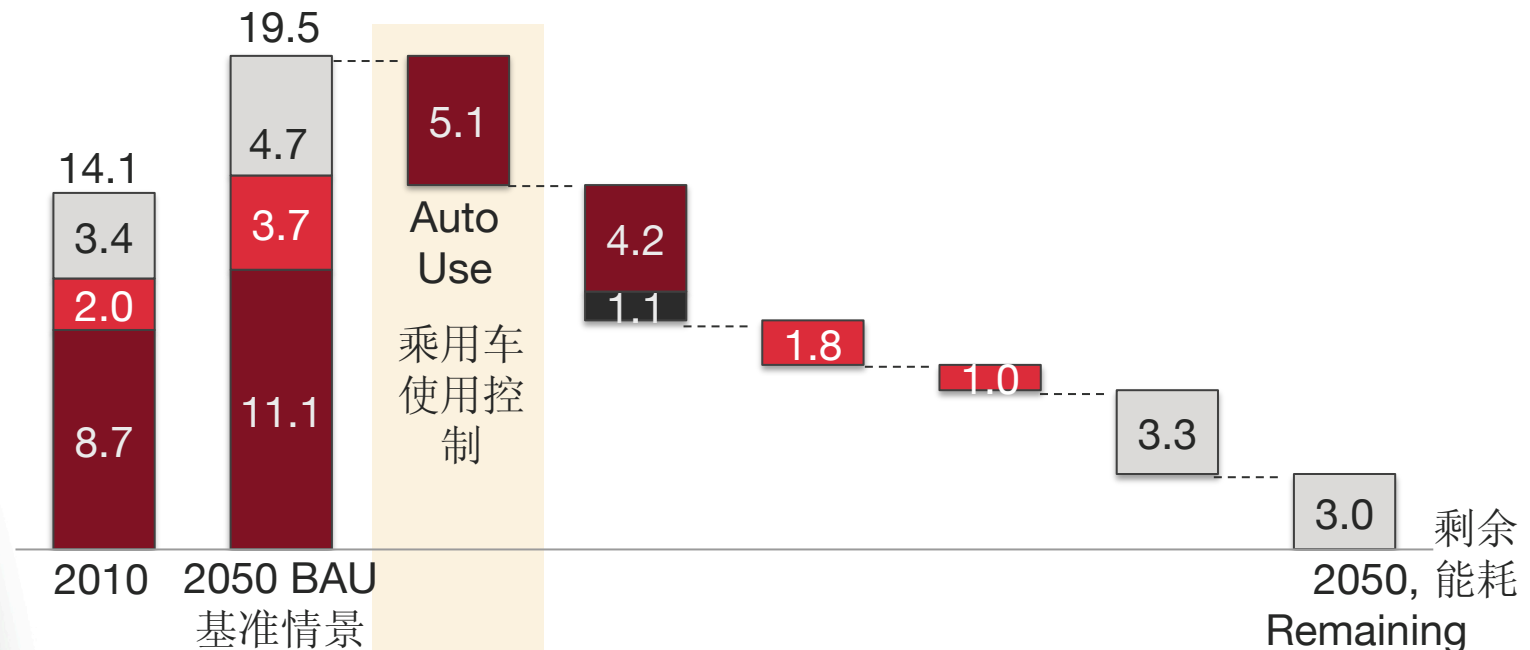


MORE PRODUCTIVE USE REDUCES DRIVING DEMAND

更有效率的出行降低了驾驶需求和通勤能耗

U.S. Transportation Sector Fuel Savings (million bbl per day)

美国交通部门石油消耗(百万桶/天)



More productive use includes

- Smart growth
- Alternative and multimodal commuting
- Pricing signals
- Intelligent transportation systems

更为高效的乘用车使用方式:

- 精明增长
- 替代交通与多式联运
- 价格信号与定价激励
- 智能交通系统

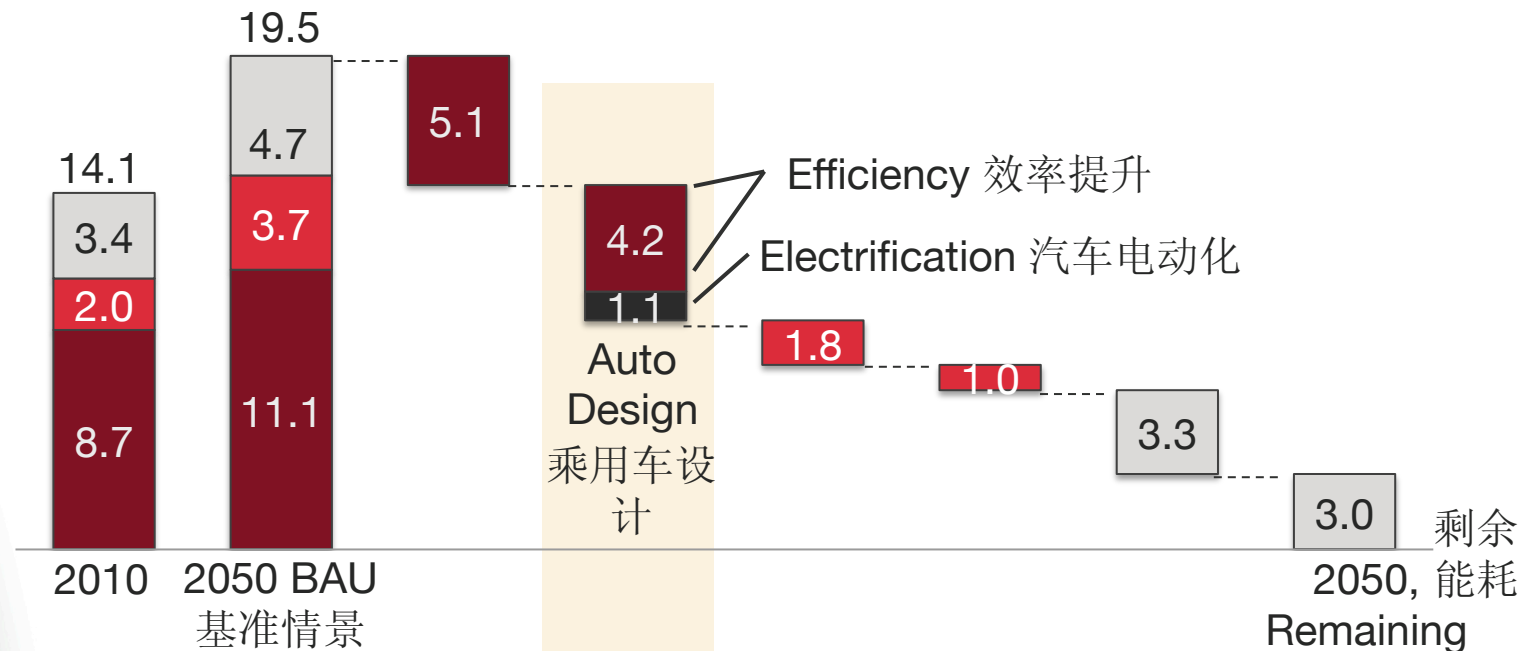


TECHNOLOGY REDUCES REMAINING AUTO OIL CONSUMPTION

技术改进进一步降低了乘用车的剩余能耗

U.S. Transportation Sector Fuel Savings (million bbl per day)

