Creating a world
fit for the future

Using economic analysis to design clean air action plans for cities
利用经济分析方法设计城市清洁空气行动计划

The 14th China City Air Quality Management Workshop
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www.ricardo.com

Agenda
日程安排

- Introduction to Ricardo
  里卡多公司简介
- Overview of clean air action plans
  清洁空气行动计划概要
- Using economic tools to develop CAAPs
  利用经济学工具制定清洁空气行动计划
- Ricardo / Clean Air Asia ADB seven cities air quality technical assistance contract and BAQ2020
  里卡多和亚洲清洁空气中心受亚行委托执行的亚洲7座城市技术援助项目及BAQ2020会议

Introduction
里卡多简介

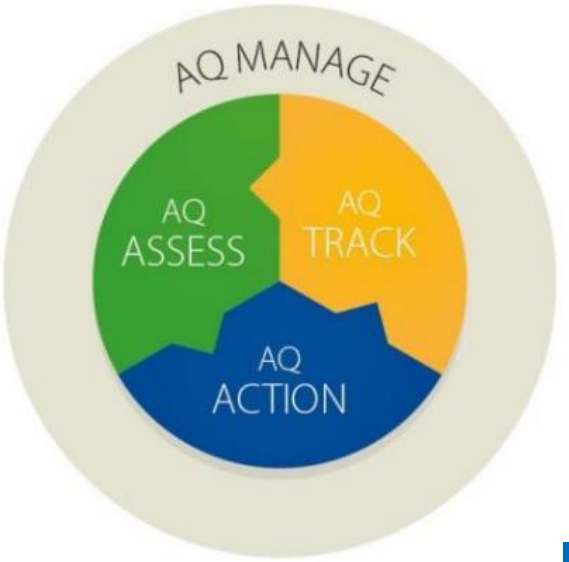
Introduction to Ricardo Energy & Environment
里卡多能源环境介绍

- Part of Ricardo Group (**里卡多集**团) – a global, multi-industry consultancy for engineering, technology, project innovation and strategy
里卡多集团的重要部分，里卡多集团是一个在工**程、技**术、项目创新及战略方面的全球化、跨行业咨询公司
- Strategic consultancy and project leadership for Governments, international bodies, multinational corporations and a wide range of public and private sector organisations around the world
为世界各地政府、国际团体、跨国公司企业及广**泛的公共及私有部**门组织项目领导管理及战略咨询服务
- Over 3,000 staff working in 40 offices worldwide
全球共40个办公室，近3000**名**员工

Air quality 空气质量团队

- Start from the “**London Smog**” in early 1950s
- Over 150 engineers, scientists, economists and IT consultants delivering air quality services including:
  - Operation of air pollution measurement networks
  - Delivery of atmospheric modelling studies and pollution forecasting services at all scales
  - Emission inventory design, development, compilation, interpretation and analysis
  - **Advice to over 250 cities on their air pollution problems and action planning**
  - Support for development, implementation and review of air quality and emissions legislation

- 业务起源于上世纪**50年代的伦敦烟雾事件**
- **150余名工程**师、科学家、经济学家和**IT技**术顾问提供空气质量咨询服务
- **在英国、**爱尔兰、直布罗陀、沙特阿拉伯等全球各地运营空**气**污染监测网
- **提供局地、区域和国**际性的大气建模研究和污染预警服务
- **排放清**单设计、制定、汇编、解读和分析，包括交付了模范**式的英国国家大气排放清**单
- **为250余个英国和国际城市提供空气污染问题解决建议**
- 为空气质量和排放管理法律的开发、实施及评估提供支持



Ricardo air quality work in China
里卡多空气质量中国工作

- Ricardo has been active in air quality work in China for more than 10 years.
  里卡多自在中国空气质量方面相关工作已有十余年历史
  - Liaoning Integrated Environment Programme - 5 major industrial cities – air quality management (and CBA tools) one component of the EU-CHINA funded programme.
    辽宁综合环境规划 – 协助**5个主要工**业城市进行空气质量管理及成本效益分习工具培训
  - Jinan City – two studies looking at source apportionment & policy analysis
    济南空气污染源解析及空气质量管理政策研究项目 – **繁荣基金**
  - Vehicle emission modelling and analysis for typical Chinese cities
    正在进行的**中国典型城市机**动车排放模拟及**道路**边空气质量影响**分析** （**北京、深圳等**）
  - Current ongoing ADB TA is developing air quality action plans for three cities in the Greater Beijing-Tianjin-Hebei region – 2017-2019 [Baoding, Changzhi, Xingtai]
    当前正在为亚行进行的制定泛京津冀区域**3座城市空气**质量行动计划（2017-2019）项目 （**保定、**长治、邢台）

- Ongoing cost-benefit analysis for Tangshan AQ Roadmap for CRAES, under a TA contract of ADB.
  正在协助中国环科院进行的唐山市空气质量路线图成本效益分析
- Working with key national partners and experts including CAA, CRAES, Shandong Society for Environmental Sciences, Tsinghua University, Chinese Academy of Environmental Planning and valuable discussions and engagement with city Environmental Protection Bureaux and Development and Reform Commissions
  在众多项目上与来自亚中清洁空气中心、环科院、山东环境科学学会、清华大学和环规院等国内重要合**作方及**专家的紧密合作；与地方环保局和发改委的积极交流

Overview of Clean Air Action Plans

清洁空气行动计划概要

What are CAAPs and why are they important?
清洁空气行动计划介绍及其重要性

- **Clear plan for improving air quality setting out targeted and time-limited actions to be taken to achieve objectives and associated delivery mechanisms and partners**
  清晰的改善空气质量计划会设定针对性的、有时间限制的行动方案，给出需达到的目标、实施机制与参与伙伴

- **Objectives** could include specific standards, target reduction in emissions / concentrations, reducing population exposure
  可以是针对特定的标准、排放削减或浓度改善目标、改善人口暴露等

- Often form part of an overarching **air quality strategy**
  通常是国家空气质量长远战略的一部分

- Can be used to support **stakeholder engagement** – often an iterative process to develop / finalise
  能够支持利益方推进工作 – 通常是一个制定与确定的循环过程

What should an action plan / air quality strategy include?
行动计划/空气质量战略需要

Objectives of the plan and what it is attempting to deliver e.g. ambient AQ levels

计划的目标及目的，如空气质量等级，减排等

Details of **current air quality and emissions** status and how it is expected to evolve without further action

当前空气质量及排放情况的详细内容，以及如果不采取任何措施的未来情景

Which **sectors** are the main contributors to poor air quality

影响空气质量主要部门

What **actions are already being taken** (policies and measures) or will in the future

什么政策或措施已经实施或即将实施

Policies & measures that have been considered, assessed & which are to be implemented

