Good practices on control and prevention of transboundary air pollution

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Status and Major Issues in South Asia

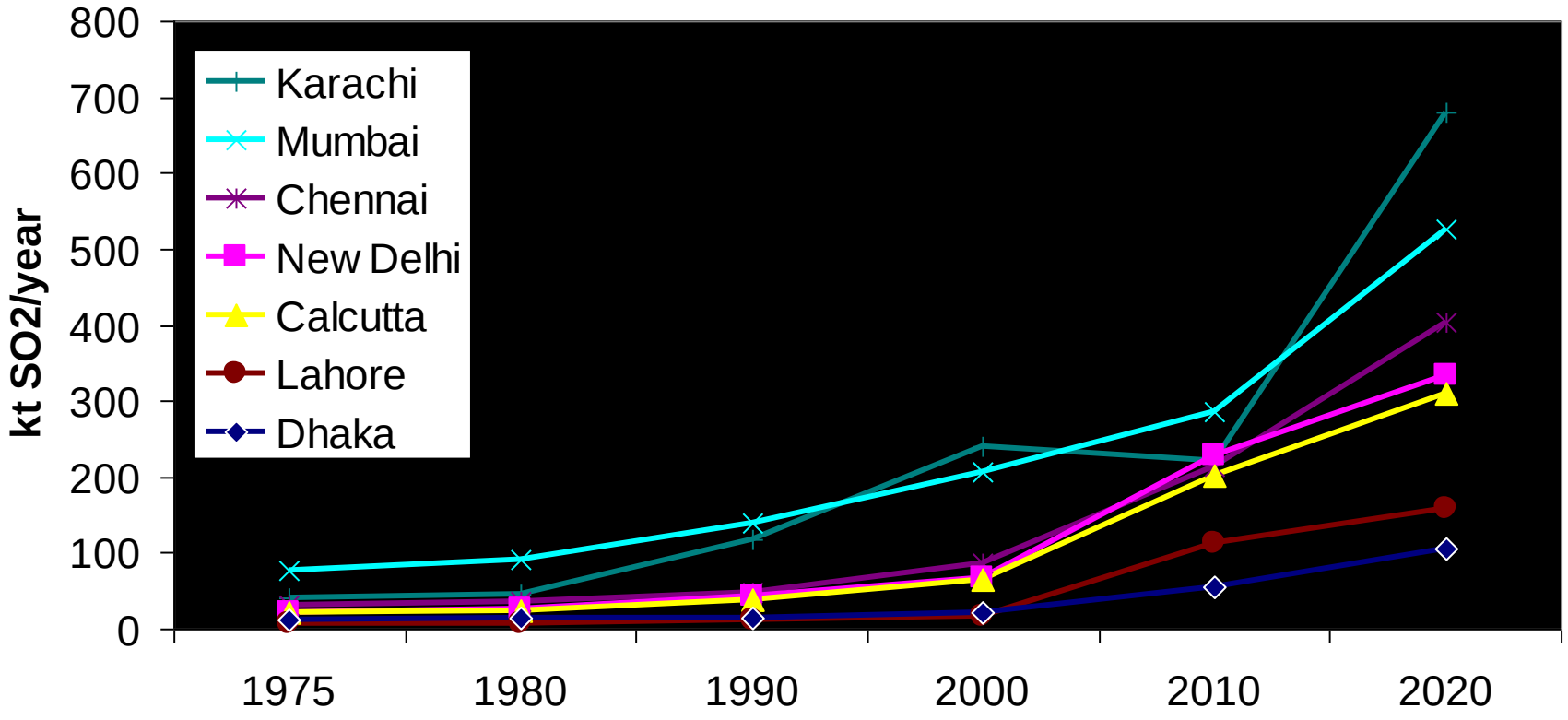
Population Growth in South Asia

Items	World	South Asia	Banglade sh	Bhuta n	India	Maldive s	Nep al	Pakista n	Srilank a
Population (millions)	6,438	1,470	141.8	636.6 thousands	1,09 4.6	329.2 Thousan d	27.1	155.8	19.6
Urban population (% of total)	48.8	28.5	25.1	11.1	28.7	29.6	15.8	34.9	15.1
Urban population growth (average annual %, 1990–2005)	2.2	2.7	3.6	3.3	2.5	3.7	6.2	3.3	0.9*
Total population growth (average annual %, 1990–2005)	1.4	1.9	2.1	0.4	1.7	2.8	2.3	2.4	1.0

