Chapter 7
Environmental Protection

7-1. Urban air pollution

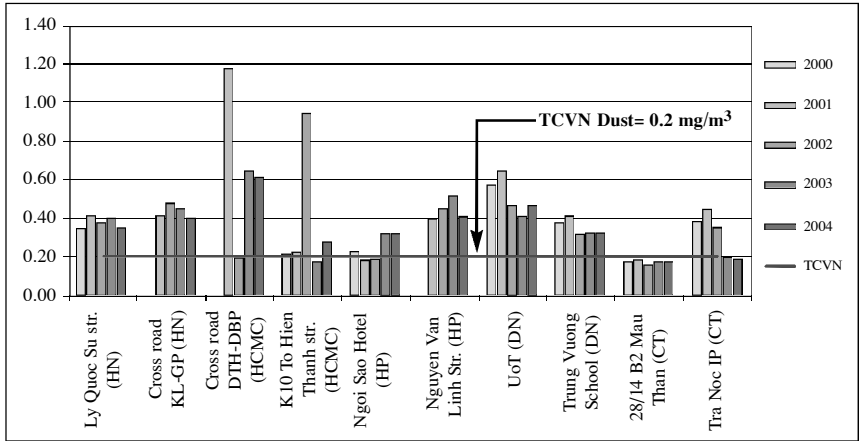
In the last ten years, Vietnam has been transformed from a country with relatively few motorized vehicles to a country with a large number of motorized vehicles, especially in urban areas. Unlike other countries where automobiles dominate, motorcycles occupy by far the largest share of transport in Vietnam (chapters 1 and 5). With one motorcycle for every two persons, virtually all households in Hanoi and HCMC have access to private transport. Although motorcycles in Hanoi and HCMC are individually no more polluting than those in other large cities in Asia, the sheer density of motorcycles gives rise to air pollution and high exposure to exhaust in these cities.

The monitoring data of the Center for Environmental Engineering of Towns and Industrial Areas (CEETIA) shows that, in the period from 2000 to 2004, air pollutants such as carbon monoxide (CO), nitrogen dioxide (NO2), dust and particles at a number of locations exceeded nationally stipulated standards for ambient air quality (TCVN 5937--see below) as shown in Fig.7-1. The noise level is also persistently high.

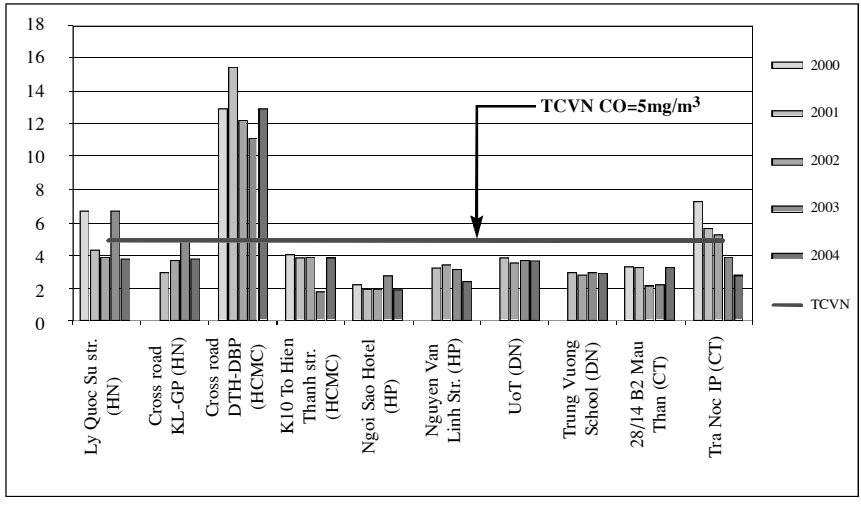
The study of the National Institute of Occupational and Environmental Health (NIOEH) in 2003 indicated that, in rush hours, dust content in air environment was 4 times, CO was 2.5-4.4 times, and hydrocarbon was 12.1-2,000 times higher than the national standard mentioned above. The concentration of other pollutants, such as nitrogen dioxide (NO_2), sulfur dioxide (SO2), carbon monoxide (CO) and volatile organic compounds (VOC) also exceeded limits by 5 to 35 times.

