# Consultation regulation impact statement (CRIS) for reducing emissions from wood heaters

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Standing Council on Environment and Water Secretariat
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Thank you for the opportunity to comment on this important regulatory impact statement. I have summarised my expertise in this field in the Appendix.

As clearly demonstrated in the CRIS, wood-smoke from residential firewood use in Australia continues to be a serious air pollution issue. I strongly support the statements in the CRIS suggesting that past management of residential sources of wood-smoke have not achieved their objectives. This makes the current review of management of emissions from wood heaters both timely and very important. I also strongly support the suggested independent auditing of wood heater models to ensure they comply with any regulations in place.

At the date it was written, the CRIS provided a good overview of the wood heater industry, the use of wood heaters in Australia and the health impacts of fine particles including wood-smoke. It is bad luck that several important studies and surveys were completed too late to be included in the CRIS. These are discussed below.

**Content of this submission**

**Summary of my views on wood heater emissions**

1. The health costs of emissions from wood heaters in Australia are unacceptable.
2. Urgent action is required to reduce winter wood-smoke concentrations in cities and towns across southern Australia.
3. Regulation has had only limited success in reducing smoke over the past 20 years. Education of wood heater users in correct operation of their heaters has also only had limited success, but this has been over more than 30 years.
4. Wood smoke could be reduced by reducing the number of wood heaters through restrictions on new installations and a set date by which all wood heaters must cease operation in all urban areas. It appears governments are very reluctant to take such a heavy handed approach. There are good reasons for not eliminating all wood heaters in urban areas and this approach is not advocated here. But if other approaches fail, this might be the only option.
5. The alternative is to regulate to ensure new models of wood heater emit far less air pollution when used in people's homes. This must be linked to a program phasing out the older wood heaters, including the models being installed today.
6. Studies of real-world emissions from wood heaters show very large changes in emissions from household to household and from day to day in a single household. This demonstrates that the current Australian Standard for limiting emissions from wood heaters leads to approval of models that are far too sensitive to typical household operation. The operation of wood heaters during standard testing must be changed to better reflect the way people now use their heaters. Simply lowering the emission limit, but keeping the same test method, is unlikely to achieve the goal of significantly reducing emissions.
7. The nine policy options put forward in the CRIS do not go far enough and the range of options is too narrow. Suggestions for additional policy options are provided below.

**Urban wood-smoke and health**

The CRIS summarises the adverse health impacts of wood-smoke with an emphasis on the physical properties of particles in the smoke. I agree with the list of widely acknowledged health impacts listed on page 24. The chemical composition of wood-smoke particles and gaseous emissions contribute to the concerns expressed by health experts.

Wood heaters are a major source of PAHs in cities and towns in Australia. Modelling suggests that regions with more than about 20% of households using firewood for home heating are unlikely to meet the National Monitoring Investigation level of 0.3ng/$m^3$ (annual average) for benzo[a]pyrene. Long term exposure to PAHs (based on the B[a]P indicator) is likely to lead to increased lung cancer and other serious diseases. Other air toxics in relatively high concentrations in wood-smoke include benzene and formaldehyde.

Many of the compounds found in cigarette smoke are also present in wood-smoke. Public concern about passive smoking, which has resulted in many restrictions on where people can smoke in public, has not been translated to wood-smoke; although ambient wood-smoke concentrations in winter in many areas probably pose a far greater health risk.

Recent papers by Johnston *et al*. 2013 and Noonan *et al*. 2012 report measurable improvements in health in quite small cities/towns where intervention to reduce wood-smoke has been successful. Johnston *et al*. carried out a retrospective analysis of mortality in Launceston and found statistically significant reductions in mortality when a period of high wood-smoke concentration (1994 to 2000) was compared with a period of lower smoke concentrations (2001 to 2007). In a population of 70,000 Johnston *et al*.'s results suggest about 30 fewer deaths per year as a result of the smoke reduction program. Noonan *et al*. were able to carry out surveys of children's respiratory problems before and after an intervention to reduce wood-smoke from residential heating in a small US city: Libby, Montana. They found a statistically significant improvement in health as smoke levels reduced. These two studies reinforce the potentially large savings in health costs that are likely to result from intervention that reduces wood-smoke.

Another very recent publication linking lung cancer to fine particles (not specifically wood-smoke) was mentioned in *The Times* (10 July 2013, page 2)[1]. This study, published in *Lancet Oncology*, found an 18% increase in lung cancer risk for long term exposure to each additional 5µg/$m^3$ increase in $PM_{2.5}$. There was no lower cut-off point.