Source: The Little Green Data Book 2007/ The World Bank, * UNICEF, 2007

Emission of Major Transboundary Air Pollutants

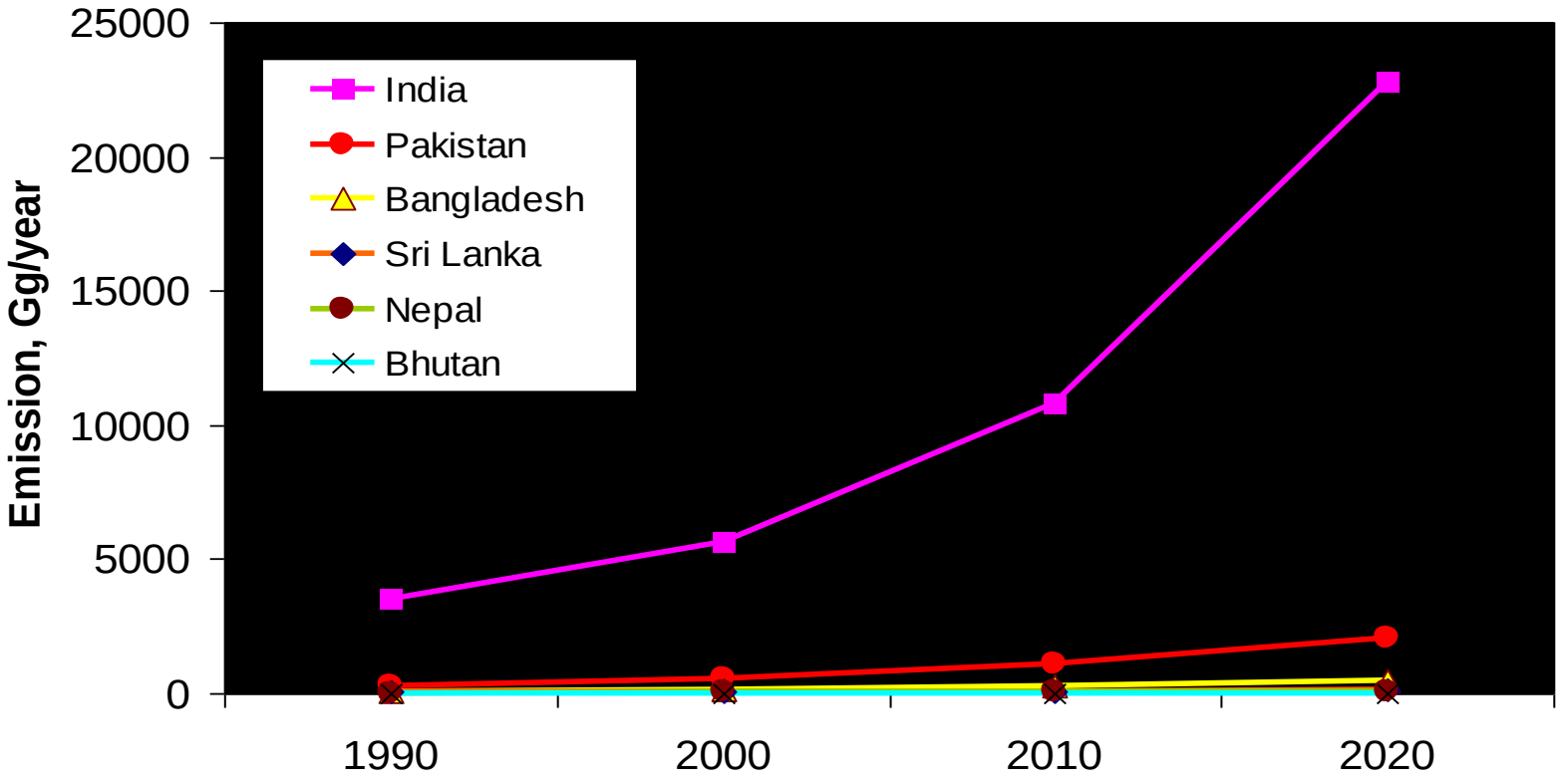
Increasing trend of SO2 emission in South Asian Cities



Source: Guttikunda et al., 2003

Emission of Major Transboundary Air Pollutants

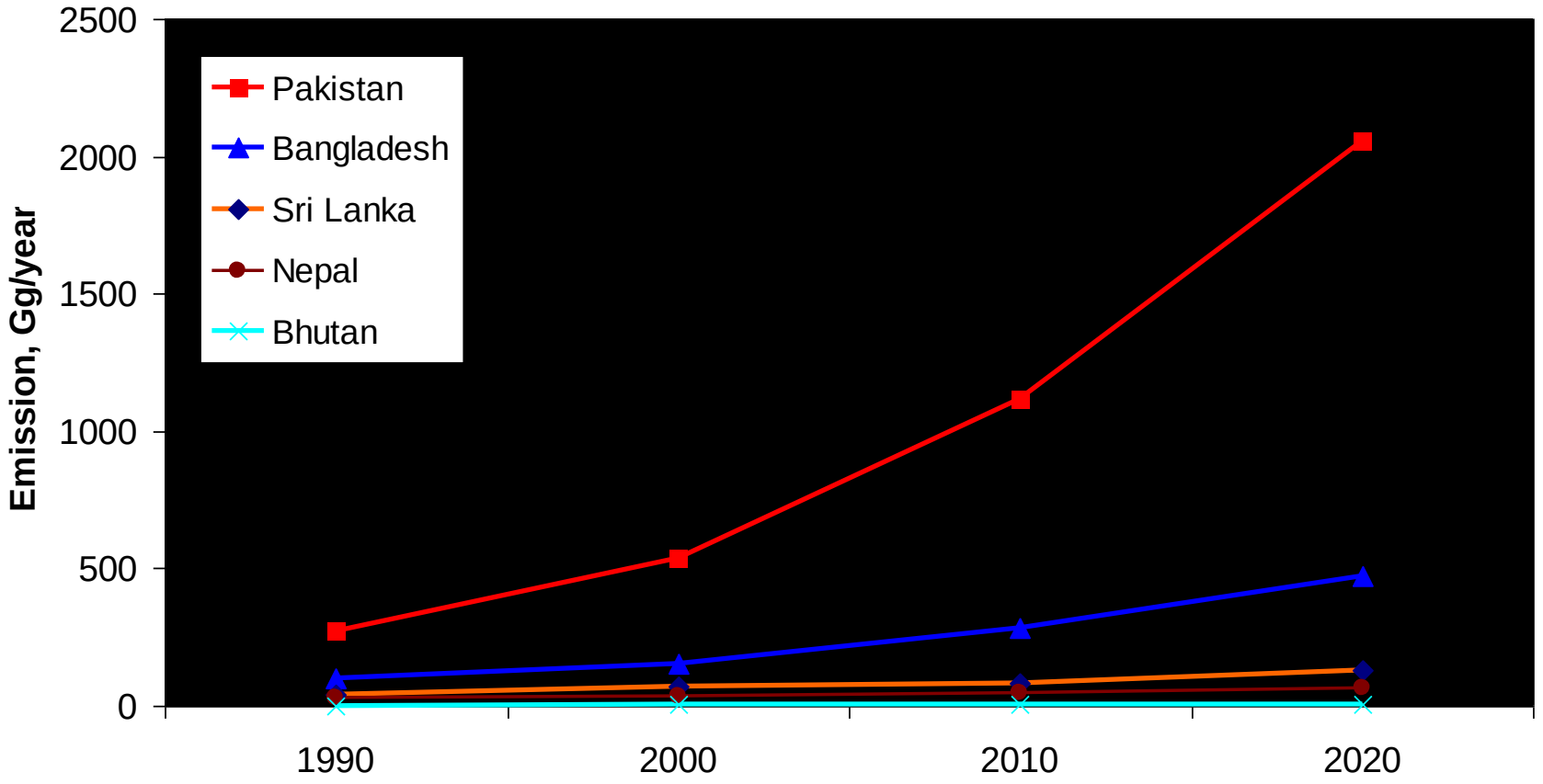
Trend of NOx emission in South Asia (1990-2020)



