California Environmental Protection Agency
Air Resources Board

Advanced Clean Cars

California Light-Duty Greenhouse Gas Standards and Compliance

加州轻型车温室气体排放标准与监管

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California Air Resources Board

International Workshop on Technology and Policy Solutions for Energy-efficient and Low Carbon Light-duty Vehicle Fleet: The China Perspectives

June 4-5, 2014 Beijing

Topics 主题

- Key CA policy factors
- Existing GHG standards
- Technical basis for standards
- Compliance policy

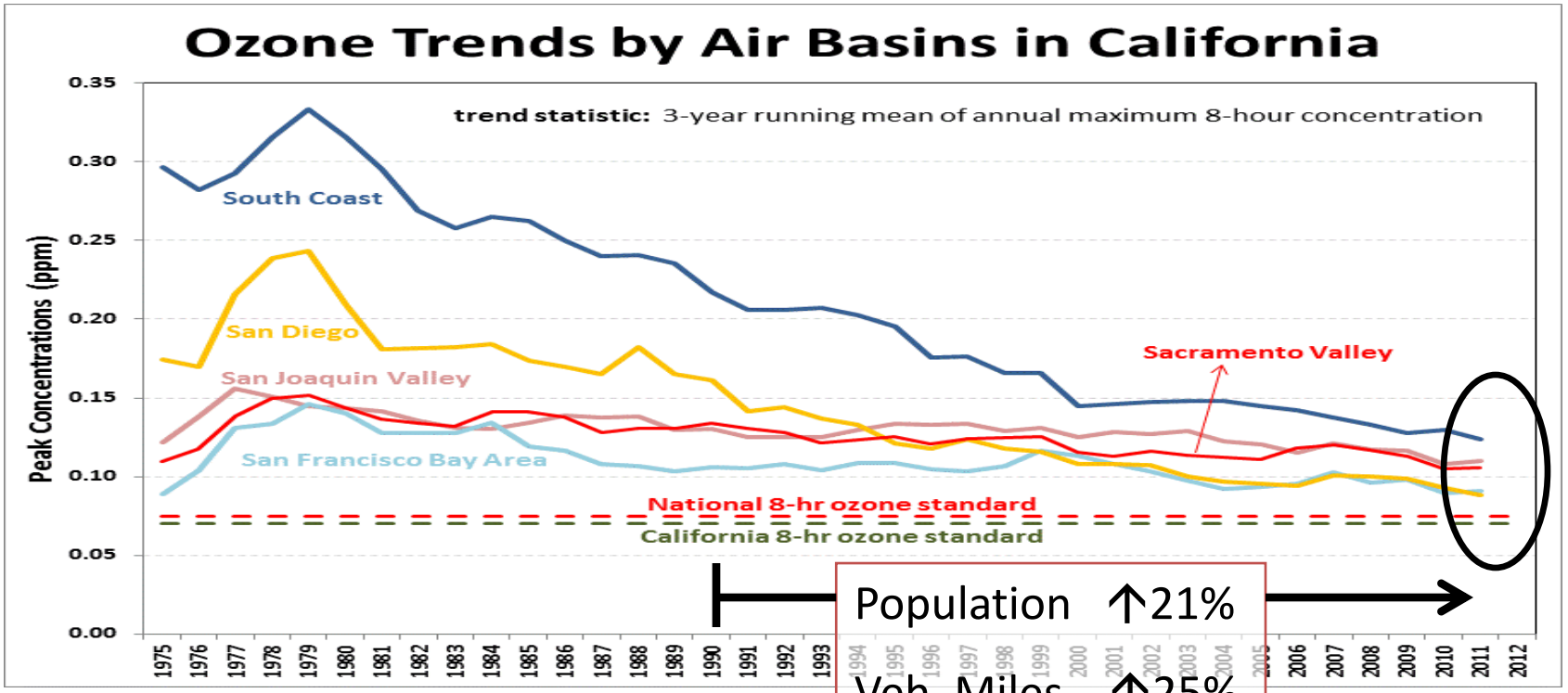
- 加州关键的政策因素
- 现有温室气体排放标准
- 排放标准的技术依据
- 监管政策

