

**Asia-Pacific Environmental Innovation Strategies (APEIS)
Research on Innovative and Strategic Policy Options (RISPO)
Good Practices Inventory**

Shift from Two- to Four-Stroke Motorcycles in Bangkok

Summary of the Practice

Keywords: Four-stroke engine, emissions standard, inspection

Strategy: Development of environmentally sustainable transport systems in urban areas

Environmental areas: Air pollution, urban environment

Critical instruments: Awareness/capacity building, Design, planning and management, Partnerships, Regulatory instruments

Country: Thailand

Location: Bangkok

Participants: National and local government, automobile manufacturers, consumers

Duration: Since 1990

Funding: United States Environmental Protection Agency, World Bank, motorcycle manufacturers and consumers

Background:

Bangkok has been undergoing rapid urbanization and industrialization, especially since the 1960s. The increasing population and the development of infrastructure such as road networks and real estate developments has resulted in the expansion of the city into surrounding areas. Based on registration records of 2002, Bangkok has a population of 5,782,159 with a density of 3,686 persons per sq. km. (NSO, 2003).

Just like other fast growing cities, Bangkok has an ever-increasing vehicle fleet contributing to serious traffic congestion and aggravating air pollution. Among the various means of road transportation, motorcycles are a popular mode for carrying people and goods, but at the same time have been major contributors of air pollution in Bangkok. In the early 90s, motorcycles in Bangkok numbered about 1.3 million, were increasing at a rate of 10-15 percent per annum (Kiravanich, 1993 cited in Chanchaona, 1995) and constituted almost 50 percent of the total fleet of vehicles. They were considered to be the largest mobile source of hydrocarbon (HC) emissions (at 70 percent), contributed 30 percent of the carbon monoxide (CO) and 14 percent of the particulate matter less than 10 microns in diameter (PM₁₀) originating from mobile sources in 1997 (SECOT Consulting 2000, cited in Bhaopichitr and Warapetcharayut 2001).

Until the mid 1990s, a large majority of the motorcycles (up to 80 percent of them) were of the 2-stroke engine variety. (SECOT Consulting, 2000 cited in Bhaopichitr and Warapetcharayut, 2001). Motorcycles with two stroke engines emit twice as much HC and suspended particulate matter (SPM) as do the four-stroke types (Chongpeerapien, 1991). Hydrocarbon emissions from 2-stroke engines can be reduced to 3 g/km, while emissions from 4-stroke engines can be lowered to 0.8-1 g/km (<http://groups.yahoo.com/group/sustran-discuss/message/142>). Four-stroke motorcycles have several other advantages over their two-stroke counterparts: improved fuel economy, less noise, comparable price and established technology, although the two-stroke motorcycles have lower engine weight, smaller size, higher output and greater operating smoothness than four stroke motorcycles.

Against this background, the use of four-stroke motorcycles was promoted in Thailand (particularly in Bangkok) for the purpose of reducing air pollution through the implementation of emission standards and other measures. Particularly after the announcement of the third emission standards in 1996, the number of

four-stroke motorcycles increased in the country. Besides promoting four-stroke motorcycles, Thailand also introduced—first in 1992 and again in 1998—an improved lubricating oil for two-stroke motorcycle engines that reduces white smoke emissions.

Objectives:

The objective of this initiative is to improve the quality of air and the health of urban residents by reducing emissions of local pollutants, particularly hydrocarbon (HC) and particulate matter (PM₁₀) in Bangkok. This is to be achieved through the reduction/elimination of two-stroke motorcycle engines and the promotion of four-stroke motorcycles.

Description of the activity:

Since the early 1990s, Thailand has been actively promoting four-stroke motorcycles. This has been done through a number of activities, such as new emission standards, partnerships with relevant stakeholders, and public awareness campaigns. In fact, direct policy support from the higher levels of government for strict new emission standards has been highly effective in promoting these engines. At the same time, new standards for low-smoke lubricating oil for two-stroke engines have been established. Beyond that, two-stroke motorcycles are not directly banned.

New motorcycle emission standards constitute the core of the entire strategy for shifting public opinion from two- to four-stroke motorcycles in Bangkok. Starting with a first enactment in 1993, the standards were revised five times (as discussed in Critical Instruments below). This gradually led to the displacement of two-stroke motorcycles by the more environmentally friendly four-strokes. The Bangkok Metropolitan Administration (BMA), with the involvement of various parties, launched a number of activities to encourage users to comply with emission standards. An intense public campaign was launched to reduce emissions from motorcycles through various activities and projects. An objective of the Green Fleet Project, for example, was to reduce air pollution from motor vehicles by providing incentives for private sector involvement, by raising public awareness, and by formulating more advanced policies. Replacing 2-stroke motorcycles with cleaner 4-stroke ones was an important component of the project.

