2. 项目介绍与背景

受中国环境保护部的委托，ICCT从2009年7月起，开始对中国机动车排放控制措施进行综合性评估。本次评估项目——在此称为回顾分析，主要包括以下几个方面：

1) 对中国当前的机动车污染控制措施进行定量和定性评估，分析成果和不足之处。

2) 提出近期推荐方案（针对“十二五”计划）和长期推荐方案(2015 – 2030)。

3) 为今后的方案效果评估提供技术方法。

此次的项目，涵盖了包括农用车的所有道路机动车类型，同时还包括了燃料消耗量管理方案分析。ICCT的研究分析工作从四个主要任务入手，实现上述目标:

1) 总结中国现有的标准和实施措施，将其与国际先进管理经验进行比较；

2) 设计未来情景，分析引入和实施排放标准及燃料消耗量标准的效果；

3) 开发机动车模型，评估现有和今后可能的排放标准及燃料消耗量标准的影响；

4) 评估现有和今后可能的管理方法所带来的健康影响价值和经济收益。

ICCT的项目组由Fanta Kamakate和ICCT董事会会长Michal Walsh(本项目的指导顾问)二位领导，包括冯淑慧、Ben Sharpe、何卉、Kate Blumberg和孙永伶几位组员组成。内部审查委员会成员包括Alan Lloyd、Drew Kodjak、John German 和Anup Bandivadekar。ICCT董事会成员王全录参与部分替代燃料与新能源汽车章节的撰写工作。同时ICCT与机动车排污监控中心（隶属于环保部的政策研究中心）和清华大学合作这研究项目。这两个合作单位为我们提供了所需的数据和信息，这些数据和信息很有价值，能使我们更好的了解中国的国情。

2.1 历史背景和现行车辆排放控制措施的意义

在过去的30年中，中国的机动车保有量显著增长。过去10年中的飞速增长，使中国在2009年成为世界上最大的汽车生产和销售国。如图2.1所示，道路机动车的年销售量（不含两轮车辆和农用车）已经从1980年的25万辆增长至2008年的1000万辆。与此同时，两轮车辆（摩托车和电动自行车）的年销售量也从60万辆增至惊人的5000万辆以上。从2000年至今，轿车、卡车和巴士总保有量翻了两番以上，从1350万辆增长至6000万量以上。而在这10年当中，摩托车的保有量也增加了两倍，从6800万增加至2亿辆以上。

2. Project introduction and background

The International Council on Clean Transportation's (ICCT) comprehensive assessment of China's vehicle emission control program began in July of 2009 at the request of the Ministry of Environmental Protection (MEP) of China. The main objectives of this project-hereto referred to as the Retrospective Study-are as follows:

1) Assess both quantitatively and qualitatively the successes and gaps in China's current vehicle pollution control program.

2) Provide recommendations for program improvements in the near term (to inform the 12th 5-year plan) and the long term (2015 – 2030) .

3) Provide tools for continued assessment of the program's impact.

The project scope extends to all on-road vehicle types as well as rural vehicles and includes an analysis of fuel consumption regulations. The ICCT organized its activities to achieve these objectives in four major tasks:

1) Summarizing regulations adopted and implemented to date and comparing them to international best practices；

2) Establishing future scenarios for the adoption and implementation of emission and fuel consumption regulations；

3) Developing a fleet model to estimate emission and fuel consumption impacts of current and potential future regulations；

4) Assessing costs and monetizing health benefits associated with current and potential future regulations.

The ICCT project team is led by Fanta Kamakaté and Michael Walsh, chairman of the ICCT board (advisor) and includes Freda Fung, Ben Sharpe, Hui He, Kate Blumberg, and Yongling Sun. The internal review committee is comprised of Alan Lloyd, Drew Kodjak, John German, and Anup Bandivadekar. Board member Michael Wang provided input to the chapter on Alternative Fuels and New Energy Vehicles. Collaborations with the Vehicle Emission Control Center (VECC), which is a policy research center affiliated with MEP, and Tsinghua University have facilitated the availability of data and information, which has been extremely valuable in better understanding the Chinese context.

2.1 Historical context and significance of the current vehicle emission control program

The vehicle population in China has experienced significant growth over the past thirty years. The tremendous growth in the last decade has led China to become in 2009 the largest vehicle producer and consumer in the world. As shown in Figure 2.1, annual sales of on-road vehicles (excluding two-wheelers and rural vehicles) have grown from roughly 250,000 in 1980 to nearly 10 million vehicles in 2008. Over that same time period, two-wheelers (motorcycles and electric bikes) annual sales have grown from about 600,000 to a staggering 50+ million. Since 2000, the total stock of cars, trucks, and buses has more than quadrupled from 13.5 to over 60 million vehicles. Over this ten-year span, the total stock of motorcycles has roughly tripled from 68 to over 200 million.

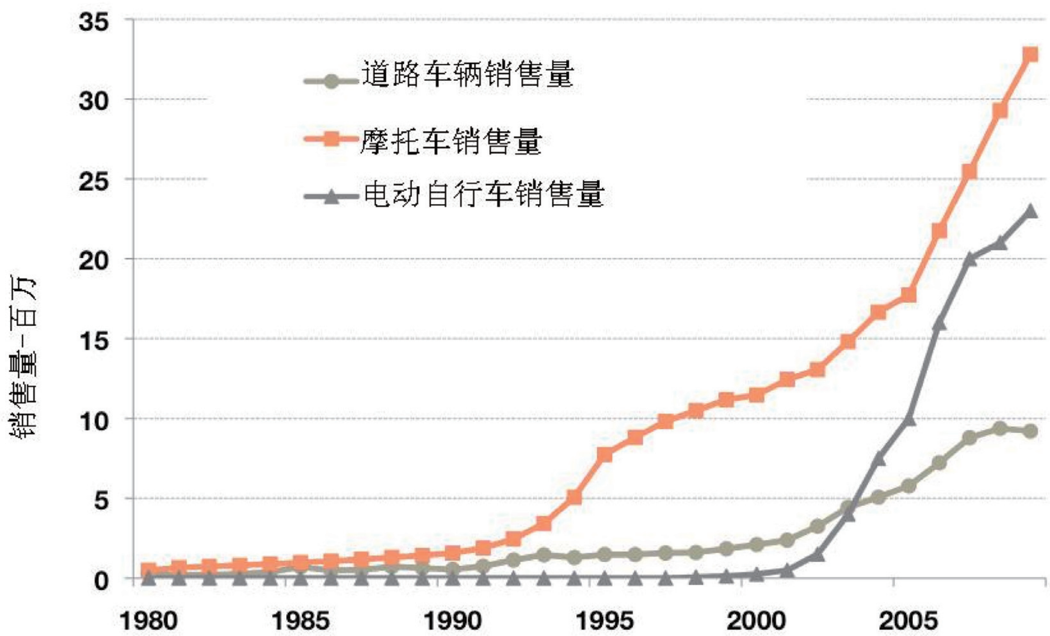

图 2.1: 1980 – 2009[6]年车辆销售量 (道路车辆包括乘用轿车、卡车和巴士)

考虑到过去10年中机动车的增长情况，控制机动车排放影响的工作就显得意义更加重大。回顾过去在改善空气质量方面所取得的成就，从上世纪80年代初开始，中国的排放控制立法取得了重大发展。图2.2展示了中国移动源排放控制的几个里程碑，包括颁布和修订《大气污染防治法》。此法为中国实施各项空气质量管理措施的基石。针对机动车排放，具有重大意义的第一步就是1999年在北京和上海开始实施国I排放标准[7]。更多车辆和燃料管理措施将会在后面的章节中予以讨论。

6 图中的数据来源于中国机动车模型(China Fleet Model, CFM)。CFM模型中所包含的历史销售量数据/评估值来源于美国阿岗实验室与霍红共同开发的一个模型。这些数据是基于1980-2008年中国汽车技术研究中心的《汽车工业年鉴》，并据此对此后几年做出情景分析。因此，图中2008年以后的销售数据可能无法准确体现真实销售量。

7 和世界上许多国家一样，中国也选择了效仿欧盟的车辆和燃料管理标准。在欧盟管理中，轻型车和重型车标准分别采用阿拉伯数字和罗马数字来编号，而在中国却没有正式区分，轻型车和重型车标准都是使用罗马数字。和欧盟模式一样，数字数值的越高表明实施的标准越严格。

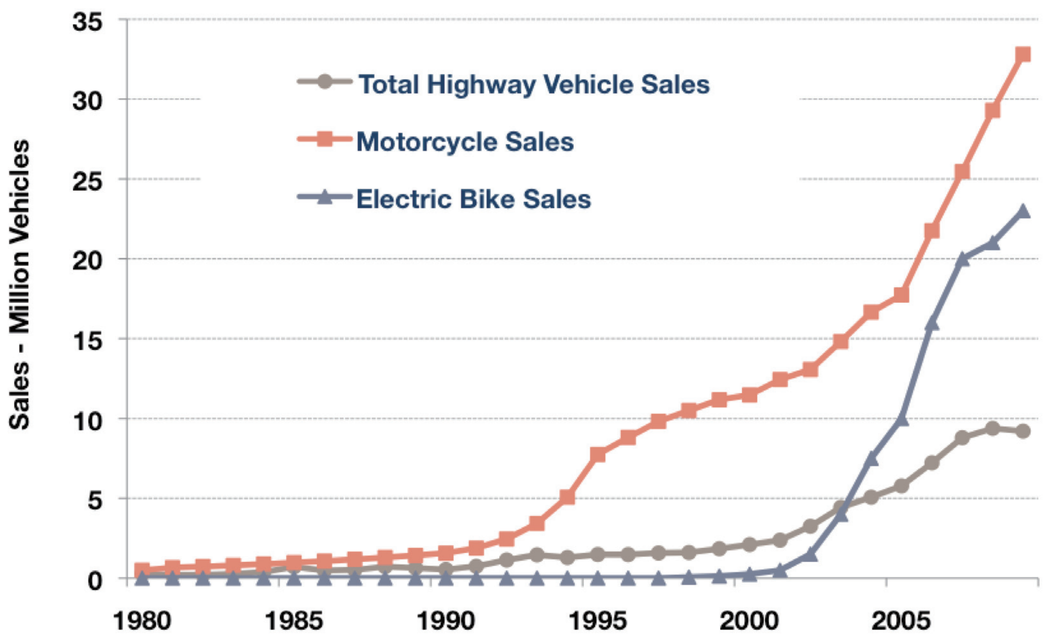

Figure 2.1: Vehicles sales from 1980 – 2009[6] (highway vehicles include passenger cars, trucks, and buses)

Given the sheer magnitude of vehicle growth over the past decade, the task of curbing the negative impacts of vehicle emissions has taken on increased significance. Looking at the history of efforts to improve air quality, emission control legislation in China has evolved greatly since its inception in the early 1980s. Figure 2.2 highlights a few select milestones in China's mobile source emission control including the establishment and revisions of the "Air Pollution Prevention and Control Law", the cornerstone of the air quality program. The first significant policies targeting vehicle emissions were phased in with the implementation of 'China I' standards[7] in Beijing and Shanghai in 1999. The various elements of the vehicle and fuel programs are discussed in more detail in later chapters.

6 Data in this figure comes from the China Fleet Model (CFM). The CFM has historical sales data/estimates from the model developed by Hong Huo and the Argonne National Laboratory. This data is based on China Automotive Technology and Research Center (CATARC) "Automotive Industry Yearbooks" for years 1980 through 2008, and then projections are used for the subsequent years. As such, data points in this figure may not accurately represent sales for years after 2008.

