

## CHAPTER 4: Large Stationary Sources (LSS)

The contribution of LSS to pollutant emissions into the major Australian airsheds varies depending on the nature, type, size and number of industry activities operational within any particular airshed. In most cases, the transport sector outweighs the total industrial/LSS contribution to pollutant load. For the six specified pollutants under study in this Inquiry, only sulfur oxides (SO<sub>x</sub>) and particulates are not dominated by the transport sector's contribution (Chapter 1).

The role that LSS management options will play in maintaining or improving ambient air quality in any given airshed will depend on the industrial mix in that airshed and its relative contribution, in pollution terms, compared to transport.

For analytical purposes, stationary sources were divided into four broadly defined industry segments:

- Building
- Gas and Oil
- Power and Energy
- Chemical and Metalliferous

These segments cover the majority (80%) of emissions emanating from the sector giving the analysis a high, but not exhaustive, coverage. Table 13 outlines the significance of contributions to pollutant emissions by segments.

The likely future direction and performance of these industrial segments is a key consideration in determining the dimension of air quality problems.

**Table 13: Significant industry emission sources**

<b>Emission</b>	<b>Pb</b>	<b>CO</b>	<b>SOx</b>	<b>NOx</b>	<b>Part.</b>	<b>VOC</b>
<b>Source</b>						
Power/coal			+	+	+	
Power/gas		+		+		+
Oil		+	+			+
Building					+	
Chemical						+
Min/metal	+	+	+		+	
Misc	+				+	+

+ indicates a significant contribution to a particular pollutant by a specific industry.

### Power/Energy

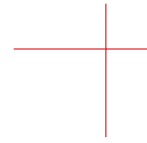
Australian thermal electricity generation is dominated by fossil fuels and in particular coal as demonstrated in Table 14.

The vast majority of electricity is generated in large coal fired stations, usually situated close to mines at some distance from urban airsheds. Except in rare

**Table 14: Energy source mix for Australia 1996**

<b>Fuel</b>	<b>% Contribution to Power Generation</b>
Coal	84
Oil	2
Gas	11
Water	3
<b>Total</b>	<b>100</b>

Source: ABARE (1997a)



circumstances, there is little interaction with, or effect on, major urban airsheds. Perth and, to a lesser extent, Brisbane still have a pollutant contribution from this sector due to power station location at Kwinana and Swanbank. Fossil fuel stations produce the overwhelming majority of Australian base load power.

Coal combustion is responsible for significant quantities of SO<sub>x</sub>, NO<sub>x</sub> and particulates. Australian coals are generally low sulfur, limiting the extent of SO<sub>x</sub> release. The large stations minimise NO<sub>x</sub> release through the installation of low NO<sub>x</sub> burners. Fabric filters and electro-static precipitators are used to control particulate emission. Stringent environmental conditions are part of operational requirements in the sector.

There are many combustion turbines in Australia either serving remote locations or providing for peak demand in urban regions. A high proportion of these turbines use distillate or other oil products rather than gas and therefore emit higher levels of NO<sub>x</sub> and some hydrocarbons depending on the fuel type.

There are a small number of gas fired power stations, being a selection of steam turbine plant, gas engines and gas turbines with simple cycle, combined cycle or cogeneration, located within or adjacent to urban regions. Interest in gas as a potential fuel, with reduced greenhouse emissions, has helped to promote the installation of these power stations. There is, however, a NO<sub>x</sub> trade-off that needs to be considered in their location.

Simple cycle gas turbine units discharge hot gas to the atmosphere and have the lowest efficiency. Combined cycle units pass this exhaust gas through a waste heat boiler and use the steam generated to drive a steam turbine providing a much higher efficiency per unit and reduced greenhouse gas release. Cogeneration units can use gas engines or gas turbines and can only be utilised where there is an adjacent requirement for steam or relatively low grade heat.

This last type of unit has the potential, under advantageous conditions, to offer the highest overall energy efficiency. They tend to be located in urban regions close to industry. In cities with long, hot summers such as Brisbane, the waste heat can be used for absorption cycle chillers for air conditioning.