The ambient air quality in Bangkok shows a decided improvement in recent years (PCD, n.d). The increased use of four-stroke engine motorcycles is considered to be the most important contribution to a decrease in the PM₁₀ level in Bangkok in recent years.

Critical Instruments

Overview

To discourage the use of polluting two-stroke motorcycles in Bangkok, a host of measures were launched, such as campaigns and seminars, check-points, mobile inspection units, motorcycle clinics, and setting emission standards. The government played a major role through its various agencies in developing and implementing emission standards with complementary activities to reduce pollution. The critical instruments that were responsible for the success of this strategy are discussed below:

Awareness/capacity building

Campaigns and seminars for better inspection and maintenance

Under the Motorcycle Upgrade Programme (MUP), the BMA launched a campaign to reduce emissions from motorcycles by distributing manuals for the proper care of motorcycles. [The MUP project was begun in collaboration with BMA, World Bank, motorcycle manufacturers, petroleum product producers, Thailand Motor Vehicle Industry Association and other related agencies in 2000 and is now ended.]. A seminar was organized under MUP on May 30, 2001 for manufacturers, dealers, motorcycle users and related agencies in Bangkok to provide information about the inspection and maintenance of motorcycles, as well as brainstorming on how to reduce their pollution. (Thavisin 2003). About 1,200 people attended the seminar. The vehicle manufacturing industry regularly modified the design of their products to ensure compliance with more stringent emissions standards.

Design, planning and management

Check-points, mobile inspection units and motorcycle clinics

Check-points to control vehicles which emit black smoke were set up in 50 districts in Bangkok. Mobile inspection units were established with the cooperation of the Traffic Police Division of Royal Thai Police and the Department of Land Transport. A number of motorcycle clinics were also established to reduce pollution and increase public awareness about the pollution that can come from them. (Thavisin, 2003).

Partnerships

Collaboration between national and local government, and private garages

The Pollution Control Department (PCD) within the Ministry of Natural Resources and Environment proposes emission standards for motorcycles and then the Thai Industrial Standards Institute under the Ministry of Industry establishes them. Motorcycles that are five years old and more are subject to emission (HC, CO and white smoke) and safety inspections annually at the time of their license renewal. If the white smoke is more than 30 percent opaque, a fine of 500 Baht per motorcycle is charged. This is checked by the traffic police at roadside check-points. There is no provision as yet for checking HC and CO or to penalize the violators. For this, the government relies on licensed private garages for the annual inspection of motorcycles. Selected private garages are designated by the Land Transport Department for this inspection. Equipment used for these inspections is quite expensive, costing more than 100,000 Baht (about U.S.\$ 2,500), there is no government support provided to the private sector for this activity. The Land Transport Department is aware that this imposes a real burden upon private garages who then fail to carry out these inspections properly. When the government agency receives complaints from the owners, the garages are checked, either as a routine or randomly. If the garage is found guilty, the department issues a warning the first time; if it happens again, their licenses are revoked. These inspections are not very effective in Thailand, however, due to lack of proper management practices.

The BMA declared 1999 as the year for mitigation of pollution through the implementation of various measures by public and private agencies, such as, Traffic Police Division of Royal Thai Police, PCD, Department of Land Transport, etc. Mass media such as television, video, pamphlets and leaflets were also used for raising public awareness and securing public participation.

Regulatory instruments

Emission standard

New motorcycle emission standards in Thailand: Emissions standards target new vehicles which have yet to appear on the road. In this way, setting such standards allows the entry into the market of only those vehicles which meet the requirements. (Table 1). The first emission standard for motorcycles in Thailand was set in 1993, followed by a second in 1995. These two standards were based on European emission standards. Due to the large number of motorcycles in use, Thailand further set up its own standard, the third, in 1997. This third standard was already very rigorous for the manufacturers of two-stroke motorcycles, but new regulations, with even tougher requirements were introduced later in a fourth standard in 2001, similar to the Taiwanese model. This fourth emission standard was intended to make it impossible both technically and economically to manufacture/use two-stroke motorcycles. (<http://www.gdrc.org/uem/sustran/stran-36.html>). Since then, Thailand has now implemented a fifth new emissions standard in 2004, also similar to the Taiwanese standards. (Warapetcharayut 2004).