7 Like many countries around the world, China has chosen to mirror its vehicle and fuels programs after those set forth by the European Commission. In the Euro program, the Arabic numerals and Roman numerals denote standards for light- and heavy-duty vehicles respectively; however, in China, there is no official distinction, and Roman numerals are used to represent both light- and heavy-duty standards. As with the Euro program, increasing number values imply greater stringency of the standard.

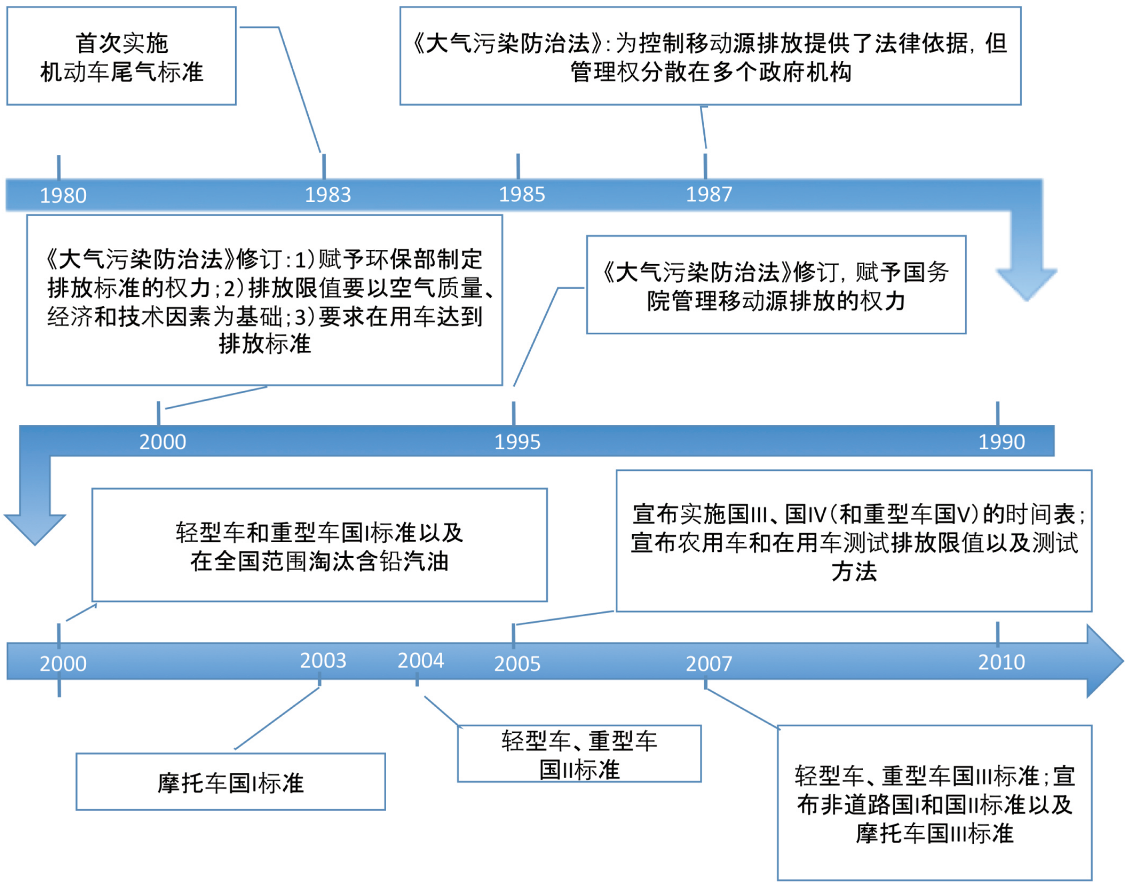

图2.2：中国机动车排放控制政策的里程碑

尽管车辆保有量和使用率都有巨大增长，中国的车辆排放控制措施还是能有效的削减常规污染物排放。根据中国机动车模型（CFM），从2000年到2010年，较之无管理情景，现有管理措施累计减排总碳氢化合物（THC）4450万公吨、一氧化碳（CO）2.387亿公吨、氮氧化物（NOx）3800万公吨和颗粒物（PM）700万公吨。中国机动车模型（CFM）数据源、假设和方法论详见附录B。

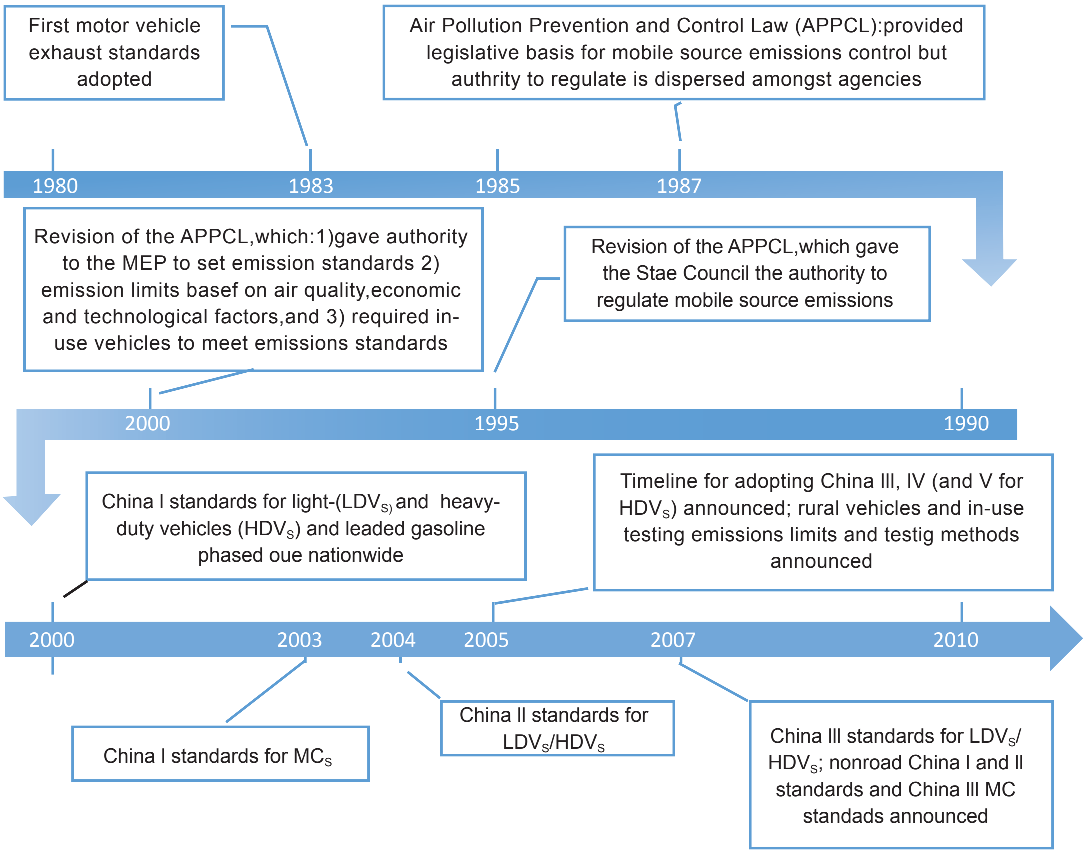

Figure 2.2: Selected milestones in China's vehicle emission control program

Despite the massive growth in vehicle stock and activity, China's vehicle emission control program has been effective in curbing criteria pollutant emissions. According to the China Fleet Model (CFM), between 2000 and 2010, the cumulative emissions benefit of the current program over a "no program" scenario has been 44.5 million metric tons for total hydrocarbons (THC), 238.7 million metric tons for carbon monoxide (CO), 38 million metric tons for oxides of nitrogen (NOx), and 7 million metric tons for particulate matter (PM). For a detailed account of the China Fleet Model data sources, assumptions, and methodology, please see Appendix B.

