Australian Bureau of Statistics

Energy and Greenhouse Gas Emissions Accounts, Australia

1992–93 to 1997–98

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AUSTRALIAN BUREAU OF STATISTICS

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INQUIRIES

- For further information about these and related statistics, contact Bob Harrison on Canberra 02 6252 7369, or the National Information Service on 1300 135 070.

CONTENTS

LIST OF TABLES AND GRAPHICS

INTRODUCTION

SUPPLY AND USE TABLES

PREFACE

This is one of a series of Australian Bureau of Statistics (ABS) publications reporting on estimates of Australia's naturally occurring resources. It presents a set of statistics on Australia's energy resources, as well as greenhouse gas emissions associated with the combustion of these resources. It is part of a broader project being undertaken by the ABS on environmental accounts. Statistics on the supply and use of energy resources have been presented in an environmental accounting framework.

This publication also contains experimental estimates of indirect energy use (and greenhouse gas production), or energy embodied in goods and services produced in Australia. These estimates are based on input-output analysis techniques and are the result of the integration of physical data with ABS monetary input-output tables.

Many individuals and organisations provided data for inclusion in this publication. The ABS wishes to acknowledge the contribution from Federal and State government departments, and a range of private sector organisations that provided data for this project. Without their contributions this publication would not have been possible.

The ABS is also indebted to many people who willingly provided their time to review the draft manuscript.

In Australia, environmental accounting is still a relatively new endeavour. Suggestions and comments on this ABS publication, or environmental accounting in general, would be greatly appreciated and should be sent to the Director, Environment and Energy Statistics Section, Australian Bureau of Statistics, PO Box 10, Belconnen, ACT 2616.

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LIST OF ABBREVIATIONS AND OTHER USAGES

ABBREVIATIONS

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ACA	Australian Cogeneration Association
AGA	Australian Gas Association
AGO	Australian Greenhouse Office
AGSO	Australian Geological Survey Organisation
AHECC	Australian Harmonised Export Commodity Classification
BMR	Bureau of Mineral Resources
BRS	Bureau of Resource Sciences
CAPEX	capital expenditure
CNG	compressed natural gas
COP6	Sixth Conference of Parties
DPIE	Department of Primary Industry and Energy
DRC	direct requirement coefficients
EDR	economic demonstrated resources
EPA	Environment Protection Authority
ESAA	Electricity Supply Association of Australia
GDP	gross domestic product
GWP	global warming potential
HTISC	Harmonised Tariff Item Statistical Code
I-O	input-output
IEA	International Energy Agency
IFR	inferred resources
IOIG	Input-Output Industry Group
IOPC	Input-Output Product Classification
IVA	industry value added
LNG	liquefied natural gas
LPG	liquefied petroleum gas
NGGI	National Greenhouse Gas Inventory
NGGIC	National Greenhouse Gas Inventory Committee
NPV	net present value
OECD	Organisation for Economic Co-operation and Development
OVC	other volume change
SDR	sub-economic demonstrated resources
SEEA	System of Integrated Environmental and Economic Accounting
SNA	System of National Accounts
TPES	total primary energy supply
TRC	total requirement coefficients
UN	United Nations

SYMBOLS AND OTHER USAGES

Bcm	billion cubic metres
CH_4	methane
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
Gg	gigagram
GJ	gigajoule
GL	gigalitre
kWh	kilowatt hour
N_2O	nitrous oxide
n.a.	not available
n.e.c.	not elsewhere classified
PJ	petajoule
TJ	terajoule
—	nil or rounded to zero (including null cells)
. .	not applicable

CHAPTER 1 INTRODUCTION

BACKGROUND

Energy is a vital input to all sectors of an economy. Many industries are highly dependent on the supply and use of energy in its various forms to operate effectively. Society, in general, is afforded an increased standard of living with the utilisation of energy resources.

Energy production and consumption is also a major source of human-generated greenhouse gases, with fossil fuel production and use responsible for about three-quarters of man-made (that is, anthropogenic) carbon dioxide emissions (the main greenhouse gas). Emissions related to energy use can also contribute to local and regional atmospheric pollution problems.

This publication presents information on:

- the supply, use and stock of primary energy resources;
- the supply and use of secondary energy products; and
- greenhouse gas emissions associated with the use of these energy resources.

Primary energy products include raw materials such as: non-renewable fossil fuels such as coal, oil and gas; uranium concentrates; as well as renewable fuels such as solar, wood, bagasse etc.

Secondary energy products or sources are those that have been derived from a primary energy source. That is, primary energy sources are enhanced or changed in state to create a secondary product before consumption. Secondary energy products include thermal electricity, which is derived mainly from coal, and refined petroleum products (e.g. automotive petrol)—derived from crude oil. It is worth noting that, although hydro-electricity can be considered a primary energy source, it is treated as secondary in the supply and use tables for ease of comparison with thermal electricity generation.

This publication presents information from a number of different sources, relating to a number of different years. Due to the varying classification systems, definitional differences, presentational styles and various states of revision of data sources, it is not always possible to reconcile the data from the different sources. It should be noted that some differences may also occur between the published National Greenhouse Gas Inventory (NGGI) (AGO 2000) and data presented here. The NGGI is prepared according to guidelines set out by the UN Framework Convention on Climate Change and emissions are presented by source category rather than by end users. The National Greenhouse Gas Inventory is the official source of greenhouse gas statistics for Australia.

BACKGROUND *cont.*

Australia, as a nation, is highly dependent on energy resources. In addition to being one of the world's largest exporters of coal, Australia's per capita energy consumption is one of the highest in the world, with a heavy reliance on fossil fuels. Australia has a higher dependence on fossil fuels for electricity production (90%) than most other countries or regions in the world.

Australia's trends in energy production and use are a reflection of the abundance of the nation's fossil fuel and mineral energy resources. In 1997–98, Australia's coal, oil, gas and uranium reserves totalled over 2 million PJ, worth around $76 billion. Tables 1.18 and 1.19 present these details by energy asset. More than 65% of primary energy supply was exported in 1997–98 (mainly coal and uranium concentrates), contributing over $13 b, or around 15%, to total exports.

Crude oil is the exception, with imports outweighing exports of this product. Although exports of this material have increased by around 46% since 1992–93, they represented only 6% of Australia's exports of primary energy in 1997–98.

Australia's wealth of fossil fuel resources, especially coal, combined with our high rates of electricity consumption and transport use, poses specific problems for Australia in achieving substantial reductions in greenhouse gas emissions. The combustion of fossil fuels is the major contributor to Australia's greenhouse gas emissions (about 73% of net emissions, excluding land clearing, in 1997–98).

In particular, turning coal into electricity involves sizeable losses of energy in the transformation process. For every one unit of electricity generated, about three units of coal must be burnt, a relatively greenhouse expensive process. Hence, electricity generation accounts for about one half of Australia's energy-related greenhouse gas emissions. Promoting greater use of renewable energy is one aim of Australian governments in addressing greenhouse gas reductions (in 1997–98, renewable energy sources provided under 6% of Australia's domestic energy requirements). Recent government initiatives have set a mandatory target for electricity retailers to source an additional two per cent of their electricity from renewable energy sources by 2010. Introduction of new power plant energy efficiency standards over the next few years is another measure being taken to reduce emissions, as are strategies aimed at increasing the use of alternative fuels such as compressed natural gas (CNG) and liquefied petroleum gas (LPG).

Energy use by transport is a major contributor to Australia's energy-related greenhouse gas emissions. Total transport activity, including industrial and domestic use of motor vehicles, contributes about one quarter of these emissions. In the following tables, motor vehicle use by industry and households is allocated to these using sectors, thus the road transport *industry* excludes those activities undertaken by other industries and households. For an analysis of total transport *activity*, see chapter 3.

Overall, about 23% of Australia's energy-related greenhouse gas emissions are generated in the production of exports (valued at over $83 b in 1994–95). Households are ultimately responsible for around 56% of total (energy-related) emissions, mainly through electricity consumption and motor vehicle use. Promoting energy efficiency in industry and in the household sector is another measure being undertaken by governments to reduce Australia's greenhouse gases.

AN OVERVIEW OF ENERGY SUPPLY AND USE

Diagram 1.1 presents an overview of net energy supply and use in Australia for 1997–98. Total net energy accounts for the transformation process of a primary energy product to a secondary energy product (and related conversion losses). In this way, estimates for total net energy avoids double-counting the amount of converted primary energy.

Australia's total energy supply is comprised of Australian production of energy, plus imports of energy products, with imports contributing only a small amount to Australia's total energy supply (less than 10%).

Most of Australia's total energy supply is exported (more than 66% in 1997–98), the bulk of which is unrefined materials in the form of coal and uranium concentrates. These make up around 85% of total energy exports, with almost 98% in the form of primary energy (not shown).

Of the 4,824 PJ available for domestic consumption in 1997–98, about 30% of this is lost in the conversion process of a primary energy product to a derived product (1,442 PJ).

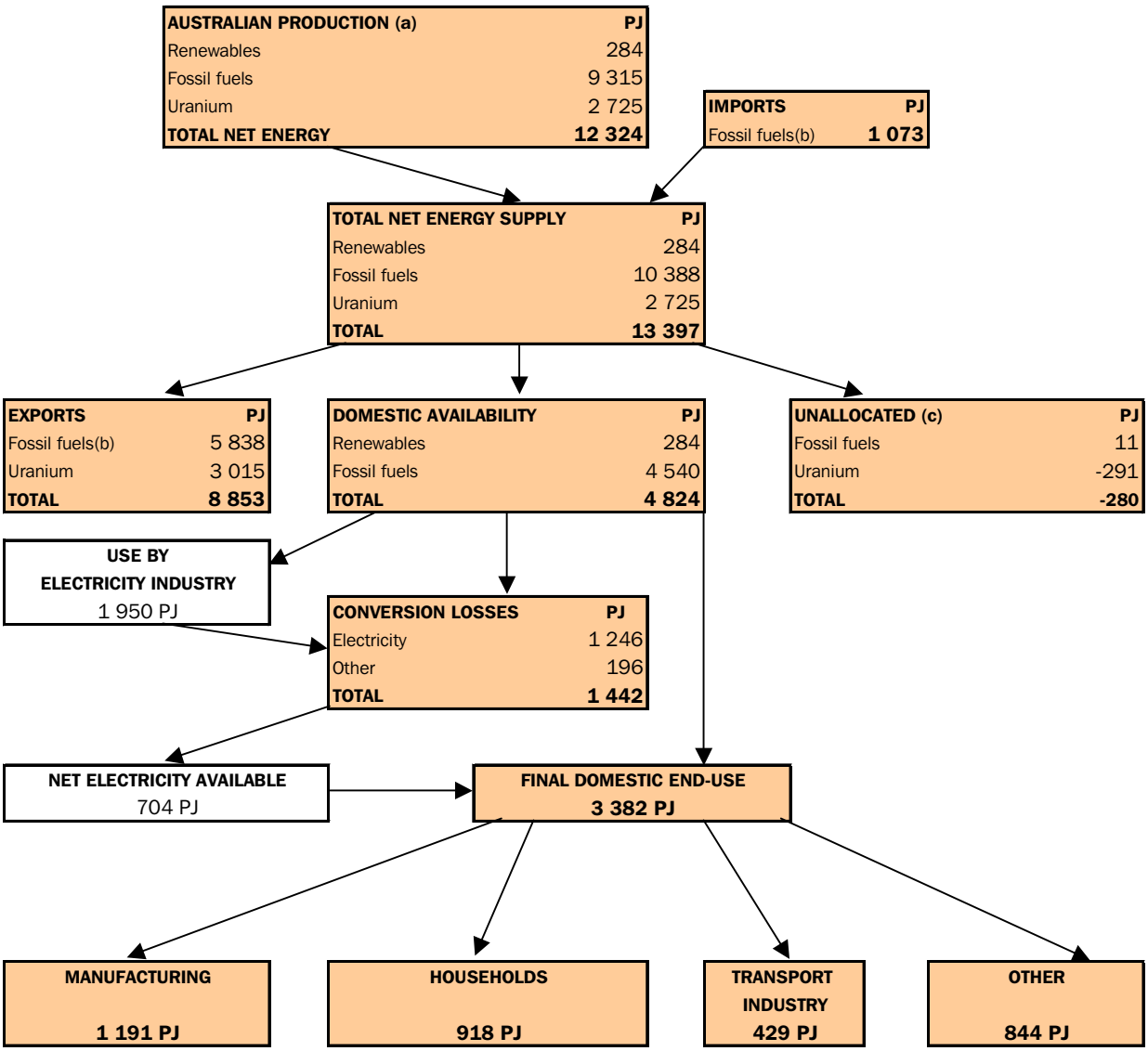
The bulk of this loss is due to the generation of electricity, which consumed 40% of domestically available energy in 1997–98 (1,950 PJ). More than 63% of this amount is lost in the conversion of the primary fuel (mainly coal) to electricity, resulting in energy for final domestic end-use totalling 3,382 PJ.

Of this available energy, the manufacturing industry used about 35%, or 1,191 PJ. (Many of the products of industry are ultimately consumed by households.) Direct household consumption of energy amounted to 27%, or 918 PJ, with automotive petrol and electricity the major forms of energy used.

The transport industry—which excludes road transport activity of households and other industries—used a further 13%, with mining, construction and all other service industries combined consuming the remaining 25%. Overwhelmingly, domestic fuel use is dominated by the fossil fuels coal, oil and gas, and their derivatives. Renewable energy, comprising bagasse, firewood, solar energy and hydro-electricity, accounted for about 6% of the domestically available energy.

Chapter 2 provides a detailed look at gross energy consumption, by fuel type, for the years 1992–93 to 1997–98. These tables show the gross consumption of fuels by all industries and households, including the energy transformation industries (e.g. electricity supply). These figures are of particular interest in the consideration of the direct generation of greenhouse gas emissions.

1.1 NET(a) ENERGY SUPPLY AND USE, Australia—1997–98



(a) Excludes domestically produced secondary energy. This avoids double-counting the amount of converted primary energy.

(b) Includes secondary energy products.

(c) Unallocated products and change in inventories.

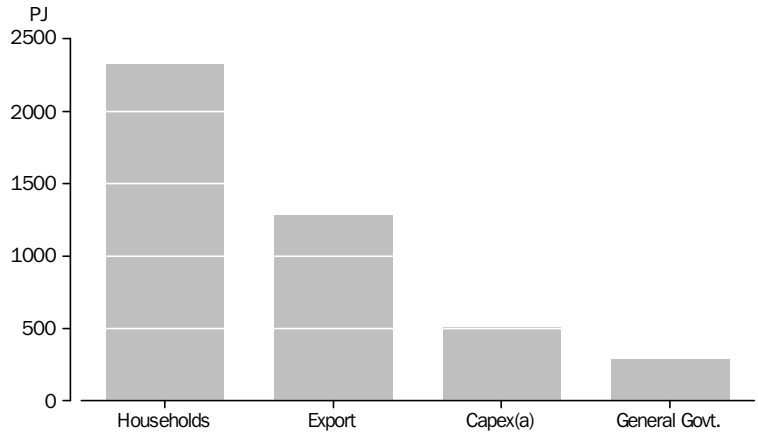
ENERGY USED INDIRECTLY BY FINAL CONSUMPTION

Diagram 1.1 presented information for 1997–98 on the overall supply and use of energy in Australia, the bulk of which is exported as raw material. The amount of energy combusted domestically is of particular interest in relation to Australia's attempts to reduce the amount of greenhouse gases emitted by energy-consuming activities, given Australia's heavy reliance on fossil fuel use.

The following analysis is based on input-output modelling for the 1994–95 year, although the derived proportions are expected to remain fairly stable from year to year. The amount of energy combusted domestically totalled 4,419 PJ in 1994–95. Graph 1.2 looks at the amount of energy used directly and indirectly by the final users of the goods and services. These final users may not necessarily use energy directly, but they are considered to be using energy *indirectly* by the consumption of products—i.e. *inducing* the consumption of energy. See chapter 4 (diagram 4.2) for a diagrammatic representation of the reallocation of energy to final uses.

Over half of the total energy combusted domestically (53%) was used either directly or indirectly by households through consumption of products. Goods and services produced for export made up a further 29%; gross capital formation induced 11% (e.g. energy embodied in buildings, road, rail, pipeline infrastructure etc.); and government final consumption (mainly government administration and the provision of services such as education, health and community services) directly and indirectly used the remaining 7% of domestically combusted energy.

1.2 ENERGY COMBUSTED IN AUSTRALIA, By Final Use—1994–95



(a) Gross fixed capital formation.

Note: Figures are modelled based on 1994–95 data—see chapter 4 for more details.

Energy used and induced by households and exports

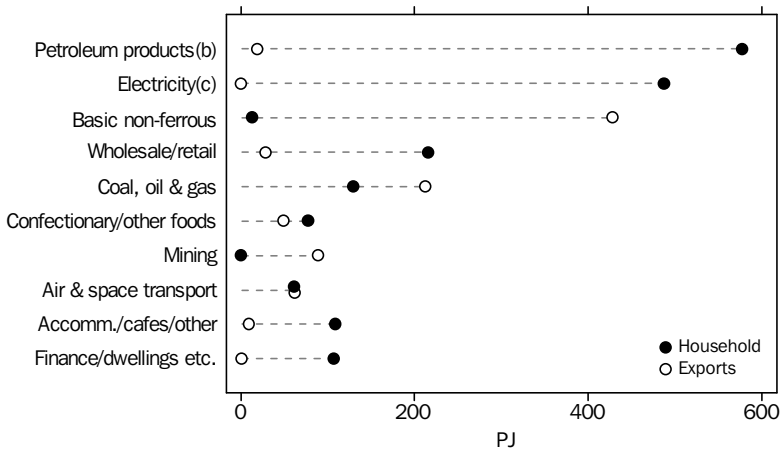
Energy combusted domestically for household final consumption totalled 2,321 PJ and energy used for the production of goods and services for export totalled 1,286 PJ in 1994–95 (includes energy lost in the conversion process).

Petroleum products (mainly motor vehicle fuels) contributed the most (577 PJ or 25%) to energy combusted domestically for household consumption, followed by household electricity (487 PJ) (graph 1.3). Household consumption of wholesale, retail and repairs also induced significant amounts of energy to be consumed (215 PJ).

For export, the biggest contributor was basic non-ferrous metals and products, due to the large amount of electricity used in their production (428 PJ). About 64% of the energy used in the consumption of electricity to produce these products for export is due to conversion losses.

Chapter 4 contains more detailed analyses of energy demand induced by the consumption of different product types. In particular tables 4.5 and 4.6 provide a disaggregation of energy use separately into its direct and indirect components.

1.3 ENERGY COMBUSTED IN AUSTRALIA, By Product Type(a)—1994–95



(a) Ten product types that use the largest amount of energy for household final consumption or exports.

(b) Produced domestically from crude oil. Includes conversion loss from crude oil to derived product.

(c) Includes conversion loss from primary fuel to derived product. Excludes hydro-electricity.

AUSTRALIA AND THE REST OF THE WORLD

Table 1.4 shows key energy indicators for major world regions and Australia for 1997, based on statistics from the International Energy Agency (IEA). Terms and definitions are those used by the IEA and are defined in the tables where appropriate. Australia's contribution to world total primary energy supply (TPES—equivalent to net consumption of energy) and total carbon dioxide emissions from fuel combustion is relatively small (1.0% and 1.3%, respectively). However, Australian carbon dioxide emissions, total primary energy supply and electricity consumption per capita were higher than the averages for all major world regions, with the exception of North America (Canada and the United States). Australia's per capita carbon dioxide emissions were more than four times the world average and nearly 50 per cent greater than the average for OECD countries.

Graph 1.5 compares Australia's total primary energy supply (net energy consumption) per capita since the early 1970s with a number of other developed countries as well as Asia. Australia's per capita total primary energy supply has increased steadily since 1971, contrasting with the world trend of fairly stable and much lower, per capita total primary energy supply.

1.4 SELECTED ENERGY INDICATORS FOR WORLD REGIONS AND AUSTRALIA—1997

Selected regions/countries	*TPES(a)* PJ	*TPES/pop* GJ/capita	*CO_2(b)* Mt	*CO_2/pop* t CO_2/capita	*Elect cons/pop* GJ/capita	*TPES/GDP(c)* GJ/$US'000	*CO_2/GDP(c)* kg CO_2/$US'000
World	*404 185*	*69.9*	*22 981.1*	3.97	*8.1*	*12.3*	*699*
OECD	212 166	194.0	12 235.0	11.18	27.5	11.1	640
Europe	64 694	172.9	3 477.8	7.73	18.6	10.0	537
Middle East	14 876	95.2	955.9	6.12	7.6	21.9	1 408
Former USSR	37 928	130.0	2 257.2	7.74	13.4	35.1	2 090
Non-OECD Europe	5 049	80.9	309.1	4.95	10.8	21.0	1 283
Asia	43 748	24.1	2 034.1	1.12	1.8	11.0	510
Latin America	18 493	46.6	878.8	2.22	5.2	8.6	408
Africa	19 783	26.9	729.4	0.99	1.8	15.4	569
Canada	9 965	329.0	477.4	15.76	61.1	16.8	805
United States	90 527	339.3	5 470.5	20.50	47.3	13.7	825
China	46 603	37.8	3 162.0	2.56	3.1	10.7	727
Australia	**4 254**	**229.6**	**306.1**	**16.52**	**33.3**	**12.3**	**887**

(a) Total primary energy supply (defined as domestic production plus imports minus exports minus international marine bunkers plus/minus stock changes). This is equivalent to total domestic availability of energy, or net energy consumption.

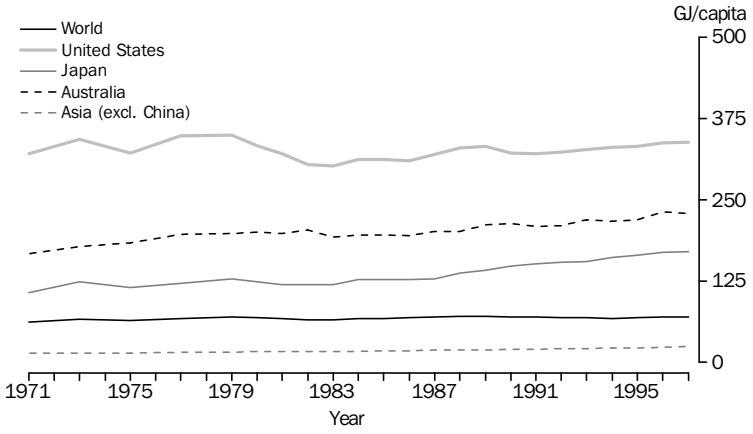
(b) From fuel combustion.

(c) Using purchasing power parities.

Source: OECD/IEA 2000a; 2000b.

AUSTRALIA AND THE REST OF THE WORLD *cont*.

1.5 TOTAL PRIMARY ENERGY SUPPLY(a) PER CAPITA—1971–1997



(a) Total primary energy supply consists of: domestic production plus imports minus exports minus international marine bunkers plus/minus stock changes.

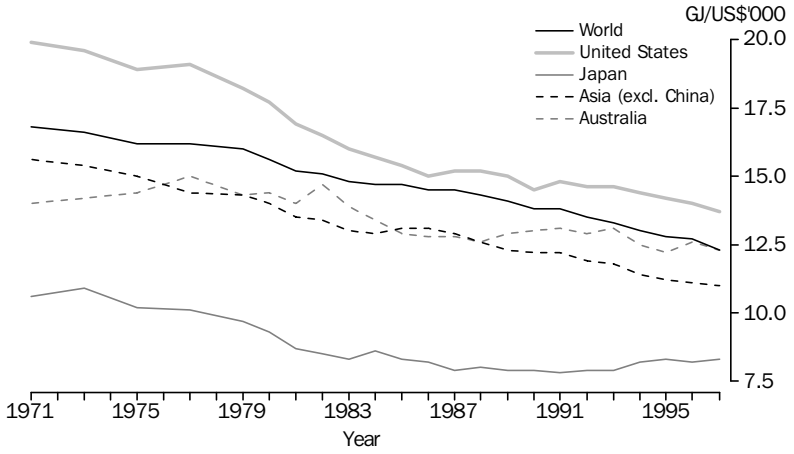
Source: OECD/IEA 2000a; 2000b.

Changes or differences in energy intensity have traditionally (but not in this publication) been interpreted as a measure of changes or differences in energy efficiency. Appendix 3 contains details on the differences and the relationship between energy intensity and energy efficiency.

In the following, energy intensity is simply calculated by dividing the total primary energy supply (TPES) by gross domestic product (GDP). Australia's energy intensity is slightly higher than the OECD average, and its greenhouse gas emissions intensity is more than 25% greater than the OECD average (table 1.4). This reflects Australia's economic structure and the fact that Australia has relatively more highly energy intensive industries than the OECD average, and the significant role coal plays as a fuel source in these industries, and particularly for power generation.

Since the early 1970s, world energy intensity has been showing a decline (graph 1.6). Over this period, Australia's energy intensity has shown some variability, with the overall decline in aggregate energy intensity less pronounced since the mid 1980s than most of the other regions presented. By contrast, the United States has achieved quite a dramatic reduction in aggregate energy intensity since the mid 1970s, although the overall level remains higher than Australia (and the world).

1.6 ENERGY INTENSITY(a), Selected Countries/Regions—1971–1997



(a) Measured in terms of total primary energy supply/GDP (using purchasing price parities).

Source: OECD/IEA 2000a; 2000b.

Energy use, greenhouse gases and the economy—Australia

Graphs 1.7 and 1.8 show estimates of energy and greenhouse intensities for selected industries, based on information in table 1.9. These should be looked at in association with the data in table 1.9, to assess the overall contribution these industries make to energy consumption/greenhouse production and the economy.

These data are based on the 1994–95 financial year, corresponding with the 1994–95 input-output financial tables. Input-output relationships have been found to be reasonably stable over time. Therefore those derived for 1994–95 would generally be applicable for more recent reference years but would be expected to become less accurate as the reference year moves from this base year.

Energy use per million dollars of Australian production indicates the amount of energy needed directly to produce $1m of output by that industry. Similarly, greenhouse gases emitted per million dollars of Australian production indicates the amount of greenhouse gases generated directly to produce $1m of output by that industry. Industry value added is another common measure of economic contribution and some studies may compare energy use to this instead of to output. Estimates of industry value added are therefore included as well as those of output in table 1.9.

Electricity generation is the largest user of total energy, and by far the largest direct emitter of greenhouse gases, due to the predominant use of coal to generate electricity, and the relative inefficiency of this process. Electricity production emits just over 10 Gg of carbon dioxide equivalent emissions (CO_2-e) per million dollars of Australian production (graph 1.8).

Energy use, greenhouse gases and the economy—Australia *cont.*

Manufacturing of petroleum and coal products is the second largest industrial user of energy (just under 30% of total energy consumption by industry in 1994–95), and ranks as the most energy intensive industry in terms of energy use per million dollars of Australian production (184 TJ/$m) (graph 1.7). This industry ranked 8th in greenhouse intensity, emitting 0.8 Gg CO2-e per million dollars of Australian production. A large portion of this industry's energy use, and related greenhouse emissions, is due to the conversion of crude oil, a primary energy product, to secondary energy (petroleum) products. Crude oil is therefore used as a feedstock and not as a fuel in this instance.

Coke (and coal by-products) is produced by the iron and steel industry, and the energy use and emissions associated with this production is included in iron and steel.

Non-energy industries

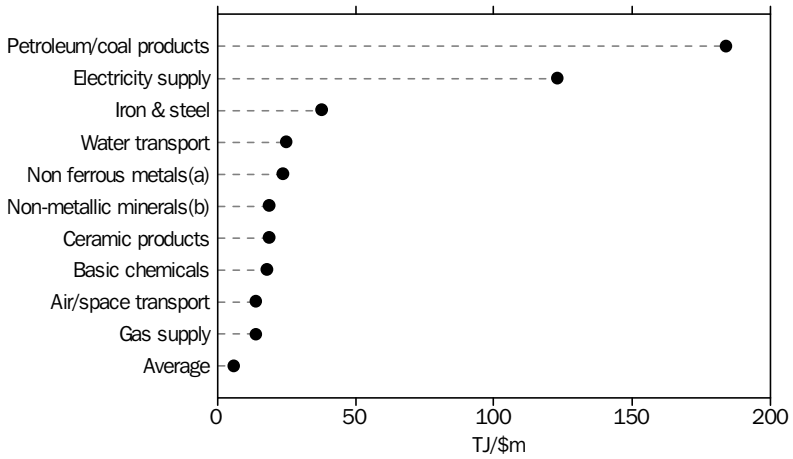
Of the other goods and services producing industries, iron and steel, and basic non-ferrous metals and products, were the largest energy users. Around 14% of total energy consumed by the iron and steel industry was used in the production of coke (not shown). As well as consuming about 13% of total energy used by industries in Australia in 1994–95, these industries ranked as the 3rd (iron and steel), and 5th (basic non-ferrous metals) most energy-intensive industries in terms of energy use per million dollars Australian production. Basic non-ferrous metals and products use a large amount of electricity and natural gas in their production process, whereas iron and steel is a particularly large user of coal products (including coke). These industries also rank highly as greenhouse gas intensive industries (graph 1.8).

Other greenhouse gas intensive producers (excluding energy producing industries) included water transport and air and space transport. Of these industries, air and space transport emitted a total of 11,361 Gg CO_2-e (4% of industry emissions). Water transport emitted 4,754 Gg CO_2-e in total.

The least energy and greenhouse-intensive industries include most of the service industries (0.03 Gg CO_2-e or less per million dollars Australian production), and some manufacturing industries including: beverages; tobacco; textiles, clothing and footwear; fabricated metal products; and transport equipment/other manufacturing. Each of these industries produced 0.05 Gg CO_2-e or less of greenhouse gas emissions per million dollars Australian production. Most of these industries are also large employers.