Air Quality and Climate Change -Key Factors in California

空气质量与气候变化 -加州的关键因素

Advanced Clean Cars

- Progress towards meeting ozone air quality standards
- 臭氧空气质量标准达标进展



Air Quality and Climate Change -Key Factors in California

空气质量与气候变化 -加州的关键因素

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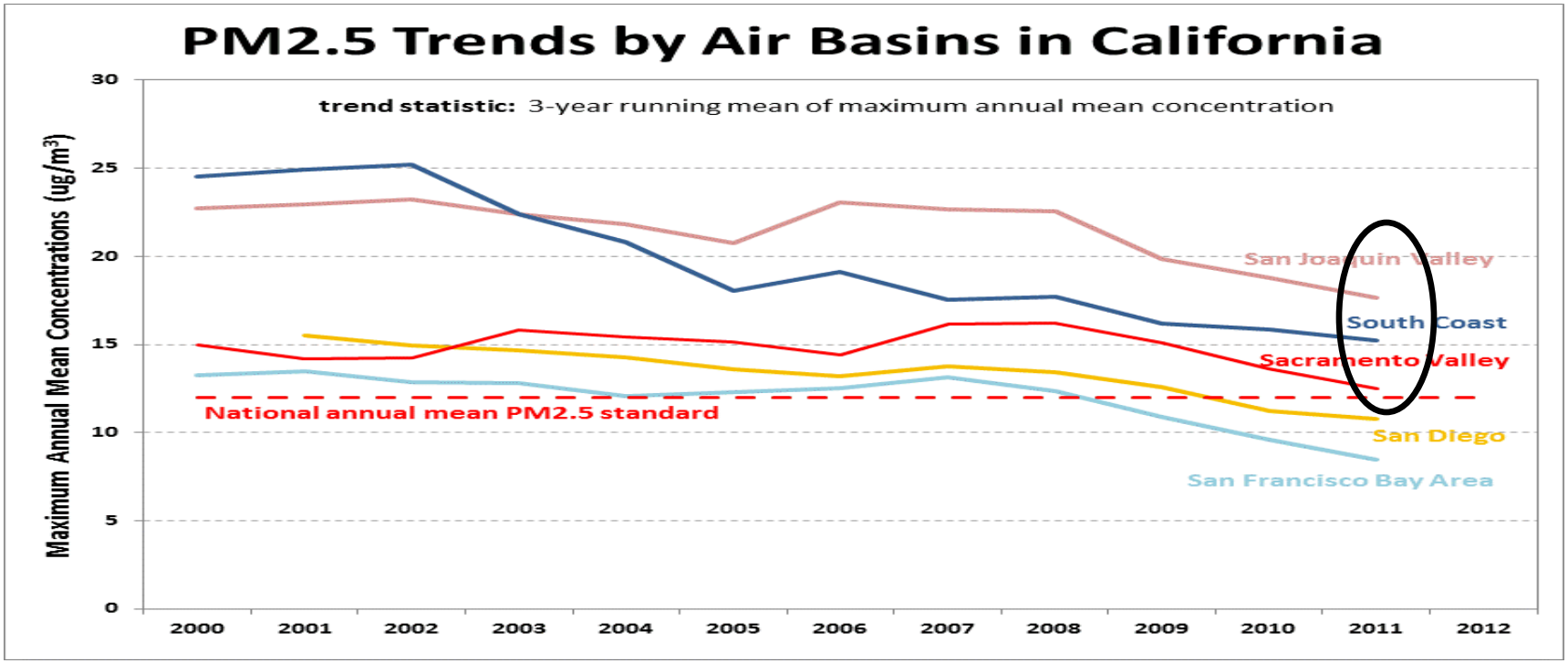
- Progress towards meeting PM air quality standards
- 颗粒物空气质量标准达标进展



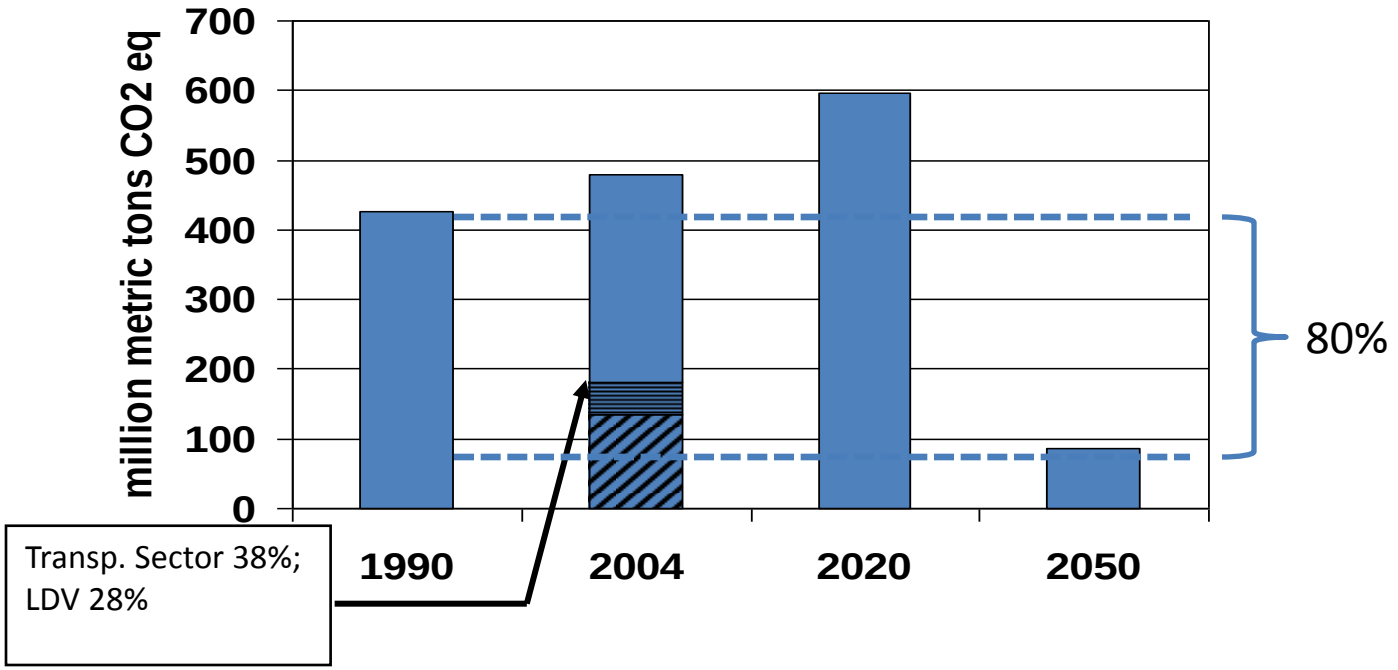
Air Quality and Climate Change -Key Factors in California