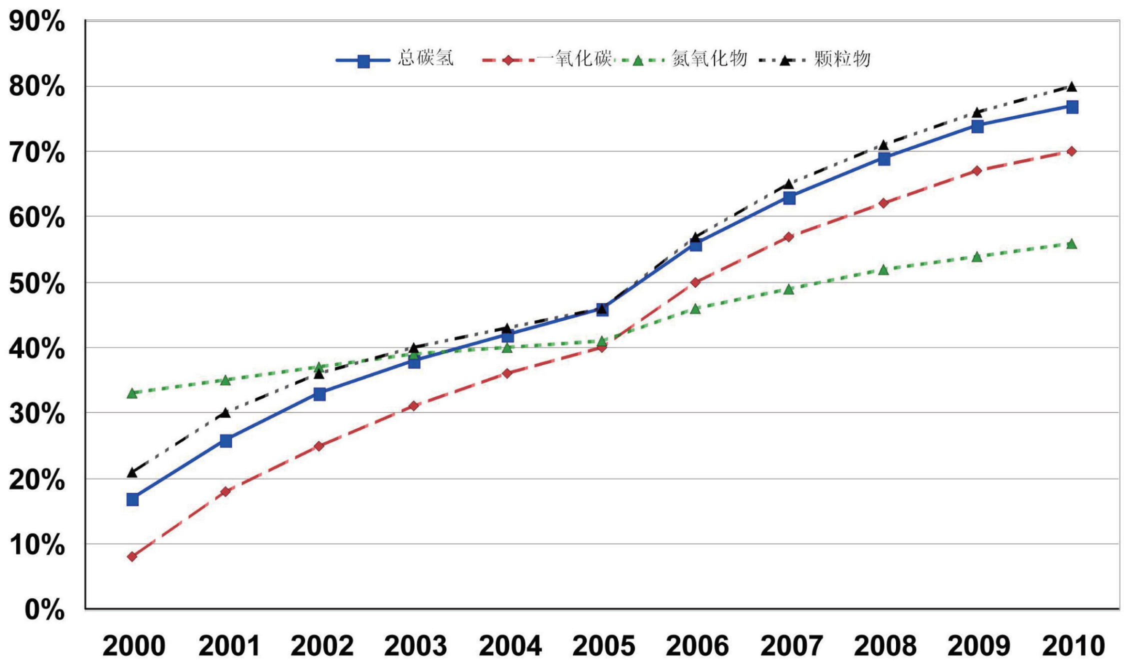

图 2.3: 相对于无管理情景实施现行管理措施的减排效果（减排百分比）

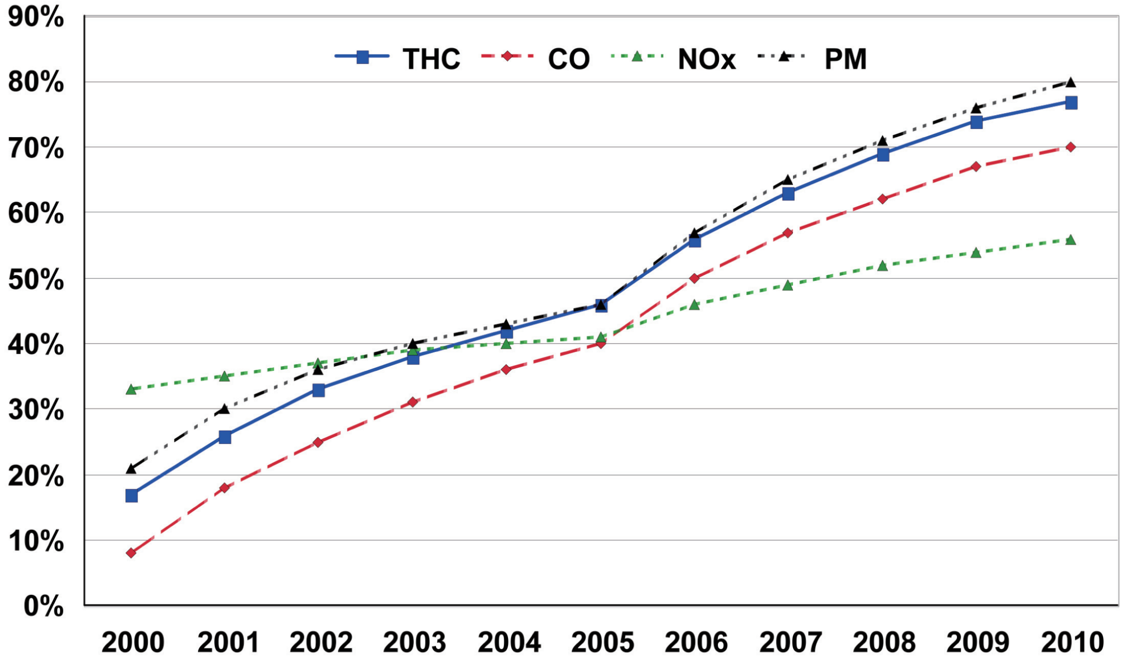

Figure 2.3: Percent emission reductions of current program versus no program

科学界一致认同，人口暴露于机动车的尾气污染物中会增加死亡率和发病率。很明显，实施各项政策至今已取得了实质性的健康收益。我们根据CFM模型的减排计算结果，估算出了现行机动车管理措施已避免的过早死亡人数和其它健康影响。而这一估算仅仅是包括了车辆直接排放的颗粒物和由NOx排放所形成的二次颗粒物的健康影响，尚没有将臭氧形成以及直接的NOx、CO、有毒物质、挥发性有机化合物（VOCs）和其它排放物的影响考虑在内。表2.1列出了评估结果，显示中国现行的各项政策在过早死亡、急慢性支气管炎、哮喘、入院就医和工作影响天数等方面所取得的效益。关于健康影响定量评估的方法论，详见附录B。

这些健康收益结论与近期由Zhang等人开展的一项关于中国空气污染健康影响的研究结论相一致，但我方更趋于保守[8]。与Zhang的研究相比，我们的结果显示2004年（Zhang的研究完成的同年）机动车排放所带来的健康影响占空气污染健康影响的十分之一。在工业化国家的主要城市，移动源污染在空气污染中的贡献率通常高达50%-80%以上[9]。并且移动源污染靠近人体呼吸高度，在中国增长速度也很快。可以估计，移动源在中国应带来比这研究计算更大比例的健康影响，并且影响力还将随着时间不断加大[10]。与其它研究相比，本文中的分析结论应该说是比较保守的，对健康影响的估计较低。

表2.1: 当前政策对避免不利健康影响的收效评估

健康影响 (千人或千天)	2000年	2005年	2010年
提前死亡	6.3	30	110
入院就医	0.95	4.2	15
慢性支气管炎	14	63	220
急性支气管炎	75	320	1,100
哮喘	96	420	1,400
工作影响天数	7,400	33,000	110,000

根据保守估计，健康收益的价值十分可观。2010年，避免健康损害的收益约价值1700亿人民币（250亿美元），相当于国内生产总值（GDP）的0.5%。在本研究中，对于健康影响价值的评估，主要是基于在中国大陆地区进行的一些关于中国对降低由空气污染带来的健康风险的付出预期的研究。关于健康影响评估的具体方法论，详见附录B。

8 Zhang, M等人著，2008年，《中国111个城市颗粒污染物的健康影响经济学评估---疾病带来的经济负担分析》（ Economic assessment of the health effects related to particulate matter pollution in 111 Chinese cities by using economic burden of disease analysis ）《环境管理期刊》（Journal of Environmental Management ）88:947-954.

9 Han, X, 和 Naeher, L.P. 2006年，《发展中国家的交通空气污染评估研究》，《国际环境》（Environment International ）32:106-120.

10 近期一项关于北京PM2.5 的研究表明机动车是城市颗粒物的主要污染源(Chan, C.T. 等人，2005年，《北京地区PM2.5、PM10，和含碳物质的垂直分布特征和来源》,《大气环境》39:5113-5124; Dan等人，2004年，《北京地区含碳物质的特征与在PM2.5中成分的来源》,《大气环境》38:3443-3452)。根据Dan等人的研究，2001-2002年期间，PM2.5的浓度在冬季上升了50%-100%，这说明尽管已经采用清洁燃料取代了煤来减少颗粒物，家庭取暖仍是一个重大的排放源。尽管如此，根据估算，如不采取额外的排放控制措施，机动车排放所带来的健康影响，在中国仍然至少要占20-30%，甚至比例更大。

Given the consensus within the scientific community that human exposure to the pollutants in vehicle exhaust can lead to increased incidence of mortality and morbidity, it is evident that the policies carried out to date have resulted in substantial public health benefits. Avoided premature deaths and other health impacts were estimated using outputs from the CFM. These estimates only account for direct PM and secondary PM formation due to NOx emissions and do not include health impacts due to ozone formation and direct emissions of NOx, CO, toxics, volatile organic compounds (VOCs) and other species. Table 2.1 provides the estimated incidences of premature mortality, chronic and acute bronchitis, asthma attacks, hospital admissions, and restricted activity days that have been avoided in China due to the current policies that are in place. More details on the methodology for quantification of health impacts can be found in Appendix B.

These benefits are in line with, but lower than, recent estimates by Zhang et al. of the total health impacts of air pollution in China[8]. Compared with Zhang's study, this analysis would imply that vehicle emissions were responsible for one-tenth of the health impacts of air pollution at 2004 pollution levels, the year in which Zhang's study was done. As mobile sources tend to be responsible for 50 to more than 80 percent of air pollution in major cities in industrialized countries[9], are in close proximity to people breathing, and are a rapidly growing source in China, it would be expected that mobile sources are responsible for a larger portion of the health impacts and are growing over time[10]. Comparison of this analysis with other recent studies suggests that these findings should be viewed as conservative, low-end estimates of impacts.

Table 2.1: Avoided incidences of health impacts due to the current policy package

HEALTH IMPACTS (THOUSANDS)	2000	2005	2010
Premature mortality	6.3	30	110
Hospital admissions	0.95	4.2	15
Chronic bronchitis	14	63	220
Acute bronchitis	75	320	1,100
Asthma attacks	96	420	1,400
Restricted activity days	7,400	33,000	110,000

Using conservative estimates to value health impacts, the total economic impact is significant. The avoided health impacts in 2010 are valued at a total of 170 billion RMB ($25 billion), the equivalent of 0.5% of the GDP. This study valued health impacts based on studies conducted in mainland China of the willingness to pay to reduce the risk of dying from air pollution. The methodology for the valuation of health impacts is included in Appendix B.

8 Zhang, M, et al. 2008. Economic assessment of the health effects related to particulate matter pollution in 111 Chinese cities by using economic burden of disease analysis. Journal of Environmental Management 88:947-954.

9 Han, X, and Naeher, L.P. 2006. A review of traffic-related air pollution assessment studies in the developing world. Environment International 32:106-120.

10 Recent studies of PM_2.5 sources in Beijing found vehicles to be one of the major sources of particles in the city (Chan, C.T. et al. 2005, Characteristics of vertical profiles and sources of PM_2.5, PM_{10}, and carbonaceous species in Beijing. Atmospheric Environment 39:5113-5124; Dan et al. 2004. The characteristics of carbonaceous species and their sources in PM_2.5 in Beijing. Atmospheric Environment 38:3443-3452.). In the 2001-2002 study by Dan et al., however, PM_2.5 concentrations rose by 50 to 100 percent in winter months, suggesting that home heating has been a significant source of emissions, although this source is declining as other, cleaner fuels are replacing coal. Nonetheless, it would be expected that vehicle emissions be responsible for at least 20 to 30 percent or more of health impacts in China with the share growing substantially if additional emission controls are not put in place.

2.2 展望未来

尽管目前的政策措施已经在减排和维护健康方面取得了显著成就，但是随着汽车市场的不断扩大，仍需要不断加严政策措施来减轻汽车排放对健康和气候的影响。图2.4展示了从现在到2030年的车辆销售量预测，图2.5则展示了同期道路车辆的增长情况。图2.6和2.7展示了在现行管理情景下，如果不采取更加严格的管理措施，在模型中模拟出的污染物排放和燃料消耗量结果。

2.2 A look to the future

Despite the emission reductions and concomitant health benefits achieved by the current program, continued policy measures will be required to mitigate the negative health and climate impacts of the significant projected growth trends in the vehicle market. Figure 2.4 provides the projected vehicle sales from today to 2030, and Figure 2.5 shows an estimate of total highway vehicle population growth over the same time period. Figure 2.6 and 2.7 show the model results for criteria pollutant emissions and fuel consumption, assuming no further action is taken to tighten regulations beyond their current, or business-as-usual (BAU), state.