美国交通部门石油消耗(百万桶/天)



- Aerodynamics, low rolling resistance, reduce weight
- Powertrain efficiency
- Electrify
- Transformative weight reduction through carbon fiber and integrative design

- 空气动力学, 低阻轮胎, 车辆减重
- 动力系统效率
- 电动化
- 通过碳纤维材料和整体设计实现减重



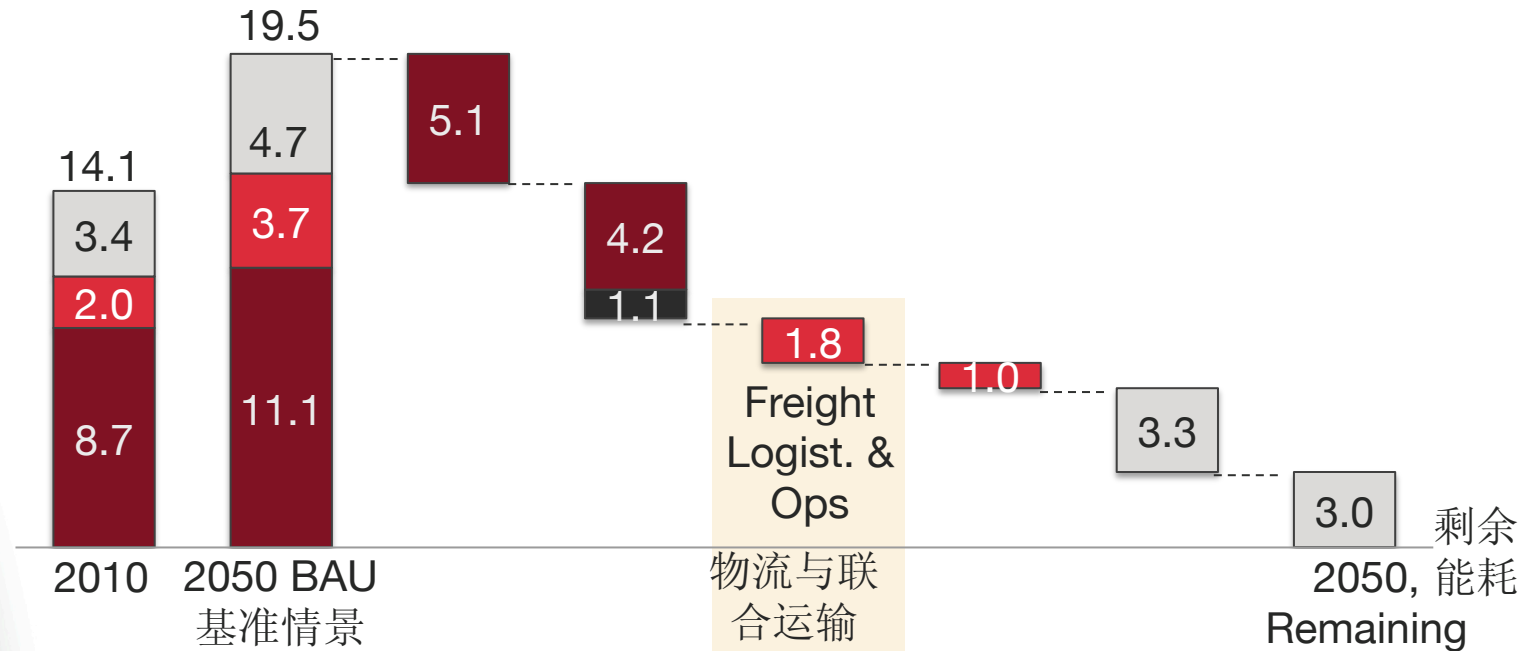
OPERATIONAL IMPROVEMENTS REDUCE ROAD FREIGHT DEMAND

物流运输改进降低了道路运输需求



U.S. Transportation Sector Fuel Savings (million bbl per day)

美国交通部门石油消耗(百万桶/天)



- Load and route optimization
- Intermodal
- Double trailers
- Software and driver behavior

