8. 燃料经济性和温室气体管理方案

通常，国家能源安全是制订车辆燃料经济性标准的主要推动力。在过去的15年中，中国已经从一个原油自给自足的国家成为了世界上最大的原油进口国之一。20世纪末，中国成为仅次于美国和日本的世界第三大原油消耗国。在过去的20年里，中国的原油消耗量每年增长4%，到2000年达到2.1亿吨，2009年达到3.94亿吨。2000年中国原油进口量达到7000万吨，占当年原油消耗总量的30%，并且到2009年，这一数字已经上涨至2.04亿吨，占全年总量的52%[87]。 造成中国原油消耗量上涨的主要原因之一就是交通领域的快速增长，特别是机动车的快速增长[88]。2009年，中国原油消耗量的60%是用于交通领域。

如今，全世界各国政府都在日益担忧温室气体所带来的气候影响。目前，世界上最大的七个汽车市场已经实施了或至少计划实施燃料经济性标准或温室气体排放标准。中国是世界上最大的温室气体排放国之一并且拥有世界上机动车增长速度最快的市场。目前中国正面临着减少石油消耗和温室气体减排的双重挑战。

从减轻石油依赖性出发， 中国于2005年成为世界上为数不多第一批对轻型乘用车实施了燃料消耗量标准的国家。实施轻型车燃料消耗量一阶段和二阶段标准已经帮助将新车百公里燃料消耗量从2002年的9升(9 L/100km)降低至2008年的8升左右，或者说是降低了10%。目前，中国正在批准通过三阶段标准。中国还对摩托车也实施了燃料消耗量标准。重型车的燃料消耗量管理也在发展。这些管理标准中没有直接强调温室气体排放。

除了不断加严标准以来，改善标准的设计也能够帮助实现燃料或碳消耗量的减少。下文中总结了国际管理方案和中国管理方案，并通过比较得出今后的改善建议。

8.1 国际管理方案概述

本节将介绍世界各国正在实施和计划实施的轻型乘用车及商用车燃料经济性标准和温室气体排放标准。在此主要针对美国和欧盟的管理，因为美国和欧盟占据了世界汽车产量的半数以上。为方便和中国对比，各国原来规定的指标被转化为NEDC工况下的升/百公里，与中国采取的工况和单位相同，标注在原指标后的括号中。

美国

过去几十年来，美国联邦燃料经济性法规关注的主要是能源安全。2010年4月1日，美国国家环境保护局（EPA）和美国交通部（DOT）共同制定了新的温室气体排放和燃料经济性联合标准，主要针对2012至2016年型的轻型车（包括乘用轿车和轻型卡车）。EPA依据《清洁空气法》实施了有史以来第一个全国温室气体排放标准，DOT则依据《能源政策和节能法》实施了新的企业平均燃料经济性（CAFE）标准。规定的主要原则将在下文中予以归纳。

87 Wang Qian，2010年，《中国燃料进口量已达警戒线》（Oil imports hit alarming level in China: Study）《China Daily》。

88 He, Hao, Zhang, He, Walsh和Wang. 2005年，《中国道路交通燃料消耗量和CO_2排放的现状、未来趋势和政策指导》（Oil consumption and CO_2 emissions in China's road transport, current status, future trends and policy implications. ）《能源政策》第 33。

8. Fuel efficiency and greenhouse gas programs

Traditionally, national energy security has been the main driver for vehicle fuel economy standards. Over the past decade and a half, China has gone from being self sufficient in oil to becoming one of the largest importers in the world. By the end of the 20th century, China became the world's third largest oil consumer after the US and Japan. With an annual rate of increase of 4% in oil consumption experienced in the past 20 years, China's oil consumption reached 210 million tons in 2000 and 394 million tons in 2009.[87] The amount of oil imported by China reached 70 million tons in 2000, accounting for 30% of that year's total oil consumption and has since risen to 204 million tons or 52% of the annual total in 2009. A major cause of the increase in Chinese oil consumption can be attributed to the rapid growth of the transportation sector in general and motor vehicles in particular[88].About 60% of China's oil consumption in 2009 was for transportation.

Nowadays, governments around the world are also increasingly concerned about the climate impacts of greenhouse gases (GHG). To date, seven world-leading auto markets have adopted or at least proposed vehicle fuel economy or GHG emissions standards. China, as one of the world's largest GHG contributors and with the world's most rapidly growing auto market, is confronting the dual challenge of reducing fossil oil consumption and curbing GHG emissions.

Driven by oil independence concerns, China was among the first countries in the world to adopt its first phase of fuel consumption standard for light-duty passenger vehicles in 2005. The implementation of Phase I and Phase II light-duty vehicle standards helped reduce the fleet fuel consumption from about 9 liters per hundred kilometer (9 L/100km) in 2002 to about 8 L/100km in 2008, or a 10 percent of reduction. Now China is in the process of approving the third phase of the standard. China also established fuel consumption standard for motorcycles. Fuel consumption regulations for heavy-duty vehicles are also in development. None of these regulations addresses GHG emissions directly.

The design of various regulations may be improved to enable more certain fuel or carbon reduction outcomes. The following provide a summary of international programs, China's programs and through a comparison highlights recommendations for future improvements.

8.1 Overview of international programs

This section reviews current and proposed light-duty passenger and commercial vehicle fuel economy or GHG emissions standards around the world. The focus is on the U.S. and EU regulations, as those two markets together account for over half of world's auto production. For easy comparison with China, country-specific targets are converted from their original metrics to liters per hundred kilometer (L/100km) under the NEDC cycle, the same metric adopted in China, in the brackets next to the original target values.

The United States

For decades, the focus of U.S. federal fuel economy regulation was energy security. On April 1st, 2010, the U.S. Environmental Protection Agency (EPA) and Department of Transportation (DOT) finalized a new joint regulation for greenhouse gas (GHG) emissions and fuel economy for light-duty vehicles (including passenger cars and light trucks) for model years 2012 through 2016. The EPA established the first-ever national greenhouse gas (GHG) emissions standard under the "Clean Air Act", and the DOT established an updated Corporate Average Fuel Economy (CAFE) standard under the "Energy Policy and Conservation Act". Key elements of the rule are summarized below.

87 Wang Qian. 2010. Oil imports hit alarming level in China: Study. China Daily.

88 He, Hao, Zhang, He, Walsh and Wang. 2005. Oil consumption and CO_2 emissions in China's road transport, current status, future trends and policy implications. Energy Policy 33.

严格程度： 要求轻型车平均温室气体排放量从2008年型的平均342克CO_2/英里下降至2016年型的250克CO_2/英里，降幅为27%。2012-2015年期间会采用过渡标准。燃料经济性会从2008年型的平均每加仑26英里(10.3L/100km)提升至2016年型的每加仑34.1英里(7.6 L/100km)，总改善幅度为31%。每个车型年，温室气体平均排放降低3.8%，燃料经济性提高3.5%。

污染物： 对包括车辆空调系统的氢氟碳化合物在内非二氧化碳的温室气体排放也有另外的要求， 对单车氧化亚氮和甲烷的排放量提出限值。其它气候影响物，如黑炭等没有被纳入管理范围。

标准设置： 沿用当前DOT的燃料经济性标准框架，新的标准根据车辆的尺寸或称“脚印面积”（四个车轮围出的面积）来设定乘用轿车和轻型卡车的标准。与过去所采用的S型标准曲线不同，新的温室气体排放量标准是基于车辆尺寸制定的“分段线性”函数。这样，大体上，尺寸越大的车辆还是会依据曲线面临越来越松的标准，但是脚印面积最大的车型会面临一个固定的上限标准（即不再随着脚印面积增大面临较松的标准），这样的设置可以鼓励车辆尺寸小型化。

灵活性： 主要的达标途径是提高车辆燃料经济性。但是，也可以通过其它方式获取达标信用额度，包括空调系统技术和发展灵活燃料车。

美国总统在2010年5月21日宣布要求EPA和DOT共同制定了下一阶段针对2017-25车型年的轻型车温室气体排放和燃料经济性的联合标准。有关这标准的主要内容，包括2017-25车型年可于全国范围达到的标准限值，会于2010年9月30日公布。

在过去几十年来，美国联邦燃料经济性法规关注的主要是能源安全。2010年4月1日，美国国家环境保护局（EPA）和美国交通部（DOT）共同制定了新的温室气体排放和燃料经济性联合标准，主要针对2012至2016年型的轻型车（包括乘用轿车和轻型卡车）。EPA依据《清洁空气法》实施了有史以来第一个全国温室气体排放标准，DOT则依据《能源政策和节能法》实施了新的企业平均燃料经济性（CAFE）标准。规定的主要原则将在下文中予以归纳。

美国目前没有设置重型车的燃料经济性或温室气体标准。但是《2007年能源独立与安全法》中要求美国交通部为重型卡车制订燃料经济性规定，最早将实施于2016车型年。美国科学院全面的研究了重型车从技术层面提高燃料经济性的潜能，这为今后制订规定提供了基础。同时，美国环保局也以温室气体为重点，开展了重型车排放控制方案的评估研究。美国总统在2010年5月21日指令环保局和交通局合作制定轻型与中、重型车温室气体排放和能源法规的发布中同时要求EPA和DOT合作在2011年7月完成制定重型车的温室气体/燃料经济性标准。 EPA和DOT共同制定的中、重型车温室气体排放 / 燃料经济型标准方案于2010年11月公布。

加州

2002年，加州颁布了第一个要求限制机动车温室气体排放的州立法案（AB1493）。依照法律规定，加州空气资源局（CARB）于2004年针对两类车发布了从2009车型年至2016车型年逐年的温室气体排放目标，给予车辆生产者5年的适应时间。2009年底，EPA给予了加州豁免权，令加州可以制定自己的2009年–2011年车辆的温室气体排放标准。加州随后修订了自己的管理方案，允许生产企业通过满足联邦标准来证明满足了加州标准。加州预期将在2010年底推出下一阶段标准，即2017年–2025年的标准。

Stringency: Average light-duty vehicle GHG emission rate would be reduced from the average of model year 2008, which was 342 gCO_2e/mile, to 250 gCO_2e/mile in model year 2016, a 27% reduction. Interim standards would apply for 2012-2015. Fuel economy would increase from an average model year 2008 level of 26 miles per gallon (10.3L/100km) to 34.1 miles per gallon (7.6 L/100km) by model year 2016, a 31% improvement. Annually, this would be a 3.8% reduction per model year in average GHG emissions, and 3.5% increase per model year in fuel economy.