Fig. 7-1 Air Pollution in Urban Areas, 2000-2004

(a) Dust (mg/m³)



(b) Carbon Monoxide (mg/m³)



Source: Center for Environmental Engineering of Towns and Industrial Areas (CEETIA), various years.

Tab. 7-1 Pollutant Concentration at Intersections in Hanoi during Rush Hours, 2003

Monitoring station	*Pollutant concentration (mg/m³)*			
	NO_2	*SO_2*	*CO*	*VOC*
Vong	3.9	3.6	360	170
Kim Lien	3.7	3.5	350	160
So	3.8	3.7	355	165
National standard (TCVN 5937-1995)	0.4	0.5	40	5.0

Source: NIOEH survey (2003).

Concentrations of CO and PM10 (particulate matter less than 10 microns in diameter) in the air of Hanoi and HCMC have remained relatively stable in recent years. According to the Vietnam Register data, motorcycles are the major source of air pollutant emissions, accounting for 54.4% of total CO emitted, 54.1% of HC, 54.5% of Pb and 43.0% of dust.

7-2. Health impact of air pollution

It is well known that people's health is adversely affected by primary pollutants from vehicles such as PM10 and PM2.5 (particulate matter less than 10 or 2.5 microns in diameter, respectively), nitrogen oxides (NO_x), SO_2 and CO, as well as secondary pollutants such as ozone. These cause respiratory problems, sinusitis, bronchitis, asthma, lung cancer, cardiovascular diseases and premature death. Particles have also been shown to increase the mortality rate. People with asthma and respiratory diseases in turn are highly susceptible to particles, NO_x, SO_2 and ozone. In addition, lead particles have serious effects on children's growth and development. Children with high lead levels in their blood are often deficient in weight and tend to have a low count of red blood cells. Their IQ levels on average are also lower than those with lower lead levels.

In Vietnam and other countries in the region, air pollution is now acknowledged as a serious public health threat. WHO estimates that globally about 800,000 people die prematurely every year because of exposure to urban outdoor air pollution. Among them, about 500,000

are believed to be in Asia. The Disability Adjusted Life Years (DALY) indicator[29] shows that out of the 6.4 million affected by air pollution, 3.8 million are in Asia. According to the Vietnam Statistical Year Book 2005, the majority of respiratory diseases in Vietnam are related to air pollution[30].

The health effect of air pollution was first studied in Vietnam as early as in 1995 with a focus on traffic police officers[31]. Due to extended exposure to high levels of air and noise pollution, 2.9% of traffic policemen were infected with tuberculosis, compared with an average infection rate of 0.075%. Moreover, 76% of traffic policemen suffered from ear, nose, and throat infection, and 32% of them had reduced hearing ability.

Separately, NIOEH conducted a study on the health impacts of air pollution in 2005. It showed that 83.1% of the respondents suspected that dust pollution came from transportation. Examination of persons who worked more than 8 hours per day on roadside found a significant difference in the health conditions between targeted and reference groups (Tab.7-2).

Tab. 7-2 Disease Frequency of Persons Working in Roadside

Symptom	***Targeted group*** Persons working more than 8 hours per day on roadside	***Reference group***
Chronic bronchitis level III	3.8%	0.0%
Chest pain	51.2%	42.1%
Difficulty in breathing	21.5%	4.5%
Nose, throat, sinusitis and dermal diseases	15.1%	4.7%
Abnormal X-ray	44.4%	11.7%

[29] According to WHO's definition, the DALY for a disease is computed as the sum of years of life lost (YLL) due to premature mortality and the years lost due to disability (YLD) for incident cases of the health condition. It is a broad health gap measure which includes, in addition to premature deaths, equivalent years of "healthy" life lost in states of less than full health, which may be termed disability. One DALY represents the loss of one year of equivalent full health.

[30] According to the Statistical Yearbook 2005, the most common diseases related to air pollution in Vietnam are lung diseases (415.09 per 100,000 persons), throat and tonsil diseases (309.40 per 100,000 persons), and bronchial tube diseases (305.51 per 100,000 persons).

