

Woodheater-Car Comparison

Many people think that cars are the worst pollutants. Sydney has lots of cars but few woodheaters, so we'd expect all the passenger cars in Sydney to produce more total pollution than the small number of woodheaters. PM2.5 are now considered the most health-hazardous air pollutant, responsible for about 10 to 20 times as many premature deaths as the next worst pollutant, ozone.

New diesel cars must satisfy [strict Euro 5/6 pollution standards](#), which require a new car, 4WD or SUV travelling 20,000 km to year to emit less than 0.1 kg of PM2.5. In contrast, the NSW EPA estimates that a new wood heater will emit 9.8 kg of health-hazardous PM.25 per year. **Thus a brand new AS4013 heater emits as many PM2.5 in 10 hours as a new car does in an entire year and a heater burning 2 tonnes of firewood will emit 19.6 kg of PM2.5, as much as 196 diesels and [1000 petrol cars](#)!**

A total of 5457 tonnes of PM2.5 per year in Sydney are emitted by Sydney's woodheaters, compared to a total of 135 tonnes from the exhausts of all petrol vehicles, 813 from diesel vehicle exhausts and 597 tons from road, brake and tyre wear. This means that the average woodheater more PM2.5 pollution than several hundred passenger cars.

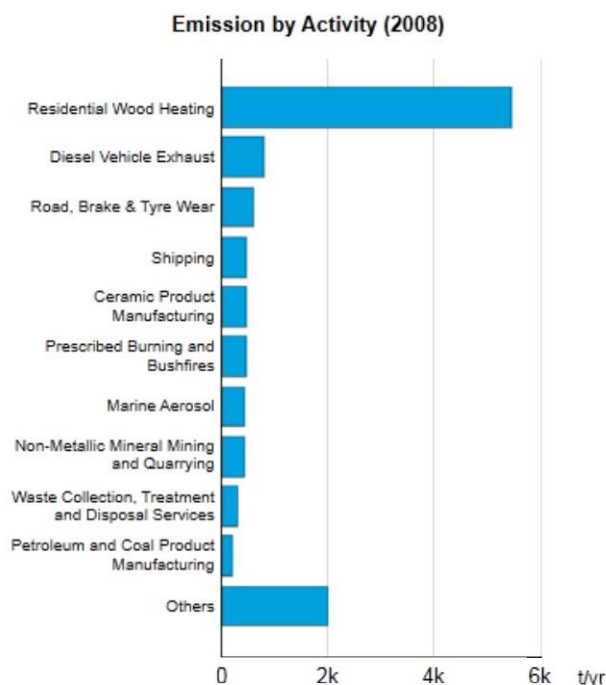
Sydney has lots of cars. Armidale has lots of woodheaters. The graph below compares monthly average PM2.5 nephelometer measurements, recorded by the NSW EPA in Armidale in 1996 and Sydney in 1999. When woodheaters are not in use, Armidale has cleaner air. But as soon as the woodheating season starts, Armidale's pollution rises dramatically, with only a small rise in Sydney where only 4.3% of households use wood as the main form of heating. This again shows that the average woodheater emits a lot more health-hazardous PM2.5 pollution than the average car and that the only way for Armidale to have wintertime air that is as clean and healthy as in Sydney is for residents to use non-polluting heating.

The [NSW Air Emissions Community Web tool](#) (image, below) shows that residential wood heating is responsible for more PM2.5 emissions in Sydney that all other sources combined

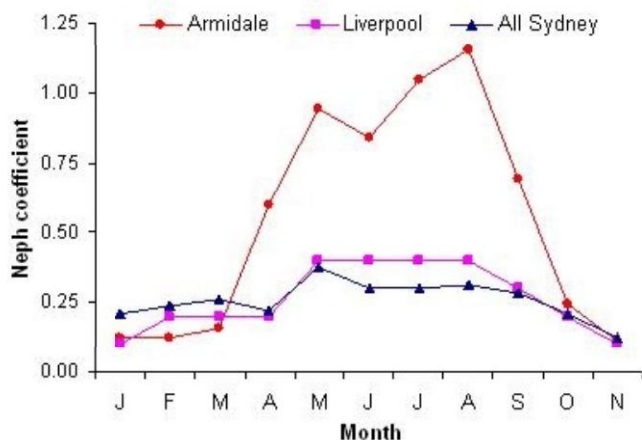
Region: Sydney
 Substance: PM2.5
 Sector: (All)
 Unit: tonnes per year

Menu

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This is despite being used as the main form of heating by only 4.3% of households, [ABS data showing the main for of energy used for space heating for 2008](#), the year the most recent Emissions Inventory was compiled.