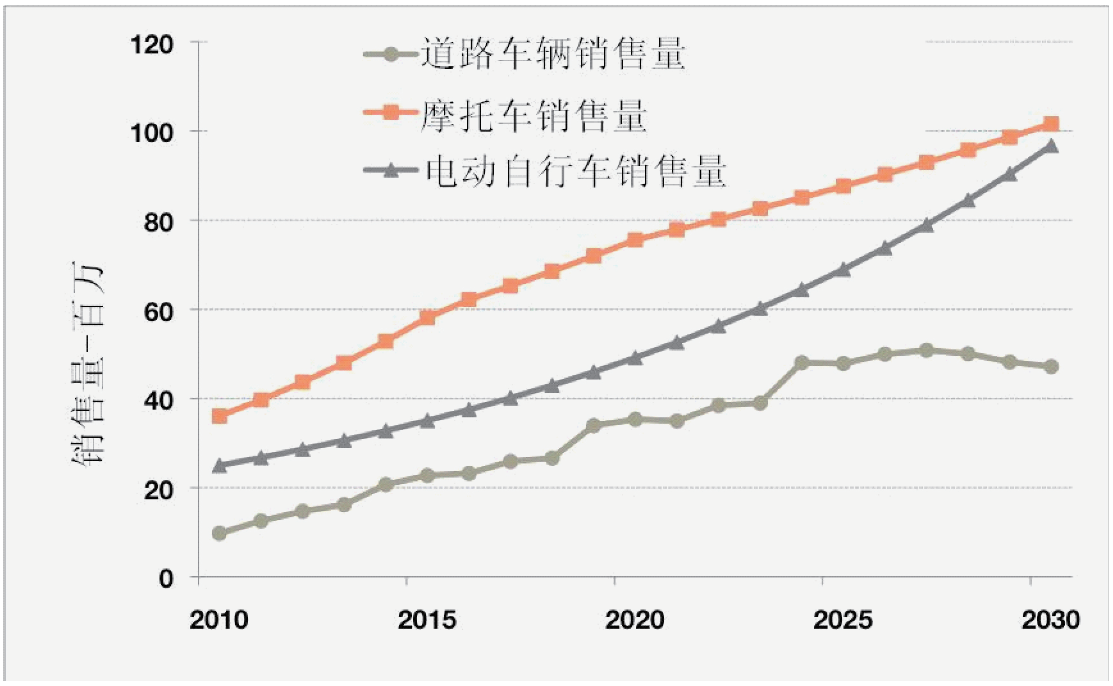

图2.4: 2010 – 2030年[11]机动车销售量模拟

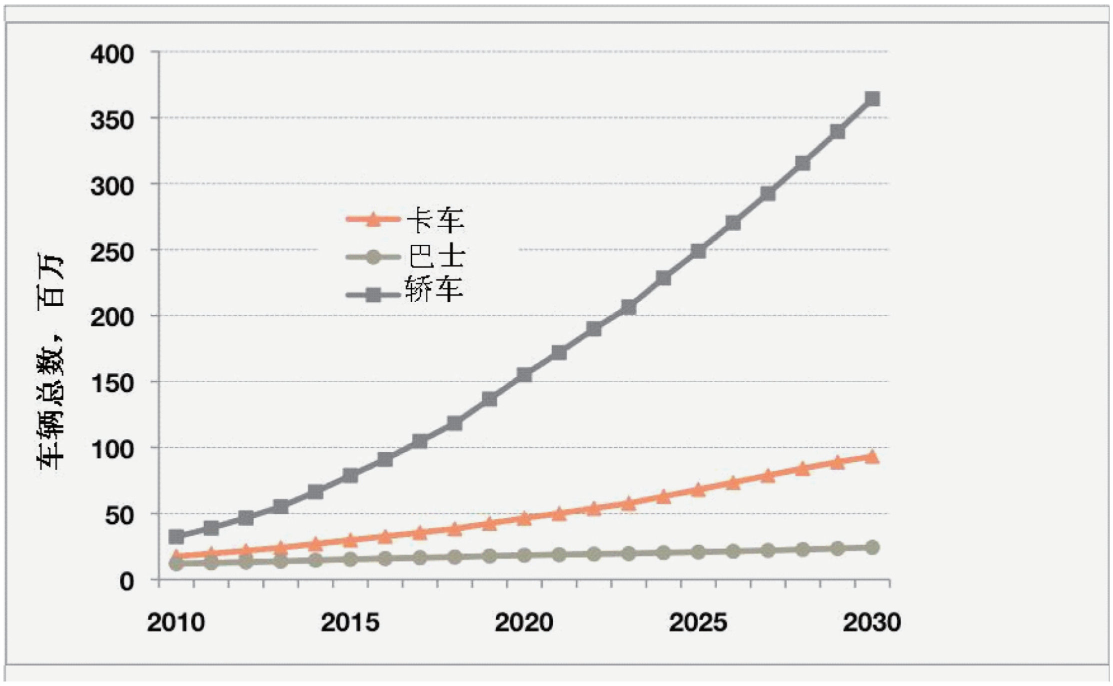

图 2.5: 2010 – 2030年道路机动车保有量模拟

11 道路机动车销售量模拟基于霍红及阿贡实验室共同开发的一款模型。摩托车和电动自行车的销售量预测基于项目人员的最佳判断。模型方法论详情，请参见附录B。

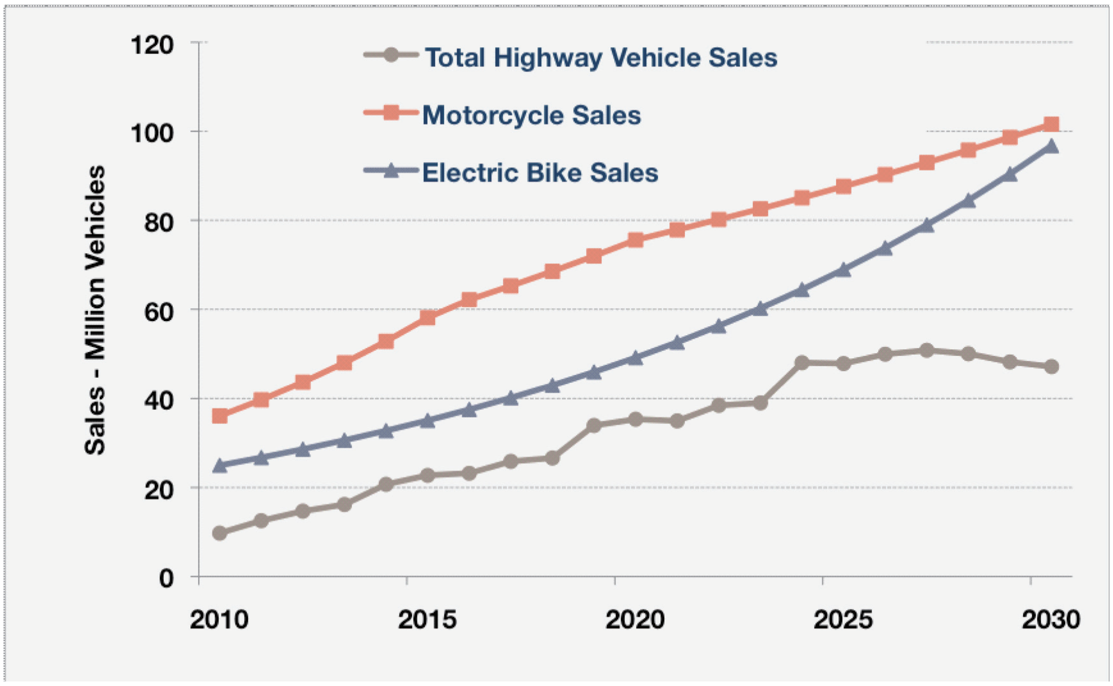

Figure 2.4: Modeled vehicles sales from 2010 – 2030[11]

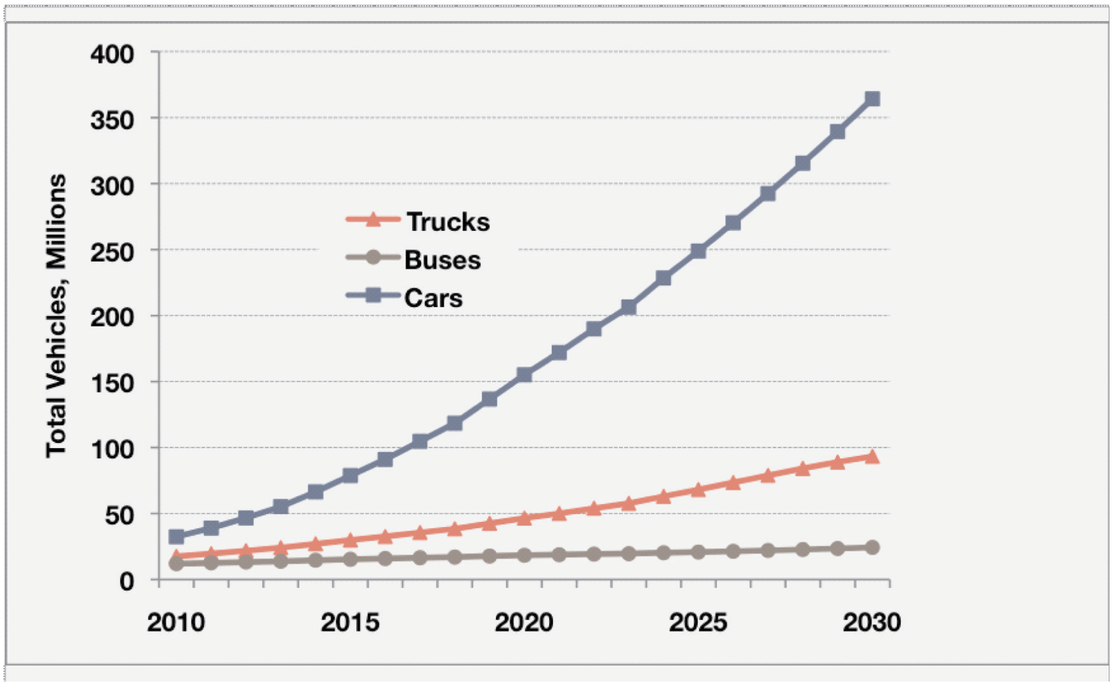

Figure 2.5: Modeled highway vehicle stock from 2010 – 2030

11 For highway vehicles, projections of vehicle sales are based on the model developed by Hong Huo and the Argonne National Laboratory. Forecasts for motorcycle and electric bike sales are based on the team's best judgment. More details about modeling methodologies are discussed in Appendix B.

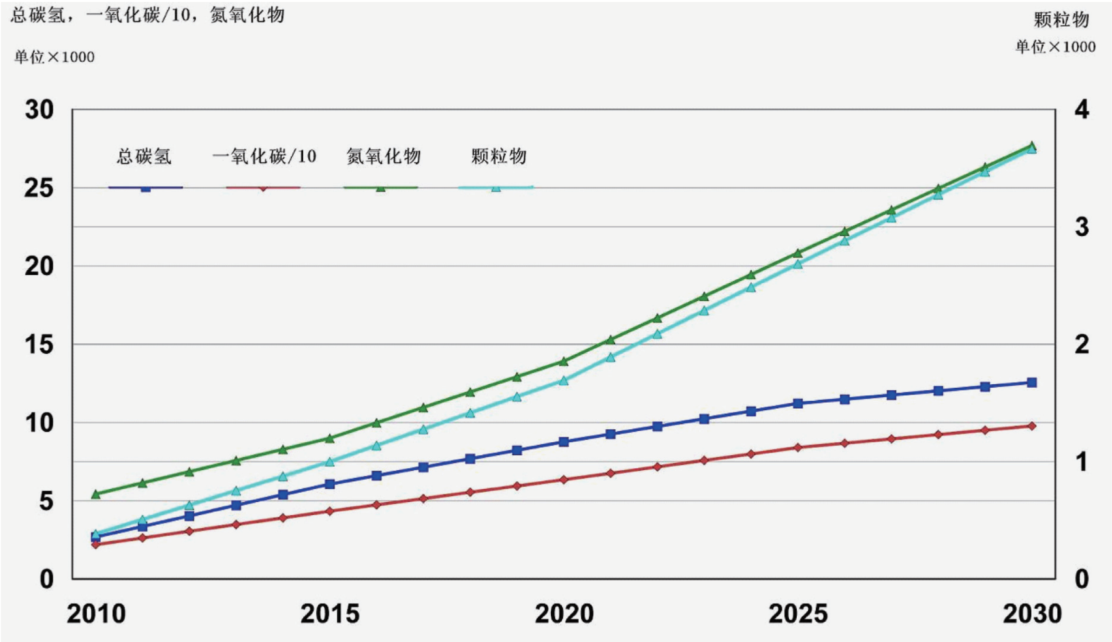

图2.6: 现行管理情景下的排放趋势2010 – 2030年(1000 公吨)

