APPENDIX I. PRESENTATIONS AT THE MEETING

(6) **Clean Coal Technology**, Robert Williams, UNIDO

Clean Coal Technology

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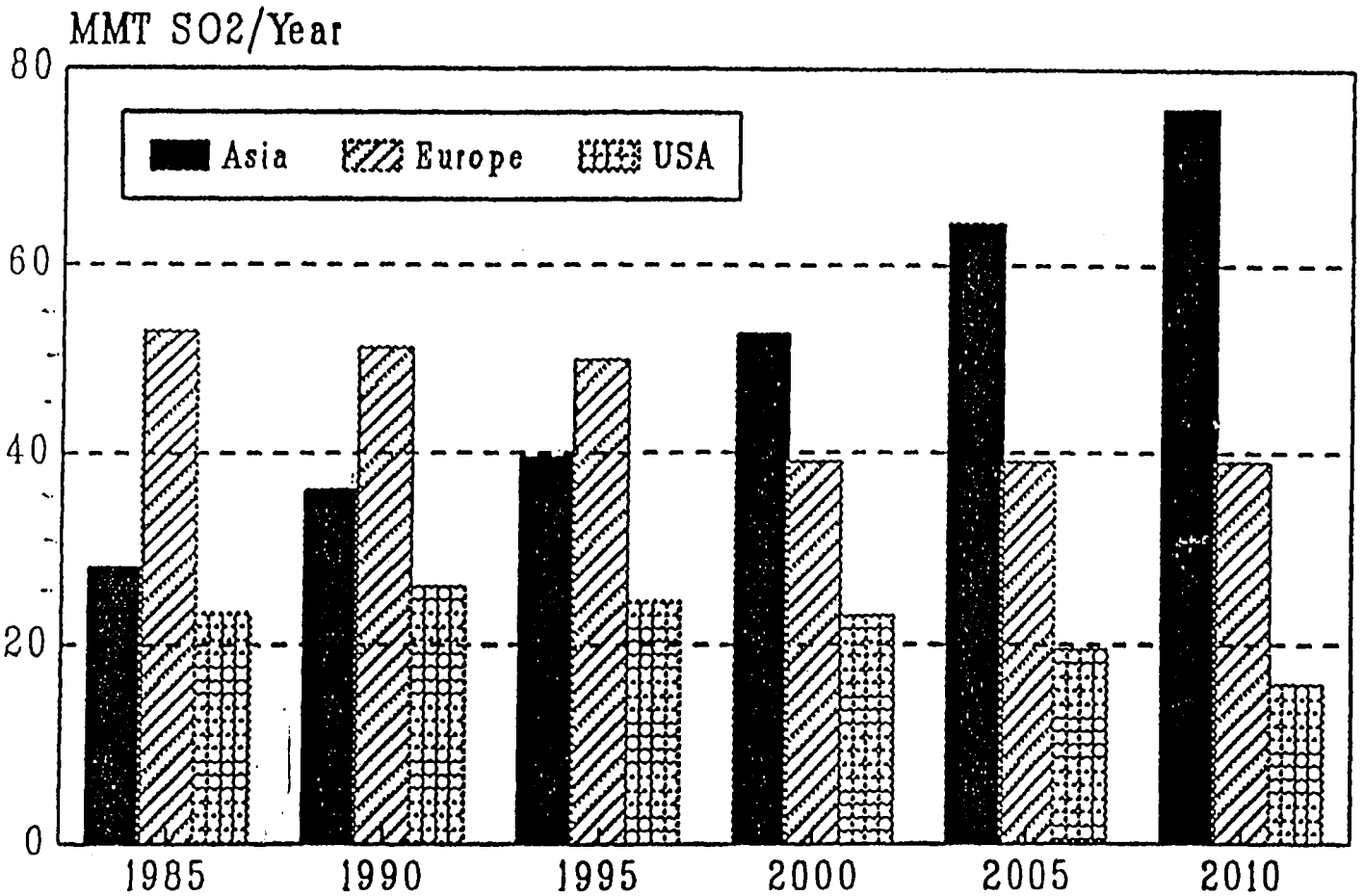
For presentation at:
Technical Committee Meeting
on Approaches for Estimating and
Comparing Risks from Energy Systems in the Far Future

Vienna, 6-10 October, 1997

Current and Projected SO_2 Emissions



Source: World Bank and ADB data.