Pollutants: Additional requirements would be imposed on non-CO_2 GHG emissions, including hydrofluorocarbons (HFCs) from vehicle air conditioning systems. Per-vehicle emission caps would be set for nitrous oxide (N_2O) and methane (CH4) emissions. Other climate forcers, such as black carbon, are not covered.

Structure: Following the current DOT fuel economy standard framework, the program sets separate numerical standards for vehicle size or "footprint" (i.e., the area defined by the wheelbase and average track width) for passenger cars and light trucks. In contrast to the S-shaped constrained logistical curve previously used, the new proposed system uses "piecewise linear" functions between vehicle footprint and the test-cycle GHG emission rate. This general shape allows for different-size vehicles to have different standards in the sloped portion, but constrains the largest vehicles at the upper bend and incentivizes vehicles below the lower bend.

Flexibility: The main compliance mechanism is improving vehicle fuel efficiency. But compliance credits can also be achieved via other mechanisms, including air conditioning system technology and the deployment of flexible fuel vehicles.

On May 21st, 2010, the President requested the EPA and DOT, in collaboration with the State of California, to jointly develop the next set of light vehicle GHG/fuel economy standards that will run from 2017 through 2025. A notice will be released by September 30th, 2010 that lays out the key components of the standards, including the potential standards that could be practically implemented nationally for the 2017-2025 model years.

The US currently does not have an established fuel economy or GHG standard for heavy-duty vehicles. But the"Energy Independence and Security Act of 2007" has requested US DOT to formulate fuel economy rule making for heavy trucks which at the earliest will be effective from Model Year (MY) 2016. The National Academy of Science has conducted thorough studies on technology potential for fuel economy improvement of heavy-duty vehicles, which will lay the grounds for the upcoming rule making. At the same time the US EPA had laid out in its review of policies to address GHGs several options for the control of emissions from heavy-duty vehicles. The announcement made by the President on May 21st, 2010 directing EPA and DOT to jointly develop policies for regulating GHG emissions and energy consumption of light vehicles and medium- and heavy-duty trucks, calls for EPA and DOT to jointly complete a final rule for heavy-duty vehicle GHG/fuel economy standards by July 2011. The two agencies have jointly released a proposal for the medium- and heavy-duty vehicle GHG/fuel economy standards in November 2010.

The State of California

In 2002, California enacted the first state law (AB 1493) requiring GHG emission limits for motor vehicles. As directed by the statute, the California Air Resources Board (CARB) issued a regulation in 2004 to establish year-by-year GHG emissions targets for two vehicle class categories from MY 2009 to 2016, giving automakers a 5-year lead time. In late 2009, EPA granted a waiver to California to implement its GHG standard for 2009–2011 vehicles. California subsequently revised its program to allow manufacturers to show compliance with California's standards by complying with the federal standards. It is expected that California will propose the next set of standards, for years 2017–2025, by the end of 2010.

欧盟

1998年，欧盟与向欧盟市场出售车辆的汽车生产企业签署了一份自愿协议，到2008年底，将车辆二氧化碳排放降至140g/km 。这一自愿目标并没有实现，到既定时期，欧盟范围内车辆平均二氧化碳排放量为159g/km 。欧盟决定设立强制标准来削减轿车的二氧化碳排放。2008年12月，欧盟委员会实施了新的管理规定，降低新乘用车的二氧化碳排放。主要管理特征如下：

*严格程度：*这一目标主要依靠提高车辆能效技术来实现，有10g/km的额外削减是通过其它方式实现的，包括改变胎压、变速箱指示器、空调，增加生物燃料使用量和财税政策。尽管欧盟委员会要到2013年才能考虑实现目标的技术路线，但已经宣布了更长远的目标，即到2020年降至95 g/km(3.8L/100km)。

标准设置： 标准是以重量为基础的平均二氧化碳排放量。法规规定了一个线性公式[89]，用来根据车重计算各个车辆的规定排放目标。生产企业的目标值则是再根据其生产的车型，按销售权重计算出来的。线性曲线的斜率参考了欧盟制造商当前的车辆质量和二氧化碳排放量关系的趋向线，但是经过修改，比实际趋势线的斜率要平缓。这样的设计是为了防止生产企业任意增大车队的质量来投机取巧，获得更宽松的排放目标。

轻型商用车标准： 2009年10月，欧盟委员会通过了新的提案，计划降低轻型商用车的二氧化碳排放（货车或欧盟分类中的N1车辆[90]）。到2014年，轻型商用车的平均排放值要降至175g/km。长期的目标是到2020年实现135g/km的目标。这一提案也是采用以重量为基础的线性曲线来计算各个车辆的目标值，标准设计与乘用轿车类似。

澳大利亚

联邦汽车工业联合会于2005年颁布了自愿性目标值，到2010年，将NEDC工况下的新乘用车全国平均碳排放（NACE）降低至每公里222克二氧化碳(9.5L/100km)。

加拿大

2009年12月，加拿大发布了2011–2016年限制乘用轿车温室气体排放量的管理草案。标准将采取美国最新制定的以车辆尺寸为基础的设置。虽然加政府还在进行更详尽的分析，初步预测2016年加拿大新轿车和轻型卡车的温室气体排放量均值将能达到美国设计的每公里153克二氧化碳(7.6 NEDC L/100km)。这与2007年在加拿大销售的新车群体相比，大约降低了20%。不过，加拿大的车辆平均尺寸比美国要小很多，采用相同的以尺寸为基础的标准设置，加拿大应当能实现比政府所预期的排放水平更低的排放。假设加拿大取得相似的年度燃料经济性提高比例[91], 则对加拿大而言将2016年车辆平均标准设为每公里149克二氧化碳(6.9L/100km NEDC工况下)更为接近现实状况。因此，每公里155克二氧化碳的官方目标可以被看做是一个低端目标。

89 新乘用轿车的二氧化碳排放目标计算公式为：目标值= 130 + a*(M-M0), 其中M是车辆质量，从2012到2015年，M0等于1372,，a等于0.0457。2016年以后，M0将被调整为之前三年新乘用轿车平均质量，系数a还是等于0.0457。生产企业的年度排放目标值应根据生产企业该年度登记注册的新乘用轿车的平均二氧化碳排放来计算。 来源：欧盟委员会：欧盟议会管理规定(EC) No 443/2009，2009年4月23日。

90 这类车在美国的车型分类中属于轻型车。

The European Union

In 1998, the European Union signed a voluntary agreement with auto manufacturers selling to the EU market to reduce fleet CO_2 emissions to 140 g/km by 2008. That voluntary target was not met, and at the end of the compliance period the EU-wide fleet average CO_2 emission rate was 159 g/km. The EU decided to establish mandatory standards to curb CO_2 emissions from cars. In December 2008, the European Commission adopted a new regulation to reduce the average CO_2 emissions of new passenger cars. Key features of the regulation are as follows:

Stringency: The fleet-wide CO_2 target was set at 130g/km (5.2L/100km) by MY 2015. That target is to be met with vehicle efficiency technology improvements alone, with an additional 10g/km cut achieved through additional measures including changes to tire pressure, gear shift indicators, and air conditioning, as well as an increased use of biofuels. A more far-reaching 2020 target of 95g CO_2/km (3.8L/100km) was also announced, though the European Commission will have to consider the technology pathways to achieving this target by 2013.

Structure: The standard is a weight-based corporate average of CO_2 emissions. The regulation specifies a linear equation[89] to calculate the specific emission target for each vehicle depending on its weight. The target for a particular manufacturer is then calculated by sales-weighting the specific targets of all vehicle models it produces. The slope of the linear curve is determined largely based on the current weight and CO_2 performance relationship trend line of manufacturers in EU, but is manipulated to be flatter than the slope of the actual trend line. This is to prevent manufacturers to cheat against the system by arbitrarily up-weighting their car fleet in order to gain a more lenient target.

Standard for light commercial vehicles: In October 2009 the European Commission adopted a new legislative proposal to reduce CO_2 emissions from light commercial vehicles (vans or N1 category under the European classification[90]). A fleet average for all new light commercial vehicles of 175g/km will apply as of 2014. A long-term target of 135g/km is specified for the year 2020. The proposal also adopts a weight-based linear curve to calculate the specific target for each vehicle, similar to the regulatory design for passenger cars.