空气质量与气候变化 -加州的关键因素

Advanced Clean Cars

- Reduce GHG emissions
  - 1990 levels by 2020
  - 80% below 1990 levels by 2050

- 减少温室气体的排放
  - 于2020年降到1990年水平
  - 于2050年降到1990年水平的20%以下（80%降幅）

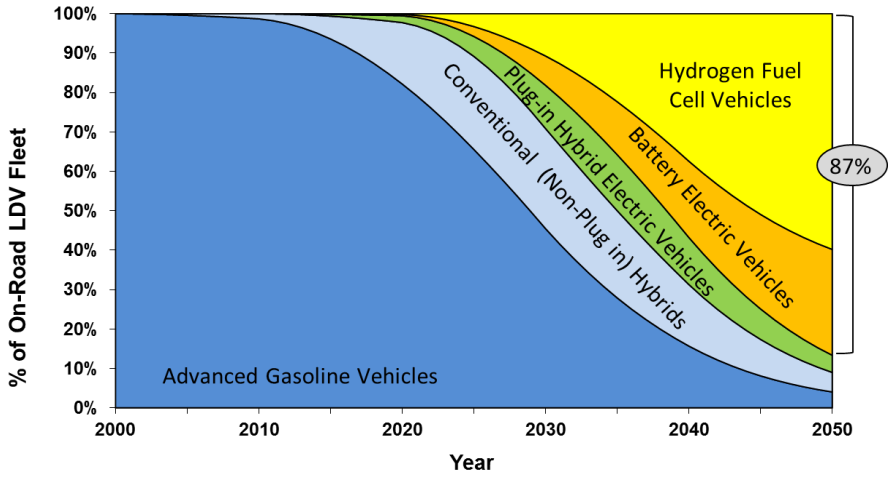


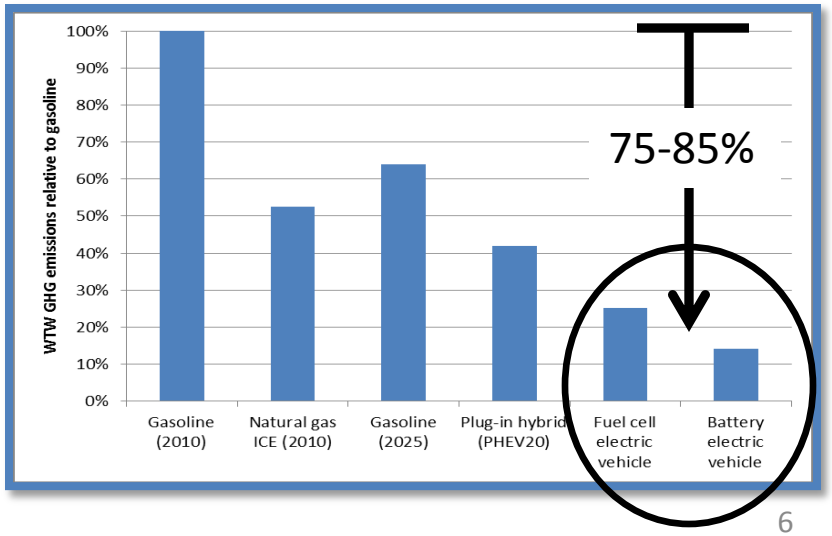
Long term GHG Goals: Light Duty Vehicles

温室气体减排的长期目标：轻型车辆

- Fuel: Low Carbon Alternatives
  - Clean electricity and H_2 focus
- Vehicles: Advanced Technologies
  - Virtually all ZEVs by 2050
- Transportation: Improved Efficiency
  - Reduce vehicle usage
  - City planning

- 燃油：可替代性低碳油料
  - 清洁的电力和氢能源为主
- 车辆：先进技术
  - 到2050年基本实现零排放
- 交通运输：提高能效
  - 减少车辆使用
  - 优化城市规划





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History 历史回顾

Advanced Clean Cars

2004 2006 2008 2010 2012

ARB adopts 1st vehicle GHG std in U.S. (2009-2016)
ARB颁布了美国的第一份车辆温室气体排放标准 (2009-2016)

U.S. EPA adopts CA 2012-2016 stds
美国环保局采纳了加州的2012-2016排放标准

ARB/U.S. EPA joint technical report on possible 2017+ stds
针对可能的2017年之后的排放标准，ARB和美国环保局出台了联合技术报告

Obama Administration announces agreement with manufacturers, ARB, Federal agencies on a National standard
奥巴马政府宣布与制造商，ARB，以及多个联邦机构就全国排放标准达成一致