Table 1: New motorcycle emission standards in Thailand

Emission Standard Level	Reference Standards	Announcement Month/Year*	Enforcement Month/Year**
1	ECE 40-00	August 1992	August 1993
2	ECE 40-01	September 1993	March 1995
3	CO≤13 (g/km); HC≤5 (g/km)	March 1996	July 1997
4	CO≤4.5, HC+NOx ≤3 g/km White smoke ≤ 15 percent Evaporative≤2 g/test Evap. for 150cc. Up	July 1999	July 2001
5	Evaporative ≤ 2 g/test CO ≤ 3.5; HC+NOx ≤ 2 g/km White smoke ≤ 15 percent Evaporative > 2 g/test ≤ 6 g/test CO ≤ 3.5; HC+NOx ≤ 1.8 g/km White smoke ≤ 15 percent	October 2002	≤ 110 cc: June 2004 All type: July 2004

Note: ECE: Economic Commission for Europe *Voluntary or general standard **Compulsory standard.
Source: PCD Record; Warapetcharayut, 2004.

The number of four-stroke motorcycles in Thailand, particularly in Bangkok, has increased considerably since the third emission standard was introduced in 1997 (Table 4).

In-use motorcycle emission standard: The in-use emission standards target those vehicles, which are already on the road. Making sure that such vehicles also meet certain emission standards (Table 2) reduces pollution from the existing vehicle stock. Although in-use standards typically regulate CO under idling conditions, Thailand is one of the countries where smoke (opacity) and/or HC are also considered.

Table 2: In-use motorcycle emission standard in Thailand

Pollutant	Standard	Instrument	Measuring Method
CO	4.5 percent	NDIR	Idle Test
HC	10,000 ppm		
White Smoke	30 percent	Opacity	Measured at ¾ of maximum horse power
Noise	100 dBA	Sound Level Meter	Measuring at ½ or ¾ of maximum horse power

Note: NDIR: Non-dispersive infrared

Source: PCD Record; Warapetcharayut, 2004.

Impacts

- With the adoption of the various measures described above, especially with the enforcement of stricter new vehicle emission regulations, there has been a sharp rise in four-stroke motorcycles sales in Thailand (Table 3) and Bangkok (Table 4) in recent years. Five years after the third standard was launched, the sales of four-stroke motorcycles had grown by 43 percent. (<http://groups.yahoo.com/group/sustran-discuss/message/142>)

Table 3: Sales of two- and four-stroke motorcycles in Thailand (%)

Type of Motorcycles	Motorcycle Sales (%)									
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2-stroke	87.0	85.9	82.1	74.4	55.8	46.2	30.0	18.0	6.0	2.0
4-stroke	13.0	14.1	17.9	25.6	44.2	53.8	70.0	82.0	94.0	98.0

Source: Thai Honda Manufacturing Co. Ltd.

Table 4: Sales of two- and four-stroke motorcycles in Bangkok (%)

Type of Motorcycles	Motorcycle Sales (%)									
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2-stroke	94.0	93.0	90.0	81.0	71.0	53.0	37.0	15.0	6.0	2.0
4-stroke	6.0	7.0	10.0	19.0	29.0	47.0	63.0	85.0	94.0	98.0

Source: Thai Honda Manufacturing Co. Ltd.

- The PM_{10} level increased in 1995-1996 due to an increase in the number of 2-stroke engine motorcycles. In 1997, a number of tough emission standards for motorcycles were implemented, resulting in the reduction of 2-stroke vehicle production. With campaigns promoting the adoption of less-smoke producing 4-stroke motorcycles, the PM_{10} level declined (in 2000), though it was still a problem (PCD, n.d.).

Lessons Learned

- Motorcycle emission standards play an important role in reducing vehicular pollution. Through the enforcement of such standards, the use of cleaner four-stroke engines can be encouraged and polluting two-stroke engines can be displaced.
- Regulatory measures accompanied by other tools such as institutional arrangements, stakeholders' participation and awareness/ capacity building programs assist in reducing emissions.

Potential for Application

A shift from two- to four-stroke motorcycles could help in reducing pollution derived from the transportation sector in fast growing Asian cities such as Bangkok where motorcycles account for a considerable proportion of the vehicles. Increasing motorization is usually the result of continued economic expansion, and the availability of two wheelers is an important element for travelers and the good life. Because four stroke engines are more fuel-efficient than two-stroke engines, the shift from two- to four-stroke engine motorcycles will reduce the rate of major urban air pollutants, and could thus be beneficial for other cities as well, striving hard for a higher growth rate with fewer adverse effects on the environment.

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Information date: 24 May 2004