What is the cost of wood-smoke from residential heating in Australia? The AECOM (2011) study of wood-smoke in NSW uses the same sources as the CRIS for deriving a cost on the emissions of $PM_{10}$. For the purposes of this argument I will use their number because it has been scaled for the whole of NSW (the CRIS provides separate values for large cities, smaller cities and rural areas). At $72,000 per tonne of $PM_{10}$ the 40,000 tonnes emitted by wood heaters (page 49 of CRIS) represents an annual cost of $2.88 billion dollars to Australia. Even if the figure of $72,000 is a bit 'rubbery', surely this massive cost is too big to be treated lightly. I suspect the $72,000 cost per tonne of $PM_{10}$ is, in fact, quite realistic because every time another study of the health costs of fine particles is carried out very large numbers result. If wood-smoke from residential heating is costing the country several billion dollars a year it needs urgent, swift and quite severe action.

**Wood heater numbers in Australia**

The baseline assumption in the CRIS is that wood heater numbers will continue to decrease in line with decreases between 1994 and 2008. This trend to fewer and fewer wood heaters was reassuring, it meant air quality was likely to improve whether intervention measures were very successful or not. However, the ABS survey published in 2011 raises serious doubts about this assumption. The survey showed a significant reversal in the trend of decreasing popularity of wood heaters. This is illustrated in Figure 1. The figure, based on

[1] I am travelling and unable to access academic literature at the moment, but the work referred to seems significant and reinforces many other studies showing links between fine particle concentrations and health. The Times article by the Health Correspondent Chris Smyth refers to a study led by Raaschou-Nielsen from the Danish Cancer Research Centre in Copenhagen.

ABS surveys, shows the annual change in the number of wood heaters used as the main living area heating in Australian homes.

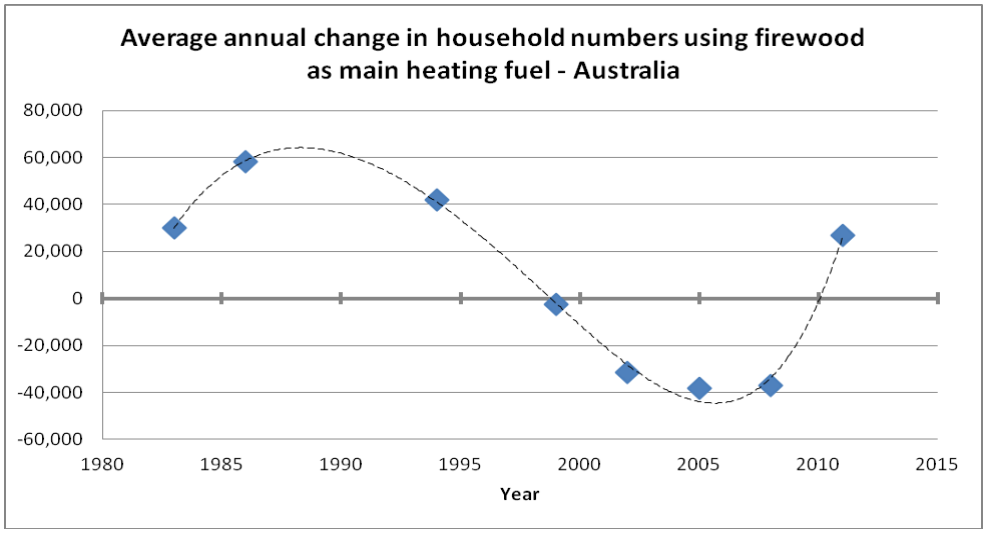


**Figure 1.** Annual changes in household numbers using firewood as their main living area heating fuel (adapted from ABS surveys)

Through the 1980s, wood heater numbers increased at an increasing rate (i.e. each year towards the end of the 1980s there were about 60,000 more wood heaters in use). Growth continued (but at a slower rate) up to 1999 and then numbers started to decline at a rate of about 40,000 fewer wood heaters in use per year. This continued up to 2008. The 2011 survey shows a very significant change, with numbers growing by about 27,000 additional wood heaters in use per year (average from 2008 to 2011). This translates to an additional 1,000t of fine particles released into mostly urban air sheds each year (or $72 million more in health costs each year).

It seems likely that increasing electricity and gas prices in the residential sector contributed to the increase in popularity of wood heaters. Population growth also contributed.

It would be unwise to assume the most recent trend will continue on the basis of one survey. The 2014 ABS survey will give some indication of how robust the increased popularity of wood heaters really is. But high prices for reticulated electricity and gas might well mean continued growth in wood heater numbers. If this continues at the same rate as indicated by the most recent ABS survey the baseline curve will increase by up to 50%, rather than decrease, in the period covered by the CRIS.

Unless there is a successful program to significantly improve the emissions from new wood heaters a 50% increase in wood heater numbers would mean additional annual costs of $1.5 billion dollars (2011 dollars) by 2030 due to more wood-smoke. Clearly this is unacceptable.