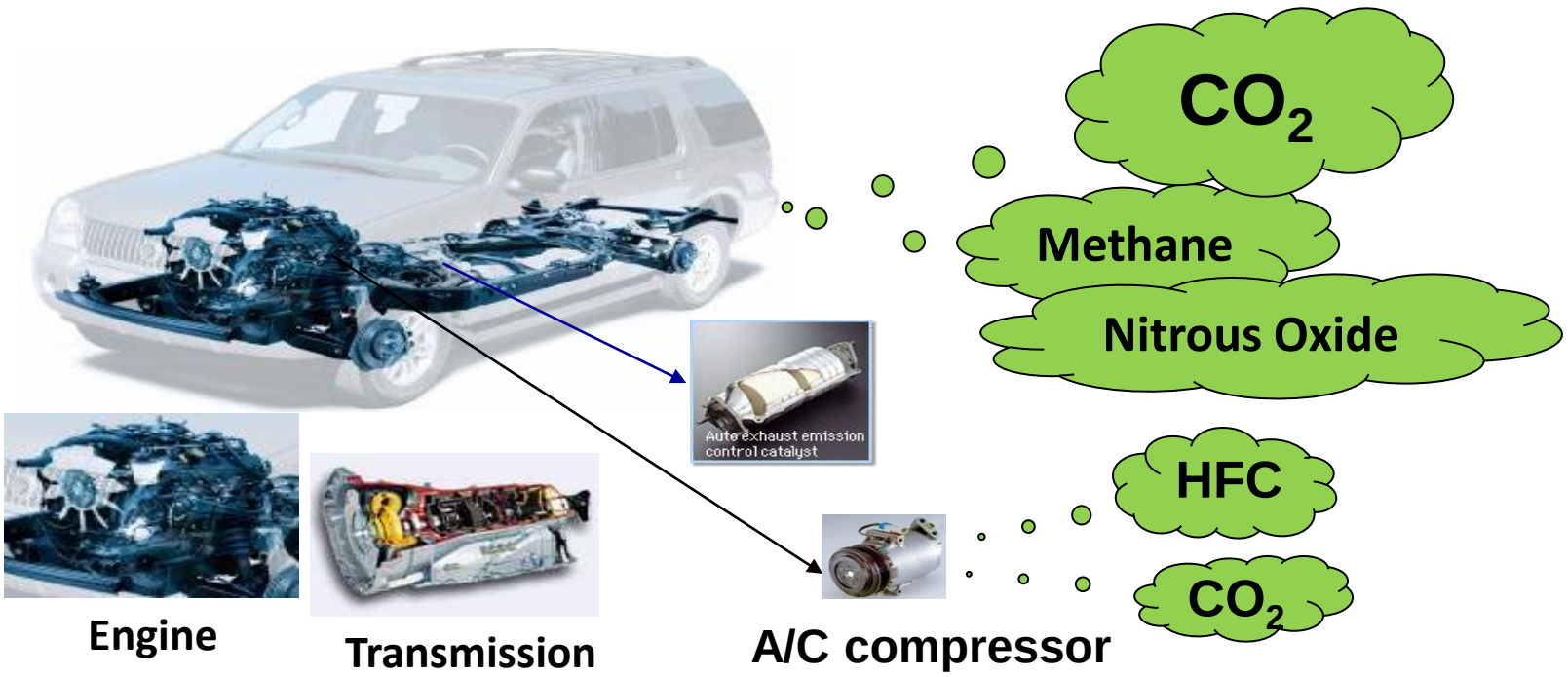
ARB adopts 2017-2025 stds
ARB颁布了2017-2015排放标准

U.S.EPA/NHTSA adopt 2017-2015 stds
美国环保局与国家公路交通安全管理局也颁布了2017-2015排放标准

GHG Standards, not Fuel Economy

温室气体排放标准，而非燃油经济性

Advanced Clean Cars



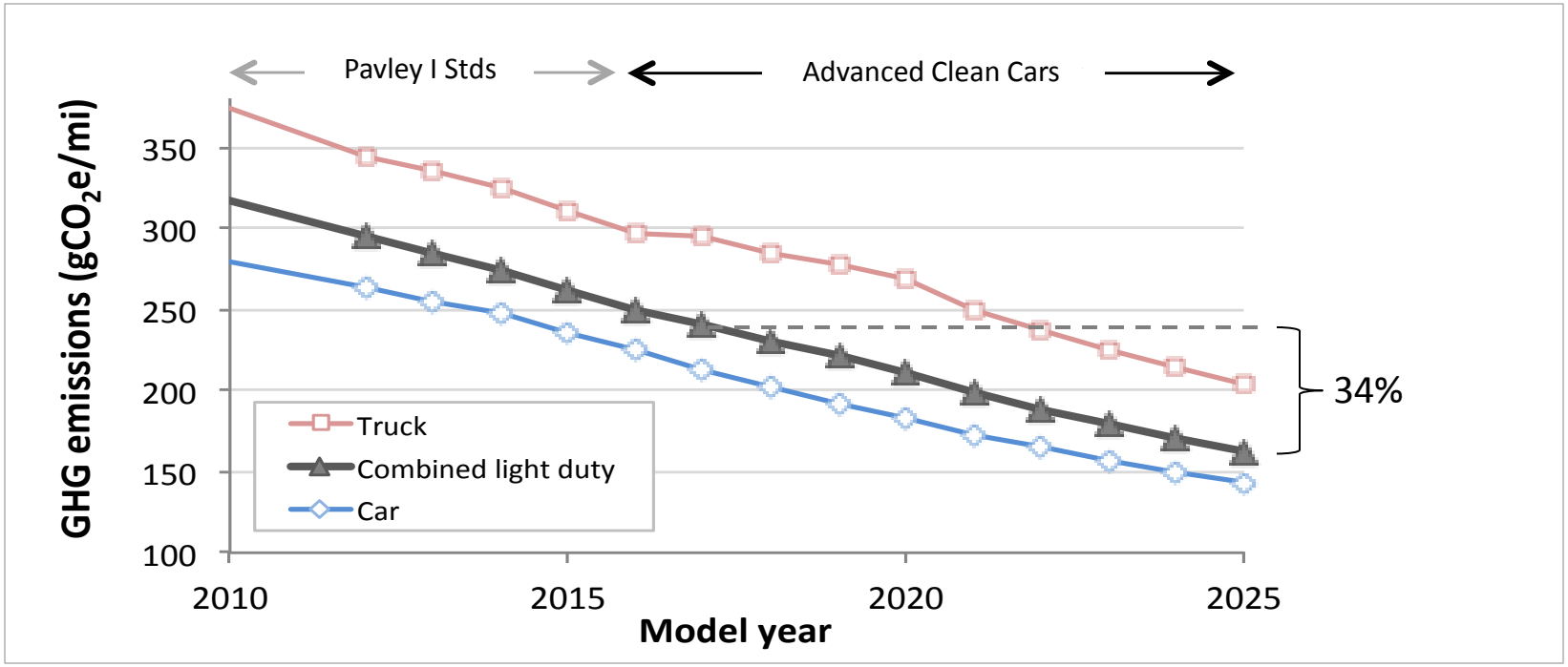
- All GHG emissions from cars covered
  - Not just CO_2 from tailpipe