- 货运负载与路线最优化
- 多式联运
- 双节挂车
- 软件辅助与驾驶习惯

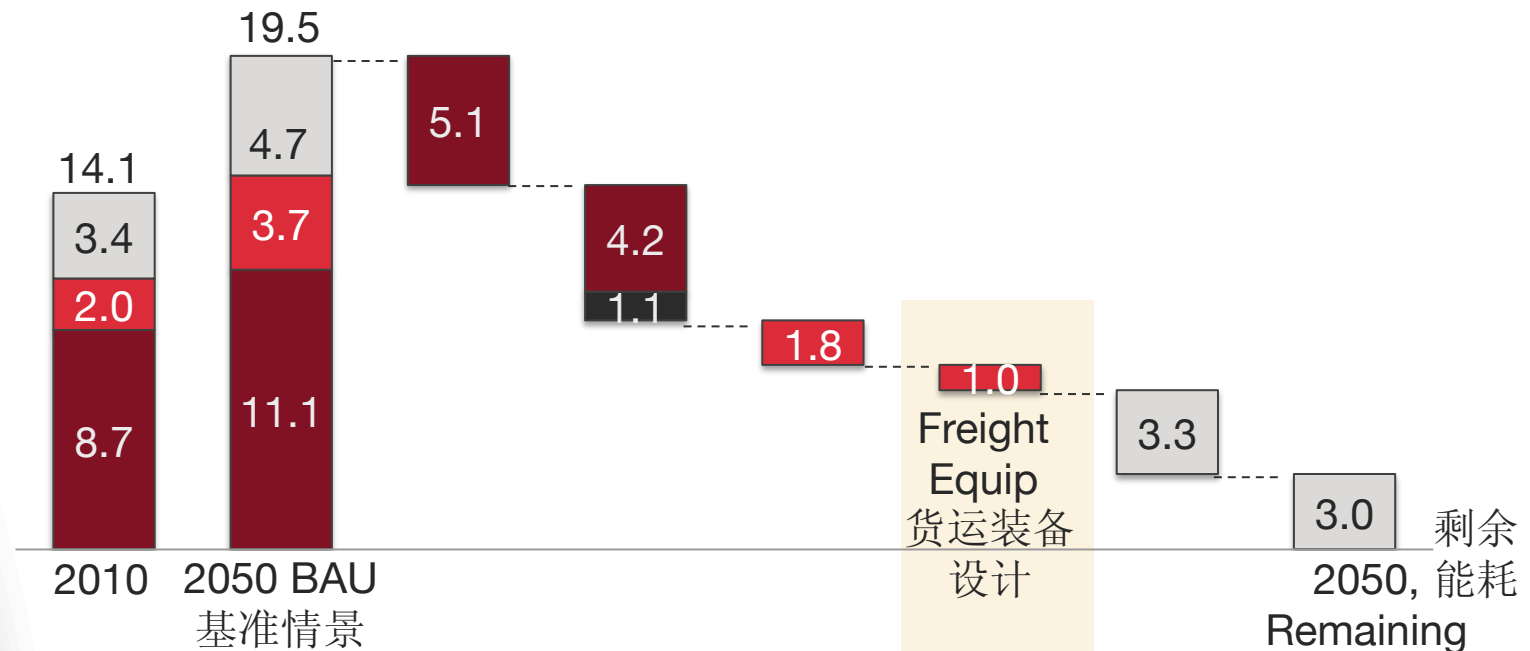


EFFICIENT EQUIPMENT REDUCES REMAINING ROAD FREIGHT DEMAND

高效的货运装备进一步降低道路运输需求

U.S. Transportation Sector Fuel Savings (million bbl per day)

美国交通部门石油消耗(百万桶/天)



- Aerodynamics, low rolling resistance, weight reduction
- Powertrain improvements
- Increase usable volume
- Aux. power units

- 空气动力学, 低阻轮胎, 车辆减重
- 动力系统性能提升
- 可用运输空间增加
- 辅助动力系统

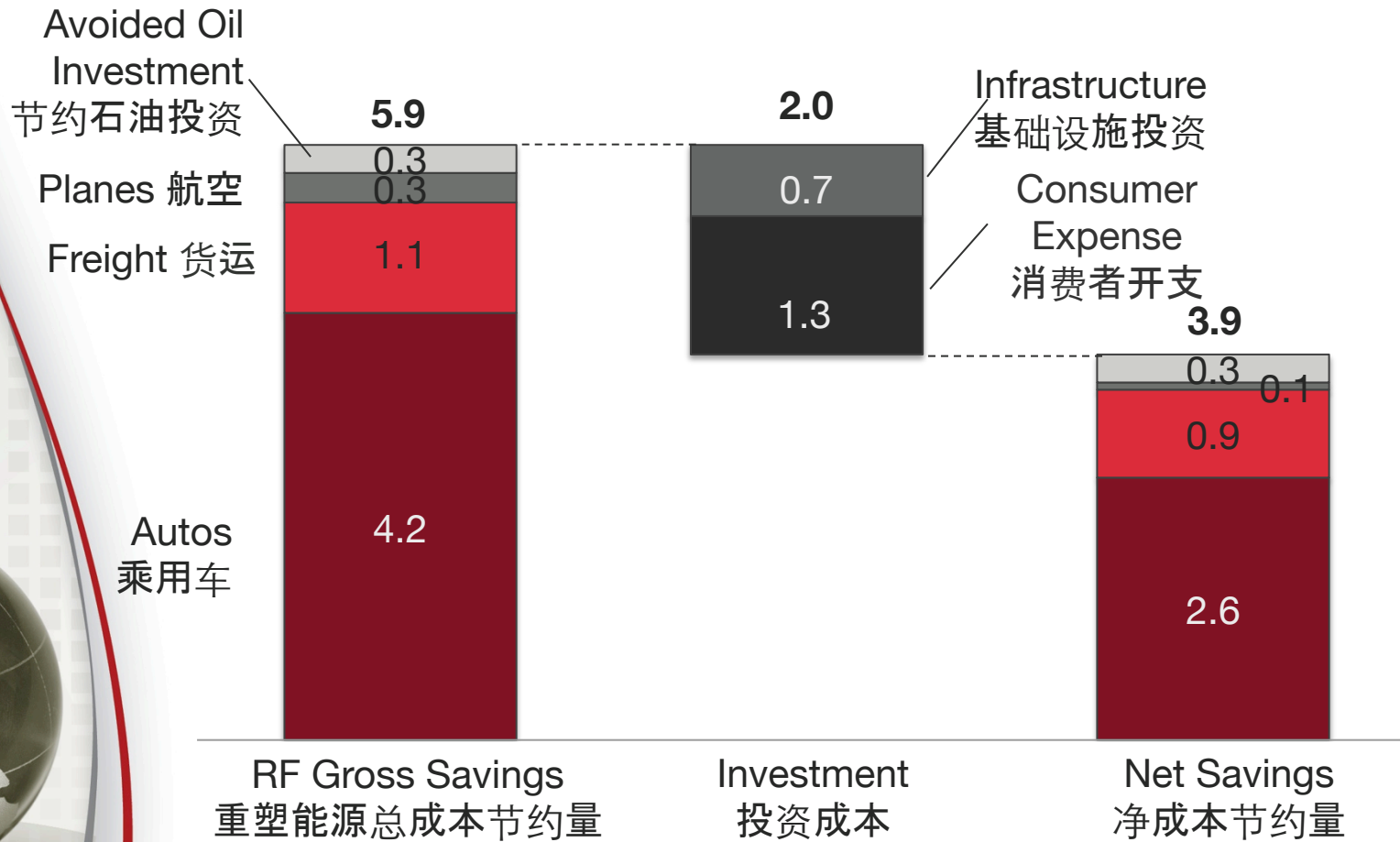


SAVING OIL SAVES MONEY

节约能源就是节约金钱



Value of U.S. Transportation Sector Savings, 2010–2050 (\$ Trillions)
美国交通部门成本节约量, 2010-2050



REINVENTING FIRE: CHINA HAS AMBITIOUS GOALS



“重塑能源：中国”项目拥有远大的目标

5 objectives 五大目标：

- 1** Model economic path for China to meet its energy needs using the **maximum share of efficiency and clean energy** through 2050
为中国探索一条以最大限度提升能源效率和推广清洁能源来满足能源需求的目标2050年的经济发展路径
- 2** Document **global best practices** for widespread application in China
汇总可供中国推广的全球最佳实践案例
- 3** Provide **policy recommendations** for the central government to achieve the shared clean energy vision 为中央政府提供实现清洁能源共同目标的政策建议
- 4** Engage government, industry, and other thought leaders to **accelerate action** 集聚政府，企业及各方专家合力推动实践进程
- 5** **Create capacity within China's government** for ongoing pursuit of this vision 为中国政府提供实现远景的不竭动力



