

Nitrous oxides (NO_x) and Trigeneration: A health problem from an energy solution?

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An Introductory Thought

*In the period from 1992 to 2008, nitrous oxides emissions from industry in Sydney have increased by 51%. They are **projected to grow a further 13% over the next 8 years to 2016.** This scenario **DOES NOT** include any shifts in the location of electricity generation (such as cogeneration) which would exacerbate the challenge of reducing ozone levels.*

NSW OEH Nitrogen Oxide Policy for Cogeneration

The Agenda



- Trigeneration Systems

- The Advantages

- The Disadvantages

- Nitrous Oxides

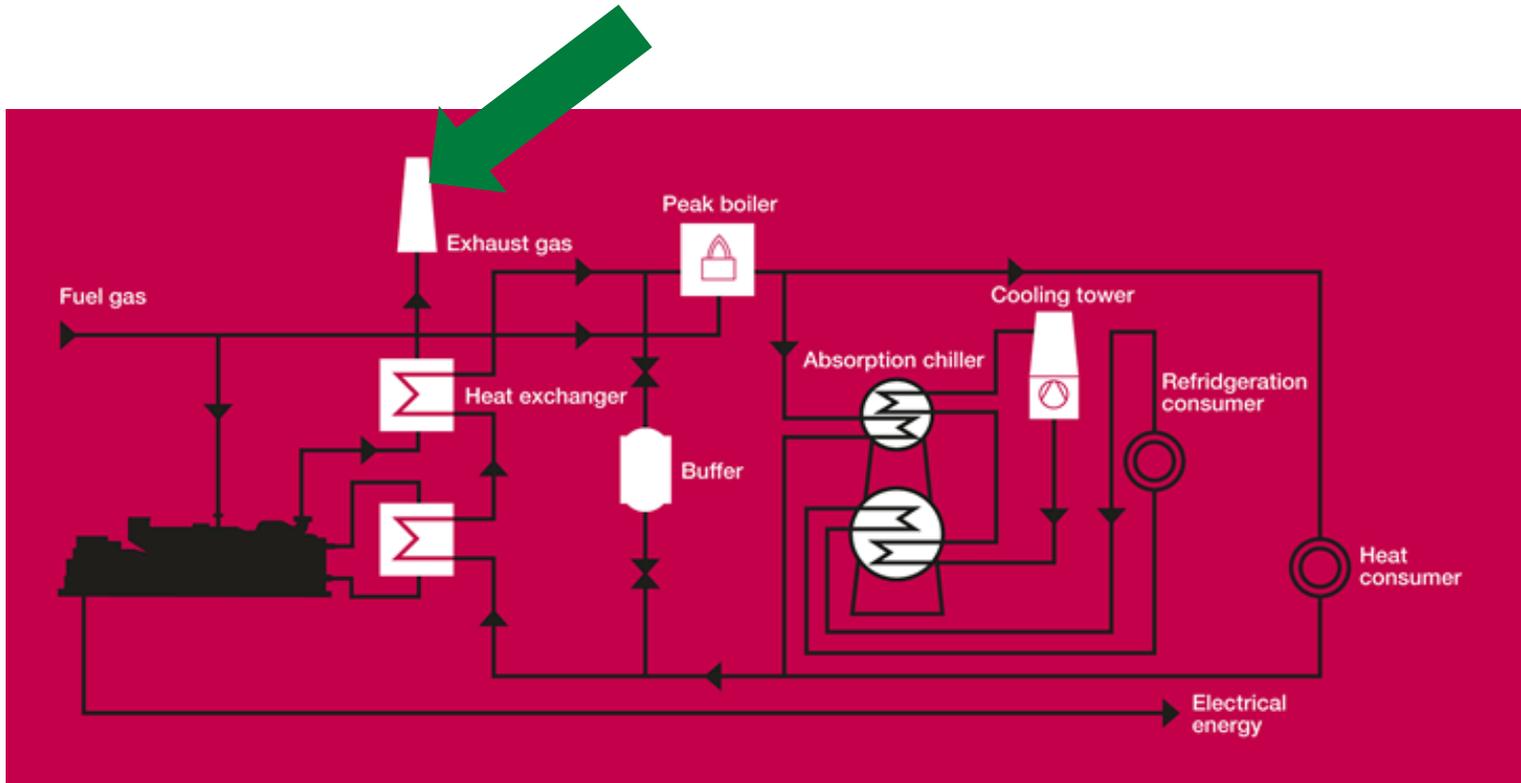
- Health Implications

- Current Standards

- Case Study

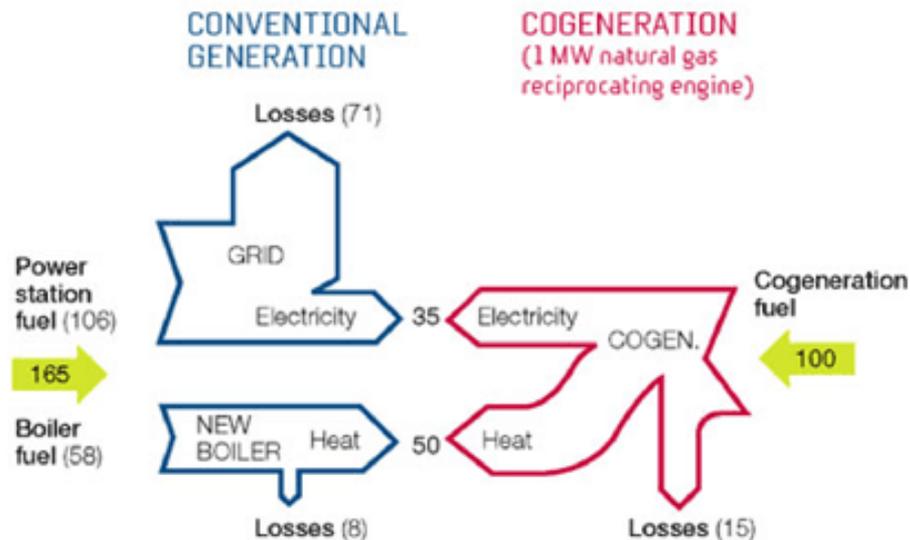
- A Need To Redirect Focus

Cogeneration and Trigeneration Systems



The Advantage of Cogen/Trigen

Energy Efficiency - Cogeneration will usually provide an overall energy conversion efficiency somewhere in the range of 70–75%, if all useable heat is recovered. This compares to the 25–30% conversion efficiency of a typical single-cycle centralised power station. (ResourceSmart Business, Sustainable Manufacturing, 2006)