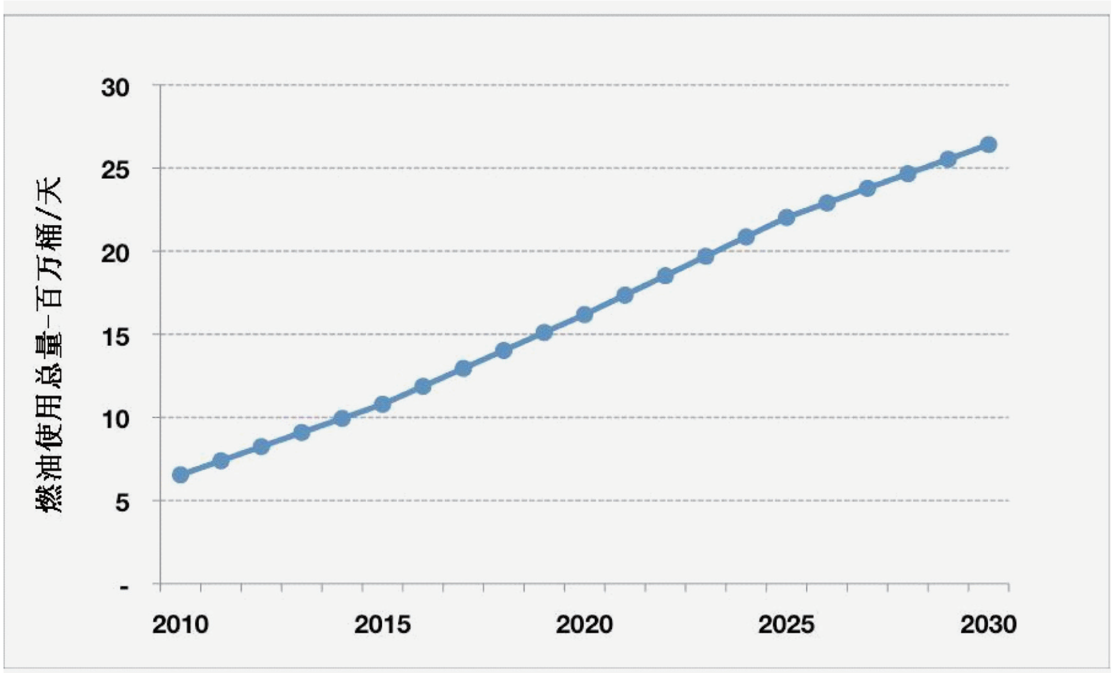

图2.7: 现行管理情景[12]下的燃料消耗量趋势2010 – 2030年

12 现行管理情景假设在第三期乘用车燃料消耗量标准后不实施任何燃料经济性政策。

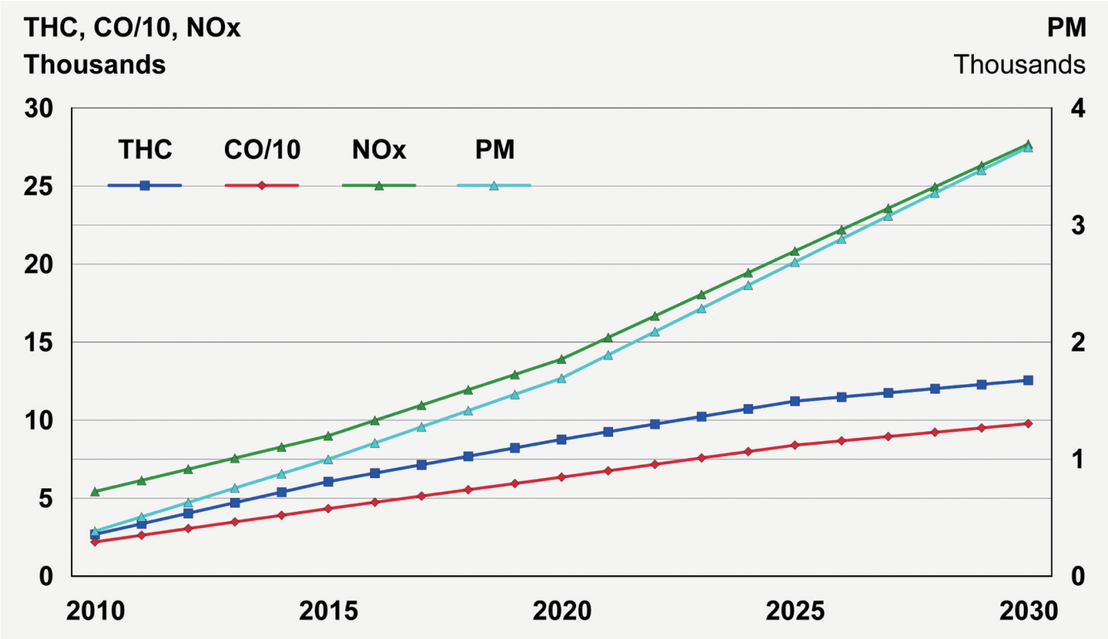

Figure 2.6: 'Business as Usual (BAU)' trends, 2010 – 2030 (thousands of metric tons)

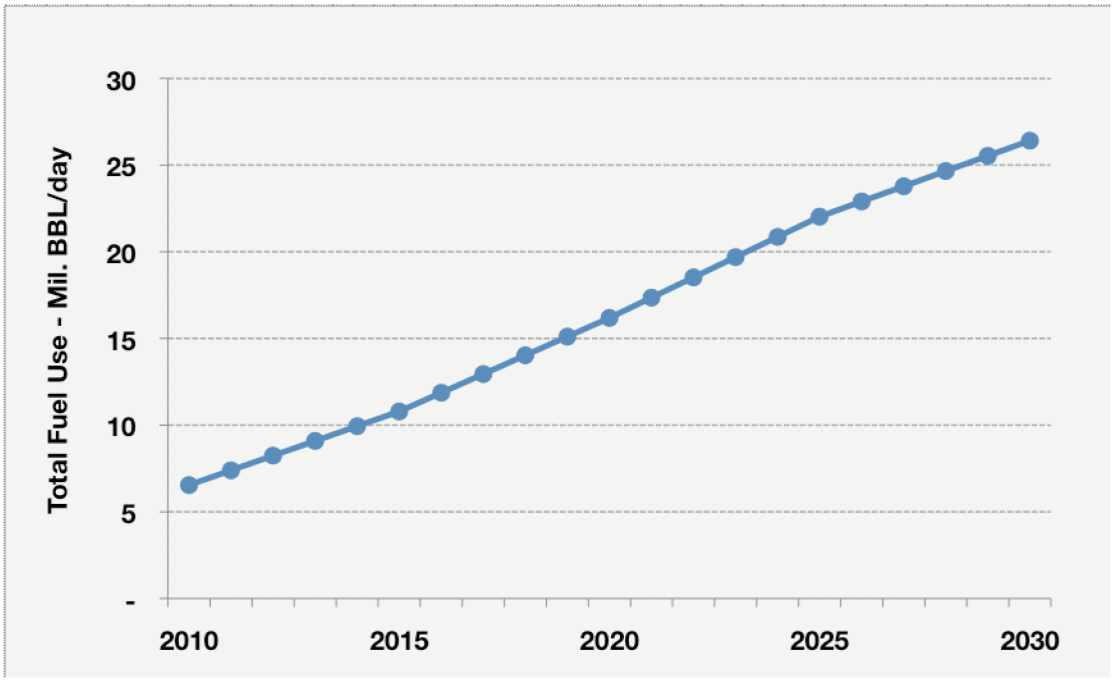

Figure 2.7: 'Business as Usual[12] (BAU)' trends for fuel consumption, 2010 – 2030

12 With continued commitment to ratcheting down vehicle and fuel standards and by introducing new policy elements that parallel international best practice, China can drive down emissions trends and move towards a world-class control program.

中国若能不断加严车辆和燃料标准，且配合引入国际先进的管理政策，将能够降低排放，并逐步实现世界一流的排放控制方案。为了模拟中国现有措施的改进路线，我们设计了三种情景方案：改善方案、强化方案和城市改善方案。改善方案假设在未来的若干年中（2010-2025年）实施更加严格的标准并配合优化的实施方案。强化方案则为今后设计了比改善方案步伐更快、力度更强的短期和长期标准和实施方案。最后的一个情景方案是城市改善方案，强化了改善方案中对重型车部分的要求，增加了有超低硫柴油燃料供应的城市地区的颗粒物减排收益。在咨询了VECC、清华大学以及环保部官员的意见后，目前，这些情景中所设置的目标（情景描述详见表2.2）能够反映出项目人员对到2030年可能取得的成就的最佳判断。情景分析包括以下几个方面：

1) 排放标准: 逐步实施到国VI及后续标准的时间表；

2) 油品标准: 在全国范围内实现超低硫汽柴油的时间表；

3) 燃料经济性[13](FE): 乘用车：现行管理措施情景包括了第I、 II和III阶段标准，从2005年持续实施至2015年。在模拟现行乘用车措施的实施效果时，每年车队燃料经济性改善率以从2002年到2015年第三阶段标准完全实施期间的年改善率，即2%来计算。中重型车及轻型或微型卡车：现行方案情景假定了燃料经济性逐年提高1%；

4)标准实施和执法方案：由于缺乏特定数据来量化实施和执法方案的效果，这些政策因素被模拟为高排放车辆所占百分比的减少[14]；

5)电动化程度：电能是此次唯一纳入情景中的替代能源。根据ICCT的判断，在本研究项目所考虑的时间范围中，电动重型车的使用可能十分微小，因此电动化情景中不包含重型车；

各种模拟情景的进一步描述详见下方表2.2。

13 在改善方案和强化方案情景中，一个重要的假设就是增加混合动力车的使用能够改善燃料经济性。但是，混合动力车并没有从燃料经济性或市场占有率角度进行特别模拟。

14 在模型中，高排放车辆的排放水平相当于无发动机排放控制装置或后处理装置的车辆的排放水平。

To model how China might strengthen its current program of today, three scenarios were developed: an Improved Program, a Strong Program, and an Improved Urban Program. The Improved Program assumes the adoption of more stringent standards and other program improvements in the near-and mid-term (2010-2025). The Strong Program includes more accelerated near- and long-term improvements as compared to the Improved Program. The final scenario, the Improved Urban Program is an enhancement of the heavy-duty vehicle portion of the Improved Program providing additional PM reduction benefits in urban areas that have early access to ultra low sulfur diesel. After consulting with the project team at the VECC and Tsinghua University and stakeholders within the MEP, the goals set forth in these scenarios (see Table 2.2 for scenario descriptions) reflect the project team's best judgment for what can be achieved by 2030. The analysis included the following dimensions:

1) Emission standards: the timeline for moving to China VI standards and beyond

2) Fuel standards: the timeline for providing ultra low sulfur gasoline and diesel nationwide

3) Fuel economy[13] (FE): for light-duty vehicles, the BAU scenario includes Phases I, II, and III which extend from 2005 to 2015. The effect of the current program was modeled as an annual FE improvement of 2% based on estimates of sales-weighted FE in 2002 and the Phase III target for 2015. For medium and heavy-duty vehicles as well as light and mini trucks, the BAU annual improvement was assumed to be 1%.

4) Compliance and enforcement: due to lack of China-specific data quantifying the efficacy of compliance and enforcement programs, these policy components were modeled as having the cumulative effect of driving down the percentage of gross emitters[14].

5) Degree of electrification: electricity was the only alternative fuel for which a penetration scenario was developed. Heavy-duty vehicles are not included in the electrification scenarios based on the ICCT's judgment that electric vehicles would have very minimal adoption in on-road heavy-duty applications in the study timeframe.

Each modeled scenario is further described below in Table 2.2.

13 An important assumption in the Improved and Strong scenarios is that increased adoption of hybrid-electric vehicles will lead to improvements in FE. However, hybrid vehicles are not specifically modeled in terms of their FE performance or market penetration.

14 In the model, gross emitting vehicles have emissions equivalent to vehicles with no engine or aftertreatment emission control features.