A DISTINCTIVE TEAM IS UNITED TO EXECUTE

拥有多方合作的卓越团队



5 objectives五大目标 | 4 partners四方合作



Unprecedented
Pan-Pacific
collaboration
前所未有的泛太
平洋合作



China
Energy
Group



ENERGY FOUNDATION
building a new energy future



THE SCOPE WILL TAKE 2 YEARS TO COMPLETE 将历时两年完成



5 objectives五大目标 | 4 partners四方合作 | **2 years**历时两年

June 2013
2014年6月

Initiative Launch
项目启动
(Beijing 北京)



May 2014
2014年5月

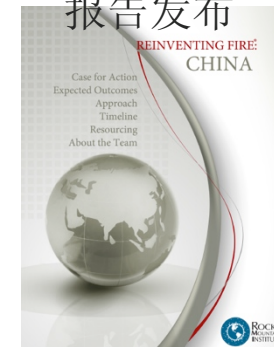
Mid-term review
中期评审

CHINA'S
5-YEAR PLANS



April 2015
2015年4月

Public report
Release
报告发布



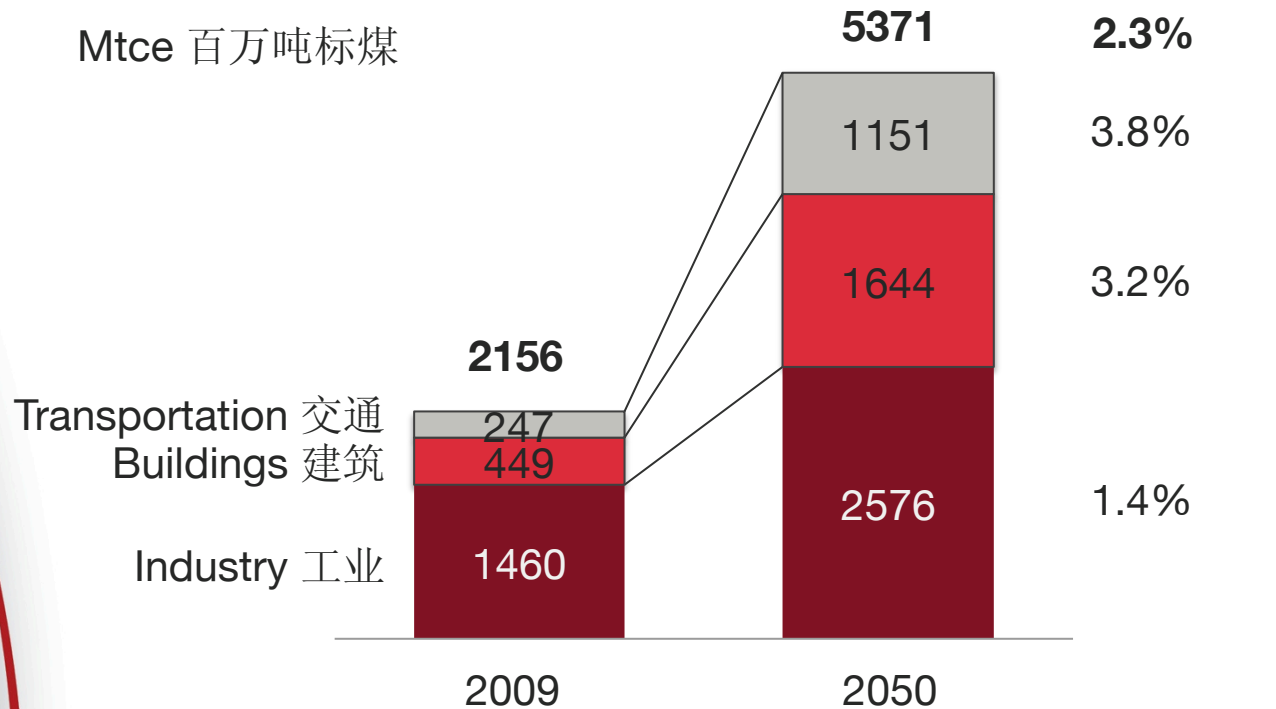
CHINESE ENERGY DEMAND IS EXPECTED TO GROW RAPIDLY

中国未来的能源需求将会迅速增长



Projected increase in energy demand 预测的能源需求增长

Mtce 百万吨标煤



CHINA HAS UNIQUE OPPORTUNITIES TO REINVENT MOBILITY

中国拥有独一无二的重塑交通方式的机会



Urbanization and rapid infrastructure build out
城镇化和高速的基础设施建设

Build right the first time to capture system benefits
确保从启动阶段就逐步激发系统性政策红利

Growing auto industry
高速成长的汽车业

Capitalize to produce "vehicles of the future"
通过资本运作推动“未来汽车”生产

Strong role of government
强有力的政府

Align market rules to strategic goals
协调市场规则与战略目标



EARLY RESEARCH HAS FOCUSED ON VEHICLE EFFICIENCY OPPORTUNITIES

早期研究主要关注机动车的能效提升机会

Three focus areas: 三大关注点:



Passenger autos
乘用车



Light duty trucks
轻型卡车



Heavy duty trucks
重型卡车

Reduce frictional losses 减少摩擦损失

- Start with aerodynamics, low rolling resistance tires, and low cost weight reduction
从空气动力学设计、低阻轮胎和低成本轻量化改造入手
- Improve conventional powertrain
提升传统动力系统性能