考虑过的政策和措施，以及这些政策措施是如何评估的，那些是可以实施的（包括预期效果）

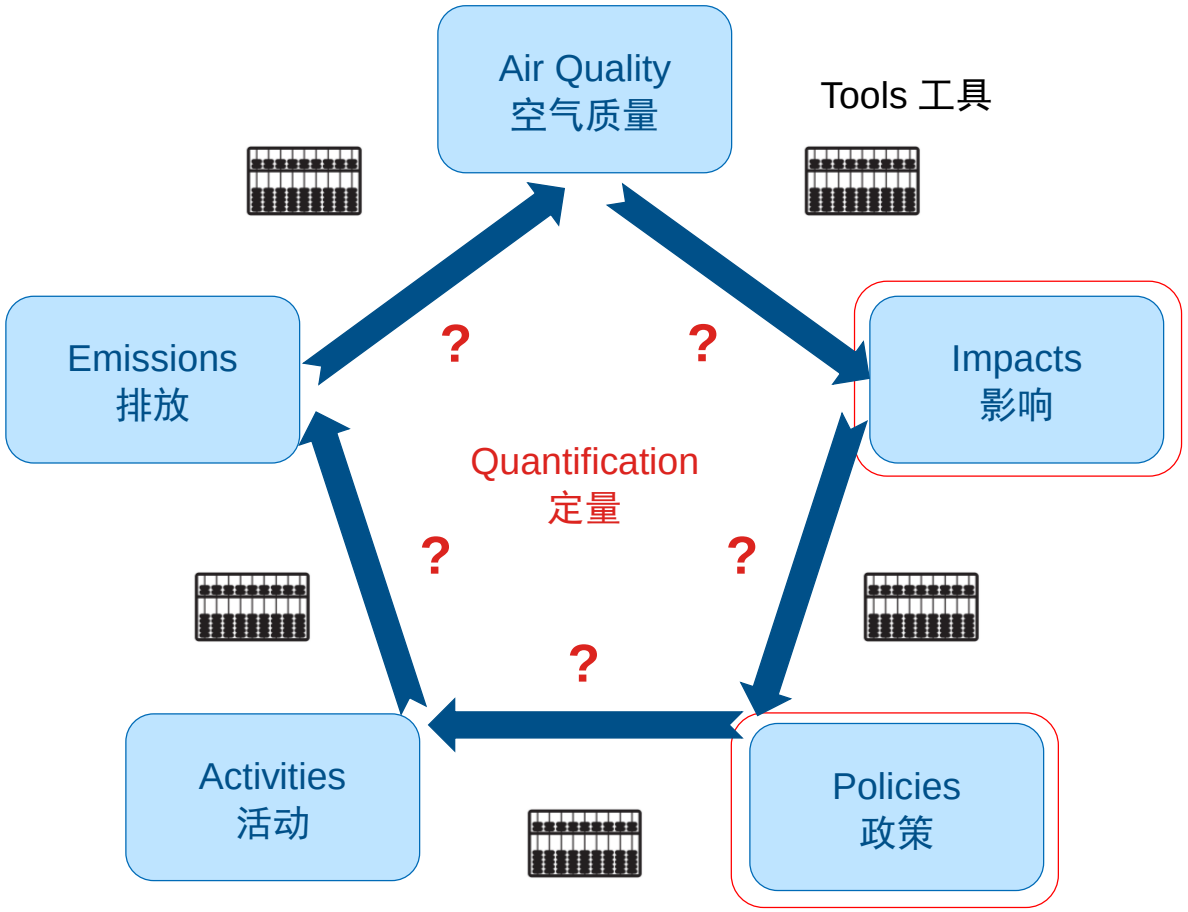
Clarity on **delivery timescales and partners**

阐明时间期限及参与方

How progress will be **monitored** and **evaluated**

如何对效果进行监督和评价

Air quality policy making cycle - 空气质量政策制定周期



- The design of policy to improve air quality requires characterising the current situation (baseline) and quantifying the effect of abatement measures.
- 改善空气质量的政策设计需要描述当前情况（基线）并量化减排措施的效果。

- This process is complex and requires the combination of multiple disciplines (physics, chemistry, economics, etc.).
- 这个过程很复杂，需要多学科（物理，化学，经济学等）的结合。

- The process should be supported by efficient tools that provide an answer to each of its stages.
- 该过程需要有效工具的支持，这些工具可为每个阶段提供相应的答案。

- Most of these tools consist of models: emission models, dispersion and chemical models, health impact models, behavioural response models, etc.
- 这些工具大多由模型组成：排放模型，扩散和化学模型，健康影响模型，行为反应模型等。

Objective: Building a strong evidence base for decisions
目标：为决策建立强有力的证据基础

Importance of data – 基础数据的重要性

Activities 活动水平	Emissions 排放	Air Quality 空气质量	Impacts 影响	Policies 政策
• Energy mix • 能源结构 • Energy consumption • 能源消耗 • Vehicle fleet and flows • 车队和车流 • Manufacturing data • 制造数据 • Shipping activity • 运输活动 • Population growth • 人口增长 • Available technologies • 可用技术	• Emission inventories • 排放清单 • Emission models • 排放模型 • Emission factors • 排放因子 • Gridded emissions • 网格排放 • Technology uptakes • 技术提升	• Dispersion models • 分散模型 • Meteorological data • 气象资料 • Receptors data • 受体数据 • Monitoring data • 监控数据 • Validation criteria • 验证标准 • Atmospheric deposition • 大气沉积	• Epidemiological studies • 流行病学研究 • Dose-response funct. • 剂量反应功能 • Demography data • 人口统计数据 • Population grids • 人口网格 • Crop damage functions • 作物损坏功能 • Abatement costs • 减少成本 • Damage costs • 损坏费用	• Behavioural responses • 行为反应 • Knock-on effects • 敲击效果 • Current legislation • 现行立法 • Future legislation • 未来的立法 • Response optimisation • 响应优化 • Policy acceptance • 政策接受

Using economic tools to develop CAAPs

利用经济学工具制定清洁空气行动计划

Understanding economic impacts

- **Net benefits of EU's 2030 clean air policy package are at least €40 billion per year**
  欧盟的2030清洁空气政策每年至少有400亿欧元的净效益

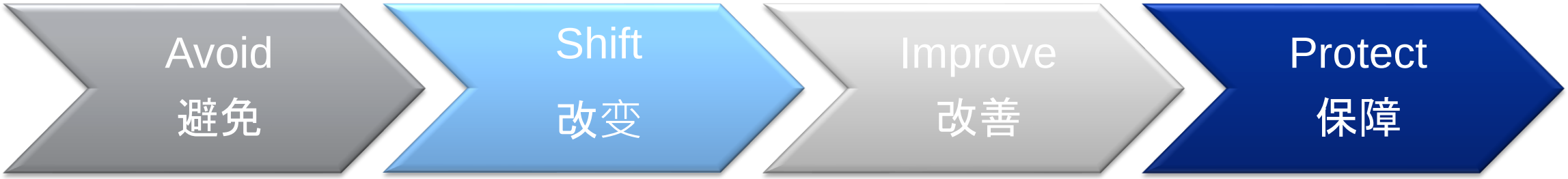
- Global cost associated with **health damage from ambient air pollution estimated to be $5.7 trillion, 4.8% of global GDP in 2016**.
  2016年，**全球由于**环境空气污染造成的健康损害约5.7**万**亿美元，占全球GDP**的**4.8%。

