

# **Household Energy Use in Australia:**

## **End Uses, Greenhouse Gas Emissions and Energy Efficiency Program Coverage**

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for the

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## Summary

The household sector accounts for about 373 PJ of delivered energy, or about 11.5% of the national total. Because a large proportion the energy used is electricity, the most greenhouse gas-intensive form of delivered energy, the sector is estimated to account for over 17% of Australia's energy-related greenhouse gas emissions.

Total household energy use increased by 11.7% between 1990 and 1995, while population grew by 5.7% and the number of households by 10.1%. The consumption of natural gas increased faster than other energy forms. Electricity consumption per household declined slightly between 1990 and 1995.

In 1995, electricity accounted for nearly 84% of the greenhouse impact of national household energy use, and natural gas for nearly 14%. The emissions contribution from wood was low because unlike coal, gas and petroleum, wood is a renewable fuel.

On an end use basis:

- space heating accounted for over 40% of household energy in 1995 but less than 13% of greenhouse gas emissions;
- water heating accounted for nearly 27% of household energy and nearly 28% of greenhouse gas emissions;
- refrigeration accounted for less than 9% of household energy but over 17% of emissions, a higher proportion than space heating and cooling combined.

The reason for the large discrepancy between energy impacts and greenhouse impacts is the fact that gas and wood supply a large share of the thermal end uses (space heating, water heating and cooking), whereas the other end uses are all-electric.

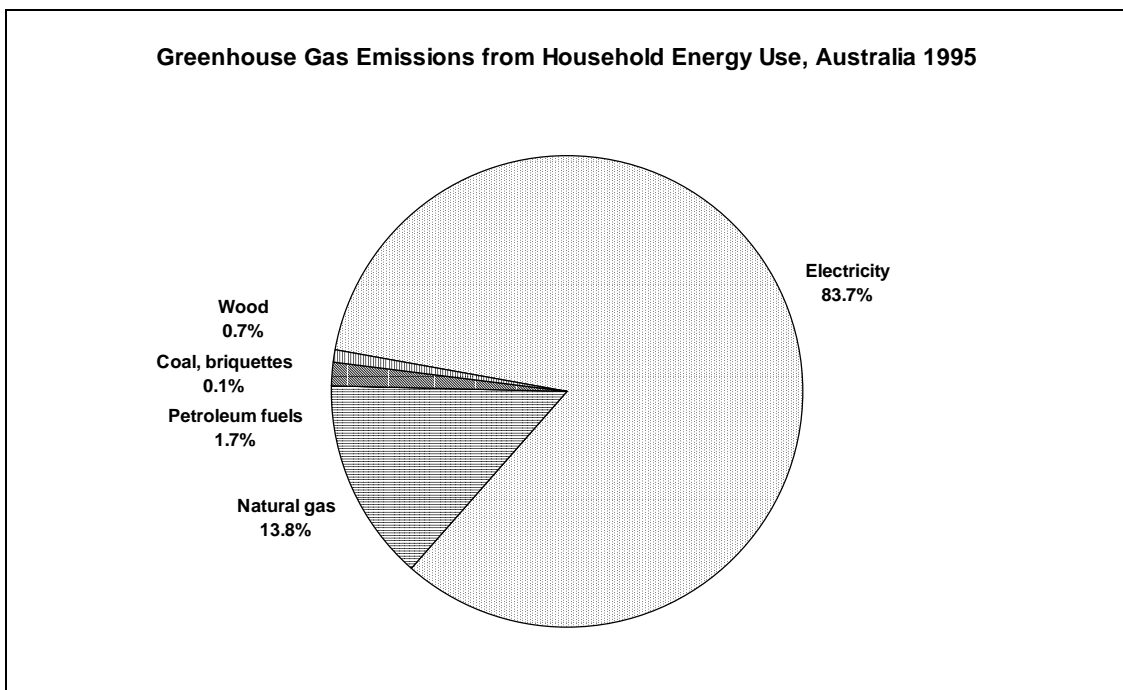
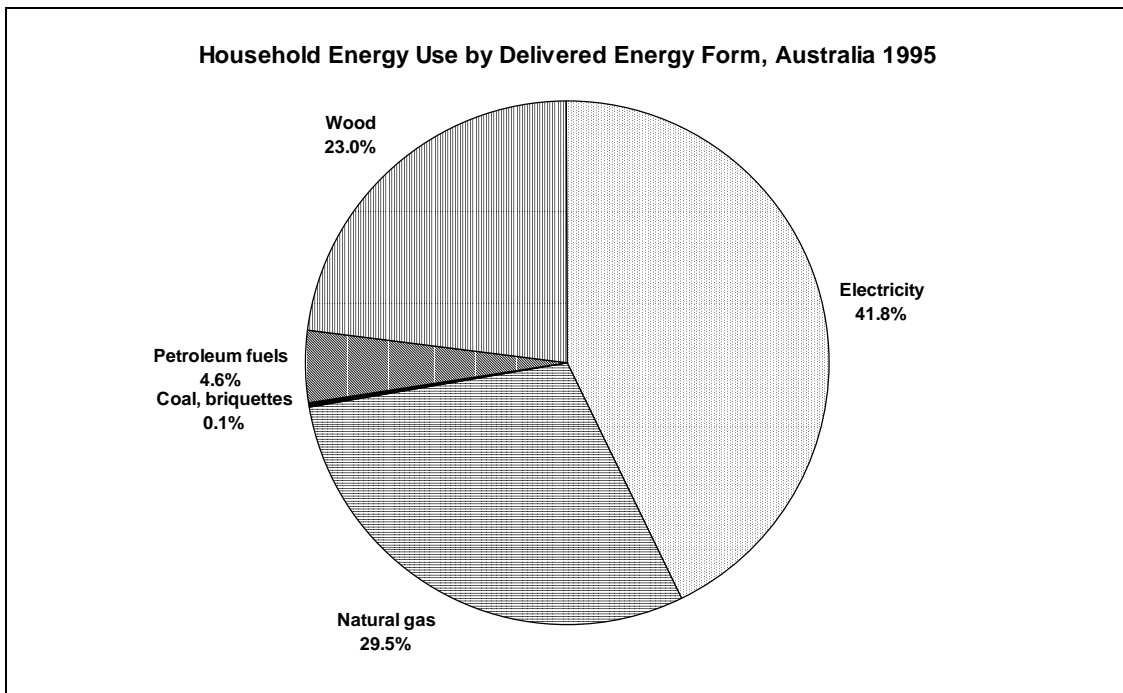
There are several programs which aim to increase the energy efficiency of the new appliances purchased by households, by influencing appliance purchase behaviour or appliance design directly. There are also programs to influence "upstream" and "downstream" efficiency, ie to reduce the amount of energy which space heaters and water heaters are required to produce irrespective of their own efficiency.

