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Copenhagen Consensus 2008 Perspective Paper

Air Pollution

Jitendra (Jitu) Shah[1]
World Bank
Washington, DC USA

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Jitendra (Jitu) Shah
Country Sector Coordinator
The World Bank
30th Floor Siam Tower, 989 Rama I Rd,
Pathumwan, Bangkok
Thailand 10330
Phone: 66 2 686 8360;
Fax 66 2 686 8301
Email: jshah@worldbank.org

[1] The findings, interpretations and conclusions expressed in this paper are that of the authors and do not necessarily reflect the views of the World Bank or any other institution.

I. Introduction:

This paper reviews the Copenhagen Consensus 2008 Challenge Paper on Air Pollution by Bjorn Larsen, Guy Hutton and Neha Khanna. The challenge paper (Bjorn et al. 2008) addresses the impacts of air pollution in both indoor and outdoor environments; however, our perspective paper is limited to outdoor urban air pollution. In this challenge paper, section I provides an introduction and overview of air pollution. Section II is a brief commentary on the challenge paper and lists areas where we agree or have differing views. Section III elaborates our views and outlines alternative or additional ways for achieving a more cost effective and sustainable outcome regarding air pollution control, especially in developing countries.

Fast growing economies have resulted in cities that record some of the highest levels of urban air pollution in the world (Molina and Molina 2004, Chow, et. Al. 2004), especially in East and South Asia, as shown in Figure 1 (CAI-Asia 2008)[2]. These cities and regions also have the fastest growing emitters of greenhouse gases (GHG), largely on account of China, India, and others, who are dependent on fossil fuel based energy. According to the World Health Organization (WHO), each year thousands of people in Asia die prematurely because of poor air quality and millions of people are affected in their daily lives. There are other impacts besides health which should not be ignored completely – smog, tourism, agriculture productivity, property damage and other impacts are important for some of the cities and need to be considered.

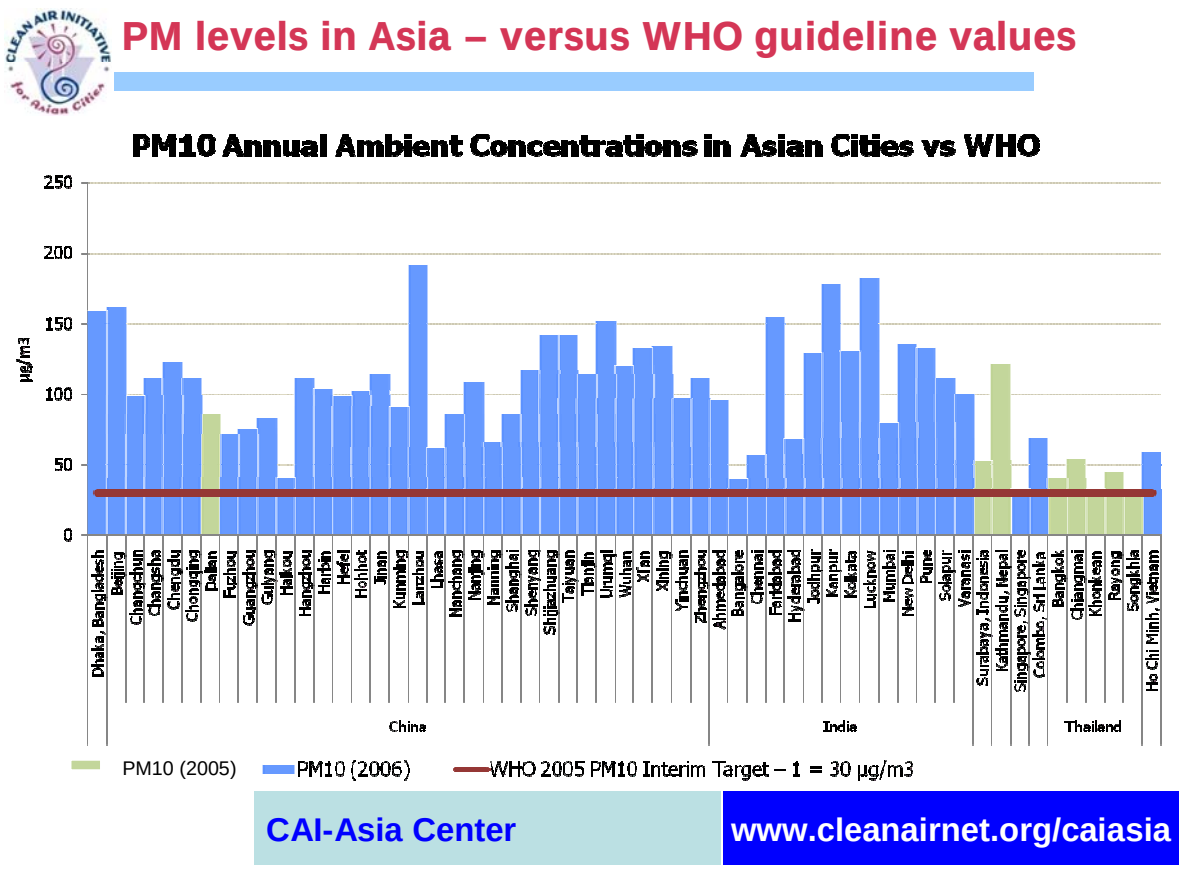
In Bangkok, Thailand, air quality has improved significantly over the last decade, with reductions in lead, carbon monoxide and particulates in urban areas because of comprehensive and sustained setting of emissions standards and control measures over a decade. The total cost of exposure to PM_{10} in the six main cities of Thailand for excess deaths and bronchitis was estimated at $644 million annually in 2002 (World Bank 2002). While PM_{10} levels meet the standards on average, they are exceeded frequently along transport corridors. These emissions come from diesel-powered buses, trucks, older 2-stroke tuk-tuks, motorcycles, vehicles and cooking by vendors. The Government of Thailand is evaluating a comprehensive set of options to further reduce vehicular pollution – retrofitting older vehicles, inspection and maintenance for commercial and high polluting vehicles, promotion of alternative and clean fuels, and transportation management.