Although these industries are not large direct producers of emissions, these figures should be looked at in association with data presented in chapter 4 on greenhouse gases indirectly produced by final users. Graph 1.17 shows that the consumption (mainly by households) of many of the products provided by some of the service industries (e.g. wholesale, retail and repairs) contributes quite significantly to total greenhouse gas emissions. In other words, the supply of these products and services (mainly to households) is ultimately dependent on the more greenhouse-intensive industries such as electricity supply, transport services, and products manufactured by other industries. Any shift towards less energy-intensive and greenhouse-intensive service (or other) industries, and/or increased household consumption of these products, would need to be in conjunction with more efficient and/or less polluting energy producing technologies to promote substantial greenhouse reduction measures.

1.7 ENERGY USE (TJ) PER $1M AUSTRALIAN PRODUCTION, Top Ten—1994–95

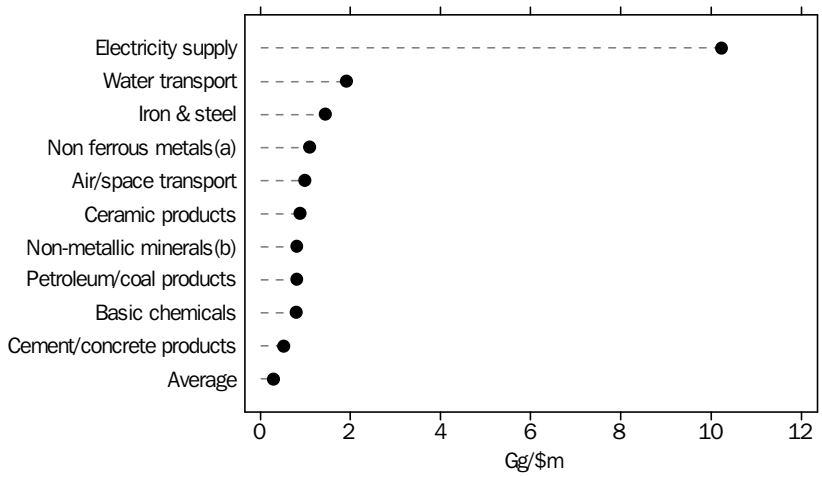


(a) Includes metal products.

(b) Includes mineral products.

Note: In this situation crude oil is used as a feedstock and not a s a fuel.

1.8 EMISSIONS PER $1M AUSTRALIAN PRODUCTION, Top Ten—1994–95



(a) Includes metal products.

(b) Includes mineral products.

Note: Figures are in Gg carbon dioxide equivalents (CO_2-e). See Glossary for more details.

1.9 ENERGY USE, EMISSIONS AND ECONOMIC INDICATORS, By Industry—1994–95

Industry	Total gross energy use PJ	Total emissions Gg CO_2-e (a)	Australian production $m	Industry value added(b) $m	Employed persons(c) no.	Exports $m
Petroleum and coal products	1 654.3(d)	7 390	8 986	892	6 938	729
Electricity supply	1 708.6	141 773	13 848	7 926	50 000	27
Coal; oil and gas mining	184.5	7 577(e)	16 907	11 086	27 175	9 556
Other mining	75.5	4 719	18 926	8 819	57 700	9 274
Agriculture, forestry and fishing	104.4	6 518	29 811	12 947	357 550	5 391
Meat and meat products	16.4	744	10 627	1 787	50 913	4 071
Dairy products	15.4	747	6 148	1 228	14 375	1 516
Fruit and vegetable products	6.6	325	2 960	898	8 875	353
Oils and fats	3.3	159	810	198	888	67
Flour mill products and cereal foods	6.4	310	2 920	724	8 750	449
Bakery products	5.5	221	2 899	1 212	35 250	164
Confectionery, other food products	109.2	902	9 941	2 880	33 425	2 888
Beverages	8.0	338	6 406	1 918	13 663	855
Tobacco products	1.1	47	935	284	2 800	154
Textiles, clothing and footwear, leather	12.8	617	11 792	2 841	95 800	2 329
Wood and wood products, printing and publishing	76.7	2 494	25 438	9 532	169 575	1 095
Basic chemicals	104.7	4 620	5 763	1 509	19 588	1 128
Other chemicals, rubber and plastic	30.8	323	16 602	5 089	75 388	1 290
Glass and glass products	11.6	541	1 180	517	7 838	66
Ceramic products	28.4	1 285	1 457	624	15 938	63
Cement, lime, plaster and other concrete products	42.8	2 852	5 518	1 753	20 100	35
Other non-metallic mineral products	15.2	676	819	337	5 963	84
Iron and steel	379.0	15 836	10 957	3 632	40 063	1 601
Basic non-ferrous metal and products	304.4	13 832	12 589	2 876	27 000	7 567
Fabricated metal products	13.6	489	12 803	4 345	107 750	591
Transport equipment and other machinery	26.2	819	37 828	11 363	222 050	5 774
Other manufacturing	9.5	98	5 996	1 997	77 938	420
Gas supply(f)	22.4	639	1 599	976	7 538	—
Water supply; sewerage and drainage services	7.2	121	6 081	3 785	28 088	7
Construction	66.6	4 582	58 423	25 260	547 000	121
Wholesale, retail, repairs	103.6	3 482	115 382	50 202	1 404 825	7 410
Road transport	125.7	8 475	21 317	8 166	164 563	1 545
Rail, pipeline, services to transport	63.6	4 520	22 834	13 946	143 450	2 694
Water transport	62.2	4 754	2 496	627	8 800	1 837
Air and space transport	162.7	11 361	11 439	3 640	41 238	3 262
Communication services	6.3	189	20 642	11 616	140 300	845
Finance and insurance, ownership of dwellings, property and business dwellings	36.0	1 145	192 319	108 019	945 313	3 412
Government administration	24.1	664	38 748	19 268	398 158	183
Education, health and community services	44.8	1 717	62 330	47 422	1 052 025	1 824
Other services, accommodation and cafes	31.5	1 006	57 586	26 467	703 938	2 691
TOTAL	**5 711.3**	**258 908**	**892 062**	**418 608**	**7 138 520**	**83 365**

(a) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

(b) These estimates relate to industries' *factor incomes* which is industry value added (IVA) net of taxes and subsidies on products and imports paid by the industries. See Industry value added in the Glossary for more details.

(c) Full-time equivalent.

(d) In this situation crude oil is actually used as a feedstock and not a fuel.

(e) It should be noted that most emissions associated with Coal, oil and gas mining arise from the production of LNG.

(f) Production of LNG is included under Coal, oil and gas mining. See footnote (e).

Source: ABS input-output tables.

State Estimates

ABARE estimates of energy consumption include energy use by industries as well as households, thus high estimates may reflect the presence of energy intensive industries in the affected States and years. The data show per capita consumption of energy for Australia increased from 231 GJ/capita in 1992–93 to 255 GJ/capita in 1997–98, an increase of 10% over this period.

New South Wales and Victoria were the largest consumers of energy (1,382 PJ and 1,280 PJ in 1997–98, respectively). Together these States consumed about 56% of Australia's domestically available energy. New South Wales, however, was one of the lowest per capita consumers of energy, with only Tasmania using less energy per capita in 1997–98 (table 1.10).

Northern Territory and Western Australia were the largest per capita consumers of energy, at 368 GJ/capita and 362 GJ/capita, respectively, in 1997–98. These States (and Queensland) have experienced quite rapid growth in energy consumption since the mid 1970s. This is due mainly to the concentration of a number of strongly growing energy intensive industries, particularly in the mining and minerals processing sectors in these States (Bush et al. 1999).

Queensland and Western Australia continued to experience the largest increase in per capita energy consumption between 1992–93 and 1997–98, at 15% and 16%, respectively. South Australia's per capita energy use showed a gradual decline between 1993–94 and 1995–96, but has shown an increase since then, with its highest per capita use in 1997–98 (210 GJ/capita) since 1992–93. South Australia has been importing electricity from Victoria since 1989–90. This has led to a reduction in the use of energy for electricity generation in South Australia and a corresponding increase in Victoria. These imports have increased significantly since the deregulation of the Victorian electricity industry in the mid 1990s.

The Northern Territory (includes South Australia), Queensland and New South Wales totalled 7,859 PJ of Australia's energy exports (table 1.11). This was nearly 90% of Australia's total energy exports. The large increase in exports between 1992–93 and 1997–98 was mainly attributed to the Northern Territory/South Australian uranium exports over this period.

1.10 ENERGY CONSUMPTION(a), By State

	1992–93	*1993–94*	*1994–95*	*1995–96*	*1996–97*	*1997–98*
	PJ	PJ	PJ	PJ	PJ	PJ
New South Wales(b)	1 249	1 277	1 315	1 351	1 381	1 382
Victoria	1 105	1 103	1 152	1 185	1 203	1 280
Queensland	759	793	847	883	914	967
South Australia	300	305	304	297	300	312
Western Australia	522	554	593	630	650	663
Tasmania	90	92	92	93	95	96
Northern Territory	57	59	62	67	70	70
Australia	**4 082**	**4 182**	**4 366**	**4 506**	**4 611**	**4 778**
	PER CAPITA (GJ/CAPITA)					
New South Wales(b)	198.1	200.7	204.5	207.4	209.9	207.8
Victoria	247.1	245.8	255.0	259.9	261.2	274.6
Queensland	244.1	248.8	242.9	264.5	269.1	279.8
South Australia	205.4	208.0	206.9	201.5	202.7	209.8
Western Australia	311.1	325.3	342.0	356.9	361.0	362.0
Tasmania	190.8	194.5	194.2	196.0	200.6	203.4
Northern Territory	333.9	340.3	349.2	368.4	374.5	368.4
Australia	**231.1**	**234.3**	**241.6**	**246.1**	**249.0**	**254.9**

(a) Total energy consumption is the total quantity (in energy units) of primary and derived fuels consumed less the quantity of derived fuels produced. Note that these figures also include solvents, bitumen, lubricants and greases.

(b) Includes Australian Capital Territory.

Source: Bush et al. 1999; ABARE 2000.

1.11 ENERGY EXPORTS, By State

	1992–93	*1993–94*	*1994–95*	*1995–96*	*1996–97*	*1997–98*
	PJ	PJ	PJ	PJ	PJ	PJ
New South Wales	1 642	1 658	1 674	1 765	1 910	2 150
Victoria	196	207	158	199	227	249
Queensland	2 121	2 119	2 300	2 275	2 334	2 545
South Australia/Northern Territory	1 325	2 079	2 085	2 641	2 859	3 164
Western Australia	324	363	559	588	630	736
Tasmania	—	—	—	—	—	—
Australia(a)	**5 617**	**6 430**	**6 780**	**7 470**	**7 961**	**8 853**

(a) Includes refinery products.

Source: ABS international merchandise trade (unpub); Bush et al. 1999.

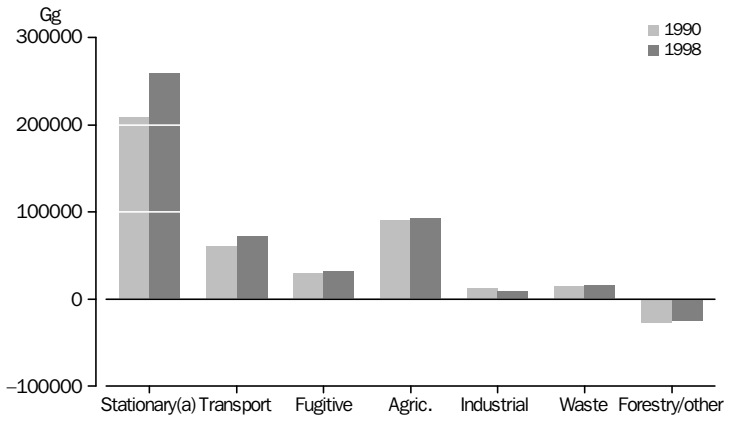
AUSTRALIA'S GREENHOUSE GASES

In December 1992, Australia ratified the United Nations Framework Convention on Climate Change, the main objective of which was to achieve a stable level of greenhouse gas concentrations in the atmosphere that would prevent dangerous human-induced interference with the climate system (AGO 1998b). In 1995, a review was made of the adequacy of commitment of the developed countries. This led to negotiations on strengthening their commitments and resulted in the birth of the Kyoto Protocol in December 1997.

Australia was actively involved in the Kyoto negotiations and argued for differential emissions targets depending on circumstances in each country. Australia was allocated a target of restricting emissions to a maximum of eight per cent above 1990 levels in the budget period 2008 to 2012. Factors considered in setting Australia's targets were its current dependence on fossil fuels and relatively high economic and population growth rates. At the Sixth Conference of the Parties (COP 6) held in The Hague in the Netherlands in November 2000, negotiations failed to reach final agreement on key issues of the mechanisms, compliance, carbon sinks, and the role of the developing counties, in the whole process of the protocol. At this stage Australia, and others, have not yet ratified the Kyoto agreement.

In 1998, fuel combustion (stationary energy and transport) generated almost three-quarters (about 73%) of Australia's net greenhouse emissions, excluding land clearing. Other contributors included: agricultural emissions (about 20%); fugitive emissions from fuels (7%); industrial processes and waste (2% and 3%, respectively); with forestry (and other) constituting a sink equivalent to about 5% of emissions (graph 1.12).

1.12 GREENHOUSE GAS EMISSIONS (CO_2-e), By Sector



(a) Stationary energy.

Source: AGO 2000.

Note: Figures in this publication refer to Stationary energy and Transport-related emissions. Greenhouse emissions caused by road transport activity have been re-allocated to industries and the household sector undertaking the activities.

AUSTRALIA'S GREENHOUSE GASES *cont.*

Graph 1.13 shows the energy sector's emissions of carbon dioxide, nitrous oxide and methane in total from 1992–93 to 1997–98. Detailed data for these three key greenhouse gases are presented in chapter 2. The data only include emissions resulting from fuel combustion. Total carbon dioxide equivalent (CO_2-e) emissions for these three gases increased by 19% over that period from 285,168 to 339,597 tonnes. The largest increase occurred between 1996–97 and 1997–98, with emissions increasing by around 6% between these years.

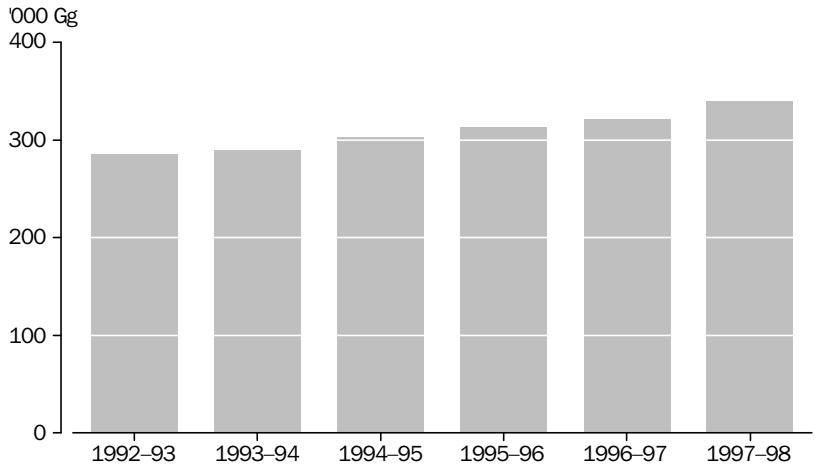
The bulk of the increase over the years is due to increased electricity generation (over 60% of the increase between 1992–93 and 1997–98), although significant increases in emissions also occurred in the manufacturing, transport and mining sectors (graph 1.14).

The electricity supply sector accounted for about half of total energy-related emissions between 1992–93 and 1997–98, with their heavy reliance on the combustion of brown and black coal for electricity generation. In 1998, coal accounted for 80% of the fuel share in electricity generation in Australia. Brown coal in particular is the most emission-intensive fuel for electricity generation, and its share in thermal electricity generation increased between 1992–93 and 1997–98. Chapter 3 takes a more detailed look at electricity generation and thermal efficiencies associated with it. Overall, greenhouse gas emissions increased by 25% between 1992–93 and 1997–98 in this sector.

The manufacturing sector contributed about 17% of total energy-related emissions in 1997–98, and total emissions increased by about 9% between 1992–93 and 1997–98. Two industry groups—iron and steel; and basic non-ferrous metal and products—accounted for over half of this sector's total emissions. See tables 2.30–2.35 for more detail.

Households generated about 13% of greenhouse gas emissions directly in 1997–98, an increase of about 8% from 1992–93. This compares with a population increase of 6% over the same period. The vast majority of this (over 80%) is due to household use of the motor vehicle.

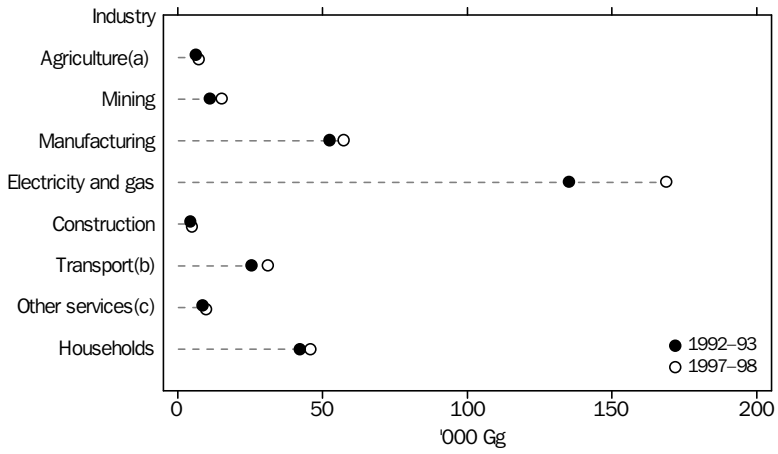
1.13 ENERGY-RELATED(a) GREENHOUSE GASES (CO_2-e)—1992–93 to 1997–98



(a) Emissions resulting from fuel combustion.

Note: Emissions include carbon dioxide, methane and nitrous oxide only.

1.14 DIRECT GREENHOUSE GAS EMISSIONS—1992–93 and 1997–98



(a) Includes hunting and trapping; forestry and fishing.

(b) Road transport activity of households and industries has been re-allocated to the using industry, and households.

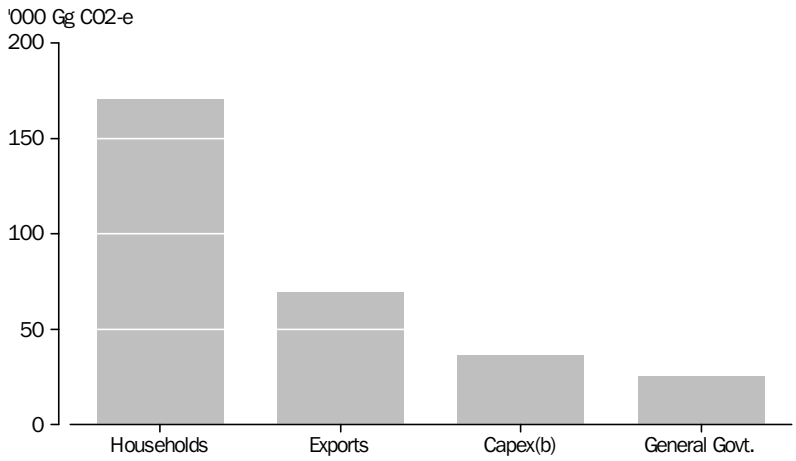
(c) Other services includes water and gas.

Note: Refers to energy-related greenhouse gas emissions. Figures are Gg carbon dioxide equivalents (CO2-e). See Glossary for more details.

Indirect production of greenhouse gas emissions

The previous graph described the direct generation of greenhouse gases by the energy-using industry group, or sector. The bulk of Australia's energy-related greenhouse gases were emitted in the production and consumption of goods and services for the purpose of household final consumption (about 56%—graph 1.15). A further 23% of energy-related emissions were generated in the production of goods and services for export. Other final use categories (general government final consumption, gross fixed capital formation) induced the remaining emissions. Diagram 1.16 describes the direct and indirect production of greenhouse gases, by the final uses.

1.15 GREENHOUSE GAS EMISSIONS(a), By Final Use Category—1994–95



(a) Energy-related emissions produced either directly or indirectly by final use.

(b) Gross fixed capital formation.

Note: Figures are modelled based on 1994–95 data—see chapter 4 for more details.

Indirect production of greenhouse gas emissions *cont.*

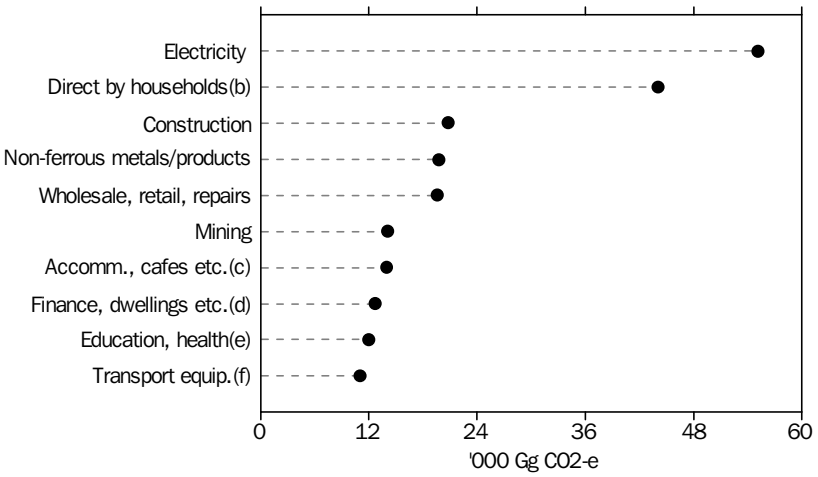
The consumption of electricity by households indirectly produced the greatest amount of energy-related greenhouse gas emissions (over 50,000 Gg CO_2-e). This was followed by direct emissions by households (44,051 Gg CO_2-e), most of which is due to the consumption of motor vehicle fuels (graph 1.16 and diagram 1.17). Household use of motor vehicles totalled nearly 36,000 Gg CO_2-e. Chapter 3 looks at energy use and emissions generated from transport activity in more detail.

Together, household electricity use and motor vehicle use by households, accounted for over 30% of Australia's energy-related greenhouse gas emissions.

Construction also induced a large amount of greenhouse gases due to its use of building materials which were energy-intensive to produce. Basic non-ferrous metals and metal products, produced mainly for export, were the next largest contributor to total greenhouse gas emissions (graph 1.16).

Chapter 4 explores the contribution that the production and consumption of all product types make to Australia's energy-related greenhouse gas emissions—including the final purpose of the product.

1.16 GREENHOUSE GASES INDUCED(a) BY FINAL USE, By Product Type—1994–95



(a) Emissions produced indirectly via consumption of products. The exception is direct emissions by households.

(b) Direct production by households, mainly through motor vehicle use.

(c) Includes restaurants, cultural and recreational services, personal and other services.

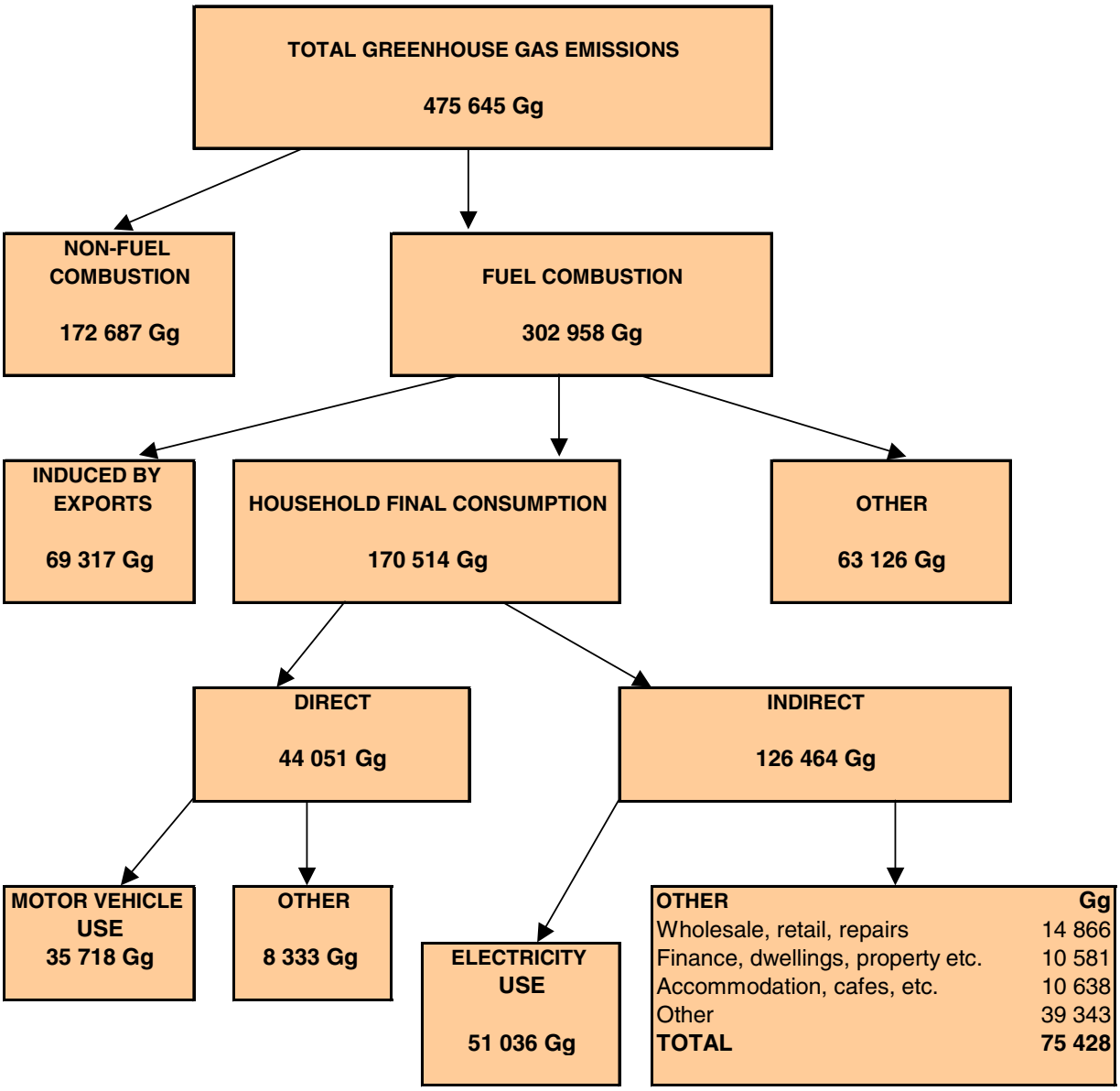
(d) Includes insurance, property and business services.

(e) Includes community services.

(f) Includes other machinery.

Note: Refers to energy-related greenhouse gas emissions only. These figures are modelled based on 1994–95 data—see chapter 4 for more details.

1.17 GREENHOUSE GAS EMISSIONS, Allocated to Final Uses—1994–95



Note: Figures are Gg of carbon dioxide equivalents (CO_2-e). Values may not add due to rounding.

ENERGY STOCKS

Australia's abundance of fossil fuel and mineral reserves underpins our patterns of energy production and use. In 1998, the expected life spans of black and brown coal resources were calculated at over 200 and 700 years respectively (table 1.18). Australia also has the world's largest demonstrated uranium resources, which provide for an export market. In addition, Australia has significant natural gas reserves. Some basins supplying natural gas to eastern States have less than ten years worth of proven resources. However, it is anticipated that increased demand will extend the life of the resource as it becomes economic to further develop reserves and as gas pipeline networks are extended, creating access to new markets. Further exploration may also result in new discoveries.

The net present value of these resources was estimated at $76 b in 1998, with natural gas and black coal accounting for 70% of this total value (table 1.19). The estimated value of energy assets has doubled since 1992–93, mainly as a result of these two products.

1.18 DEMONSTRATED SUB-SOIL ENERGY ASSETS—1998

	Economic demonstrated resource(a)	*5 year lagged moving average of resource life*
	PJ	years
Black coal	1 379 700	258
Brown coal	398 670	744
Crude oil	8 880	9
Natural gas	53 040	48
Condensate	7 141	33
Liquefied petroleum gas	4 576	45
Uranium	285 290	131

(a) Refers to that part of demonstrated resources for which extraction is expected to be profitable over the life of the mine given current prices and costs.

Source: Converted to petajoules from ABS 2000a; AGSO 1998b.

1.19 NET PRESENT VALUE OF ENERGY ASSETS, By Resource Type

	1992	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Resource category	$m	$m	$m	$m	$m	$m	$m
Black coal	3 282	8 164	7 830	12 824	11 706	16 363	25 019
Brown coal	169	288	428	488	541	663	659
Uranium	2 187	1 962	1 631	1 535	1 532	1 642	1 909
Crude oil	13 385	15 646	17 909	18 031	16 644	14 546	12 821
Condensate	2 575	3 196	3 399	4 292	4 553	5 496	5 501
Natural gas	14 770	18 597	20 247	25 476	26 384	28 424	27 904
LPG	1 253	912	1 168	1 682	1 851	2 244	2 090
Total energy assets	**37 621**	**48 765**	**52 612**	**64 328**	**63 211**	**69 378**	**75 903**

Source: ABS 2000a.

CHAPTER 2 SUPPLY AND USE TABLES

INTRODUCTION

Chapter 2 presents the flow tables for the 1992–93 to 1997–98 financial years. The flow tables consist of two parts, the supply and use tables. They show the flow of energy products in petajoules (PJ), from the environment through the production process and finally, consumption by end-users. Greenhouse gas emissions are also presented. These are treated, in environmental accounting, as wastes and residuals resulting from economic activity that are deposited back to the environment.

