

**Scenarios for vehicular air pollutant
emissions abatement:
a case study in Hangzhou, China**

Key words: Control policy, Emission abatement, Scenario analysis, Vehicular pollution

Cite this as: Qing-yu Zhang, Xin-xing Li, Wei-li Tian, Ang-yi Fu, Wei-fei Du, Cui Wang, 2014. Scenarios for vehicular air pollutant emissions abatement: a case study in Hangzhou, China. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 15(9):753-760. [doi:10.1631/jzus.A1400013]

BACKGROUND AND PURPOSE

- The vehicle population of China will increase more than 1470 million by the year 2030. With the rapid growth of vehicle population in China, the haze days in several major cities have reached more than 30% for the entire year, some even up to 50%.
- There are many ways to control the vehicle emission, such as improve the oil standard, choices of fossil fuelled and low emission vehicles, etc. However, single control measures cannot be effective in reducing vehicle emissions and integrated management measures must be taken.
- We evaluate vehicle emissions abatement by different integrated measures in a scenario analysis from 2011 to 2015 in the case city of Hangzhou. We simulated the prospective abatement quantity and reduction rates. Provide the most effective motor vehicle emission reduction policy and the potential management strategies.



METHOD

- Vehicle number projection:

Model: Long-range Energy Alternative Planning (LEAP) system:

$$Stock_i = Stock_{i-1} \times f_i(GDP, \theta)$$

Categories of vehicles: passenger cars (PCs), buses, taxies, light duty trucks (Lts) and heavy duty trucks (Hts)

- Definition of vehicle emission control policy scenarios:

Business as usual (BAU), eliminate substandard vehicle (ESV), high-standard oil replacement (HOR), and alternative energy replacement (AER),

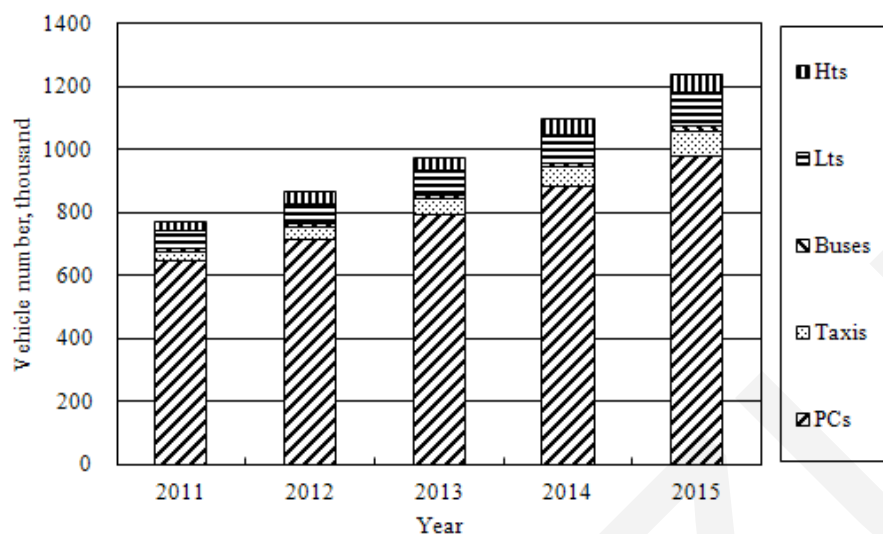
- Emission inventory establishment:

Vehicular emission calculation equation was shown as:

$$Q_i = V_{i,j} \times EF_{i,j,running} \times VKT_{i,j} + V_{i,j} \times EF_{i,j,start-up} \times T_{i,j} \times 365$$

RESULTS AND CONCLUSIONS

Vehicle population prediction:



Total number of vehicles increase from 0.773 million in 2011 to 1.241 million in 2015, with an annual growth rate at 12.5%.

Annual growth rate for buses is the highest, which reached to 30.9%.

Fig. The predicted number of vehicles in Hangzhou from 2011 to 2015. Hts represents: heavy duty trucks; Lts: light duty trucks, Lts: PCs: passenger cars

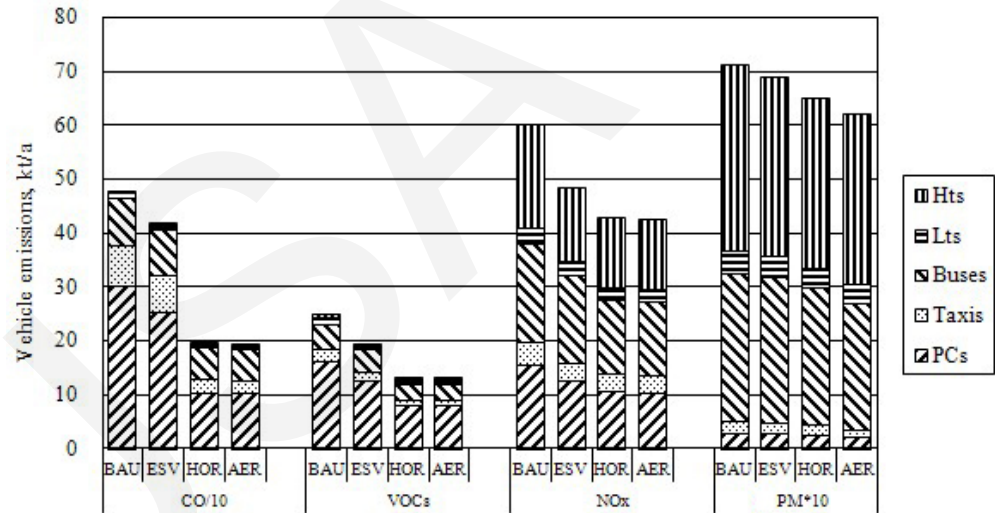
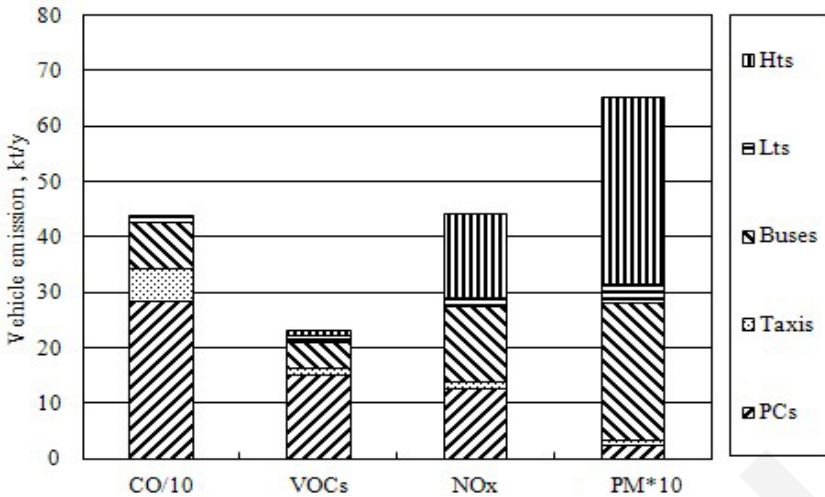
Table Increased, eliminated and new energy vehicle number in each scenario