Substitute drivetrain technology 运用最新传动技术

- Add-on hybrid/battery electric where cost effective
以经济可行性为参考逐步引入混合动力和纯电动系统



FIVE PACKAGES ARE USED TO ANALYZE INCREASINGLY EFFICIENT AUTOS

分析五种技术组合对乘用车能效的提升作用



Increasing efficiency, cost
效率, 成本递增

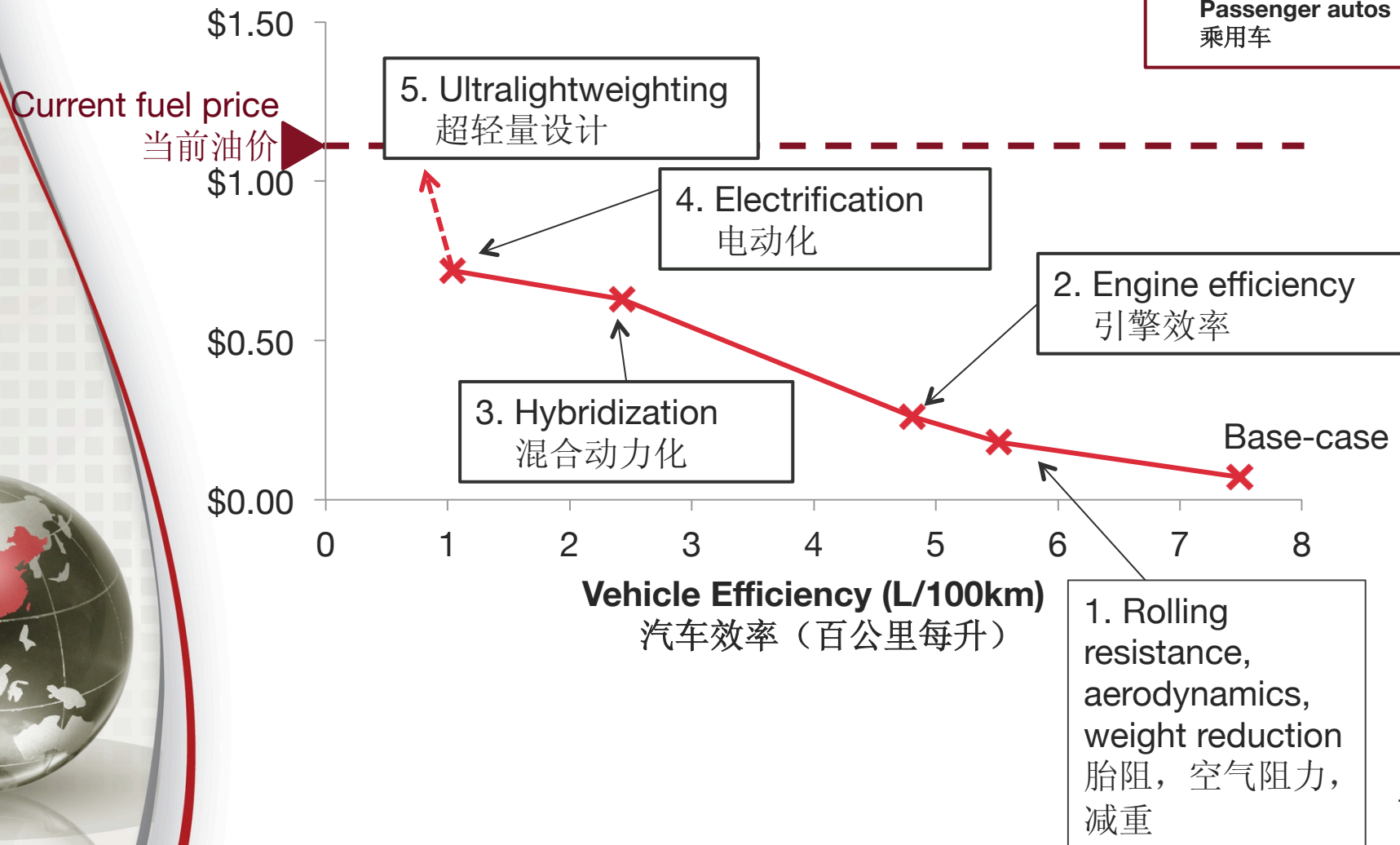
Package 组合	1	2	3	4	5
Aerodynamics, low rolling resistance, 18% weight reduction 空气动力学设计, 低阻, 18%减重	X	X	X	X	X
Engine efficiency 发动机效率		X	X		
Hybrid Electrification 混合电气化			X		
Full Electrification 完全电动化				X	X
Ultralightweighting (e.g., carbon fiber) 超轻量设计 (例如, 碳纤维材料)					X

THESE PACKAGES LEAD TO MUCH HIGHER FUEL ECONOMY

以上技术组合可显著提高乘用车燃油经济性



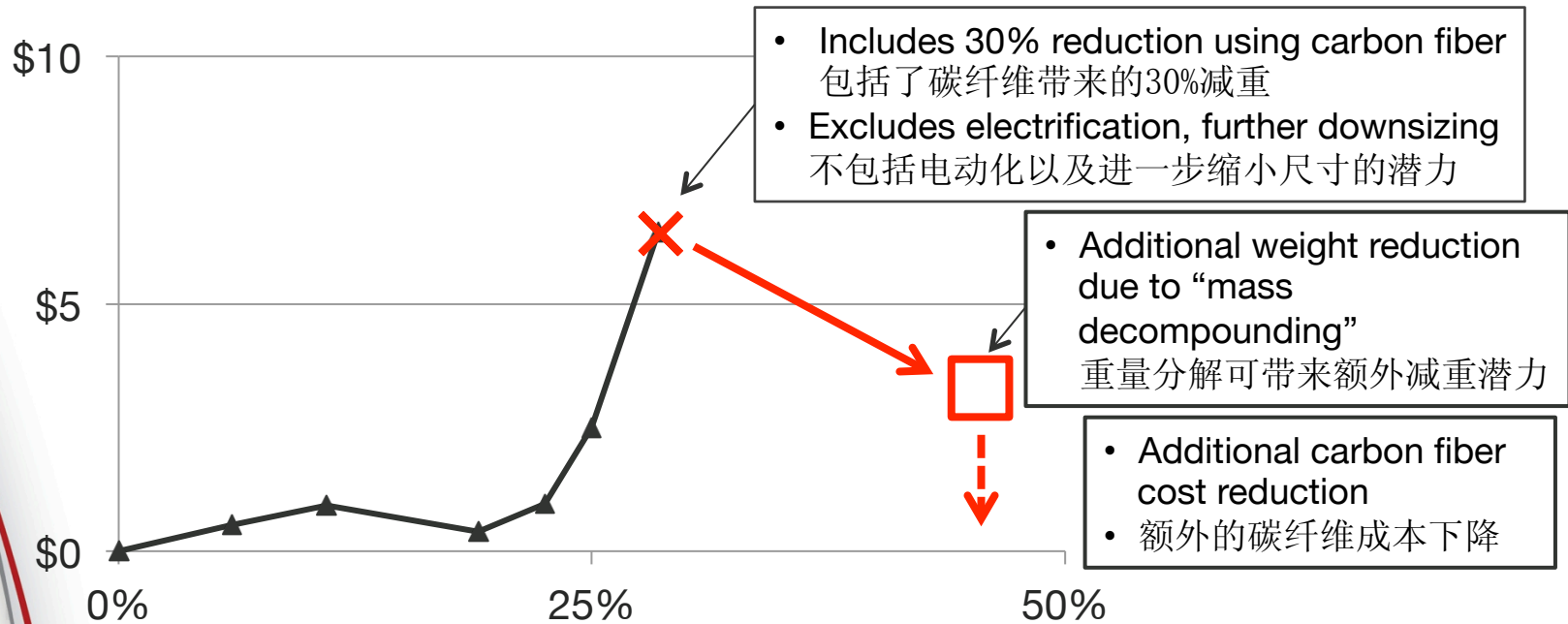
Cost per liter saved for auto technology packages (3 years)
乘用车节能技术运用后每升燃料成本节约量 (3年)



