

Health effects of Woodsmoke Pollution

PM2.5 are most closely linked to premature mortality

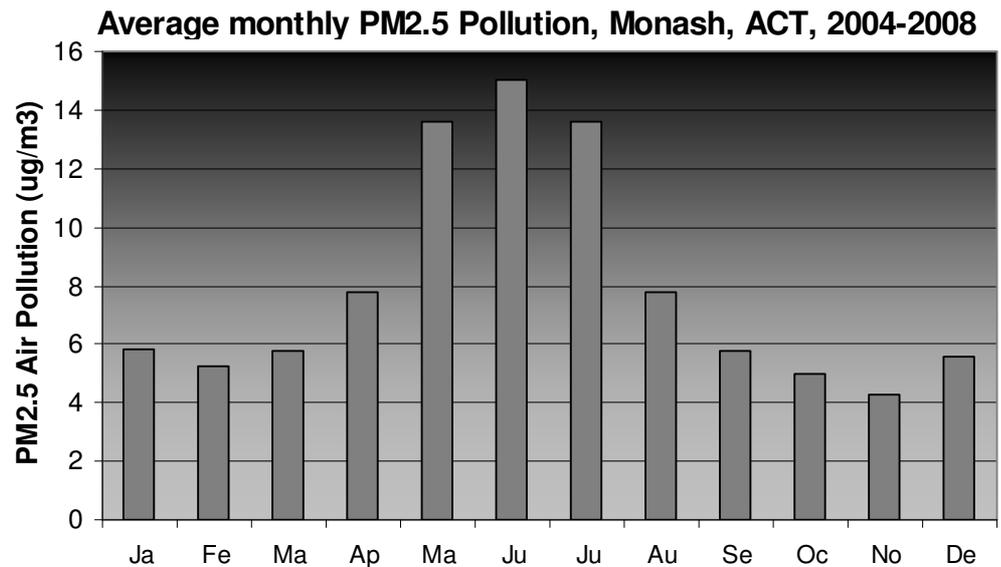
The pollutant of most concern (the one most closely linked to premature mortality and other health problems) is PM2.5 - fine particles less than 2.5 millionths of a metre, that penetrate into the deepest recesses of our lungs where they cause inflammation, leading to heart and lung diseases. PM2.5 are so tiny they behave like gases, entering houses even when all doors and windows are shut. The only way to keep them out is to make the house airtight – but then people would die from lack of oxygen.

A review published in 2007 by the UK Committee on the Medical Effects of Air Pollutants “suggests that air pollution has a greater effect on mortality in the UK than previously thought, with a 10 µg m⁻³ increase in fine particles being associated with a 6% increase in risk of death from all-causes.”[1] A review in 2008 by for California Air Board, taking account of new spatial analysis methods to estimate the effects of PM2.5 pollution, concluded that the effect on health was even greater – a 10 µg m⁻³ increase in PM2.5 being associated with 10% increased mortality.[2]

Canberra

The graph of monthly average pollution levels at Monash (calculated from daily PM2.5 measurements provided by David Power of ACT Environment) shows much higher pollution during the winter months – averaging 5.3 µg m⁻³ higher than October-March. National Pollutant Inventory data do not yet cover domestic PM2.5 emissions, but show that woodheaters emit

67% of Canberra’s 950 tonnes PM10 pollution (i.e. 640 tonnes from wood heaters, and consequently 640 tonnes of PM2.5 because woodsmoke particles are almost all less than 2.5 microns). These facts suggest that wood heaters in Canberra are increase death rates by 5.3% during April to October, or about 2.6% over the entire year.