Input-output concepts and classifications were used to compile the supply and use tables. Further explanation of input-output methodology can be found in the Explanatory notes, as well as in *Australian National Accounts: Input-Output Tables* (Cat. no. 5209.0) and *Australian National Accounts: Input-Output Tables (Product Details)* (Cat. no. 5215.0).

The supply and use of energy is primarily driven by population growth and fluctuations in economic activity. Australia has extensive fossil fuel deposits and thus the cost of extraction and use of these energy sources is relatively low. This comparative advantage in producing energy has created an economy which is heavily dependent on relatively energy intensive industries. The sustained economic growth which occurred in the Australian economy over the reporting period has resulted in increased domestic supply and use of energy to maintain the pace of economic activity. International demand has also resulted in increased exports of primary energy, particularly coal and uranium.

The reliance on fossil fuels as the primary energy source for industrial, commercial and domestic use is important in relation to Australia meeting its greenhouse gas emission targets as identified in the Kyoto Protocol. Conditions imposed to meet these targets will have the greatest impact on those industries which use the most carbon intensive fuels. The use tables show that the electricity supply, manufacturing and transport industries have the highest use of energy products in the economy. Supply of fossil fuel resources has increased steadily between 1992–93 and 1997–98, by over 20%. Directly related to the increase in supply of these fuels is the strong growth in the electricity supply industry. This has impacted on the amount of greenhouse gas emissions generated by this industry (an increase of around 25%, or more than 33,000 Gg CO_2-e between 1992–93 and 1997–98).

SUPPLY TABLE

Table 2.1 shows the supply (domestic production plus imports) of energy products for the 1992–93 to 1997–98 financial years. Data shown in the supply tables are from a number of sources. Imports were sourced from ABS international trade data. Production data were sourced from the Australian Bureau of Agricultural and Resource Economics (ABARE), ABS, Department of Industry, Science and Resources, Electricity Supply Association of Australia and the Australian Gas Association. The energy supply data have been converted to PJ using conversion rates as outlined in the Explanatory notes.

2.1 AUSTRALIAN ENERGY SUPPLY, By Energy Product

	1992–93	*1993–94*	*1994–95*	*1995–96*	*1996–97*	*1997–98*
	PJ	PJ	PJ	PJ	PJ	PJ
Primary						
Firewood	105	108	109	109	110	109
Black coal (all types incl. briquettes)	4 780	4 808	5 177	5 235	5 558	5 980
Brown coal–lignite (all types including briquettes)	467	484	502	525	569	648
Crude oil (including condensate)	1 888	1 880	1 953	2 036	2 107	2 225
Natural gas(a)	994	1 058	1 189	1 222	1 234	1 276
Liquefied natural petroleum gases; oil and gas n.e.c.	141	146	149	156	166	170
Uranium concentrates	1 271	1 293	1 237	2 399	2 818	2 725
Bagasse	78	84	91	102	110	113
Solar	3	3	3	4	4	4
Total	*9 727*	*9 865*	*10 410*	*11 787*	*12 676*	*13 250*
Secondary						
Automotive petrol; gasolene refining or blending; motor spirit(b)	625	642	642	664	672	674
Kerosene (incl. kerosene type jet fuel)	158	164	176	193	202	204
Gas oil or fuel oil(c)	594	596	616	634	652	650
Refinery products n.e.c.	88	91	97	98	98	97
Coal by-products	38	39	38	34	36	36
Metallurgical coke, coke breeze and retort carbon	111	118	127	125	116	124
Electricity generation, transmission and distribution						
Hydro-electricity	61	60	59	58	62	58
Remainder electricity generation, transmission and distribution	528	543	564	581	597	646
Total	*2 203*	*2 253*	*2 319*	*2 387*	*2 435*	*2 489*
Total gross	11 930	12 118	12 729	14 174	15 111	15 739

(a) Includes liquefied natural gas.

(b) Includes aviation spirit.

(c) Excludes motor spirit and kerosene.

Note: Values may not add due to rounding.

Primary energy

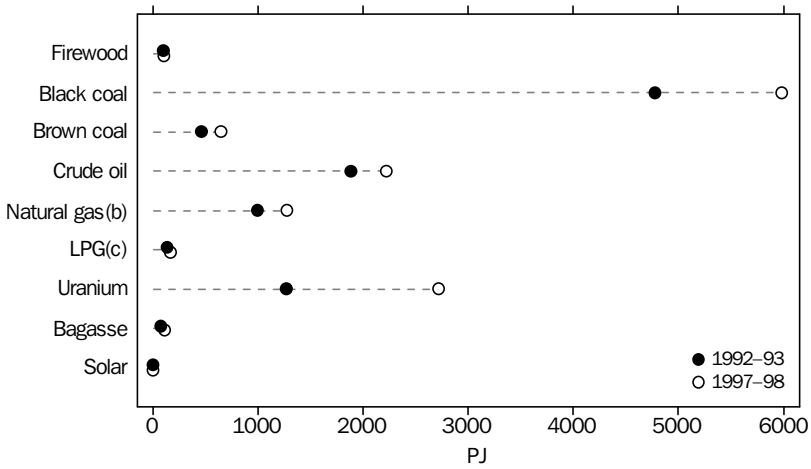
Table 2.1 and graph 2.2 show that from 1992–93 to 1997–98, overall supply of primary energy products increased by more than 35% from 9,727 PJ to 13,250 PJ. Black coal totalled 49% of total primary energy supply in 1992–93, falling to 45% in 1997–98 due to the growth in production of uranium. The supply of uranium concentrates increased by 114% over these years. Supplies of black and brown coal increased by 25% and 39%, respectively.

Table 2.5 provides a breakdown of energy supply into its components—imports and domestic production.

Natural gas production (including liquefied natural gas (LNG)) increased by 28% between 1992–93 and 1997–98. Production is expected to grow strongly in the future also with ABARE projections predicting an average annual growth rate of 6.9% per year to 2014–15 (ABARE 1999).

The supply of crude oil grew from 1,888 PJ to 2,225 PJ over the period. Imports grew at a faster rate than production and the ratio of domestically produced crude oil to total supply declined from about 60% in 1992–93 to 56% in 1997–98.

2.2 SUPPLY(a) OF PRIMARY ENERGY PRODUCTS—1992–93 and 1997–98



(a) Imports plus production.

(b) Includes liquefied natural gas.

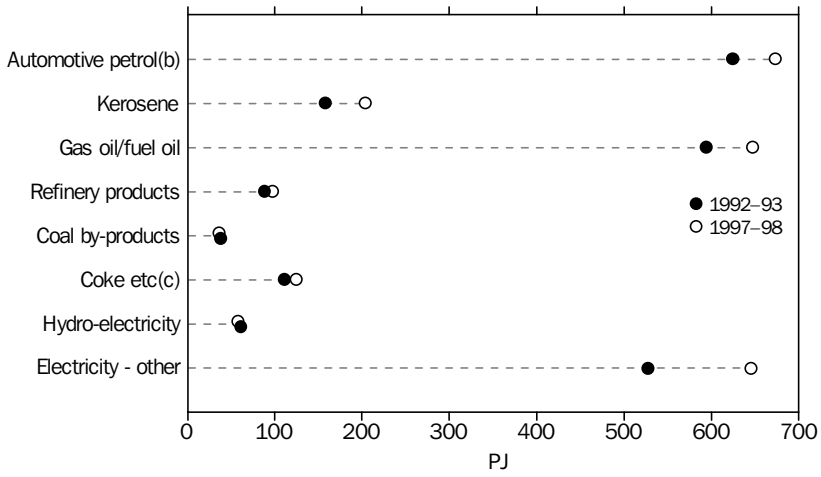
(c) Includes oil and gas n.e.c.

Secondary energy

Total supply of secondary energy increased by 13% from 2,203 PJ to 2,489 PJ between 1992–93 and 1997–98 (table 2.1 and graph 2.3). These products are derived from a primary energy source. Energy used to create these products is included in the use tables. Transport fuels and electricity (excluding hydro) comprised most of the total supply of secondary energy products. Electricity (excluding hydro-electricity) increased by 22% at an average of more than 4% per year. Most electricity is derived from coal fired power stations. The supply of hydro-electricity remained stable.

Imports consistently comprised around 4% of the total supply of secondary energy products. The bulk of this is imports of gas oil or fuel oil (table 2.5).

2.3 SUPPLY(a) OF SECONDARY ENERGY PRODUCTS—1992–93 and 1997–98



(a) Imports plus production.

(b) Includes gasolene refining or blending; motor spirit (including aviation spirit).

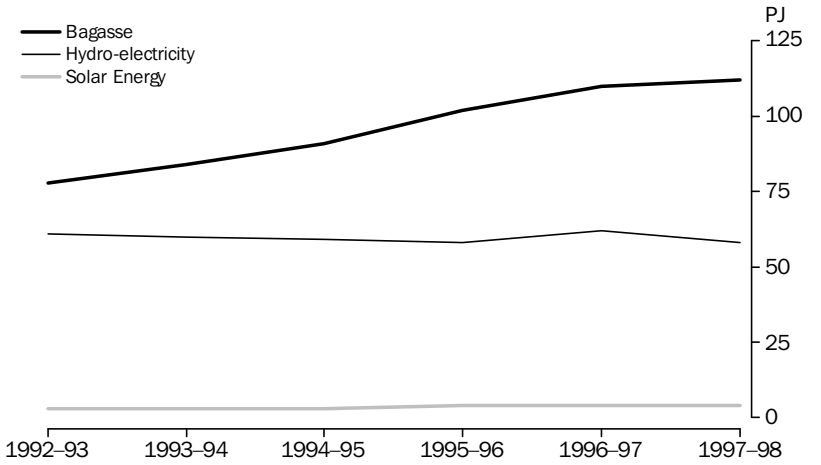
(c) Metallurgical coke; coke breeze and retort carbon.

Renewable energy

The main sources of renewable energy are wood, bagasse, solar energy and hydro-electricity. Other forms of renewable energy, such as wind, have been omitted due to lack of data and because the amount produced and consumed is small in comparison to the other renewables considered. Renewable energy's share of total energy supply is only around 2%.

Graph 2.4 shows the supply of selected renewable energy sources from 1992–93 to 1997–98. Supply and use of hydro-electricity and solar energy has remained relatively stable over the period. The supply of bagasse increased from 78 PJ in 1992–93 to 112 PJ in 1997–98. Bagasse is the 'fibrous residue of the sugar cane milling process which is used as a fuel in sugar mills' (Bush et al. 1997). Bagasse's share of total primary energy supply is low, but the increase in cogeneration projects using this renewable energy source and the implementation of the government's additional 2% renewables initiative should mean that the increasing trend will continue (ACA 1999). However there is a limit to the increase in bagasse's share, which is related to the production of sugar canes.

2.4 RENEWABLE ENERGY SUPPLY—1992–93 to 1997–98



Source: Bush et al. 1999.

2.5 SUPPLY TABLE—Energy products

Products	*Imports* PJ	*Production* PJ	*Total supply* PJ
1992–93			
Primary energy			
Firewood	—	105	105
Black coal (all types including briquettes)	2	4 778	4 780
Brown coal–lignite (including briquettes)	—	467	467
Crude oil (including condensate)	752	1 136	1 888
Natural gas (includes liquefied natural gas)	—	994	994
Liquefied natural petroleum gases; oil and gas n.e.c.	4	137	141
Uranium concentrates	—	1 271	1 271
Bagasse	—	78	78
Solar energy	—	3	3
Total	*758*	*8 969*	*9 727*
Secondary energy			
Motor spirit–gasolene (including aviation spirit)(a)	13	612	625
Kerosene (including kerosene type jet fuel)	1	157	158
Gas oils and fuel oils (including diesel; excluding motor spirit and kerosene)	73	521	594
Refinery products n.e.c.	1	87	88
Coal by-products	—	38	38
Retort carbon, metallurgical coke and coke breeze	1	110	111
Electricity, generation and distribution			
Hydro-electricity(b)	—	61	61
Remainder electricity generation and distribution	—	528	528
Total	*89*	*2 114*	*2 203*
Total gross	847	11 083	11 930
1993–94			
Primary energy			
Firewood	—	108	108
Black coal (all types including briquettes)	5	4 803	4 808
Brown coal–lignite (including briquettes)	—	484	484
Crude oil (including condensate)	785	1 095	1 880
Natural gas (includes liquefied natural gas)	—	1 058	1 058
Liquefied natural petroleum gases; oil and gas n.e.c.	5	141	146
Uranium concentrates	—	1 293	1 293
Bagasse	—	84	84
Solar energy	—	3	3
Total	*795*	*9 069*	*9 864*
Secondary energy			
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	18	624	642
Kerosene (including kerosene type jet fuel)	3	162	164
Gas oil or fuel oil (excluding motor spirit and kerosene)	67	529	596
Refinery products n.e.c.	3	88	91
Coal by-products	—	39	39
Metallurgical coke, coke breeze and retort carbon	3	115	118
Electricity generation and distribution			
Hydro-electricity(b)	—	60	60
Remainder electricity generation and distribution	—	543	543
Total	*94*	*2 160*	*2 253*
Total gross	889	11 229	12 117

(a) Motor spirit–gasolene (including aviation spirit) was changed to 'automotive petrol; gasolene refining or blending, motor spirit (including aviation spirit)' for all financial years after 1992–93. Slight changes in the wording of some other codes also occurred after 1992–93, but the composition of energy products within these codes did not change.

(b) Although hydro is not derived from a primary energy product, it is shown under secondary energy for ease of comparison with thermal electricity generation. For information on the calculation of hydro-electricity please see the Explanatory notes.

Note: Values may not add due to rounding.

2.5 SUPPLY TABLE—Energy Products *continued*

Products	*Imports* PJ	*Production* PJ	*Total supply* PJ
1994–95			
Primary energy			
Firewood	—	109	109
Black coal (all types including briquettes)	4	5 173	5 177
Brown coal–lignite (including briquettes)	—	502	502
Crude oil (including condensate)	799	1 154	1 953
Natural gas (includes liquified natural gas)	—	1 189	1 189
Liquefied natural petroleum gases; oil and gas n.e.c.(a)	7	142	149
Uranium concentrates	—	1 237	1 237
Bagasse	—	91	91
Solar energy	—	3	3
Total	*810*	*9 600*	*10 410*
Secondary energy			
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	21	621	642
Kerosene (including kerosene type jet fuel)	9	167	176
Gas oil or fuel oil (excluding motor spirit and kerosene)	68	548	616
Refinery products n.e.c.	3	94	97
Coal by-products	—	38	38
Metallurgical coke, coke breeze and retort carbon	3	125	127
Electricity generation, transmission and distribution			
Hydro-electricity(b)	—	59	59
Remainder electricity generation, distribution	—	564	564
Total	*104*	*2 216*	*2 319*
Total gross	914	11 816	12 729
1995–96			
Primary energy			
Firewood	—	109	109
Black coal (all types including briquettes)	3	5 232	5 235
Brown coal–lignite (including briquettes)	—	525	525
Crude oil (including condensate)	917	1 119	2 036
Natural gas (includes liquefied natural gas)	—	1 222	1 222
Liquefied petroleum gases–natural, coal gas and similar, other than petroleum gases and other gaseous hydrocarbons n.e.c.(a)	11	145	156
Uranium concentrates	—	2 399	2 399
Bagasse	—	102	102
Solar energy	—	4	4
Total	*931*	*10 857*	*11 787*
Secondary energy			
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	19	646	664
Kerosene (including kerosene type jet fuel)	7	186	193
Gas oil or fuel oil (excluding motor spirit and kerosene)	72	562	634
Refinery products n.e.c.	2	96	98
Coal by-products	—	34	34
Metallurgical coke, coke breeze and retort carbon	2	124	125
Electricity generation, transmission and distribution			
Hydro-electricity(b)	—	58	58
Remainder electricity generation, distribution	—	581	581
Total	*102*	*2 287*	*2 387*
Total gross	1 033	13 144	14 174

(a) In 1995–96 some codes were split into two or more codes. To maintain comparability with previous financial years these codes have been added together from 1995–96. For further information see the Explanatory notes.

(b) Although hydro is not derived from a primary energy product, it is shown under secondary energy for ease of comparison with thermal electricity generation. For information on the calculation of hydro-electricity please see the Explanatory notes.

2.5 SUPPLY TABLE—Energy Products *continued*

Products	*Imports* PJ	*Production* PJ	*Total supply* PJ
1996–97			
Primary energy			
Firewood	—	110	110
Black coal (all types including briquettes)	3	5 555	5 558
Brown coal–lignite (including briquettes)	—	569	569
Crude oil (including condensate)	959	1 149	2 107
Natural gas; liquefied natural gas	—	1 234	1 234
Liquefied natural petroleum gases; oil and gas n.e.c.	15	151	166
Uranium concentrates	—	2 818	2 818
Bagasse	—	110	110
Solar energy	—	4	4
Total	*977*	*11 700*	*12 676*
Secondary energy			
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	37	635	672
Kerosene (including kerosene type jet fuel)	1	201	202
Gas oil or fuel oil (excluding motor spirit and kerosene)	69	583	652
Refinery products n.e.c.	1	96	98
Coal by-products	—	36	36
Metallurgical coke, coke breeze and retort carbon	—	116	116
Electricity, generation, transmission and distribution			
Hydro-electricity(a)	—	62	62
Remainder electricity generation/distribution	—	597	597
Total	*108*	*2 326*	*2 435*
Total gross	1 085	14 026	16 111
1997–98			
Primary energy			
Firewood	—	109	109
Black coal (all types including briquettes)	3	5 977	5 980
Brown coal–lignite (including briquettes)	—	648	648
Crude oil (including condensate)	968	1 257	2 225
Natural gas; liquefied natural gas	—	1 276	1 276
Liquefied natural petroleum gases; oil and gas n.e.c.	13	157	170
Uranium concentrates	—	2 725	2 725
Bagasse	—	113	113
Solar energy	—	4	4
Total	*984*	*12 266*	*13 250*
Secondary energy			
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	25	649	674
Kerosene (including kerosene type jet fuel)	2	202	204
Gas oil or fuel oil (excluding motor spirit and kerosene)	61	589	650
Refinery products n.e.c.	1	96	97
Coal by-products	—	36	36
Metallurgical coke, coke breeze and retort carbon	—	124	124
Electricity, generation, transmission and distribution			
Hydro-electricity(a)	—	58	58
Remainder electricity generation/distribution	—	646	646
Total	*89*	*2 400*	*2 489*
Total gross	1 073	14 666	15 739

(a) For information on the calculation of hydro-electricity please see the Explanatory notes.

Source: Bush et al. 1999; ABARE 2000; ABS various economic statistics publications, AGO unpublished data; FASTTRACCS, unpublished data; AGA 1994, 1995, 1996, 1997, 1998; ESAA 1994, 1995, 1996, 1997, 1998.

USE TABLES

Tables and graphs 2.6 through to 2.27 present information about the direct use of energy products by industry for intermediate use in production, as well as direct consumption by final use (household consumption and exports). The tables presented are summary tables for the 1992–93 to 1997–98 financial years.

Primary energy

Total domestic use (Australian industries and households) of primary energy products increased by about 17% between 1992–93 and 1997–98 (from 4,165 PJ to 4,866 PJ) (table 2.6). The manufacturing and electricity sectors accounted for the bulk of this energy use (more than 85%), as these sectors are responsible for transforming primary energy products into secondary energy products for use. The majority of primary energy supply, however, is exported (8,667 PJ in 1997–98) (graph 2.7).

Tables and graphs 2.10 to 2.27 present a breakdown of fuel type used by industries, households, and for export. Domestically, the primary energy products used most were crude oil and black coal. In 1997–98, intermediate use of these products by industry was 1,672 PJ for crude oil, and 1,344 PJ for black coal. Together this represented 62% of domestic consumption of primary energy products by Australian industry and households in that year. Consumption of these products was mainly in the production of electricity (black coal), and transport fuels (crude oil). The final use of these derived products is also shown in these tables and discussed on the following page. Domestic use of crude oil and black coal increased by 12% since 1992–93. The domestic use of brown coal (used almost exclusively for thermal electricity generation in Victoria) increased by 36% from 476 PJ in 1992–93 to 647 PJ in 1997–98.

The manufacturing sector is the largest domestic user of natural gas. It used around 42% of domestically available natural gas in 1997–98, increasing its use from 316 PJ in 1992–93 to 359 PJ in 1997–98. Other major users included the electricity supply industry (20% of domestic use), and the mining industries (17%). Direct consumption by households accounted for about 14% of total domestic use of natural gas.

In 1997–98 about 65% of Australia's primary energy supply was exported. This mainly comprises black coal and uranium. All uranium produced is exported. Exports of uranium have more than doubled over the period 1992–93 to 1997–98 (increasing to 3,015 PJ in 1997–98).

More than 75% of the black coal supply was exported from 1992–93 to 1997–98. This amounted to 4,613 PJ in 1997–98.

About 25% of the total supply of crude oil was exported in 1997–98 (547 PJ), with exports increasing by 46% since 1992–93. Significant quantities of natural gas are also exported (about 33% of total supply of natural gas in 1997–98, or 416 PJ).

2.6 AUSTRALIAN PRIMARY ENERGY USE

	1992–93	*1993–94*	*1994–95*	*1995–96*	*1996–97*	*1997–98*
	PJ	PJ	PJ	PJ	PJ	PJ
Agriculture; hunting and trapping; forestry and fishing	4	5	5	15	6	7
Mining	121	125	138	151	156	164
Manufacturing	2 244	2 303	2 367	2 414	2 464	2 489
Electricity	1 498	1 525	1 594	1 656	1 712	1 855
Construction	1	1	1	1	2	4
Transport	23	27	31	32	34	36
Other services(a)	78	79	84	85	86	90
Total intermediate use	*3 969*	*4 065*	*4 220*	*4 356*	*4 460*	*4 645*
Household consumption	197	198	208	213	219	222
Total domestic use(b)	*4 165*	*4 262*	*4 429*	*4 567*	*4 678*	*4 866*
Exports	5 450	6 270	6 642	7 297	7 766	8 667
Unallocated products(c)	109	–668	–660	–79	232	–285
Total	**9 727**	**9 865**	**10 410**	**11 787**	**12 676**	**13 250**

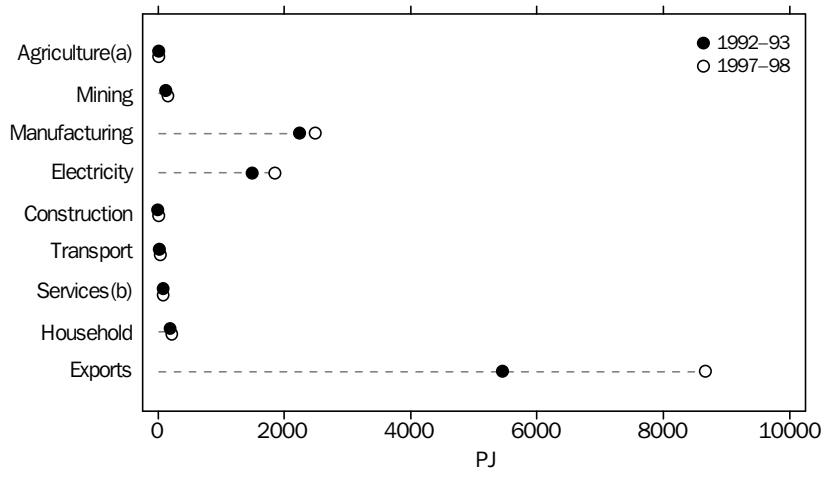
(a) Includes water and gas.

(b) Total intermediate use plus household consumption.

(c) Includes change in inventories and statistical discrepancies.

Note: Values may not add due to rounding.

2.7 DIRECT PRIMARY ENERGY USE—1992–93 and 1997–98



(a) Includes hunting and trapping; forestry and fishing.

(b) Excludes transport; electricity.

Secondary energy

The household sector is the major user of secondary energy sources, particularly automotive petrol (492 PJ) and electricity (166 PJ). Households used about 30% of total secondary energy products consumed domestically in 1997–98 (table 2.8).

The manufacturing sector used about 23% of secondary energy (domestically), and was the largest consumer of electricity (240 PJ).

The transport industry experienced an increase of 22% between 1992–93 and 1997–98 (graph 2.9). Most of this was due to an increase in kerosene (jet fuel). Service industries use of secondary energy increased by 22%, mainly due to a 30% increase in electricity use over the period.

Exports of secondary energy products accounted for 6 to 8% of total supply each year, mainly in the form of gas oil or fuel oil.

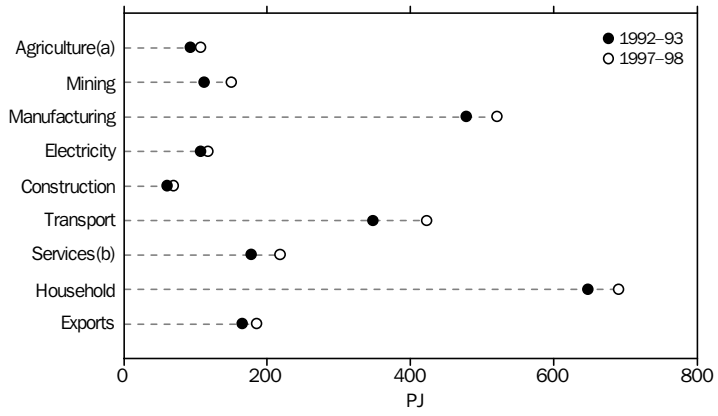
2.8 AUSTRALIAN SECONDARY ENERGY USE

	1992–93	*1993–94*	*1994–95*	*1995–96*	*1996–97*	*1997–98*
	PJ	PJ	PJ	PJ	PJ	PJ
Agriculture; hunting and trapping; forestry and fishing	93	96	98	102	105	108
Mining	112	116	122	134	143	150
Manufacturing	478	494	513	514	502	521
Electricity	108	108	115	118	110	118
Construction	61	63	64	65	67	69
Transport	348	359	384	418	426	423
Other services	178	183	193	203	210	218
Total intermediate use	*1 377*	*1 418*	*1 488*	*1 554*	*1 563*	*1 606*
Household consumption	648	655	677	678	684	691
Total domestic use(a)	*2 026*	*2 073*	*2 167*	*2 229*	*2 248*	*2 295*
Exports	166	158	136	173	195	186
Unallocated products	11	23	17	–15	–9	3
Total	**2 203**	**2 253**	**2 319**	**2 387**	**2 435**	**2 489**

(a) Total intermediate use plus household consumption.

Note: Values may not add due to rounding.

2.9 DIRECT SECONDARY ENERGY USE—1992–93 and 1997–98



(a) Includes hunting and trapping; forestry and fishing.

(b) Excludes transport; electricity.

2.10 USE TABLE, By Industry—1992–93

Product	*Agriculture; hunting and trapping; forestry and fishing*	*Mining*	*Manufacturing*	*Electricity*	*Construction*	*Transport*	*Other services*	*Total intermediate use*
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Primary energy								
Firewood	—	—	23	—	—	—	1	24
Black coal (all types including briquettes)	—	6	277	906	—	4	2	1 196
Brown coal–lignite (including briquettes)	—	11	6	456	—	—	2	476
Crude oil (including condensate)	—	—	1 495	—	—	—	—	1 495
Natural gas(a)	—	103	316	136	—	6	55	617
Liquefied natural petroleum gases; oil & gas n.e.c.	4	1	49	—	1	13	18	86
Uranium concentrates	—	—	—	—	—	—	—	—
Bagasse	—	—	78	—	—	—	—	78
Solar energy	—	—	—	—	—	—	—	—
Total	*4*	*121*	*2 244*	*1 498*	*1*	*23*	*78*	*3 969*
Secondary energy								
Motor spirit–gasolene (including aviation spirit)	9	1	9	—	7	67	36	129
Kerosene (including kerosene type jet fuel)	—	—	—	—	—	136	—	136
Gas oil or fuel oil (excluding motor spirit and kerosene)	75	70	52	31	54	138	34	454
Refinery products n.e.c.	—	1	82	—	—	—	—	83
Coal by-products(b)	—	2	35	1	—	—	—	38
Retort carbon, metallurgical coke and coke breeze	—	—	94	—	—	—	—	94
Electricity, generation and distribution								
Hydro-electricity	1	4	22	8	—	1	11	46
Remainder electricity generation and distribution	8	34	184	68	—	6	97	397
Total	*93*	*112*	*478*	*108*	*61*	*348*	*178*	*1 377*

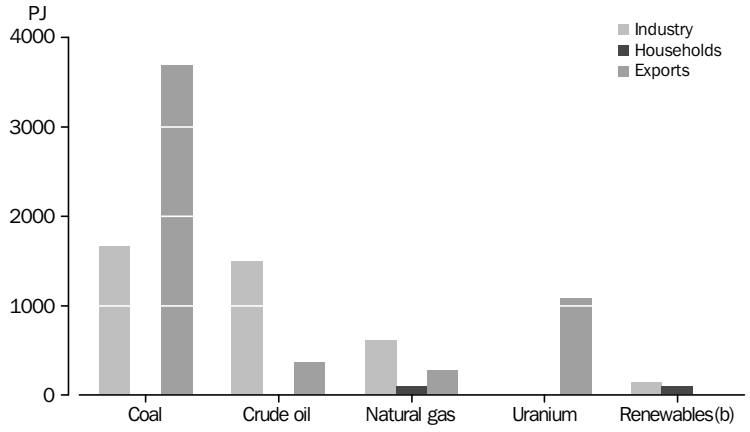
(a) Natural gas includes liquefied natural gas (LNG). According to the Input-Output Product Classification (IOPC), LNG should be included with liquefied natural petroleum gases; oil and gas n.e.c. This break from the IOPC has occurred to maintain consistency with ABARE use data.