Australia

The Federal Chamber for Automotive Industries established a voluntary target in 2005 to reduce National Average Carbon Emissions (NACE) for all new passenger vehicles to 222 grams of CO_2/km (9.5L/100km) under the NEDC driving test cycle by 2010.

Canada

In December 2009, Canada released a draft regulation to limit GHG emissions from passenger cars and light trucks in model years 2011 through 2016. The standards will adopt the footprint-based structure proposed in the latest U.S. rulemaking. While a more detailed analysis is being conducted, the Canadian government anticipates that the average GHG emission performance of the 2016 Canadian fleet of new cars and light trucks would match the average level of 155g CO_2/km (7.6 L/100-km) that has been projected for the U.S. That would represent an approximate 20% reduction compared to the new vehicle fleet that was sold in Canada in 2007. However, with a much smaller average fleet size than that in the U.S., by adopting the same footprint based standard structure, Canada should be able to achieve a lower average emissions level than what the government has anticipated. If it is assumed that Canada will achieve a similar annual fuel economy improvement rate, a more realistic target for Canada would be a fleet-average of 149g CO_2/km (7L/100-km under NEDC cycle) by 2016. The 155g CO_2/km target therefore could be considered as a low end target.

89 The equation to calculate the specific CO_2 emission target for each new passenger car is :Target= 130 + a*(M-M0), where M is the mass of a particular vehicle, from 2012 to 2015, M0 equals 1372, a equals 0.0457. After 2016, M0 will be adjusted to be the average mass of new passenger cars in the previous three calendar years, while the value of parameter a will still be equal to 0.0457. The specific emissions target for a manufacturer in a calendar year shall be calculated as the average of the specific emissions of CO_2 of each new passenger car registered in that calendar year of which it is the manufacturer. Source: The European Union Commission:

Regulation (EC) No 443/2009 Of The European Parliament and Of The of 23 April 2009.

90 This vehicle category is under light-duty vehicle classification in the US.

日本

2007年开始引入现有的燃料经济性管理，以重量为基础设置了2015车型年的平均标准。一旦实现2015目标值，在日本JC08测试工况下，车辆平均燃料经济性将达到16.8 km/L (5.4 L/100km)，比2004年(13.6 km/L)提高了23.5%。日本也为轻型商用车（货车）设定了2015年15.2 km/L (6 L/100km)的燃料经济性目标。

韩国

2009年7月，韩国针对2015车型年提出了17km/L和140gCO_2/km (6.4 L/100km)的燃料经济性标准和温室气体排放标准。新标准将以重量为基础，采用美国的CAFE综合测试工况。

8.2 中国燃料经济性管理方案概述

乘用轿车

2005年，中国针对新乘用车（欧盟分类中的M1车辆）引入了第一个全国燃料消耗量标准。三年后，二阶段的实施使标准加严了10%。2009年8月，中国进一步提出了更严格的三阶段标准。标准发展详见图8.1。

和世界其它地区实施的平均燃料经济性或车辆温室气体排放标准不同，中国标准的前两个阶段是针对单车认证油耗值标准。在这种体制下，每个新车型必须满足该重量等级的燃料消耗量要求才能进入市场。这样的管理方案，尽管能尽早淘汰技术落后的车辆，却不能鼓励生产企业采纳最先进的燃料经济性技术。在计划实施的三阶段标准管理中，中国正考虑将单车认证标准和公司平均标准体系相结合。不过目前具体的实施方案还未出台。

一阶段和二阶段标准促使新乘用车平均油耗量从2002年的9.1 L/100 km改善至2009年的8.1 L/100 km 。根据来自中国汽车技术研究中心的信息，计划实施的三阶段标准将到2015年全面实施，届时将把新乘用车的平均燃料消耗量降低至7 L/100 km。这代表从现在到2015年，车辆平均燃料经济性将提升13%，或者说每年提升1.8%。图8.2对比了世界各国轻型车燃料经济性（温室气体）标准。在同时期标准的严格程度上，中国的新目标落后于日本、欧盟和韩国，名列第四位。应注意的是，这里的绝对严格程度排名并没有考虑不同汽车市场的平均车辆重量的不同（一般来说重量轻的车油耗低）。

91 鉴于北美汽车市场的一致性，两个市场的技术水平提高情况非常接近，因此这里用美国每年技术改进的比例来预估加拿大的技术进步速度是比较合理的。

Japan

Introduced in 2007, the current fuel efficiency regulation sets weight-based binned corporate average standards for model year 2015. When the 2015 targets are met, the fleet average fuel economy is expected to be 16.8 km/L (5.4 L/100km) under the new Japanese JC08 driving test cycle, a 23.5% increase over 2004 (13.6 km/L). Japan also established a fuel economy target for light commercial vehicles (vans) of 15.2 km/L (6 L/100km) for 2015.

South Korea

In July 2009, South Korea proposed a combined fuel economy and GHG emissions target of 17km/L and 140gCO_2e/km (6.4 L/100km) for MY 2015. The new standards will be weight-based, and will use the U.S. CAFE combined cycle for testing purposes.

8.2 Overview of China's fuel efficiency programs

Passenger Cars

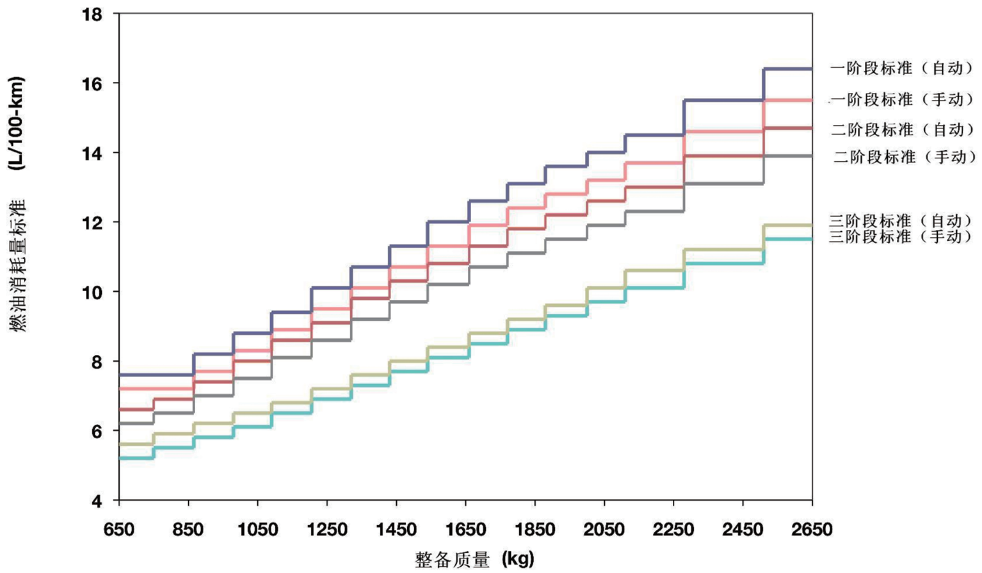
China introduced its first national fuel consumption standards for new passenger vehicles (M1 category under the European classification) in 2005. Three years later, as the second stage, the standards were made about 10 percent more stringent. In August 2009, China proposed a further strengthened Phase III standard. The evolution of these standards is illustrated in Figure 8.1.

Unlike the corporate average fuel economy or vehicle GHG emissions standards adopted in other parts of the world, the first two phases of the Chinese standards were per-vehicle certificate standards. Under that type of system, a new vehicle model must meet the minimum fuel consumption requirement for its weight class before it can enter the market. Such a compliance scheme, though useful to phase out vehicles with outdated technologies at an early stage, cannot encourage manufacturers to adopt state-of-the-art fuel efficiency technologies over time. In the proposed Phase III regulation, China is considering a combined per-vehicle certificate standard and corporate average standard system. So far a detailed implementation plan has not been released.

Phase I and Phase II standards helped improve the fuel efficiency of new passenger cars from 9.1 L/100 km in 2002 to 8.1 L/100 km in 2008. According to the China Automotive Technology and Research Center (CATARC), the proposed Phase III standards will reduce the fleet-average fuel consumption of the new car fleet to 7L/100 km when fully implemented in 2015. This represents a 13% improvement in fleet wide fuel efficiency between now and 2015, or 1.8% annual gain over the period. Figure 8.2 compares the world's light-duty vehicle fuel efficiency (GHG) regulations. China's new target ranks fourth after Japan, the European Union, and South Korea in terms of regulatory stringency. Note that such ranking does not correct for the differences of average vehicle weight among various markets. Generally speaking, the heavier a vehicle, the more fuel will be consumed to move it.

91 This is very likely because the technology improvements between the two markets are very close given the high harmonization of the North American auto market.