Courts and environmental agencies in India have mandated tough measures in mega-cities like Delhi, Mumbai and others. These cities have taken comprehensive actions over the last few years. They have relocated industrial units; moved quickly to Euro III standards for vehicles; introduced CNG for buses, and three-wheelers; and open burning is banned. But PM_{10} levels in Delhi are increasing again after a few years of respite and NOx levels are on the rise (Roychowdhury, 2008). Many in India including

[2] http://www.cleanairnet.org/caiasia/1412/channel.html

the supreme courts have argued that not everything can be reduced to economics or cost and benefit. The right to breathe clean air is considered a fundamental human right.

Figure 1: PM 10 levels in selected cities in Asia during 2005 and 2006



Source: Clean Air Imitative for Asian cities: Fourth Regional Dialogue of AQM Initiatives and Programs in Asia, 30-31 January 2008 in Bangkok.

The World Bank and others have estimated the economic cost of air pollution in China to be in excess of 3.8 per cent of its GDP (China Daily, November 19, 2007). Beijing, after being labeled as one of the most polluted cities in the world has made a lot of progress over the last decade. Despite spending over $17 billion on clean-up efforts, air quality remains a concern for residents and many athletes and visitors coming to the Olympics (*Reuters, April 2, 2008, http://www.enn.com/)*. China is considering ceasing operation ofa large number of industries around Beijing and restricting car use, thus slowing economic activity, during the upcoming Olympics to try and improve air quality. If one adds the costs of air pollution control in other large cities in China, chances are the total costs would far exceed $75 billion (the allocation assumed for the Copenhagen

consensus). Global public events like the Olympic Games can be a unique opportunity for implementing politically difficult actions. Such events have an overwhelming impact on the city and environmental sustainability should be fully integrated in the planning and infrastructure investments. However, not every city in Asia will have such momentous events and hence, cost effective and sustainable air quality management is needed.

In summary, many cities have been trying very hard to control air pollution and yet, sustainable solutions for air quality management have been few and far between. Gains in Delhi, Bangkok and other cities after a long battle may now get reversed in just a few years as rural-urban migration continues unabated. Regional cooperation is also needed as at times most of the pollution comes from neighboring cities and countries (e.g. Hong Kong, Beijing, Singapore, Kuala Lumpur, etc.). Thus, everyone would probably agree that air pollution should be included in the top ten Copenhagen challenges. Because much of the air pollution impact is in developing cities and countries, it is extremely important to deal with this challenge in a cost effective manner, as there are many other competing development priorities.