- 包括了所有来自汽车的温室气体排放
  - 并不仅仅是来自尾气的二氧化碳

Standards 标准

Advanced Clean Cars

- 2025 Target: 166 gCO_2e/mile
  - 4.6%/year for 2017-2025
  - Total reduction of 34%
  - Separate car and truck std
- 2025年的目标：166 克CO_2e/英里
  - 在2017年至2025年期间每年减排4.6%
  - 总共要完成34%减排量
  - 分别制定汽车和卡车各自的减排标准



Footprint Based 基于脚印面积

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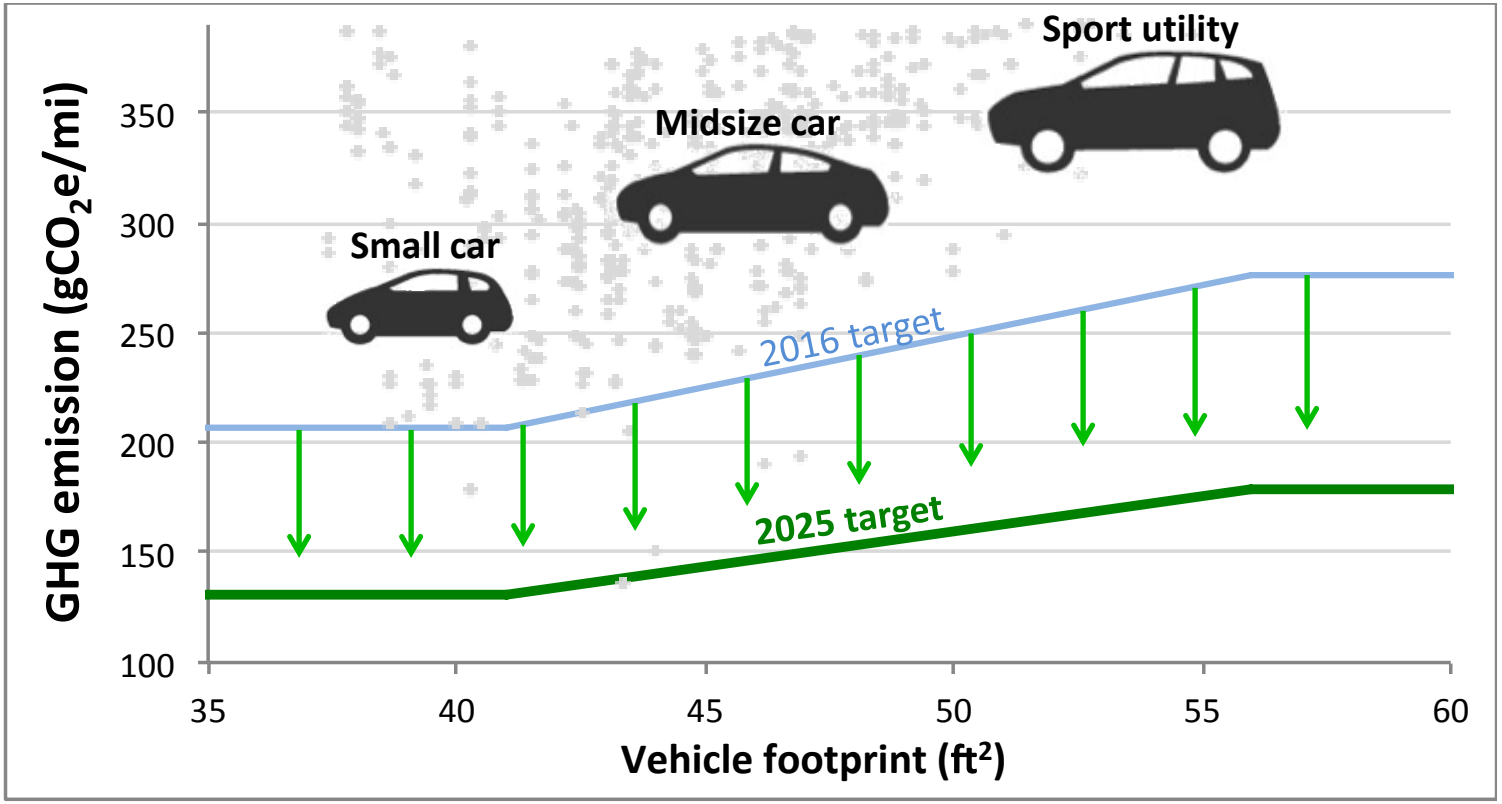
- All vehicles must reduce GHG emissions by about the same percent
- 所有车辆必须减少相同百分比的温室气体排放



Note: There are corresponding footprint based standard targets for trucks

Additional Provisions 其他规定

- Manufacturer sales-weighted average (corporate average)
- Credit banking (5-year carryforward, 3-year carryback)
- Technology-specific credit opportunities
  - Air conditioning efficiency and refrigerant
  - “Off-cycle” technologies: LED lights, idle stop-start, etc.