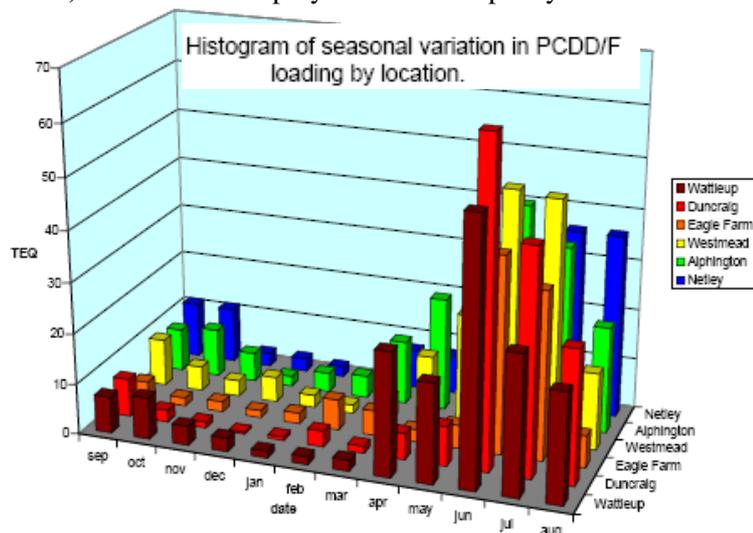


Sydney

In 2006, Chief health officer Denise Robinson told a public inquiry at Parliament House that between 600 and 1400 deaths every year could be attributed at least partly to Sydney’s foul air. Total estimated health costs of PM pollution in Sydney exceed \$3.3 billion (see <http://www.environment.nsw.gov.au/resources/aqms/airpollution05623.pdf>). The DECC air emissions inventory (see appendix) shows that wood heaters the largest single source of health-hazardous PM2.5 pollution (4503 tonnes per year) - 34% of all PM2.5 emissions in Sydney, compared to 6.4% for light duty diesels, 6.1% for petrol cars and 5.2% for heavy duty diesels. With total estimated health costs exceeding \$3.3 billion, the 34% from woodheaters has estimated health costs of more than \$1 billion.

Air toxics: PCDDs, PCDFs and polychlorinated biphenyls (PCBs)

Polychlorinated dibenzo dioxins (PCDDs) and furans (PCDFs) and dioxin-like polychlorinated biphenyls (PCBs), are amongst the most toxic pollutants known. A 12-month study of 6 locations in Australia covering industrial and residential sites, showed that levels of these harmful pollutants were close to zero, except when wood heaters were in use, when concentrations were up to 10 times higher than the non-heating season (see graph, right from Gras et al. http://www.cmar.csiro.au/e-print/open/gras_2005a.pdf).



Dublin banned smoky home heating - 2,000 fewer deaths over 6 years

The health effects of air pollution are real. When one study of air pollution, involving six cities, was followed up, PM2.5 had dropped substantially in one

city, moderately in another, remaining stable elsewhere. Death rates fell in the first two cities relative to the other four. Dublin reduced PM2.5 pollution by banning non-smokeless coal in September 1990. There were 15.5% fewer respiratory and 10.3% fewer cardiovascular deaths in the 6 years after the ban, compared with the previous 6 years – a total of 696 fewer respiratory and 1458 cardiovascular deaths in the first 6 years of the ban[3]. Having experienced the health benefits, it is hard to imagine Dubliners would want to go back to the smoky old days.

Montreal: new wood heaters banned from 28 April 2009

Like Dublin, other cities are solving their air pollution problems. Montreal has freezing cold winters. Daily minimum temperatures average -13C in January; daily maxima average -5C. Despite the cold climate, installation of all new wood stoves was banned from 28 April 2009, to protect people's health.

<http://www.montrealgazette.com/Technology/Wood+stove+passes/1543628/story.html>

Montreal had 45 days with PM2.5 levels exceeding the standard in the winter months from November 2008 to March 2009. According to the Lung Association of Quebec, 61% of fine (PM2.5) particles are emitted by wood heating, compared to 22% from industries and 14% from transportation. PM2.5 cause an estimated 6,028 cases of infantile bronchitis, 40,449 days of asthma symptoms and 1,540 premature deaths in Montreal

http://www.pq.lung.ca/environment-environnement/wood_smoke-fumee_bois/enjeu-montreal/

New Zealand

NZ also suffers from woodsmoke pollution. Measured pollution was used as input to a cost-benefit analysis (<http://www.hapinz.org.nz/>) which concluded that woodheaters in Christchurch (pop 333,000) cause 124 premature deaths, with estimated total cost of NZ\$127 million per year, about \$2,700 per heater per year.