II. Commentary on the Challenge paper:

The challenge paper covers the subject well and has many useful references, facts and figures, and food for thought. The outdoor air pollution is a result of economic development and requires good policies and technical interventions. The paper defines urban air pollution narrowly and focuses on PM and health impacts alone. A more holistic view of total pollutants (including carbon dioxide which has been ruled as an air pollutant by the US Supreme Court recently, and which means the USEPA must control it) and total effects is needed to make the B/C analysis more meaningful. If one wants to narrow the focus to one pollutant, however, PM10 or PM2.5 is the right pollutant because of the associated and estimated health impacts (Pope and Dockery 2006 and Chow et al. 2006)

Air monitoring around the globe has shifted to PM10 or PM2.5. Over 2 billion people are exposed to outdoor pollution in cities (mostly in India and China) and thus much of the problem now is in the developing countries. To combat this pollution, a broad range of interventions is required and choices should be based on their cost effectiveness (Bachmann 2007 and Chow et al. 2007). Conducting source apportionment studies is a good way to identify and quantify contributions from different sources so that control strategies can be focused. Annual emissions inventories, although necessary, are notoriously inaccurate, especially when emission factors from developed countries are applied (Guttikunda et al. 2008). Based on the analysis presented here as well as what we have observed, for most countries and cities the major sources of PM10 pollution are: vehicle emissions (gasoline and diesel), re-suspended road dust (fugitive and construction) coal and oil combustion (domestic and industrial), biomass burning (for

cooking, heating, agricultural, and disposal), secondary sulfate and nitrate, uncontrolled industry (power plants, cements, etc.), and others (or unexplained). Emissions from shipping and associated goods movement is becoming more widely recognized as a major source in port areas.

The challenge paper (Bjorn et al. 2008) shifts the focus to low sulfur fuel and its benefits for vehicular emissions control and the related benefit cost studies. The authors suggest that low sulfur diesel fuel and vehicles with appropriate emissions control are the silver bullets that will substantially improve urban pollution levels. The analysis does not examine alternatives that might invest the same amount of money across a broad range of emissions reductions that might have a much larger benefit to air quality, and more broadly to overall public health and quality of life. To exclusively focus on this one solution is not well supported or documented in the literature for developing or developed countries. Current EPA and EURO fuel and vehicle emission standards were adopted because after more obvious, and cost-effective, emission reduction measures were implemented. These costly measures became necessary because the low-hanging fruit has been picked. This is not the case in most developing countries. While it may be true for developed countries where vehicle emissions are dominant, for developing countries with low vehicle turnover, many other sources of air pollution, and weak capacity and institutions, the proposed focus is misplaced. If the toxicity of the vehicular pollution was included, this focus may be justified. However, without better supporting arguments and comparison with benefits and cost of control options for other sources, the reason for focusing exclusively on emissions from vehicles seems abrupt. The authors seem to ignore their own analysis presented earlier where they documented that the urban air pollution problem is in developing countries like India and China, where vehicular pollution is not the biggest contributing source to PM_{10}. It would be appropriate to look at pollution control options, and enforcement of their use, for major sources, such as coal-fired power stations, including the role of low sulfur diesel fuel. There is also much to be gained from better appliances, fuels, and education in the domestic heating and cooking sectors. Vehicular emissions should be looked at in a more comprehensive manner by evaluating other control options including public transport, demand management, emission standards, better enforcement of existing emissions standards (e.g., I&M), fiscal incentives for cleaner engines, methods to identify gross polluters, inspection and maintenance, retrofitting and re-powering, alternative fuels, and transportation management (Fulton et al. 2002, Matsumoto et al. 2007). Recent successful examples of achieving improved air quality by focusing on improved public transport (bus rapid transit) in Bogotá, Columbia shows that such measures may be much more appropriate, cost effective and sustainable and should be considered in a comprehensive strategy (Hidalgo, 2005).

The challenge paper (Bjorn et al. 2008) acknowledges that economic benefit cost studies are not available globally. Using the sketchy data available with assumptions based on a few studies, this is applied to Dakar, Senegal without considering the realism of such application and looking at other sources. We agree with all the

limitations, and the issue of multiple uncertainties, mentioned in the last section. Government capacity limitation to implement the recommended action is mentioned but these limitations have not been adequately analyzed or reflected in their recommended focus on low sulfur diesel fuel and vehicular emission controls in developing countries.