- for household electricity use, about 36% of energy (and emissions) are fully covered by such programs, 31% mostly or partly covered and about 33% not covered;
- for household gas use, about 91% of energy (and emissions) are fully covered, and 9% not covered; and
- for the household sector as a whole, about 42% of energy and emissions are fully covered, 17% of energy (27% of emissions) mostly or partly covered, and 40% of energy (30% of emissions) not covered.

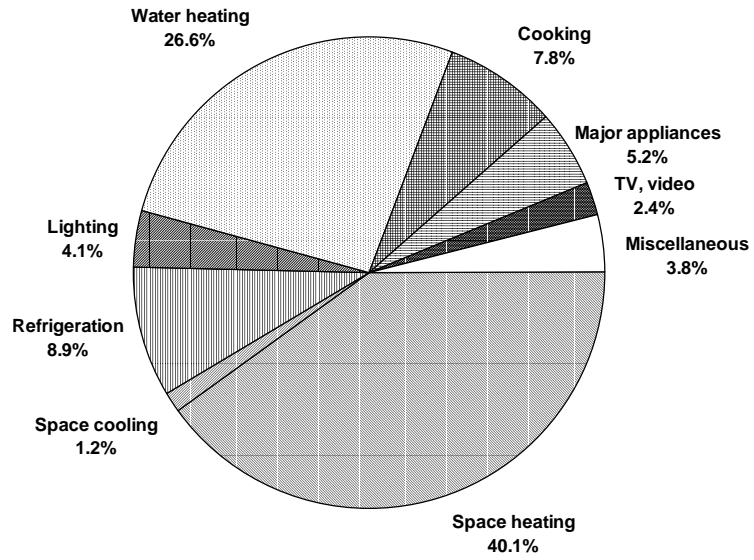
One of the ways to increase coverage is to extend labelling and/or MEPS to appliances and end uses not presently covered. The most important of these areas are:

- electronics, communications and control functions, such as TVs and VCRs, and standby power consumption in appliances (including labelled appliances); and
- household lighting.