NZ has strict policies to control woodsmoke, e.g. in Otago, only appliances rated less than 0.7 g/kg (i.e. emitting no more than a pellet stove) can be installed and appliances with PM10 discharge standards of 1.5g/kg and higher will be prohibited from use from 1 January 2012

<http://www.orc.govt.nz/Portal.asp?contentid=1242&nextscreenid=201.102.103.101&categoryid=20&screenid=201.102.101.101&sessionx=384EE7A8-D570-400A-89B4-BA61A920F08B>

California and Launceston

California's Healthy Hearths Program (http://www.aqmd.gov/healthyhearths/Why_HH.htm) bans all wood burning devices in new buildings and also bans the use of all wood burning devices whenever PM2.5 pollution is forecast to exceed the air quality standard. Launceston, Tas, also suffers from woodsmoke pollution. After a community survey, Launceston's Strategic Plan 2008-2013 was formulated. As well as seeking further funding for the woodheater buyback program, it sets a target to "Evaluate the introduction of a by-law that prevents the installation of wood heaters in homes" by 2011 (Strategy 1.1 of Priority 1, <http://www.launceston.tas.gov.au/content/view/164/365/>)

New heaters in Australia fail to deliver reduced pollution

A study published in May 2008 found that real-life emissions of heaters in Launceston satisfying current Australian Standards averaged 9.4 g/kg – about 3 times higher than their AS4013 ratings.[4] Launceston's extensive education program included 2 full time smoke patrol officers and 2 part time "work for the dole" assistants. During a visit in 2006, I was very impressed by the lack of smoking chimneys, perhaps 1 there for every 50 in Armidale.

Everyone in Launceston seemed to understand the health effects of woodsmoke, so households who volunteered for the emissions study would most likely operate their heaters correctly. Indeed, the study notes: "there was no evidence that overloading occurred. Nor was there any evidence that woodheaters were allowed to smoulder overnight; in contrast they appeared to be refuelled periodically throughout".[5]

Many new heaters in Australia are incorrectly operated and so much more polluting. But even if we could afford a woodsmoke education and smoke patrol program similar to Launceston, a new heater burning an average of 4 tonnes of wood would still emit 38 kg PM2.5, as much health-hazardous PM2.5 pollution as driving 250 passenger cars 15,000 km, i.e. a total of 3.8 million km. Most of the 3.8 million km would be driven on open roads away from populated areas, so cause little damage to human health. But when the same amount of pollution is emitted by a single wood heater in a residential area, the toxic pollution is aimed at downwind neighbours. As noted earlier, PM2.5 are so tiny they behave like gases and enter houses even when all doors and windows are shut. The only way to keep them out is to make houses airtight, but then the occupants would die from lack of oxygen.

No doubt because of the failure of new heaters to live up to expectation, cities such as Christchurch, Montreal and Launceston have all decided that they must protect the health of their residents by banning the installation of new heaters. California's Healthy Hearths Program) bans all wood burning devices in new buildings and also bans the use of all wood burning devices whenever PM2.5 pollution is forecast to exceed the air quality standard. Sydney councils that ban new woodheaters include Waverley and Pittwater, with bans also in Manooka Valley, new developments in Holroyd, as well as western Sydney's Growth Centres - Oran Park and Turner Road.

No 'safe level'

Even though the air quality NEPM (National Environment Protection Measure) set an advisory reporting standard of 25 ug/m³ (maximum daily average) and 8 ug/m³ (annual average), calling it a "standard" is misleading because there is no known "safe" level below which adverse health effects are not experienced. The NEPC acknowledged that even when the advisory "standards" are met, more than 1,000 Australians will still die prematurely from PM_{2.5} pollution.

Most Australians value their health, but despite attempts at education, people seem to have little understanding of the effect of polluted air. For example, most people know that tobacco smoke causes heart disease, but, despite the fact that woodsmoke and tobacco smoke contain the same and very similar chemicals, toxins and carcinogens, few people seem to understand that reducing PM_{2.5} pollution lowers the risk of heart disease. Scientists now understand the mechanism – that the inflammation caused by PM_{2.5} in the deepest recesses of the lungs spills over into the bloodstream, explaining why 1458 fewer Dubliners died from heart disease in the first 6 years of the ban on non-smokeless fuels.

Similarly, few people here appreciate that exposure to woodsmoke reduces the ability of the lungs to fight infection, as demonstrated in the lab experiments that exposed 3 similar groups of mice either to clean air, oil furnace fumes or wood smoke for 6 hours, after which they were challenged by a flu bug. After 2 weeks, 5% of the mice in the control group exposed to air and bacteria had died, along with a similar percentage of the mice breathing the oil fumes. But 21% of the wood-smoked mice were felled.[6]

Colds and flu are common winter ailments. Few people seem to realise that without woodsmoke, we'd be less likely to become infected when exposed to respiratory bugs, decreasing the number of sick people in the city, and reducing the risk of other spreading these illnesses, on high and low pollution days. How many people would want to continue using woodheaters if they knew the truth about the increased risks of heart and respiratory diseases, mouth throat and lung cancers, cot deaths, middle ear infections and genetic damage in babies from PAH exposure?