III Approaches for Cost Effective and Sustainable Air Quality Management

Our review suggests that low sulfur diesel fuel (<50 or 15 ppm) and other technologically advanced solutions are needed to reduce vehicular emissions and will have to be part of a comprehensive air pollution control strategy. Such options take a long lead time and should be part of overall urban planning. However, benefit cost or cost effectiveness of low sulfur diesel fuel needs to be compared with appropriate control options for other major sources. Focusing exclusively on low sulfur diesel may not be the most cost-effective approach for many developing countries. Uncontrolled heavy industrial emissions, dirty coal-fired power stations, and non-traditional area sources such as burning (e.g., garbage, slash and burn, peat land fires, and rice paddies), construction, and re-suspended road dust which are important contributors to air pollution have higher benefit cost ratios (World Bank 1997b). Similarly, some of the “no regret actions” listed in Table 1 may be implemented, as they too would have higher benefit cost ratios. The low sulfur fuel and vehicle emission control costs may also come down further in the future and that may make them more attractive (Lloyd and Cackette 2001, Chow 2001).

Table 1: Examples of "no-regret" actions for air pollution control in cities (compiled from delegates at the 2004 International Air Quality Forum in Indianapolis, IN).

Policy Initiatives	▪ Phase-in improved technology vehicles and engines, through tighter standards ▪ Remove fuel subsidies ▪ Abolish burning of garbage and other biomass ▪ Lower taxes on clean products
Institutional Measures	▪ Identify and encourage champions for change ▪ Formulate a Clean Air Group that includes industry, fuel providers and non-governmental organizations (NGOs)
Road, Transport, and Traffic Management	▪ Make public transportation affordable or even free for downtown destinations ▪ Train bus drivers about pollution and fuel use ▪ Promote fuel efficiency for cars and industry ▪ Establish one-way traffic with synchronized signals ▪ Pave roads, including access roads
Awareness, Media, Educational, and Social	▪ Publish and broadcast Air Quality Indices ▪ Promote a regular media outlet for air quality stories to keep up interest ▪ Offer environmental education in primary schools and agricultural extension services
Technical Measures	▪ Eliminate refueling leaks, establish primary volatile organic compounds (VOCs) recovery, as a minimum ▪ Reduce sulfur content of diesel fuel and gasoline to 500ppm or lower ▪ Require new gasoline powered vehicles to have operational catalytic converters ▪ Mandate inspection and maintenance for commercial vehicles ▪ Design and disseminate better stoves for coal briquettes, wood pellets, and other solid fuels ▪ Focus on less polluting – better ventilated kitchens ▪ Promote more efficient agricultural burning methods
Enforcement Initiatives	▪ Identify and target gross polluters ▪ Provide complaint phone or text message numbers for visual sighting of polluters

Source: Chow et al. 2004. Critical Review Discussion: Megacities and Atmospheric Pollution, Journal of Air and waste management Association. 54:1226-1235

Developing countries need good science and analysis that: 1) quantify which sources are the largest contributions to outdoor concentrations (not the same as the emissions inventory; 2) evaluate the effectiveness and costs of a large number of emission reduction strategies; 3) rank the strategies by cost benefit and politically acceptability; 4) implement and enforce the strategies; and 5) periodically evaluate their effectiveness and adjust them for greater effect. Alll potential sources and major decision making dimensions must be considered (financial, technical, economic, implementability, political viability, etc.). Public awareness and support for disciplined time bound action, effective regulators, and above all political champions are needed for successful implementation! There is a tendency to recommend what has been applied and worked

in developed countries without adequately recognizing the limitations and political economy in developing countries. In addition, technology has advanced since many of these policies were implemented in developed countries, and leapfrogging opportunities should be recognized. South-south cooperation may be more effective and convincing for policymakers. Leapfrogging is a very good idea – but there are no silver bullets that will magically get rid of the pollution that has been building up for decades. It is important to recognize and address institutional capacity to make sure that the anticipated benefits of costly technologies really come to fruition.