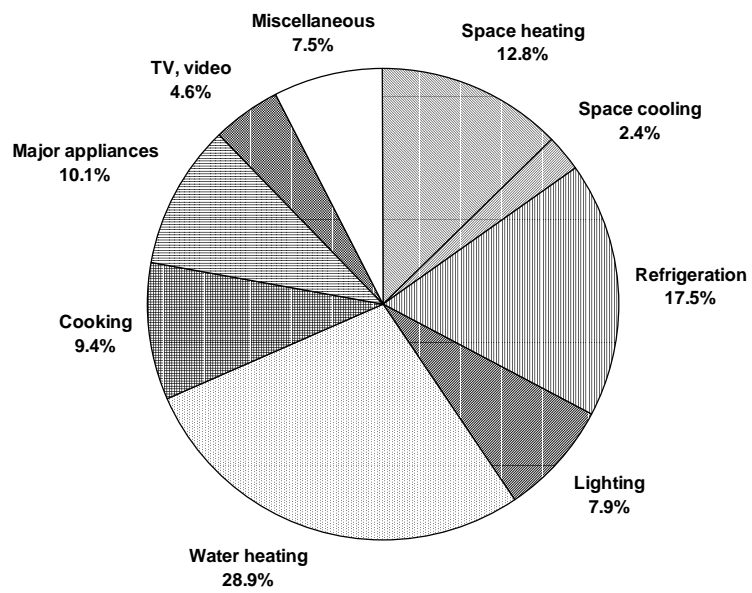
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**Household Energy Use by End Use, Australia 1995**



**Greenhouse Gas Emissions by End Use, Australia 1995**



# 1. Household Energy Use

## *Forms of Delivered Energy*

In the current financial year, the household sector will account for about 373 PJ of delivered energy, or about 11.5% of the national total (ABARE 1997). However, because a large proportion the energy used in households is electricity, the most greenhouse gas-intensive form of delivered energy, the sector is estimated to account for over 17% of Australia's energy-related greenhouse gas emissions (GWA 1997).

As indicated in Tables 1 and 2, electricity represents the largest share of household energy use nationally. It also has the largest share in every State except Victoria, where the ratio of natural gas use to electricity use is about 2.3 to 1. This is because Victoria has the highest proportion of households connected to natural gas, and very high average consumption for gas space heating. It is also possible that wood represents a larger share of household delivered energy than electricity in Tasmania, but all wood data are subject to uncertainty (see below).

Total household energy use increased by 11.7% between 1990 and 1995, while population grew by 5.7% and the number of households by 10.1% (ie the average number of people per household fell from 2.75 in 1990 to 2.64 in 1995).

The consumption of gas increased faster than other household energy forms. Although average consumption per connected household remained steady, the number of households connected increased by more than 19% between 1990 and 1995. Most of this increase in penetration rates took place in NSW and the ACT.

Since virtually all households are connected to electricity, changes in connection rates are not a factor in total electricity consumption. Electricity consumption per household declined slightly between 1990 and 1995, but electricity consumption per capita increased since there were fewer people per household.

Petroleum fuels (liquefied petroleum gas (LPG) and heating oil) accounted for 5.2% of household energy in 1990 and 4.6% in 1995. Some of this decline was due to the connection of LPG-using households to natural gas, and some to the non-replacement of oil heaters as they came to the end of their service life.

Wood represents a large but uncertain element of household energy use. Unlike gas and electricity its consumption is not metered, and much of it is self gathered rather than purchased from commercial suppliers. The Australian Bureau of Agricultural and Resource Economics (ABARE) estimates that wood represents about 23% of household delivered energy use, and a recent study by the International Energy Agency concluded that 23% of Australian households used wood as their main heating fuel (IEA 1997). Even if this is so, and allowing for some secondary use of wood fuel

in households where the main form of heating is gas or electricity, the ABARE estimates of wood use still appear to be two to three times too high.

