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Options to Reduce GHG Emissions through National

Appropriate Mitigation Actions and Sectoral Approaches

Taking the lead: implications of adopting advanced fuel economy standard in China's transportation sector

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Agenda

- International Experience with Fuel Economy Standards
- China's First Steps with Fuel Economy Standards
- Further Steps in the Implementation of Fuel Economy Standards
- Benefits and Co-Benefits of the Implementation of Fuel Economy Standard
- Costs of Implementation

International Experience with Fuel Economy Standards

Measures to Promote Fuel Efficient Vehicles

Fuel efficiency approach	*Measures/forms*	*Country/region*
Fuel economy standards	Numeric standard in mpg, km/L, or L/100-km	United States, Japan, Canada, Australia, China, Taiwan, South Korea
GHG emission standards	Grams/km or grams/mile	European Union, California
High fuel taxes	Fuel taxes at least 50% greater than crude oil base price	European Union, Japan
Fiscal incentives	Tax relief based on engine size, efficiency, and carbon dioxide emissions	European Union, Japan
R&D programs	Incentives for particular technologies and alternative fuels	United States, Japan, European Union
Economic penalties	Gas guzzler tax	United States
Technology mandates and targets	Sales requirement for ZEVs	California
Traffic control measures	Hybrids allowed in HOV lanes; ban on SUVs	Several U.S. States (hybrid HOV lanes); Paris (SUV ban)

International Experience with Fuel Economy Standards

Fuel Economy and GHG Standards

Country/region	*Type*	*Measure*	*Structure*	*Test method*[a]	*Implementation*
United States	Fuel	mpg	Cars and light trucks	U.S. CAFE	Mandatory
European Union	CO_2	g/km	Overall light-duty fleet	EU NEDC	Voluntary
Japan	Fuel	km/L	Weight-based	Japan 10-15	Mandatory
China	Fuel	L/100-km	Weight-based	EU NEDC	Mandatory
California	GHG	g/mile	Car/LDT1 and LDT2[b]	U.S. CAFE	Mandatory
Canada	Fuel	L/100-km	Cars and light trucks	U.S. CAFE	Voluntary
Australia	Fuel	L/100-km	Overall light-duty fleet	EU NEDC	Voluntary
Taiwan, South Korea	Fuel	km/L	Engine size	U.S. CAFE	Mandatory

a Test methods include U.S. Corporate Average Fuel Economy (CAFE), New European Drive Cycle (NEDC), and Japan 10-15 Cycle.
b LDT1 and LDT2 are categories of light-duty trucks.

China's First Steps with Fuel Economy Standards

- In 2004, new "Policies on Auto Industry" were published to align with WTO regulations and added more market-oriented factors into the management system.

- Also in 2004, the government had set up limits of fuel consumption level for two periods, for cars with different complete mass "Maximum Limits of Fuel Consumption (L/100-km) for Passenger Cars" (GB19578-2004)
- applicable to vehicles which:
  - 1) are equipped with ignition engine or compression ignition engine;
  - 2) have the maximum designed vehicle speed no less than 50km/h;
  - 3) have the maximum designed mass no more than 3500 kg;
  - 4) are passenger vehicles that have no more than 9 seats

Further Steps in the Implementation of Fuel Economy Standards

Fuel economy standard for LDV & passenger cars Phase I + II

- Phase 2: 1/2008 (for passenger cars)
- Phase 1: 2/2008 (for LDV)
- Phase 2: 1/2011 (for LDV)

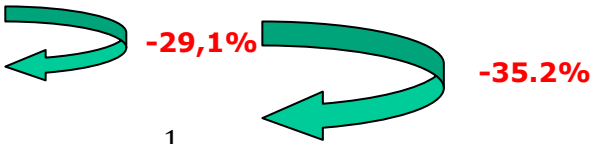
Fuel economy standard for HDV as well as Phase III for LDV and passenger cars

- Phase 3: 1/2012 (for passenger cars)
- Phase 3: 1/2015 (for LDV)
- Phase 1: 1/2015 (for HDV) (conservative assumption of 10%)