- Outdoor air pollution could cause **6-9 million premature deaths a year by 2060 and cost 1% of global GDP – around USD 2.6 trillion annually** – as a result of sick days, medical bills and reduced agricultural output, unless action is taken
  如果不采取相应行动，室外空气污染在2060**年会造成每年**600-900**万的**过早死亡，并损耗全球经济的1% - 约每年2.6**万**亿美元 – **包括人口疾病的天数**，医**药开销，农产品**减少**。

- Implementing package of top 25 Clean Air Measures **projected to cost US$300–600 billion per year, about 5% of projected annual GDP increase of US$12 trillion**
  25项清洁空气措施实施方案预计每年花费3000-6000亿美元，约为预期年GDP增长（12万亿美元）的5%

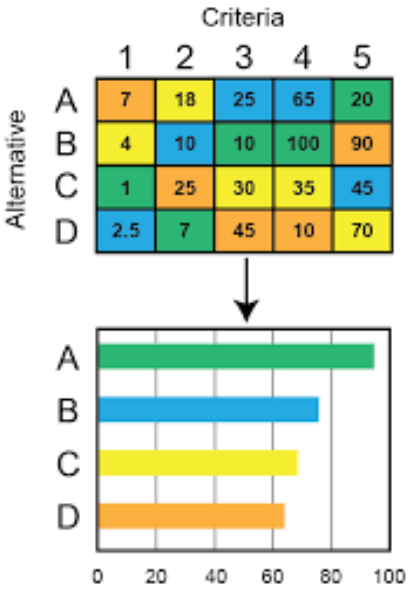
How should CAAPs be developed?
应当如何制定清洁空气行动计划

- Should to be underpinned by **robust data** to ensure measures are targeted - **maximise investments and achieve objectives in most efficient way**
  需要坚实可靠的数据基础能保证措施是具有针对性的 – **最大化投资利用，并以最有效的方式达成目标**
- **Toolkits** available to support the development of the evidence base – including for economic analysis
  支持证据基础数据探索的工具包 – **包括**经济学分析
- Build on actions taken elsewhere **tailored to local circumstances**
  参考在其他城市地区行动措施的行动经验
- Consider policies and measures around **key themes**
  考虑对重点关注问题的政策措施



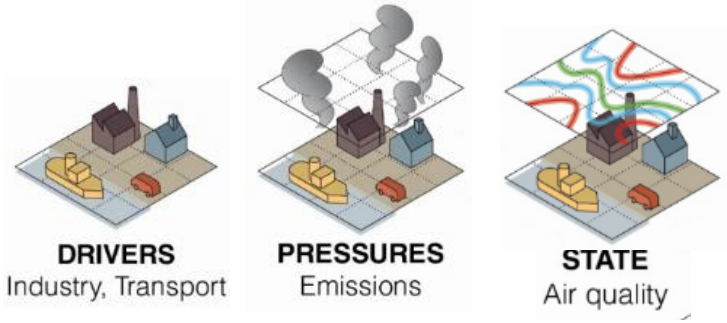
Selecting policies and measures (PaMs)
筛选政策措施

- Air quality is a global issue – **broad range of PaMs available and often well documented**
  空气质量是全球性话题 – 有广泛的政策措施库，并且都有很好的文本记录
- Based on source apportionment (sectors and pollutants) develop **long list of PaMs** – initial screening with stakeholders to help develop **short list**
  基于源解析（分部门、污染物）开发政策措施长清单 – 与利益相关者讨论，保留重点政策措施内容
- Approaches for assessing **most attractive options** e.g.:
  评估最有吸引力选项的方法，如：
  - Least cost / cost-effectiveness analysis
    最低成本/成本效果分析
  - Cost-benefit analysis (CBA)
    成本效益分析
  - Multi-criteria analysis (MCA)
    多尺度分析



- Consider **packages of PaMs** – to enhance outcomes and/or enablers
  考虑政策措施库 – **确保成果**
- Consider how they would be **financed**, **monitored and evaluated** after implementation
  考虑这些政策措施在实施后如何进行筹资、监督及评价

Air quality action plans for three cities in the Greater Beijing-Tianjin-Hebei region
泛京津冀区域3城市空气质量计划制定方案



Baseline
建立基础情景

- Current & projected activity & emissions.
  目前及预测的活动和排放
- Projected evolution of air quality.
  空气质量变化预测
- Reference for assessment.
  评估标准

Source Apportionment
源解析

- Main contributing sources & magnitude of their contribution.
  主要污染源及贡献度
- Seasonality and temporality.
  季节性分析，时间尺度分析
- Spatial variation of contribution.
  空间分布规律
- Defines priorities for action.
  确定行动措施优先级

Policy Scenarios
政策情景

- Long list of policies for main sectors.
  主要部门政策清单
- Selection of measures for policy packages.
  为政策包选择措施
- Additional to those of the baseline.
  对基准情景的加强
- Consider co-benefits
  考虑成本效益

Emissions & air quality
排放及空气质量

- Effect of measures on emissions & air quality.
  措施对排放和空气质量的影响
- Effect of measures on sources contrib.
  措施对污染源贡献的影响
- Effect of measures on environmental standards. 措施对环保标准影响

Assessment of Impacts
影响评估

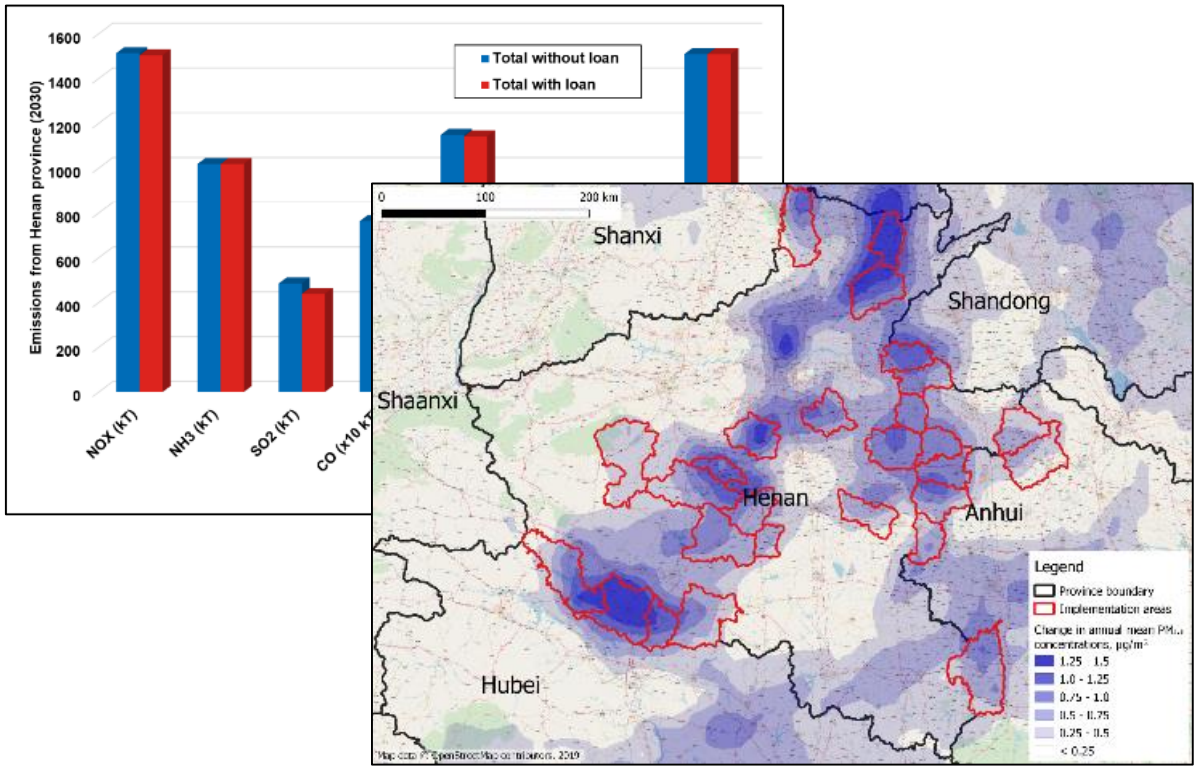
- Reducing health impacts from exposure to air pollution
  减少暴露于空气污染带来的健康影响
- Assessment of costs 评估成本
- Assessment of economic & other benefits
  评估经济及其他效益
- Cost-benefit analysis.
  成本效益分析