**Wood heater technology**

The current generation of wood heaters evolved in the 1980s. Large ceramic-glass doors with an 'air-wash' down the inside of the door meant good views of the fire with limited sooting of the glass. A baffle directs hot products of combustion towards the front of the heater and then back to the flue above the baffle. This increases efficiency and helps reduce emissions. In the 1980s many wood heater models included a baffle-bypass damper. This allowed smoke to directly access the flue while refuelling the heater, thus reducing smoke spillage into the living room. To reduce construction costs this feature is no longer part of most new wood heaters. One consequence is significantly more smoke spillage and likely problems with indoor air quality.

Some wood heaters in the 1980s included pre-heated secondary combustion air to assist in clean burning at slow combustion rates. Many, but not all, heater models now include this desirable feature. Some wood heater models in the 1980s included automatic controls on the combustion air which increased air flow if the heater became too cool to ensure good combustion. Very few models now include this feature.

The publication of an Australian Standard and an emission limit for wood heaters in 1992 led to one important improvement for reducing emissions: the requirement for a minimum air setting that the householder could not override in normal use. This is a good feature, but in many heater models it meant the heater was no longer capable of burning for 8 to 10 hours on one load of fuel (i.e. achieve 'overnight burn'). In some cases heater models were illegally sold with a reduced minimum air supply (as shown in the 2004 audit of wood heaters, DEH 2004), in other cases householders modified the minimum air setting themselves (it was sometimes as simple as removing a single screw). Thus, the minimum air setting was a good feature but one that was sometimes overridden.

The general design of the combustion chamber in wood heaters (other than the changes mentioned above) has changed little since the 1980s. There are no innovative emission reduction features, and heaters remain very sensitive to the way they are operated. This is reflected in generally high real-world emissions, with some instances of extremely high real-world emissions (e.g. 90g/kg instead of the limit specified in the standards of 4g/kg, see Todd 2013a).

It seems likely that some form of automatic combustion air control, coupled with other improvements to the combustion chamber, will be required if real-world emissions are to be significantly reduced.

**Standard test methods**

The operation of heaters during the standard test used for certification is flawed. It is too far removed from real-world operation. This means manufacturers are designing heaters to suit the test but not to suit the way they are operated in the real-world. This contributes to high real-world emissions.

In the standard test, the combustion air control is left fully open until the mass of the fuel load has dropped by 20%. This may take 10 to 20 minutes. So, in the standard test there is always a strong, hot fire burning before the air control is reduced for slow or medium burn rates. This is a very good way of reducing emissions. But in reality households do not wait this long to turn the air supply down after refuelling. Many simply leave the air control at its minimum setting when adding firewood. A national survey of wood heater operating practices showed many common operating practices that are known to increase emissions (Todd 2008). This is one cause of much higher emissions. The standard test method should reflect real-world operation, not ideal operation.

This, and other, shortcomings of the standard test methods are discussed in Todd (2013b). The standard is now under review (in 2013), but it is not known if any significant changes will be made to the operation of wood heaters during testing.

**Non-uniform requirements across Australia**

Air quality varies significantly from one air shed to another due to differences in dispersion, topography and the number and character of sources of air pollutants.

For this reason, it seems inconsistent to suggest that there should be uniform regulation of wood heaters. Perhaps that was not what was intended in the CRIS, but some of the wording might be interpreted in this way. Local areas should be encouraged, and assisted, in setting restrictions that meet their immediate needs. This might mean preventing the installation of wood heaters in new homes in some areas, especially in regions that do not meet air quality standards.

**Longer term development of very low emission wood heaters**

A national strategy for development of very-low emission woodheaters is needed. The current generation of wood heaters emit, on average, about 10grams of fine particles for each kilogram (dry weight) of wood burnt (i.e. 1% of the wood mass is emitted as fine particles). In some cases emission factors an order of magnitude higher have been measured. This is far too high. A goal of around 0.1 to 0.5g/kg (real-world) is needed if this source of air pollutants is to be brought in line with transport and industrial emissions.

There is limited capacity in the Australian wood heater industry to conduct basic research on wood combustion in small scale appliances (i.e. room heaters). The most cost effective way to conduct this basic research may well be to encourage Universities to involve postgraduate students in this research. The establishment of one or two research hubs with small groups of academics, technical staff and test facilities is very desirable.

The wood heater industry can then make use of this basic research in its own research facilities (there are at least two Australian manufacturers with good test facilities) and apply it in the development of commercial appliances.

A national body to coordinate this effort would be required, providing targeted research funding to develop both better standard test methods and very low emission heaters.

**Other issues**

Any certification program used to identify heater models that meet requirements set out in standards and regulations should be operated by an independent body, not part of the wood heater industry.

It was very disappointing when the AHHA removed the lists of emission factors for certified wood heaters from their web site. This effectively stopped consumers choosing heater models with lower emissions. Wood heaters are not required to carry labels stating their emission factor so the web list was the only way consumers, regulators, or inspectors could get this information. It seemed totally out of step with any desire to see wood-smoke levels reduced.