中国2015设定的全体乘用车队平均目标值是在假定届时车辆重量构成情况仍然与2008年相同的基础上的。实现这一目标的一个潜在障碍就是中国的轿车正在日趋大型化和重型化[92]。中国以重量为基础的油耗标准不利于鼓励生产企业采用轻型化技术来削减车重。随着市场对重型和高性能车辆需求的增加，车辆平均燃料消耗量可能将无法达到7 L/100 km的目标。



注: 在2016车型年以前，三阶段（自动挡）目标将适用于三排座以下的自动挡轻型车。2016车型年以后，所有轻型车都要遵守同样的三阶段（手动挡）目标。

图 8.1: 中国新乘用车燃料消耗量标准

其它车型

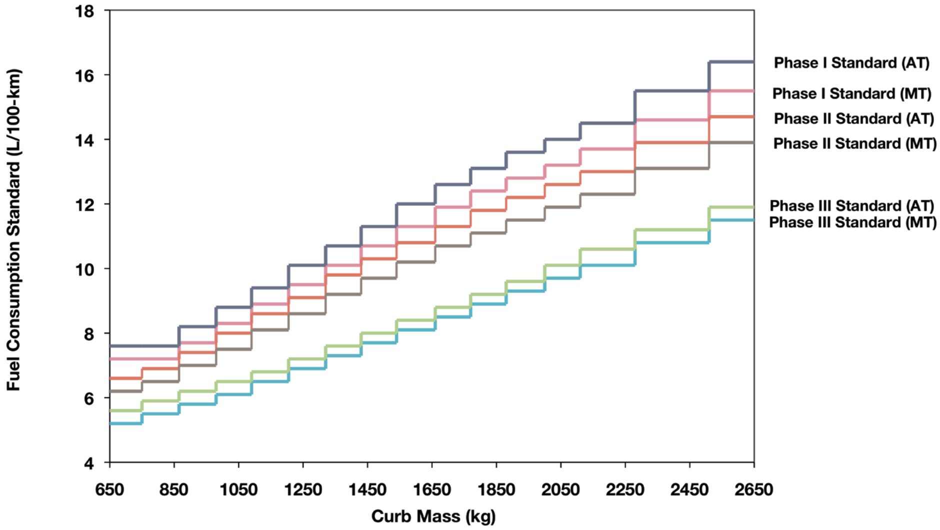
2005年，中国针对轻型车（欧洲分类中的N1和M2车辆）发布了两个阶段的燃料消耗量标准。类似于乘用轿车的一阶段和二阶段标准，标准的主要作用是加速车辆群体的现代化进程，淘汰落后技术。2008年，中国实施了摩托车燃料消耗量标准。中国目前正在开发测试程序以便最终制定重型车标准，并且即将完成二阶段摩托车燃料消耗量标准。

与世界各国燃料经济性标准的严格程度对比

表8.1总结了世界各国轻型乘用车标准的主要情况，包括强度和标准设置情况。表8.2则比较了中国、欧洲、美国和日本已经实施或计划实施的轻型商用车燃料消耗量标准。

92 来自中国汽车技术研究中心（CATARC）的数据表明2002年整备质量小于1,090 kg的车辆份额为44%，到2006年这一比率降低至27%。来源：CATARC 2008年，《乘用车燃料消耗量标准评估》。

The 2015 target value is projected assuming the fleet mix by vehicle weight will remain the same as in 2008. One potential barrier to reaching the target is that cars in China are getting larger and heavier[92]. China's weight-based fuel efficiency standard does not provide any incentive for manufacturers to adopt light-weighting technologies to cut vehicle weight. As market demand for heavier and higher-performance vehicles rises, the fleet-average fuel consumption will not be able to meet the 7L/100 km target.



Note: Before CY 2016, the Phase III (automatic transmission, AT) targets will apply to LDVs with three rows of seats or less and with automatic transmissions. After CY 2016, all LDVs will be subject to the same Phase III (manual transmission MT) targets.

Figure 8.1: Chinese new passenger vehicle fuel consumption standards

Other vehicle types

In 2005, China announced a two-phase fuel consumption standard for light commercial vehicles (N1 and M2 categories under European classification). Similar to the Phase I and Phase II passenger car standard, the main purpose of the standard is to speed up the phase-out of outdated technologies by accelerating the modernization of the fleet. In 2008, China introduced fuel consumption standard for motorcycles. China is currently developing a test procedure to eventually set a new standard for heavy-duty vehicles, and is about the finish the second phase of motorcycle fuel consumption standard.

Comparing the stringency of world fuel efficiency standards

Table 8.1 summarizes the key features, including stringency and structure, of light-duty passenger vehicle standards worldwide. Table 8.2 compares the design of China's light-duty commercial vehicle fuel consumption standards with those proposed or adopted in the EU, US and Japan.

92 Data from CATARC reveal that the share of models with curb mass below 1,090 kg was 44 percent in 2002, while that ratio dropped to 27 percent in 2006. Source: CATARC 2008, "Evaluation of Passenger Vehicle Fuel Consumption Standards".

表8.1: 世界各国轻型乘用车标准汇总

国家/地区	实施车型年	标准类型	未调整的车辆目标值/测量值††	标准设置	目标车辆群体	测试工况
美国	2016	燃料经济性 /温室气体	34.1 mpg* 或 250 gCO_2e/mil	以尺寸为基础企业平均	轿车/轻型车	美国综合工况
加拿大(计划)	2016	温室气体	153 (141)† gCO_2e/km	以尺寸为基础企业平均	轿车/轻型车	美国综合工况
欧盟	2015	二氧化碳	130 gCO_2/km	以质量为基础企业平均	轿车/轻型车	NEDC
澳大利亚(自愿性)	2010	二氧化碳	222 gCO_2/km	单车平均	轿车/轻型车	NEDC
日本	2015	燃料经济性	16.8 km/L	以质量为基础企业平均	轿车	JC08
中国(计划)	2015	燃料消耗量	7 L/100km	以质量为基础单车限值和企业平均	轿车/轻型车	NEDC
韩国(计划)	2015	燃料经济性/温室气体	17 km/L 或 140 gCO_2e/km	以质量为基础企业平均	轿车/ SUVs	美国综合工况

* 美国每加仑行驶的里程数目标值里面提供了燃料经济性信用额度的灵活达标手段，这个额度等于由改进空调系统获得的温室气体减排量。

† 加拿大的目标值是由加拿大政府宣布的。但鉴于加拿大车队的平均车辆尺寸比美国的车队要小，这个目标值只是一个底限目标。ICCT估计，对加拿大来说，2016年更合理的目标值为NEDC测试工况下149gCO_2/km或7L/100km。

†† gCO_2/km为每公里行驶排放的二氧化碳, gCO_2e/km为每公里行驶排放的二氧化碳当量。

尽管各个国家的计量单位和测试工况有所不同，ICCT在2007的一份报告，即《全球乘用车温室气体或燃料经济性标准的最新政策》中提出一项方法论来统一不同的测试行驶工况，实现不同标准之间的公平对比[93]。图8.2展示了比较结果，所有标准都被统一到NEDC工况下，以L/100km为单位。从绝对目标值的角度讲，欧盟和日本已经实施或即将实施将世界上最严格的标准。不过，在比较各国政策的严格程度时，不能忽视了车辆群体构成特点。车辆群体偏重型和大型的国家设置的目标绝对值会比较松。这意味着各国标准所要求的技术改进可能并不能直接反映在排放目标的绝对严格程度上。

93 ICCT. 2007年，Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update. (http://www.theicct.org/information/reports/car_and_light_truck_fuel_efficiency#)。

Table 8.1: Summary of world light-duty passenger vehicle standards

COUNTRY/ REGION	MODEL YEAR EFFECTIVE	STANDARD TYPE	UNADJUSTED FLEET TARGET /MEASURE††	STRUCTURE	TARGETED FLEET	TEST CYCLE
US	2016	Fuel economy /GHG	34.1 mpg* or 250 gCO_2e_2/mil	Footprint-based corporate average	Cars/LT	US combined
Canada (Proposal)	2016	GHG	155 (149)† gCO_2e_2/km	Footprint-based corporate average	Cars/LT	US combined
EU	2015	CO_2	130 gCO_2/km	Weight-based corporate average	Cars/LT	NEDC
Australia (Voluntary)	2010	CO_2	222 gCO_2/km	Single average	Cars/LT	NEDC
Japan	2015	Fuel economy	16.8 km/L	Weight-based corporate average	Cars	JC08
China (Proposal)	2015	Fuel consumption	7 L/100km	Weight-based Per vehicle and corporate average	Cars/LT	NEDC
S. Korea (Proposal)	2015	Fuel economy /GHG	17 km/L or 140 gCO_2e_2/km	Weight-based corporate average	Cars/ SUVs	US combined