AGGRESSIVE WEIGHT REDUCTION COMPLEMENTS ELECTRIFICATION 进一步的汽车减重与电动化相辅相成



NHTSA/EDAG Study: \$/kg saved for reducing vehicle weight
汽车减重的成本节约 (美元/千克)



- Includes 30% reduction using carbon fiber
包括了碳纤维带来的30%减重
- Excludes electrification, further downsizing
不包括电动化以及进一步缩小尺寸的潜力

- Additional weight reduction due to "mass decomposition"
重量分解可带来额外减重潜力

- Additional carbon fiber cost reduction
额外的碳纤维成本下降

3 reasons for lower carbon fiber prices 降低碳纤维价格的三大主因

- **Technology:** Advanced processing and alternate precursors
技术: 先进的处理技术和新原丝工艺
- **Quality:** Switch from aerospace to auto-grade material
质量: 从航空领域到汽车材料领域的工艺调整
- **Competition:** Energy, labor, capital savings
竞争: 能源, 劳动力, 资本节约



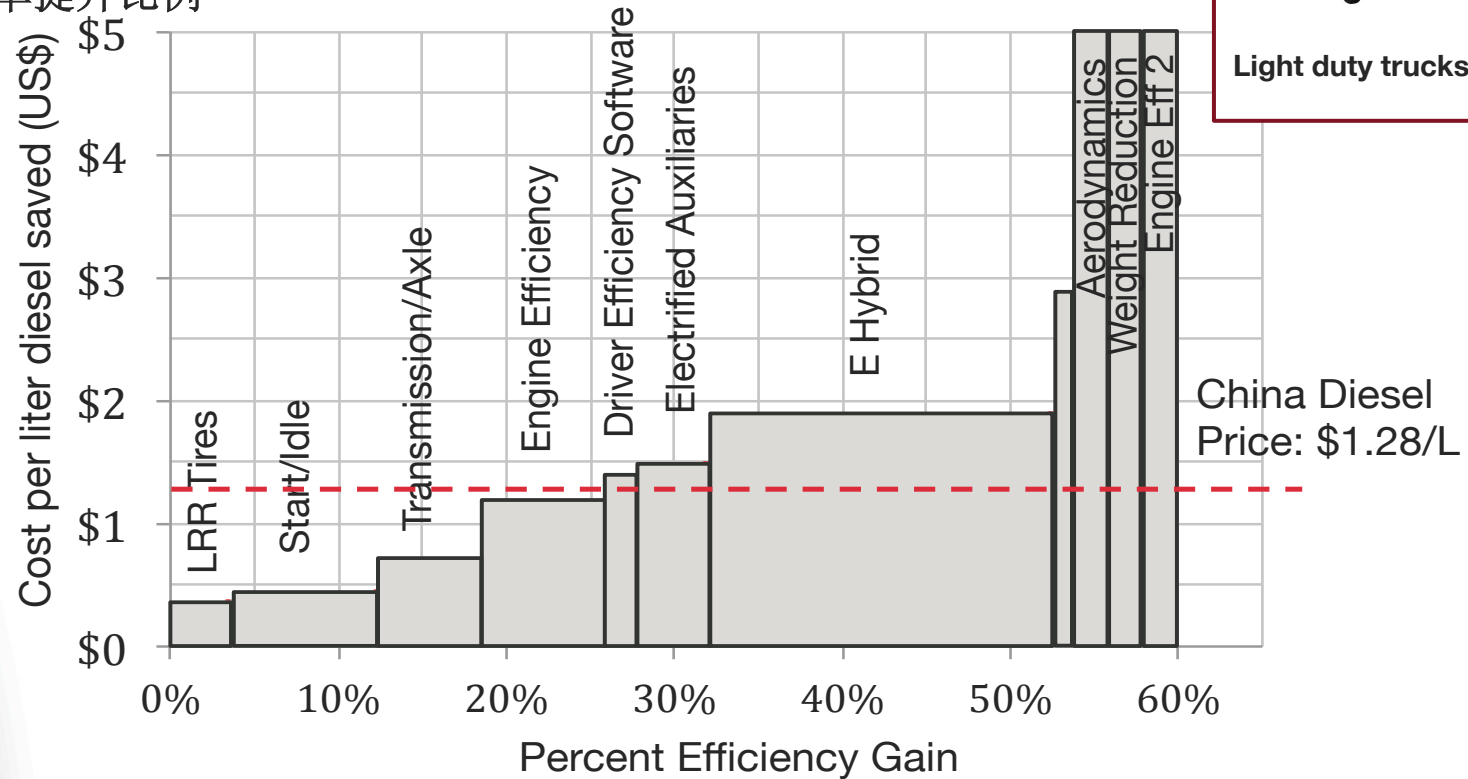
CHINA'S LIGHT TRUCKING FLEET CAN BE MUCH MORE EFFICIENT



中国的轻型卡车可实现更高的能效

Cost vs percent efficiency gain

成本 vs. 效率提升比例



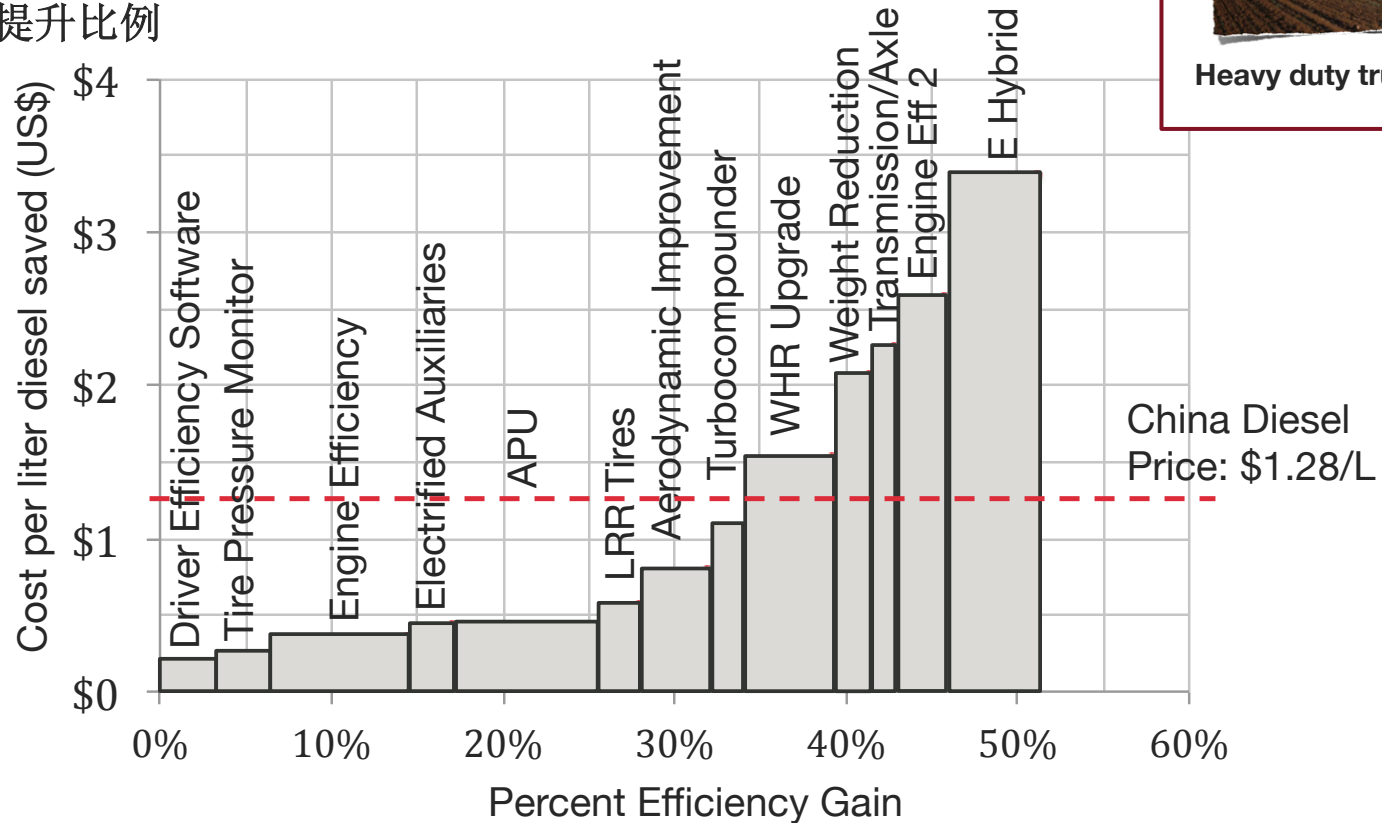
- Hybrids, start/idle, and electrified auxiliaries have greater benefit in China's stop and go traffic