Policy Recommendations
政策建议

Air Quality Action Plan
空气质量行动计划

PaM assessment Case study: “Coal substitution” in Henan Province
政策措施案例：河南省“气代煤”项目效益评估

- **Context** – Targeted loan from ADB to local authorities, replace coal with clean energy – nature gases, mainly in domestic sector.
  利用空气质量模型、经济及健康模型评估ADB拟投**的“气代煤”**贷款项目对河南省及替代城镇的环境及**社会效益**

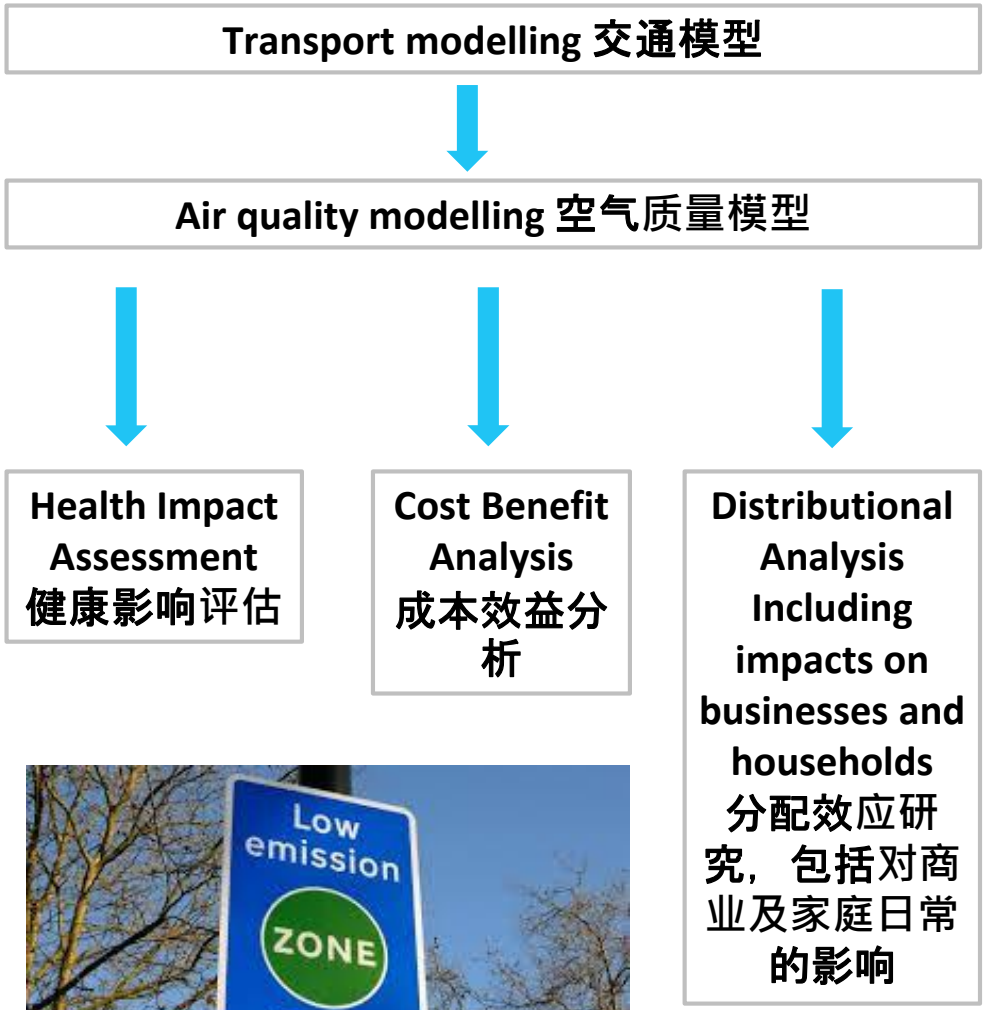


- **Env. Benefits** – Average 0.4, 0.2 and 0.05 µg/m^3 reduction in concentration of $PM_{2.5}$, SO_2 and NO_2 with the measure. Maximum 1.7, 1.5 and 0.5 µg/m^3 reduction in pilot counties in 2030.
  环境效益 – 至2030年，**全省**$PM_{2.5}$, SO_2**和**NO_2**年均浓度可分**别降低0.4, 0.2 and 0.05 µg/m^3, 实施城镇最大**可降低**1.7, 1.5 and 0.5 µg/m^3 。