Source: Aardenne et al., 1999

Emission of Major Transboundary Air Pollutants

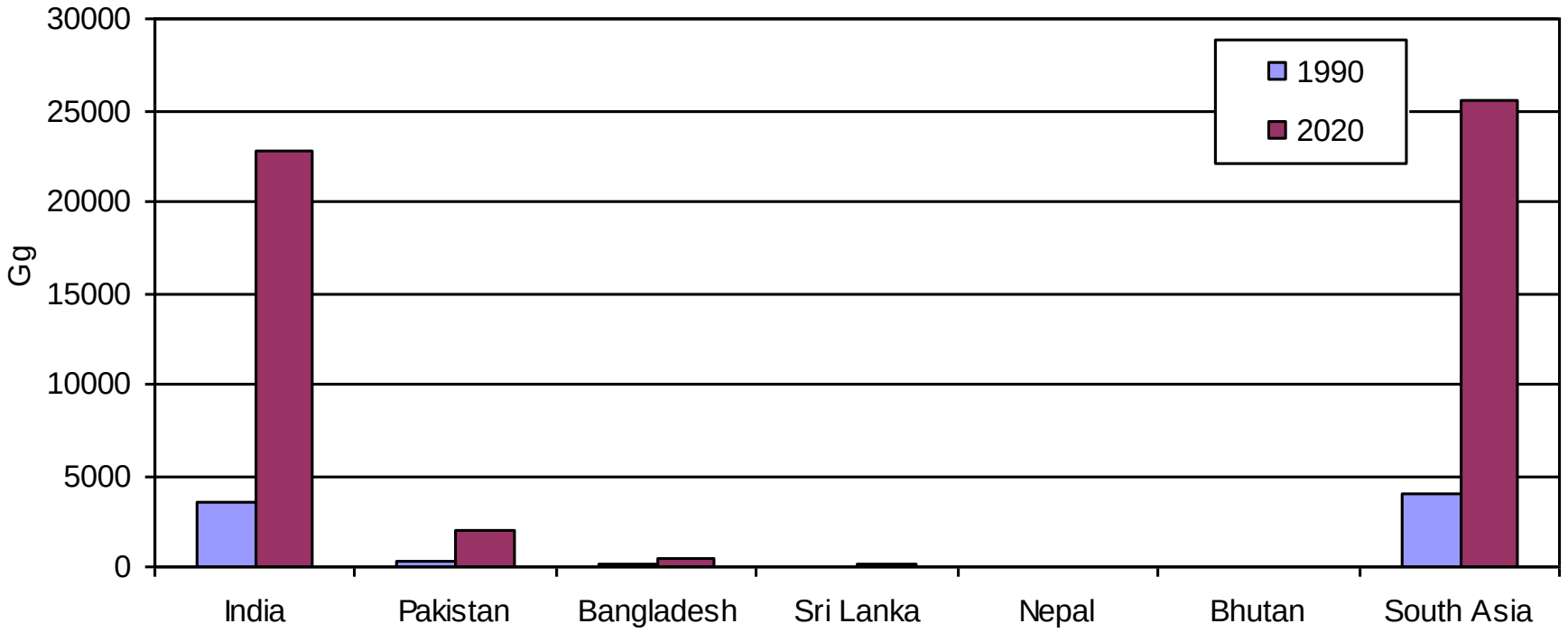
Trend of NOx emission in South Asian countries excluding India (1990-2020)



Source: Aardenne et al., 1999

Emission of Major Transboundary Air Pollutants

NOx emission in South Asian countries in 1990 and 2020



- NOx emission in India will grow by a factor of 5 in 2020

Source: Aardenne et al., 1999

Growing exposure to increasing SO2 concentration in future

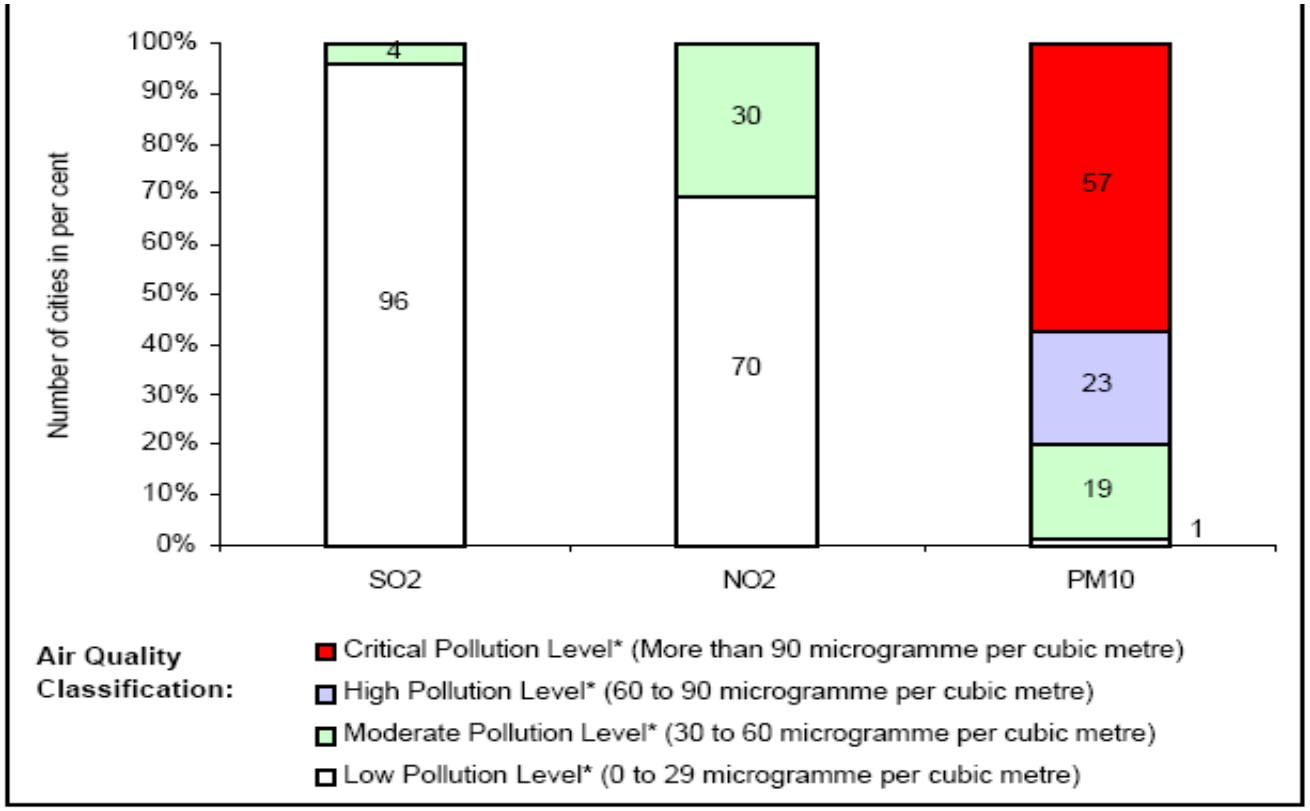
- In 2020, peak SO_2 concentrations would reach 226 mg/m^3 (average concentration 33 mg/m^3)for Mumbai.