The (leaked) NSW Government Action for Air 2009 states: "Together with the Growth Centres Commission, DECC has investigated measures to manage installation of woodheaters in new land release areas to prevent further pollution or disturbance of amenity of nearby residents. As a result, development control plans (DCP) for the first two precincts in the Growth Centres - Oran Park and Turner Road in Western Sydney - prohibit open fireplaces and slow combustion stoves." DECC also advises against installing woodheaters on steep hills and in the bottom of valleys – terrain that covers a large part of Armidale.

DECC's advice could be a cheap and effective way forward for urban areas. New houses should be designed on environmentally friendly principles, with adequate insulation and living areas with at least some winter sun. Heating bills of well-designed houses should be 70% lower than a typical uninsulated weatherboard house. Many cities enjoy mild sunny days in winter, when a passive solar house would need little or no additional heating. Our average daily winter maximum is a far cry from Montreal's -5 C, yet health concerns in Montreal were deemed so important that all new wood heaters have been banned.

Our efforts to reduce pollution are being offset by the installation of new heaters that, in real-life tests, are almost as polluting as older models. Responding to woodsmoke complaints costs Council time and money.

Encourage local industry – switch to pellet heaters



Pellet Heaters Tasmania advertises they can "Heat a typical home for around \$20 per week. (consumption estimate based on an average of 2 bags per week for 25 weeks per winter)" Pellets are made locally

<http://www.pftas.com.au/pages/pellet.html> . Rather than driving people away, permitting only pellet heaters in new housing would stimulate new local industry and make new developments less smoky, so that people who are affected by

woodsmoke would not have to move out of town and increase global warming by driving long distances to get to work.



Sources of information

1. COMEAP, *Long-Term Exposure to Air Pollution: Effect on Mortality A report by the Committee on the Medical Effects of Air Pollutants (COMEAP) (available at: <http://www.advisorybodies.doh.gov.uk/comeap/statementsreports/longtermeffectsmort2007.htm>)*. 2007.
2. Tran, H.T., et al., *Methodology for Estimating Premature Deaths Associated with Long-term Exposures to Fine Airborne Particulate Matter in California*. 2008, California Environmental Protection Agency, Air Resources Board.
3. Clancy, L., et al., *Effect of air-pollution control on death rates in Dublin, Ireland: an intervention study*. *Lancet*, 2002. **360**(9341): p. 1210-4.

- CSIRO, "Measurement of real-world PM10 emission factors and emission profiles from woodheaters by in situ source monitoring and atmospheric verification methods". 2008, CSIRO Atmospheric Research, May 2008, available at <http://www.environment.gov.au/atmosphere/airquality/publications/emission-factor.html>.
- Meyer, C.P.M., et al., *Measurement of real-world PM10 emission factors and emission profiles from woodheaters by in situ source monitoring and atmospheric verification methods*. 2008, CSIRO Marine and Atmospheric Research (CMAR), (available at: <http://www.environment.gov.au/atmosphere/airquality/publications/emission-factor.html>).
- Stone, R., *Environmental toxicants under scrutiny at Baltimore meeting. (March 1995 Society of Toxicology conference)*. Science, 1995. **March 24**, v267 n5205 p1770(2).

Appendix – DECC Emissions Inventory on PM2.5 pollution in Sydney.