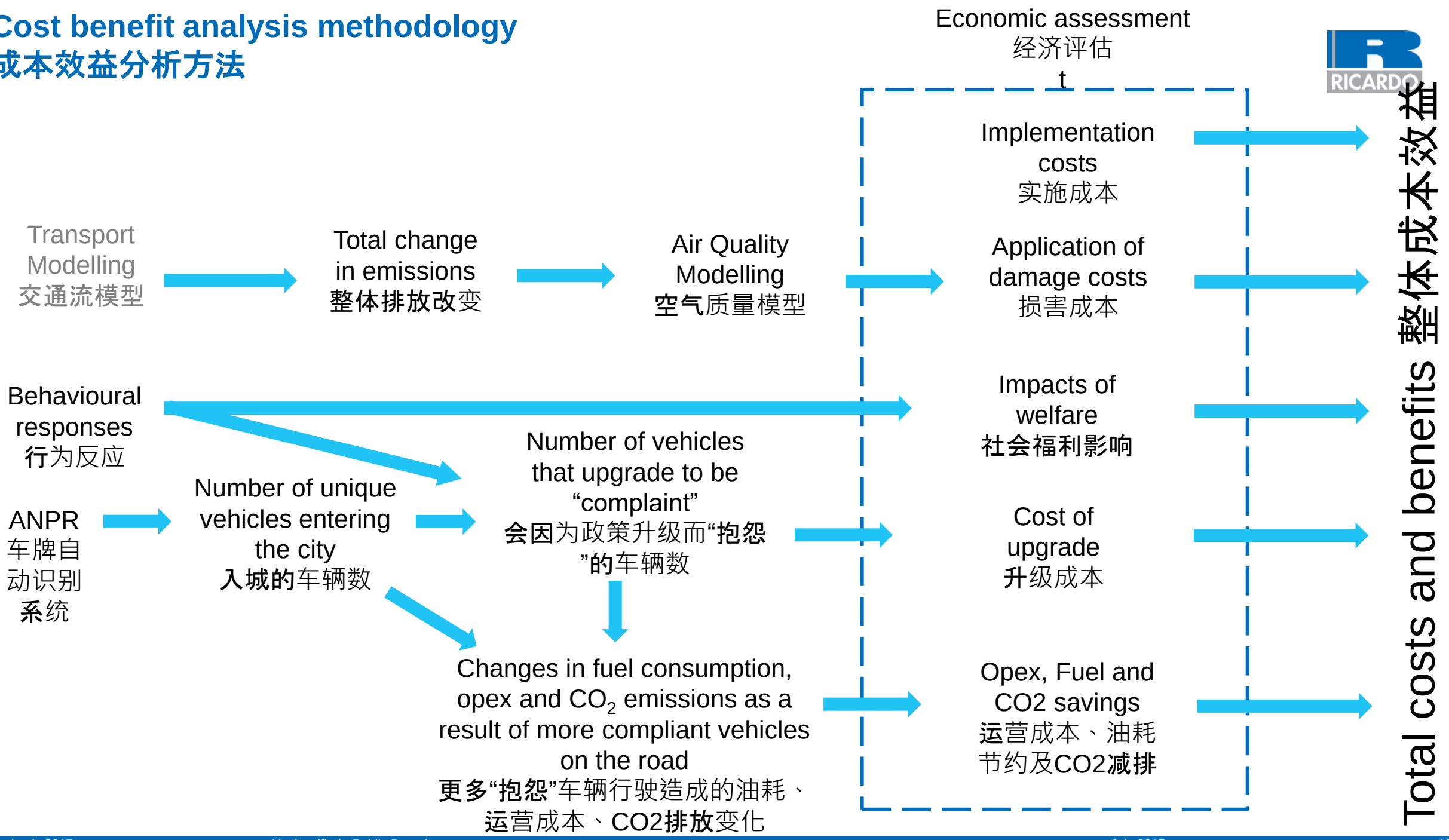
- **Social Benefits** – 2533 avoided deaths and 29515 avoided years of life loss. Total economic benefits were calculated to lie between 1.2-5.1 billion US dollar in 2030.
  社会效益 – 预计可避免2533**例**过早死亡及29515**年的生命**损失。相当于12 – 51亿美元的经济效益

UK Clean Air Zone (CAZ) development
英国清洁空气区制定

- Our Clean Air Zone work looks at the various impacts of policies that seek to reduce air pollutant from transport in cities – 8 cities to date
  英国清洁空气区的制定工作主要为了各城市寻求不同的交通减排政策并评估其影响 – 目前已完成8个城市
- Example policies include charging schemes, traffic bans 其中包括一些收费措施、交通管制等措施
- Impacts include: 其影响评估可能包括
  - GHG emissions 温室气体排放
  - Changes in air quality 空气质量改善
  - Welfare / health 社会福利及健康
  - Implementation costs 实施成本
- Impacts to the local community including 本地影响包括
  - Costs of buying new vehicles 新车购置成本
  - Changes in health outcomes 健康情况的变化
  - Changes in pollution at key sites including schools and hospitals 重要监控点位（如学校、医院）的污染变化
  - Analysis of how the young, elderly, disabled and poorest will be impacted 分析幼年、老年、残疾及贫困等敏感人群的影响



Cost benefit analysis methodology
成本效益分析方法



Calculating changes in costs 计算成本变化

Cost of transport policies 交通政策成本

- New vehicles 新车
- Fuel consumption 油耗
- Maintenance costs 运维成本
- Greenhouse gas emissions 温室气体排放

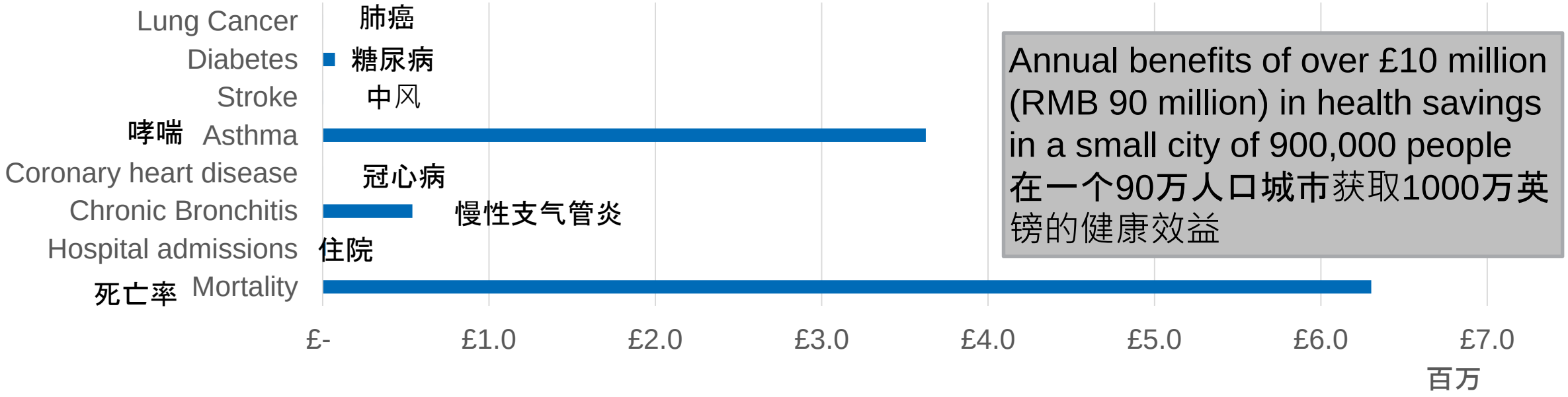
(Vehicle fleet after new policies 政策情景下的车队情况 − Current fleet 当前车队) × Annual costs 年均成本 × Number of years before the baseline would catch up 基准年份达到预期成果所需要的年份