Prof John Todd’s article in “Clean Air and Environmental Quality” notes that there has been “*only marginal improvement over the past 15 years*” in woodheater emissions. Emissions from new cars have also improved. A new car driving 15,000 km per year emits about 150 g of PM2.5. With average fuel consumption of 2 tonnes per year (Sydney) or 4 tonnes (Armidale), **a new woodheater will emit 133 times (Sydney) or 267 times (Armidale) as much health-hazardous PM2.5 pollution as the average new car driving 15,000 km per year.**

Woodheaters also emit more greenhouse gases than other forms of heating. Many councils offer subsidies to replace woodheaters with non-polluting heating. Woodheater owners who are concerned about their health or the environment should remember the advice of the NSW DECC “***If you can see or smell smoke from your wood heater then you are causing a problem for yourself, your family and your neighbors***” and consider taking up this offer.

Proportion of PM2.5 emissions (the most health-hazardous air pollutant) emitted by residential wood heaters (purple line joining the triangles) in Sydney by month. This [graph from NSW EPA website](#), is from their emissions inventory which shows that more than half of all man-made PM2.5 emissions are from the small proportion of households using wood heaters. ABS statistics show that only 5% of Sydney households use wood as the main form of heating.

Table 3.8 MAIN SOURCE OF ENERGY USED IN SPACE HEATING–2008

	NSW	Vic.	Qld	SA	WA	Tas.
	CAPITAL CITY					
Number ('000)						
Electricity	788.5	252.8	299.7	225.1	192.8	62.3
Mains gas	274.0	1,090.7	6.2	163.6	258.4	0.6
LPG/bottled gas	33.2			3.5	2.0	1.6
Wood	70.7	38.0	22.7	25.0	46.3	12.1
Oil	4.8			6.5	3.3	1.8
Other	16.6	23.7	2.7	8.9	8.4	1.2
No heater used	454.9	42.9	406.1	46.4	113.0	4.7
Total	1,642.7	1,456.2	742.5	479.1	624.3	84.3
Proportion (%)						
Electricity	48.0	17.4	40.4	47.0	30.9	73.9
Mains gas	16.7	74.9	0.8	34.1	41.4	0.7
LPG/bottled gas	2.0			0.7	0.3	1.9
Wood	4.3	2.6	3.1	5.2	7.4	14.3
Oil	0.3			1.4	0.5	2.2
Other	1.0	1.6	0.4	1.9	1.4	1.4
No heater used	27.7	2.9	54.7	9.7	18.1	5.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

Other Air Toxics

The table below compares all major pollutants and air toxics emitted by the average petrol-fuelled passenger car and the average woodheater, according to the NSW EPA Emissions Inventories for **2008** and **2003**.