- 制造商销售加权平均值（公司平均值）
- 累积信用额度（5年延用，3年偿还）
- 可获取特殊技术信用额度
  - 空调效率和制冷剂
  - “工况外”技术：LED照明，怠速自动熄火/启动，等等

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Roadmap to Setting Standards

制定排放标准的流程

- ☑ Air quality need for lower standards
- ☑ Authority to adopt standards
- ☑ Accurate inventory model to assess impacts/benefits from cars
- ☑ Technology feasibility assessment
- ☑ Cost-effectiveness assessment
- ☑ Adoption of standards

- ☑ 空气质量需求
- ☑ 获取制定法规的授权
- ☑ 精确的排放清单模型以评估减排的影响与获益
- ☑ 技术可行性评估
- ☑ 成本效益评估
- ☑ 颁布排放标准

Inventory Modeling 排放清单模型

- Computer model to calculate emissions
  - How many and what type of vehicles
  - How they are operated
  - Emission rates
- Estimates benefits from future standards
- Updated every few years
  - New emission data, vehicle inventory and usage data

- 利用计算机模型计算排放量
  - 车辆数量与类型
  - 车辆使用情况
  - 排放率
- 估计执行未来排放标准的收益
- 每若干年更新
  - 新的排放数据，车辆清单，和使用数据

EMFAC for California (http://www.arb.ca.gov/msei/msei.htm)
MOVES for U.S. EPA (http://www.epa.gov/otaq/models/moves/)

Roadmap to Setting Standards

制定排放标准的路线图

- ☑ Air quality need for lower standards
- ☑ Authority to adopt standards
- ☑ Accurate inventory model to assess impacts/benefits from cars
- ☑ Technology feasibility assessment
- ☑ Cost-effectiveness assessment
- ☑ Adoption of standards

- ☑ 对于更低标准的空气质量需求
- ☑ 采纳排放标准的权限
- ☑ 精确的排放清单模型来评估对汽车的影响与获益
- ☑ 技术可行性评估
- ☑ 成本效益评估
- ☑ 采纳排放标准

Technical Feasibility 技术可行性

- ARB has substantial in-house vehicle emission control expertise
  - But, GHG reduction technologies slightly different
- Developed additional in-house expertise
  - Research (technical papers, conferences)
  - Discussions (manufacturers, suppliers)
- Contracted out with engineering companies/consultants
  - Fill gaps in knowledge
  - Use firms also used by manufacturers to ensure credibility of technical work

- ARB自身拥有丰富的车辆排放监控的专业能力
  - 但是，温室气体减排技术略有不同
- 扩展自身的专业技能
  - 科研（技术论文和会议）
  - 讨论（制造商和供应商）
- 承包给工程和咨询公司
  - 填补知识空缺
  - 使用制造商雇用的公司来确保技术工作质量

Examples of Contract Work

承包工作的例子

- Powertrain technology modeling
  - Model predicts effect of various combinations of technology (e.g., turbo-charging and downsizing)
  - Model derived from lab testing
  - Often same model used by manufacturers
  - Ex: Ricardo, FEV
- Vehicle Lightweighting
  - Engineering firms used to redesign vehicles using lighter materials
  - Detailed results including component comparisons, weight savings, manufacturing changes, cost impacts, and simulated crash testing results
  - Final reports included peer review
  - Ex.: Lotus, EDAG

- 车辆驱动技术模型
  - 模型预测各种技术集成的影响（比如涡轮增压和功率优化）
  - 模型源于实验室测试
  - 制造商经常使用相同的模型
- 车辆减重
  - 工程公司通常重新设计车辆使用轻型材料
  - 详细的结果包括元件比较，重量减轻，制造变化，成本影响，和模拟撞击测试结果
  - 最终报告经同行审查

Cost Assessments 成本评估

- Goal: Accurately project costs for manufacturers
  - Including ultimate costs to consumer
- Approach:
  - Detailed discussions with manufacturers, suppliers
  - Contracted with firms that specialize in tear-down reports
    - Disassemble existing components and detail materials, costs, manufacturing processes, etc.
  - Projections of future costs considering improvements from high volume production, learning/evolution of designs

- 目标：精确地预测制造商成本
  - 包括对于消费者的最终成本
- 方法：
  - 与制造商和供应商详细讨论
  - 承包给专长于分解报告的公司
    - 分解现有的组件以及详述材料，成本，制造过程，等等
  - 考虑大规模生产和设计学习/演变带来的改善进步，从而预测未来的成本

Cost Assessments (cont.)

成本评估（续）

- Included non-component costs:
  - Design, calibration, manufacturing, warranty
- Analyze costs to consumers
  - Increased retail price of new car
  - Annual/lifetime savings from reduced fuel consumption
- Analyze economic impacts to society
  - Impacts on jobs, taxes, due to increased vehicle prices, reduced fuel consumption, etc.
- Cost estimates often highly debated

- 包括非组件成本
  - 设计，校准，制造，保修
- 分析消费者的花费
  - 增加新车的零售价
  - 由燃油消耗减少带来的每年/终生资金节余
- 分析对社会的经济影响
  - 车辆提价，燃油消耗减少等等对于工作，税收的影响
- 成本评估通常辩论激烈

Fleet Analysis 车队分析

- Created a baseline fleet
  - Identified all vehicles/models available, sales numbers, and existing technology
- Selected a potential future standard
- Incrementally added technology packages to baseline vehicles until fleet met the potential standard
- Assessed the benefits and costs
  - Incremental increased cost of new car vs. fuel savings for consumer
- Repeated to analyze standards varying from 3-6% reductions per year
  - Find maximum level that is feasible and cost-effective

- 创建一个基准车队
  - 确认所有可获车辆/模型，销售数目，和现有技术
- 选择一个潜在的未来标准
- 逐步向基准车辆添加技术元件直到样本达到潜在标准
- 评估效益和成本
  - 新车成本增加和消费者的燃油节省的比较
- 重复以上步骤来评估每年3-6%的减排变化
  - 找到可行的以及符合成本效益的最大减排量