Scenario	Vehicle Number	2011	2012	2013	2014	2015	Total
BAU ^a	Increased	82319	95323	108387	123578	141304	550911
ESV/HOR/AE R ^b	Eliminated	42246	29259	19359	4653	4653	100170
AER	New energy	10302	16626	21257	29620	41019	118823

About 100.17 thousand vehicles will be eliminated and approximately 118.823 thousand vehicles will be replaced by alternative fuel.

RESULTS AND CONCLUSIONS

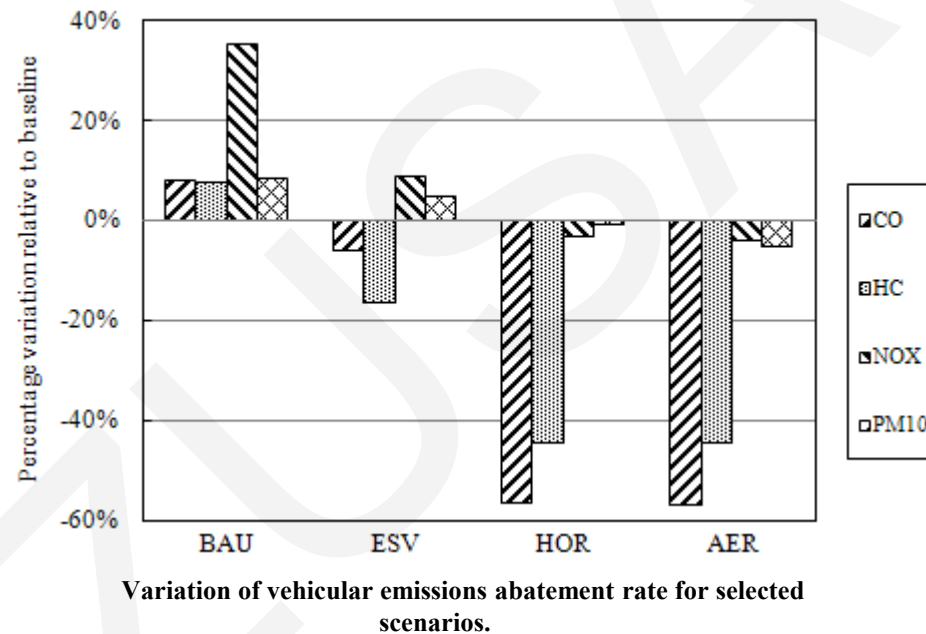
Scenario analysis and emission reduction potentials:



Scenario	Items	CO	HC	NO _x	PM
Baseline	Emission inventories in 2010 (kt/a)	440.551	23.079	44.255	6.532
	Emission inventories in 2015 (kt/a)	475.931	24.883	59.899	7.088
BAU ^a	Increased emissions(kt/a)	35.380	1.804	15.644	0.556
	Growth rate (%)	8.03%	7.82%	35.35%	8.50%
	Emission inventories in 2015 (kt/a)	415.098	19.327	48.218	6.862
ESV ^b	Increased missions(kt/a)	-25.453	-3.753	3.963	0.330
	Growth rate (%)	-5.78%	-16.26%	8.95%	5.05%
	Emission inventories in 2015 (kt/a)	192.344	12.873	42.822	6.492
HOR ^c	Increased missions(kt/a)	-248.207	-10.206	-1.432	-0.040
	Growth rate (%)	-56.34%	-44.22%	-3.24%	-0.62%
	Emission inventories in 2015 (kt/a)	190.354	12.809	42.464	6.196
AER ^d	Increased missions(kt/a)	-250.197	-10.270	-1.791	-0.335
	Growth rate (%)	-56.79%	-44.50%	-4.05%	-5.14%

RESULTS AND CONCLUSIONS

Implication of vehicular pollutants abatement:



Conclusion: Integrated control policy, including upgrade vehicle emission standard, eliminate substandard vehicles, supply National-IV standard oil and introduce alternative fuel vehicles (e.g., HEV, BEV and CNG) will reduce vehicle emissions effectively, with 56.79%, 44.50%, 4.05% and 5.14% reduce rate for CO, VOCs NO_x and PM, respectively.