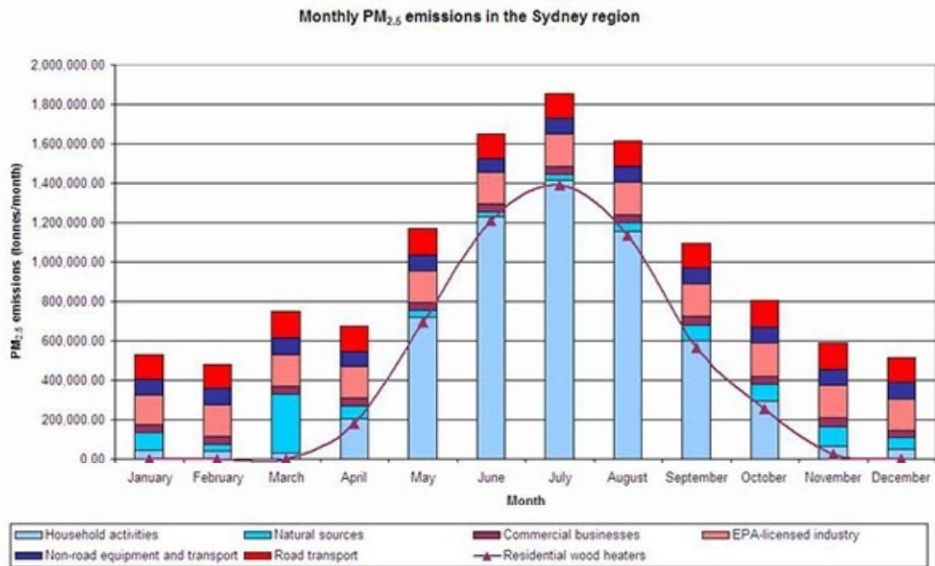
Exhaust emissions from petrol-fuelled passenger cars in Sydney have fallen from 797 tonnes PM2.5 per year, to 88 tonnes, with substantial reductions in all major pollutants. In contrast, wood heater emissions have increased from 4503 tonnes to 7359 tonnes, almost 10 times more than all the petrol-fuelled passenger cars in Sydney.

This is despite the fact ABS estimates show a decline in the proportion of households using wood as the main form of heating in NSW (from 11.8% 2002 to 10.3% in 2008).

Because of the big reduction in emissions per vehicle (from 0.44 kg per year to 0.05 kg), a heavily used wood heater in Sydney can emit over 1,000 times as much PM2.5 (the most health-hazardous pollutant) as the average petrol-fuelled passenger car. In general, woodheaters emit more toxic pollutants – about 44 times as many PAH as the average car, 12 times as much benzene and other VOC (volatile organic compounds) and 66 times as much formaldehyde.

Comparison of air pollution emissions from woodheaters and petrol-fuelled passenger cars in Sydney in 2008 and 2003

2008 Emissions - Sydney <u>Ambient AQ NEPM</u>	Cars		Woodheaters		Ratio <u>woodheater/car</u>
	<u>t/yr</u>	<u>kg/vehicle</u>	<u>t/yr</u>	<u>kg/heater</u>	
PM2.5	88	0.05	5457	51.43	1059.66
VOC (ozone precursor)	7789	4.30	5952	56.10	13.04
CO	75067	41.45	40034	377.32	9.10



NO _x	21575	11.91	601	5.66	0.48
SO ₂	144	0.08	96	0.90	11.38
Air toxics NEPM	t/yr	g/vehicle	t/yr	g/heater	woodheater/car
Benzene	382	211	274	2582	12.2
Toluene	712	393	76	716	1.8
Formaldehyde	117	65	454	4279	66.2
Xylene	589	325	42	396	1.2
PAH	39	22	100	943	43.8

For both tables, emissions per vehicle and per wood heater were calculated by dividing total emissions (NSW DECC Emissions Inventory, Tables ES4 in the domestic-commercial and on-road emissions in the 2008 inventory, ES4 and and ES1.4 in the 2003 inventory) by the number of woodheaters (106,100) and passenger cars (1.811 million in 2007) in Sydney.

2003 Emissions - Sydney Ambient AQ NEPM	Cars		Woodheaters		Ratio woodheater/car
	t/yr	kg/vehicle	t/yr	kg/heater	
PM _{2.5}	797	0.44	4503	42.44	96.39
VOC (ozone precursor)	26066	14.39	9524	89.76	6.24
CO	323953	178.88	27889	262.86	1.47
NO _x	38175	21.08	361	3.40	0.16
SO ₂	645	0.36	73	0.68	1.92
Air toxics NEPM	t/yr	g/vehicle	t/yr	g/heater	woodheater/car
Benzene	1217	672	463	4364	6.49
Toluene	1311	724	148	1395	1.93
Formaldehyde	340	188	777	7323	38.95
Xylene	1815	1002	71.9	678	0.68
PAH	120	66	69.2	652	9.82