- In 2020, the population exposed to SO_2 pollution levels above WHO standard (industrial area limit = 80 mg/m^3) is 10.8 million for Mumbai city alone.

Source: Guttikunda et al., 2003, The contribution of megacities to regional sulfur pollution in Asia, Atmospheric Environment 37 (2003) 11–22

Urban regions in South Asia suffer with PM_{10}

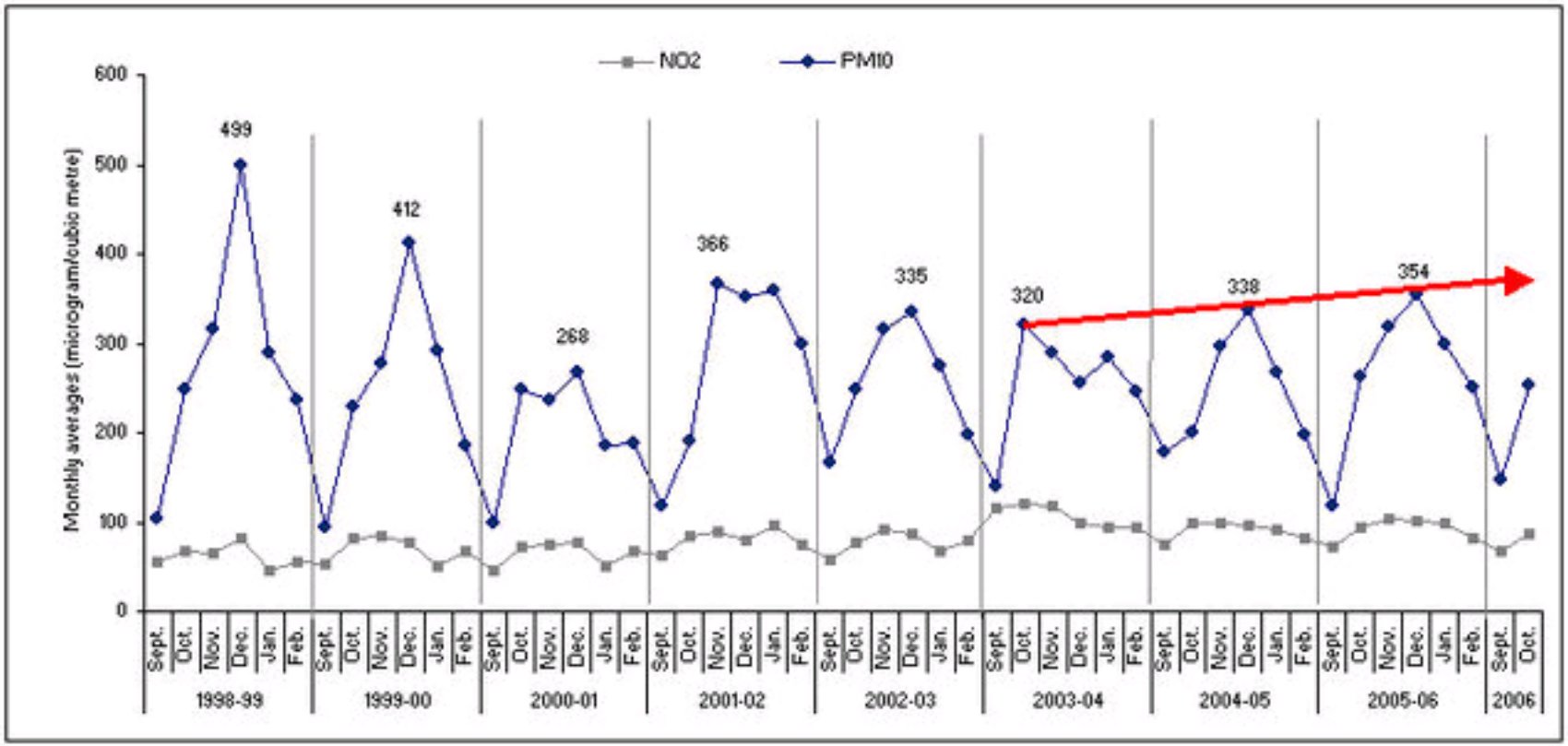
In India, half of the cities monitored during 2004 show critical level of PM_{10}