(b) Produced in the coke making process and used as a fuel in coke ovens and associated iron and steel plants.

Note: Sums will not necessarily equal totals due to rounding.

Source: Bush et al. 1997; Bush et al. 1999; AGO unpublished data; ABS unpublished international trade data; EPA 1999.

2.11 TOTAL USES(a) OF PRIMARY ENERGY PRODUCTS, By Product—1992–93



(a) Excludes unallocated products etc.

(b) Includes hydro-electricity.

2.10 USE TABLE, By industry—1992–93 *continued*

Product	*Household consumption* PJ	*Total domestic use(a)* PJ	*Exports* PJ	*Unallocated products(b)* PJ	*Total supply* PJ
Primary energy					
Firewood	81	105	—	—	105
Black coal (all types including briquettes)	—	1 196	3 683	–98	4 780
Brown coal–lignite (including briquettes)	—	476	1	–10	467
Crude oil (including condensate)	—	1 495	374	19	1 888
Natural gas(c)	99	716	277	1	994
Liquefied natural petroleum gases; oil and gas n.e.c.	14	99	40	2	141
Uranium concentrates	—	—	1 076	195	1 271
Bagasse	—	78	—	—	78
Solar energy	3	3	—	—	3
Total	*197*	4 165	*5 450*	*109*	*9 727*
Secondary energy					
Motor spirit–gasolene (including aviation spirit)	471	600	26	–1	625
Kerosene (including kerosene type jet fuel)	1	137	17	3	158
Gas oil or fuel oil (excluding motor spirit and kerosene)	29	484	98	13	594
Refinery products n.e.c.	—	83	9	–4	88
Coal by-products(d)	—	38	—	—	38
Retort carbon, metallurgical coke and coke breeze	—	94	16	—	111
Electricity generation and distribution					
Hydro-electricity	15	61	—	—	61
Remainder electricity generation and distribution	132	529	—	—	528
Total	*648*	*2 026*	*166*	*11*	*2 203*

(a) Intermediate consumption by industries plus household consumption.

(b) Unallocated products includes change in stocks and statistical discrepancies.

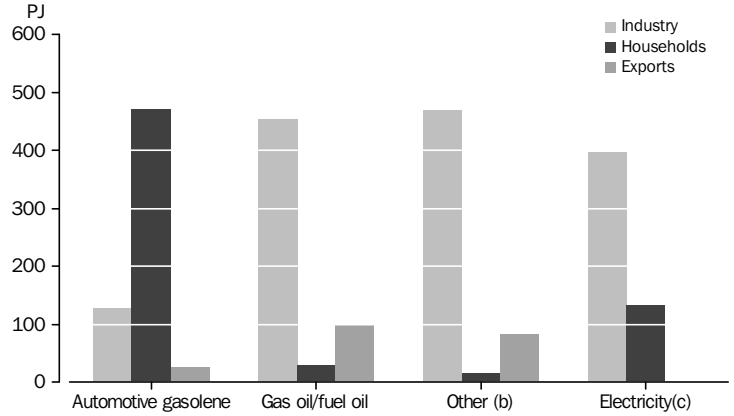
(c) Natural gas includes liquefied natural gas (LNG). According to the IOPC, LNG should be included with liquefied natural petroleum gases; oil and gas n.e.c. This break from the IOPC has occurred to maintain consistency with ABARE use data.

(d) Produced in the coke making process and used as a fuel in coke ovens and associated iron and steel plants.

Note: Sums will not necessarily equal totals due to rounding.

Source: Bush et al. 1997; Bush et al. 1999; ABS unpublished international trade data; AGO unpublished data; EPA 1999.

2.12 TOTAL USES(a) OF SECONDARY ENERGY PRODUCTS, By Product—1992–93



(a) Excludes unallocated products etc.

(b) Includes naturally occurring LPG; kerosene (including kerosene type jet fuel); refinery production n.e.c.; coal by-products; retort carbon, metallurgical coke and coke breeze.

(c) Excludes hydro-electricity.

2.13 USE TABLE, By industry—1993–94

Product	*Agriculture; hunting and trapping; forestry and fishing*	*Mining*	*Manufacturing*	*Electricity*	*Construction*	*Transport*	*Other services*	*Total intermediate use*
	PJ	PJ	PJ	PJ	PJ		PJ	PJ
Primary energy								
Firewood	—	—	26	—	—	—	1	26
Black coal (all types including briquettes)	—	6	284	917	—	4	2	1 213
Brown coal–lignite (including briquettes)	—	13	5	462	—	—	2	482
Crude oil (including condensate)	—	—	1 518	—	—	—	—	1 518
Natural gas(a)	—	105	334	146	—	8	55	649
Liquefied natural petroleum gas; oil & gas n.e.c.	5	1	52	—	1	15	19	93
Uranium concentrates	—	—	—	—	—	—	—	—
Bagasse	—	—	84	—	—	—	—	84
Solar energy	—	—	—	—	—	—	—	—
Total	*5*	*125*	*2 303*	*1 525*	*1*	*27*	*79*	*4 065*
Secondary energy								
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	9	1	9	—	7	69	37	132
Kerosene (including kerosene type jet fuel)	—	—	—	—	—	141	—	141
Gas oil or fuel oil (excluding motor spirit and kerosene)	78	73	53	31	56	142	35	468
Refinery products n.e.c.	—	1	84	—	—	—	—	85
Coal by-products(b)	—	2	36	1	—	—	—	39
Metallurgical coke, coke breeze and retort carbon	—	—	96	—	—	—	—	96
Electricity generation and distribution								
Hydro-electricity	1	4	22	8	—	1	11	46
Remainder electricity generation/ distribution	8	35	194	68	—	6	100	411
Total	*96*	*116*	*494*	*108*	*63*	*359*	*183*	*1 418*

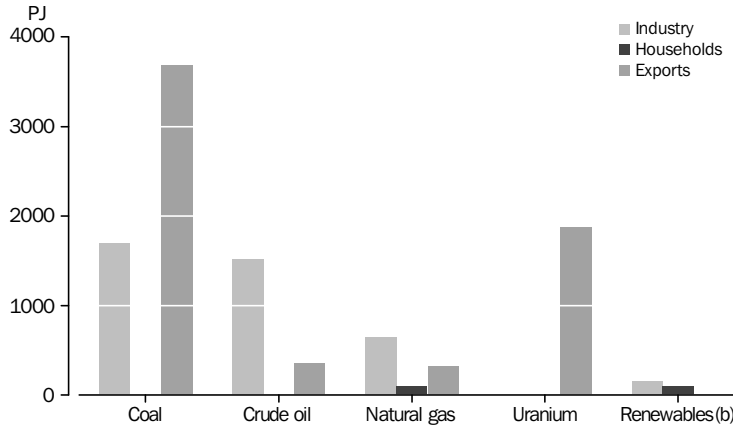
(a) Natural gas includes liquefied natural gas (LNG). According to the IOPC, LNG should be included with liquefied natural petroleum gases; oil and gas n.e.c. This break from the IOPC has occurred to maintain consistency with ABARE use data.

(b) Produced in the coke making process and used as a fuel in coke ovens and associated iron and steel plants.

Note: Sums will not necessarily equal totals due to rounding.

Source: Bush et al. 1997; Bush et al. 1999; ABS unpublished international trade data; AGO unpublished data; EPA 1999.

2.14 TOTAL USES(a) OF PRIMARY ENERGY PRODUCTS, By Product—1993–94



(a) Excludes unallocated products etc.

(b) Includes hydro-electricity.

2.13 USE TABLE, By industry—1993–94 *continued*

Product	Household consumption PJ	Total domestic use(a) PJ	Exports PJ	Unallocated products(b) PJ	Total supply PJ
Primary energy					
Firewood	82	108	—	—	108
Black coal (all types including briquettes)	—	1 213	3 683	–88	4 808
Brown coal–lignite (including briquettes)	—	482	1	1	484
Crude oil (including condensate)	—	1 518	353	10	1 880
Natural gas(c)	98	747	321	–10	1 058
Liquefied natural petroleum gases; oil and gas n.e.c.	15	107	35	3	146
Uranium concentrates	—	—	1 877	–584	1 293
Bagasse	—	84	—	—	84
Solar energy	3	3	—	—	3
Total	*198*	*4 262*	*6 270*	*–668*	*9 864*
Secondary energy					
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	479	611	31	1	642
Kerosene (including kerosene type jet fuel)	1	142	17	5	164
Gas oil or fuel oil (excluding motor spirit and kerosene)	29	497	92	8	596
Refinery products n.e.c.	—	85	4	2	91
Coal by-products(d)	—	39	—	—	39
Metallurgical coke, coke breeze and retort carbon	—	96	14	8	118
Electricity generation and distribution					
Hydro-electricity	15	61	—	—	60
Remainder electricity generation and distribution	131	542	—	—	543
Total	*655*	*2 073*	*158*	*23*	*2 253*

(a) Intermediate consumption by industries plus household consumption.

(b) Unallocated products includes change in stocks and statistical discrepancies.

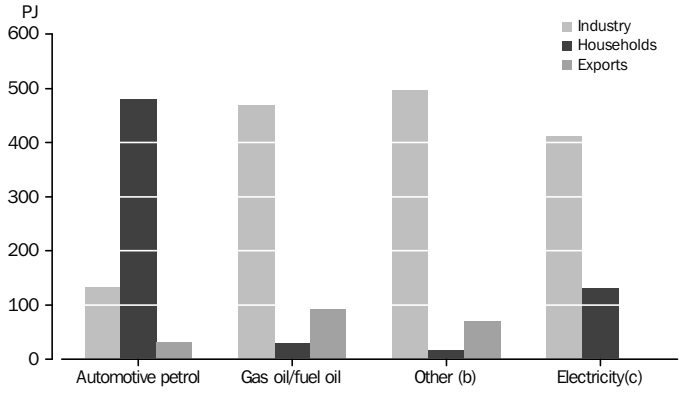
(c) Natural gas includes liquefied natural gas (LNG). According to the IOPC, LNG should be included with liquefied natural petroleum gases; oil and gas n.e.c. This break from the IOPC has occurred to maintain consistency with ABARE use data.

(d) Produced in the coke making process and used as a fuel in coke ovens and associated iron and steel plants.

Note: Sums will not necessarily equal totals due to rounding.

Source: Bush et al. 1997; Bush et al. 1999; ABS unpublished international trade data; AGO unpublished data; EPA 1999.

2.15 TOTAL USES(a) OF SECONDARY ENERGY PRODUCTS, By Product—1993–94



(a) Excludes unallocated products.

(b) Includes naturally occurring LPG; kerosene (including kerosene type jet fuel); refinery production n.e.c.; coal by-products; retort carbon, metallurgical coke and coke breeze.

(c) Excludes hydro-electricity.

2.16 USE TABLE, By industry—1994–95

Product	*Agriculture; hunting and trapping; forestry and fishing*	*Mining*	*Manufacturing*	*Electricity*	*Construction*	*Transport*	*Other services*	*Total intermediate use*
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Primary energy								
Firewood	—	—	27	—	—	—	1	27
Black coal (all types including briquettes)	—	8	282	947	—	4	2	1 243
Brown coal–lignite (including briquettes)	—	13	5	480	—	—	2	500
Crude oil (including condensate)	—	—	1 562	—	—	—	—	1 562
Natural gas(a)	—	117	346	167	—	9	58	697
Liquefied natural petroleum gas; oil & gas n.e.c.	5	1	54	—	1	18	21	100
Uranium concentrates	—	—	—	—	—	—	—	—
Bagasse	—	—	91	—	—	—	—	91
Solar energy	—	—	—	—	—	—	—	—
Total	*5*	*138*	*2 367*	*1 594*	*1*	31	*84*	*4 220*
Secondary energy								
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	9	1	9	—	7	59	38	123
Kerosene (including kerosene type jet fuel)	—	—	—	—	—	159	—	159
Gas oil or fuel oil (excluding motor spirit and kerosene)	80	77	54	34	57	159	36	497
Refinery products n.e.c.	—	1	93	—	—	—	—	93
Coal by-products(b)	—	2	35	1	—	—	—	38
Metallurgical coke, coke breeze and retort carbon	—	—	106	—	—	—	—	106
Electricity generation, transmission and distribution								
Hydro-electricity	1	4	21	8	—	1	11	45
Remainder electricity generation/distribution	8	37	195	72	—	6	108	427
Total	*98*	*122*	*513*	*115*	*64*	*384*	*193*	*1 488*

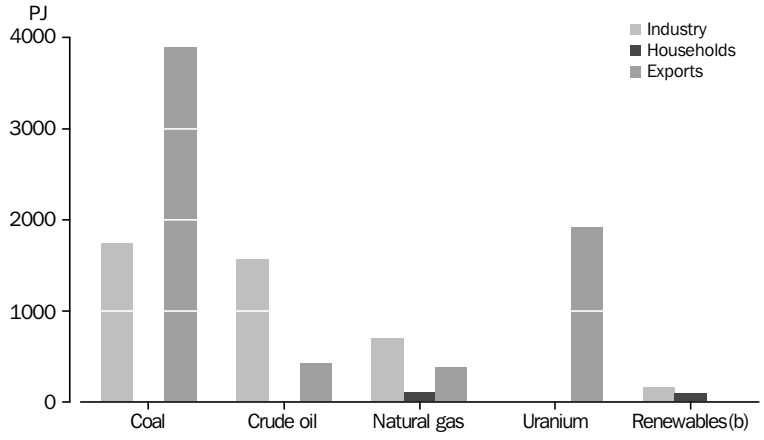
(a) Natural gas includes liquefied natural gas (LNG). According to the IOPC, LNG should be included with liquefied natural petroleum gases; oil and gas n.e.c. This break from the IOPC has occurred to maintain consistency with ABARE use data.

(b) Produced in the coke making process and used as a fuel in coke ovens and associated iron and steel plants.

Note: Sums will not necessarily equal totals due to rounding.

Source: Bush et al. 1997; Bush et al. 1999; ABS unpublished international trade data; AGO unpublished data; EPA 1999.

2.17 TOTAL USES(a) OF PRIMARY ENERGY PRODUCTS, By Product—1994–95



(a) Excludes unallocated products etc.

(b) Includes hydro-electricity.

2.16 USE TABLE, By industry—1994–95 *continued*

Product	Household consumption PJ	Total domestic use(a) PJ	Exports PJ	Unallocated products(b) PJ	Total supply PJ
Primary energy					
Firewood	82	109	—	—	109
Black coal (all types including briquettes)	—	1 243	3 888	46	5 177
Brown coal–lignite (including briquettes)	—	500	1	1	502
Crude oil (including condensate)	—	1 562	424	–33	1 953
Natural gas(c)	106	803	384	2	1 189
Liquefied natural petroleum gases; oil and gas n.e.c.	17	118	32	—	149
Uranium concentrates	—	—	1 913	–676	1 237
Bagasse	—	91	—	—	91
Solar energy	3	3	—	—	3
Total	*208*	*4 429*	*6 642*	*–660*	*10 410*
Secondary energy					
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	495	618	23	1	642
Kerosene (including kerosene type jet fuel)	1	160	16	—	176
Gas oil or fuel oil (excluding motor spirit and kerosene)	29	528	86	4	616
Refinery products n.e.c.	—	93	4	—	97
Coal by-products(d)	—	38	—	—	38
Metallurgical coke, coke breeze and retort carbon	—	106	8	13	127
Electricity generation, transmission and distribution					
Hydro-electricity	15	60	—	—	59
Remainder electricity generation/distribution	137	564	—	—	564
Total	*677*	*2 167*	*136*	*17*	*2 319*

(a) Intermediate consumption by industries plus household consumption.

(b) Unallocated products includes change in stocks and statistical discrepancies.

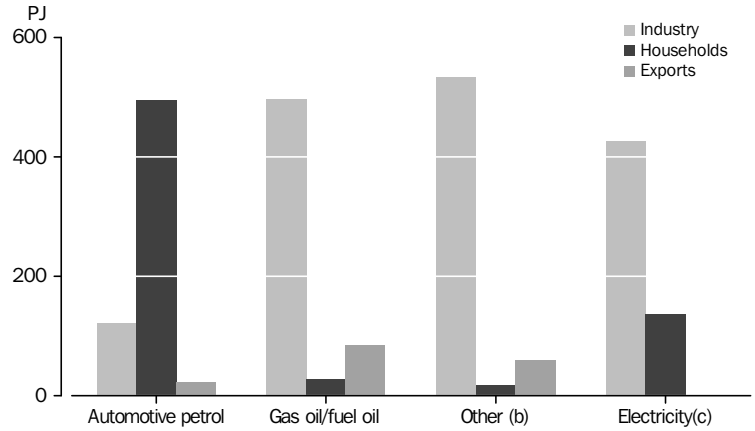
(c) Natural gas includes liquefied natural gas (LNG). According to the IOPC, LNG should be included with liquefied natural petroleum gases; oil and gas n.e.c. This break from the IOPC has occurred to maintain consistency with ABARE use data.

(d) Produced in the coke making process and used as a fuel in coke ovens and associated iron and steel plants.

Note: Sums will not necessarily equal totals due to rounding.

Source: Bush et al. 1997; Bush et al. 1999; ABS unpublished international trade data; AGO unpublished data; EPA 1999.

2.18 TOTAL USES(a) OF SECONDARY ENERGY PRODUCTS, By Product—1994–95



(a) Excludes unallocated products etc.

(b) Includes naturally occurring LPG; kerosene (including kerosene type jet fuel); refinery production n.e.c.; coal by-products; retort carbon, metallurgical coke and coke breeze.

(c) Excludes hydro-electricity.

2.19 USE TABLE, By industry—1995–96

Product	*Agriculture; hunting and trapping; forestry and fishing*	*Mining*	*Manufacturing*	*Electricity*	*Construction*	*Transport*	*Other services*	*Total intermediate use*
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Primary energy								
Firewood	—	—	26	—	—	—	1	27
Black coal (all types including briquettes)	—	8	268	1 001	—	4	1	1 283
Brown coal–lignite (including briquettes)	—	12	5	503	—	—	2	522
Crude oil (including condensate)	—	—	1 623	—	—	—	—	1 623
Natural gas; liquefied natural gas	9	130	340	152	—	9	59	700
Liquefied petroleum gases–natural, coal gas and similar, other than petroleum gases and other gaseous hydrocarbons n.e.c.(a)	6	1	50	—	1	19	22	99
Uranium concentrates	—	—	—	—	—	—	—	—
Bagasse	—	—	102	—	—	—	—	102
Solar energy	—	—	—	—	—	—	—	—
Total	*15*	*151*	*2 414*	*1 656*	*1*	*32*	*85*	*4 356*
Secondary energy								
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	9	1	9	—	7	70	37	133
Kerosene (including kerosene type jet fuel)	—	—	—	—	—	172	—	172
Gas oil or fuel oil (excluding motor spirit and kerosene)	83	87	55	35	58	168	39	525
Refinery products n.e.c.	—	1	98	1	—	—	—	100
Coal by-products(b)	—	2	31	1	—	—	—	34
Metallurgical coke, coke breeze & retort carbon	—	—	106	—	—	—	—	106
Electricity generation, transmission and distribution								
Hydro-electricity	1	4	17	8	—	1	11	43
Remainder electricity generation/distribution	9	39	198	73	—	7	116	441
Total	*102*	*134*	*514*	*118*	*65*	*418*	*203*	*1 554*

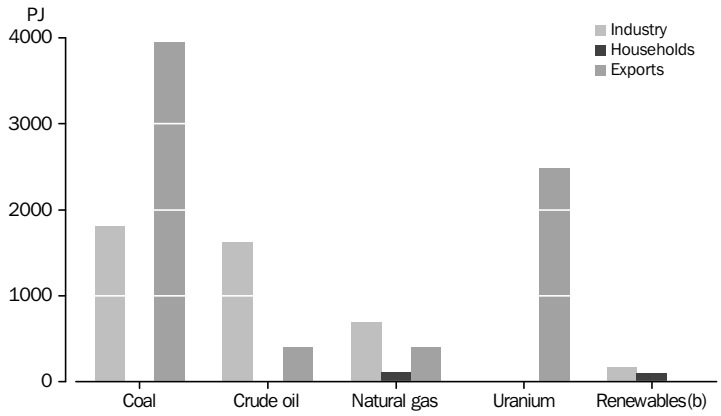
(a) In 1995–96 some codes were split into two or more codes. To maintain comparability with previous financial years these codes have been added together for 1995–96 and 1996–97. For further information please see the Explanatory notes.

(b) Produced in the coke making process and used as a fuel in coke ovens and associated iron and steel plants.

Note: Sums will not necessarily equal totals due to rounding.

Source: Bush et al. 1997; Bush et al. 1999; ABS unpublished international trade data; AGO unpublished data; EPA 1999.

2.20 TOTAL USES(a) OF PRIMARY ENERGY PRODUCTS, By Product—1995–96



(a) Excludes unallocated products etc.

(b) Includes hydro-electricity.

2.19 USE TABLE, By industry—1995–96 *continued*

Product	*Household consumption* PJ	*Total domestic use(b)* PJ	*Exports* PJ	*Unallocated products(c)* PJ	*Total supply* PJ
Primary energy					
Firewood	82	109	—	—	109
Black coal (all types including briquettes)	—	1 283	3 956	–4	5 235
Brown coal–lignite (including briquettes)	—	522	1	2	525
Crude oil (including condensate)	—	1 623	403	9	2 036
Natural gas; liquefied natural gas	111	811	413	–2	1 222
Liquefied petroleum gases–natural, coal gas and similar, other than petroleum gases and other gaseous hydrocarbons n.e.c.(a)	17	116	40	—	156
Uranium concentrates	—	—	2 484	–85	2 399
Bagasse	—	102	—	—	102
Solar energy	4	4	—	—	4
Total	*214*	*4 568*	*7 297*	*–79*	*11 787*
Secondary energy					
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	490	622	41	—	664
Kerosene (including kerosene type jet fuel)	1	173	21	–1	193
Gas oil or fuel oil (excluding motor spirit and kerosene)	31	554	98	–18	634
Refinery products n.e.c.	—	100	2	–3	98
Coal by-products(d)	—	34	—	—	34
Metallurgical coke, coke breeze and retort carbon	—	106	11	8	125
Electricity generation, transmission and distribution					
Hydro-electricity	16	59	—	—	58
Remainder electricity generation, transmission and distribution	140	581	—	—	581
Total	*678*	*2 229*	*173*	*–15*	*2 387*

(a) Refer to footnote (a) on previous page.

(b) Intermediate consumption by industries plus household consumption.

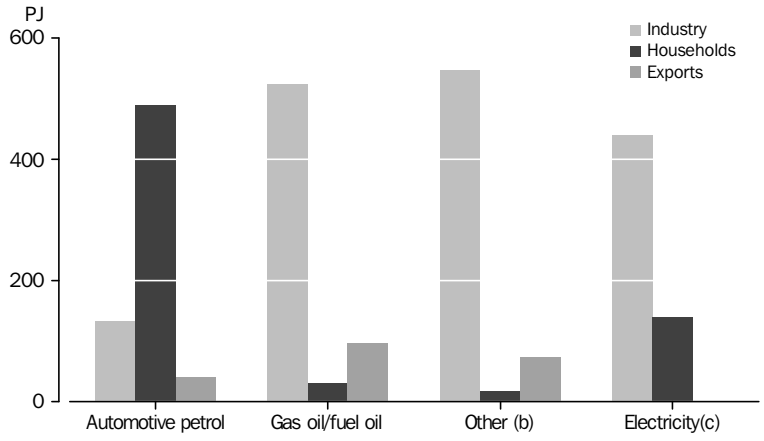
(c) Unallocated products includes stocks and statistical discrepancies.

(d) Produced in the coke making process and used as a fuel in coke ovens and associated iron and steel plants.

Note: Sums will not necessarily equal totals due to rounding.

Source: Bush et al. 1997; Bush et al. 1999; ABS unpublished international trade data; AGO unpublished data; EPA 1999.

2.21 TOTAL USES(a) OF SECONDARY ENERGY PRODUCTS, By Product—1995–96



(a) Excludes unallocated products.

(b) Includes naturally occurring LPG; kerosene (including kerosene type jet fuel); refinery production n.e.c.; coal by-products; retort carbon, metallurgical coke and coke breeze.

(c) Excludes hydro-electricity.

2.22 USE TABLE, By industry—1996–97

Product	*Agriculture; hunting and trapping; forestry and fishing*	*Mining*	*Manufacturing*	*Electricity*	*Construction*	*Transport*	*Other services*	*Total intermediate use*
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Primary energy								
Firewood	—	—	26	—	—	—	1	27
Black coal (all types including briquettes)	—	8	277	1 018	—	4	1	1 309
Brown coal–lignite (including briquettes)	—	14	5	546	—	—	2	566
Crude oil (including condensate)	—	—	1 648	—	—	—	—	1 648
Natural gas; liquefied natural gas	—	133	359	148	—	10	59	709
Liquefied petroleum gases–natural, coal gas and similar, other than petroleum gases and other gaseous hydrocarbons n.e.c.(a)	6	1	39	—	2	20	23	91
Uranium concentrates	—	—	—	—	—	—	—	—
Bagasse	—	—	110	—	—	—	—	110
Solar energy	—	—	—	—	—	—	—	—
Total	*6*	*156*	*2 464*	*1 712*	*2*	*34*	*86*	*4 460*
Secondary energy								
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	9	1	9	—	7	70	37	133
Kerosene (including kerosene type jet fuel)	—	—	—	—	—	179	—	179
Gas oil or fuel oil (excluding motor spirit and kerosene)	86	95	55	28	60	169	40	533
Refinery products n.e.c.	—	1	77	1	—	—	—	79
Coal by-products(b)	—	2	34	—	—	—	—	36
Metallurgical coke, coke breeze and retort carbon	—	—	106	—	—	—	—	106
Electricity generation, transmission and distribution								
Hydro-electricity	1	4	19	8	—	1	13	46
Remainder electricity generation/distribution	9	40	202	73	—	7	120	451
Total	*105*	*143*	*502*	*110*	*67*	*426*	*210*	*1 563*

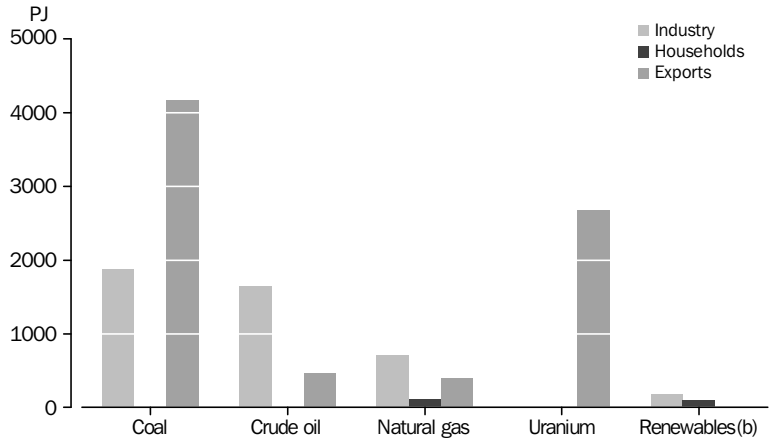
(a) Refer to footenote (a) on page 38.

(b) Produced in the coke making process and used as a fuel in coke ovens and associated iron and steel plants.

Note: Sums will not necessarily equal totals due to rounding.

Source: Bush et al. 1997; Bush et al. 1999; ABS unpublished international trade data; AGO unpublished data; EPA 1999.

2.23 TOTAL USES(a) OF PRIMARY ENERGY PRODUCTS, By Product—1996–97



(a) Excludes unallocated products etc.

(b) Includes hydro-electricity.

2.22 USE TABLE, By industry—1996–97 *continued*

Product	Household consumption PJ	Total domestic use(b) PJ	Exports PJ	Unallocated products(c) PJ	Total use PJ
Primary energy					
Firewood	83	110	—	—	110
Black coal (all types including briquettes)	—	1 309	4 161	88	5 558
Brown coal–lignite (including briquettes)	—	566	1	2	569
Crude oil (including condensate)	—	1 648	459	—	2 107
Natural gas; liquefied natural gas	114	823	401	10	1 234
Liquefied petroleum gases–natural, coal gas and similar, other than petroleum gases and other gaseous hydrocarbons n.e.c.(a)	18	108	65	–7	166
Uranium concentrates	—	—	2 680	139	2 818
Bagasse	—	110	—	—	110
Solar energy	4	4	—	—	4
Total	*219*	*4 678*	*7 766*	*232*	*12 676*
Secondary energy					
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	490	623	46	2	672
Kerosene (including kerosene type jet fuel)	1	180	27	–4	202
Gas oil or fuel oil (excluding motor spirit and kerosene)	32	566	113	–26	652
Refinery products n.e.c.	—	79	1	18	98
Coal by-products(d)	—	36	—	—	36
Metallurgical coke, coke breeze and retort carbon	—	106	9	1	116
Electricity generation, transmission and distribution					
Hydro-electricity	16	62	—	—	62
Remainder electricity generation, transmission and distribution	145	596	—	—	597
Total	*684*	*2 248*	*195*	*–9*	*2 435*

(a) Refer to footnote (a) on page 38.

(b) Intermediate consumption by industries plus household consumption.