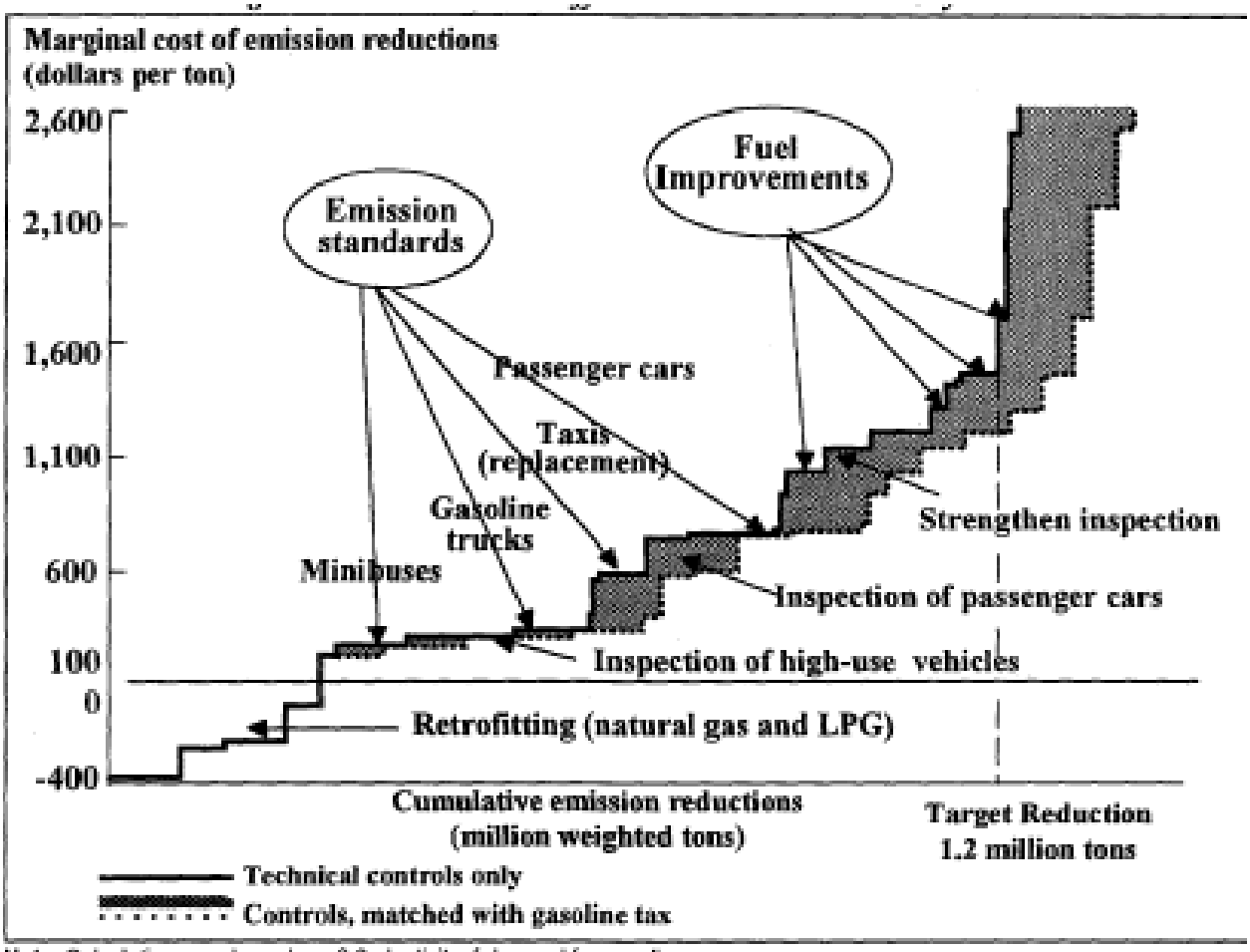
Looking at control options from a technical viewpoint only may not deliver the expected benefits and for developing countries, non-technical issues including capacity constraints and implementation difficulties should be considered when developing air pollution control strategies. Champions are needed in developing countries to promote innovative solutions that may sometimes be viewed as “too expensive” or anti-growth. We need to support these champions in making sure that the recommended actions are in fact the most cost effective. These champions may loose credibility if valuable resources are expended to control sources while achieving no perceptible improvements in air quality.

The Incremental Cost of Abatement Curve is a useful analytical and presentational tool that can be derived directly from cost effectiveness analysis. Figure 2 gives details for an incremental cost curve developed for Mexico City. Under the cost-effectiveness analysis, the costs and benefits of three groups of abatement strategies for vehicular pollution were analyzed (Eskeland 1992). The benefits were expressed in tons abated, but not valued in economic terms. The three groups of options analyzed were: (a) options that promote the use of cleaner fuels (e.g., natural gas retrofits and fuel improvements such as unleaded petrol); (b) options that promote the use of cleaner transport technologies (e.g., vapor recovery, tighter emission standards, and increased inspections of vehicles); and (c) options that reduce overall travel demand or shift demand to less polluting travel modes (e.g., a gasoline tax). On the left side of the curve - natural gas retrofits and vapor recovery - are the technical options that offer the cheapest emissions abatement. (In fact, these two are "win-win" options, in that they pay for themselves financially, not only economically.) The middle part of the curve shows that inspections of vehicles and the imposition of emissions standards are the next most cost-effective options to be pursued. Finally, starting at emissions reduction of about 700,000 tons, the imposition of a gasoline tax improves the cost effectiveness of the purely technical options.