表2.2: 情景设定说明下图总结了模拟结果，阐释了先进车辆排放控制方案所带来的收益

情景设定	排放标准	燃料标准	燃料消耗量标准	实施情况	电动车比例
无管理	止步于1999年标准	止步于1999年标准	无	只进行型式核准	无
现行管理	国I, II, III, (IV)	国 I, II, III	轻型车: 第I、II、III阶段标准 (每年加严2%); 对重型车无管理要求	10% 的车辆为高排放车	无
改善方案	2015年实施国VI	2015年，低硫汽柴油 (50 PPM)	轻型车: 每年加严3%; 重型车:从2015年起，到2030年共加严 20%	到2015年，仅5%的车辆为高排放车	轻型车: 2030年, 新车销售的5%为电动车
强化方案	国 V (2012) 国VI (2015)，2020年实现“超低排放”(轻型车) 及 “国 VII”(重型车)	2015年，超低硫汽柴油(10 PPM)	轻型车: 每年加严4%; 重型车:从2015年起，到2030年共加严 50%	到2020年, 仅3%的车辆为高排放车	轻型车: 2030年, 新车销售的10%为电动车
城市改善方案	2012年国 IV + 柴油车颗粒物捕集器，2015年国VI	2012年，低硫汽柴油(50 PPM)	同改善方案	同改善方案	同改善方案

下图总结了模拟结果，阐释了先进车辆排放控制方案所带来的收益。

Table 2.2: Scenario descriptions

SCENARIOS	EMISSION STANDARDS	FUEL STANDARDS	FUEL CONSUMPTION STANDARDS	ENFORCEMENT AND COMPLIANCE	DEGREE OF ELECTRIFICATION
No regulation	Stop at standards adopted by 1999	Stop at standards adopted by 1999	None	Existing type approval only	None
BAU/Baseline	China I, II, III, (IV)	China I, II, III	LD: Phase I, II, and III (2% annual improvement); no HD regulation	10% of vehicle fleet are gross emitters	None
Improved Program	China VI by 2015	Low-sulfur gasoline and diesel (50 PPM) by 2015	LD: 3% annual improvement; HD: 20% improvement by 2030, starting in 2015	By 2015, only 5% of vehicle fleet are gross emitters	LD: by 2030, 5% of new vehicle sales are electric vehicles
Strong Program	China V (2012) and VI (2015) and "SULEV" (LD) and "China VII" (HD) by 2020	Ultra low-sulfur gasoline and diesel (10 PPM) by 2015	LD: 4% annual improvement; HD: 50% improvement by 2030, starting in 2015	By 2020, only 3% of vehicle fleet are gross emitters	LD: by 2030, 10% of new vehicle sales are electric vehicles
Improved Urban Program	China IV + diesel particle filter in 2012 and China VI by 2015	Low-sulfur gasoline and diesel (50 PPM) by 2012	Same as Improved Program	Same as Improved Program	Same as Improved Program

The following figures summarize the modeling results and illustrate the significant benefits of a progressive vehicle emission control program.

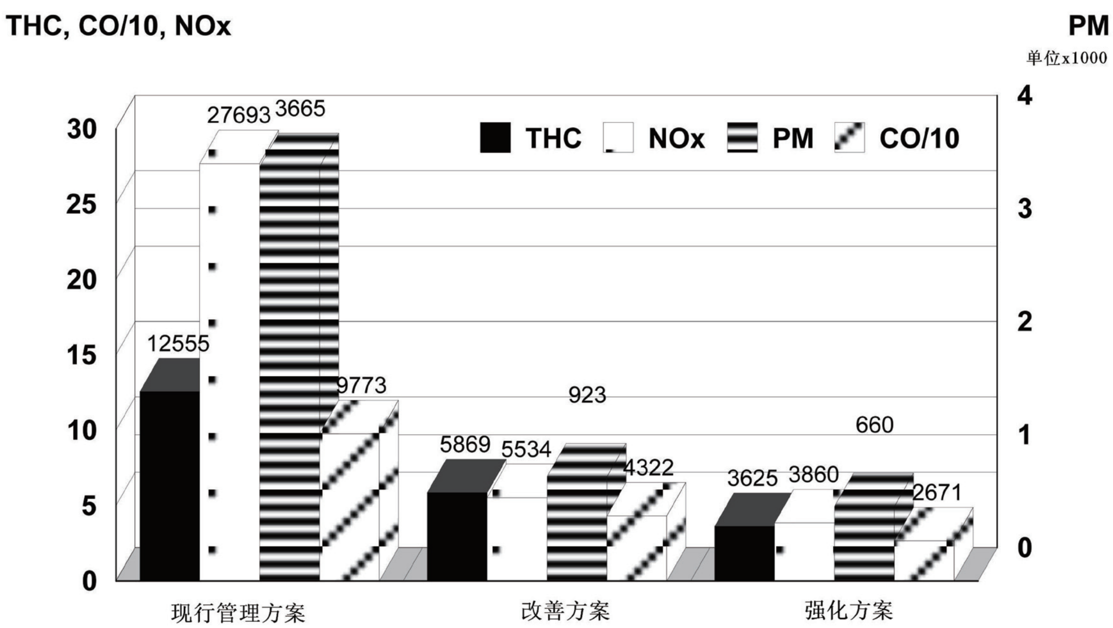

图 2.8: 现行管理、改善方案和强化方案情景下2030年的排放情况 (1000公吨)

改善方案和强化方案带来的大幅减排在未来将带来重大的健康收益。表2.3展示了到2015年、2020年、2025年和2030年各个情景下健康风险发生率降低情况的评估结果。

表 2.3: 强化和改善方案下可避免健康影响的效益评估

健康影响(千人或千天)	2015年		2020年		2025年		2030年	
	改善	强化	改善	强化	改善	强化	改善	强化
提前死亡	34	38	100	110	200	220	310	340
入院就医	4.4	5	13	14	24	27	35	41
慢性支气管炎	67	76	180	210	330	370	480	530
急性支气管炎	310	350	820	920	1,400	1,600	2,000	2,200
哮喘	410	470	850	960	1,500	1,700	2,200	2,400
工作影响天数	32000	36,000	84000	94,000	150,000	160,000	200,000	220,000

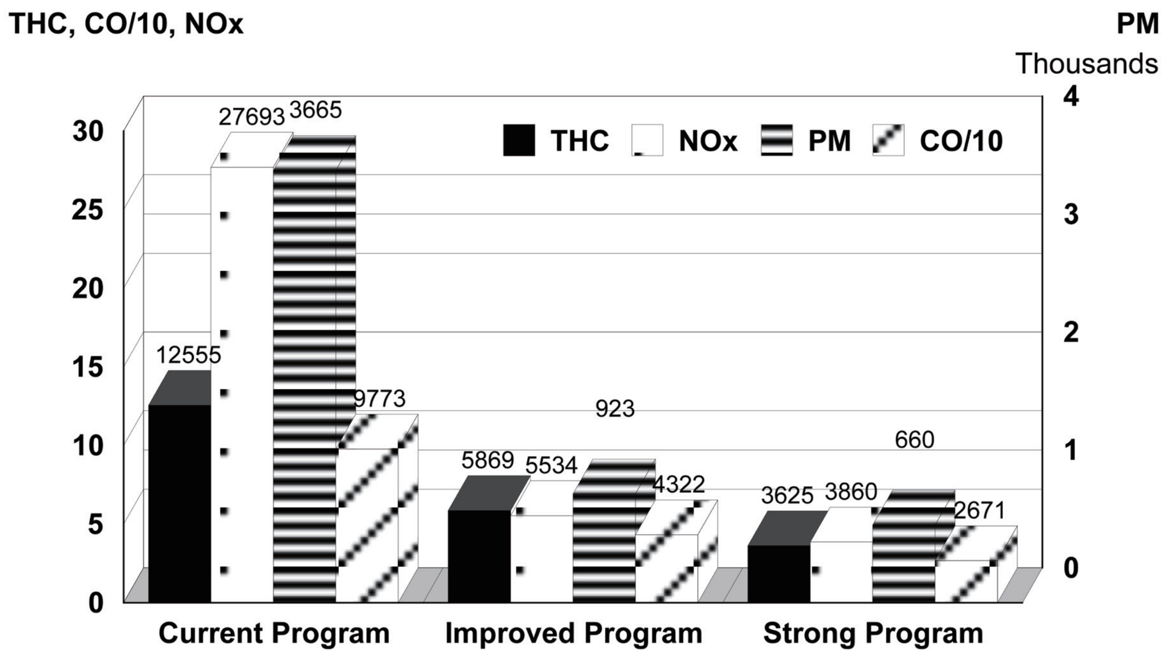

Figure 2.8: Emissions of the BAU, Improved, and Strong Programs in 2030 (thousand metric tons)

The dramatic reductions in emissions with the Improved and Strong Programs would translate into important reductions in adverse health impacts in future years. Table 2.3 provides the estimated incidences of adverse health impacts that could be avoided in each scenario in the years 2015, 2020, 2025, and 2030.

Table 2.3: Avoided incidences of health impacts due Strong and Improved Programs

HEALTH IMPACTS (THOUSANDS)	2015		2020		2025		2030	
	IMPROVED	STRONG	IMPROVED	STRONG	IMPROVED	STRONG	IMPROVED	STRONG
Premature mortality	34	38	100	110	200	220	310	340
Hospital admissions	4.4	5	13	14	24	27	35	41
Chronic bronchitis	67	76	180	210	330	370	480	530
Acute bronchitis	310	350	820	920	1,400	1,600	2,000	2,200
Asthma attacks	410	470	850	960	1,500	1,700	2,200	2,400
Restricted activity days	32000	36,000	84000	94,000	150,000	160,000	200,000	220,000

从图2.9中可以看到，在过去的10年中，现行管理措施已经拯救了许多生命，而实施强化方案，在未来的若干年中，可避免由于污染而过早死亡的人数将会比现行管理方案高2倍。

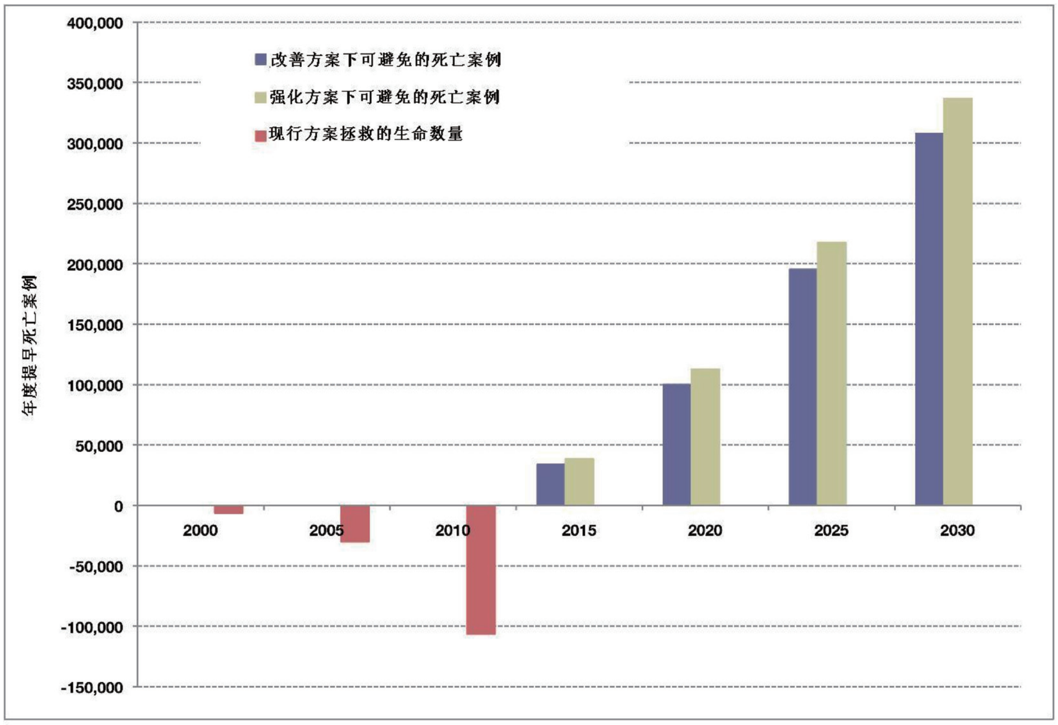

图 2.9: 各种情景下提前死亡案例的数量

到2030年，实施改善方案和强化方案的预期健康收益的经济价值可达2.4-2.6万亿人民币（3500-3900亿美元），相当于国内生产总值（GDP）的2.3-2.6%。健康影响价值评估方法论详见附录B。中国其它研究学者进行的分析和英国以及其它地区的研究结果都肯定了这样的价值评估，甚至认为在减少提前死亡方面，减排所带来的健康收益和经济收益应比我们当前预计的更高[15]。

仅仅考虑北京、上海和天津三个城市，在2015年，实施城市改善方案能够额外拯救1900人的生命。尽管减排量很小，但是由于大城市内人口暴露于污染物中的比率高，因此对死亡率的影响较大。

15 如之前所述，在最近由Zhang等人进行的两项研究中，从2000年到2005年，各种污染源造成的空气污染所造成的提前死亡率比ICCT的研究结果高10倍，自然其估计的健康收益经济影响的价值也要高得多。英国政府近日公布了欧盟环境总署的研究结论，即该国每年过早死亡个例高达5万人，占死亡总数的10%（英国国会下议院，环境审核委员会，空气质量，2009年10月第五次会议报告，2010年3月22日）。根据这一分析，由机动车污染造成的死亡百分比约在0.2%和3%这一最高的估计范围内（2030年排放水平，无额外控制措施）。还有其它许多研究都指出了机动车空气污染会对死亡率和经济都造成更大影响，而这些研究结果还被认为是比较保守的。

As can be seen in Figure 2.9, the current program has saved numerous lives in the past decade but a strong emissions control program could prevent three times as many premature deaths in the coming years.