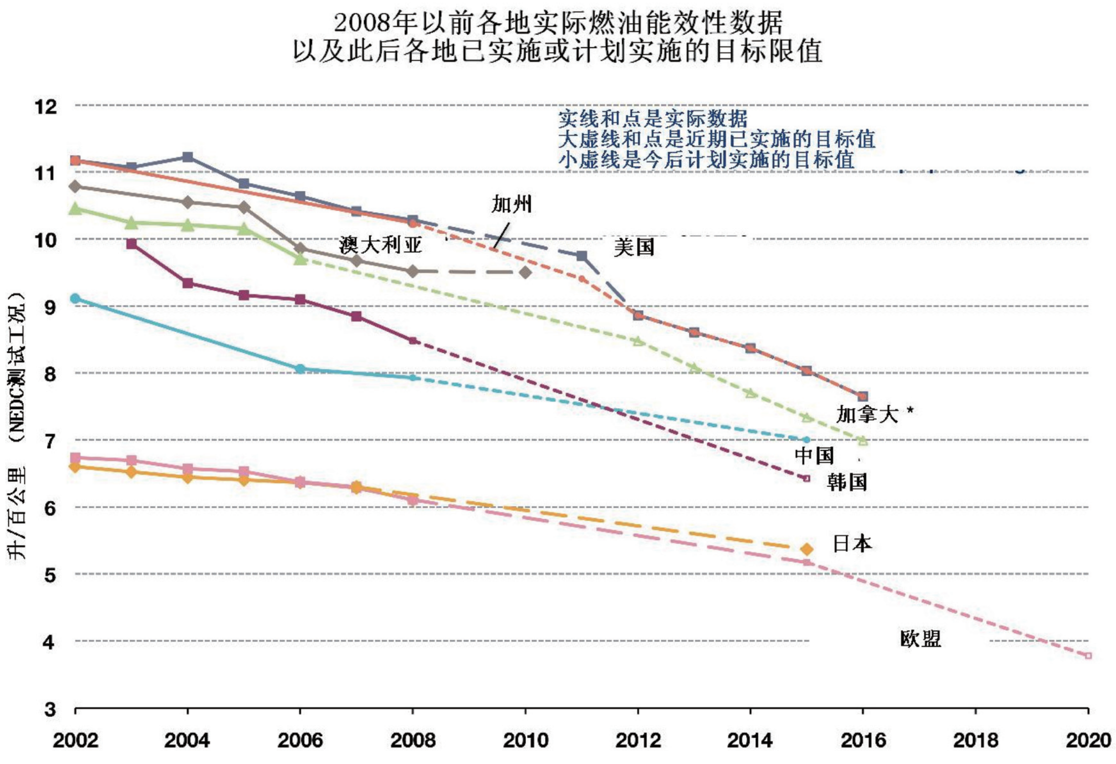
*The U.S. mpg target incorporates a fuel economy credit equivalent to the GHG emissions reduction achieved through the improvement of vehicle air conditioning system.

† The Canadian target is announced by the Canadian government. But this is only a bottom line target given that Canada has an averagely smaller fleet than the US. The ICCT estimates a more reasonable 2016 target for Canada to be 149.gCO_2/km, or 7L/100km under the NEDC test cycle.

†† gCO_2/km is the metric for CO_2 emissions per km traveled, gCO_2e/km is the metric for presenting the GHG emissions per km traveled that are equivalent to the global warming potential of the potential of CO_2.

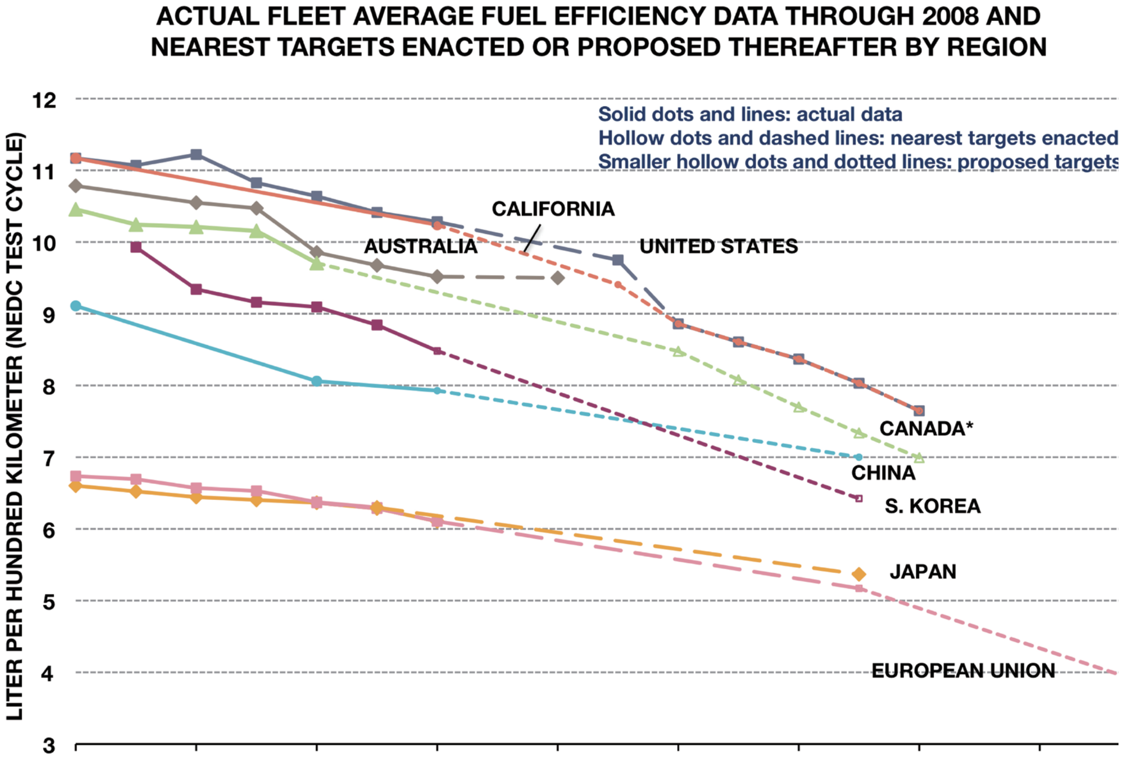
Though metrics and driving test cycles vary from country to country, the ICCT developed a methodology in its 2007 report – Passenger Vehicle Greenhouse Gas or Fuel Economy Standards: A Global Update -- to normalize the different driving test cycles to allow apples-to-apples comparison of different standards 92. Figure 8.2 shows this comparison, with standards normalized to the NEDC cycle in L/100km. In terms of absolute value performance and target, the EU and Japan have adopted or proposed the most stringent standards in the world. However, when comparing the stringency of various policies, one cannot ignore the variation of fleet characteristics. Countries with heavier and bigger cars tend to set less stringent targets in absolute terms. This also indicates that improvements in technology required under these various regulations may not be directly reflected in the absolute stringency of their emission targets.

93 ICCT. 2007. Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update. (http://www.theicct.org/information/reports/car_and_light_truck_fuel_efficiency#).



* 图中所示的加拿大2016年的目标值为ICCT的估计值，而非其官方公布值。原因如前文述。

图8.2: 世界各国乘用车燃料经济性或温室气体排放目标对比



* For Canada, the ICCT estimated target value for 2016 is shown, for reasons mentioned in the Canadian bullet point.

Figure 8.2: Comparison of standards by region

表 8.2: 世界各国轻型商用车燃料经济性标准

	欧盟	美国	日本	中国
目标车辆	N1类最大车辆总质量3.5吨，N2和M2	轻型卡车最大车辆总质量10000磅（=4.6吨）（包括SUV、短货台货车、乘用面包车，不包括工作卡车、多层车和中型车）	车辆最大总质量不超过3.5吨的货车	N1类 (最低设计时速50 km/h) 和车辆最大总质量不超过3.5吨的N2类
目前的二氧化碳平均排放水平[1]	203 g/km (2007)[2][NEDC]	388 g/mi = 241 g/km (2009)[3]	13.5 km/l ≈ 177 g/km (2004)[4] [JC08]	未知
达标后新车平均排放水平预测	175 g/km (2016) (从2014年起逐步实施管理) 135 g/km (2020)[5]	352 g/mi = 218 g/km (2012) 302 g/mi = 188 g/km (2016)[6]	15.2 km/l ≈ 157 g/km (2015)[4]	未知
标准设置	以重量为基础	以尺寸为基础	以重量为基础	以重量和排量为基础
目前的管理现状	计划中	已实施	已实施	已实施

1. 注: 由于车型定义不同，所以不能直接比较车辆平均值
2. 来源: AEA – 《轻型商用车二氧化碳排放立法途径评估》 第18页。
3. 来源: EPA – 《轻型车技术、二氧化碳排放和燃料经济性趋势：1975-2009年》第21页。采用了没有经过调整的测试数字。
4. 来源: METI – 《2007最佳汽车报告》，第11页。假设汽油车份额为90%进行了简单换算，详见第20页。
5. 来源: COM(2009) 593/3。
6. 来源: EPA管理通告2009年9月(EPA-420-F-09-047)。

8.3　标准设计要点

标准类型

世界上主要采用两大类标准：车辆燃料效率标准和温室气体排放标准。燃料效率标准包括燃料经济性标准，测量单位燃料行驶的里程长度(英里/加仑或公里/升)，还有燃料消耗量标准，测量既定距离使用的燃料数量（如升/百公里）。温室气体排放标准可以只考虑燃烧直接排放的二氧化碳，或是考虑车辆行驶和使用车辆配置的附件装置（如空调）排放出的一系列温室气体——如二氧化碳、甲烷、含氟碳氢化合物化合物和氧化亚氮。

黑炭（或称炭黑）是燃烧不完全产生的一种颗粒物（气溶胶），具有很强的气候影响作用（引起气候变暖）。但是到目前为止，任何车辆温室气体排放标准都没有将黑炭纳入管理。不过，因为黑炭是尾气排放出的细颗粒物的一部分，如果有严格的常规污染物标准就也对其有所限制。减少颗粒物就能减少黑炭排放。还有一种方案，是将黑炭的二氧化碳当量纳入到温室气体排放标准当中。这要求我们了解车辆黑炭排放和黑炭的全球变暖潜能值（GWP）。根据IPCC的官方数据，ICCT预测黑炭的100年GWP为460。但是考虑到减少黑炭给气候带来的短期影响，在制订温室气体标准时，应考虑各种温室气体污染物的20年GWP值。根据ICCT估计，黑炭的20年GWP值为1600 （远远高于CO_2)。