Source: CSE, 2006

Trends of NOx and PM_{10} in Delhi

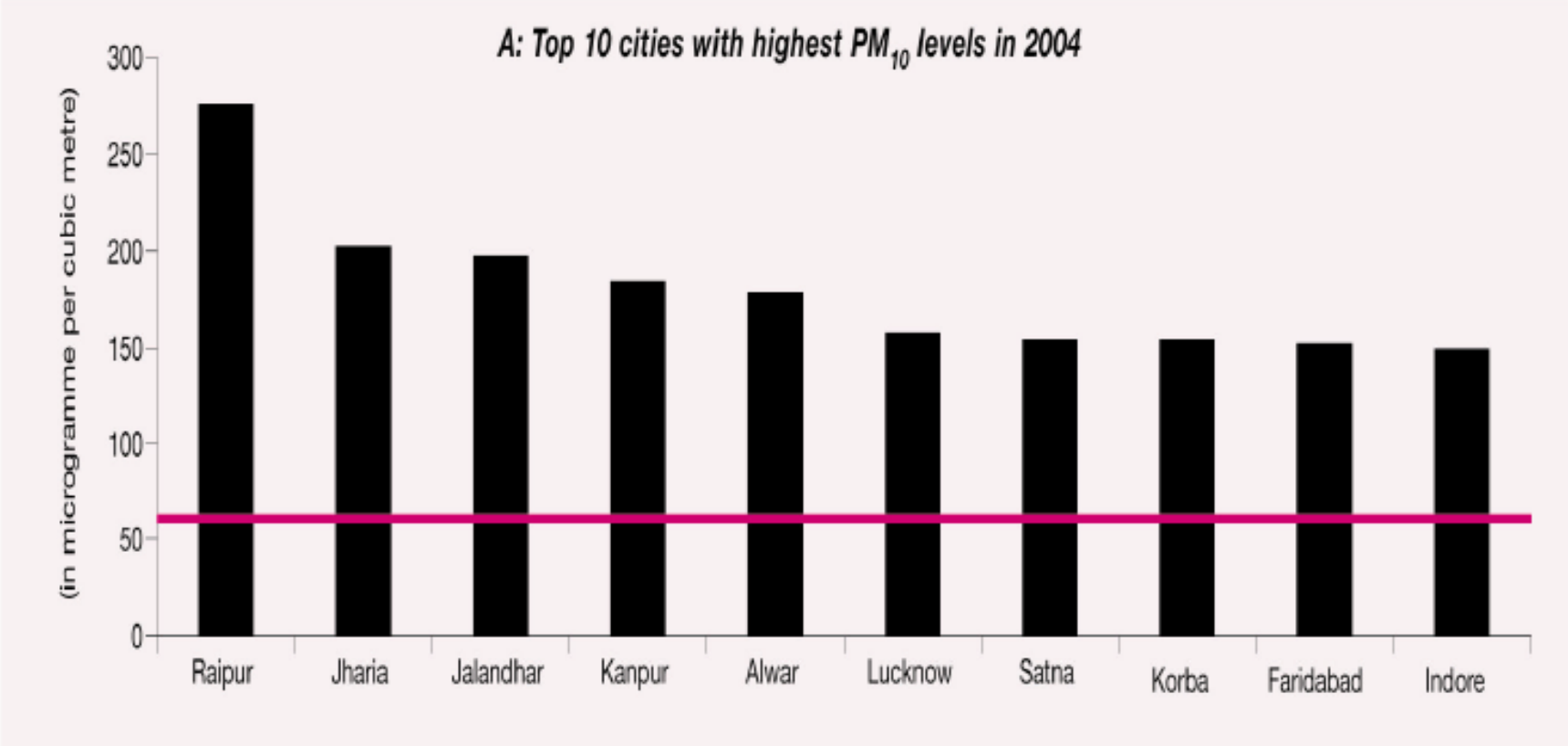
In Delhi, after introducing CNG vehicles, reduced PM concentration was achieved. However, recent trend shows increasing trend of PM_{10} .



Source: Greencarcongress, 2006 (quoting CSE, India)

Small cities also have PM_{10} problem

In India, smaller towns displace megacities in the dubious list of ten most polluted cities of the country



Source: CSE, 2006

Major Factors behind Air Pollution in South Asia

- **growing thermal power generation and the role of coal**
- **low efficiency in power generation**
- **inefficient coal preparation/cleaning mechanism**
- **lack of emission control mechanism in power plants**
- **lack of regulations on industrial pollution and enforcement of existing regulations**
- **urbanization and growth of personal transport vehicles**
- **lack of land-use planning in urban development**
- **inefficient use of energy in demand side**
- **high dependence on biomass fuel burning in rural areas**
- **lack of effective regulatory and economic policies to improve air quality**

Growing thermal Power Generation in the region and the role of coal

India

- In South Asia as a whole, coal accounts for 72% (147,368 ktoe) of energy use in power generation. Out of it, nearly 99% (147,287 ktoe) is used by India.
- Coal based electricity generation accounts for 80% of total electricity generation in India in 2004 (IEA, 2004)
- The coal consumption in India had increased from 140 Mt in 1984 to over 400 Mt in 2004 with a growth rate of 5.4% (GOI, 2006). In this context, if coal import is to be avoided in future, India has to increase its domestic coal production in order to meet its growing coal demand (GOI, 2006)
- Coal demand in India increases to 1020 million tonnes by 2030 from 441 million tonnes in 2004 in reference scenario (IEA, 2006).
- Government of India, under the various scenarios, has estimated coal requirement from a low of 1580 Mt to high of 2555 Mt for year 2031/32 (GOI, 2006).