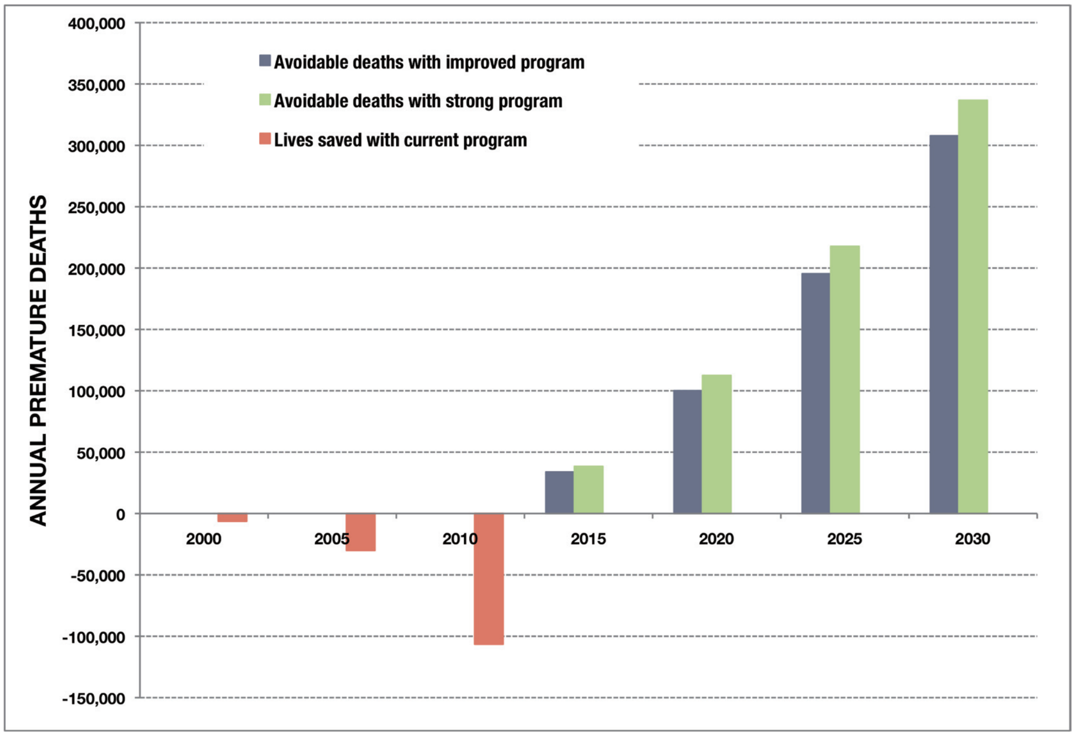

Figure 2.9: Annual premature deaths under different scenarios

In 2030, the monetary benefits associated with the reduced health impacts of the Improved Program and Strong Program scenarios would be expected to have health benefits of approximately 2.4–2.6 trillion RMB ($350–390 billion), equivalent to an estimated 2.3-2.6 percent of the GDP. The complete methodology for valuation of health impacts is included in Appendix B. Analyses conducted by other researchers in China, the United Kingdom and elsewhere confirm these findings with similar or higher expected impacts in terms of levels of premature mortality due to air pollution and total monetary benefits of reducing emissions[15].

Considering the impacts in just the three cities of Beijing, Shanghai, and Tianjin, the Improved Urban Program would save an additional 1,900 lives in the year 2015. While the emissions reduction is very small, it has a larger impact on mortality because of the higher exposure rate in these large cities.

15 As previously reported, two recent studies by Zhang et al. found premature mortality rates in the years 2000 through 2005 associated with air pollution from all sources to be up to 10 times higher than the ICCT findings, with the value of the impacts also an order of magnitude higher. The UK government recently publicized findings by the European Environment Agency that premature deaths in that country could be as high as 50,000 per year, or 10 percent of all deaths (House of Commons, Environmental Audit Committee, Air Quality. Fifth Report of Session 2009-10. March 22, 2010). In this analysis, the percentage of deaths due to air pollution from vehicles varied between 0.2 percent and three percent at the extreme (2030 emissions with no additional controls in place). Many other studies have also reported much higher impacts of air pollution from vehicles both in terms of mortality rates and economic impacts, suggesting that these study results should be considered conservative.

改善燃料经济性政策将有效节省燃料并减少二氧化碳排放，同时将中国在这一政策领域的地位推向世界领先位置（图2.10和图2.11）。到2030年，根据估算，较之现行管理措施，实施强化方案将节省780亿加仑燃料。另外，颗粒物的减少还会带来附加的气候变化收益，因为颗粒物排放的减少直接减少了具有重大气候影响危害的黑炭的排放（图2.12）。

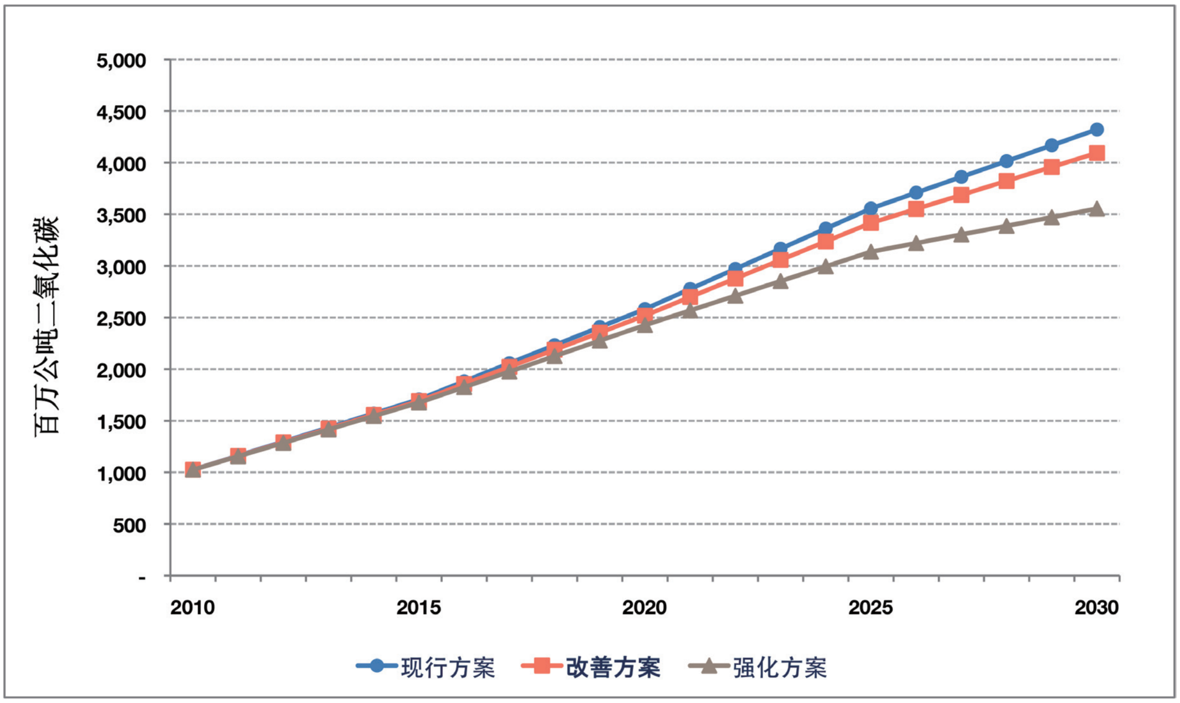

图2.10: 现行方案、改善方案和强化方案情景下的CO_2 排放趋势2010 – 2030年

Additional improvements to the fuel economy program will yield substantial fuel savings and avoided carbon dioxide (CO_2) emissions as well as cement China's position as a global leader in this policy arena (Figures 2.10 and 2.11). In 2030, it is estimated that the Strong Program will save roughly 78 billion gallons of fuel as compared to the baseline scenario. In addition, there are considerable climate co-benefits associated with decreasing particulate matter emissions due to the fact that black carbon—the highly potent climate forcing aerosol that is a subset of PM-is reduced as well (Figure 2.12).

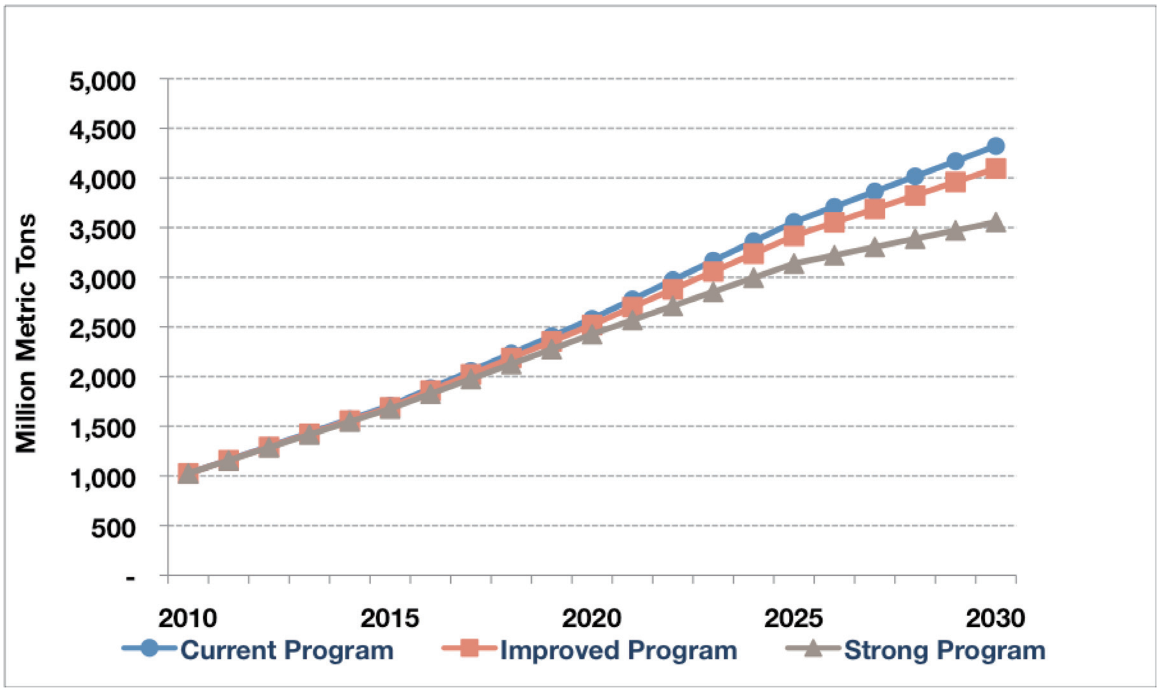

Figure 2.10: CO_2 emission trends for BAU, Improved and Strong Programs, 2010 – 2030