[31] The study of Labor Protection Unit of HCMC, 1995. Also see Dang Dinh Nguyen, "Air Pollution in Urban Areas: Reality and Solutions," *Saigon Giai Phong Thu Bay*, no.276, 1995.

The costs related to health problems caused by air pollution in Hanoi were estimated at US$23 million in 2006, or about VND1 billion per day. Meanwhile, the World Bank Environment Monitor Reports 2002 estimated the health-related air pollution costs to be US$392 million for Metro Manila in 2001 and US$424 million for Bangkok in 2000. Compared with these cities in the region, the health costs of air pollution in Vietnam, which is at an early stage of motorization, is much lower. However, it is likely to grow rapidly unless preventive measures are taken.

7-3. Current regulation for controlling vehicular pollution

The Vietnamese government recognizes that air pollution causes rapid deterioration of environment and negative health effects. After the Environment Law was adopted in 1994, the government issued Instructions on Strengthening Environmental Protection in the Period of Industrialization and Modernization (No.36-CT/TW, 1998, Vietnam Communist Party).

Air pollution from vehicles is regulated by the following legislations:

- Air Quality, Ambient Standards (TCVN 5937, 1995)
- Air Quality, Hazardous Substance Standards (TCVN 5938, 1995)
- Standards for Noise in Public and Residential Areas (TCVN5945, 1995)
- Standards for Noise on Road Motor Vehicle (TCVN5948, 1995)
- Instruction No. 24/2000/CT-TTg on Using Non-lead Petrol (2000)
- The National Action Plan on Emission Reduction from Transport Vehicles (2003)
- Decision 249/2005/QD-TTg on Setting the Roadmap for Application of Emission Standards to Road Motor Vehicle (2005)

Despite these regulations, the country remains in violation of the air ambient quality standards. To comply with the standards, controlling pollution from motorized vehicles, especially motorcycles, is crucial.

7-4. Policy direction

The overall policy goal should be to place the total amount of motorcycle emission on a declining trend and attain meaningful (not small) improvement in the atmospheric environment of Vietnam's urban areas by 2020, with appropriate steps between now and 2020, under the projected increase in the number of motorcycles (chapter 3).

Total pollutant load and air pollutant concentration are related but not the same. International experiences show that environmental and health costs from air pollution may rise greatly as total pollutant sources increase and affected areas expand, even with the same or lower level of pollutant concentration at any location. In Vietnam, it is also possible that air pollution level at any location may remain stable or decrease slightly in the next 15 to 20 years, even under the predicted increase in the number of motorized vehicles and fuel consumption, provided that the currently proposed policies are fully and effectively implemented. Even in that case, the total cost of urban air pollution may increase.

However, Vietnam lacks scientific studies on the situation and causes of urban air pollution. For some pollutants, motorized vehicles in general and motorcycles in particular are the predominant source, and for others they are a contributor but not the dominant source. Vietnam first needs reliable data and analyses on the mechanism of urban air pollution in Hanoi and HCMC before setting concrete policy goals and designing action plans[32].

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[32] The study by Hoang Xuan Co and Nghiem Trung Dung (2006) offers scientific projections regarding one source, namely total suspended particulate matter (TSP). Taking the environmental situation in 2002 as the base, they projected three scenarios for TSP concentration in ambient environment in Hanoi in 2010 as follows: (i) without any additional countermeasure; (ii) countermeasures suggested by the JICA project; and (iii) with 75% reduction on total emission sources relative to 2002. The dispersion model ISC3-AIRMOD was first used to analyze the air quality of Hanoi in the base year, which revealed that some areas near industrial zones and some areas of high population density had high counts of TSP. Under scenario (i), air quality of Hanoi in 2010 will be much worse. Under scenario (ii), with current planning plus measures suggested by the JICA project, some sources will be reduced but the total amount of sources will increase, with the result that air quality of Hanoi in 2010 will be more or less the same as in 2002. Scenario (iii) suggests that at least 75% reduction of sources is necessary to make visible improvements. Efficient ways to reduce TSP concentration include removal of old enterprises from inner city as well as introduction of new technology and high efficiency treatment systems for emission control.