Savings to health from changes in air pollution
改善空气污染从而保证健康

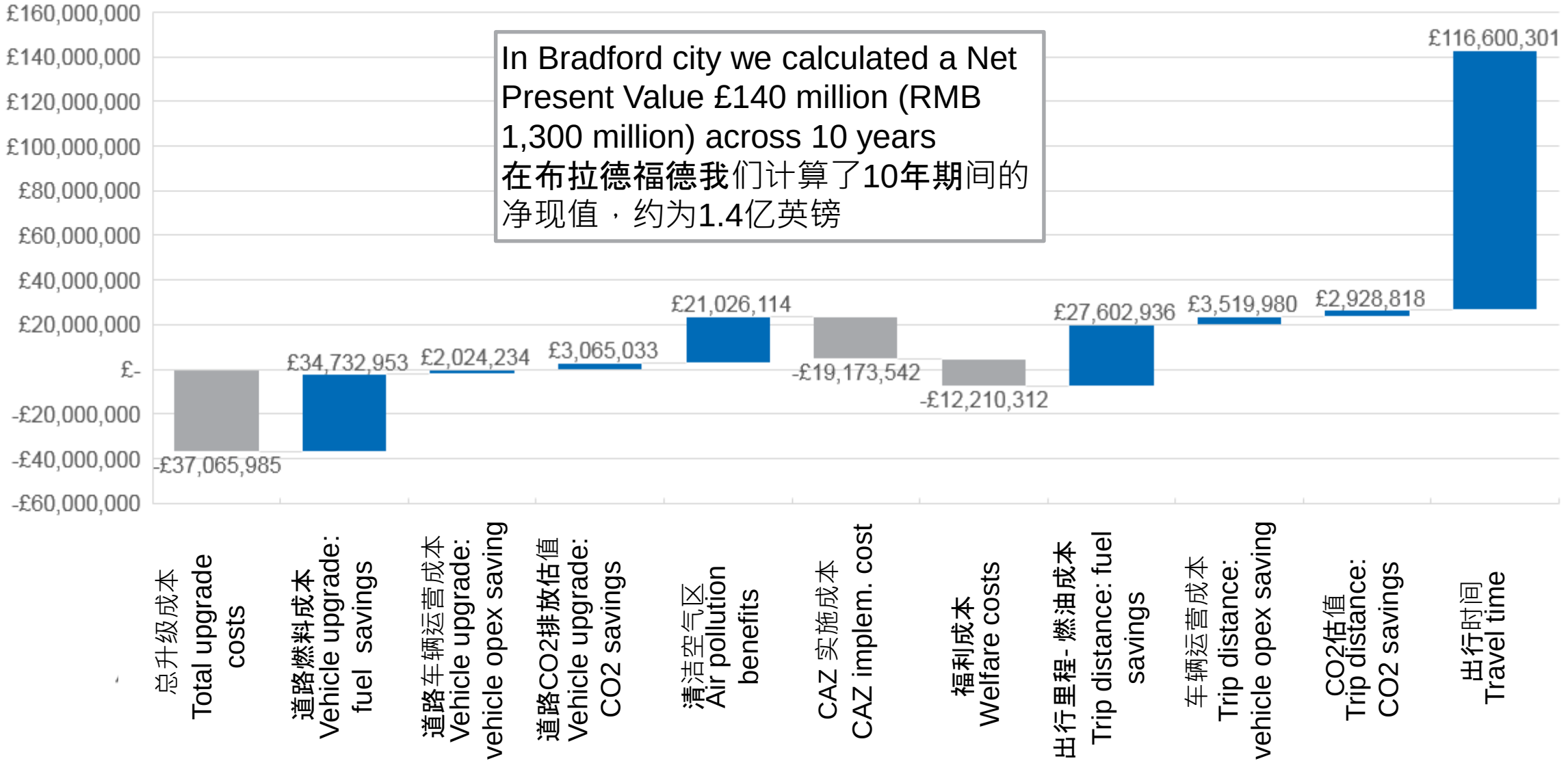
- Air pollution impacts on human health, ecosystems, crops, or soils can be modelled through different methodologies. Health impacts are the most pressing ones.
- 空气污染对人类健康，生态系统，作物或土壤的影响可以通过不同的方法进行建模。 健康影响是最紧迫的。

- Health impacts can be estimated from exposure to $PM_{2.5}$, NO_2 and O_3. Heavily determined by epidemiologic results, demography, and exposure considerations.
- 健康影响通过$PM_{2.5}$，NO_2和O_3的暴露来评估，受到流行病学研究结果，人口统计学和接触考虑等因素影响。

- Costs associated with health impacts can be estimated based on values from literature.
- 与健康影响相关的成本可以基于文献中的值来估算。