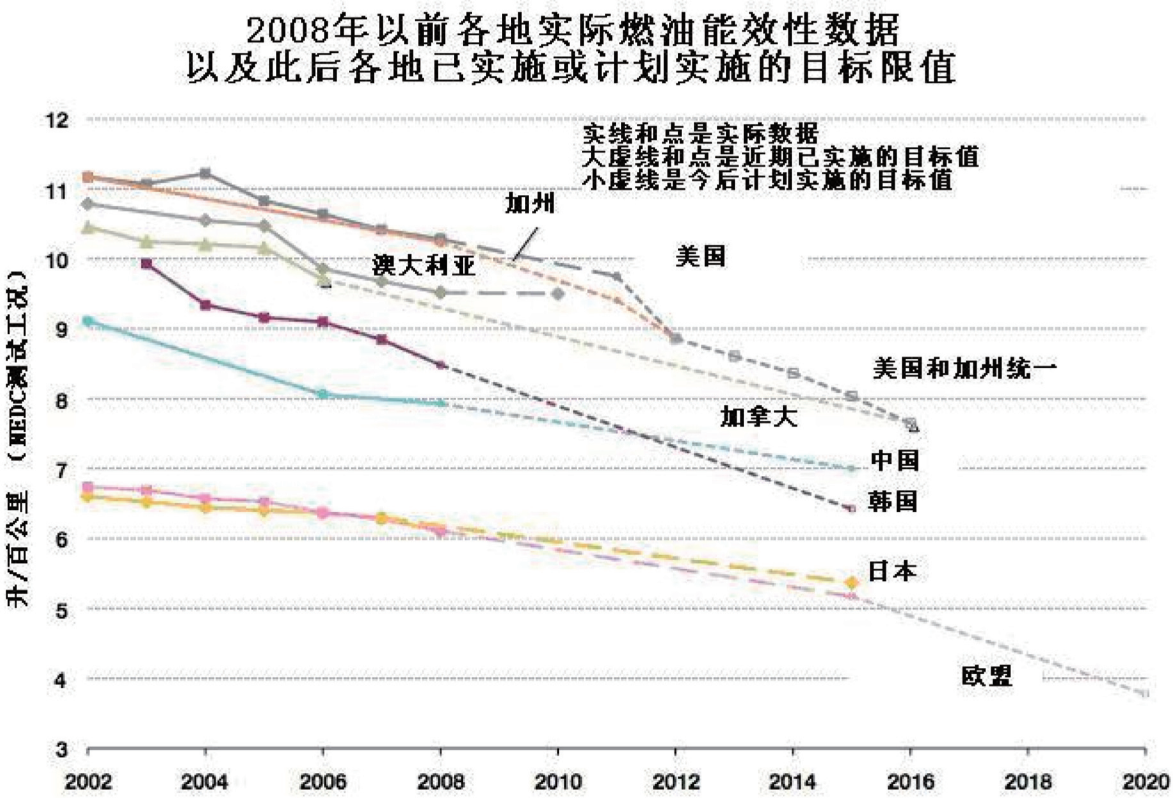

图 2.11: 部分国家/地区燃料经济性水平和法定目标值的发展趋势2002 – 2030年

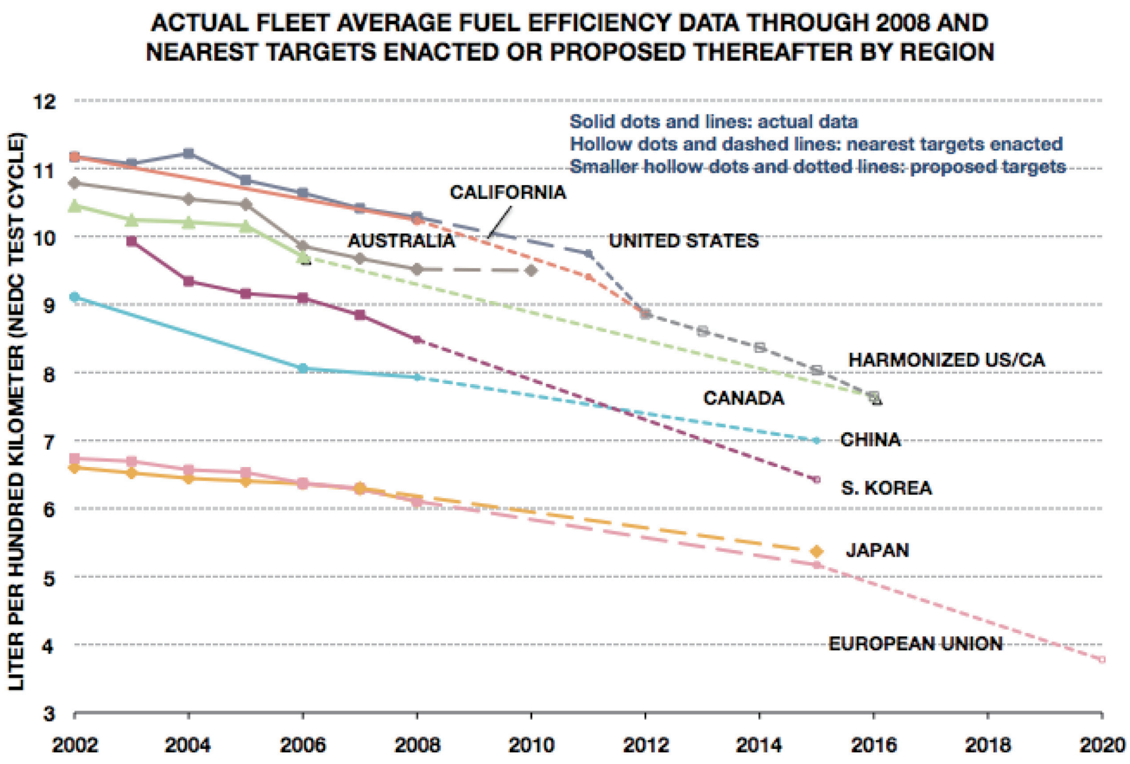

Figure 2.11: Fuel economy trends of select countries/regions, 2002 – 2030

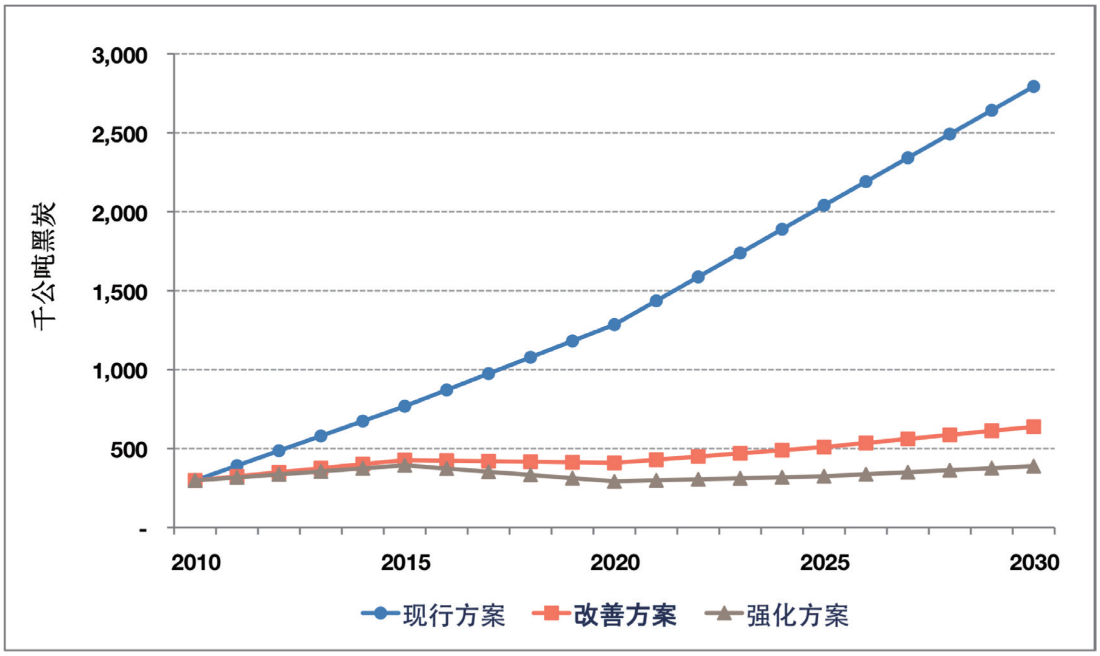

图 2.12: 现行方案、改善方案和强化方案情景下的黑炭排放趋势2010 – 2030年

在接下来的七章中，我们将从多方面分析现行的车辆污染控制方案，并与国际最佳经验进行比较。通过比较能够帮助我们提出推荐意见，改进现行方案，在未来的10年中，挽救中国更多人的生命。

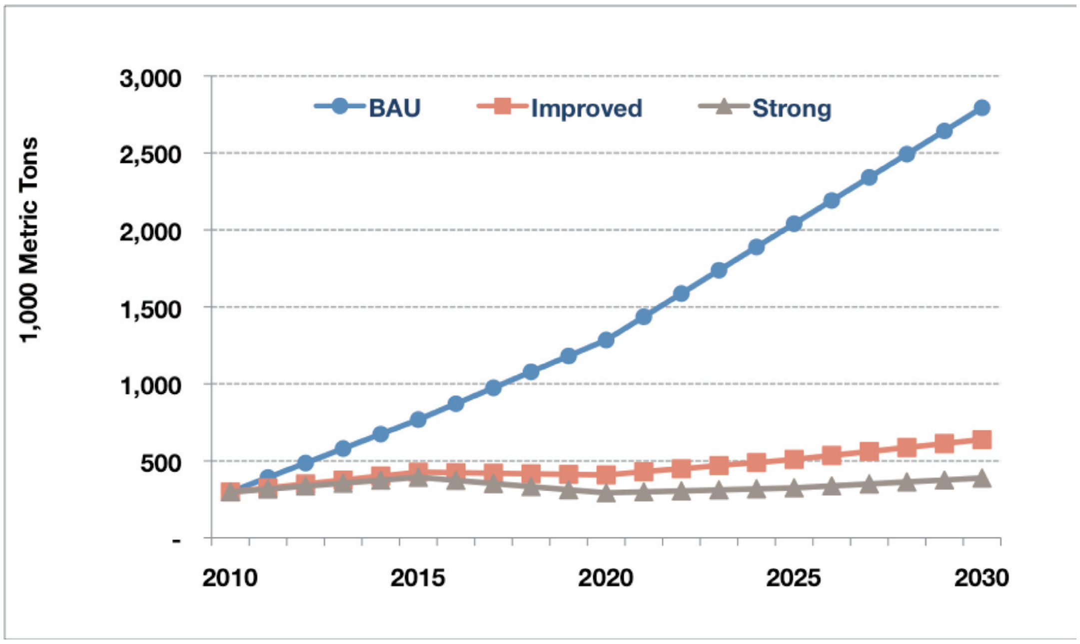

Figure 2.12: Black carbon trends for BAU, Improved and Strong Programs, 2010 – 2030

The next seven chapters will review each component of the current vehicle pollution control program and compare them to international best practices. The comparison will help identify recommendations that will assist in enhancing the current program and saving lives in China over the next decade.