Projected Technologies

预测的技术

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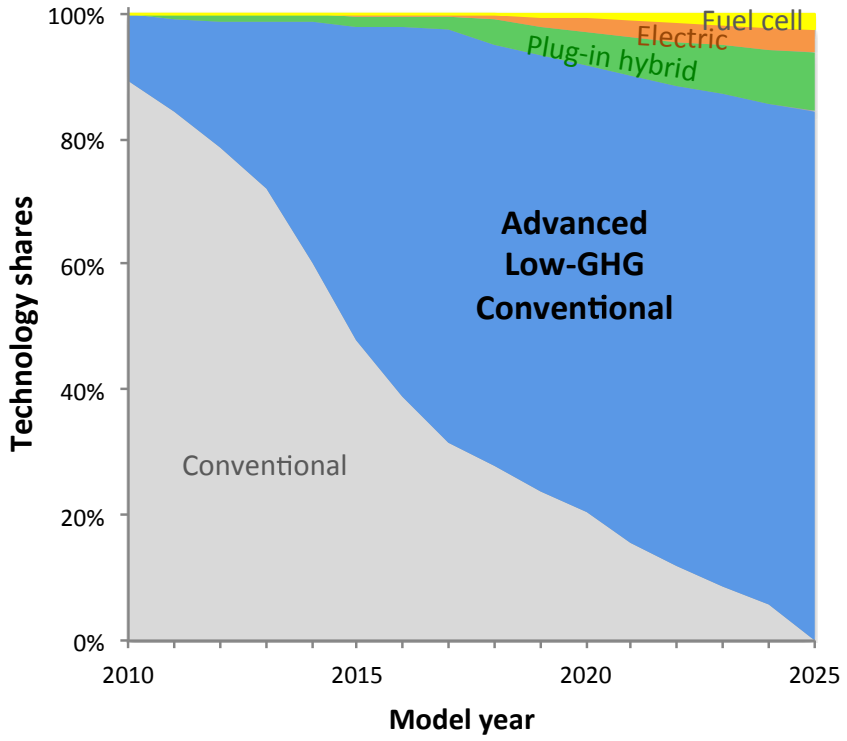
- Primarily, existing technologies used more extensively
- 首先要更广泛地使用现有的技术



ZEV technology: ultra-low GHG

Engine
- Variable valve control (可变阀控制)
- Direct injection (直喷)
- Turbocharging (涡轮增压)
- Cylinder deactivation (气缸钝化)
- Cooled exhaust gas recirculation (冷却排气再循环)

Driveline
- Optimized controls (最优化控制)
- 8-speed transmission (8速自动变速箱)
- Continuously variable (连续变化)
- Dual clutch transmission (双离合变速箱)

Vehicle
- Engine stop-start (引擎怠速熄火/启动系统)
- Hybrid power assist (混合动力辅助)
- Aerodynamics (空气动力学)
- Low rolling resistance tires (低滚阻轮胎)
- Advanced lightweight materials (先进轻型材料)
- Low-GWP refrigerant (1234yf) (低GWP制冷剂)
- Electric accessories (电子配件)