Table 8.2: World light-duty commercial vehicle fuel economy standard

	EU	US	Japan	China
Targeted Fleet	N1 max. GVW 3.5 tons, N2 and M2 monitoring only	Light trucks max. GVW 10.000 pounds (= 4.6 tons) (incl. SUVs, short-bed pickup trucks, passenger vans; excl. work trucks, multi-stage and medium-duty vehicles)	Freight vehicles max. GVW 3.5 tons	N1 (min. 50 km/h) and N2 max. GVW 3.5 tons
Current average CO_2 emissions[1] level[1]	203 g/km (2007)[2][NEDC]	388 g/mi = 241 g/km (2009)[3]	13.5 km/l ≈ 177 g/km (2004)[4] [JC08]	Unknown
Estimated effect of regulation on average new fleet performance	175 g/km (2016) (phase-in from 2014 on) 135 g/km (2020)[5]	352 g/mi = 218 g/km (2012) 302 g/mi = 188 g/km (2016)[6]	15.2 km/l ≈ 157 g/km (2015)	Unknown
Metric of target system	Weight-based	Footprint-based	Weigh-based	Weight and displacement based
Current status of regulation	Proposal	In force	In force	In force

1. note: average fleet values not directly comparable due to differences in vehicle definitions
2. source: AEA –"Assessment of Options for the Legislation of CO2 emissions from Light commercial Vehicles", p. 18
3. source: EPA – "Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends": 1975 Through 2009, p. 21. The unadjusted test numbers were used.
4. source: METI – 2007 top runner report, p. 11. "Simplified Conversion Based on Assumption of a 90 % gasoline share", see p. 20
5. source: COM(2009) 593/3
6. source: EPA regulatory announcement, September 2009 (EPA-420-F-09-047)

8.3 Key regulatory design issues

Type of standard

Two broad types of standards are adopted worldwide: vehicle efficiency standards and GHG emissions standards. Efficiency standards include fuel economy standards, measured by distance traveled per unit of fuel (mpg, Km/L), and fuel consumption standards, measured by amount of fuel used for a given distance of travel (L/100km). GHG emissions standards may narrowly refer to CO_2 emissions directly from combustion or to a suite of GHGs— such as CO_2, CH_4, HFC and N_2O—emitted from operating a vehicle and auto accessories.

Black carbon (or soot) is an aerosol emitted from incomplete combustion, and has a strong positive climate forcing (which causes warming). But so far, the warming impact of black carbon is not regulated under any vehicle GHG standard. But because black carbon is a part of the fine particles in vehicle exhaust emissions, it is regulated under tight conventional pollutants standards. Removal of particulate matter can reduce the emission of black carbon as well. Alternatively, the CO_2-equivalent value of black carbon can be incorporated into a GHG standard. This requires knowledge of the black carbon emissions from the vehicle and its Global Warming Potential (GWP). The ICCT has estimated a 100-year GWP of 460 based on official IPCC data. But to take full account of the immediate climate benefits of black carbon reductions, the design of a GHG standard should take into consideration the role of 20-year GWP values, which would be necessary for all pollutants in the GHG basket. For black carbon ICCT estimates a 20-year GWP of 1600.

尽管相互关联，但燃料效率标准和二氧化碳标准不可相互取代。只有所有车辆都依赖于单一能量源的条件下，二者才可以互换。只要市场上有多种燃料可供选择，由于不同燃料（或能源）的碳含量不同，对不同燃料的车辆而言，相同的燃料消耗量标准并不能转换成相同的二氧化碳排放量。并且，各种燃料（或能源）生产过程中的上游二氧化碳排放量也有差异。因此，政策制定者必须考虑燃料效率标准和温室气体排放标准之间的差异。

温室气体排放标准还可以提供一些达标弹性，考虑发动机以外的技术来达到减排——例如空调系统和制冷剂改进。使用甚至是安装空调系统都会给发动机带来额外的负荷，这就造成更多的燃料消耗并排放出更多的二氧化碳。额外负荷所造成的排放可以依靠改进系统设计，提升空调的能效和使用替代制冷剂来削减。例如，外控变排量压缩机就是一个替代系统设计方案。

空调系统制冷剂泄漏会导致相当大的气候影响。目前美国最常用的空调制冷剂是HFC-134a，其全球变暖潜能值是二氧化碳的1300倍。虽然泄漏发生率相对难以控制，特别是车祸造成的泄漏，但是用GWP值较低的替代制冷剂可以显著减少泄漏造成的气候影响。目前，考虑在机动车上应用的替代制冷剂是R1234YF，其GWP值是4。用丙烷取代当前的制冷剂，可减少90%的由泄漏造成的等效二氧化碳排放。而提高车辆燃料能效是无法反映出上述收益的。

标准的类型是一种政策选择并取决于国家的政策目标的侧重点。过去，能源安全和石油依赖程度是制订燃料效率标准的主要原因。现在，随着全球对气候变化的认识不断深化，转而设置温室气体排放目标的倾向十分明显。2009年哥本哈根气候世界气候大会之后，中国承诺到2020年碳强度降低40%-45%。中国目前的轻型车标准或未来的重型车标准都没有将重点直接放在温室气体排放上，不过燃料消耗量限值可以临时转化为二氧化碳目标，因为目前几乎所有乘用轿车都是用单一燃料——汽油。然而，今后替代燃料车越来越常见，这种直接转化关系将不复存在。另外，如前文所提到的，燃料消耗量标准不能鼓励通过改进空调系统来减少温室气体排放。因此，将车辆燃料效率标准转型为温室气体排放标准会是实现这一目标的重要战略之一。

以重量为基础与以尺寸为基础的标准设置方式

以车辆物理参数为基础的车辆标准，如根据车辆重量或尺寸来制定不同标准能够减少对生产企业竞争力的影响，并避免令消费者的选择范围过于局限，同时这样的标准也更公平，在政策上更容易接受。这就是为什么世界上大多数政府都对轻型车采取这种以车辆技术参数为基础的标准。美国采取的是以尺寸为基础的标准，选择的尺寸量度标准是“脚印面积”，定义为轮胎之间的面积（轴距乘以轮胎之间的宽度）。欧洲、日本、中国和韩国则都是采取以整备质量为基础的标准。

除了政策本身的影响之外，参数的选择也会对销售趋势造成很大影响。1979年美国首次实施轻型卡车燃料经济性标准时，标准只适用于最大额定总质量（GVWR）不大于6000磅的车。到1980年，GVWR上限提升至8500磅并一直延续至今。生产企业巧妙地将很多原属轿车的车型重新分类为轻型卡车，从而争取到比较宽松的轻型卡车标准。生产企业还增加了部分车型的GVWR，这样这些车型就可以从CAFE标准中豁免。这在过去20年里，使车辆平均重量增加了28%，还降低了车辆平均燃料经济性[94]；当然，其它一些因素，比如消费者对于更豪华更高性能车辆的需求也是造成上述结果的原因。尽管有严格的基于汽车重量的税收方案，但在日本还是出现了类似的趋势。1993年开始实施以重量为基础的燃料消耗量标准，在此标准之下，常规轿车的重量比90年代水平增加了13%[95]。这一现象对中国有很重要的启示，中国也已经出现了车辆重量化、高动力化和燃料经济性低下的趋势。重量化趋势值得政策制定者认真思考，特别是在中国汽车工业快速增长的前提下。

94 EPA. 2008年. 《轻型车技术和燃料经济性趋势：1975-2008年》。可从以下链接获得http://www.epa.gov/oms/cert/mpg/fetrends/420s08003.pdf 2008年9月29日。

95 T&E. 2007年. 《减少新轿车的二氧化碳排放：2006年主要轿车生产企业进展情况研究》。可从以下链接获得http://www.transportenvironment.org/Publications/prep_hand_out/lid:513。

Although related, a fuel-efficiency standard and a CO_2 emission standard cannot replace each other. The two are interchangeable only if the whole fleet is relying on a single source of energy. When there are multiple fueling options in market, the same fuel consumption requirement does not translate into same CO_2 impact from tailpipe emissions of vehicles running on different fuels, given the different carbon content in the fuels (or energy). Furthermore, the upstream CO_2 emissions for producing the fuels (or energy) vary. Therefore, policy makers must take into consideration the difference between fuel efficiency and GHG emissions standards.

A GHG emission standard also provides compliance flexibility by taking into account non-engine technology improvements—to the air conditioning system and refrigerants, for example. Operating and even carrying the A/C system places an additional load on the vehicle engine, and causes additional fuel to be consumed and therefore more CO_2 emissions. Emissions as the result of such extra load can be mainly reduced by system redesign to increase the A/C efficiency, and using alternative refrigerants. For example, an alternative system design is the externally controlled variable displacement compressors (VDCs).

Leaking refrigerant from the A/C system can have a considerable climate impact. The most commonly used A/C refrigerant in the current U.S. fleet is HFC-134a, which has a global warming potential (GWP) 1,300 times that of CO_2. Although the incidence of leaks is relatively difficult to control, especially leaks that result from car accidents, adopting alternative refrigerant compounds with lower GWP can significantly reduce the leakage-related climate impacts. Alternative refrigerants that are being considered for vehicle application include R1234YF with a GWP of 4. Replacing the current refrigerant with propane, for example, reduces the CO_2–equivalent emissions from leakage by more than 90 percent. That benefit, however, is not reflected in the improvement of vehicle fuel efficiency.