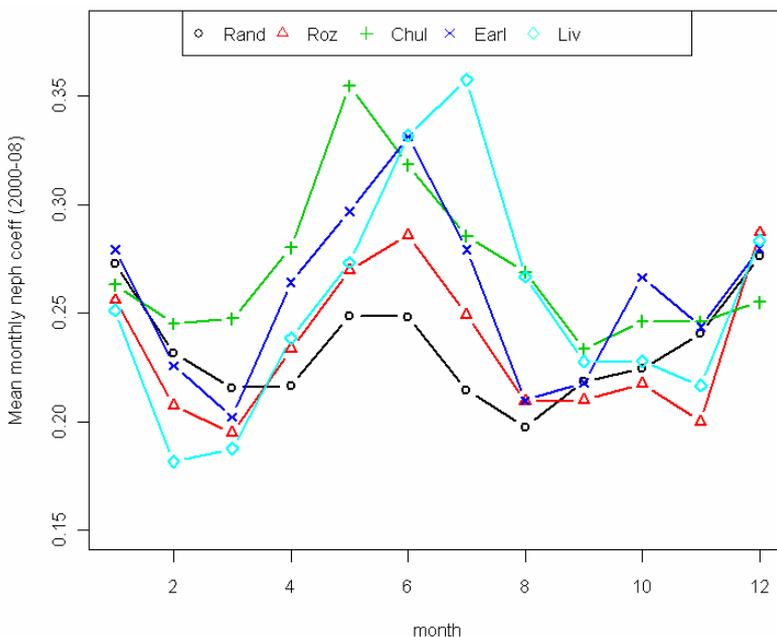
Only a small proportion of households use woodheaters in Sydney’s a much milder climate, yet they are still the largest single source of health-hazardous PM2.5 pollution (4503 tonnes per year) - 34% of all PM2.5 emissions, compared to 6.4% for light duty diesels, 6.1% for petrol cars and 5.2% for heavy duty diesels. PM2.5 measurements are not yet available on the DECC’s website, but nephelometer coefficients are highly correlated with PM2.5. In fact the study of air pollution and premature mortality in Sydney [7] showed that nephelometer coefficients were the pollution measurement most closely related to premature mortality and the only one to remain significant in the multi-pollutant models.

Confirming the results of DECC’s air emissions inventory, graphs of monthly average neph coefficients for Randwick, Rozelle, Chullora, Earlwood and Liverpool all peak in winter. However, the peaks (0.35, compared to about 0.25 in non-heating months) are much smaller than cities such as Canberra and Armidale, where a higher proportion of households use woodheating.

With total estimated health costs of PM pollution in Sydney exceeding \$3.3 billion, the 34% from woodheaters has estimated health costs of more than \$1 billion. With attractive non-polluting alternatives available (pictures from Montreal overleaf) – how can we justify health-hazardous polluting woodheaters in urban areas?

Table ES10 Ten largest anthropogenic sources of particulate matter < 2.5 µm

Source Group	Source Type	Particulate Matter < 2.5 µm		
		Annual Emissions (tonnes/year)	Proportion of Annual Anthropogenic Emissions (%)	Cumulative (%)
Sydney				
Domestic-Commercial	Solid Fuel Combustion	4,503	34.3	34.3
Off-Road Mobile	Industrial Off-Road Vehicles and Equipment	1,152	8.78	43.1
On-Road Mobile	Exhaust Emissions Light Duty - Diesel	840	6.40	49.5
Industrial	Crushing, grinding or separating works	807	6.15	55.6
On-Road Mobile	Exhaust Emissions Passenger Cars - Petrol	797	6.08	61.7
On-Road Mobile	Exhaust Emissions Heavy Duty Commercial - Diesel	681	5.19	66.9
Industrial	Ceramics production (excluding glass)	606	4.62	71.5
Industrial	Other land-based extraction	418	3.18	74.7
Commercial	Poultry Farming (Meat)	237	1.81	76.5
Industrial	Petroleum refining	237	1.80	78.3
All	Other	2,848	21.7	100.0



Comparison of monthly average neph coefficients in Armidale, Liverpool and all Sydney

As outlined in Robinson et al. (reference [3]), current research shows a 6-10% increase in mortality per 10 ug/m³ of PM_{2.5} exposure, suggesting that Armidale can expect 12-18 premature deaths from heart and respiratory diseases, mouth, throat and lung cancers.

Problems with new heaters in Australia

Few prospective purchasers realise that a brand-new woodheater can put out as much health-hazardous PM_{2.5} pollution as driving 3.8 million km, or about 250 years worth of driving. This problem was created by a reluctance to set and enforce appropriate standards. The failings were revealed in an audit of retail models in 2003, when 58% of the models tested failed the Australian Standards AS4013 test. In fact, there was no relationship between claimed and actual emissions.