The great value of this incremental cost curve is that it explicitly and clearly shows the results of cost-effectiveness analysis. It is useful both analytically, to show priorities for action, as well as presentationally, to illustrate to decision-makers and the general public the underlying logic of the action plan. Such incremental cost of abatement curves should be developed for other major sources for development of comprehensive pollution control action plans by city planners and decision makers. The Simple

Interactive Model (SIM) discussed below includes such analysis and displays results that are easy to understand by policy makers.

Figure 2: Ranking of measures to reduce traffic emissions in Mexico City



Note: Calculations are based on -0.8 elasticityof demand for gasoline.
Source: G. Eskeland, World Bank (1992).

There is usually little in the way of an organized knowledge base or development or application of analytical tools that may help support air quality management. Most available tools are complex and data-intensive and there is a need for a new generation of simple interactive tools that can be used in cities in the developing world recognizing their information and institutional challenges. The SIM is an easy to use Microsoft Excel based open source modeling tool to assist making informed air quality managementdecisions (http://www.cleanairnet.org/cai/1403/article-59386.html ; http://www.pcd.go.th/info_serv/en_air_diesel.html#). Utilization of such an easy to use tool, that includes cost and benefits analysis, is recommended. SIM is utilized by researchers in many cities for an integrated analytical approach to air quality management. Modern information technology advances and increasing presence and

networking in developing world cities offer a tremendous opportunity to develop simple tools to help city managers, regulators, the regulated, academia, and citizen groups to develop a coordinated knowledge base and analytical approaches to develop a shared stakeholder vision for the issues and options in integrated air quality management for a city. The model include typical management options and these are pre-programmed and linked to cost and health impacts (assumptions and linkages can be modified by the users). The management options programmed in SIM-AIR include:

1. CNG Conversion of Buses (percent x of fleet converted to CNG or clean fuel)
2. Low-Sulfur Diesel (percent y reduction of sulfur levels in diesel)
3. Energy Efficiency in Industry
4. Shift Industries from grid A to B
5. Coal to LPG shift in Domestic/Area sources
6. Scrappage (retirement of highly polluting vehicles e.g. replacing motorcycles with 2-stroke engines with motorcycles with 4-stroke engines)
7. Trucks using Bypass (avoiding high density areas like downtown, schools, hospitals, etc. to reduce congestion)
8. Encourage Public Transport (percent z cars off road)

A holistic approach is recommended where the major sources of air pollution and their potential damages are considered. Then one can look at what are the costs and benefits of cleaning up each source, by using the least cost abatement curve.

Acknowledgement

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Annex 1. List of clarifications and logistical errors in the challenge paper

- Page 26. It would be good if the authors make it clear that the World Bank estimated air pollution levels in 3,000 cities are based on modeling. Also, has the World Bank, the authors or anyone else tried to validate these estimates for their reasonableness by comparing the modeled numbers with measurements in some of the cities?
- Page 30 – section 2 titled Solution: The opening line for the first paragraph seems to contradict the first line of the second paragraph. The paper seems to say that reducing air pollution exposure is largely a technical issue and these need policies and applying these policies is an economic issue rather than technical. This should be clarified as it is confusing right now.
- Source apportionment studies – there is a long section that is a summary of many reports but this can be easily summarized in a table so that one does not get lost in details.
- While lowering sulfur in diesel will have immediate benefit in terms of lower PM, this depends on the starting level of sulfur and the actual reduction of PM without mandating DPF is small in comparison with costs of lowering sulfur. This may be mentioned on page 37. Much of the PM benefits come only when one goes to ultra low sulfur diesel with emissions control.
- Table number 5.3 on page 37 should be Table 2.11
- On page 38 there is mention of Thailand going to Euro iv soon. FYI, Thailand will go to Euro iv in 2012. It would be good if such details are mentioned as this will give the time frame.