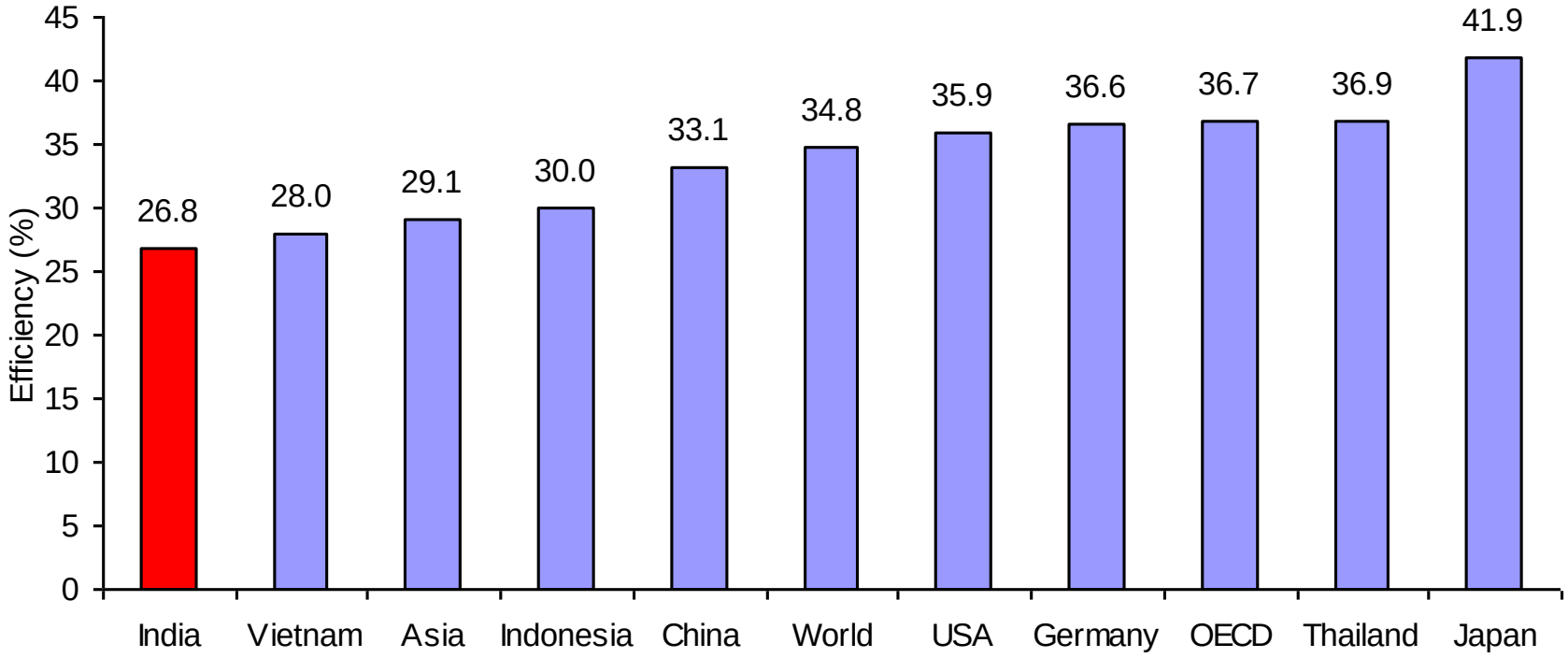
Growing thermal power generation

Pakistan: Share of thermal electricity generation 80%; coal may play major role in future with more discovery of low sulfur lignite.

Bangladesh: Heavily based on natural gas; coal share likely to increase in future.

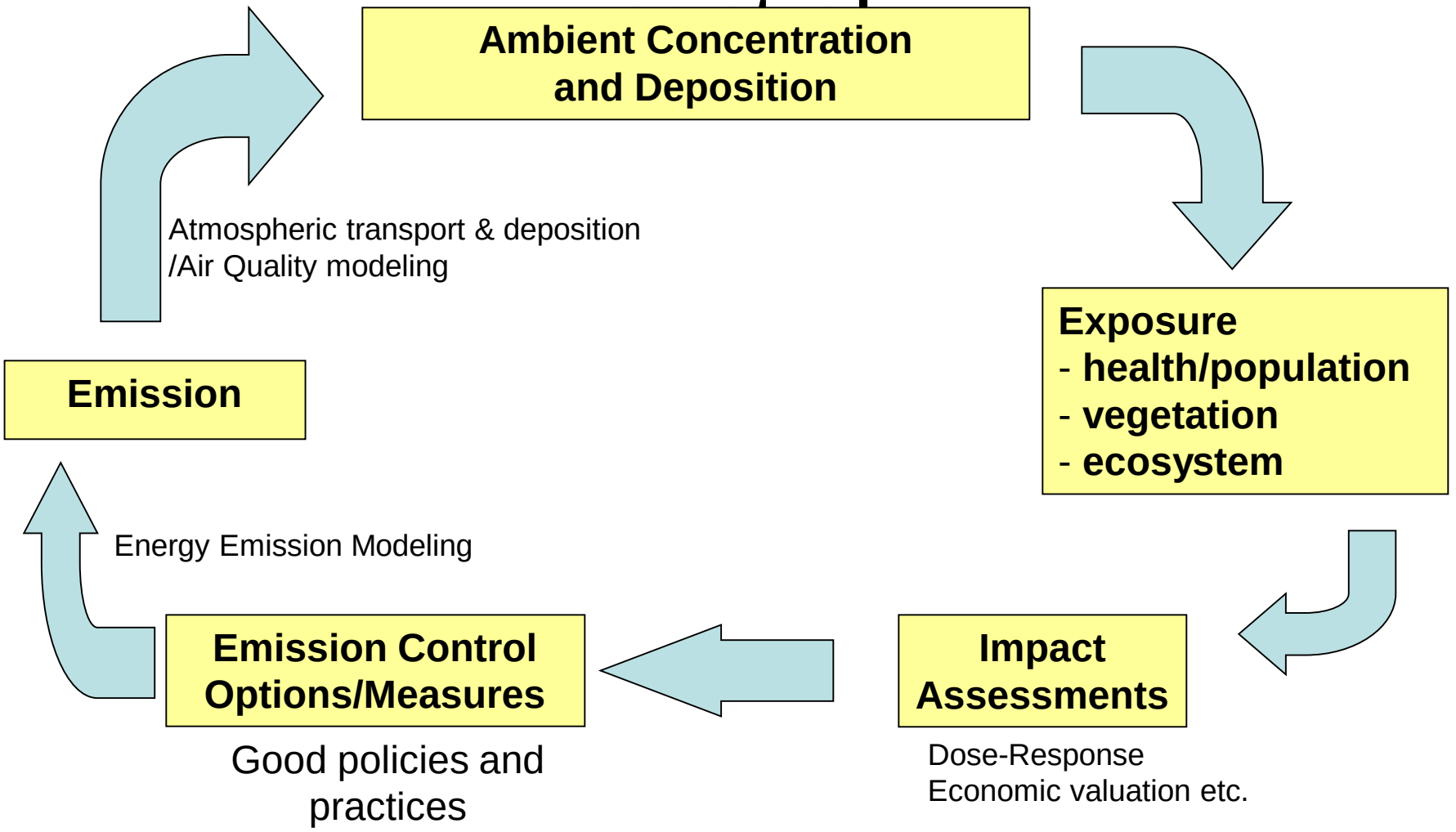
Sri Lanka: Gearing towards more thermal power generation (thermal electricity share has grown from 1% in 1990s to 30% now)

Efficiency gap in Coal Fired Power Generation in the region



- **If the efficiency of coal fired power generation in India was improved to the level of Japan in year 2002, coal requirements of and SO_2 emission from the power sector in India would be reduced by about 36%.**
- **Similarly, if the efficiency in India was improved to the OECD level, the coal requirement and SO_2 emission would be reduced by 26.9%.**

Schematic Cycle of Decision Support System in air pollution



Approaches to control/prevent air pollution

- Command and control
- Market/economic
- Others

Command and Control Approaches

- Setting Standards
  - Technology standards (e.g. scrubber, catalytic converter)
  - Emission standards (e.g. SO_2 kg/kWh)
  - Fuel quality standard (e.g. according to sulfur content)
- Banning and phasing out of high polluting vehicles/technologies
- Banning of dirty fuels

Market Based Approaches

- Direct Instrument
  - Emission taxes/environmental taxes
  - Emission permits (Allowances)

- Indirect Instrument
  - Energy tax,
  - tax on polluting equipments or products,
  - feed-in tariffs,
  - green pricing etc.