The Disadvantage of Cogen/Trigen



Capital Cost



National electricity rules and an inefficient connection process



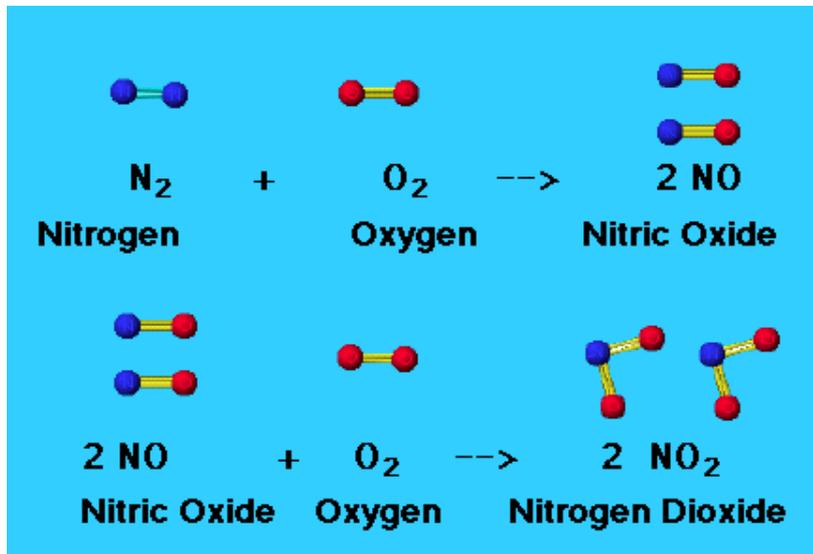
Emissions → Nitrous oxides (NO_x) and affect indoor environment quality and wellbeing

Nitrous Oxides (NO_x) and Nitrogen Dioxide



Refers to oxides NO converted to NO₂ (nitric oxide and nitrogen dioxide), produced from the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperatures.

By-product of cogeneration and trigeneration systems (exhaust) with levels further exacerbated in high traffic volumes



Health Implications

- Nitrogen dioxide is known to affect the throat and the lung. The main effects are emphysema and cellular damage which reduce the efficiency of breathing. In levels encountered in polluted air, people with respiratory problems, particularly infants, may be affected.
- The current standard limit for nitrogen dioxide is 0.12 parts per million (ppm) for one hour and 0.03ppm for one year (EPAV)



Health Implications (cont.)