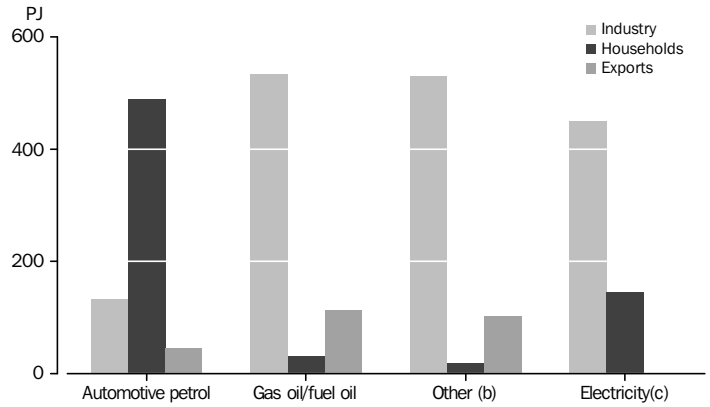
(c) Unallocated products includes change in stocks and statistical discrepancies.

(d) Produced in the coke making process and used as a fuel in coke ovens and associated iron and steel plants.

Note: Sums will not necessarily equal totals due to rounding.

Source: Bush et al. 1997; Bush et al. 1999; ABS unpublished international trade data; AGO unpublished data; EPA 1999.

2.24 TOTAL USES(a) OF SECONDARY ENERGY PRODUCTS, By Product—1996–97



(a) Excludes unallocated products etc.

(b) Includes naturally occurring LPG; kerosene (including kerosene type jet fuel); refinery production n.e.c.; coal by-products; retort carbon, metallurgical coke and coke breeze.

(c) Excludes hydro-electricity.

2.25 USE TABLE, By Industry—1997–98

Product	*Agriculture; hunting and trapping; forestry and fishing*	*Mining*	*Manufacturing*	*Electricity*	*Construction*	*Transport*	*Other services*	*Total intermediate use*
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Primary energy								
Firewood	—	—	27	—	—	—	1	28
Black coal (all types including briquettes)	—	7	271	1 061	—	4	1	1 344
Brown coal–lignite (including briquettes)	—	11	8	627	—	—	1	647
Crude oil (including condensate)	—	—	1 672	—	—	—	—	1 672
Natural gas; liquefied natural gas	—	146	359	167	2	11	61	746
Liquefied petroleum gases–natural, coal gas and similar, other than petroleum gases and other gaseous hydrocarbons n.e.c.(a)	7	—	39	—	2	21	26	95
Uranium concentrates	—	—	—	—	—	—	—	—
Bagasse	—	—	113	—	—	—	—	113
Solar energy	—	—	—	—	—	—	—	—
Total	*7*	*164*	*2 489*	*1 855*	*4*	*36*	*90*	*4 645*
Secondary energy								
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	9	1	9	—	7	70	37	133
Kerosene (including kerosene type jet fuel)	—	—	—	—	—	180	—	180
Gas oil or fuel oil (excluding motor spirit and kerosene)	89	98	53	26	62	164	41	533
Refinery products n.e.c.	—	1	83	1	—	—	—	84
Coal by-products(b)	—	2	34	—	—	—	—	36
Metallurgical coke, coke breeze & retort carbon	—	—	102	—	—	—	—	102
Electricity generation, transmission and distribution								
Hydro-electricity	1	4	20	8	—	1	11	45
Remainder electricity generation, transmission and distribution	9	44	220	83	—	8	129	493
Total	*108*	*150*	*521*	*118*	*69*	*423*	*218*	*1 606*

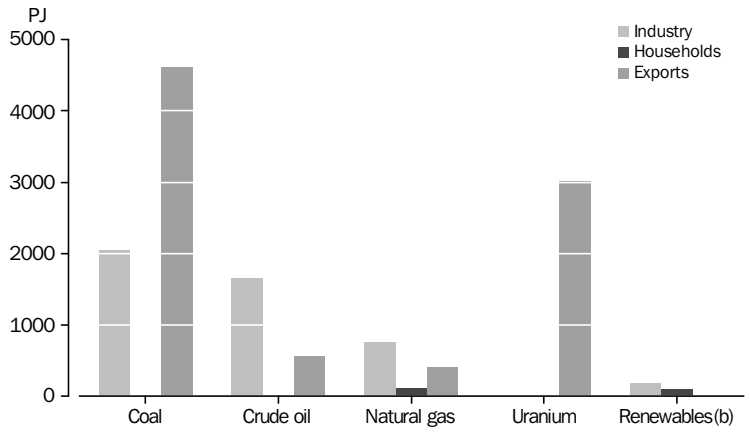
(a) Refer to footnote (a) on page 38.

(b) Produced in the coke making process and used as a fuel in coke ovens and associated iron and steel plants.

Note: Sums will not necessarily equal totals due to rounding.

Source: Bush et al. 1997; Bush et al. 1999; ABARE 2000; ABS unpublished international trade data; AGO unpublished data; EPA 1999.

2.26 TOTAL USES(a) OF PRIMARY ENERGY PRODUCTS, By Product—1997–98



(a) Excludes unallocated products etc.

(b) Includes hydro-electricity.

2.25 USE TABLE, By industry—1997–98 *continued*

Product	Household consumption PJ	Total domestic use(b) PJ	Exports PJ	Unallocated products(c) PJ	Total supply PJ
Primary energy					
Firewood	82	109	—	—	109
Black coal (all types including briquettes)	—	1 344	4 613	23	5 980
Brown coal–lignite (including briquettes)	—	647	—	—	648
Crude oil (including condensate)	—	1 672	547	6	2 225
Natural gas; liquefied natural gas	117	863	416	–3	1 276
Liquefied petroleum gases–natural, coal gas and similar, other than petroleum gases and other gaseous hydrocarbons n.e.c.(a)	19	114	76	–20	170
Uranium concentrates	—	—	3 015	–291	2 725
Bagasse	—	113	—	—	113
Solar energy	4	4	—	—	4
Total	*222*	*4 866*	*8 667*	*–285*	*13 250*
Secondary energy					
Automotive petrol; gasolene refining or blending; motor spirit (including aviation spirit)	492	626	54	–6	674
Kerosene (including kerosene type jet fuel)	1	181	27	–3	204
Gas oil or fuel oil (excluding motor spirit and kerosene)	32	565	92	–8	650
Refinery products n.e.c.	—	84	9	4	97
Coal by-products(d)	—	36	—	—	36
Metallurgical coke, coke breeze and retort carbon	—	102	5	17	124
Electricity generation, transmission and distribution					
Hydro-electricity	13	58	—	—	58
Remainder electricity generation, transmission & distribution	153	646	—	—	646
Total	*691*	*2 295*	*186*	*4*	*2 489*

(a) Refer to footnote (a) on page 38.

(b) Intermediate use by industries and household consumption.

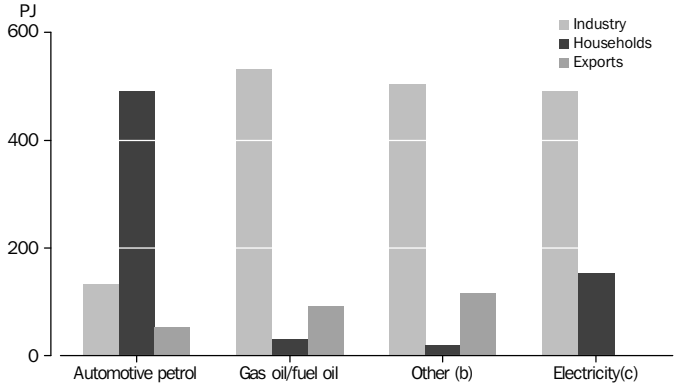
(c) Unallocated products includes change in stocks and statistical discrepancies.

(d) Produced in the coke making process and used as a fuel in coke ovens and associated iron and steel plants.

Note: Sums will not necessarily equal totals due to rounding.

Source: Bush et al. 1997; Bush et al. 1999; ABARE 2000; ABS unpublished international trade data; AGO unpublished data; EPA 1999.

2.27 TOTAL USES(a) OF SECONDARY ENERGY PRODUCTS, By Product—1997–98



(a) Excludes unallocated products etc.

(b) Includes naturally occurring LPG; kerosene (including kerosene type jet fuel); refinery production n.e.c.; coal by-products; retort carbon, metallurgical coke and coke breeze.

(c) Excludes hydro-electricity.

GREENHOUSE GAS EMISSIONS

Table 2.29 is a summary table of the total supply from the energy sector (stationary energy and transport) of three greenhouse gases; carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). These gases are identified as priority gases in the Kyoto Protocol. Emissions for all three gases are measured in giga grams (Gg) of CO_2 equivalents (CO_2-e). The data are presented by industry for 1992–93 to 1997–98. Fugitive emissions are not included.

Graph 2.28 shows the top seven direct greenhouse gas emitters based on more detailed information presented in tables 2.30 and 2.35. These contribute about 83% towards total greenhouse gas emissions, with all other industries contributing less than 20%.

The electricity supply industry accounts for nearly half of total energy-related emissions, followed by households, which contribute around 13%. Most household emissions are due to motor vehicle use. Chapter 4 separately identifies emissions due to motor vehicle use.

The next highest group of emitters included: manufacturing of iron and steel; mining; manufacturing of basic non-ferrous metal and products; air and space transport; and road transport. Combined emissions from this group accounted for nearly 20% of energy-related greenhouse gases in 1997–98.

Tables 2.30—2.35 show emissions of CO_2, CH_4 and N_2O by industry at a disaggregated level. Data were sourced from published and unpublished NGGI data (AGO). Data are not directly comparable to published NGGI figures due to some differences in classification (See Explanatory notes).

Carbon dioxide

CO_2 emissions are by far the greatest component of total greenhouse gas emissions derived from energy sources, representing about 98% of total CO_2-e emissions from the three gases reported. CO_2 emissions increased by 19% between 1992–93 and 1997–98, from 279,437 Gg to 332,410 Gg. The electricity supply industry contributes just under half of these emissions, with its heavy reliance on the combustion of black and brown coal for electricity generation. Direct emissions by this industry increased by around 25% between 1992–93 and 1997–98, consistent with an increase in (non-hydro) electricity consumption by Australian industries and households over these years. In particular, there was an increase of 10% between 1996–97 and 1997–98, partly due to the greater use of brown coal which has a higher emission factor than other fuels (AGO 2000).

The other major contributors to CO_2 emissions were the manufacturing sector, and households, contributing about 17% and 12%, respectively. Direct CO_2 emissions from the manufacturing sector increased by around 9% between 1992–93 and 1997–98. The iron and steel; and the basic non-ferrous metal and products industries contributed over half of this sector's CO_2 emissions in 1997–98, or about 9% of total energy-related CO_2 emissions.The iron and steel industry, which includes coke production, increased its emissions by about 16% between 1992–93 and 1997–98.

Other relatively large emitters of CO_2 in the manufacturing sector included: petroleum and coal products manufacturing (around 13% of total CO_2 emissions by the manufacturing sector); and basic chemicals (about 8%).

Carbon dioxide *cont.*

CO_2 emissions by the transport industry increased around 22% from 1992–93 to 1997–98. Most of the transport industry's emissions are attributed to air and space transport (about 39% in 1997–98), followed by the road transport industry. Emissions due to motor vehicle use by industries and households are not included in the road transport industry. The road transport industry includes: road freight transport; bus transport; taxi transport and hire car services. Rail transport experienced the largest relative increase in CO_2 emissions in this sector, with emissions increasing by just over 30% between 1992–93 and 1997–98.

CO_2 emissions by the mining sector showed a relatively large increase—around 38% over the same period. Total direct CO_2 emissions by this sector was about 5% of total energy-related CO_2 emissions in 1997–98 (15,059 Gg). Most emissions associated with mining arise from the production of LNG.

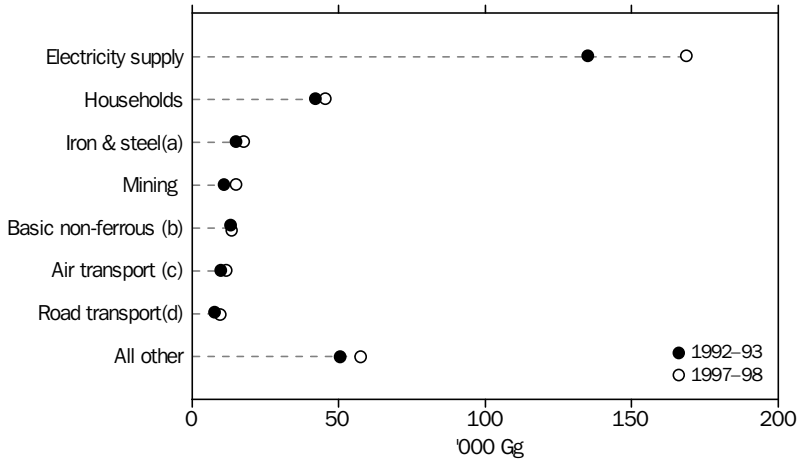
Methane

CH_4 emissions were equivalent to less than 1% of total emissions from the energy sector from 1992–93 to 1997–98. Households accounted for about 85% of CH_4 emissions resulting from combustion. The main activity producing these emissions is burning of firewood. Increases in emissions from the manufacturing sector are attributed to increasing use of bagasse in sugar mills, although the amount is very small.

Nitrous oxide

N_2O emissions contribute just over 1% to total emissions from the energy sector in terms of carbon dioxide equivalent units. Between 1992–93 and 1997–98 total N_2O emissions from the combustion of fuels grew by around 43% from 3,357 CO_2-e Gg to 4,797 CO_2-e Gg. In 1997–98, households accounted for 60% of N_2O emissions derived from combustion. Household emissions increased by 47% over the period reported, mainly due to emissions from petrol.

2.28 TOP GREENHOUSE GAS EMITTERS (CO_2-e)—1992–93 and 1997–98



(a) Includes coke production.

(b) Includes metals and products.

(c) Includes space.

(d) Excludes motor vehicle activity of households and other industries.

2.29 SUPPLY OF GREENHOUSE GAS EMISSIONS, Summary

Industry	Carbon dioxide (CO_2) CO_2-e Gg (a)	Methane (CH_4) CO_2-e Gg(a)	Nitrous oxide (N_2O) CO_2-e Gg(a)	Total CO_2-e Gg(a)
1992–93				
Agriculture; hunting and trapping; forestry and fishing	5 976	21	56	6 053
Mining	10 940	17	29	10 986
Manufacturing	52 122	40	274	52 431
Electricity	134 790	30	436	135 256
Construction	4 240	12	41	4 293
Transport(b)	24 882	178	382	25 443
Other services(c)	8 312	35	164	8 512
Households	38 175	2 045	1 974	42 194
Total	**279 437**	**2 378**	**3 357**	**285 168**
1993–94				
Agriculture; hunting and trapping; forestry and fishing	6 169	20	63	6 252
Mining	11 189	16	32	11 237
Manufacturing	52 601	42	290	52 934
Electricity	135 951	30	443	136 424
Construction	4 362	12	46	4 419
Transport(b)	25 748	178	406	26 332
Other services(c)	8 520	34	184	8 737
Households	38 742	2 055	2 194	42 990
Total	**283 283**	**2 387**	**3 658**	**289 325**
1994–95				
Agriculture; hunting and trapping; forestry and fishing	6 430	20	67	6 518
Mining	12 244	18	34	12 295
Manufacturing	55 307	45	311	55 665
Electricity	141 285	32	455	141 773
Construction	4 521	12	49	4 582
Transport(b)	28 466	186	459	29 111
Other services(c)	8 727	34	201	8 964
Households	39 594	2 052	2 404	44 051
Total	**296 577**	**2 399**	**3 980**	**302 959**

(a) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

(b) Includes: road freight transport; bus transport; taxi transport, hire car service. Excludes industry and household use of motor vehicles.

(c) Other services includes water and gas.

Note: Sums will not necessarily equal totals due to rounding.

Source: EPA 1999; NGGIC 1996a, 1996b, 1996c, 1996d, 1997, 1998, 1999a, 1999b.

2.29 SUPPLY OF GREENHOUSE GAS EMISSIONS, Summary *continued*

Industry	*Carbon dioxide (CO_2)* CO_2-e Gg (a)	*Methane (CH_4)* CO_2-e Gg(a)	*Nitrous oxide (N_2O)* CO_2-e Gg(a)	*Total* CO_2-e Gg(a)
1995–96				
Agriculture; hunting and trapping; forestry and fishing	6 648	21	68	6 737
Mining	13 218	18	35	13 271
Manufacturing	56 228	48	327	56 603
Electricity	147 026	32	473	147 531
Construction	4 747	12	50	4 809
Transport(b)	30 058	186	464	30 708
Other services(c)	9 098	34	202	9 335
Households	39 884	2 062	2 415	44 361
Total	**306 908**	**2 413**	**4 034**	**313 355**
1996–97				
Agriculture; hunting and trapping; forestry and fishing	6 891	21	75	6 988
Mining	14 529	29	37	14 596
Manufacturing	55 044	58	333	55 437
Electricity	152 358	39	502	152 899
Construction	4 752	12	55	4 819
Transport(b)	30 743	156	516	31 415
Other services(c)	9 274	33	229	9 535
Households	40 507	2 037	2 742	45 286
Total	**314 098**	**2 385**	**4 489**	**320 975**
1997–98				
Agriculture; hunting and trapping; forestry and fishing	7 081	23	84	7 188
Mining	15 059	33	44	15 136
Manufacturing	56 748	60	358	57 166
Electricity	168 197	79	569	168 845
Construction	4 885	13	60	4 958
Transport(b)	30 272	126	540	30 939
Other services(c)	9 497	35	247	9 780
Households	40 671	2 021	2 896	45 587
Total	**332 410**	**2 390**	**4 797**	**339 597**

(a) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

(b) Includes: road freight, bus and taxi transport; hire car service. Excludes industry and household use of motor vehicles.

(c) Other services includes water and gas.

Note: Sums will not necessarily equal totals due to rounding.

Source: EPA 1999; NGGIC 1996a, 1996b, 1996c, 1996d, 1997, 1998, 1999a, 1999b; AGO 2000.

2.30 SUPPLY OF GREENHOUSE GAS EMISSIONS By Industry, 1992–93

Industry	Carbon dioxide (CO_2) CO_2-e Gg (a)	Methane (CH_4) CO_2-e Gg(a)	Nitrous oxide (N_2O) CO_2-e Gg(a)	Total CO_2-e Gg(a)
Agriculture; hunting and trapping; forestry and fishing	5 976	21	56	6 053
Mining	10 940	17	29	10 986
Manufacturing				
Meat and meat products	716	1	3	719
Dairy products	714	1	3	717
Fruit and vegetable products	301	—	2	303
Oils and fats	156	—	1	157
Flour mill products and cereal foods	295	—	1	296
Bakery products	201	—	1	202
Confectionery; other food products	620	8	104	731
Beverages	323	1	2	326
Tobacco products	47	—	—	48
Textiles, clothing & footwear	518	1	3	522
Wood and wood products; paper, printing, and publishing	2 333	5	34	2 372
Petroleum and coal products	6 724	3	20	6 747
Basic chemicals	4 160	3	13	4 175
Other chemicals, rubber and plastic products	210	—	2	213
Glass and glass products	596	—	1	596
Ceramic products	1 188	1	2	1 191
Cement, lime & concrete; plaster & other concrete products	2 366	2	7	2 374
Other nonmetallic mineral products	780	—	2	782
Iron and steel	15 133	3	27	15 163
Basic non-ferrous metal and products	13 319	6	29	13 354
Fabricated metal products	436	2	6	444
Transport equipment; other machinery and equipment	747	2	8	757
Miscellaneous manufacturing	239	1	3	242
Total	*52 122*	*40*	*274*	*52 431*
Electricity and gas				
Electricity supply	134 790	30	436	135 256
Gas supply	723	2	5	731
Total	*135 513*	*32*	*442*	*135 987*
Construction	4 240	12	41	4 293
Transport				
Road transport	7 512	50	233	7 795
Rail, pipeline, other transport; services to transport, storage	4 184	46	35	4 265
Water transport	3 546	50	28	3 625
Air and space transport	9 641	31	86	9 758
Total	*24 882*	*178*	*382*	*25 443*
Services				
Wholesale trade; retail trade; repairs	3 122	14	74	3 211
Communication services	174	1	5	180
Finance & insurance; ownership of dwellings; property & business services	1 035	7	35	1 077
Government administration	611	2	9	621
Education; health and community services	1 692	3	12	1 708
Accommodation, cafes and restaurants; cultural and recreational services; personal and other services	842	5	24	871
Water supply, sewerage and drainage services	112	—	1	113
Total	*7 589*	*33*	*159*	*7 781*
Total intermediate production	*241 262*	*333*	*1 383*	*242 974*
Household production	38 175	2 045	1 974	42 194
Total	**279 437**	**2 378**	**3 357**	**285 168**

(a) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

Note: Sums will not necessarily equal totals due to rounding.

Source: EPA 1999; NGGIC 1996a, 1996b, 1996c, 1996d, 1997, 1998, 1999a, 1999b; AGO 2000.

2.31 SUPPLY OF GREENHOUSE GAS EMISSIONS By Industry, 1993–94

Industry	*Carbon dioxide (CO_2)* CO_2-e Gg (a)	*Methane (CH_4)* CO_2-e Gg(a)	*Nitrous oxide (N_2O)* CO_2-e Gg(a)	*Total* CO_2-e Gg(a)
Agriculture; hunting and trapping; forestry and fishing	6 169	20	63	6 252
Mining	11 189	16	32	11 237
Manufacturing				
Meat and meat products	736	1	3	740
Dairy products	711	1	3	715
Fruit and vegetable products	318	—	2	320
Oils and fats	155	—	1	156
Flour mill products and cereal foods	300	—	1	302
Bakery products	187	—	1	188
Confectionery; other food products	698	9	112	819
Beverages	338	1	3	341
Tobacco products	44	—	—	45
Textiles, clothing & footwear	510	1	3	513
Wood and wood products; paper, printing, and publishing	2 279	5	37	2 321
Petroleum and coal products	6 692	4	22	6 717
Basic chemicals	4 084	3	13	4 100
Other chemicals, rubber and plastic products	212	—	2	214
Glass and glass products	586	—	1	587
Ceramic products	1 164	1	2	1 167
Cement, lime & concrete; plaster & other concrete products	2 615	2	8	2 625
Other nonmetallic mineral products	771	—	1	772
Iron and steel	15 092	3	27	15 122
Basic non-ferrous metal and products	13 639	6	29	13 675
Fabricated metal products	448	2	7	457
Transport equipment; other machinery and equipment	780	2	9	792
Miscellaneous manufacturing	242	1	3	246
Total	*52 601*	*42*	*290*	*52 934*
Electricity and gas				
Electricity supply	135 951	30	443	136 424
Gas supply	732	2	6	740
Total	*136 684*	*32*	*449*	*137 164*
Construction	4 362	12	46	4 419
Transport				
Road transport	7 771	49	250	8 070
Rail, pipeline, other transport; services to transport, storage	4 294	47	38	4 378
Water transport	3 682	51	29	3 761
Air and space transport	10 001	32	89	10 123
Total	*25 748*	*178*	*406*	*26 332*
Services				
Wholesale trade; retail trade; repairs	3 202	14	83	3 299
Communication services	174	1	6	180
Finance & insurance; ownership of dwellings; property & business services	1 061	6	39	1 106
Government administration	625	2	10	636
Education; health and community services	1 739	3	13	1 755
Accommodation, cafes and restaurants; cultural and recreational services; personal and other services	871	5	27	903
Water supply, sewerage and drainage services	116	—	1	117
Total	*7 788*	*32*	*178*	*7 997*
Total intermediate production	*244 541*	*332*	*1 464*	*246 335*
Household production	38 742	2 055	2 194	42 990
Total	**283 283**	**2 387**	**3 658**	**289 325**

(a) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

Note: Sums will not necessarily equal totals due to rounding.

Source: EPA 1999; NGGIC 1996a, 1996b, 1996c, 1996d, 1997, 1998, 1999a, 1999b; AGO 2000.

2.32 SUPPLY OF GREENHOUSE GAS EMISSIONS By Industry, 1994–95

Industry	*Carbon dioxide (CO_2)* CO_2-e Gg (a)	*Methane (CH_4)* CO_2-e Gg(a)	*Nitrous oxide (N_2O)* CO_2-e Gg(a)	*Total* CO_2-e Gg(a)
Agriculture; hunting and trapping; forestry and fishing	6 430	20	67	6 518
Mining	12 244	18	34	12 295
Manufacturing				
Meat and meat products	740	1	3	744
Dairy products	743	1	4	747
Fruit and vegetable products	322	1	2	325
Oils and fats	158	—	1	159
Flour mill products and cereal foods	308	—	1	310
Bakery products	219	—	1	221
Confectionery; other food products	771	9	122	902
Beverages	334	—	3	338
Tobacco products	47	—	—	47
Textiles, clothing & footwear	613	1	3	617
Wood and wood products; paper, printing, and publishing	2 451	5	39	2 494
Petroleum and coal products	7 363	4	22	7 390
Basic chemicals	4 603	4	14	4 620
Other chemicals, rubber and plastic products	320	—	3	323
Glass and glass products	540	—	1	541
Ceramic products	1 281	1	3	1 285
Cement, lime & concrete; plaster & other concrete products	2 842	2	8	2 852
Other nonmetallic mineral products	674	—	1	676
Iron and steel	15 803	4	29	15 836
Basic non-ferrous metal and products	13 795	6	30	13 832
Fabricated metal products	480	2	7	489
Transport equipment; other machinery and equipment	806	3	10	819
Miscellaneous manufacturing	94	1	4	98
Total	*55 307*	*45*	*311*	*55 665*
Electricity and gas				
Electricity supply	141 285	32	455	141 773
Gas supply	631	2	6	639
Total	*141 917*	*34*	*461*	*142 412*
Construction	4 521	12	49	4 582
Transport				
Road transport	8 149	49	277	8 475
Rail, pipeline, other transport; services to transport, storage	4 433	48	39	4 520
Water transport	4 664	53	38	4 754
Air and space transport	11 220	36	105	11 361
Total	*28 466*	*186*	*459*	*29 111*
Services				
Wholesale trade; retail trade; repairs	3 377	14	91	3 482
Communication services	183	1	6	189
Finance & insurance; ownership of dwellings; property & business services	1 096	6	43	1 145
Government administration	652	2	11	664
Education; health and community services	1 699	3	14	1 717
Accommodation, cafes and restaurants; cultural and recreational services; personal and other services	972	6	29	1 006
Water supply, sewerage and drainage services	121	—	1	121
Total	*8 098*	*32*	*195*	*8 325*
Total intermediate production	*256 983*	*347*	*1 576*	*258 908*
Household production	39 594	2 052	2 404	44 051
Total	**296 577**	**2 399**	**3 980**	**302 959**

(a) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

Note: Sums will not necessarily equal totals due to rounding.

Source: EPA 1999; NGGIC 1996a, 1996b, 1996c, 1996d, 1997, 1998, 1999a, 1999b; AGO 2000.

2.33 SUPPLY OF GREENHOUSE GAS EMISSIONS By Industry, 1995–96

Industry	*Carbon dioxide (CO_2)* CO_2-e Gg(a)	*Methane (CH_4)* CO_2-e Gg(a)	*Nitrous oxide (N_2O)* CO_2-e Gg(a)	*Total* CO_2-e Gg(a)
Agriculture; hunting and trapping; forestry and fishing	6 648	21	68	6 737
Mining	13 218	18	35	13 271
Manufacturing				
Meat and meat products	715	1	3	719
Dairy products	752	1	3	756
Fruit and vegetable products	350	1	2	353
Oils and fats	148	—	1	149
Flour mill products and cereal foods	332	—	2	334
Bakery products	232	—	1	233
Confectionery; other food products	935	10	135	1 080
Beverages	321	1	3	325
Tobacco products	48	—	—	48
Textiles, clothing & footwear	602	1	3	606
Wood and wood products; paper, printing, and publishing	2 433	5	39	2 477
Petroleum and coal products	7 647	4	23	7 674
Basic chemicals	5 507	4	16	5 527
Other chemicals, rubber and plastic products	369	1	3	373
Glass and glass products	502	—	1	503
Ceramic products	1 159	1	3	1 163
Cement, lime & concrete; plaster & other concrete products	2 633	2	8	2 643
Other nonmetallic mineral products	662	—	1	663
Iron and steel	15 681	3	29	15 713
Basic non-ferrous metal and products	13 784	7	30	13 821
Fabricated metal products	485	2	7	494
Transport equipment; other machinery and equipment	834	3	10	847
Miscellaneous manufacturing	97	1	4	102
Total	*56 228*	*48*	*327*	*56 603*
Electricity and gas				
Electricity supply	147 026	32	473	147 531
Gas supply	716	2	6	724
Total	*147 743*	*34*	*479*	*148 256*
Construction	4 747	12	50	4 809
Transport				
Road transport	8 529	49	282	8 860
Rail, pipeline, other transport; services to transport, storage	4 623	48	39	4 710
Water transport	4 767	53	38	4 858
Air and space transport	12 138	37	105	12 280
Total	*30 058*	*186*	*464*	*30 708*
Services				
Wholesale trade; retail trade; repairs	3 500	14	92	3 606
Communication services	189	1	6	196
Finance & insurance; ownership of dwellings; property & business services	1 138	6	43	1 187
Government administration	669	2	10	681
Education; health and community services	1 732	4	14	1 750
Accommodation, cafes and restaurants; cultural and recreational services; personal and other services	1 027	6	30	1 063
Water supply, sewerage and drainage services	127	—	1	128
Total	*8 382*	*32*	*196*	*8 610*
Total intermediate production	*267 024*	*351*	*1 619*	*268 994*
Household production	39 884	2 062	2 415	44 361
Total	**306 908**	**2 413**	**4 034**	**313 355**

(a) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

Note: Sums will not necessarily equal totals due to rounding.