The type of standard is a political choice and depends on national priority. In the past, energy security and oil dependence were the primary drivers of fuel efficiency standards. Today, as global awareness of climate change mounts, there is a noticeable shift toward setting GHG emissions targets. After the 2009 Copenhagen Climate Conference, China pledged a 40%–45% reduction in carbon intensity by 2020. Currently, China's light-duty or future heavy-duty vehicle standards do not directly address GHG emissions, though the fuel consumption limit may temporarily translate into a CO_2 target given that almost all passenger cars currently are using a single fuel -- gasoline. However, when alternative-fueled vehicles become more common in the future, such direct relation will not hold. In addition, as mentioned previously, a fuel consumption standard does not encourage improvements of A/C system to reduce GHG emissions. Therefore realigning the vehicle efficiency standard to GHG emissions standard could be part of the strategy to fulfill this goal.

Weight-based versus size-based structure

An attribute-based vehicle standard, such as one that differentiates by vehicle weight or size, can reduce the impact on manufacturers' competitiveness and avoid restricting consumer choices, and therefore may be fairer and more politically acceptable. This is the main reason why most governments apply attribute-based standards to light-duty vehicles. The U.S. adopted a size-based standard, and its chosen size metric is the vehicle "footprint", defined as the area between the tires (wheelbase times track width). The EU, Japan, China and South Korea have all adopted curb-weight based standards.

Choice of attribute can have a huge impact on sales trends, as well as on the results of the policy itself. When the U.S. light truck fuel economy rule was first established in 1979, it applied only to vehicles up to 6,000 pounds gross vehicle weight rating (GVWR). This ceiling was raised to 8,500 pounds GVWR in 1980, where it has remained. Manufacturers reclassified many models as light trucks, instead of cars, to take advantage of less stringent light truck standards. Manufacturers also increased the GVWR of some models so that they would be exempt from the CAFE standards. This has largely contributed to a 28% increase in average vehicle weight and a decrease of fleet-average fuel economy over two decades[94]; of course other factors such as consumer demand for more luxury models and performance also played a role. Despite a stringent weight-indexed vehicle taxation program, Japan has evidenced a similar trend. Under its weight-based fuel consumption standards, introduced in 1993, the average weight of normal cars increased by 13% over 1990 level[95]. The implications are important to China, where a trend of shifting to a heavier, more powerful, and less fuel-efficient fleet is already happening. The up-weighting trend is an important concern to current policy makers, especially given the rapid growth of China's auto industry.

94 EPA. 2008. "Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2008", available online at http://www.epa.gov/oms/cert/mpg/fetrends/420s08003.pdf as of Sept. 29, 2008.

95 T&E. 2007. Reducing CO_2 Emissions from "New Cars: A Study of Major Car Manufacturers' Progress in 2006", available online at http://www.transportenvironment.org/Publications/prep_hand_out/lid:513.

以重量为基础的标准体系，如中国目前实施的标准，不能有效阻止车辆平均重量的增加。以重量为基础的标准鼓励了生产企业去增加他们车辆的重量，从而有资格适用更宽松的标准，这对使用先进技术来降低车辆重量并提高燃料经济性的生产者来说是不公平的。理想的标准设置应当鼓励使用燃料经济性技术，包括更好的传动设计、缩小发动机规模和采用轻型材料，同时允许针对目标市场，全面生产各种尺寸的车辆。

相比以重量为基础的标准，美国以尺寸为基础的标准设置则拥有以下这些优势。标准有利于使用燃料经济性技术和轻型材料，而同时惩罚了另燃料消耗增加的车辆重型化。标准不鼓励以燃料经济性为代价去追求更大的发动机和更高的性能表现。另外，通过尺寸标准基础的定义（即脚印面积），能够减少生产企业“欺骗”的机会，避免在车上增加很大的保险杠或其它配件来增加车辆的外部尺寸，从而使车辆适用于更宽松的标准。

8.4 财税政策的作用

财税政策是交通和应对气候变化政策的重要组成部分。一方面，生产企业常常无法从消费者身上收回用于先进技术和清洁技术方面的投资，如汽油直喷、无级变速器、可变气门组以及混合动力等等。这是因为消费者严重的低估了这些技术在车辆使用寿命周期内带来的节油效益[96]。有了财税政策，生产企业采用这些技术的回报就更加确定。另外，财税政策可以向消费者提供鼓励高燃料经济性和低排放的价格信号，帮助这些更节能高效的车辆增加市场份额。

基于二氧化碳排放量或燃料消耗量设置的车辆税或其它税费应比以车辆物理参数（重量或排量）为基础的政策能更行之有效地鼓励低排放和燃料经济性高的车辆。这是因为生产企业会调整车辆的物理参数来获得财税鼓励，而这种调整并不一定会改变车辆的油耗性能和二氧化碳排放量。比如，在鼓励小型发动机的财税政策体系下，生产企业增加涡轮增压装置来减小发动机排量就可以获益，然而这个发动机可能和替换下来的大排量的自然吸气式发动机动力相仿，使用的燃料和排放的二氧化碳也都一样多。目前，美国和欧洲的部分国家已经开始实施以燃料经济性或二氧化碳为基础的财税政策。

在过去的几年里，中国对车辆消费税和购置税进行了改革，提高了大排量车的税率，同时减少了小排量车的税率。改革的目的是为了鼓励节油的车辆。但是，基于上述原因，这项政策的结果只能是车辆小型化，但并没有改善车辆的油耗水平。将政策的征税基础改为燃料消耗量或二氧化碳排放量则能更直接的鼓励生产企业和消费者，而不一定需要引入额外的税收负担。法国的奖惩机制根据二氧化碳排放性能来对消费者进行补贴或收税，这不但刺激了法国国内汽车市场还成功的引导消费者购买低碳汽车。英国和德国也都实施了以二氧化碳为基础的财政鼓励措施，推动低碳汽车的销售。ICCT2010年的一份报告（最佳财税奖惩方案的设计和实施）和即将完成的另一份报告（影响二氧化碳排放水平的轻型车财税政策的回顾和评估）中详细的介绍了不同的设计方案、国际财政补贴方案经验及减少轿车温室气体排放的财政鼓励方案。中国在制订自己的财政政策时可以参考这两本报告。在2010年6月1日，中国政府实施了一项新的财税政策，所有购置符合第三阶段油耗标准及发动机排放量为1.6升以下车辆的消费者都可以得到3000元/辆的一次性定额补助。这个新的财税政策是迈向正确方向重要的一步。

96 Greene, D.L., J. German 和 M.A. Delucchi, 2009年.《燃料经济性：市场失败案例》（“Fuel Economy: the Case for Market Failure”），第11章Ch. 11, D. Sperlin和J. Cannon,《降低交通领域气候影响》（Reducing Climate Impacts in the Transportation Sector）; 斯普林杰科学与商务媒体（Springer Science and Business Media）。

A weight-based standard system, such as the one currently implemented in China, is ineffective in preventing an increase in average vehicle weight. Weight-based standards give manufacturers an incentive to up-weight their fleet in order to qualify for more lenient standards and penalize manufacturers who use advanced technologies to reduce vehicle weight and improve fuel efficiency. An ideal standard structure would encourage all fuel-efficient technologies, including better powertrain designs, engine downsizing, and lightweight materials, while at the same time allowing vehicles to be produced across the entire range of sizes typical for the targeted market segment.

The U.S.-style footprint-based standard structure has all these advantages over the weight-based standard. It rewards the use of fuel-efficient technology and lightweight materials, while punishing up-weighting of vehicles that is directly responsible for more energy consumption. It discourages pursuing bigger engines and higher performance at the expense of fuel efficiency. In addition, the footprint standard basis, by definition, can reduce the chances of manufacturer "cheating" by adding big bumpers or other accessories that would increase vehicle exterior size and qualify the vehicles for a weaker standard.

8.4 The role of fiscal policies

Fiscal policies are a crucial component of transportation climate policies. On one hand, manufacturers' investments in advanced and green technologies, such as gasoline direct injection, continuously variable transmission, variable valve train, hybridization, and so on, often cannot be fully passed on to consumers. This is because consumers tend to severely discount the lifetime fuel saving benefit from technologies[96]. With fiscal policies, the manufacturers' rewards for adopting such technologies are more certain. In addition, fiscal policies provide consumers with price signals for fuel efficiency and lower emissions, and help increase the mix of more efficient vehicles in the market.

Vehicle taxes or other charges that vary with vehicle CO_2 emissions or fuel consumption are potentially more effective than policies based on vehicle attributes (such as weight or displacement) in encouraging lower emissions and more fuel-efficient vehicles. This is because manufacturers may adjust vehicle attributes in response to an incentive based on that attribute, without changing vehicle performance and CO_2 emissions. For example, under an engine displacement incentive system, manufacturers are rewarded for adding turbochargers and downsizing the engine, even though the engine may be just as powerful and use just as much fuel and generate the same CO_2 emissions as the larger naturally aspirated engine it replaced. Currently, the U.S. and a number of European nations have adopted either fuel economy or CO_2 based fiscal policies.