### *Future electricity demand growth*

For many years the rate of demand for electricity in Australia grew at a consistent rate of 6%. This has tapered off over the last five years to about 2%. A recent confidential International Energy Agency (IEA) study suggests that this level of growth will continue through to 2015.

The Council of Australian Governments (COAG) has promoted the development of a competitive market for electricity throughout Australia. This has seen a number of older power stations of lower efficiency closed down and this trend will continue.

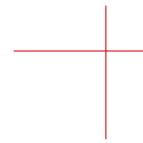
The competitive market is well developed in NSW and Victoria and is developing in the other States. At present there is excess reserve capacity of power in the NSW, Western Australian and Victorian power systems, adequacy in the Queensland, Northern Territory and Tasmanian systems and a deficit in the South Australian system. Interconnection between the States is anticipated to be operational by 1999. At this point, all eastern States power generation facilities will be competing and 92% of Australian power generation will be in one market. A consequence of this is expected to be the evening out of reserve margins and the elimination of excess capacity.

The economics of small to medium power generation units will become more attractive as the above events unfold. In all likelihood, gas will be the fuel of choice because of low capital costs, deregulated gas markets leading to more competitive pricing and lower greenhouse gas emissions.

Expansion of hydro inputs to the grid is unlikely with few new sites available, excess water capacity being almost non-existent and competing demands further limiting availability. Nuclear power, while technologically feasible, does not appear to be on the political agenda. While this energy source is emission free, other issues such as waste disposal play a role in resistance within the Australian community to this option. This alternative is unlikely in the foreseeable future.

No renewable sources of energy have been harnessed to provide large scale energy at this stage but this might be possible by 2015. Wind energy and solar photovoltaics are possible sources but independent reviewers suggest that they are unlikely to contribute more than of 3 to 4% of total demand by 2015.

Additions to the generation system are, therefore, likely to be either coal or gas based.



- *New coal technologies*

Two new, high efficiency power station technologies have been developed. These have much lower greenhouse gas release than conventional plants and are now available commercially.

The first of these is pressurised fluidised bed combustion (PFBC). This technology burns coal in a fluidised bed furnace at high pressure. This results in significantly greater efficiency, consequent reduction in greenhouse gas release and capture of a high proportion of any sulfur compounds released from coal. Two commercial plant capacities are available, 70 and 350 MW. There are about five 70 MW plants around the world which have been in service for up to five years.

The other technology is that of integrated gasification combined cycle (IGCC). In this plant, coal is gasified at high pressure and the gas used to feed a conventional combined cycle unit. It also has considerably higher efficiency compared with conventional coal fired units and would result in a reduction of 25% in greenhouse gas release if adopted. This technology has the added advantage of much lower release of sulfur oxides, nitrogen oxides and particulates. There are three 250 MW IGCC demonstration power stations operating effectively in the US and the Netherlands.

- *Gas technology*

Competitive electricity markets have led, in other countries, to the selection of plant with the least capital cost. Generally, these have been gas or oil fired thermal units.

Most new gas turbines, operating on gas, can maintain better than 25 ppm NO<sub>x</sub> release. The next generation is targeting 10 ppm. This is most important as the main application of gas turbine technology is for combined cycle and cogeneration which tends to be in small and medium size units within an urban area to take advantage of available heat and/or steam needs of local industry. In Japan, half of natural gas sales are for cogeneration, mainly in gas engines, with commercial buildings using the waste heat for winter heating and summer air conditioning.

By comparison with many OECD countries, there is relatively little cogeneration in Australia. The Australian Gas Association (AGA, 1997) estimates that current installed cogeneration capacity in Australia is about 1,500 MW, not all of which

is operational. This represents about 4% of Australia's installed electrical capacity. There are currently at least five large combined cycle cogeneration plants under development or consideration in NSW, with total electrical capacity of 1,100 MW. The majority of these are to be located in urban areas.

New gas-fired generation has a number of environmental impacts. From the greenhouse perspective it is positive with emissions of CO<sub>2</sub> being lower.