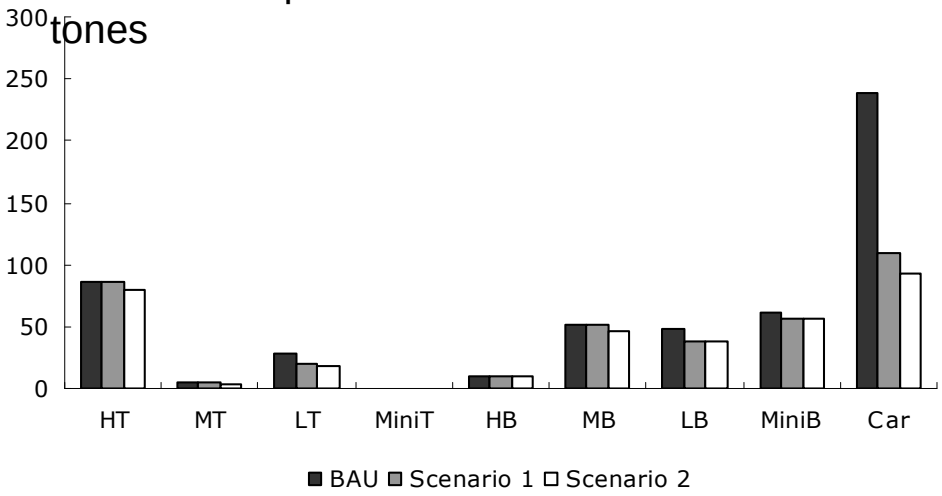
Benefits and Co-Benefits of the Implementation of Fuel Economy Standards

- Primary Effects on Energy Security (Energy Efficiency till 2030)

  - Oil Consumption in BAU-Scen. = 529.761 mio. tones
  - Oil Consumption in Scenario 1 = 375.678 mio. tones
  - Oil Consumption in Scenario 2 = 343.085 mio. tones



$$OC = \frac{1}{FE^{t}_{c,f}} * TM^{t}_{c,f} * VP^{t}_{c,f} * D^{t}_{f}$$



FE = fuel economy
TM = annual average traveled mileage
VP = vehicle population
D = fuel density in kg/l
c = vehicle category (HT, MT, HB, etc.)
f = fuel type (gasoline, diesel)
t = time period/year

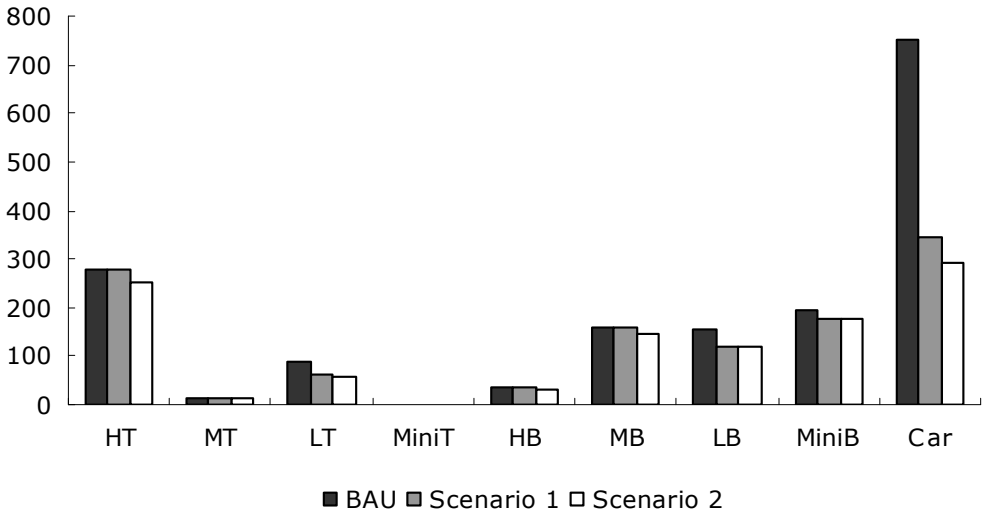
Benefits and Co-Benefits of the Implementation of Fuel Economy Standards

- Implication on CO_2 Reduction

- CO2 emission in BAU-Scen. = 1672.546 mio. tons
- CO2 emission in Scenario 1 = 1188.002 mio. tons
- CO2 emission in Scenario 2 = 1084.937 mio. tons

-29.0%

-35.1%



$$CO_2 = OC_{c,f}^{t} * \frac{44}{12} * CC_f^t$$

OC = oil consumption
CC = carbon content of fuel in %
T = time period/year
C = vehicle category (HT, MT,HB, etc.)
F = fuel type (gasoline, diesel)