Market Based Approaches

- Emission Taxes
  - Pollution charge on polluting activity as a penalty which is “Polluters pay principle”
  - Emission Taxes on VOC emissions from aircraft engines practiced in Switzerland, Sweden and UK.
  - Emission Charges is widely practiced in European countries as SO_2 and NOx charges. e.g. NOx charge in Norway
  - Emission charge in Japan as pollution damage taxes
  - Differential Emission taxes for revenue generation as well as for compliances
  - Refund based tax system in Sweden

Fuel Taxes

Applied as differential taxes based on sulfur content (higher the sulfur content, higher will be the taxes)

Market Based Approaches

- Emission Reduction Credit/Emission Trading System (Cap and Trade Mechanism)
  - firms are issued a permit or allowance, which is based on the emission reduction target

  (set based either on ambient air standard in the region or on the necessity of the reduction from a reference emission level).
  - If a source reduces emission below the level ALLOWED, the difference is a credit earned by the source.
  - These credits can be used by the same or another firm to comply with the emission allowance. As the cost of pollutant abatement may be different for different firms, some firms may opt for buying the credits from other firms if the cost of abatement of the former is higher than that of the latter.
  - E.g. Sulfur Allowance Trading in the US, NOx trading in the US and Netherlands

Approaches based on Voluntary Action

- In these apporaches, individuals or individual firms engage in pollution-control activities in the absence of any formal, legal obligation to do so.

  - In Poland, in addition to the command and control approach, names of top 80 the worst national polluters are published. This has helped increase compliance of the standards in the country (Peszko et al, 2001).

- Another example of voluntary action is the willingness on the part of some electricity users to buy green electricity (electricity from renewable energy technologies) at a premium price. This is also known as the concept of Green Pricing, which exists in Europe and the US.

Other Approaches

Fuel Switching Options

- Switching to the cleaner fuels
  - Use of low sulfur content fuel (e.g. ultra low sulfur diesel)has been widely adapted in developed countries like USA and European countries
- Switching to cleaner fuels like CNG and electric vehicles are some of the options in practice
  - Public Passenger Transport Vehicle switching to Compressed Natural Gas Vehicles in Delhi
  - Electric Vehicles in Nepal (using electricity from hydro resources)

Renewable Portfolio Standards

Energy Efficiency Improvement (Demand and Supply Side)-integrated resource planning

Land-use planning in urban region (compact city)

Other Approaches

- Congestion Charge
  - It is a charge applied to the vehicles using a designated region based on the degree of congestion. (e.g. Singapore, Hongkong and London).
  - Though the main purpose of this practice is to reduce traffic congestion in and around the charging zone rather than to obtain environmental benefit, this practice is able to reduce NOx and particulate matter to a larger extent within the charging zone (Beevers et al., 2005).

- License permits
  - It is aimed at reducing the congestion related pollution from vehicles in designated time. These permits are used by Regulatory body in countries like Singapore and Chile for regulating the vehicular operation. A user requires acquiring these permits in order to run his/her vehicle.

Other approaches

- Banning of Vehicles
  - imposing a regulation that ban cars running on designated day.
  - E.g. in Mexico, the day was determined by the last digit of the license plate;
- Restricting the vehicle operating days e.g., by using even and odd number of the license plates.
  - However, it is reported that, in Mexico, the practice was counterproductive with over investment in new vehicles in longer run.

Some good practices

Some Good practices in Asia

- Two-control zone SO2 control program in China
- Transport demand management in Singapore
- CNG buses in Delhi
- Brick kilns in Kathmandu and Bangladesh
- Electric vehicles and solar water heaters in Nepal
- Phasing out of more polluting 3-wheelers (Vikram tempos) in Kathmandu
- Differentiated vehicle tax in Bangkok; tax incentives provided to smaller size vehicles
- Environmental Performance Award for Industries in India
- Improving fuel quality (lowering sulfur content in diesel)
- Micro-hydro program in Nepal

- Failure cases:

Electric trolley buses in Kathmandu (management failure)

Two-control zone program in China

Two zones of control:

- Sulfur pollution control in 64 cities with high ambient concentration of sulfur
- acid rain control zone covering 12 provinces of southern and eastern China

Together the 2 zones covered about 2/3rd of sulfur emission in the country

Major Activities:

- **Gradual phasing out of mining of coal containing 3% or more sulfur**
- **Prohibition of Coal fired power stations inside large and medium-sized cities and surrounding suburbs.**
- **Regulation on coal quality: Sulfur content of coal used in new and renovated power stations to be not more than 1%.**
- **Use of Flue gas desulfurization**
- **Implementation of Sulfur emission charges**

Transport demand management in Singapore

Major components:

- Additional registration fee (ARF)-an additional tax on new vehicles (ARF =110% of open market value)

  (reduced ARF when an old vehicle of the same size is taken off the road at the time the new vehicle is acquired.)

- Area license scheme (ALS) since 1975

  - required vehicles a license to enter restricted zones (RZs) of the city initially during peak hours and later extended during 7:30 a.m. to 7:00 p.m. during working days in 1994.

  - ALS replaced by electronic road pricing (ERP) since 1998.

- Vehicle quota system
- Electronic road pricing
- Flexible schemes (off-peak car scheme, park and ride schemes)

Singapore Transport management: ERP

- Similar to ALS but its enforcement is automatic
- Electronic equipment like sensors, cameras with short-range radio communication system are utilized to sense the vehicle entry
- Vehicles are equipped with an electronic in-vehicle unit (IU) (a smart card with positive cash balance) are inserted before the vehicles' entry to RZs.
- Charges are different for motorcycles, cars, good vehicles, taxies and buses;
- The ERP charge varies every half-hour of a day and varies by type of vehicle and by time of day (e.g. peak and off-peak).