From an air quality perspective the outcome may not be so positive. Assuming the projected capacity (1000 MW) is all base load, the contribution to Sydney region NO<sub>x</sub> emissions will be significant — an additional 14.9 t/day by 2015 or an approximate 40% increase in NO<sub>x</sub> from industrial sources. It is uncertain whether this growth will be compensated for by other sectors lowering NO<sub>x</sub> emissions.

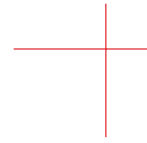
### **Building Industry**

This sector provides an unusual problem. Construction is a considerable point source for emissions (particularly particulates) during the construction phase, subsequently diminishing to minor contributory status. Life cycle assessment (LCA) is emerging as a method to evaluate the environmental burden associated with building. It embodies cradle to grave concepts and seeks to quantify materials, energy, emissions and their impacts with a view to improvement. Current market valuation however, is too insensitive to environmental impacts to reflect LCA considerations in production costs. Fragmentation of the construction industry and the lack of reliable data are also major impediments to its widespread introduction and use.

Reducing energy utilisation in industry aligns strongly with reducing emissions. Consequently, the embodied energy in commercial and other building should be a major parameter for any construction activity. Recycling and reuse of materials may have a profound effect on embodied energy and, in any event, should be encouraged due to the consequent lesser environmental burden.

### *Emissions*

Cement based products and systems are the principal building material worldwide. Australia produces 17 x 10<sup>6</sup> cubic metres of premixed concrete annually and nearly equal volumes of other cement based products such as tiles and bricks. Cement and lime industries contribute 60% of all building industry emissions and are the second largest source of particles in the Sydney region



after transport. EPA Victoria inventories show that non-metallic processing (glass, fibreglass, insulation, ceramics, brick, cement etc) contributes 80% of SO<sub>x</sub>, NO<sub>x</sub> and PM<sub>10</sub> in the Dandenong area (EPAV, 1996). For greater Sydney the contribution of SO<sub>x</sub> and NO<sub>x</sub> from this sector is calculated to be 2 and 7% respectively.

Cement kilns, in NSW, are generally coal fired and release SO<sub>x</sub> and NO<sub>x</sub> as combustion products. Older plants may see reduction of NO<sub>x</sub> emissions by more than 30% with improvements in combustion. Similar or greater possibilities exist in glass production. In general, however, NO<sub>x</sub> is not a major problem for LSS. SO<sub>x</sub> emission is an issue when coal is the fuel for cement manufacture but ambient levels are generally low in Australian airsheds and well below levels associated with physical damage to buildings.

#### *Remedial measures*

Lowering NO<sub>x</sub> emissions results from optimising combustion in kilns and furnaces. Low NO<sub>x</sub> firing technologies are available but not universally adopted. Energy saving incentives could have a major role in controls for small to medium plant. Using additives to reduce calcination temperatures and improve efficiency in cement manufacture may also play a part.

Many waste materials going to landfill may be safely disposed of as fuels in cement kilns. Waste products may also be used as raw material alternatives and blenders. For example fly ash, blast furnace slag, silica fume and red mud, when used, change or enhance cement properties as well as reduce total energy investment and emissions.

Specification of products with a “fit for purpose” strategy leads to alternatives, for instance hollow blocks, using less energy and primary materials. Extending the service life of facilities through selection of more durable products reduces stress on the environment and consequent emissions. Sustainable infrastructure development will be aided by the increased use of high performance construction materials which allow increased innovation in the design of structures, enhanced versatility, construction efficiency and improved service life performance.

The management of solid inorganic waste is desirable for environmental and economic reasons. Annual waste management markets in Australia are estimated at \$2.2 - \$3b and are growing at a rate of 20%. Whereas solid waste

recycle rates are as high as 60% in parts of Europe, Japan and the USA, landfill remains the primary repository of waste generated in Australia. To be internationally competitive, wastes arising from manufacturing and construction operations must be adequately disposed through recycle and reuse.