Benefits and Co-Benefits of the Implementation of Fuel Economy Standards

- Health Benefits

Epidemiological research into air pollution has shown that air pollution is damaging to human health:

Carbon Monoxide: reduces the flow of oxygen in the bloodstream

Hydrocarbons: react in the presence of nitrogen oxides and sunlight to form ground-level ozone (irritates the eyes, damages the lungs, aggravates respiratory problems

exhaust hydrocarbons: some are toxic and can cause cancer

- improvement in air quality will save lives
- WHO estimate (0.5 % - 1 % additional daily deaths for every 10μg/m3 increase in daily ambient concentration of particles smaller than 10μm
- *Vennemo et al.* found out that the median of all studies is 70 and the percentiles 34 and 161

Benefits and Co-Benefits of the Implementation of Fuel Economy Standards

- Health Benefits

- ***between 34 and 161 lives can be saved for each million ton of CO_2 reduced inxChina***

Saved lives till 2020:

Scenario 1: 7,900 – 37,300

Scenario 2: 9,300 – 44,000

Saved lives till 2030:

Scenario 1: 16,500 – 78,000

Scenario 2: 20,000 – 94,600

Benefits and Co-Benefits of the Implementation of Fuel Economy Standards

- Monetary Benefits

Direct effects:

can be measured by means of the market prices of the reduced amount of consumption

Indirect effects:

impacts can be translated into estimates of monetary benefits by using impact assessment models to value the effects and benefits on

- *higher agricultural yields* (valued at market prices)

- *less corrosion* (valued by costs of maintenance and avoided repairs)

- *less wear and tear of buildings* (valued by costs of maintenance and avoided repairs)

- *hospital admissions, outpatient visits and lighter cases of disease* (valued by an estimate of real resources spent, on medicines, doctor's time and, an appropriate share of hospital's capital costs

Benefits and Co-Benefits of the Implementation of Fuel Economy Standards

- Monetary Benefits

i) Health Benefits

How much is saving a life worth?

Given the estimate obtained above of 34–161 lives saved per million ton CO_2, and using 1 million RMB to illustrate the value of a statistical life saved (Vennemo et al. 2006: 222,223):

34 and 161 million RMB are saved per million ton CO_2

	Scenario 1	Scenario 2
2020	7.9 – 37.3 billion RMB	9.3 – 44.0 billion RMB
2030	16.5 – 78.0 billion RMB	20.0 – 94.6 billion RMB

Benefits and Co-Benefits of the Implementation of Fuel Economy Standards

- Monetary Benefits

ii) Saved Oil Imports

Assumed barrel price for crude oil: 100 US$ (in our calculation in December 2007) 130 US$ (in June 2008)

100US$-Scenario

	Scenario 1	Scenario 2
2020	US$ 54 billion	US$ 63.7 billion
2030	US$ 112.95 billion	US$ 136.85 billion

130US$-Scenario

	Scenario 1	Scenario 2
2020	US$ 70.23 billion	US$ 82.8 billion
2030	US$ 146.84 billion	US$ 177.9 billion

Costs of Implementation

- 2 different approaches to calculate the implementation of a fuel economy standard

Technological Approach

- Costs of development of technologies
- Production Costs

Political Approach

- Costs of the policies which are necessary to support a fuel economy standard
  - i) Fuel taxes and fees
  - ii) Vehicle taxes and fees
  - iii) New vehicle incentive programs

Costs of Implementation

- Technological Approach

In Phase I report we refered to *Huo 2002* and her recommendations about costs and
benefits of efficient technologies.
6 years after her publication and after the implementation of Phase I of the fuel economy standard the share of models using upgraded technology changed

	2002 models	2006 models
Multi-Valve	37 %	85 %
Variable valve system	1.5 %	20 %
Electronic throttles	0 %	56 %
Roller rocker/arm oil tappet	0 %	9 %
Aluminum material	10 %	40 %
4MT	24 %	2 %
5MT	55 %	65 %
6MT	0 %	4.5 %
4AT	11.5 %	25 %
5AT	3 %	9 %
6AMT	0 %	5 %

Source: Tian, Guo, Zhang 2007 p. 102.