混合动力, 启动/空转, 辅助设备电气化在中国的拥堵环境下有更大的潜力
- Electric hybrids likely to be cost effective in near-term due to battery cost reductions
混合动力在近期内会因电池成本降低而更具成本优势

IMPROVEMENT FOR HEAVY TRUCKING IN CHINA IS ALSO SIGNIFICANT 中国重型卡车的能效提升空间巨大



Cost vs. percent efficiency gain

成本 vs. 效率提升比例



- Lower benefit from aerodynamics due to lower speeds
较低的行駛速度削弱了空气动力学改善潜力
- Possibly greater gains from switch to radial tires from bias ply
由斜交胎向子午胎的换代可能拥有很大节能潜力

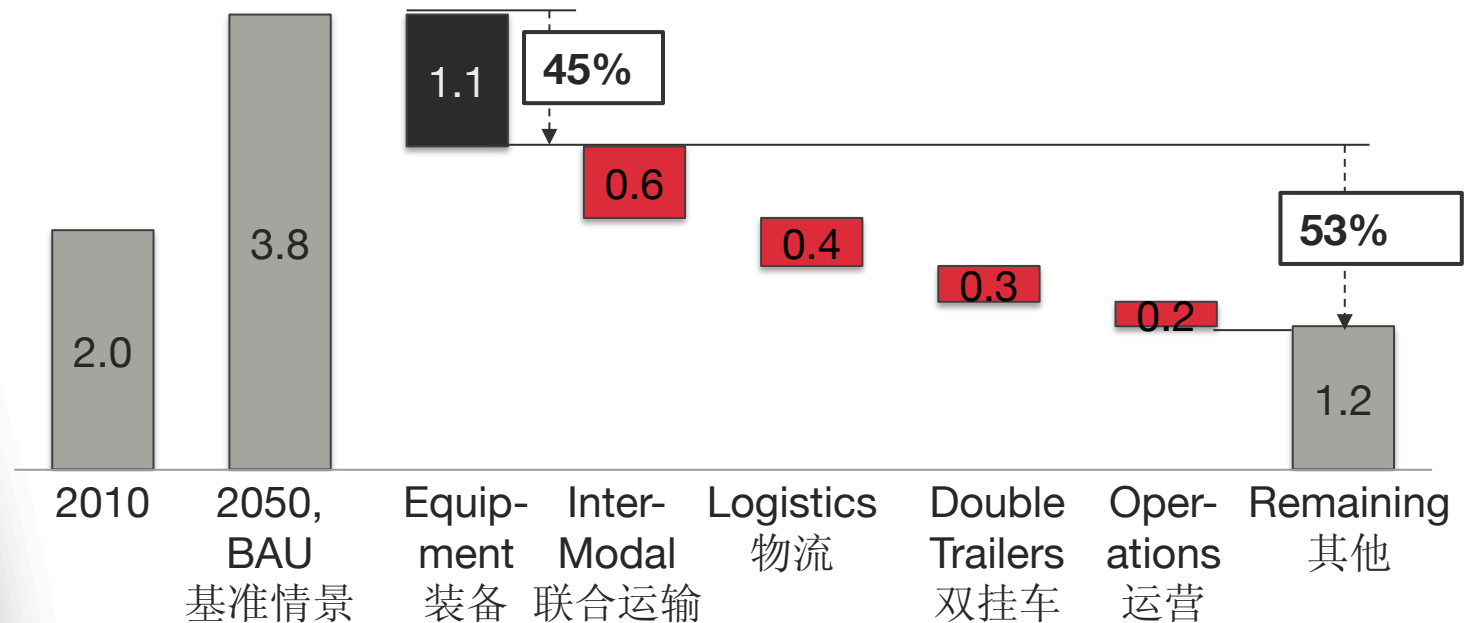
OPERATIONS AND LOGISTICS COULD BE AN EVEN LARGER OPPORTUNITY

运营和物流创造更大的机会



US Analysis Freight Sector Fuel Savings

美国货运部门燃料消耗量
Million bbl per day 百万桶每天



- Greater savings in US from operations than technology
美国的运营和物流改进拥有比技术更大的节能潜力
- Opportunity could be larger in China 中国机会更大
 - Load factors currently 33% lower 装载量低33%
 - Fragmented freight industry (~40% single truck fleets) 碎片化的货运市场结构 (约40%企业只拥有一辆卡车)
 - Evolving infrastructure 基础设施更新迅速