In recent years, China reformed its vehicle excise tax and acquisition tax by raising the tax rate for larger engine vehicles while reducing that for smaller-engine vehicles. The purpose of the reform is to encourage a more fuel-efficient fleet. But for the reasons stated above, such a policy may only result in a fleet of small vehicles without much improvement in vehicle efficiency. Shifting the policy basis to fuel consumption or CO_2 emission could provide a more direct incentive to manufacturers and consumers without introducing an extra tax burden. The French Bonus-Malus program that rewards and penalizes buyers based on a vehicle's CO_2 emission performance not only stimulated the domestic vehicle market but have also successfully directed consumers to buy lower carbon vehicles. The United Kingdom and Germany have also introduced CO_2-based fiscal incentives to promote sales of low-carbon vehicles. A 2010 ICCT report (Best Practices of Feebate Program Design and Implementation) and an upcoming report (Review of Fiscal Policies to Influence Light-duty Vehicle CO_2 Emissions) detail various design issues and international experiences of feebate programs and broader vehicle fiscal incentive programs that aim at reducing GHG emissions from cars. These reports can be a reference for China when designing its own fiscal policies. Starting from June 1, 2010, the Chinese government offers a one-time 3000-yuan incentive to consumers who purchase small engine-size (<1.6 liter) vehicles that meet the Phase III fuel consumption standards. This new incentive is an important step towards the right direction.

96 Greene, D.L., J. German and M.A. Delucchi, 2009. "Fuel Economy: the Case for Market Failure", Ch. 11, in D. Sperling and J. Cannon, eds., Reducing Climate Impacts in the Transportation Sector, Springer Science and Business Media.

8.5 建议

以下建议主要针对环保部，涵盖五个方面：授权、严格性、标准设置、实施和辅助政策。

环保部应力争获得监测和管理机动车温室气体排放的授权

作为世界上最大的温室气体排放国之一和世界上汽车市场增长速度最快的国家，中国在减轻气候变化方面的作用十分重要。环保部应当牵头强调固定源和移动源的气候变化影响。近期，环保部应力争获得管理道路车辆温室气体排放的授权，并开始监测和收集新车及在用车的温室气体排放数据。这些数据可以用来开发温室气体排放清单，并与常规污染物排放清单数据库相整合，为今后制订温室气体标准做准备。由环保部来确保对常规污染物和气候变化影响物采取的管理措施相一致从而取得共同收益是最适宜的。为了获得管理权，环保部可能需要进行机动车温室气体排放影响方面的基础研究。2009年美国EPA发布了两份报告，得出如下结论：机动车排放的温室气体会引起的气候变化会危及我们及后代的健康和福利。从中长期角度（三阶段标准以后），环保部可以考虑对新车实施温室气体排放标准，或考虑和先进国家如美国和欧洲一样，统一燃料消耗量标准和温室气体排放目标值。

中国应加强现有燃料消耗量标准的力度

对乘用车而言，计划中的三阶段目标是实施严格程度在世界范围名列第四的标准。但是，如果将中国的目标与和中国车队的平均重量和尺寸相似的欧盟和韩国的目标进行比较，中国的目标是最宽松的。目前，2015年的目标是7L/100km，每年仅改善1.8%，而韩国同期的改善幅度是4.4%。尽管在欧盟新的管理方案中年度改善率为2.7%，但欧盟的基准（目前的水平）比中国要低很多。在改善情境设计中，中国应当力争到2030年以前，每年改善3%，即整体车队目标达到4.25L/100km。如果可能，应考虑4%的年度改善率，则到2030年可以实现3.5 L/100km。在本案的改善情景和强化情景中，模拟了实施上述两个目标的节油和温室气体减排效果。

对于重型商用车而言，中国目前的管理设计尚处于初级阶段。但是，基于美国进行的技术潜力研究的结论，以2015年为基准，到2030年中国的新车能够实现高达50%的改善。为阐明这一结论，本案在改善方案情景分析中设计了20%的车辆平均改善，在强化方案情景下设计了50%的改善幅度。

为了车辆群体实现更明确的燃料节约和碳减排，中国应调整现有燃料消耗量标准的设置

目前中国的乘用轿车燃料消耗量标准结构是以重量为基础的，这会鼓励车辆增加重量，令车队平均目标值降低。轻型商用车采取以发动机排量为基础，更加影响实施效果，生产企业可以很通过加装涡轮增加装置达到小型化发动机，从而获得宽松的标准。如果代之以以尺寸为基础的结构可以避免这些影响。另外，采用连续曲线取代阶梯形曲线来设置目标值也会带来收益。

中国应采取以二氧化碳温室气体排放为基础的财税政策取代现有的以排量为基础的汽车税，从而更好的支持燃料消耗量管理和全面的碳减排目标。

在过去的几年中，中国不断的做出努力，改革车辆税收政策来鼓励市场转向小型和节能的车辆。一方面，这些努力取得了积极的市场反应，小排量汽车的新车销售呈现大幅增长趋势。另一方面，现有的财政政策在支持车辆燃料消耗量和温室气体排放目标方面还不够理想。用直接与燃料消耗量或二氧化碳排放量挂钩的税收替代现有的以排量为基础的车辆税收会在引导消费者购买低碳、节油汽车方面取得更好的效果，欧洲实施以二氧化碳为基础的车辆税收的效果证明了这一点。如果环保部考虑实施财税政策鼓励购买低排放的车辆，也应该考虑将温室气体纳入设计当中，从而在最大程度上获取鼓励方案的效果，减少常规污染物和温室气体排放。

8.5 Recommendations

The following recommendations primarily aimed at MEP cover five areas: authority, stringency, structure, enforcement and complementary policies.

MEP should seek the authority to monitor and regulate GHG emissions from motor vehicles

As one of the highest contributors of gross national GHG emissions and with the most rapidly growing auto market in the world, China's actions in mitigating climate change are extremely important. MEP should take the lead in addressing climate change issues from both stationary and mobile sources. In the near term, MEP should seek the authority to regulate GHG emissions from on-road vehicles, and begin to monitor and collect GHG emissions data from both new and in-use vehicles. This data can be used to develop a GHG inventory that can be included in the conventional pollutants inventory database , as preparation for establishing any future GHG standards. MEP is best position to ensure that action both on conventional pollutants and climate forcers are consistent with each other and lead to co-benefits. In order to obtain the regulatory authority, MEP might need to conduct basic studies of GHG impacts from automobiles. In 2009, the US EPA issued two reports concluding that GHG emitted from motor vehicles contribute to climate change that endangers public health and the welfare of current and future generations. In the mid-term (post-Phase III standard), MEP may consider establishing GHG emissions standards for new vehicles, or consider harmonizing the fuel consumption standards with GHG emissions targets as was done in other leading markets such as the US and EU.

China should enhance the stringency of its current fuel consumption standards

For passenger vehicles, the proposed Phase III target is the fourth most stringent standard in the world in absolute terms. However, if China' s target is compared with those in EU and South Korea, where the fleet are of very similar average size and weight, China's target is the least stringent. Currently the 2015 target of 7L/100km represents an annual improvement rate of only 1.8%; while that rate for South Korea is about 4.4% over the same period. Although the annual improvement rate is 2.7% under EU's new regulation, EU has a much lower baseline (current performance) than China. China should pursue an annual improvement rate of 3% through 2030, which translates into a fleet-wide target of 4.25L/100km, as an improved program scenario. If possible, a 4% annual improvement that would achieve 3.5 L/100km fleet-wide, in 2030, should be considered. The fuel savings and GHG reductions from adopting these two targets are modeled in the improved program scenario and strong program scenario in this study.

For heavy commercial vehicles, China is currently in the preliminary stage of regulatory design. However, based on findings from US studies on technology potential, China could achieved as much as 50% improvements in new vehicles by 2030 from the 2015 baseline. To illustrate this, a 20% fleet-average improvement as the improved program scenario and a 50% improvement as the strong program scenario were analyzed in this study.

China should adjust the design structure of its current fuel consumption standards, in order to deliver more certain fuel and carbon reduction fleetwide

China's current weight-based structure for passenger cars fuel consumption standards encourages up-weighting, which may dilute the fleet-average target. The use of engine displacement, as is currently done for light commercial vehicles is even less effective, as it can be easily gamed by adding smaller displacement engines with turbochargers. These effects can be avoided by adopting a size-based standard structure instead. In addition, it would be beneficial to adopt a continuous line instead of step functions in determining the specific target for each attribute class.

China should replace the current displacement-based fiscal policies with a CO_2 / GHG-based scheme to better support the fuel consumption regulations and an overall carbon reduction goal

China in the past few years has made continuous efforts to reform its vehicle tax policies to encourage a market shift to smaller and thus more efficient vehicles. On one hand, these efforts have led to very positive market response and trends showing that new sales of smaller engine vehicles had grown drastically. On the other hand, current fiscal policies are not ideal for supporting vehicle fuel consumption or GHG emissions targets. Substituting direct taxes on fuel consumption or CO_2 emission for the existing displacement-based vehicle taxes would be more effective in directing consumers to purchase low carbon vehicles, as evidenced by the European experience with CO_2-based vehicle taxes. As MEP considers providing fiscal policies to encourage the purchase of low emission vehicles, the ministry should consider taking into account GHGs in the design so as to maximize the benefits of the incentive program in reducing conventional pollutants and GHG emissions.