- *Health effects*
Epidemiological studies have shown that symptoms of bronchitis in asthmatic children increase in association with long-term exposure to NO₂.
- Reduced lung function growth is also linked to NO₂ at concentrations measured (or observed) in cities of Europe and North America.
- Indoor air pollution → approximately 2 million premature deaths.
- Urban outdoor air pollution → approximately 1.3 million deaths.



Current Standards (Airborne)



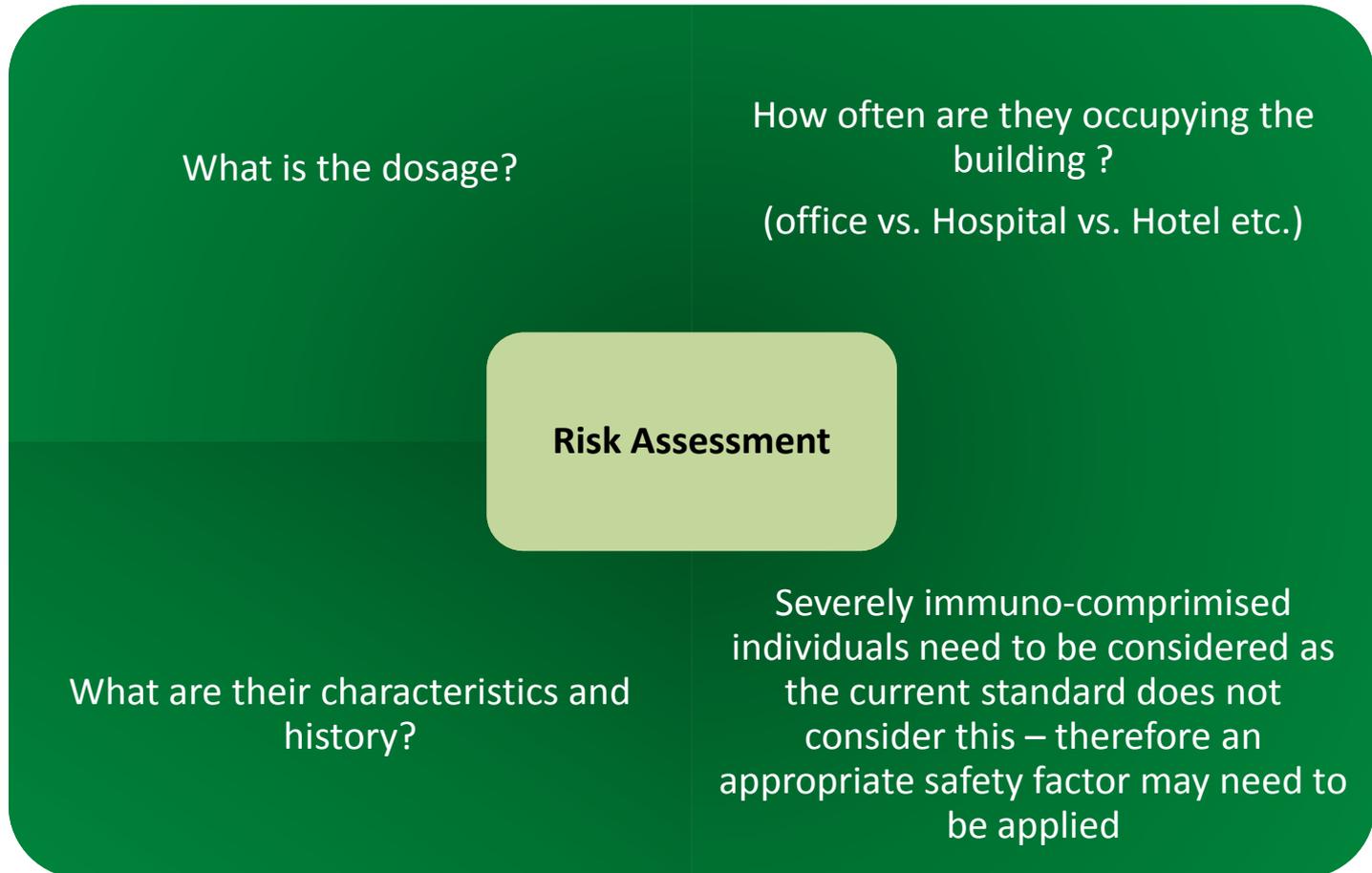
	Victorian Environmental Protection Agency	National Environment Protection Council Australia	Queensland Government (DERM)	US Environmental Protection Agency	European Guidelines (as set by the World Health Organisation)
Period of an hour	0.12ppm	0.12ppm	0.5 (healthy individuals)* 0.16 (children)	-	0.2 mg/m3 (~ 0.4ppm)
Period of a year (annual)	0.03ppm#	0.03ppm	-	0.053ppm	0.021 to 0.026ppm