AMBIENT POLLUTION IN SELECTED ASIAN CITIES

	Approx. Range of Atmospheric Particulate Concentration ($\mu g/m^3$)	Approx. Range of Atmospheric SO_2 Concentration ($\mu g/m^3$)
BEIJING	250 - 400	30 - 120
BOMBAY	150 - 270	30 - 50
BANGKOK	150 - 250	20 - 30
SHANGHAI	180 - 280	30 - 120
WHO GUIDELINES	90	60

Source: UNEP City Air Quality Trends

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NATURAL GAS

Benefits of Use in Power Generation

- Efficiencies above 50% in combined cycle applications
- Compared with coal, 40% less CO_2 per unit of energy generated
- SO_2 and particulate emissions eliminated and NO_x reduced, (cofiring option)
- Costs less than equivalent sized coal plant

Increased use subject to:

- Increase in overall energy prices to reflect economic and environmental costs of using coal
- Capability of global markets to secure long term investments in transportation

EFFICIENCY OF THERMAL POWER PLANTS

- Average plant efficiencies <30% (35-38% in industrialized countries)
  [When η =25%, 1% increase in η reduces CO_2 3.3%]

INDIA

☞ High ash content in coal results in poor heat transfer and metal erosion. Specific Fuel Consumption, (pithead/bus), can reach 710g/kwh.

☞ Use of washed coal loaded over 1000 KM could reduce annual CO_2 emissions by 53 Mt by 2010.

CHINA

☞ Small, (<50 MWe) plants proliferate and remain in service beyond retirement due to acute power shortages.
(SFC's of 450g/kwh)

☞ Increasing average plant efficiency to 35% by 2010 could reduce annual CO_2 emissions by 130 Mt.

PHYSICAL COAL BENEFICIATION

Benefits of Reducing Ash Content:

- **Improved efficiency in transport/handling**
- **Enhanced heating value & boiler operating efficiency**
- **Reduced erosion/corrosion**
- **Reduced bottom ash/fly ash for disposal**

Other Major Benefit:

- **Reduction in SO_2 emissions of 10 - 30%**

Trade-offs:

- **Additional investment (incremental power cost of 2%)**
- **Wet product may require further treatment which can, itself, cause subsequent product instability**

REDUCING PARTICULATE EMISSIONS

Many existing power plants in developing countries have only rudimentary & usually inadequate particulate removal.

These plants contribute significantly to high ambient TSP concentrations in the atmosphere in urban areas.

Problem is exaggerated by the use of coals with high ash content, (30 - 40 %)

Costs of particulate control are manageable in most countries, (2 to 5% addition to the cost of power). Easily off set by savings on avoided increased health costs of continued emissions.

ESPs have 99.9% efficiency. TSP loading down to 100 mg/Nm^3 in exit gas readily achieved.
(EU standard for <500 MWe)

Fabric filters could be less expensive than ESPs for high ash coals.

POWER PLANT-SPECIFIC MITIGATION MEASURES
Potentially applicable for High Sulphur Coals
(Compared with conventional PF plant)

Measure	Impact on Efficiency	SO_2 Emissions Reductions (%)	NO_x Emissions Reductions (%)	Impact on Solid Waste Generation	Impact on Water Pollution
Physical Coal Beneficiation	+ve	10 - 30		Reduced bottom ash	Coal washery discharge
Wet FGD & $deNO_x$ [SCR]	-ve (8% of output power)	>90	80 - 90	Large volumes of marketable Gypsum	
Sorbent Injection and spray-dry FGD	-ve	50 - 70		Increased fly ash (unreacted lime, sulphated sorbent)	Leaching from dumps
Nat. Gas Cofiring	-ve	<25	60 -70		
Low-NO_x Burners/Air staging			20 - 50		
EB/Ammonia	-ve	90	70	Saleable fertilizer	
CFBC	Acceptable efficiency over wide range of fuels	>90	<60	Increased volume of dry alkaline waste (Ca solids)	Leaching

PLANT SPECIFIC MITIGATION MEASURES
[Potentially applicable in Developing Countries]

Measures	Cost ($/KW)	Incre-mental Power Cost	Status
Physical Coal Beneficiation		2%	Well established technology
FGD & deNO_x, [SCR]	350	10 to 20%	Extensive experience new & retrofit
Sorbent Injection and spray-dry FGD	50 to 100		Limited experience on high sulphur coals
Nat. Gas Cofiring or Reburning	15 to 30		
Low-NO_x Burners & Air Staging	5 to 25		Widely used
Combined SO_x & NO_x removal (EB/Ammonia)	250 to 350		Developmental
CFBC	1600 (New plant)		Extensive experience <250 MWe

HIGH EFFICIENCY COAL USE TECHNOLOGIES

Technology	Potential Impact on Plant Efficiency (%)	Approximate # of plants worldwide & Capacity range (MWe)	SO_2 Emissions Reduction (%)	NO_x Emissions Reduction (%)	Applications
PFBC	+5%	<10 (70-100 MWe)	90-95%	150 -300 mg NO_2/m^3 at 6% O_2	Repowering in 100 to 200 MWe sizes (China)
IGCC	+5 to 10%	<5 (250-300 MWe)	95-99% (<10mg/Nm^3)	120 - 300 mg NO_2/m^3 at 6% O_2	Refineries ? Phased construction
Large Capacity Supercritical PFC + FGD & de NO_x	+2 to 3%	1/2 (350-700 MWe)	90	500 - 650 mg NO_2/m^3 at 6% O_2	New plants

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