When such data and analyses are available, Vietnam should establish a concrete and realistic roadmap for air pollution control based on the current EURO standard. Vietnam is already on the EURO roadmap but details are yet to be decided. To implement the EURO roadmap, the fuel quality monitoring and control system and the vehicle inspection and maintenance system are the two key pre-conditions. The former is absent at present and the latter needs to be greatly improved.

7-5. The roadmap

As a member of APEC, Vietnam is required to adopt the EURO standard in air pollution control. Decision 249/2005/QD-TTg on Setting the Roadmap for Application of Emission Standards to Road Motor Vehicle stipulates that EURO-II equivalent (Tab.7-3) will be applied for second-hand automobiles imported into Vietnam from July 2006, and for all domestically produced or imported automobiles from July 2007. By the year 2025 all vehicles in Vietnam are required to satisfy EURO-V, a very strict standard that only advanced countries are now beginning to adopt. However, details of how EURO-II as well as higher levels of EURO standards will be introduced remain to be decided. The problem that Vietnam faces in emission regulation is not what must be attained in the long run, but how and at what speed the proposed roadmap should be realized.

Tab. 7-3 Maximum Emission Limits of Road Motor Vehicles

Pollutants in exhaust gas	*Vehicles fitted with spark ignition engines*					*Vehicles fitted with compression ignition engines*		
	Automobiles			*Mopeds motorcycles*				
	Limit 1	*Limit 2*	*Limit 3*	*Limit 1*	*Limit 2*	*Limit 1*	*Limit 2*	*Limit 3*
CO (% volume)	4.5	3.5	3.0	4.5	-	-	-	-
HCC (ppm volume)								
Four-stroke engines	1,200	800	600	1,500	1,200	-	-	-
Two-stroke engines	7,800	7,800	7,800	10,000	7,800	-	-	-
Special engines	3,300	3,300	3,300			-	-	-
Smoke opacity (% HSU)	-	-	-	-	-	72	60	50

Source: Appendix to the Prime Minister's Decision No. 249/2005/QD-TTg dated Oct. 10, 2005.

Notes: This table shows Vietnamese emission standards in steps to adopt EURO-II. Timing of implementation has not been specified so far. Special engines include Wankel engines and a number of other engines with structures different from those of piston engines which are widely used.

The EURO emission standards are primarily for automobiles. The upper-level EURO standards (EURO-IV and V) for motorcycles are not yet determined even in the EU. However, in Vietnam where motorcycles are the dominant source of urban air pollution, regulating emissions for automobiles while ignoring motorcycles greatly reduces the environmental policy impact. Vietnam should have a long-term emission control strategy for both automobiles and motorcycles. For automobiles, the EURO roadmap should be followed. For designing motorcycle emission control, the experiences and standards of neighboring countries such as Thailand and Taiwan should be studied, and expert opinions should be heard.

One important question is how to fully implement EURO-II, especially for motorcycles. At present, details or timing of implementation of EURO-II for motorcycles are not determined in Vietnam, although the issue is currently under consideration by the Vietnam Register. It is clear that urban air quality will not improve much if motorcycles are excluded from Vietnam's EURO roadmap. While new motorcycles must also comply with the standard, it is of utmost importance to regulate (and ban if necessary) ill-maintained old vehicles which are the worst polluters on

the road[33]. To be effective, the EURO roadmap must encompass all motorcycles, both old and new, and have an inspection and maintenance system that is practical and comprehensive.

Another issue is whether EURO-III should be skipped. EURO-II and III can be satisfied mainly by mechanical improvements while EURO-IV and V must be achieved by the use of electronic technology. There is a significant jump from EURO-III to EURO-IV in both technology and anticipated environmental results. Under these circumstances, one option is to adopt EURO-II, III, IV and V sequentially, while another option is to skip EURO-III and move directly from EURO-II to EURO-IV and V[34]. The gradual approach may look less burdensome for a developing country like Vietnam, but it is expected to generate a number of problems that increase transition and adjustment costs, such as frequent changes in anti-pollution equipment and the need to re-invest in refinery technology to upgrade fuel quality. In addition, needless to say, an earlier adoption of EURO-IV will provide cleaner air for urban citizens sooner.