**A safety factor of between three and four has been adopted here for normal children.
http://www.epa.vic.gov.au/air/issues/air_nox.asp*

Beyond the Standards

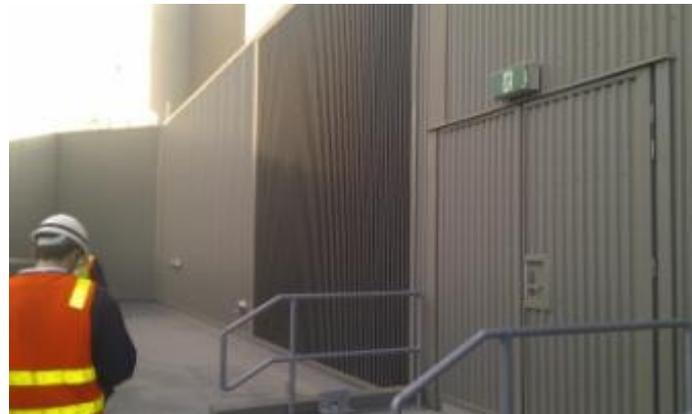
- Important to consider and risk assess the occupants



Case Study



- Wind tunnel modelling used to identify potential levels at air intakes and balconies of a major building after implementation of a trigeneration system
- Levels projected to be above EPAV guidelines, even not considering other emission sources (nearby traffic, diesel generators tested periodically etc.)
- A safety factor was applied to projected and validated results following a risk assessment of the occupants



Case Study (cont.)

Modelled One Minute Mean Maximum Concentration measured at specific air intakes. Units in parts per million of stack concentration.

Ranges:

All sources

10,000 – 50 ppm_v

Trigen (470C and 170C)

1,000 – 300 ppm_v

NO_x: 0.13 – 0.61 ppm

NO₂: 0.05 – 0.24 ppm (40% conversion)

Various stack heights modelled –
higher stacks ≠ more favourable results

Case Study (cont.)



- Tested under various wind conditions
- Handheld instantaneous readings AND measurements taken over a period of time using air sampling equipment. Included NO_x and NO_2 .
- Levels of NO_x up to 0.05ppm and levels of NO_2 up to 0.04ppm. Levels still above proposed limit despite other sources not considered.
- NO_x to NO_2 conversion at 80-90% (as opposed to 40% modelled, considered)
- Further testing considering cumulative effects of other emission sources still in progress



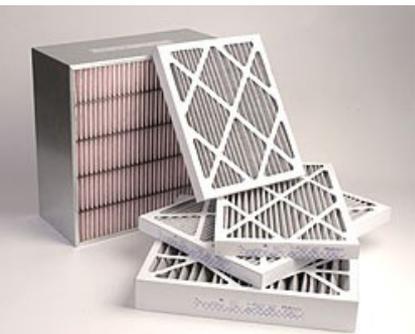
Conclusions and Implications

Projected modelled results were validated with air monitoring studies following construction

Recommendation to retrospectively install gaseous filtration at all affected air intakes (additional capital costs) and implement control measures for balcony use

Imperative to consider emission sources, environmental conditions, initial design specifications, occupant wellbeing, health implications, additional capital costs, and ongoing maintenance costs

Ongoing need for a holistic approach and more focus on indoor environment quality (IEQ)



Why focus on IEQ?

- People are the key concern, cost and function of buildings
- Energy 5%, People 85% of costs



Further Implications - Environment

How can building managers control emissions from their facility and the impact on the overall pollution to the city?



“...widespread development of CHP projects (Cogen/Trigen) would essentially relocate the source of some of the NO_x emissions produced by the power generating sector from a few, very large point sources outside the city to many, small point sources inside the city. Implementation of CHP changes both the amount AND geographical distribution of NO_x emissions...”

For additional information please do not
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