Singapore Transport management:

Vehicle quota scheme (VQS)

- A quota on vehicles implemented since 1990.
- Requires all prospective purchasers of new vehicles to own a Certificate of Entitlement (COE) to operate vehicles on the road,
- COEs valid for 10 years and need to be purchased in an auction (open bidding process since 2002),

Singapore Transport management:
Off-peak car scheme

- Permits to operate cars only during off-peak hours;
- Special permits to cars to run during weekends only under Weekend Car Scheme;
- OPC aims at reducing car usage during work days;
- Offers the new and existing car owners with OPC permits a rebate on car registration and road taxes

Singapore Transport demand management:

Other measures

- Improvement in communication system
- investments on and improvements to public transport system
- traffic management schemes;
- integrated transport and landuse planning

The Singapore Example: Can it be replicable?

- The prerequisites:
  - Provision of a good alternative public transport system
  - strong commitment of govt. on better air quality
  - Effective enforcement mechanism
  - Effective communication system

Better managability of vehicle growth being a city state

CNG Public Passenger vehicles in Delhi

- The Supreme Court of India through its verdicts and directives played the major role in conversion of buses to CNG use in Delhi.
  - Judicial activism (or a judicial “good practice”)
- Inadequacy of CNG filling stations and shortage were the initial hurdles.
- By 2003, all buses and nearly all auto-rickshaws were reported to operate on CNG.
- By 2006, 10,761 buses, 63,962 three wheelers, 19,351 private cars, over 5,229 taxis and 5, 258 vans running on CNG.
- SO2 concentration drastically reduced to the safe level during 1998-2005.
- NOx concentration within annual average national standard, but an increasing trend recently.
- Suspended particulate matter far above the national standard.

Judicial good practices (?)

- Pro-environmental/pro-public health judicial interventions (through public interest litigations) in India.
- Supreme court verdicts/directives on CNG buses in New Delhi and polluting industries around Agra.
- Similar judicial interventions in other countries

CNG vehicles in other countries

- Over 900,000 CNG vehicles in Pakistan
- Examples of Bangladesh
- CNG taxis and micro-buses in Bangkok

The US Acid Rain Program (1)

- Started in 1995
  - initially affected 263 large mostly coal fired plants
- Uses a market based ("cap and trade") approach.
- Plants or units that emit below their allowed level can
  - trade the surplus allowances with other units in their system (within the same utility) or
  - sell them to other utilities
  - bank them to meet emission reduction obligations in future years

- Some allowances (2.8%) are auctioned annually by USEPA. Typically, environmental groups acquire them for different purposes including permanent retirement of the allowances (which would lower the emission limit permanently).

The US Acid Rain Program (2)

The program

- has a fixed upper limit on total annual sulfur emissions from the utilities;
- allows anyone to meet the emission limit by acquiring the allowances;
- facilitates real time emission monitoring and real time online allowance trading mechanism;
- has a mechanism of penalty for non-compliance which is adjusted with inflation rate; and
- Proved less costly option for reducing emission to the utilities and the society

The US Acid Rain Program (3)

- Utilities have adapted one or more options including:
  - blending low-sulfur coal,
  - installing SO2 and NOx controls (such as scrubbers and low-NOx burners),
  - purchasing allowances from the market or using banked allowances in order to meet the emission reduction requirements
  - increased use of efficient advanced combined gas cycle units based on natural gas.

NOx charge in Sweden

- Implemented since 1992 and administered by the Swedish Environmental Protection Agency (SEPA).
- Large energy combustion plants charged on the basis of their actual NOx emission
- But NOx revenue redistributed to the plants according to the level of energy production
- Plants with less NOx emission per unit of energy production benefit more from the scheme.

  => incentive to reduce emission
- Offers flexibility on technology choice: Utilities/firms are free to choose the means to reduce the emission.
- The 1995 target of a 35% reduction from the 1990 emission level was already achieved by 1993.
- Average cost to reduce NOx is reported as SEK10/kg NOx.

Treaties/Agreements and Protocols

- Examples from the Europe and the US:
- Convention on Long-Range Transboundary Air Pollution (CLRTAP)
  - Helsinki Protocol (SO2 emission reduction)
    - At least 30% reduction from 1980-1993
  - Oslo Protocol (SO2 emission reduction)
    - 70-80% (for western Europe), 40-50% for eastern Europe from 1980 levels by 2000
  - Sofia Protocol (NOx emission reduction)
    - Emission from 1994 onward does not exceed 1987 level
  - Geneva Protocol (VOC emission reduction)
    - 30% reduction with 1984-1990 base year by 1999
  - Gothenburg Protocol (SO2, NOx, VOC, NH3 emission reduction)
    - Binding emission ceilings for four pollutants to be achieved by 2010

Steps in Regional air pollution control/prevention

A collective action in the region

- Regional Treaty/Agreement

A commitment through an agreement

Protocol
- Regional Emission Reduction
- National Emission Ceilings
- Time frame

Individual country formulates acts and appropriate measures/strategies/policies to attain the committed emission reduction targets.

- National Acts/Appropriate Measures/ strategies/ approaches

Command and Control Approach
- **Emission Standards**
- **Fuel standard**
- **Technology standards**

Market Based Approach
- **Emission Taxes**
- **Emission permits/Emission Trading (Bubble, Netting, Offsetting, Banking Mechanism)**
- **Fuel Taxes (Indirect)**

Other approaches
- **Voluntary Action**
- **Moral suasion**

Treaties/Agreements and Protocols

- European Commission National Emission Ceilings Directive (2001/81/EC)
  - Similar to Gothenburg Protocol but more stringent Target for SO2, NOx, VOC, NH3
- Malé Declaration in South Asia
  - It does not have a protocol yet.

Policy analysis of environmental policies/strategies

Should a good practice in a country be necessarily effective and good elsewhere?

Answer lies on the outcome of policy analysis (based on various criteria):

- Cost of implementing a policy/strategy (economic efficiency, cost effectiveness)
- Financial affordability
- scientific, technical and managerial capacity to design implement the policy
- administrative complexity (enforcement capacity)
- political will and sensitivity
- social acceptability
- environmental effectiveness

Constraints in South Asian Countries

- Lack of capacity to monitor and enforce the regulations/policies

  - Environmental Acts alone not enough (e.g., Nepal)

- Inadequate scientific/technical capacity to analyze emissions, assess impacts, and formulate appropriate policies/strategies

  - Large share of small firms (more difficult to monitor and enforce)

  - Inadequate resource allocation for environmental protection activities

Thank you