THESE SAVINGS CAN OFFSET GROWING DEMAND

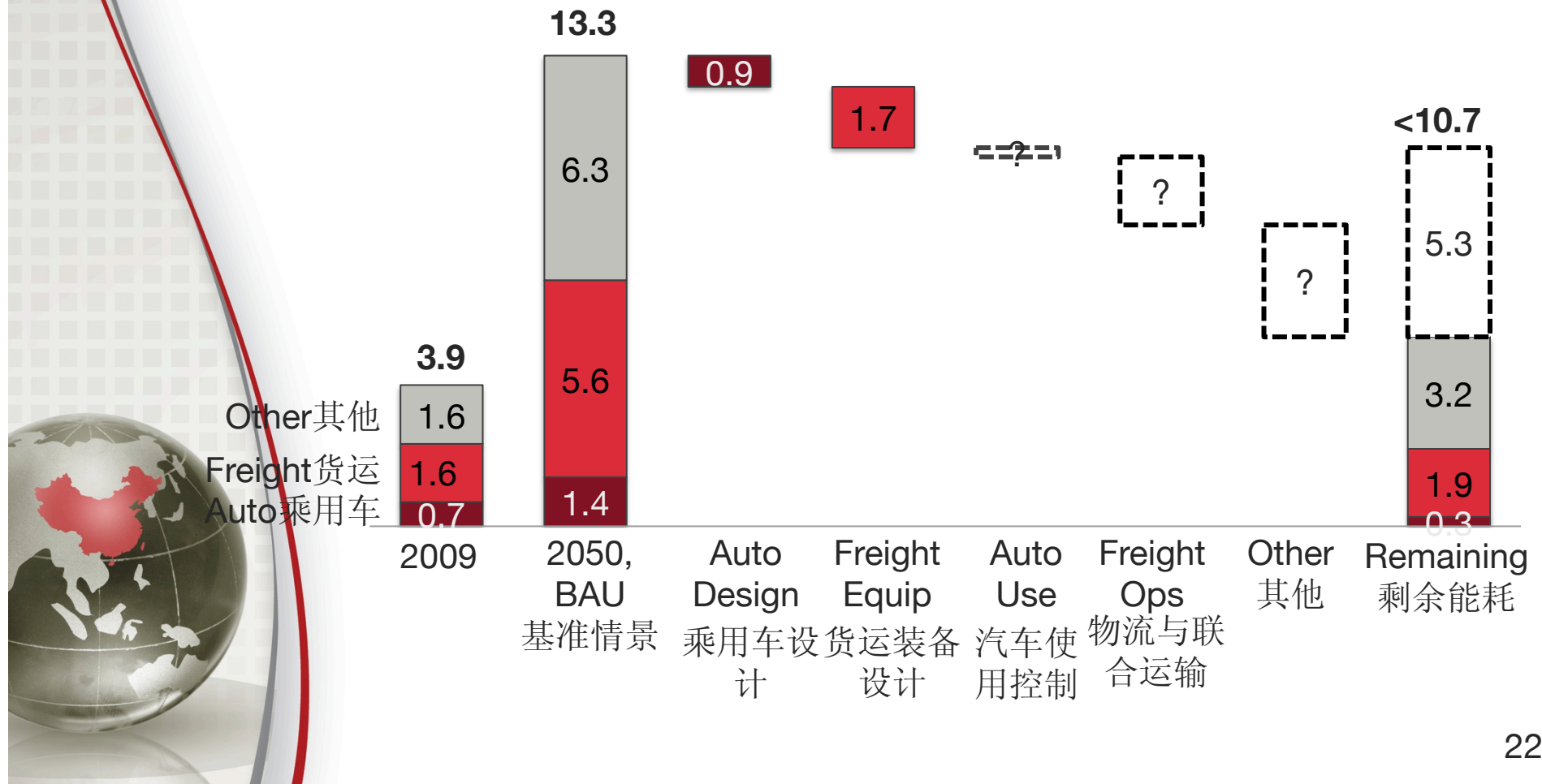


以上能耗节约可抵消高速增长的交通需求

Early estimate of transportation fuel savings in China

中国交通部门能源节约潜力—预估

Million bbl per day 百万桶每天



PATH FORWARD

后续的研究计划



Ongoing technological analysis
继续目前的技术分析研究

Demand reduction analysis
开展交通需求控制的研究

Broader project integration
更广泛地进行项目整合

- Refine duty cycles for Chinese road vehicles
- Improve resolution of current truck fleet
- Explore carbon fiber manufacturing potential
- Conduct air, rail, and ship technological analyses
- Analyze freight network optimization potential
- Assess smart growth and passenger VKT reduction opportunities
- Model baseline complete by end of 2013
- Fully integrated analysis with “transformative case” complete by May 2014
- 改善中国汽车工况
- 改善现有卡车车型构成
- 探索碳纤维的大规模制造潜力
- 对航空、铁路及水运进行技术分析
- 分析货运网络最优化改进潜力
- 评价精明增长的潜力及乘客总里程数的减少可能
- 2013年底完成基准模型
- 2014年5月完成”改进模型”并完全整合相关分析

POLICY IMPLICATIONS

政策思考

Light duty vehicles 乘用车

- 如果能够贯彻整体设计的理念，生产百公里耗油小于2L的乘用车在中国已经具备经济可行性
- 乘用车电动化仍需要借助政府的大规模干预来加速推广
- 可显著地节约由中国高速增长的汽车保有量带来的石油分销管网的基础设施建设投资

Light duty trucks 轻型卡车

- 如果能够吸收目前全球已经成熟的技术，轻型卡车能够在经济可行性满足的前提下得到30%的能效提升
- 轻型卡车的混合动力化将在近期（2020年前）实现经济可行性，并进一步带来20%的能效提升

Heavy duty trucks 重型卡车

- 如果能够吸收目前全球已经成熟的技术，重型卡车能够在经济可行性满足的前提下得到35%的能效提升
- 由于重型卡车电动化在短时间内不具备经济上的可行性，其进一步的能效提升和排放控制将依赖于替代燃料的应用（例如：天然气、生物柴油等）



POLICY IMPLICATIONS

政策思考

Light duty vehicles 乘用车

- Vehicles that achieve <2 liters per 100 km appear economic in China **today** if integrative design principles are employed in their design
- Electrification, while economic, will require a wholesale government intervention to accelerate adoption
- Significant hidden capital savings can be achieved by not building out petroleum distribution network required to keep up with China's rapidly expanding auto base

Light duty trucks 轻型卡车

- 30% efficiency gains in light trucks are cost-effective today if widely available global technologies are deployed
- Hybridization of these fleets will be cost-effective in the near-term (i.e., before 2020), offering an additional 20% fuel efficiency **potential**

Heavy duty trucks 重型卡车

- 35% efficiency gains in heavy trucks are cost-effective today if widely available global technologies are deployed
- Additional emissions savings will require switching fuels (e.g., natural gas, biodiesel), as electrification does not appear economic any time in the near term



谢谢!

THANK YOU!