The demolition and refurbishment of buildings in Australia produces large amounts of waste material. In terms of the potential for increased air pollution, the consequence is evident if this material is not reused to advantage in new construction. More recently, increased costs of disposal, development of waste processing markets and promotion of environmental concern have contributed to focus attention on opportunities for recycling and reuse of building waste and to minimise or at least reduce solid waste from the construction industry.

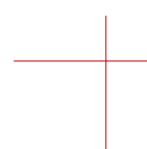
Flat wood panels are usually factory coated with fillers, sealants, primers, stains, basecoat and topcoats. Solvents in organic based coatings contain a range of volatile organic compounds; ketones, toluene, glycols etc. The use of water based coatings reduces the intensity of VOCs but emissions still contain glycols, propanol and butanol. The emission of VOCs occurs during the coating process and oven drying. All solvents not recovered represent potential emissions. Afterburners can be used to control VOC emissions and the recovered heat used elsewhere, but few plants use this form of control. Alternative plant location outside urban regions, such as the CSR plant at Oberon NSW, may be another strategy.

Information on environmental impacts promotes improved processes and reduced pollution. There is a significant need for training in the industry on environmental matters. Educating the public also has a role in improving practice.

## **Gas/Oil Industries**

### *Emissions*

Petroleum refineries are mostly located within or close to urban areas and are generally the largest stationary source of SO<sub>x</sub> emissions within those areas (Table 15). They contribute significantly to emissions of VOCs, NO<sub>x</sub>, particulates and, to a small extent, CO. Emissions result from reaction of refinery fuel gas, largely methane and ethane, fuel oil and natural gas in fuel heaters, boilers and process equipment. Other sources are flaring of gas, surges, filling and



**Table 15: Indicative oil refining emissions 1991-93**

City	Source	SO <sub>x</sub>		NO <sub>x</sub>		TSP		VOC	
		t/day	%total anthrop	t/day	%total anthrop	t/day	%total anthrop	t/day	%total anthrop
Sydney	Refining	21.7	36.6	16.9	6.0	2.9	5.0	21.4	4.7
	Fuel Storage							2.4	0.5
Melbourne	Refining	12.8	30	4.7	2.2	1.0	2.5	18.8	4.5
	Fuel Storage	-		-		-		4.2	1.0
Brisbane	Refining	19	33	3.5	1.8	2.0	3.0	21.0	10
	Fuel Storage	-		-		-		4.0	0.5

breathing of crude, intermediate and product storage tanks, emissions from catalytic cracking units, oil-water separators and cooling towers and fugitive emissions from leaking valves, flanges etc.

Sulfur emissions depend strongly on the mix of Far East and Middle East crudes and the sophistication of the sulfur recovery process used. Middle East crudes have a high sulfur content while most Far East crudes, including Australian, are low in sulfur. Most capital city airsheds are well below proposed ambient SO<sub>x</sub> standards.

Many factors are likely to affect changes in emissions from these sources until 2015. Refinery throughput is most strongly influenced by consumption of petrol and diesel fuels by motor vehicles including trucks and the fraction of those fuels that are provided by local refining as against net imports of refined products. There are capacity limits to existing refineries and major expansion is unlikely under present investment conditions.

### *Future influences and projections*

Motor vehicle fuel consumption can be expected to rise in proportion to vehicle kilometres travelled (VKT) with discounting for improvements in fleet averaged fuel consumption rates. VKT growth is expected to be much greater than population growth due to increasing vehicle ownership per capita and the steep rise in commercial/industrial transportation.

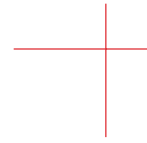
Emissions of VOCs, NO<sub>x</sub> and particulates can be expected to rise with refinery throughput and with secondary influences arising from changes of product mix, refinery expansion and government regulation. VOCs and particulate emissions will probably rise less than linearly as they depend more on refinery capacity than on throughput. Emissions of SO<sub>x</sub> will also rise with refinery throughput, but will be strongly influenced by the mix of domestic and foreign crudes and government regulation.