Other Asian countries are also adopting stricter air pollution standards. Most of them are currently at the stage of EURO-I or II equivalent, except China, India and Thailand which are moving faster. However, targets are not always implemented as scheduled because of the lack of pre-conditions such as required fuel quality or an effective vehicle inspection system.

Based on the current commitment on EURO standards, Vietnam should draft a concrete and transparent roadmap with sufficient details and reasonable timing. To do so, consideration should be given to (i) environmental achievement which is as frontloaded as possible for the

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33 Currently, 40% of motorcycles in Vietnam are more than 8 years old, and 70% of cars are more than 10 years old. Meanwhile, leading motorcycle assemblers have begun to produce models that are already in compliance with EURO-II although this standard has not been adopted for motorcycles yet.

34 One view, called the normal track, is to adopt EURO-II in 2007, EURO-III in 2012, EURO-IV in 2017, and EURO-V in 2022. The other view, called the fast track, calls for adopting EURO-II in 2007, EURO-IV in 2014, and EURO-V in 2020.

benefit of urban residents; (ii) coverage of all motorized vehicles including automobiles and motorcycles, whether used or new, domestic or imported; (iii) installation of required pre-conditions for effective implementation, namely fuel quality and inspection and maintenance (see sections below); and (iv) pre-announcement of a clear long-term roadmap to motorcycle producers and oil refinery operators in order to minimize transition and adjustment costs.

Fig. 7-2 Automobile Emission Standards for New Vehicles (Light Duty)

Country		*95*	*96*	*97*	*98*	*99*	*2000*	*01*	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*	*10*
EU	Euro 1		Euro 2					Euro 3				Euro 4			Euro 5		
Bangladesh[a]												Euro 2					
Bangladesh[b]												Euro 1					
Hong Kong		Euro 1		Euro 2				Euro 3					Euro 4[g]				
India[c]								Euro 1				Euro 2		Euro 3		Euro 4	
India[d]						E1	Euro 2					Euro 3					
Indonesia												Euro 2					
Malaysia				Euro 1			Euro 2									Euro 4	
Nepal							Euro 1										
Philippines										Euro 1				Euro 2			E 4
China[a]								Euro 1			Euro 2			Euro 3			E 4
China[c]								Euro 1		Euro 2		Euro 3		Euro 4 Beijing only			
Singapore[a]	Euro 1							Euro 2									
Singapore[b]	Euro 1							Euro 2					Euro 4				
Sri Lanka										Euro 1							
Taiwan						US Tier 1								US Tier 2 for diesel[f]			
Thailand	Euro 1							Euro 2		Euro 3							E 4
Vietnam														Euro 2			E 4

Source: CAi-Asia. May 2006.

Notes: *Italics* - under discussion; a - gasoline; b - diesel; c - entire country; d - Delhi and other cities: Euro 2 introduced in Mumbai, Kolkata and Chennai in 2001; Euro 2 in Bangalore, Hyderabad, Khampur, Pune and Ahmedabad in 2003, Euro 3 introduced in 10 mega cities since 2005; e - Beijing has adopted Euro 3; Shanghai and Guangzhou has requested approval of the State Council for implementation of Euro 3; f - Euro 4 for gasoline vehicles and California ULEV standards for diesel vehicles; g - gasoline vehicles under consideration.

7-6. Fuel quality

Fuel has direct influence on vehicle emission. Changing some components of gasoline or diesel changes vehicle emission. When a stricter emission standard is adopted, fuel becomes the key factor in making motorcycles cleaner, assuming that vehicle emission control technology remains unchanged. Since the same fuel is used for automobiles and motorcycles, it must satisfy the environmental needs of both vehicles.