Costs of Implementation

In the next 5 – 20 years the focus will lie on a wider use of the recommended engine- and transmission technologies as well as on a further development of:

- GDI engines
- Homogeneous Charge Compression Ignition (HCCI)
- Hybrid technologies, and
- Fuel Cells

Costs of Implementation

	Potentials/Costs			
	Tian, Guo, Zhang		EPA	
Engine Technologies				
GDI	10-15 %	3500 RMB	-	-
- Stoichiometric	-	-	-	122-525 US$
- Lean Burn	-	-	-	750 US$
HCCI	10-20 %[1]	3000 US$[1]	-	-
Hybrid Technology	20-40 %[1]	$^1/_3$ of total costs of a car[1]	-	-
- Integrated Starter Generator w/idle-off	-	-	7.5 %	563-600 US$
- Integrated Motor Assist (IMA)/Integrated Starter-Alternator-Dampenser (ISAD) hybrid	-	-	-	2477-3153 US$
- Two-Mode Hybrid	-	-	40 %	4655 US$
- Power-Split Hybrids	-	-	35 %	3754 US$
- Plug-in Hybrids	-	-	-	4500-6750 US$
Fuel Cell	Depends on the fuel	2000 US$/kW[2]		

Costs of Implementation

- Political Approach

i) Fuel taxes and fees

- Gasoline and diesel tax
- Carbon taxes

➢ Imposing fuel tax will excite the demand for energy-saving engines and thus promote the development and application of upgraded engines

ii) Vehicle taxes and fees

- Annual Vehicle Attribute-Based Taxes and Fees
- Tax/Fee Reduction or Exemptions for New Clean Efficient Cars

iii) New vehicle Incentive programs

- Rebates
- Fees
- Feebates

With more than 2.5 million new registered cars per year since 2004 these incentive programs seems to be the most effective one for China if it comes to the impacts to fuel economy standard.

Costs of Implementation

- Focus of the report are the New Vehicle Incentive Programs and their effects and costs

- Rebate

- offer cash back or a credit to those who buy better-performing vehicles
- exemptions from motor vehicle fees
- tax reduction

- Fee

- targeted fees impose costs only on poorly-performing vehicles
- result in the net collection of new funds, as do taxes
- the level of fees determines their effectiveness

- Feebate

- combining fees and rebates
- policy design adheres to the “polluter pays” principle
- work best when there is a large selection of vehicles to choose from
- aim of feebates is to shift consumer purchase decisions on the margin throughout the market

Costs of Implementation

	No Policy	*Gas-Guzzler Fee* ($1000 per 0.01 GPM)	*Gas-Guzzler Fee* ($2000 per 0.01 GPM)	*Feebate* ($500 per 0.01 GPM)	*Feebate* ($1000 per 0.01 GPM)	*Rebate* ($500 per 0.01GPM)
Cars (mpg)	**28.3**	**31.6**	**31.8**	**31.8**	**35.2**	**28.7**
Light trucks (mpg)	**21.8**	**25.1**	**25.1**	**26**	**29.2**	**22.4**
Total (mpg)	**25**	**28.3**	**28.4**	**28.9**	**32.3**	**25.5**
Consumers' surplus						
Governm. Expenditures	**$0**	**$0.2**	**$0.2**	**-$0.1**	**$0.1**	**-$0.8**
Changes in Sale (%)	**0**	**-0.6**	**-0.6**	**-0.5**	**-1.6**	**0.2**
Fuel Saved/vehicle (gallons)	**126**	**684**	**694**	**773**	**1195**	**223**
Total fuel savings	**$3.10**	**$16.9 (445.16%)**	**$17.1 (451.61%)**	**$19.1 (516.13%)**	**$29.2 (841.94%)**	**$5.5 (77.42%)**
Societal Value	**$2.30**	**$12.4 (439.13%)**	**$12.6 (447.83%)**	**$14.0 (508.70%)**	**$21.4 (830.43%)**	**$4.1 (78.26%)**
Manufactures' revenue	**$1.40**	**$1.1 (-21.43%)**	**$0.7 (-50.0%)**	**$1.5 (7.14%)**	**$0.4 (-71.43%)**	**$1.7 (21.43%)**

Billion Dollars

Costs of Implementation

- key advantage of feebates is that they provide an on-going incentive to increase fuel economy as new technologies are developed
- Other vehicle fuel economy policies, including gas taxes, gas-guzzler taxes, may not be as effective as feebates at increasing vehicle energy efficiency because they are less dynamic tools

Why?

- Consumers tend to under-value fuel savings, but accurately reckon vehicle prices in their purchase decisions
- Manufacturers tend to accurately weigh the costs and benefits of increasing miles per gallon so as to avoid fees and capture rebates.

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