Oil industry projections for consumption growth in developed countries over the medium term are in the range 1-1.5% per annum. These are considerably below the inferences that can be drawn for Australia.

Falling output of domestic crude oil production is likely to result in a higher fraction of imported crudes being in the throughput of Australian refineries. Deregulation of the oil industry, now occurring, is likely to result in an increased proportion of the Australian market being supplied with a mix of Far East and Middle East crudes.

Taking all of the above factors into account and allowing for no further changes in government intervention, it is expected that throughput and emissions of NO<sub>x</sub> from refineries will grow by 1.3% pa in Adelaide, 1.8% pa in Sydney, Melbourne and Brisbane and 2.5% pa in Perth. Emissions of VOCs and TSP are expected to grow at half these rates due to only minor investment in new capacity. Rates of increases in SO<sub>x</sub> emissions are expected to be 50% higher than these due to increased use of imported crudes.

By 2015, additional control measures may be needed. Technologies currently available could be relied upon for the control of up to 50% of projected emissions. Costs may be high and incentives or regulatory measures will be required for such action to take place.



## Chemicals, Minerals and Metals

### *Emissions*

Lead is no longer a significant airshed issue but there remain localised causes for concern related to the handling, processing and recycling of lead concentrates and other products in a small number of locations. Airborne lead is mainly dust, arising from handling of concentrates, residues and scrap and fume arising from smelting processes.

Stationary point sources of SO<sub>x</sub> are associated with the processing and refining of metals obtained from sulfide ore. Some sulfuric acid plants use elemental sulfur as feedstock for specific markets. Most sources are not located in major urban areas aside from Kwinana, Risdon and Newcastle. Other main sources are at Mt Isa (610 kt/yr), Kalgoorlie (240 kt/yr) and Pt Pirie (53 kt/yr). These dwarf the emissions for Brisbane and Sydney (approx 20 kt/yr).

Small amounts of CO are produced by combustion for process heat in the minerals and metals industries. Local hotspots occur in the vicinity of metallurgical industries which employ carbon as a reducing agent, mainly aluminium and iron and steel. In aluminium production CO and CO<sub>2</sub> are by-products of electrolysis. Emissions from Kurri Kurri, Tomago, Boyne Island and Portland make very significant contributions to high localised values in the Hunter Valley and at Gladstone and Portland.

### *Future influences and projections*

Lead use will continue to be concentrated in lead acid batteries with secondary sources (currently 54% of western output) having an increasing share of output (ABARE, 1997b). In Australia, 90% of lead is recovered for reprocessing. The possibility of another battery manufacturer exists in Brisbane. Lead is not usually mined in its own right, most commonly being found with zinc and silver. As the supply/demand position changes there may arise the need to dispose of surplus lead production.

WMC have announced a sulfuric acid plant will be built at Mt Isa utilising SO<sub>2</sub> from the copper smelter. This together with the potential scaling down of lead activity, could lower SO<sub>x</sub> emissions by 80% or more. Projected new acid plant with the latest technology have much improved emissions performance.

Allowing for population growth and concomitant fuel usage, CO emissions in

major urban areas may increase around 30% to 2015. As CO and CO<sub>2</sub> are produced in association, any greenhouse measure taken will impact on CO. Closure of the Newcastle steelworks will have a significant effect on Hunter Valley CO emissions.

### *Remedial measures*

In most cases, the large point sources in this sector are readily identifiable. Relocation of smelting plant or the location of new plant to mine site or remote areas have been mooted. Upgrading existing plant and replacing older smelters with the latest technologies would have an appreciable effect on emissions. This is most likely as existing facilities reach the end of their economic life times.

Other measures might include the co-installation of acid plants, the scrubbing of off-gases and improving the capture of fugitive emissions from plant and handling/storage facilities. For industries such as aluminium, the development of non-consumable anodes would make an impact, as would alternatives for the provision of chemical and thermal energy currently fossil fuel derived.

The promotion of more efficient and complete combustion through improved maintenance and better burners in small to medium plant is also recommended.