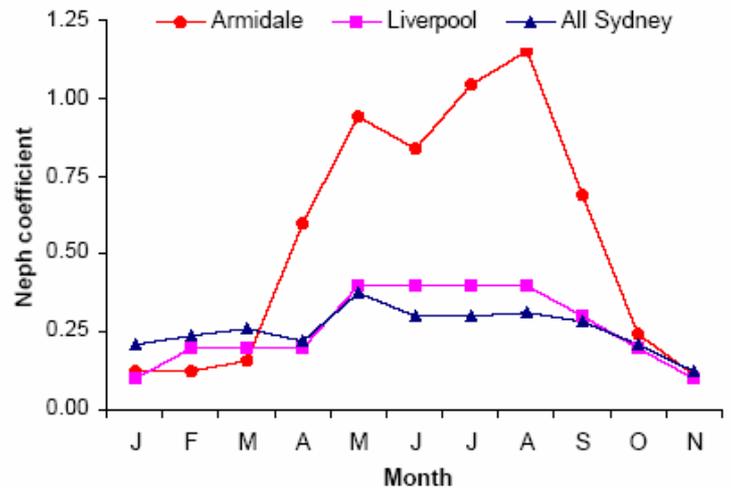
Todd (2007) commented: “Seven of the twelve heaters tested in the laboratory (58%) exceeded the 4g/kg emission limit. Average emission factors were 385% higher than the certified values and one model was almost 1000% above its certified value. The names of the heater models failing the audit have not been released to the public and there has been no recall of heaters ...

“While some (voluntary) auditing has taken place since 2003 in Australia the results remain confidential, so Australian consumers have no independent confirmation that the situation now is better or worse than it was five years ago” Todd (2008) added: “The author was involved in a research program in 2005 that required purchase of four woodheaters. Laboratory tests showed that three of the four did not meet the emission standard. Thus, two years after the national audits there was still significant retail model non-compliance”

An equally serious problem is that the Australian Standards AS4013 test does not reflect the way people operate their heaters. Attempts were made to change the test procedure, but as explained by Todd (2007) “It is Standards’ policy that any of the major stakeholders (such as industry or community representatives) can veto changes in the standard. This makes substantive change difficult to achieve, for example changes to methods that might involve additional costs to industry.” At the most recent Standards Australia meeting in Melbourne in March 2007, the majority of delegates wished to halve the limit from 4 g/kg to 2 g/kg, but this did not happen because it was vetoed by the AHHA, representing wood heater manufacturers.”

The table below (from Todd, 2008) reports estimated health costs of thousands of dollars per year for every new heater installed in urban areas. Voluntary audits have failed to protect people’s health. Manufacturers whose product does not meet the standard can simply ignore the audits. It is not in the public interest for new heaters with estimated health costs shown in the table to continue to be sold. The only realistic solution is a moratorium on the sale of new heaters until a new health-based standard (e.g. real-life emissions of 0.7 grams/hour) is developed and legislation is in place to ensure all new heaters meet this standard. There are even stricter policies in NZ, in areas NZ affected by woodsmoke, e.g. in Otago, heaters emitting more than 1.5 g/kg will be prohibited from use from 1 January 2012. Sadly, models similar to the ones that must be removed in Otago continue to be sold in Australia. As well as a moratorium to stop this unacceptable situation, considerable time, effort and funding will be needed to solve the problem of the large number of new and old heaters currently in use that have excessive emissions.

Examples of studies attributing annual health costs to particulate air pollution (this is not a comprehensive list) The right hand column assumes each woodheater burns 3 tonnes of wood year, emitting 30kg of particulates (from Todd, 2008).

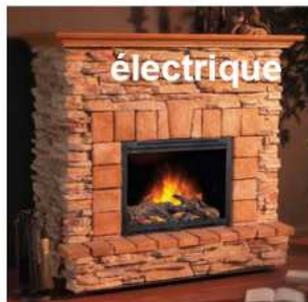


Source	Health cost per tonne of PM10	Health cost per woodheater
Todd (2006)	\$14,626	\$439
BDA-Group (2006)	\$80,211	\$2,406
Syneca (cited in BDA Group 2006)	\$78,163	\$2,345
Nolan-ITU (cited in BDA Group 2006)	\$18,500	\$555
Beer (cited in BDA Group 2006)	\$147,400	\$4,422
Kahn cited in Robinson (2003)	na.	\$1,800-\$7,300

Additional source of information – woodheater standards and emissions testing

Todd, J., *Regulation of residential woodsmoke in Australia*. Clean Air and Environmental Quality, 2007. 41: p. (3),15-18.

Attractive alternatives promoted in Montreal



Mars 2009

Montréal 