**Table 1. Household Energy Use and Greenhouse Gas Emissions by Delivered Energy Form, Australia 1990**

	Delivered Energy PJ	Share of Energy	Emissions kt CO <sub>2</sub> -e	Share of Emissions	kg CO <sub>2</sub> -e/GJ delivered
Electricity	138.8	43.7%	42157	84.6%	304
Natural gas	87.7	27.6%	6356	12.8%	72
Coal, briquettes	0.3	0.1%	30	0.1%	95
Petroleum fuels	16.6	5.2%	955	1.9%	58
Wood	74.1	23.3%	338	0.7%	5
	317.5	100.0%	49837	100.0%	157

Source: Energy consumption from ABARE (1997), emissions from GWA (1997)

**Table 2. Household Energy Use and Greenhouse Gas Emissions by Delivered Energy Form, Australia 1995**

	Delivered Energy PJ	Change 90 to 95	Share of Energy	Emissions kt CO <sub>2</sub> -e	Share of Emissions	kg CO <sub>2</sub> -e/GJ delivered
Electricity	151.8	9.4%	42.8%	43514	83.7%	287
Natural gas	104.7	19.4%	29.5%	7195	13.8%	69
Coal, briquettes	0.3	-4.8%	0.1%	28	0.1%	95
Petroleum fuels	16.2	-2.4%	4.6%	904	1.7%	56
Wood	81.7	10.3%	23.0%	376	0.7%	5
	354.7	11.7%	100.0%	52017	100.0%	147

Source: Energy consumption from ABARE (1997), emissions from GWA (1997)

**Table 3. Change in Household Energy Use Rates, 1990 to 1995**

		1990	1995	Change 90 to 95
Population	Millions	17.28	18.26	5.7%
Households	Millions	6.28	6.91	10.1%
All household energy	GJ/cap	18.4	19.4	5.7%
	GJ/HH	50.6	51.4	1.5%
Electricity	kWh/cap	2231	2309	3.5%
	kWh/HH	6144	6106	-0.6%
Natural Gas	GJ/cap	5.1	5.7	13.0%
	GJ/HH	14.0	15.2	8.5%
	HH Connected	38.1%(a)	41.4%(a)	19.4%(b)
	GJ/cap(Con)	13.3	13.9	4.1%
	GJ/HH(Con)	36.7	36.7	0.0%

Population and gas connection rates from IEA database. (a) Percentage of all households connected to natural gas. (b) Increase in the absolute number of households connected to natural gas.

## ***Greenhouse Gas Emissions***

The greenhouse gas-intensity of each form of energy used in the household in 1990 and 1995 is shown in Tables 1 and 2. These “full fuel cycle” factors take into account all emissions from the production, transformation and combustion of fuels along the supply chain in those years. The emissions are expressed in terms of “CO<sub>2</sub>-equivalent”. Over 95% of the greenhouse impact of energy production is due to CO<sub>2</sub> from fuel combustion, but there is also some effect from methane (from black coal mining and natural gas production) and nitrous oxide.

The intensity for electricity is high because most electricity in Australia is generated from coal, and the overall efficiency of the generation and distribution system is about 30%. The values are national averages: in Tasmania, where almost all electricity is generated from hydro, the emissions-intensity is close to zero. In Victoria, where brown coal is used, the value is higher than the national average.

The national average greenhouse gas-intensity of electricity declined by about 6% between 1990 and 1995, and for natural gas by about 5%. This was due largely to changes in NSW - an increase in the operating efficiency of NSW coal-fired power stations, and a reduction in the leakage of gas due to the relining of the Sydney distribution system. While there is only limited scope for further improvement in the operation of existing power stations and gas systems, there is scope for future changes in electricity intensity as the power station mix changes. In the short term, intensity may well increase as brown coal gains a larger share of the national electricity market, but in the longer term there may be a decline as gas-fired and renewable generation increase their market share.

The greenhouse intensity of wood use is low, because unlike coal, gas and petroleum, wood is a renewable fuel. For national greenhouse accounting purposes, it is considered that the CO<sub>2</sub> produced from the combustion of wood and other biofuels is exactly balanced by the takeup of carbon from the atmosphere when the biomass regrows. Therefore the greenhouse-intensity of wood use comprises only the effect of the CH<sub>4</sub> and N<sub>2</sub>O produced during its combustion. Because a large amount of wood is burned in poorly controlled conditions in open fires, the greenhouse impact is still significant.