Independent and transparent auditing of wood heater models is urgently needed. The 2004 audit (DEH 2004) identified widespread non-compliance with many heater models having far higher emissions than stated on compliance plates. Consumers were never informed which models did not comply.

**Suggested additional policy options**

Policy options in the CRIS from 1 to 4 are very similar to the present situation which is acknowledged as being unsuccessful (except that compliance with regulations would be monitored through audits – a very good addition).

Policy options 5 to 8 introduce minimum efficiency requirements and a lower emission limit (3g/kg instead of 4g/kg). In my view this is too small a step forward given the huge health costs associated with wood-smoke.

Policy option 9 reduces the emission limit to 1.5g/kg (a level that has been in place in New Zealand for many years). This would be more challenging for manufacturers and would lead to a modest reduction in emissions from new heater models. It might offer a short term transitional option, but it will not get wood heater emissions anywhere near the levels required for health.

The following options should be considered if the government is serious about dealing with this significant source of air pollution.

1. An option which includes preventing wood heater installations in new homes in regions with poor air quality.
2. An option of setting more stringent emission limits for any new wood heater installed in regions with poor air quality.
3. A national body with resources to assist local government deal with localised wood-smoke where neighbour affects neighbour. This might involve loan of equipment to monitor smoke and training of local government officers in use of the equipment.

4. A national body with resources to initiate research in universities to assist industry develop far cleaner-burning wood heaters and to develop more appropriate standard test methods.
5. A five year review to test the effectiveness of any changes in regulations.

**Conclusion**

The CRIS is an important document because it brings into focus the large health impacts of exposure to wood-smoke from residential heating in Australia. It points out that policy initiatives up to the present have not achieved substantial reductions in smoke emitted by wood heaters on the Australian market. Recent health studies from Australia and elsewhere, published in leading scientific journals, provide even stronger evidence that exposure to wood-smoke concentrations found in Australian cities and towns contributes to increased morbidity and mortality. The health costs of fine particle emissions are very large.

Over the past few years wood heater numbers have been increasing in Australia. Unfortunately this information came too late to be included in the modelling in the CRIS. The growth in wood heater numbers, and wood-smoke emissions, suggests that some stronger policy options should be added to the list in the CRIS. A number are suggested in this submission.

This is a very serious matter that requires a national approach. The Australian government should take the lead in (a) setting near-term measures to reduce wood-smoke through regulation of new wood heater emissions and education of wood heater users; (b) developing technical support and education for local government officers faced with complaints about localised smoke pollution; and (c) longer-term development of research expertise in low emission wood heaters and improved standard test methods.

**References**

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Todd J. J. 2008 '*Woodheater operation and firewood parameters: Australia*' Department of Environment and Water Resources, Canberra (available on Environment Australia web site)

Todd J. J. 2013a, 'Real-world emissions from wood heaters: a review' for presentation at *Clean Air Society of Australia and New Zealand Conference 2013*, Sydney

Todd J. J. 2013b, 'Approaches to emission certification testing of wood heaters' for presentation at *Clean Air Society of Australia and New Zealand Conference 2013*, Sydney

Appendix

**Summary of wood heater and wood-smoke experience and expertise**

Professor John J Todd

I first developed an interest in residential firewood use in 1978 and commenced testing wood heaters at the University of Tasmania in 1980. Over a period of several years I established the Fuelwood Research Group and the Home Heating Laboratory at the University. I developed a strong interest in Australian safety and performance standards for solid-fuel burning residential heaters, receiving the 1994 *Standards Award*. My laboratory, which held NATA accreditation, operated for about 10 years to 1991 when it was closed because the building housing the laboratory had to be demolished to make way for new University buildings. I maintained my research interest in biomass combustion through use of private laboratories and work with industry. Since leaving the University in 2002, I have carried out many consulting projects on biomass combustion and wood-smoke commissioned by industry and government. I have over 80 published conference papers and journal articles on biomass and over 120 commissioned studies on biomass and wood-smoke. I have run many training workshops for local government officers in most Australian states. I have collaborated on research projects on wood-smoke from residential heating in New Zealand, USA and Switzerland.

I was chairman of the Standards Australia Committee (CS-062) on Residential Solid-Fuel Burning Appliances (1980 to 1998) and remain an active committee member; and I was the Australian Delegate to the International Standards Organization Subcommittee on Domestic Heating. I am a Member of the Clean Air Society of Australia and New Zealand (receiving the Werner Strauss Clean Air Award in 2009).

I hold an honorary research associate position at the University of Tasmania and I am an Adjunct Professor at Edith Cowan University. I am the Director of the small consulting business Eco-Energy Options Pty Ltd based in Hobart.