The American Automobile Manufacturers Association (AAMA), Association des Constructeurs Européens d'Automobiles (ACEA), and the Japan Automobile Manufacturers Association (JAMA) jointly proposed the Worldwide Fuel Charter in January 1999, which classified gasoline and diesel into four categories:

> The first category comprises fuels for markets with minimal requirements for emission control, in which fuels are considered only in terms of vehicle and engine performance.
>
> The second category comprises fuels for markets with stringent requirements for emission control and other market demands (EURO-I and II).
>
> The third category comprises fuels for markets with advanced requirements for emission control and other market demands (EURO-III and IV).
>
> The fourth category comprises fuels for markets with further advanced requirements for emission control that enable sophisticated NOx technology.

Since Vietnam adopted EURO-I in 1998 for gasoline vehicles and in 2005 for diesel vehicles, its fuel falls into the second category. In addition, Vietnam switched from leaded to unleaded gasoline in 2001. The current fuel quality in Vietnam cannot meet EURO-II or higher standards because: (i) the sulfur content of gasoline and diesel is high; (ii)

the benzene content of gasoline is high; (iii) unleaded gasoline is not really lead-free; and (iv) engine oil contains phosphorus and sulfur.

In general, conforming to a higher emission regulation requires both vehicle emission control technology and corresponding fuel. To implement EURO-II or higher standards, Vietnam must have new standards and mechanisms to ensure suitable fuel quality for both domestic and imported oil products. New emission regulations must be synchronized with the improvement of fuel quality.

Tab. 7-4 Fuel Quality in Asian Countries

		Lead	*Sulfur (ppm)*	*Benzene (% v/v, max)*	*Aromatics (%)*	*Olefins (%)*	*Oxygen (% m/m, max)*	*RVP (kPa, max)*
China	Nationwide	Lead free	500	2.5	40	35	-	74
	Hong Kong	Lead free	50	1	42	18	2.7	60
India	Nationwide	Lead free	500	5	-	-	2.7	35-60
	Major cities	Lead free	150	1 and 3				
Bangladesh		Lead free	1000	-	-	-	-	68
Cambodia		Lead free	-	3.5	-	-	-	-
Indonesia		0.30g/l	2000	-	-	-	2.0 (premix)	62
Malaysia		Lead free	1500	5	40	18	-	70
Pakistan		Lead free	10000	5	40	-	-	62-69
Philippines		Lead free	1000	2	35	-	2.7	35-60
Thailand		Lead free	500	3	35	-	1-2	-
Vietnam		Lead free	5000 -10000	5	-	-	-	-

Source: CAi-Asia, 2005.

Note: In India, benzene content is 3% in metro areas and 1% in national capital region.

7-7. The vehicle inspection and maintenance system

Apart from fuel quality, the vehicle inspection and maintenance system is another key instrument for controlling vehicle emission. How this system actually operates greatly affects the vehicle's performance, including environmental impact.

Vehicle inspection can be classified into annual inspection, roadside inspection, random tests in parking lots, and inspection for road vehicles entering the city. Among these, annual inspection and roadside inspection are the most important. In Vietnam at present, vehicle inspection covers only automobiles. Inspection of motorcycle is considered by some to be infeasible due to limited equipment and human resources relative to the large number of motorcycles. However, since motorcycles are the largest source of vehicle emission in Vietnam, they must definitely be included if cleaner urban air is to be achieved and the EURO roadmap is to be realized in the future. Inclusion of old motorcycles is particularly important for this purpose.

Relevant authorities should begin to study appropriate method of motorcycle inspection. Ways should be devised to maximize environmental impact while minimizing administrative costs. A reasonable timetable should be set up for achieving this goal.

As with automobiles, motorcycles that fail to meet standards must be upgraded before they may be driven on the road. Such vehicles may be repaired in maintenance stations organized by motorcycle manufacturers or maintenance enterprises registered at the Department of Maintenance Management of the Vietnam Register. This means that manufacturers that sell motorcycles in the domestic market are required to build a system of maintenance stations capable of providing required maintenance services. Furthermore, all maintenance enterprises responsible for vehicular emission treatment must be equipped with a tailpipe exhaust analyzer and other necessary equipment.