In 1995, electricity accounted for nearly 84% of the greenhouse impact of national household energy use, and natural gas for nearly 14%.

## ***Other Environmental Impacts***

In addition to the greenhouse gases already discussed, the combustion of fuels produces a range of other pollutants: carbon monoxide (CO), oxides of nitrogen (NO<sub>x</sub>) and non-methane volatile organic compounds (NMVOC). It is these which tend to create local pollution problems, especially in urban areas.

Because so much urban wood use is consumed under poor combustion conditions and during the coldest nights of the year, when conditions are conducive to thermal inversions, wood probably makes the largest contribution to the local pollution associated with household energy use, followed by natural gas. Grid-supplied electricity has no atmospheric pollution impacts at the point of use.

## 2. End Uses of Energy

The principal end uses of energy are listed in Table 4. There is no reliable single source of data on end use covering all States and all energy forms, and no national monitoring of appliance ownership in the household sector since the last ABS Survey in 1987. The share of each form of energy allocated to each end use is derived from a number of sources, principally AESIRB (1993) and GWA (1997). Each category in Table 4 may group several technology or appliance types. For example:

- electric space heating includes both resistance heating and heating by reverse cycle air conditioners;
- electric water heating includes electricity used as backup by solar water heaters;
- electric cooking includes microwave oven use, but consumption by other plug-in kitchen appliances is included in “miscellaneous”.

Table 5 summarises energy consumption and greenhouse gas emissions by end use, for all energy forms. It indicates that, in 1995:

- space heating accounted for over 40% of household energy but less than 13% of greenhouse gas emissions;
- water heating accounted for nearly 27% of household energy and nearly 28% of greenhouse gas emissions;
- refrigeration accounted for less than 9% of household energy but over 17% of emissions, a higher proportion than space heating and cooling combined.

The reason for the large discrepancy between energy impacts and greenhouse impacts is the fact that gas and wood supply a large share of the thermal end uses (space heating, water heating and cooking), whereas the other end uses are all-electric. This is indicated by the weighted CO<sub>2</sub>-intensity values in Table 5: space heating has the lowest intensity by far (47 kg CO<sub>2</sub>-e/GJ delivered) followed by water heating (154) and cooking (177). The intensity of the all-electric end uses is, by definition, equal to the average intensity for electricity in that year: 287 kg CO<sub>2</sub>-e/GJ.

As a consequence:

- while all-electric end uses make up less than 26% of household delivered energy, they account for half of greenhouse gas emissions;
- space heating is a far less important focus for energy efficiency than it first appears: saving a GJ of space heating energy will, on average, reduce greenhouse gas emissions by only one sixth as much as saving a GJ of refrigeration, electric appliance or lighting energy. However, since wood and gas account for a large share of space heating, saving space heating energy will have a large benefit for local pollution.