How we value economic benefits and costs – overall CBA
如何将经济效益及成本价值化 – 整体成本效益

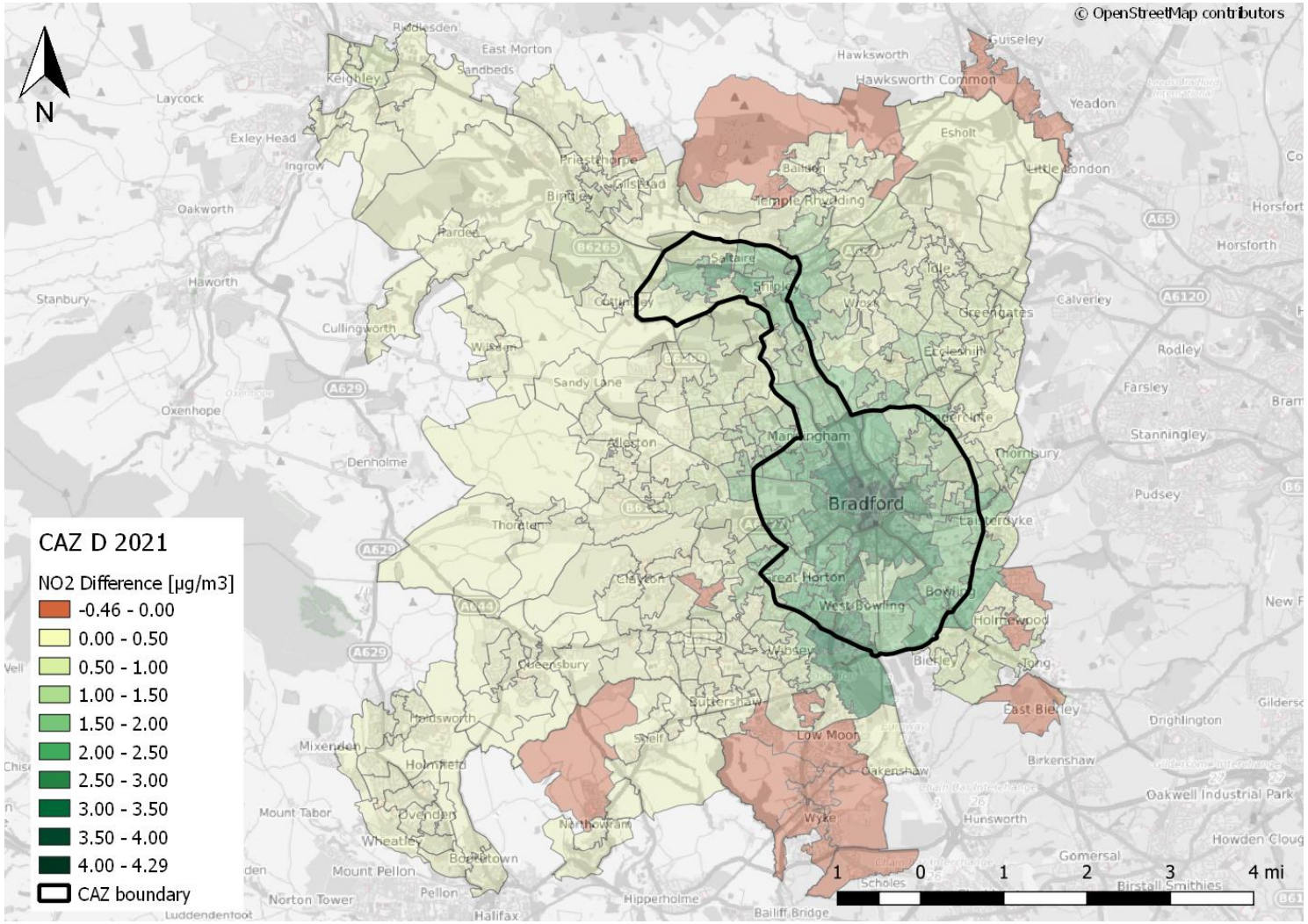


Distributional Analysis – costs and benefits 分布分析 – 成本效益

Distribution analysis looks at 6 key impact groups:
分布分析关注6个主要群体

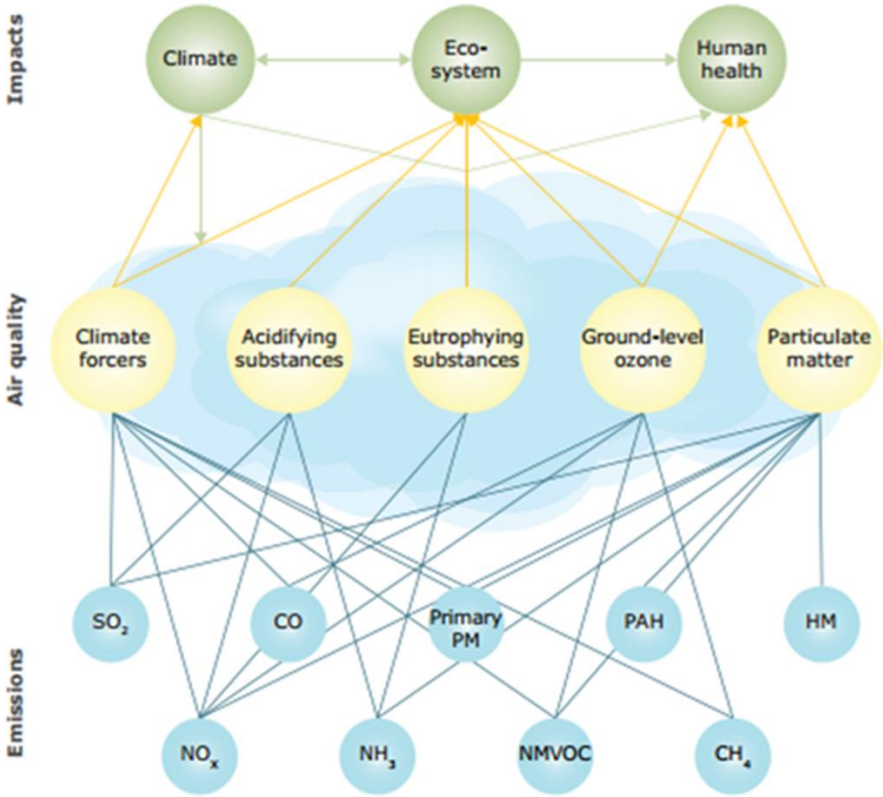
- Low income areas
  低收入区域
- Children (including schools)
  儿童区（包括学校）
- The elderly 老人
- People with disabilities 残疾人
- Businesses 商务区
- Impacts based on gender and ethnicity 性别及种族影响

Will any particular impact group be affected more? Can we maximise impacts for certain groups? E.g. children.
是否可让某种人群受益更多？例如让儿童群体的受益最大化



Maximising co-benefits when selecting policies and measures
成本效益最大化

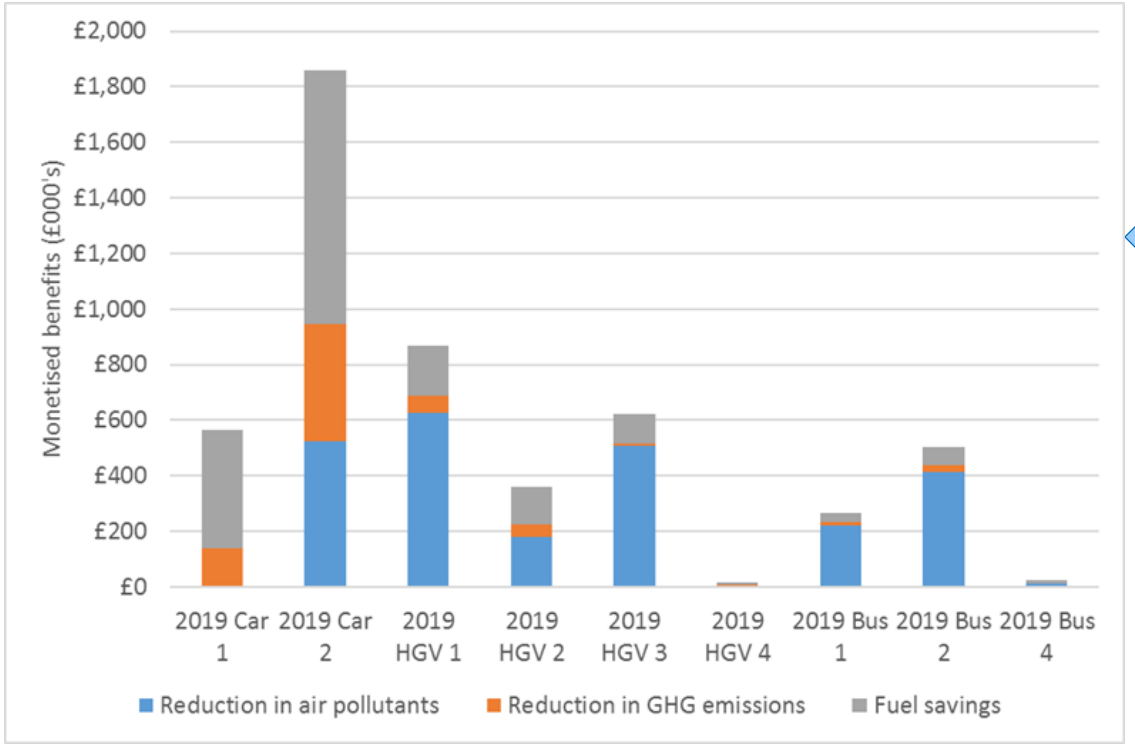
- Prioritise PaMs that **simultaneously address air pollutants and greenhouse gases** leading to a more efficient use of resources:
  优先考虑的政策措施库应当能够**同时达到空气污染物及温室气体控制，并且能引**导更加优化的资源利用效率
  - **Sources** typically the same.
    排放源分类基本相同
  - **Several air pollutants are climate forcers** (ozone and black carbon)
    一些空气污染物同样也是气候变化关注点（臭氧、黑炭）
  - **Some GHGs are ozone precursors** (methane)
    一些温室气体是臭氧前体物（甲烷）
  - **BUT can be conflicts** e.g. diesel, biomass burning
    但可能存在一些冲突 例如 柴油及生物质燃烧
- Potential for significant other benefits e.g. noise, odour, congestion / travel time
  其他潜在的显著效益，如噪音、臭味、拥堵及出行时间的降低等
- **Economic analysis can help to capture these impacts and ensure most efficient and effective options are selected**
  经济学的分析能够协助分析这些影响，并确保最终的解决方案是最有效率、效益的。