ABC News April 2008: Wood smoke worse than car exhausts

"In the limited amount of studies that have been done so far that have directly compared smoke from fires with the same level of particulates and smoke from car exhaust, industry have all tended to show that the effects from the wood smoke are actually worse for lung conditions than a similar amount from, say, car exhausts"

Norwegian Study comparing genetic damage from woodsmoke and traffic in human cell lines:

"In conclusion, woodsmoke particulate matter (WSPM) generated more DNA damage than traffic-generated PM per unit mass in human cell lines, possibly due to the high level of polycyclic aromatic hydrocarbons in WSPM. This suggests that exposure to WSPM might be more hazardous than PM collected from vehicle exhaust with respect to development of lung cancer."

Greenhouse gases.

Methane emissions from the average woodheater can cause more global warming than heating the same house with gas or reverse cycle airconditioning.

USEPA-certified stoves

The average new EPA-certified stove emits an estimated 97 lbs (44 kg) of PM_{2.5} per year. Measured emissions from gasoline-fuelled cars (PV-S, in Fig 7 below) average about 1 mg/km, implying that a small petrol (gasoline)-fuelled vehicle travelling 20,000 km per

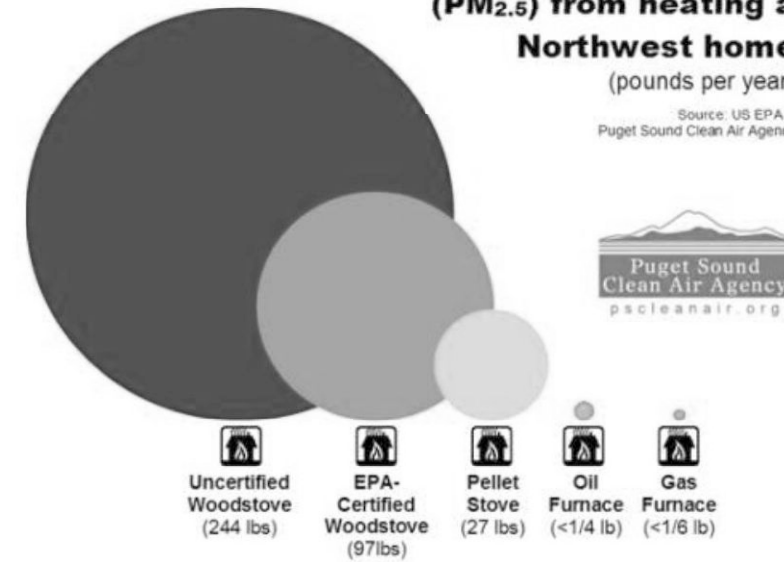
year will emit 20 grams of PM_{2.5}.

A USEPA-certified wood stove is therefore as polluting as 2,200 passenger automobiles fueled by gasoline.

Annual Fine Particle Pollution (PM_{2.5}) from heating a Northwest home

(pounds per year)

Source: US EPA &
Puget Sound Clean Air Agency



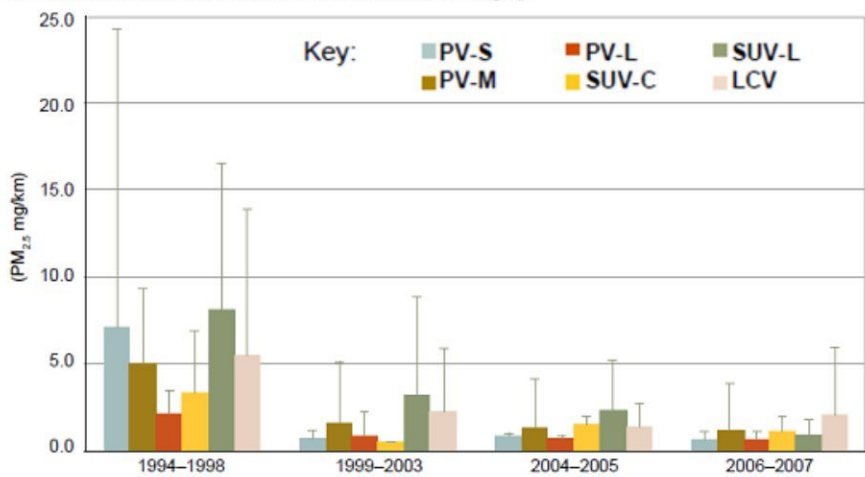
Note: Although open-hearth fireplaces are a significant source of fine particle pollution (even more than wood stove fires), they are not included in the above diagram because this diagram compares emissions based on equivalent heat output, and fireplaces are not actually a heat source for a residence. Homeowners will often find their house growing colder while a fire is burning in an open fireplace because warm air from the home is being drawn up the chimney.