**Table 4. End Use Share of Energy Use and Emissions by Energy Form, 1990 and 1995**

	1990				1995				Change 90 to 95
	End use share	GWh	PJ	kt CO <sub>2</sub> -e	End use share	GWh	PJ	kt CO <sub>2</sub> -e	
Space heating	4.5%	1719	6.2	1880	4.3%	1808	6.5	1865	5.2%
Space cooling	2.8%	1083	3.9	1184	2.8%	1192	4.3	1230	10.1%
Refrigeration	20.8%	8008	28.8	8756	20.9%	8815	31.7	9097	10.1%
Lighting	9.5%	3663	13.2	4005	9.5%	3995	14.4	4122	9.1%
Water heating	26.5%	10203	36.7	11156	26.4%	11153	40.2	11509	9.3%
Cooking	9.5%	3657	13.2	3998	9.6%	4031	14.5	4160	10.2%
Major appliances	12.0%	4632	16.7	5064	12.0%	5078	18.3	5240	9.6%
TV, video	5.5%	2110	7.6	2307	5.5%	2320	8.4	2394	9.9%
Miscellaneous	9.0%	3482	12.5	3808	9.0%	3776	13.6	3896	8.4%
All Electricity	100.0%	38556	138.8	42157	100.0%	42167	151.8	43514	9.4%
Heating	53.7%		47.1	3416	53.0%		55.5	3816	17.8%
Water heating	38.0%		33.3	2416	38.4%		40.3	2766	20.7%
Cooking	8.3%		7.2	524	8.5%		8.9	613	23.3%
All Natural Gas	100.0%		87.7	6356	100.0%		104.7	7195	19.4%
Heating	100.0%		0.3	30	100.0%		0.3	28	-4.8%
Water heating	0.0%				0.0%				
Cooking	0.0%				0.0%				
All Coal, Briquettes	100.0%		0.3	30	100.0%		0.3	28	-4.8%
Heating	70.6%		11.7	675	70.6%		11.4	638	-2.4%
Water heating	19.1%		3.2	183	19.1%		3.1	173	-2.4%
Cooking	10.2%		1.7	98	10.2%		1.7	93	-2.4%
All Petroleum Fuels	100.0%		16.6	955	100.0%		16.2	904	-2.4%
Heating	83.3%		61.7	281	83.7%		68.4	315	10.8%
Water heating	13.6%		10.1	46	13.3%		10.8	50	7.5%
Cooking	3.1%		2.3	10	3.0%		2.5	11	8.0%
All Wood (a)	100.0%		74.1	338	100.0%		81.7	376	10.3%
All Energy			317.5	49387			354.7	52017	11.7%

Source: GWA (1997) (a) Emissions from wood use exclude CO<sub>2</sub>

**Table 5. End Use Share of Energy Use and Emissions, All Household Energy, 1990 and 1995**

	1990					1995					Change 90 to 95
	Share of PJ	Share of CO <sub>2</sub> -e	PJ	kt CO <sub>2</sub> -e	kg CO <sub>2</sub> - e/GJ	Share of PJ	Share of CO <sub>2</sub> -e	PJ	kt CO <sub>2</sub> -e	kg CO <sub>2</sub> - e/GJ	
Space heating	40.0%	12.6%	127.1	6281	49	40.1%	12.8%	142.2	6663	47	11.9%
Space cooling	1.2%	2.4%	3.9	1184	304	1.2%	2.4%	4.3	1230	287	10.1%
Refrigeration	9.1%	17.6%	28.8	8756	304	8.9%	17.5%	31.7	9097	287	10.1%
Lighting	4.2%	8.0%	13.2	4005	304	4.1%	7.9%	14.4	4122	287	9.1%
Water heating	26.2%	27.7%	83.3	13800	166	26.6%	27.9%	94.3	14498	154	13.2%
Cooking	7.7%	9.3%	24.4	4631	190	7.8%	9.4%	27.6	4877	177	13.0%
Major appliances	5.3%	10.2%	16.7	5064	304	5.2%	10.1%	18.3	5240	287	9.6%
TV, video	2.4%	4.6%	7.6	2307	304	2.4%	4.6%	8.4	2394	287	9.9%
Miscellaneous	3.9%	7.6%	12.5	3808	304	3.8%	7.5%	13.6	3896	287	8.4%
All energy (a)	100.0%	100.0%	317.5	49837	157	100.0%	100.0%	354.7	52017	147	11.7%

Source: GWA (1997) (a) Emissions from wood use exclude CO<sub>2</sub>

### 3. Energy Efficiency Program Coverage

There are several programs which aim to increase the energy efficiency of the new appliances purchased for the household sector, by influencing appliance purchase behaviour, or appliance design directly. There are also programs to influence “upstream” and “downstream” efficiency, ie to reduce the amount of energy which space heaters and water heaters are required to produce irrespective of their own efficiency. There are also general information programs designed to motivate and inform users about reducing household energy use by changing their daily behaviour, but these are not considered here.

#### *Electrical Appliance Labelling*

Mandatory electrical appliance labelling now covers refrigerators, freezers, dishwashers, air conditioners, clothes washers and electric clothes dryers. Its extension to thermal cookers (ovens and hotplates) has been investigated, but has not proceeded.

#### *Electrical Appliance MEPS*

Mandatory minimum energy performance standards (MEPS) have now been adopted for refrigerators, freezers and storage water heaters, to take effect in 1999. MEPS have also been investigated for clothes dryers (with a recommendation to proceed), dishwashers and air conditioners (with a recommendation to reconsider after necessary changes to standards) and clothes washers (with a recommendation not to proceed).