Selecting policies and measures
Case study: UK City Low Emission Strategy
案例：英国城市低碳政策

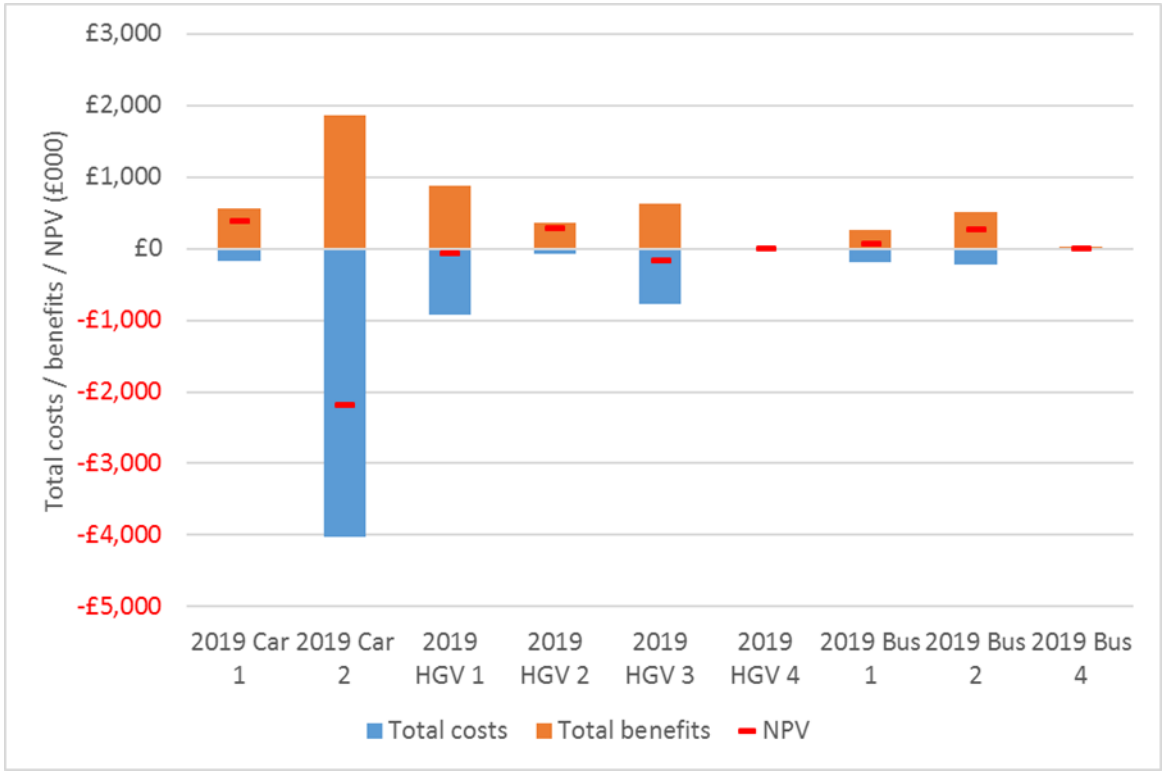
- **Context** – recognition that added value can be gained from tackling air quality and climate change in an integrated approach
  背景 – **肯定空气**质量及气候变化协同管理方法能够获取附加价值
- **Concept** – an integrated package of measures to reduce transport emissions covering both air quality and carbon emissions
  内容 – **一份降低交通运**输空气污染物及碳排放的综合政策措施库
- **Development approach**
  研究方法
  - Stakeholder engagement to support measure identification
    利益相关者的参与，支持决策制定
  - Emissions assessment covering both air pollutants and carbon emissions
    空气污染物及碳排放的排放评估
  - Cost Benefit Analysis
    成本效益分析

Case study: UK City Low Emission Strategy – Economic Case
案例：英国城市低碳政策 – 经济案例



Monetised Benefits
货币化效益

Balancing Costs and Benefits
成本效益权衡分析



Ricardo / CAA ADB seven cities air quality technical assistance contract and BAQ2020
BAQ2020及亚行7座城市空气质量技援项目情况

TA-9608 REG: Strengthening Knowledge and Actions for Air Quality Improvement
技援9608项目：强化认知以及空气质量改善行动

- 2 year programme led by Ricardo and Clean Air Asia (and supported by city partners)
  里卡多与亚洲清净空气中心牵头的**2年**项目（地方城市伙伴支持）
- Aims to address gaps in capacity to deliver improvements in air quality in cities in Asia by **enhancing the knowledge and capacity of participating cities to develop policy actions and technological solutions for air quality management**.
  旨在通过加强专业及能力建设解决亚洲城市改善空气质量工作的差异问题，参与城市制定空气质量管理技术和政策方案工作
- Partnership with the cities for the **preparation of realistic and effective City-Level Clean Air Action Plans (CAAPs) along with supporting investment plans**.
  与地方城市合作筹备有实际成效的城市尺度清洁空气行动计划，并协助投资方案等事宜

The People's Republic of China Poverty Reduction and Regional Cooperation Fund (PRC Fund)

URBAN CLIMATE CHANGE RESILIENCE TRUST FUND
Asian Development Bank

ADB

- Additional objectives include: 额外目标
  - Mainstreaming of CAAP into other planning and policy areas.
    协助CAAP**在其他**规划区域内的实施
  - Maximising co-benefits of actions taken to improve air quality e.g. climate
    最大化行动在改善空气质量以外的协同效益，如气候变化
  - Sharing of air quality management knowledge and experience from PRC and other countries (e.g. technology transfer)
    分享中国及其他国家的空气质量管理知识及经验（如技术转移）

Scope of TA contract
项目概览

- **To develop and support the implementation of CAAPs for seven cities** in five ADB DMCs:
  在5个ADB投资国家的7个城市， 分别制定清洁空气行动计划，并协助实施
  - Faridpur in Bangladesh 孟加拉的福里德布尔
  - Erdenet in Mongolia 蒙古额尔登特
  - Peshawar and Sialkot in Pakistan 巴基斯坦白沙瓦和锡亚尔科特
  - La Trinidad in the Philippines 菲律宾特拉尼达
  - Ho Chi Minh and Vinh Yen in Viet Nam (to be confirmed) 越南胡志明及永安（待定）

City level air quality studies
城市尺度空气质量研究

→

Identifying innovative tech and policy measures (including economic analysis)
确定创新技术及政策措施（包含经济学分析）

→

Preparing city level Clean Air Action Plans (CAAPs) 筹备城市尺度清洁空气行动计划

Linkages to Chengdu – BAQ 2020
连接成都 – BAQ 2020 会议

Better Air Quality conference is the biggest AQ event in Asia every 2 years
更好空气质量会议是亚洲最**大的空气**质量会议，每两年**一次**

We will be hosting all of our cities at BAQ2020 as part of the policy and technology transfer elements.
我们将在会议上为**7座城市提供**经验交流及座谈会等协**助**，**作**为项目技术转移和政**策**协助的一部分

Questions?
欢迎提问

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