Source: EPA 1999; NGGIC 1996a, 1996b, 1996c, 1996d, 1997, 1998, 1999a, 1999b; AGO 2000.

2.34 SUPPLY OF GREENHOUSE GAS EMISSIONS By Industry, 1996–97

Industry	*Carbon dioxide (CO_2)* CO_2-e Gg(a)	*Methane (CH_4)* CO_2-e Gg(a)	*Nitrous oxide (N_2O)* CO_2-e Gg(a)	*Total* CO_2-e Gg(a)
Agriculture; hunting and trapping; forestry and fishing	6 891	21	75	6 988
Mining	14 529	29	37	14 596
Manufacturing				
Meat and meat products	655	1	3	658
Dairy products	722	1	4	727
Fruit and vegetable products	336	—	2	339
Oils and fats	151	—	1	152
Flour mill products and cereal foods	329	—	2	331
Bakery products	222	—	1	224
Confectionery; other food products	863	22	145	1 030
Beverages	315	—	3	318
Tobacco products	48	—	—	49
Textiles, clothing & footwear	595	1	4	599
Wood and wood products; paper, printing, and publishing	2 682	5	41	2 728
Petroleum and coal products	6 999	4	21	7 024
Basic chemicals	4 306	2	8	4 317
Other chemicals, rubber and plastic products	383	1	3	387
Glass and glass products	502	—	1	503
Ceramic products	1 097	1	3	1 101
Cement, lime & concrete; plaster & other concrete products	2 711	2	8	2 721
Other nonmetallic mineral products	697	1	1	699
Iron and steel	16 109	4	28	16 141
Basic non-ferrous metal and products	13 882	7	31	13 920
Fabricated metal products	488	2	8	498
Transport equipment; other machinery and equipment	852	3	11	866
Miscellaneous manufacturing	100	1	4	105
Total	*55 044*	*58*	*333*	*55 437*
Electricity and gas				
Electricity supply	152 358	39	502	152 899
Gas supply	704	2	7	712
Total	*153 062*	*41*	*509*	*153 611*
Construction	4 752	12	55	4 819
Transport				
Road transport	8 914	49	316	9 279
Rail, pipeline, other transport; services to transport, storage	4 775	48	42	4 864
Water transport	4 448	53	35	4 536
Air and space transport	12 607	6	124	12 736
Total	*30 743*	*156*	*516*	*31 415*
Services				
Wholesale trade; retail trade; repairs	3 582	13	105	3 700
Communication services	194	1	7	202
Finance & insurance; ownership of dwellings; property & business services	1 174	6	49	1 229
Government administration	699	2	12	712
Education; health and community services	1 744	4	16	1 764
Accommodation, cafes and restaurants; cultural and recreational services; personal and other services	1 042	5	33	1 081
Water supply, sewerage and drainage services	134	—	1	135
Total	*8 570*	*31*	*222*	*8 823*
Total intermediate production	*273 591*	*348*	*1 747*	*275 689*
Household production	40 507	2 037	2 742	45 286
Total	**314 098**	**2 385**	**4 489**	**320 975**

(a) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

Note: Sums will not necessarily equal totals due to rounding.

Source: EPA 1999; NGGIC 1996a, 1996b, 1996c, 1996d, 1997, 1998, 1999a, 1999b; AGO 2000.

2.35 SUPPLY OF GREENHOUSE GAS EMISSIONS By Industry, 1997–98

Industry	Carbon dioxide (CO_2) CO_2-e Gg(a)	Methane (CH_4) CO_2-e Gg(a)	Nitrous oxide (N_2O) CO_2-e Gg(a)	Total CO_2-e Gg(a)
Agriculture; hunting and trapping; forestry and fishing	7 081	23	84	7 188
Mining	15 059	33	44	15 136
Manufacturing				
Meat and meat products	639	1	3	643
Dairy products	732	1	4	737
Fruit and vegetable products	334	1	2	337
Oils and fats	156	—	1	157
Flour mill products and cereal foods	332	—	2	334
Bakery products	223	—	1	224
Confectionery; other food products	844	23	149	1 016
Beverages	304	1	3	307
Tobacco products	47	—	—	48
Textiles, clothing & footwear	569	1	4	574
Wood and wood products; paper, printing, and publishing	2 596	5	43	2 644
Petroleum and coal products	7 251	3	21	7 276
Basic chemicals	4 700	2	10	4 712
Other chemicals, rubber and plastic products	372	1	3	376
Glass and glass products	493	—	1	494
Ceramic products	1 131	1	3	1 135
Cement, lime & concrete; plaster & other concrete products	2 880	2	9	2 891
Other nonmetallic mineral products	654	1	1	656
Iron and steel	17 526	5	41	17 572
Basic non-ferrous metal and products	13 505	7	30	13 542
Fabricated metal products	489	2	10	501
Transport equipment; other machinery and equipment	868	3	12	884
Miscellaneous manufacturing	102	1	4	107
Total	*56 748*	*60*	*358*	*57 166*
Electricity and gas				
Electricity supply	168 197	79	569	168 845
Gas supply	707	2	8	717
Total	*168 904*	*81*	*577*	*169 562*
Construction	4 885	13	60	4 958
Transport				
Road transport	9 159	56	341	9 556
Rail, pipeline, other transport; services to transport, storage	5 465	11	56	5 532
Water transport	3 993	53	32	4 078
Air and space transport	11 655	6	112	11 772
Total	*30 272*	*126*	*540*	*30 939*
Services				
Wholesale trade; retail trade; repairs	3 680	14	112	3 806
Communication services	198	1	7	206
Finance & insurance; ownership of dwellings; property & business services	1 194	6	53	1 254
Government administration	712	2	13	727
Education; health and community services	1 790	4	17	1 811
Accommodation, cafes and restaurants; cultural and recreational services; personal and other services	1 077	6	36	1 118
Water supply, sewerage and drainage services	139	—	1	140
Total	*8 790*	*33*	*239*	*9 063*
Total intermediate production	*291 739*	*638*	*1 902*	*294 010*
Household production	40 671	2 021	2 896	45 587
Total	**332 410**	**2 390**	**4 797**	**339 597**

(a) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

Note: Sums will not necessarily equal totals due to rounding.

Source: EPA 1999; NGGIC 1996a, 1996b, 1996c, 1996d, 1997, 1998, 1999a, 1999b; AGO 2000.

CHAPTER 3 ELECTRICITY GENERATION AND TRANSPORT USE

INTRODUCTION

This chapter focuses on the two activities which contribute the most to the production of energy-related greenhouse gas emissions in Australia: electricity generation and transport use. Together these activities have contributed over 70% of greenhouse gases due to fuel combustion since 1990 (AGO 2000).

The use of electricity and transport fuels is integral to Australia's economic and social well-being—ultimately all our economic production and consumption of goods and services is dependent on these products. Electricity generation has been identified separately in the previous chapter, as the output of the electricity supply industry. The transport industry has also been separately identified in the preceding chapters, however, transport use by all other industries and the household sector actually make the largest contribution to total transport activity in Australia. In contrast to the industry focus in chapter 2, the emphasis in this chapter is on total transport activity.

ELECTRICITY GENERATION AND GREENHOUSE GASES

International comparison

As can be seen in chapter 2, electricity supply is by far the largest contributor to Australia's greenhouse gas emissions. Australia's high per capita levels of electricity consumption (table 3.1) and, hence, electricity generation is a major factor in Australia's relatively high per capita greenhouse gas emissions. In Australia, fossil fuel shares in electricity generation account for just over 90%, with coal being by far the largest input to electricity generation. Few developed countries are as dependent on fossil fuels for electricity generation as Australia. Of those that are—Ireland, Denmark, Netherlands and Greece—total electricity generation is very small and none of these are as reliant on coal for this activity (table 3.1). This is the result of the availability of large quantities of low-cost coal in Australia, where 80% of electricity is generated from domestically produced coal. This is in contrast with other energy and electricity-intensive countries such as Canada and Norway, where their electricity is generated mainly from non-greenhouse gas emitting sources such as hydro and nuclear. Fuel shares in thermal electricity generation in Australia for 1992–93 to 1997–98 are shown in table 3.2.

Australia's reliance on fossil fuels (and coal in particular) is also greater than most developing countries which have a greater dependency on fossil fuels than developed regions. This dependency, along with generally low efficiency, results in a strong link between energy use and carbon dioxide emissions in these developing regions. Generally, however, these regions exhibit a much lower per capita use of fossil fuels and per capita carbon dioxide emissions. It should also be noted that Australia's contribution to total world electricity generation, and carbon dioxide emissions, is fairly small, at just over 1% (OECD/IEA 1999a).

3.1 FUEL SHARES IN ELECTRICITY GENERATION, Selected Countries/Regions—1998

	Electricity generation per capita	*Electricity generation*	*Coal*	*Petroleum*	*Natural Gas*	*Fossil fuels*	*Nuclear*	*Hydro-electricity*
	GJ/capita	PJ	%	%	%	%	%	%
Ireland	2.0	75	40.4	23.2	30.8	94.4	—	4.4
Denmark	27.8	148	57.6	12.1	19.9	89.6	—	0.1
Netherlands	20.9	328	29.9	3.9	57.0	90.8	4.2	0.1
Greece	15.8	166	70.3	17.5	3.7	91.5	—	8.1
Italy	16.0	913	10.0	42.3	28.8	81.1	—	16.3
United Kingdom	21.7	1 284	34.5	1.6	32.5	68.6	28.1	1.5
Germany	24.2	1 988	54.2	1.2	9.8	65.2	29.3	3.1
Turkey	6.2	400	32.1	7.1	22.4	61.6	—	38.0
Portugal	14.0	140	31.0	27.5	5.2	63.7	—	33.7
Spain	17.7	697	32.6	9.0	8.4	50.0	30.5	17.6
France	31.0	1 825	7.4	2.3	1.0	10.7	76.5	12.2
Sweden	64.4	570	2.0	2.1	0.3	4.4	46.5	47.0
Norway	94.5	418	0.2	—	0.2	0.4	—	99.4
OECD Europe	21.2	10 821	30.6	6.9	13.4	50.9	30.2	16.8
Japan	29.5	3 730	19.1	16.4	21.1	56.6	32.1	8.9
Australia	**37.3**	**699**	**80.0**	**1.2**	**9.0**	**90.2**	**—**	**8.1**
New Zealand	35.6	135	3.9	—	23.2	27.1	—	64.9
United States	50.9	13 693	52.8	3.9	14.7	71.4	18.8	7.7
Canada	66.7	2 022	19.1	3.3	4.6	27.0	12.7	59.1
Non-OECD Europe	12.2	737	37.9	8.0	8.5	54.4	18.9	26.8
Africa	2.0	1 489	48.4	14.4	16.9	79.7	3.3	16.9
Asia	2.2	3 986	45.9	14.4	17.5	77.8	4.4	16.5
China	3.5	4 311	75.6	4.4	1.5	81.5	1.2	17.4
Former USSR	15.1	4 403	20.6	7.1	37.9	65.6	15.9	18.4
Middle East	2.4	1 475	6.5	42.6	47.1	96.2	—	3.9
Latin America	6.4	2 584	3.4	9.8	10.8	24.0	1.5	72.8
World	**8.8**	**51 591**	**38.4**	**8.9**	**16.3**	**63.6**	**17.1**	**17.9**

Source: OECD/IEA 2000a; OECD/IEA 2000b.

3.2 FUEL SHARES IN THERMAL(a) ELECTRICITY GENERATION, AUSTRALIA

	1992–93	*1993–94*	*1994–95*	*1995–96*	*1996–97*	*1997–98*
	%	%	%	%	%	%
Black coal	59.3	59.1	58.2	59.3	58.6	57.1
Brown coal	29.9	29.7	29.5	29.8	31.4	32.7
Natural gas	8.9	9.4	10.3	9.0	8.5	9.0
Petroleum products	1.8	1.8	2.0	1.9	1.5	1.2

(a) Generation utilising fossil fuels.

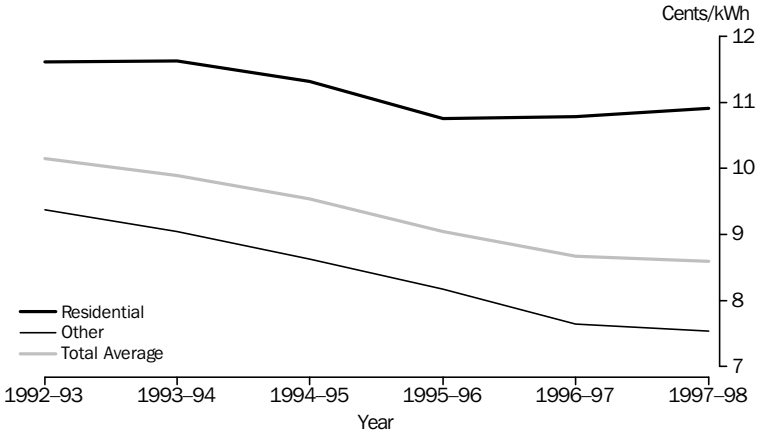
Source: Bush et al. 1999.

Electricity prices, Australia

As mentioned previously, Australia has one of the highest per capita levels of electricity consumption, partly a reflection of the relatively low cost of electricity in Australia. Average electricity retail prices have dropped since 1992–93, with the largest decrease occurring in the non-residential sector (industry and commercial)—from 9.38 cents/kWh in 1992–93 down to 7.53 in 1997–98. There has been a concomitant increase in electricity use in this sector—particularly manufacturing and the commercial sector (service industries)—over this period.

Average residential electricity prices fell to a low of 10.75 cents/kWh in 1995–96 (down from 11.61 in 1992–93), increasing to 10.91 cents/kWh in 1997–98.

3.3 AVERAGE ELECTRICITY RETAIL PRICES(a), AUSTRALIA—1992–93 TO 1997–98



(a) In 1997–98 dollars.

Note: The retail electricity prices presented are the final prices customers will pay for their electricity supply. They comprise electricity and network service components, market (pool) fees and the retailers margin.

Source: ESAA 2000

Conversion efficiency, Australia

Table 3.4 shows the average thermal efficiency and average carbon dioxide emissions of the main electricity generation plant types in Australia. Average thermal efficiency for all generation types is around 35%. Black and brown coal are the least efficient (thermal efficiencies of 35% and 29%, respectively) and most emission-intensive fuels for thermal electricity generation, and together contribute about 90% of the fuel share for thermal electricity generation (table 3.2). Increased production of brown coal is reflected in the increased share of this fuel in thermal electricity generation.

Natural gas is both more efficient (38% average thermal efficiency) and results in considerably less carbon dioxide emissions per unit of electricity produced than brown or black coal. Combined cycle electricity generation involves recovering thermal energy from the normal gas-turbine cycle which is then used to drive an electric energy generator. This significantly improves energy efficiency in comparison to open cycle gas turbines (48% average efficiency). Cogeneration is the combined production of useful heat and power. Generally power is generated near the location where the heat will be used. This type of energy production aims to minimise the amount of energy that is wasted, and has an average thermal efficiency of 77%.

Conversion efficiency, Australia *cont.*

Diagram 1.1 in chapter 1—*Energy Supply and Use, Australia, 1997–98*—shows that over 1,900 PJ of energy was combusted in the production of 646 PJ of thermal electricity. A further 56 PJ of electricity was generated via hydro-electricity power. A total of 1,246 PJ was lost in the conversion of coal, oil and gas to thermal electricity, an amount greater than total (direct) household consumption of energy in that year. Australia's heavy reliance on electricity, combined with the use of inefficient and greenhouse-intensive sources of generation, continues to be problematic in achieving greenhouse gas reduction measures.

In this publication, the various emission intensities of the electricity generation plants have been factored into the final aggregate emissions, however, the varying generation types have not been separately identified in the published tables elsewhere.

3.4 THERMAL EFFICIENCY AND CARBON DIOXIDE EMISSIONS

	Thermal efficiency(a)	*Carbon dioxide emissions*
	%	t/MWh
Cogeneration — natural gas	77	0.26
Combined cycle — natural gas	48	0.39
Thermal — natural gas	38	0.49
Thermal — black coal	35	0.93
Thermal — brown coal	29	1.23

(a) Average only. Thermal efficiency of individual power plants will vary.

Source: ACA 1998.

TRANSPORT AND GREENHOUSE GASES

International comparison

Transport activity contributes around one quarter of Australia's emissions due to fuel combustion activities (84,049 Gg CO_2-e in 1997–98). Over 40% of this can be attributed to household use of the motor vehicle.

Table 3.5 shows that Australia contributes about 1.5% of the world's transport-related emissions. Total emissions from Australia's transport activities have increased by slightly more than the world average since 1990 (17.2% compared to 15.3%). The largest increases occurred in the developing regions, including Asia (63.8%); China (51.1%); and the Middle East (48.6%).

Compared to the rest of the world, Australia's proportion of transport-related CO_2 emissions are slightly higher (25.3% compared with 22.7%), but roughly equivalent to OECD Europe (although much variation exists between countries). In general, Australia's transport-related CO_2 emissions were proportionally much higher than the developing regions, but still lower than North America and New Zealand.

In terms of transport-related emissions per capita, Australia is very high, emitting over twice the amount per capita as OECD Europe, and about four and a half times the world average. Australia is not alone in its high per capita use of transport (and, hence, related CO_2 emissions), with countries such as the United States, Canada and Luxembourg exhibiting even higher per capita emissions. In contrast to these other countries, the United States also contributes substantially to total transport-related CO_2 emissions (nearly 32% of world transport-related emissions in 1997).

3.5 CO_2 EMISSIONS FROM TRANSPORT ACTIVITIES, Selected Countries/Regions—1997

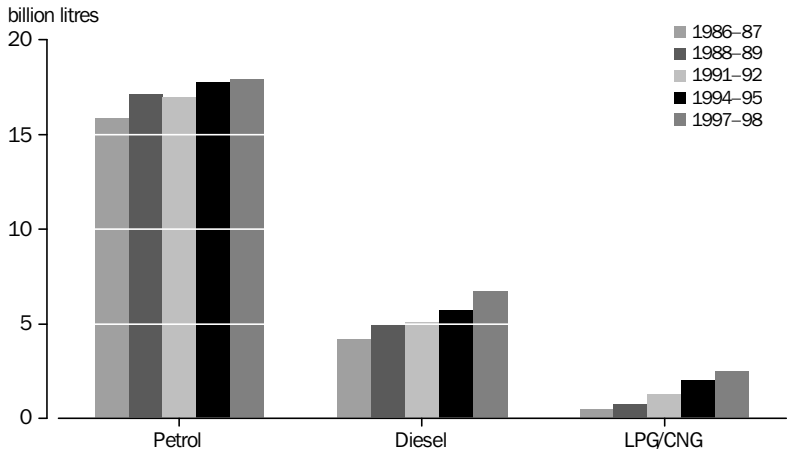
	CO_2 emissions from transport	*Proportion increase since 1990*	*As a proportion of total CO_2 emissions from fuel combustion*	*Per capita emissions by transport*	*Per capita emissions by road transport*
	Mt	%	%	kg CO_2	kg CO_2
Netherlands	40.5	30.6	22.0	2 598	1 856
Italy	118.1	14.5	27.8	2 052	1 843
United Kingdom	148.1	9.0	26.7	2 510	1 965
Germany	188.9	8.4	21.4	2 302	2 010
Turkey	36.4	26.4	19.4	571	470
Portugal	16.1	41.2	30.9	1 614	1 388
Luxembourg	4.5	45.2	51.6	10 546	8 676
Spain	84.8	25.6	33.4	2 158	1 701
France	141.2	12.5	38.9	2 409	2 068
Sweden	22.5	5.6	42.6	2 549	2 176
Norway	13.5	9.8	39.4	3 070	2 115
OECD Europe	985.2	14.3	24.6	1 936	1 614
Japan	267.0	24.4	22.8	2 116	1 753
Australia	**77.5**	**17.2**	**25.3**	**4 183**	**3 307**
New Zealand	13.3	29.1	40.2	3 543	1 744
United States	1 658.4	13.4	30.3	6 216	4 979
Canada	149.0	17.0	31.2	4 921	3 641
Non-OECD Europe	38.4	–10.2	12.4	616	515
Africa	127.0	14.0	17.4	173	138
Asia	393.0	63.8	19.3	217	179
China	231.8	51.1	7.3	188	117
Former USSR	189.3	–107.6	8.4	649	326
Middle East	179.1	48.6	18.7	1 146	1 018
Latin America	288.8	41.8	32.9	728	630
World	**5 207.7**	**15.3**	**22.7**	**901**	**660**

Source: OECD/IEA 1999.

Road transport

For most countries, including Australia, more than three-quarters of emissions related to transport activity are due to road transport activity, including use of private vehicles by householders. Total kilometres travelled in Australia in 1997–98 was 173,317 million, with passenger vehicles accounting for 77% of this (ABS 2000b). Petrol dominates as the major fuel used in motor vehicles in Australia. Graph 3.6 shows that, while only a small proportion of total fuel consumption, the use of LPG/CNG in motor vehicles continues to rise.

3.6 ANNUAL FUEL CONSUMPTION, By Fuel Type



Source: ABARE 2000.

Table 3.7 describes the use of road transport fuels by the different sectors, in terms of energy use and greenhouse gas emissions produced, for 1994–95. The following estimates are based on proportions derived for this base year. The household sector is responsible for the overwhelming majority of emissions from road transport—35,718 Gg CO_2-e in 1994–95, or nearly 60% (graph 3.8). The transport industry (mainly road transport) contributed about 17% (10,273 Gg CO_2-e) to total road transport activity. The remaining 23% was motor vehicle use by all other industries.

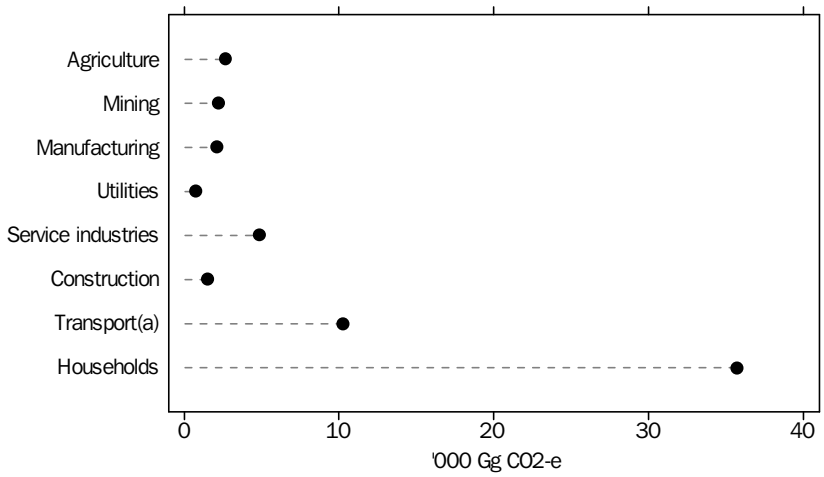
3.7 ROAD TRANSPORT USE AND ASSOCIATED GREENHOUSE EMISSIONS , By Industry—1994–95

	PETROL		DIESEL		LPG		TOTAL(a)	
	Energy use	*Emissions*	*Energy use*	*Emissions*	*Energy use*	*Emissions*	*Energy use*	*Emissions*
	PJ	Gg CO_2-e (b)	PJ	Gg CO_2-e	PJ	Gg CO_2-e	PJ	Gg CO_2-e
Agriculture	9.2	628	26.2	1 817	4.6	266	40.0	2 711
Mining	0.7	50	31.0	2 149	0.4	23	32.1	2 222
Manufacturing	9.3	630	12.3	853	11.2	643	32.7	2 126
Utilities	1.0	67	10.1	700	0.2	12	11.3	779
Service industries	37.0	2 522	24.8	1 720	11.4	655	73.2	4 897
Construction	7.4	501	13.7	948	1.3	75	22.3	1 524
Transport	58.6	3 753	159.4	5 503	17.7	1 017	235.6	10 273
Households	495.1	33 706	23.2	1 611	7.0	401	525.3	35 718
Total	**618.3**	**41 857**	**300.7**	**15 301**	**53.7**	**3 092**	**972.7**	**60 250**

(a) Excludes Natural gas as a vehicle fuel.

(b) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

3.8 GREENHOUSE GASES FROM ROAD TRANSPORT, By Industry—1994–95



(a) Total transport industry. Motor vehicle activity by industries and households has been allocated to these using sectors.

CHAPTER 4 INPUT-OUTPUT ANALYSIS, 1994–95

INTRODUCTION

Chapter 4 presents experimental estimates of direct, indirect and cumulative energy use and related greenhouse emissions based on input-output analyses of energy flows and greenhouse gas emissions. This is the first time the ABS has presented physical input-output tables and analyses that are fully integrated with Australia's monetary input-output tables. (Monetary input-output tables are part of the Australian national accounts. They describe the supply and subsequent use of all goods and services in the Australian economy. For more information on input-output tables and their uses see *Australian National Accounts: Input-Output Tables, 1994–95* (Cat. no. 5209.0).

This integration facilitates the consistent description and analysis of energy consumption in relation to economic activities, as described in the national accounts. This approach also provides a framework for the linkage of data on energy use and emissions of greenhouse gases to the physical consumption of various products and services, both energy and non-energy.

Chapter 2 presents the supply and use of energy products, showing which energy sources are *directly* used for what purpose and to what extent. However, while households and other final use sectors (which include exports, gross fixed capital formation, and general government final consumption) are final consumers of energy, industries use energy to produce goods and services which are ultimately consumed by these final use sectors. Therefore, energy directly used by industries would eventually be *indirectly* used by final demands. For example, electricity is used by the motor vehicle industry to produce cars for households, and energy *embodied* in these cars is indirectly used by households. One of the advantages of input-output modelling is that it enables *indirect energy use* to be attributed to final users so that *cumulative* energy use can be estimated for each final demand sector. Energy consumption and greenhouse emissions are said to be *induced* by final users.

This chapter considers:

- total energy consumption and greenhouse emissions used or produced, both directly and indirectly, by household final use of particular products and services;
- total amount of energy exported, including energy embodied in products and services exported and;
- total energy-related greenhouse emissions produced indirectly by exports and other final uses.

INTRODUCTION *cont.*

As stated previously, the results from this chapter are experimental and should be treated with caution, and with consideration of the assumptions and limitations underlying the input-output framework. These assumptions and the methodology used can be found in Appendix 2 of this publication. All figures in this chapter relate to the 1994–95 financial year. However, input-output relationships are relatively stable over time, hence, the derived proportions should be broadly applicable to more recent years. More results from input-output analysis are provided in an electronic release in the form of companion data to this publication on AusStats, the ABS on-line data service. A more detailed description of the methodology, including the mathematical estimation techniques, will appear in *Concepts, Sources and Methods for Australia's Water and Energy Accounts* (Cat. no. 4612.0) to be released in late 2001.

SUMMARY - DIRECT, INDIRECT AND CUMULATED TOTAL

Direct energy

Direct energy refers to energy consumed directly, either by industry in the process of producing goods and services, or by the final user such as households (e.g. use of motor vehicle fuels), or direct export of energy products such as coal and uranium. Chapter 2 refers to direct use of energy, and direct emitters of greenhouse gases. Table 4.1 summarises the supply and use of energy used directly for 1994–95. Total supply of energy comprises Australia's domestic production plus imports of energy sources. For Australia, domestic production contributes the bulk of total supply (around 91%), with imports of energy commodities playing a relatively minor role. The bulk of energy products mined, or otherwise produced, in Australia are exported (around 64% in 1994–95). Industry uses about 30% of total energy supply in the production of goods and services—either for domestic consumption or export. A relatively small proportion of Australia's energy supply is used directly by households—about 12%.

Indirect energy

It was mentioned in the introduction of this chapter that energy directly used by industries, or intermediate usage of energy, would eventually be used indirectly by final users. For Australia, total intermediate use of energy (including that embedded in imported goods and services) was 3,508 PJ (table 4.1). Of this amount, 1,338 PJ was attributed to indirect use by exports and 1,296 PJ to household consumption, around 37% each; with the remainder being attributed to other final consumption categories such as government final consumption and gross fixed capital formation.

Embedded energy

Input-output analysis can also provide a measure of energy embedded in imported goods and services. Embedded energy refers to energy used to produce these imports in their country of origin. This assumes that the same fuels and production technologies as used in Australia are used in the producing country. Table 4.1 describes energy embedded in imported goods and services which adds to total supply. In this way, the direct, indirect and total impact, on energy use, of a change in a final sector's consumption of specific goods and services can be analysed.

Embedded energy *cont.*

Energy embedded in imports of goods and services amounted to a further 420 PJ of energy imported to Australia, resulting in a cumulated total supply of energy of 10,993 PJ. About three-quarters of the embedded energy in imports goes directly into intermediate consumption.

Cumulated Energy

In total (direct plus indirect/embedded energy), Australia exports the vast majority of its total energy supply—8,131 PJ of energy, or 74% of Australia's cumulated energy supply. Most of this (about 84%) is due to the direct export of energy products, mainly black coal and uranium. The remaining 16% is energy embodied in products and services exported.

Household final consumption of energy amounted to 2,522 PJ, or around 23% of Australia's total cumulated energy supply. Consumption by households was almost equally attributed to direct use of energy (49%), and indirect energy through the consumption of goods and services, either domestically produced or imported (51%). Diagram 4.2 summarises the reallocation of energy to final uses.

Graph 4.3 shows the consumption of direct and indirect energy by households and exports. This graph also shows the final use of energy embedded in imported goods and services. Energy embedded in imports comprises only a small proportion of total final consumption (8% for households and less than 1% for exports).