### ***Gas Appliance Labelling***

Energy labelling, administered by the Australian Gas Association (AGA) now covers storage and instantaneous water heaters, room and space heaters and central heaters. The program was originally voluntary for appliance suppliers, but testing and labelling is now enforced through the AGA appliance approval process.

The AGA approvals process also applies minimum energy performance criteria to gas appliances. However, these are relatively lenient and are not true MEPS in that the levels have not been set taking into account any form of national cost-benefit analysis, as was the case for electric appliance MEPS.

### ***Upstream/Downstream Efficiency***

The main upstream and downstream programs are:

- mandatory home insulation standards in Victoria: these help reduce the overall energy requirement for space heating and cooling;
- mandatory home thermal performance standards (based on the National Home Energy Ratings Scheme, or NatHERS) in the ACT: these help reduce the overall energy requirement for space heating and cooling;
- voluntary home energy rating schemes in some of the other States: these help reduce the overall energy requirement for space heating and cooling; and
- the voluntary water efficiency labelling program for shower heads, faucets, dishwashers and clothes washers (the A to AAA rating): this helps reduce the overall energy requirement for household water heating.

### ***Coverage***

Tables 6 and 7 indicate the coverage of these programs in relation to energy and emissions end use. The effectiveness of the programs is not taken into account. Only direct coverage by appliance labelling and MEPS is considered, not upstream or downstream programs.

Table 7 shows that:

- for household electricity use, about 36% of energy (and emissions) are fully covered, 31% mostly or partly covered and about 33% not covered;
- for household gas use, about 91% of energy (and emissions) are fully covered, and 9% not covered; and

- for the household sector as a whole, about 42% of energy and emissions are fully covered, 17% of energy (27% of emissions) mostly or partly covered, and 40% of energy (30% of emissions) not covered.

**Table 6. End Uses Covered by Energy Efficiency Programs, 1995**

Energy Form, End Use	Share of PJ	Share of CO <sub>2</sub> -e	PJ	kt CO <sub>2</sub> -e	Energy efficiency program coverage
Electricity	4.6%	28.0%	6.5	1865	Some - RAC labelling
Natural gas	39.1%	57.3%	55.5	3816	Yes - labelling
Coal, briquettes	0.2%	0.4%	0.3	28	
Petroleum fuels	8.0%	9.6%	11.4	638	Most - LPG labelling
Wood	48.1%	4.7%	68.4	315	
<b>All Space Heating</b>	<b>100.0%</b>	<b>100.0%</b>	<b>142.2</b>	<b>6663</b>	
Electricity	42.6%	79.4%	40.2	11509	Most - Storage WH MEPS
Natural gas	42.7%	19.1%	40.3	2766	Yes - labelling
Coal, briquettes	0.0%	0.0%	0	0	
Petroleum fuels	3.3%	1.2%	3.1	173	Most - LPG labelling
Wood	11.5%	0.3%	10.8	50	
<b>All Water Heating</b>	<b>100.0%</b>	<b>100.0%</b>	<b>94.3</b>	<b>14498</b>	
Electricity	52.7%	85.3%	14.5	4160	
Natural gas	32.4%	12.6%	8.9	613	
Coal, briquettes	0.0%	0.0%	0.0	0	
Petroleum fuels	6.0%	1.9%	1.7	92	
Wood	8.9%	0.2%	2.5	11	
<b>All Cooking</b>	<b>100.0%</b>	<b>100.0%</b>	<b>27.6</b>	<b>4877</b>	
Space Cooling	4.7%	4.7%	4.3	1230	Yes - RAC labelling
Lighting	15.9%	15.9%	14.4	4122	
Refrigeration	35.0%	35.0%	31.7	9097	Yes - labelling & MEPS
Major Appliances	20.2%	20.2%	18.3	5240	Yes - DW, WM, CD labelling
Home electronics	9.2%	9.2%	8.4	2394	
Miscellaneous	15.0%	15.0%	13.6	3896	
<b>All-electric uses</b>	<b>100.0%</b>	<b>100.0%</b>	<b>90.6</b>	<b>25980</b>	