Projected Technology Penetration in 2025*

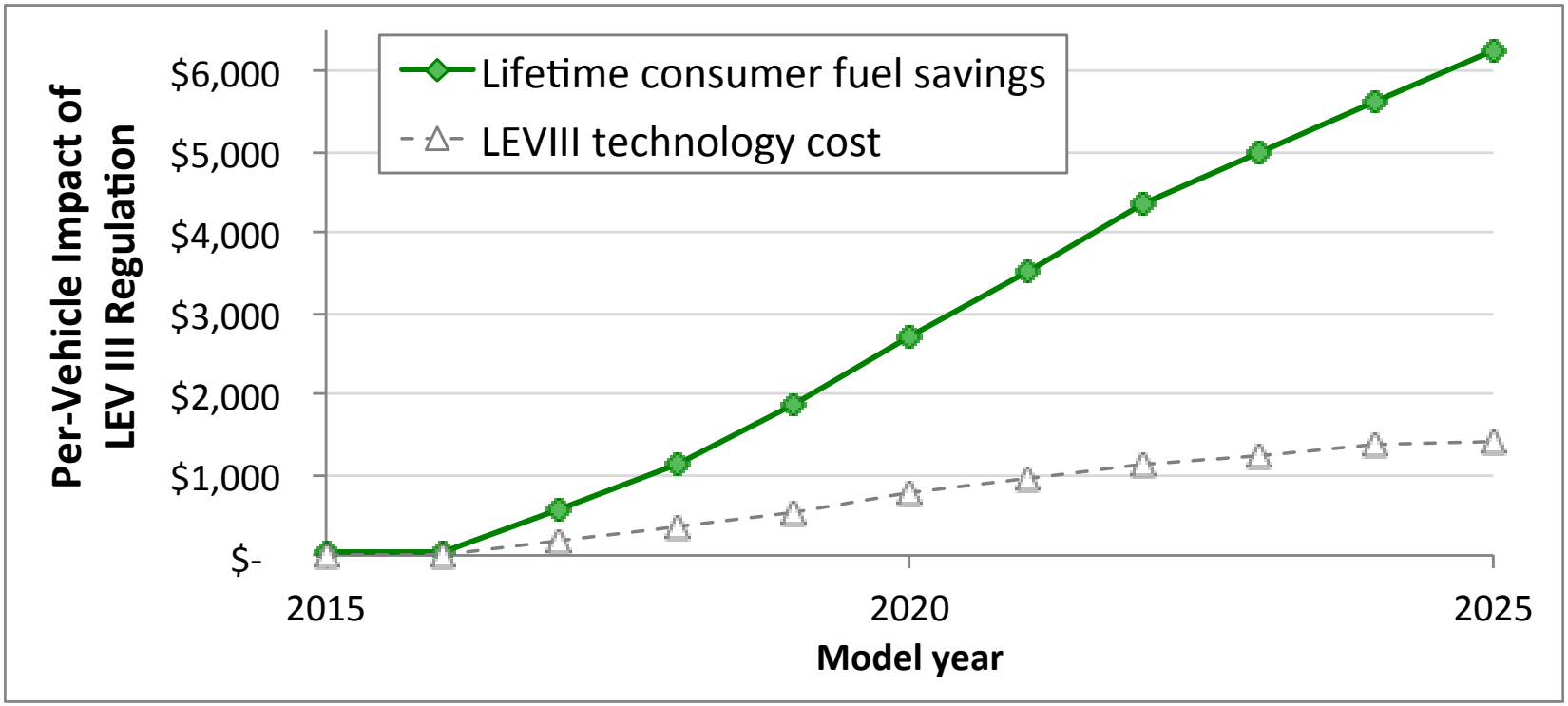
预测2025年的技术普及*

Advanced Clean Cars

Technology	技术	Cars	Trucks
Turbo-downsized (18 bar)	缩小涡轮 （18bar）	25%	19%
Turbo-downsized (24 bar)	缩小涡轮 （24bar）	63%	67%
8 Speed DCT	8速双离合变速箱	79%	9%
Cooled EGR	冷却排气再循环	11%	74%
Hybrid Electric Vehicle	混合电动车辆	4%	5%
Electric Vehicle	电动车辆	3.0%	0.3%
Low rolling resistance tires	低滚阻轮胎	96%	99%
Improved Accessories	改善配件	73%	55%
Gasoline Direct Injection	汽油缸内直喷	93%	97%
Micro-hybrid (stop/start)	微混合怠速熄火系统	20%	39%

* Projected for total U.S. fleet, not CA only fleet
* 预测针对所有美国车辆，不仅仅是加州

Cost Analysis 成本分析



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Compliance with Standards

标准合规

- Ability to verify compliance is critical
  - Competitive pressure in industry will converge on lowest cost approach
- Needed to ensure benefits realized
- Multiple paths utilized in the U.S. to ensure compliance
- Implementation and compliance use significant agency resources
  - People, time, lab testing

- 验证达标的能力至关重要
  - 工业界的竞争压力将趋于最低成本的方法
- 需要确保实现获益
- 在美国，使用多种途径来确保达标
- 贯彻实施和达标使用了大量的机构资源
  - 人力，时间，实验室测试

Step 1: Authority 第一步：权限

- Authority granted by laws such as Clean Air Act to adopt, implement, and enforce standards
- Ensure adopted standards can be readily enforced
  - Recognize they are enforceable in the standard
  - Identify how noncompliance is defined including test procedures
  - Identify penalties/remedies for noncompliance

- 由法规（例如清洁空气法）授予的权限来颁布，实施和执法排放标准
- 确保颁布的排放标准可被监管
  - 确认标准可以被监管
  - 确定如何定义未达标，比如制定测试程序
  - 确定对于未达标的惩罚/补救

Step 2: Adopt Complimentary Requirements

第二步：强化车辆品质保证

Advanced Clean Cars

- Standards that promote durability
  - Useful life (~250,000 km)
  - Emission warranty (up to ~133,000 km for some parts)
  - On-board diagnostics (OBD)
  - Inspection/maintenance (I/M) programs (e.g., CA's SmogCheck)

- 制订耐久性标准
  - 使用寿命（~250,000公里）
  - 排放保修（对于某些部件最高至~133,000公里）
  - 车载诊断系统
  - 检查/保养项目（例如加州的尾气检查）

Step 3: Employ Verification Procedures

第三步：实施验证措施

- Certification each year
  - Accounting of each manufacturer's projected compliance path
  - Verification with vehicle sales numbers
  - Annual public report (e.g., http://www.epa.gov/otaq/climate/ghg-report.htm)
- Testing on cars before certification
  - 'Spot-check' manufacturer self-testing results
- Testing on actual in-use vehicles
  - Target models based on complaints from field, new offerings (e.g., new engines, technologies, manufacturers), anomalies
  - Replicate certification testing to confirm actual performance

- 年检
  - 记述每个制造商预测的达标方式
  - 核实车辆销售数目
  - 公布年度报告 (http://www.epa.gov/otaq/climate/ghg-report.htm)
- 在鉴定之前的车辆测试
  - 逐点检查制造商自身的测试结果
- 测试实际投入使用的车辆
  - 集中测试车型基于现实中的投诉，（例如新引擎，技术，制造商）或者异常现象
  - 重复检验测试以确认实际表现

Step 4: Remedial Actions

第四步：补救措施

- Recall
  - Capture in-use vehicles to correct a 'problem'
- Monetary penalties
  - Apply fines for noncompliance to discourage/penalize
  - Covers broad range of issues:
    - Submission of fraudulent testing/data
    - Individual noncompliant vehicle models
    - Failure to meet corporate average standards
- Recalculation of corporate average
  - If individual models are noncompliant, measure actual performance and recalculate corporate average
  - Requires manufacturer to make up for shortfall

- 召回
  - 收回已投入使用的车辆来纠正问题
- 罚款
  - 对于未达标采取罚款
  - 包括全面的问题
    - 提交出现问题样品的测试/数据
    - 特定未达标的车型
    - 厂商是否无法实现整体达标
- 重新计算企业平均值
  - 如果个别车型未达标，检测实际表现并重新计算整体平均值
  - 要求制造商弥补差额

Summary

结论

- Air quality and climate change are key policy considerations
- Detailed technical work was done to establish stringent but feasible standards
- Verifying compliance is critical last step to ensure GHG benefits are realized

- 空气质量和气候变化是主要政策考虑因素
- 通过细致的技术分析来确定严格并可行的未来标准
- 验证标准的实施是保证标准能达到其实际收益的关键