4.1 TOTAL ENERGY, Supply and Use—1994–95

	Direct		*Indirect or Embedded*	*Cumulated*	
	PJ	%	PJ	PJ	%
Total supply	10 573.4	100.0		10 992.9	100.0
Domestic production	9 658.9	91.4	—	9 658.9	87.9
Imports	914.4	8.6	(a)419.6	1 334.0	12.1
Total uses	10 573.4	100.0		10 992.9	100.0
Industry (intermediate consumption)	3 192.8	30.2	(b)–3 507.6	—	—
Exports	6 793.1	64.2	1 337.9	8 130.8	74.0
Household final consumption	1 226.4	11.6	1 295.5	2 521.9	22.9
Other(c)	(d)–639.0	–6.0	979.2	340.2	3.1

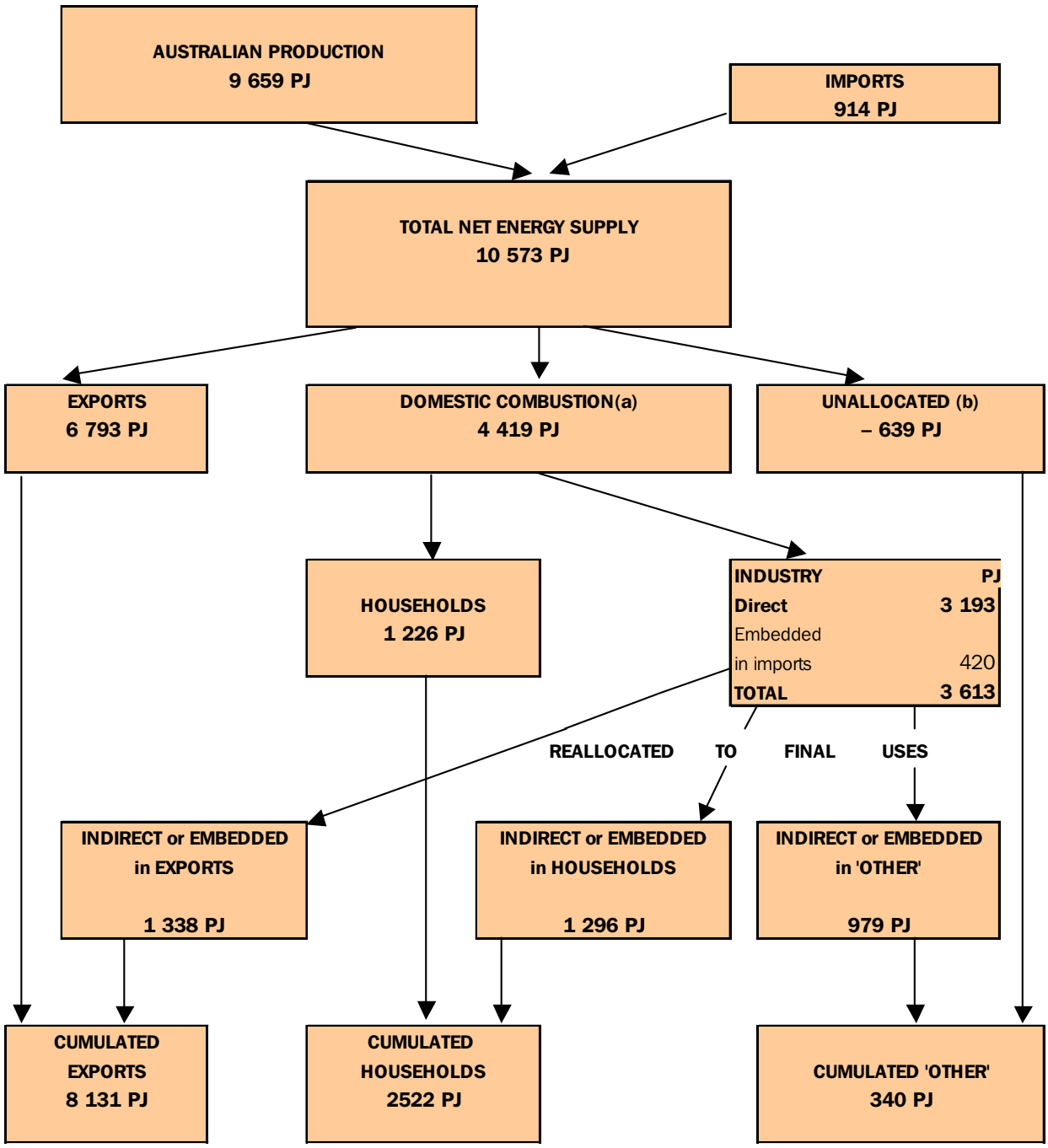
(a) Energy embedded in imports (i.e. energy used overseas to produce Australian imports).

(b) This figure is negative to denote that this amount is re-allocated back to the final users (exports, households, other) — this energy is thus referred to as indirect use by these final users.

(c) Includes: general government final consumption; gross fixed capital formation; changes in stocks.

(d) Primarily changes in inventories of uranium.

4.2 TOTAL ENERGY SUPPLY AND USE, Allocated to Final Uses—1994–95

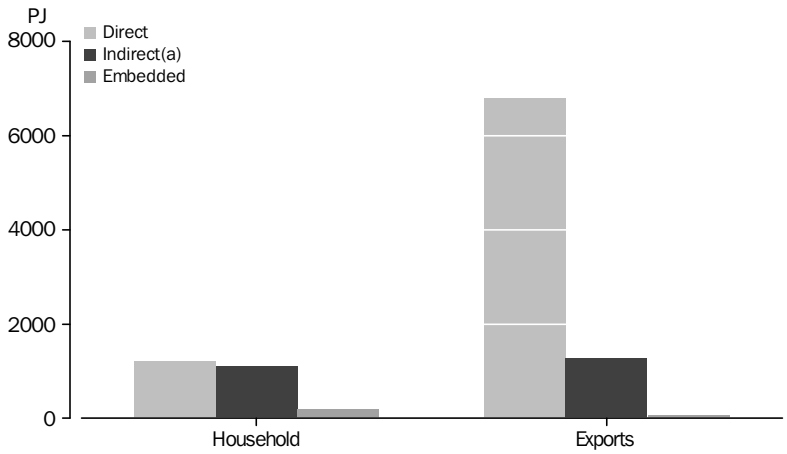


(a) Use by industry and households.

(b) Changes in stocks and statistical discrepancies.

Note: Conversion losses have been allocated to the using sector.

4.3 FINAL CONSUMPTION OF ENERGY, Households and Exports—1994–95



(a) Energy embodied in domestically produced goods and services.

CONVERSION LOSSES

The figures described on the previous page also include the amount of energy lost in the conversion from one energy source to another. This is particularly significant in the conversion of fossil fuels to electricity. See chapter 3 for a detailed description of conversion efficiencies by fuel type. Conversion losses have been attributed to the using sector and these values are separately identified in table 4.4 below.

Of the 3,508 PJ of energy used by industry in the form of intermediate consumption, about 28%—or 966 PJ—was attributed to conversion losses, leaving 2,588 PJ actually consumed in the production process.

These conversion losses have, in turn, been attributed to the final uses of energy as shown in table 4.4. This resulted in about 27% of Australia's energy embodied in exports of goods and services being attributed to conversion losses (357 PJ).

Significant conversion losses also occurred for both direct household final consumption of energy (342 PJ), and indirect consumption of energy by households (362 PJ). Each of these losses represented 28% of its respective total.

Total energy lost due to conversion amounted to about 1,076 PJ for households and exports. This represented about 10% of total energy exported or consumed by households. Energy conversion loss also occurred for other final uses such as general government final consumption and energy used by gross capital formation (3% of total energy supply, or 279 PJ, not shown in the table).

4.4 ENERGY USE AND CONVERSION LOSSES, Exports and Households—1994–95

	Energy used	*Conversion loss*	*Total*	*Conversion loss as per cent of total*
	PJ	PJ	PJ	%
INTERMEDIATE CONSUMPTION				
Total	2 541.5	966.1	3 507.6	27.5
FINAL USES				
Exports				
Direct	6 777.8	15.3	6 793.1	0.2
Indirect(a)	980.7	357.0	1 337.7	26.7
Cumulated	7 758.5	372.3	8 130.8	4.6
Household final consumption				
Direct	884.9	341.5	1 226.4	27.8
Indirect(a)	933.8	361.7	1 295.5	27.9
Cumulated	1 818.7	703.2	2 521.9	27.9

(a) Includes energy embedded in imports.

HOUSEHOLD FINAL CONSUMPTION

Table 4.5 presents energy use by household final consumption of various product types. Direct use of certain energy products is presented in the first column, and these represent 49% of total cumulated energy consumption by households. The majority of this is due to the use of products derived from coal, oil and gas. The direct use of coal, oil and gas, and their derivative products, totalled 1,108 PJ, or 44% of total energy consumed by households.

The direct use of petroleum products (mainly motor vehicle fuels) contributed the most to total household consumption of energy. This amounted to 545 PJ, or 22% (including conversion losses). The direct use of thermal electricity by households totalled 440 PJ, with 67% of this amount being attributed to conversion losses. A further 14 PJ of hydro-electricity was consumed directly by households.

Energy used indirectly in the form of consumption of (mainly) non-energy products and services totalled 1,095PJ, representing about 43% of household consumption. The most significant contribution was the indirect use of energy through the consumption of the goods and services delivered from wholesale, retail and repairs (216 PJ); accommodation, cafes and other services (108 PJ); and finance, insurance and property services (106 PJ).

The use of these three product groups contributed 17% towards total household final consumption of energy.

Energy embedded in imports represented 8% of the total, with almost 29% of this embodied in transport equipment and other machinery.

4.5 HOUSEHOLD FINAL CONSUMPTION OF ENERGY, By Product Type—1994–95

	Direct	*Indirect*	*Energy embedded in imports*	*Total*	*Per cent of total energy for household final consumption*
	PJ	PJ	PJ	PJ	%
Coal; oil and gas					
As coal, oil and gas	123.0	5.5	—	128.5	5.1
For production of petroleum products	496.9	26.0	2.1	525.0	20.8
Conversion loss to petroleum products	48.4	6.1	0.2	54.7	2.2
For production of electricity	138.6	21.8	—	160.4	6.4
Conversion loss to electricity	292.7	26.0	—	318.7	12.6
Production of electricity from petroleum products	7.9	—	—	7.9	0.3
Conversion loss petroleum products to electricity	0.4	—	—	0.4	—
Total coal, oil and gas	*1 107.9*	*85.4*	*2.3*	*1 195.6*	*47.4*
Imports of petroleum & coal products	19.0	—	0.2	19.2	0.8
Firewood	81.7	0.1	—	81.8	3.2
Solar	3.4	—	—	3.4	0.1
Hydro-electricity	14.4	5.2	—	19.6	0.8
Agriculture	. .	29.8	2.0	31.9	1.3
Mining	. .	0.2	0.6	0.8	—
Meat and meat products	. .	32.2	0.4	32.6	1.3
Dairy products	. .	25.9	1.1	27.0	1.1
Fruit and vegetable products	. .	18.2	2.4	20.6	0.8
Oils and fats	. .	3.4	1.3	4.7	0.2
Flour mill/cereal foods	. .	9.2	0.6	9.7	0.4
Bakery products	. .	15.6	0.9	16.5	0.7
Confectionary, other food	. .	77.4	5.8	83.2	3.3
Beverages	. .	16.0	3.7	19.7	0.8
Tobacco products	. .	3.8	2.1	5.9	0.2
Textiles; clothing & footwear; leather	. .	25.7	21.8	47.5	1.9
Wood & wood products; printing & publishing	. .	26.5	13.5	40.0	1.6
Basic chemicals	. .	1.1	8.9	10.0	0.4
Other chemicals; rubber and plastic	. .	22.4	16.9	39.3	1.6
Glass and glass products	. .	1.6	0.9	2.5	0.1
Ceramic products	. .	3.6	0.5	4.1	0.2
Cement, lime, plaster & other concrete products	. .	—	—	0.1	—
Other non-metallic mineral products	. .	—	0.3	0.3	—
Iron & steel (excludes coke)	. .	0.2	2.1	2.3	0.1
Basic non-ferrous metal and products	. .	12.3	0.8	13.1	0.5
Fabricated metal products	. .	5.9	3.0	9.0	0.4
Transport equipment and other machinery	. .	37.4	58.7	96.1	3.8
Other manufacturing	. .	22.6	4.8	27.5	1.1
Gas supply	. .	6.5	—	6.5	0.3
Water supply; sewerage & drainage services	. .	16.9	—	16.9	0.7
Construction	. .	—	—	—	—
Wholesale; retail; repairs	. .	215.4	0.9	216.3	8.6
Road transport	. .	30.3	0.8	31.1	1.2
Rail; pipeline; services to transport	. .	9.9	3.0	12.8	0.5
Water transport	. .	2.1	2.1	4.2	0.2
Air and space transport	. .	60.7	10.1	70.8	2.8
Communication services	. .	12.2	3.5	15.7	0.6
Finance & insurance; ownership of dwellings; property & business dwellings	. .	106.4	12.3	118.7	4.7
Government administration	. .	2.9	—	2.9	0.1
Education; health & community services	. .	41.6	2.8	44.4	1.8
Other services; accommodation and cafes	. .	108.3	9.3	117.6	4.7
Total	**1 226.4**	**1 095.0**	**200.5**	**2 521.9**	**100.0**

Note: Values may not add due to rounding.

EXPORTS OF ENERGY

Direct exports of energy products, in particular black coal, is by far the biggest contributor to total energy exported by Australia. A total of 6,793 PJ of energy is exported as raw material (84%), with the remaining 1,338 PJ being exported indirectly in the form of energy embodied in goods and services (table 4.6). Basic non-ferrous metals and metal products accounted for one third of this amount (429 PJ).

4.6 EXPORTS OF ENERGY, By Product Type—1994–95

	Direct	*Indirect(a)*	*Energy embedded in imports*	*Total*	*Per cent of total energy for exports*
	PJ	PJ	PJ	PJ	%
Coal; oil and gas					
As coal, oil and gas	4 728.7	212.1	—	4 940.8	60.8
For production of petroleum products	128.2	15.2	0.8	144.2	1.8
Conversion loss to petroleum products	12.7	3.7	0.1	16.5	0.2
For production of coke/coal by-products	8.0	0.8	—	8.8	0.1
Conversion loss to coke/coal by-products	2.6	0.3	—	2.9	—
Total coal, oil and gas	*4 880.2*	*232.1*	*0.9*	*5 112.2*	*62.9*
Imports of petroleum & coal products	—	—	0.1	0.1	—
Uranium	1 912.9	3.0	—	1 915.9	23.6
Firewood	—	—	—	—	—
Agriculture	. .	42.5	0.8	43.3	0.5
Mining	. .	89.2	2.1	91.3	1.1
Meat and meat products	. .	34.5	—	34.5	0.4
Dairy products	. .	13.7	0.1	13.9	0.2
Fruit & vegetable products	. .	2.9	—	3.0	—
Oils and fats	. .	0.8	0.2	1.0	—
Flour mill/cereal foods	. .	3.8	0.1	3.8	—
Bakery products	. .	1.1	—	1.2	—
Confectionary, other food	. .	49.3	0.7	50.0	0.6
Beverages	. .	5.7	0.3	5.9	0.1
Tobacco products	. .	0.9	—	0.9	—
Textiles; clothing & footwear; leather	. .	12.0	2.8	14.7	0.2
Wood & wood products; printing & publishing	. .	9.1	2.5	11.6	0.1
Basic chemicals	. .	31.4	5.5	36.9	0.5
Other chemicals; rubber & plastic	. .	9.5	4.2	13.8	0.2
Glass and glass products	. .	1.2	0.2	1.4	—
Ceramic products	. .	1.9	0.2	2.0	—
Cement, lime, plaster & other concrete products	. .	0.6	—	0.6	—
Other non-metallic mineral products	. .	2.6	0.1	2.7	—
Iron & steel (excludes coke)	. .	52.9	1.8	54.6	0.7
Basic non-ferrous metal and products	. .	427.8	1.5	429.3	5.3
Fabricated metal products	. .	8.0	1.2	9.2	0.1
Transport equipment and other machinery	. .	43.8	17.4	61.2	0.8
Other manufacturing	. .	4.0	0.3	4.4	0.1
Gas supply	. .	—	—	—	—
Water supply; sewerage & drainage services	. .	—	—	—	—
Construction	. .	0.7	—	0.7	—
Wholesale; retail; repairs	. .	27.9	0.1	28.0	0.3
Road transport	. .	14.1	0.3	14.4	0.2
Rail; pipeline; services to transport	. .	14.2	1.4	15.6	0.2
Water transport	. .	61.8	3.0	64.8	0.8
Air and space transport	. .	61.7	1.5	63.2	0.8
Communication services	. .	2.0	0.6	2.5	—
Finance & insurance; ownership of dwellings; property & business dwellings	. .	5.5	1.5	7.0	0.1
Government administration	. .	0.7	—	0.7	—
Education; health & community services	. .	4.0	0.1	4.1	0.1
Other services; accommodation and cafes	. .	9.0	0.5	9.5	0.1
Total	**6 793.1**	**1 285.8**	**51.9**	**8 130.8**	**100.0**

(a) Refers to energy embodied in goods and services.

ENERGY COMBUSTED IN AUSTRALIA

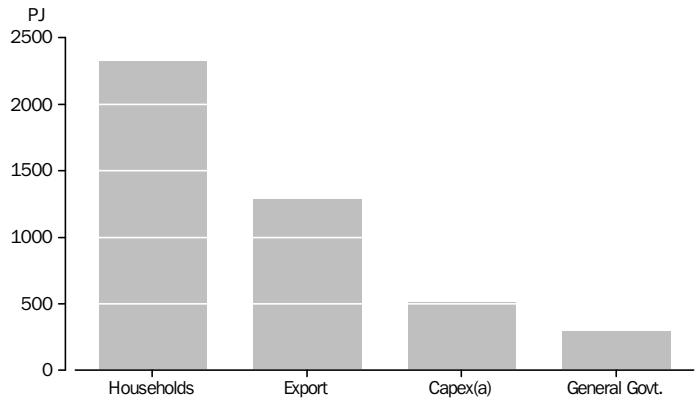
Graph 4.7 shows the amount of energy 'combusted' domestically, by final use category. These figures comprise the direct use of energy products by households, as well as energy used in producing goods and services for export; government final consumption; and gross capital formation; plus the indirect use of energy via the household consumption of domestically produced goods and services. This includes the use of renewables such as hydro and solar which, technically speaking, are not actually 'combusted'. It excludes the energy content of raw materials that are exported and combusted overseas, and energy that is embedded in imported goods and services.

Energy combusted in Australia is of particular interest for assessing the amount of greenhouse gas emissions being emitted domestically. Greenhouse gases are attributed to the country in which the greenhouse gas is emitted (and hence, where the fossil fuels and biomass are burnt). The type of energy combusted is also important, as different fuels have different emission factors.

Total energy combusted in Australia was 4,419 PJ. Over half of this amount (53%) was due to household final consumption. Goods and services produced for export comprised 29%; gross capital formation induced 11%; and government final consumption induced the remaining 7%.

Energy used for gross fixed capital formation was dominated by construction, which totalled 302 PJ of embodied energy in its products (mainly infrastructure such as railways, roads and pipelines etc.). Energy induced by government final consumption comprised mainly government administration, and the provision of education, health and community services. Combined, these services totalled about 198 PJ. Households and exports are explored separately below.

4.7 ENERGY COMBUSTED IN AUSTRALIA, By Final Use—1994–95



(a) Gross fixed capital formation.

Household final consumption and exports

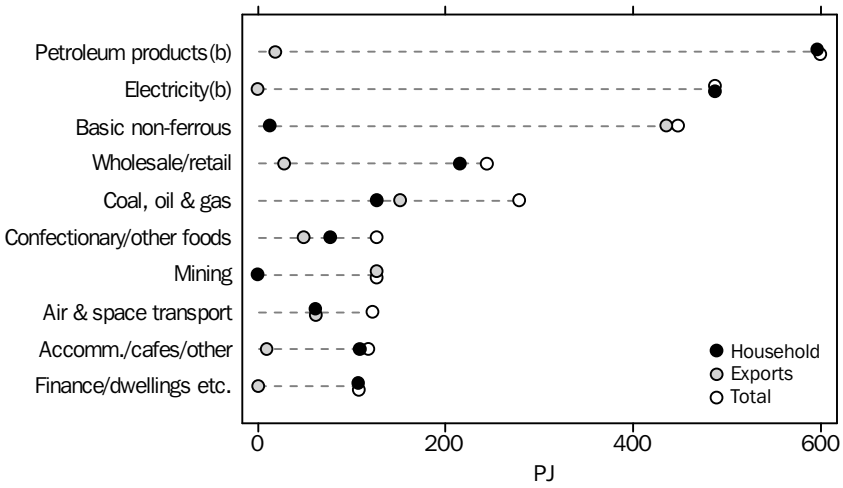
Energy combusted domestically for either household final consumption or export totalled 3,607 PJ. Of this, 2,321 PJ, or 64%, was due to household consumption, and 1,286 PJ (36%) was energy used for the production of goods and services for export.

Graph 4.8 compares the total energy combusted in Australia (as opposed to direct export of fuel products and energy embedded in imports) for the purpose of final consumption by households and exports, by selected product type. It presents the ten product types that induce the largest amount of energy consumption, representing over 70% of the energy induced by households and exports.

Petroleum products (mainly motor vehicle fuels) contributed the most (577 PJ) to energy combusted domestically for household consumption, followed by direct (thermal) electricity use (440 PJ). For export, the biggest contributor was basic non-ferrous metals and products (428 PJ).

Basic non-ferrous metals and products include products from: alumina production, aluminium smelting and aluminium product manufacturing, as well as copper, silver, lead and zinc smelting and refining, and other non-ferrous metal manufacturing.

4.8 FINAL CONSUMPTION(a) OF ENERGY COMBUSTED IN AUSTRALIA—1994–95



(a) By households and exports only.

(b) Includes conversion loss from primary fuel to derived product.

Note: Refers to the ten product types that induce the most energy.

Household consumption, by fuel

Coal, oil and gas and their derived products account for over 90% of the energy used by households in Australia, with only a small proportion attributed to hydro-electricity, solar, bagasse and firewood. The use of petroleum products (mainly motor vehicle fuels) and electricity comprised the vast majority of energy used directly or indirectly by households. Combined these amounted to 1,787 PJ, or more than three-quarters of final consumption of energy by households (graph 4.9). The use of coal, oil and gas in their primary form (mainly natural gas) contributed about 13%, while renewables made up 8%.

It should be noted that the amounts for petroleum products and electricity include the conversion losses occurring in the production from the primary fuel (coal, oil and gas) to the derived product. For electricity, the conversion loss amounted to about 66% of the total energy content (566 PJ out of 859 PJ).

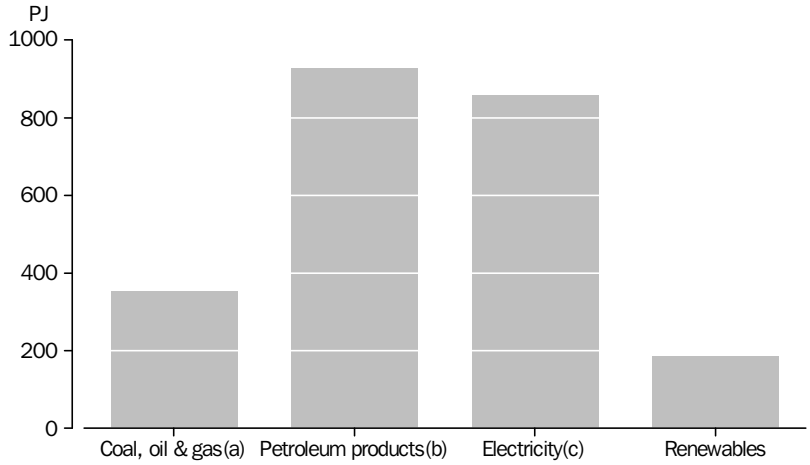
Exports, by fuel

Electricity (thermal) was the energy type used most in the production of goods and services for export (463 PJ, or 36% of export total), with basic non-ferrous metals and metal products accounting for half of this amount.

Coal, oil and gas (as primary fuels), and petroleum products, totalled 714 PJ (around 25% each) of energy used to produce exports.

Overall, household final consumption of energy accounted for nearly three times as much petroleum fuels, and almost twice as much electricity, as the energy used in the production of exports.

4.9 ENERGY CONSUMPTION INDUCED BY HOUSEHOLDS, By Fuel Type—1994–95

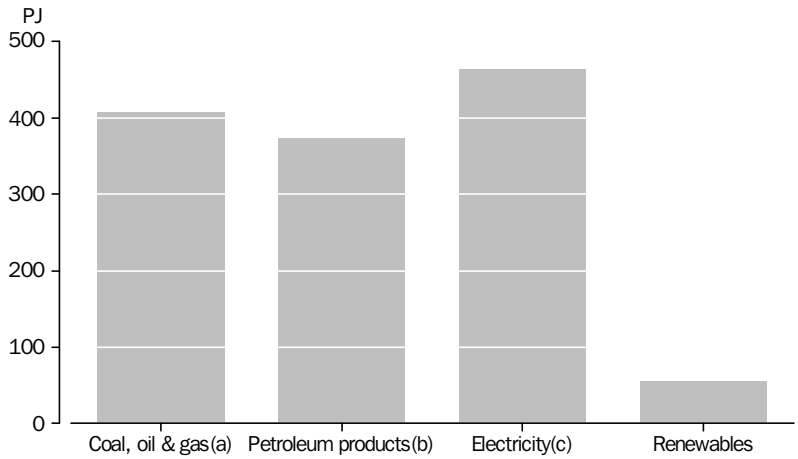


(a) Includes coke and coal by-products.

(b) Includes conversion loss from crude oil to derived product.

(c) Includes conversion loss from primary fuel to derived product. Excludes hydro-electricity.

4.10 ENERGY CONSUMPTION INDUCED BY EXPORTS, By Fuel Type—1994–95



(a) Includes coke and coal by-products.

(b) Includes conversion loss from crude oil to derived product.

(c) Includes conversion loss from primary fuel to derived product. Excludes hydro-electricity.

GREENHOUSE GAS EMISSIONS BY FINAL PURPOSE

The previous section described the amount of energy used domestically, for the purpose of household final consumption and the production of exports. These figures exclude the amount of energy embedded in imports of goods and services (that is, energy used overseas to produce an Australian import). This section presents estimates of greenhouse gas emissions (carbon dioxide, methane and nitrous oxide) associated with domestic energy use, including other final use categories such as government final consumption, gross fixed capital formation and change in inventories.

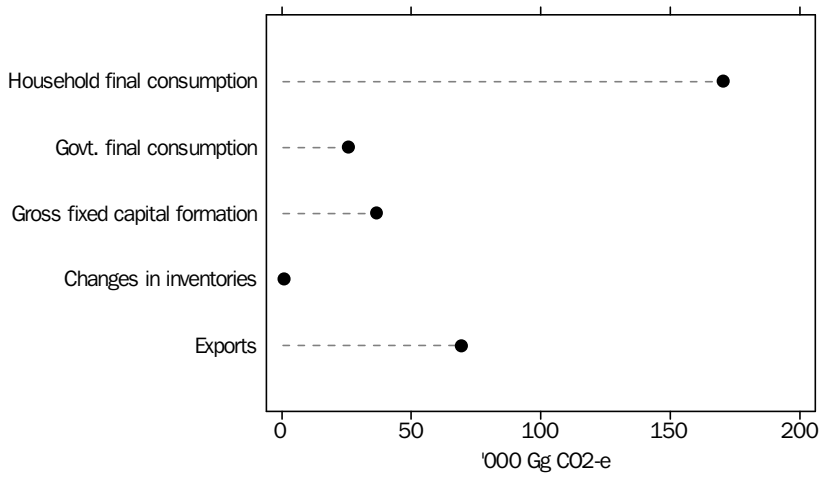
Table 4.11 and graph 4.12 show that, in 1994–95, the bulk of Australia's energy-related greenhouse gas emissions were emitted in the production and consumption of goods and services for the purpose of household final consumption (170,514 Gg CO_2-e, or 56% of greenhouse gas emissions). The production of goods and services for export contributed a further 69,317 Gg CO_2-e (23%) to total (energy) emissions, with the bulk of the remainder attributed to gross capital formation and government final consumption.

4.11 GREENHOUSE GAS EMISSIONS INDUCED, By Final Use Category—1994–95

	CO_2	CH_4	N_2O	Total
	Gg CO_2-e (a)	Gg CO_2-e	Gg CO_2-e	Gg CO_2-e
Household final consumption	165 126	2 190	3 198	170 514
Government final consumption	25 448	35	154	25 638
Gross fixed capital formation	36 281	46	226	36 553
Changes in inventories	931	—	4	935
Exports	68 792	128	397	69 317
Total	296 578	2 399	3 980	302 958

(a) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

4.12 GREENHOUSE GAS EMISSIONS INDUCED, By Final Use Category—1994–95



Total greenhouse emissions by product type

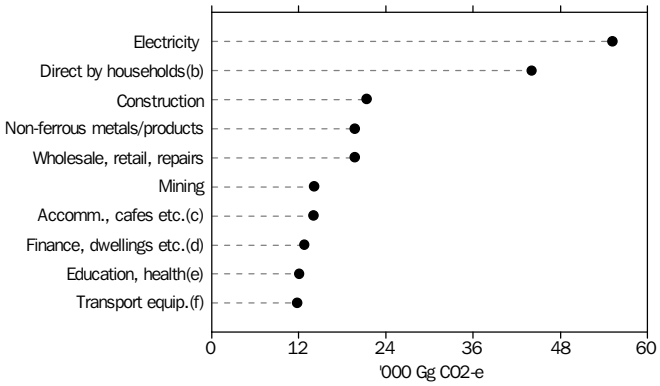
Table 4.14 presents greenhouse gas emissions produced either directly or indirectly as a result of consumption of goods and services by final users. Graph 4.13 shows the ten product groups that generated the greatest amount of emissions in their production (or use). These ten groups represent three-quarters of total energy-related emissions.