**Table 7. Energy Use and Emissions Covered by Energy Efficiency Programs, 1995**

Energy Form	Share of PJ	Share of CO <sub>2</sub> -e	PJ	kt CO <sub>2</sub> -e	Energy efficiency program coverage (a)
All Energy Forms	42.3%	42.6%	150.1	22149	Fully covered
	17.3%	27.3%	61.2	14186	Mostly or partly covered
	40.4%	30.1%	143.4	15683	Not covered
Electricity	35.8%	35.8%	54.3	15566.9	Fully covered
	30.7%	30.7%	46.7	13374.7	Mostly or partly covered
	33.5%	33.5%	50.8	14572.7	Not covered
Natural Gas	91.5%	91.5%	95.8	6582.2	Fully covered
	0.0%	0.0%	0	0	Mostly or partly covered
	8.5%	8.5%	8.9	613.0	Not covered

(a) Covered by labelling, MEPS or both

### *Potential Enhancement and Extension*

Although the end uses covered (wholly or partly) by existing appliance efficiency programs account for 60% of household energy and 70% of the related greenhouse gas emissions, there is scope for enhancing, expanding and extending the program in the following ways:

1. enhancing the effectiveness of labelling (eg by strengthening the message, using additional means of communications, reinforcing incentives for product suppliers) and of MEPS (eg raising the MEPS levels from time to time);
2. extending MEPS to appliances currently subject only to labelling: eg air conditioners, clothes dryers, dishwashers and all gas appliances,
3. extending labelling and/or MEPS to appliances not presently covered at all.

Presumably, any of these actions would be subject to prior cost-benefit analyses, consultations with stakeholders etc. One of the factors to be taken into account in considering option 3 is whether an end use is increasing, or is likely to increase its share of household energy use and emissions.

The fastest growing area of household energy use is electronics and information. This end use comprises:

- energy use by “traditional” home entertainment devices such as TVs, videos and stereos (accounting for about 5.5% of household electricity in 1995 - see Table 4);
- energy use by more recently introduced information devices such as computers and “set top boxes” for cable TV (which are evolving into general communications gateways);
- energy use in standby mode by household appliances that were formerly only energised when actively operating, such as washing machines and air conditioners. The energy consumption tests currently used for labelling do not measure this;
- small plug load transformers, eg mobile phone and laptop PC rechargers, modems, answering machines etc.

The common characteristic of these end uses are that they involve continuous power consumption, and the devices often use more energy during standby than in active mode, if indeed they have a distinct active mode at all. In these respects they differ from the devices currently covered by appliance efficiency programs, which (apart from refrigeration and water heating) deliver energy services on the basis of discrete operating cycles or operating periods selected by the user.

Electronic and information devices are increasingly becoming subject to appliance efficiency programs in other countries, for example:

- labelling to indicate that the power consumption of a device when “standing by” is less than a defined standard. This is the basis of the *Energy Star* label first introduced in the USA in 1992 for personal computers, monitors, printers, fax machines and photocopiers, and extended in 1998 to TVs and VCRs. The *Energy Star* label is currently being promoted in Australia (for office equipment only, but for home as well as business purchases) by the NSW Sustainable Energy Development Authority;
- MEPS based on standby power consumption rather than active operating mode. A voluntary program of this type has been negotiated between the European electronics manufacturers’ association and the European Commission.

The total energy use of these devices in Australia is not known, but it is likely to range from 7 to 10% of household electricity (comparable to electricity use for heating and cooling combined) and growing.

Other household end uses where there is likely to be major change in the future are:

- **lighting:** the proliferation of halogen lighting is probably increasing the quality and versatility of home lighting but reducing the energy efficiency. There may be scope for full energy labelling (or the use of *Energy Star*) for transformers and lamps. (Ballasts for linear fluorescents may become subject to MEPS, but the share of household lighting energy use by such fittings is small);
- **home heating and cooling:** unlike refrigeration, water heating and major appliances the consumption of heating and cooling is far from saturation. There is considerable scope to increase heating hours (and cooling hours, after acquisition of an air conditioner) and areas of the house heated or cooled. Although these end uses are covered by device labelling and “upstream” programs impacting on dwelling thermal efficiency, the interaction and combined effectiveness and of these programs has yet to be determined.

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