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Figure 7: Average and maximum PM_{2.5} results by vehicle and age category (fleet subset)

NISE2 fleet: average PM_{2.5}

Error bar shows maximum recorded result in that vehicle category



Note: There are no fine particulate matter limits for petrol vehicles in the ADRs.

The graph above (from the [second national in-service emissions study \(NISE2\)](#)) shows in-service PM_{2.5} emissions for petrol vehicles. The 2006-07 average PM_{2.5} emissions of 1 mg/km implies that a vehicle travelling 20,000 km will emit just 20 grams of PM_{2.5}, *less than the average domestic wood heater in the first hour after lighting*.

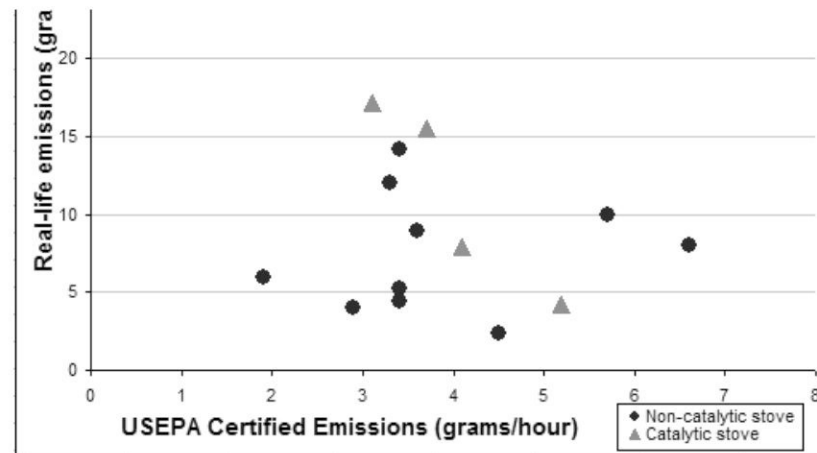
The abbreviations in the key: PV-S, PV-M and PV-L denote small, medium, large passenger vehicles; SUV-C and SUV-L denote compact and large SUV; LVC denotes light commercial vehicles.

For diesel cars, the Euro-5 limit is 5 mg/km (0.005 g/km). This is a more than 99% reduction compared to emissions of pre-1989 diesels, as discussed on page 3 of the peer-reviewed research paper: [Air pollution in Australia: review of costs, sources and potential solutions](#).

In contrast, real-life emissions of new stoves are little different from 1989. In 2013 Oregon, New York and five other states sued the USEPA because their "[25 years of inaction on woodstove emission standards violates the Clean Air Act](#)". However, progress has been slow. The [new standards](#) reduce emissions to 4.5 g/hr in 2015 and 2.5 g/hr in 2020. However, the certification process is based on a correctly-operated stove burning seasoned wood. Real-life emissions are often much higher.



A [report published in 2000](#) compared real-life and EPA-certified emissions for 16 stoves installed in Portland, Oregon and Klamath



Falls. EPA-certification values of non-catalytic stoves averaged 4.2 grams/hour, much lower than average real-life emissions of 9.7 grams/hr. EPA-certification values of catalytic stoves averaged 3.5 grams/hour, much lower than average real-life emissions of 13.8 grams/hr. As shown in the graph (left), there is little or no relationship between real-life emissions and those from the EPA-certification test. This is particularly true for catalytic stoves where the stove with the lowest EPA-certified emissions (1.6 grams/hr) had the real-life emissions of 24.1 g/hr.