The production of electricity for household consumption was the single largest contributor to domestic (energy-related) greenhouse gas emissions (over 50,000 Gg CO_2-e) (table 4.15). The consumption of electricity does not emit greenhouse gases directly, but greenhouse gases are emitted in the generation and transmission of electricity, the majority of which, in Australia, is produced from coal. This conversion process is relatively inefficient and greenhouse intensive (see chapter 3). The next largest contribution resulted from the consumption of energy products by households, where this consumption emits greenhouse gases directly—mainly motor vehicle fuels. Together, the production and supply of electricity for final use, and direct emissions from households account for almost one-third of domestically produced (energy-related) greenhouse gases—99,204 Gg CO_2-e (includes a small amount of emissions attributed to other final uses for electricity supply).

Other significant contributions are: emissions induced by demand for construction, mostly gross fixed capital formation; basic non-ferrous metals and products, almost wholly for export; and products of wholesale, retail and repairs, the bulk of which is consumed by households. Each of these contributed about 7% towards total greenhouse gas emissions.

Mining products, mainly for export, contributed 14,161 Gg CO_2-e. Several groups of services—the main final consumers of which are households and government—made the next largest contributions to greenhouse gas emissions. In total, services defined as: accommodation, cafes, restaurants; cultural and recreational; personal; education; health and community; finance, insurance, ownership of dwellings; property and business services, contributed a further 38,923 Gg CO_2-e (just under 13% of the total).

4.13 GREENHOUSE GASES INDUCED(a) BY FINAL USE, By Product Type—1994–95



(a) Emissions produced indirectly via consumption of products. The exception is direct emissions by households.

(b) Direct production by households, mainly through motor vehicle use.

(c) Includes restaurants, cultural and recreational services, personal and other services.

(d) Includes insurance, property and business services.

(e) Includes community services.

(f) Includes other machinery.

4.14 TOTAL GREENHOUSE GAS EMISSIONS(a) PRODUCED OR INDUCED, By Product Type Consumed—1994–95

	CO_2	CH_4	N_2O	Total	Proportion of total
	Gg CO_2-e (b)	Gg CO_2-e	Gg CO_2-e	Gg CO_2-e	%
Indirect					
Agriculture, hunting and trapping; forestry	5 108	11	45	5 164	1.7
Mining	14 090	18	53	14 161	4.7
Meat and meat products	4 483	9	41	4 533	1.5
Dairy products	2 542	4	20	2 565	0.8
Fruit and vegetable products	1 436	2	11	1 449	0.5
Oils and fats	220	—	1	221	0.1
Flour mill products and cereal foods	897	1	7	906	0.3
Bakery products	1 012	1	8	1 021	0.3
Confectionary; other food products	3 364	12	123	3 499	1.2
Beverages	1 532	2	11	1 545	0.5
Tobacco products	341	1	3	344	0.1
Textiles; clothing and footwear	2 711	4	18	2 733	0.9
Wood and wood products; paper, printing	2 182	3	19	2 203	0.7
Petroleum and coal products	4 569	4	16	4 588	1.5
Basic chemicals	1 972	2	7	1 980	0.7
Other chemicals, rubber and plastic	2 993	3	15	3 011	1.0
Glass and glass products	179	—	1	180	0.1
Ceramic products	344	—	1	346	0.1
Cement, lime and concrete; plaster	105	—	1	106	—
Other non-metallic minerals products	145	—	1	145	—
Iron and steel	4 225	2	10	4 238	1.4
Basic non-ferrous metal and products	19 684	11	57	19 752	6.5
Fabricated metal products	1 568	1	6	1 575	0.5
Transport equipment; other machinery	11 730	9	48	11 788	3.9
Miscellaneous manufacturing	2 278	2	13	2 294	0.8
Electricity supply	54 961	14	178	55 153	18.2
Gas supply	223	—	2	225	0.1
Water supply, sewerage and drainage	1 117	1	5	1 123	0.4
Construction	21 227	30	141	21 397	7.1
Wholesale, retail, repairs	19 518	36	177	19 730	6.5
Road transport	3 775	17	95	3 887	1.3
Rail, pipeline, other; services to transport	4 955	21	29	5 005	1.7
Water transport	4 262	44	34	4 340	1.4
Air and space transport	8 968	26	74	9 068	3.0
Communication services	1 150	2	9	1 160	0.4
Finance & insurance; ownership of dwellings; property and business services	12 690	16	85	12 791	4.2
Government administration	8 483	11	53	8 546	2.8
Education; health and community services	12 002	11	62	12 075	4.0
Accommodation, cafes, restaurants; cultural & recreational; personal and other services	13 943	17	97	14 057	4.6
Total indirect	*256 984*	*347*	*1 576*	*258 907*	*85.5*
Direct(c)	39 594	2 052	2 404	44 051	14.5
Total	**296 578**	**2 399**	**3 980**	**302 958**	**100.0**

(a) Energy-related only.

(b) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

(c) Refers to greenhouse gases emitted directly by households in the consumption of energy products, mainly motor vehicle fuels. Other less significant contributors include use of gas and firewood.

Greenhouse gases induced by household final consumption, by product type

Table 4.15 presents estimates of greenhouse gases produced by households directly, as well as greenhouse gases emitted indirectly in the consumption of goods and services (first column). As described earlier, indirect and direct emissions by household consumption of products amounted to 56% of Australia's energy-related greenhouse gas emissions. Direct greenhouse gas emissions accounted for about one quarter of total emissions attributed to household final consumption. Direct emissions are described in chapter 2 and, for households, the bulk of these emissions can be attributed to private use of the motor vehicle (chapter 3).

Indirect greenhouse gas emissions, or greenhouse gases emitted in the production of goods and services for household final consumption, accounted for about 126,464 Gg CO_2-e, or just under three-quarters of the total emissions attributed to households. The single largest contributor to indirect emissions by households was the production of greenhouse gases in the generation of electricity. This large amount is due to the relatively low thermal efficiency, and relatively high emission intensity, of the Australian electricity market. Conversion efficiency and fuel shares in thermal electricity generation are discussed in chapter 3.

The next largest generation of emissions was for products of: wholesale, retail and repairs (14,866 Gg CO_2-e); accommodation, cafes, restaurants, and other (10,638 Gg CO_2-e); and finance, insurance, ownership of dwellings, property and business (10,581 Gg CO_2-e). Together, household consumption of these products contributed 21% to the total production of energy-related greenhouse gas emissions by households. Provision of services such as these requires relatively large inputs of electricity.

Graph 4.16 shows the contribution that consumption of these products and services by households make to total energy-related greenhouse gas emissions.

4.15 PRODUCTION OF ENERGY-RELATED GREENHOUSE GASES BY FINAL USE, By Product Type—1994–95

	Household final consumption	*Exports*	*Gross fixed capital formation*	*Government final consumption*	*Changes in inventories*	*Total*
	Gg CO_2-e (a)	Gg CO_2-e	GgCO_2-e	Gg CO_2-e	Gg CO_2-e	Gg CO_2-e
Indirect						
Agriculture, hunting and trapping; forestry	2 013	2 859	329	307	–345	5 164
Mining	224	13 568	1 067	70	–768	14 161
Meat and meat products	2 156	2 306	16	—	54	4 533
Dairy products	1 677	890	16	—	–17	2 565
Fruit and vegetable products	1 233	198	13	—	6	1 449
Oils and fats	178	41	0	—	2	221
Flour mill products and cereal foods	630	259	6	—	11	906
Bakery products	941	69	9	—	3	1 021
Confectionary; other food products	2 114	1 347	28	—	10	3 499
Beverages	1 103	389	10	—	43	1 545
Tobacco products	248	58	1	—	38	344
Textiles; clothing and footwear	1 817	847	34	—	35	2 733
Wood and wood products; paper, printing	1 463	502	209	35	–6	2 203
Petroleum and coal products	2 978	1 058	1	—	551	4 588
Basic chemicals	60	1 699	29	—	192	1 980
Other chemicals, rubber and plastic	1 369	583	39	962	58	3 011
Glass and glass products	103	73	2	—	2	180
Ceramic products	176	91	16	—	62	346
Cement, lime and concrete; plaster	2	40	29	—	35	106
Other non metallic minerals products	1	122	22	—	—	145
Iron and steel	15	3 883	49	—	291	4 238
Basic non-ferrous metal and products	550	19 058	36	—	108	19 752
Fabricated metal products	382	511	622	—	61	1 575
Transport equipment; other machinery	2 608	3 051	5 810	—	318	11 788
Miscellaneous manufacturing	1 114	199	919	—	62	2 294
Electricity supply	51 036	305	2 006	1 806	—	55 153
Gas supply	211	—	15	—	—	225
Water supply, sewerage and drainage	1 091	2	2	27	—	1 123
Construction	—	48	20 464	885	1	21 397
Wholesale, retail, repairs	14 866	1 928	2 851	4	81	19 730
Road transport	2 163	1 009	200	442	73	3 887
Rail, pipeline, other; services to transport	1 087	1 566	57	2 312	–18	5 005
Water transport	144	4 206	2	—	–11	4 340
Air and space transport	4 470	4 543	53	—	2	9 068
Communication services	987	162	2	10	—	1 160
Finance & insurance; ownership of dwellings; property and business services	10 581	544	1 382	285	—	12 791
Government administration	208	49	91	8 198	—	8 546
Education; health and community services	3 824	371	28	7 852	—	12 075
Accommodation, cafes, restaurants; cultural & recreational; personal and other services	10 638	886	87	2 444	1	14 057
Total indirect	*126 464*	*69 317*	*36 553*	*25 638*	*935*	*258 907*
Direct(b)	44 051	—	—	—	—	44 051
Total	**170 514**	**69 317**	**36 553**	**25 638**	**935**	**302 958**

(a) One billion (or 10^9) grams (g). Equivalent to one thousand tonnes (Kt).

(b) Refers to greenhouse gases emitted directly by households in the consumption of energy products, mainly motor vehicle fuels. Other less significant contributors include use of gas and firewood.

Greenhouse gases induced by exports

The two most significant contributors to energy-related greenhouse emissions resulting from production of goods for export are the basic non-ferrous metals and products (19,058 Gg CO_2-e), and mining (13,568 Gg CO_2-e) (table 4.15). Combined, these represent 47% of the energy-related greenhouse gases induced by exports, but only 11% of the total.

Excluding basic non-ferrous metals and products, all other manufactured products for export embodied 18,215 Gg CO_2-e—around 26% of emissions due to export, but 6% of total energy-related domestic emissions.

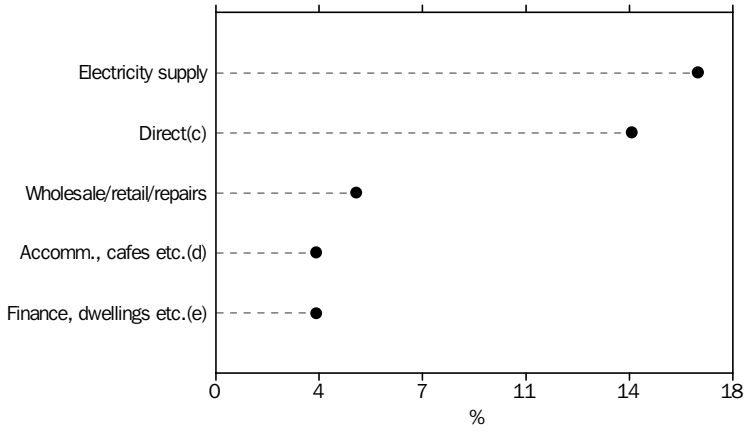
Air and space transport (4,543 Gg CO_2-e), and water transport (4,206 Gg CO_2-e), were the next largest contributors, together producing 13% of the export total. These contributions are related to the freighting of goods to departure points for export, and provision of passenger services to overseas residents. The contributions these export products make to total greenhouse gas emissions are shown in graph 4.17.

Greenhouse gases induced by other final demand

Other significant amounts of emissions attributed to final uses besides households and exports include: industry products with significant gross fixed capital formation, in particular construction. Emissions induced by gross fixed capital formation amounted to 20,464 Gg CO_2-e for construction, and 5,810 Gg CO_2-e for transport equipment and other machinery. Buildings and other construction, such as roads, irrigation systems, oil refineries, and water or gas supply systems contain high levels of embodied energy—and greenhouse gases—due to the large amount of manufactured materials they consume. Construction induces the third-highest overall level of (energy-related) domestic emissions, at around 7% (see table 4.15 and graph 4.18).

Government also indirectly produces significant amounts of emissions, in producing government administration services (8,198 Gg CO_2-e); and education, health and community services (7,852 Gg CO_2-e).

4.16 PERCENT OF GREENHOUSE GASES(a) INDUCED(b) BY HOUSEHOLDS—1994–95



(a) Refers to energy-related greenhouse gas emissions only.

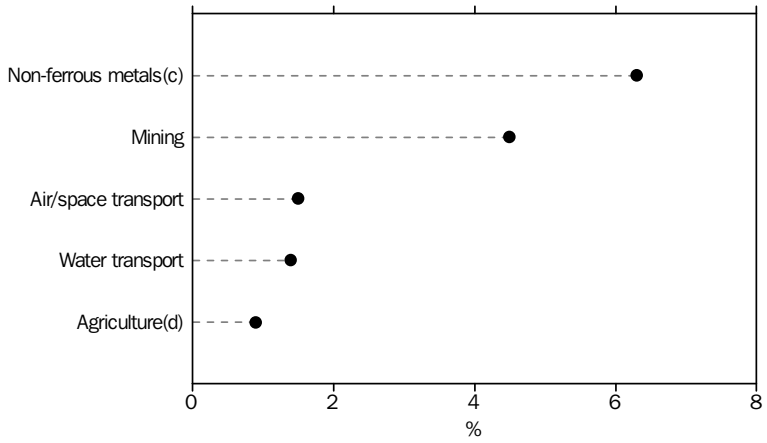
(b) Produced either directly or indirectly through the consumption of products.

(c) Direct production by households, mainly through motor vehicle use.

(d) Includes restaurants, cultural and recreational services, personal and other services.

(e) Includes insurance, property and business services.

4.17 PERCENT OF GREENHOUSE GASES(a) INDUCED(b) BY EXPORTS—1994–95



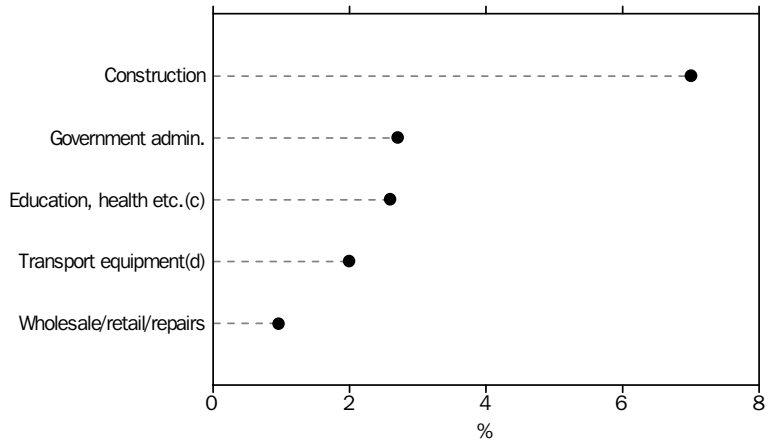
(a) Refers to energy-related greenhouse gas emissions only.

(b) Produced indirectly through the production of products for export.

(c) Basic non-ferrous metals and metal products.

(d) Includes forestry and fishing.

4.18 PERCENT OF EMISSIONS(a) INDUCED(b) BY OTHER FINAL USES—1994–95



(a) Refers to energy-related greenhouse gas emissions only.

(b) Produced indirectly by government final consumption of products or gross capital formation.

(c) Includes community services.

(d) Includes other machinery.

CHAPTER 5 THE STOCK TABLE

INTRODUCTION

Australia has large identified resources of fossil fuels and uranium. It is ranked in the top six countries in the world for economic demonstrated resources (EDR) of black and brown coal and has the world's largest EDR of uranium(ABS 2000c). It also has significant reserves of natural gas and crude oil. This chapter presents information about Australia's stocks of these energy sources, which underpin Australia's patterns of energy production and use.

The estimated life spans of black and brown coal resources in 1997–98 were calculated at over 200 and 700 years respectively (ABS 2000a). A number of factors will affect the rate of depletion of these stocks. The worldwide demand for black coal resources is expected to increase considerably over the next five years, with world coal trade projected to grow at 4.6% per year primarily due to increased demand from developing countries (Stuart 1999).

Turnover and export earnings for coal increased over the period from 1995–96 to 1997–98, but decreases in coal prices will mean that more resource will need to be extracted and productivity gains achieved to continue to obtain an adequate economic return (ABS 2000c; Stuart 1999).

Known natural gas reserves in Australia are less extensive than coal reserves, although it is expected natural gas will increase its share of the domestic energy market in the short to medium term. Gas resource extraction is projected to grow at 4.3% per year, as new pipeline infrastructure becomes available, mostly in the eastern States (Bush et al. 1999). The remaining reserves of gas in Australia have increased six fold between 1960 and 1996 to around 2,500 Bcm, mainly due to discoveries in the North West Shelf (AGSO 1998a). Further discoveries will extend the life of the resource.

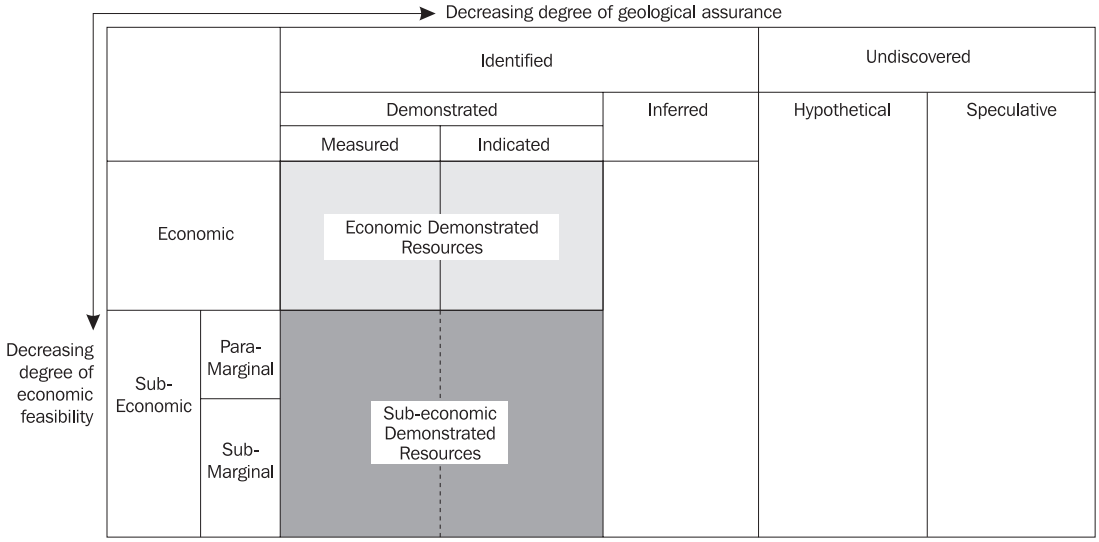
Remaining crude oil reserves have been stable since 1970 at around 250 GL (initially reserves were nearly 1000 GL) which amounts to an expected life of about 11 years from 1996–97 (AGSO 1998a). It is unlikely reserves will increase to any great extent in the future and ABARE has predicted that net crude oil imports will double from 1997–98 to 2014–15 to compensate for declining stocks (Bush et al. 1999). It is quite common for the expected reserves to only be available for the next ten years. The nature of the petroleum exploration industry means there is no need to prove reserves outside this timeframe.

Tables 5.3 to 5.5 present details of Australia's energy resources at a national level, for both energy bearing minerals and petroleum. The data have been sourced from the AGSO and have been converted to petajoules (PJ) using conversion factors as outlined in the Explanatory notes. The conversion factors are averages only, since fuel quality will vary with location, air pressure and temperature (Bush et al. 1999). This should be taken into account when analysing the data. Historical national data for 1985 to 1991, as well as a state breakdown of resource levels (1985 to 1996), are available in *Mineral Account, Australia 1996* (Cat. no. 4608.0).

MCKELVEY BOX

The ABS has adopted the same classification used by AGSO. AGSO use an adapted version of the McKelvey Box which is illustrated in diagram 5.1.

5.1 MCKELVEY BOX AS ADAPTED BY AGSO



Source: Australian Geological Survey Organisation.

The resource categories shown in diagram 5.1 are defined as follows:

Economic demonstrated resources (EDR) refer to those resources with a high degree of geological assurance and a reasonable assurance of profitability following extraction. These resources are economically exploitable.

Sub-economic demonstrated resources (SDR) have a high degree of geological assurance, but profitability is not expected to be sustained over the life of the mine. Thus, in contrast to EDR, SDR are not economically viable.

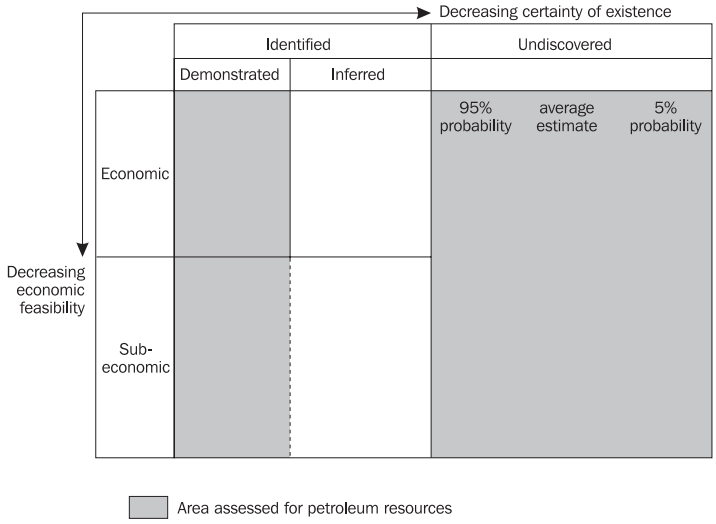
Inferred resources (IFR) are unique to minerals and relate to:

> '...resources for which quantitative estimates are based largely on broad knowledge of the geological character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repetition, of which there is geological evidence' (BMR 1984).

Petroleum resources are categorised using EDR, SDR and undiscovered resources (diagram 5.2). IFR are not used since this category relates to known resources which have a low degree of geological assurance. Undiscovered resources relate to the possibility of discovery in an area (and thus are presented with probabilities), independent of whether there are known accumulations in the area.

MCKELVEY BOX *continued*

5.2 MCKELVEY BOX ADAPTED FOR PETROLEUM RESOURCES



Source: Australian Geological Survey Organisation 1998b.

CHANGE IN ENERGY RESOURCES

Table 5.3 presents information according to the adapted McKelvey Box classifications for energy resources for the calendar years 1992 to 1998.

Black and brown coal resources remained stable over the period with both showing overall changes in EDR of less than one per cent. Fluctuations occurred as a result of the reassignment of resources between SDR and EDR and as a result of increased production of brown coal. Use of brown coal in thermal electricity generation increased from 29.9% in 1992–93 to 32.7% in 1997–98.

EDR of uranium resources increased by 37% from 1992 to 1993 as a result of extensions to known deposits. From 1994 EDR declined steadily as a result of production. Significant reclassifications of IFR to SDR and EDR occurred during the period and are reflected in the relative changes of the data for each resource classification.

The majority of Australia's petroleum resources are derived from the Carnarvon Basin in Western Australia and the Gippsland Basin in Victoria (DPIE 1997). Production is estimated to deplete crude oil resources at 3.7% per year, condensate at 1.4% per year and natural gas at 0.8% per year (BRS 1997).

Table 5.3 also shows trends at the national level in petroleum resources between 1992 and 1998. Fluctuations occurred in EDR of oil over the period with production offset by reclassification of SDR to EDR. Condensate, gas and LPG resources increased by 45%, 35% and 29% respectively, reflecting new discoveries and geological reassessments.

CHANGE IN ENERGY RESOURCES *continued*

5.3 ENERGY RESOURCES(a)—Calendar year

	1992	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Resource category	PJ	PJ	PJ	PJ	PJ	PJ	PJ
BLACK COAL							
EDR	1 381 077	1 336 690	1 335 380	1 335 396	1 330 644	1 388 691	1 379 700
SDR	105 464	117 782	117 777	137 106	136 954	102 033	102 600
BROWN COAL							
EDR	401 066	400 697	400 212	399 824	399 368	398 845	398 670
SDR	31 302	28 683	28 683	28 683	28 683	28 683	29 100
IFR	1 603 701	1 609 812	1 609 812	1 609 812	1 609 812	1 609 812	1 610 200
URANIUM							
EDR	217 140	296 570	297 510	295 630	292 340	289 050	285 290
SDR	25 850	35 720	36 190	36 190	43 710	43 710	51 230
IFR	185 180	88 830	91 180	91 180	84 600	85 070	91 180
OIL							
EDR	9 028	9 213	10 952	10 249	9 213	9 805	8 880
SDR	1 406	1 147	1 073	888	851	555	1 110
CONDENSATE							
EDR	4 921	4 995	5 735	6 734	7 252	7 030	7 141
SDR	1 998	1 961	2 368	2 479	1 887	3 256	1 998
GAS							
EDR	39 195	38 688	50 427	49 296	54 483	57 447	53 040
SDR	44 070	44 499	48 672	42 822	37 011	50 037	38 376
LPG							
EDR	3 551	3 498	4 050	3 787	4 603	4 760	4 576
SDR	2 341	2 262	2 341	2 367	1 973	3 366	2 025

(a) The original data for stocks, imports, exports, and production were converted from their units of quantity or volume to PJ using conversion factors published in ABARE Research Report 99.4 and from advice provided by ABARE. Note that these conversion factors are averages and thus may not represent specific industry based conversion rates.

Source: AGSO 1998b, 1999; ABS 1998.

OTHER VOLUME CHANGES

Other volume change (OVC) tables represent the quantitative changes which have occurred in EDR, SDR and IFR for the mineral and petroleum resources shown in table 5.3. OVCs are classified according to a number of categories as presented in the tables. Tables 5.4 and 5.5 refer to energy bearing minerals and petroleum, respectively, for the calendar years 1996 and 1997.

MINERAL RESOURCE OTHER VOLUME CHANGES

In 1996, EDR decreased for black and brown coal and uranium mainly as a result of production. Economic reclassification resulted in an increase of 7,520 PJ in SDR and decrease of 6,580 PJ in IFR for uranium. In 1997, industry revision and economic reclassification resulted in an increase of 60,507 PJ in black coal resources.

5.4 MINERAL RESOURCE OTHER VOLUME CHANGES, By Product—Calendar year

			Reclassification.....				
	Production	*Discovery*	*Economic*	*Technical*	*Industry revision*	*Other volume changes n.e.c.*	*Resource change*
Resource category	PJ	PJ	PJ	PJ	PJ	PJ	PJ
				1996			
Black Coal							
EDR	–6 814	—	—	—	—	3 517	–3 273
SDR	—	—	—	—	—	—	—
IFR	—	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Brown Coal							
EDR	–514	—	—	—	—	58	–456
SDR	—	—	—	—	—	—	—
IFR	—	—	—	—	—	—	—
Uranium							
EDR	–2 350	—	—	—	–940	—	–3 290
SDR	—	—	7 520	—	—	—	7 520
IFR	—	—	–6 580	—	—	—	–6 580
				1997			
Black Coal							
EDR	–7 314	—	34 668	—	32 184	969	60 507
SDR	—	—	–34 668	—	—	—	–34 668
IFR	—	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Brown Coal							
EDR	–582	—	—	—	—	58	–524
SDR	—	—	—	—	—	—	—
IFR	—	—	—	—	—	—	—
Uranium							
EDR	–2 350	—	—	—	–940	—	–3 290
SDR	—	—	—	—	—	—	—
IFR	—	—	—	—	470	—	470

Source: AGSO 1998b.

PETROLEUM RESOURCE OTHER VOLUME CHANGES

Other volume changes for petroleum resources are presented in table 5.5. Production and geological reassessments are the main contributors to changes in stocks with new discoveries making a relatively small contribution. EDR of natural gas increased by 3,744 PJ and 3,081 PJ in 1996 and 1997 respectively. In 1997, there was a substantial increase in SDR of natural gas, mainly as a result of geological reassessment.

5.5 PETROLEUM RESOURCE OTHER VOLUME CHANGES, By Product—Calendar year

		RECLASSIFICATION..			GEOLOGICAL KNOWLEDGE.				
	Production	*Political changes*	*Technical*	*Economic*	*Change in methodology*	*Discoveries*	*Reassessments*	*Other volume changes n.e.c.*	*Total change*
Resource category	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
					1996				
Oil									
EDR	–888	—	—	—	—	—	–481	—	–1 369
SDR	—	—	—	—	—	185	—	—	185
Condensate									
EDR	–259	—	—	—	—	—	629	—	370
SDR	—	—	—	—	—	—	–518	—	–518
Gas									
EDR	–1 209	—	—	195	—	—	4 758	—	3 744
SDR	—	—	—	–195	—	78	–4 368	—	–4 485
LPG									
EDR	–132	—	—	26	—	—	894	—	763
SDR	—	—	—	–26	—	—	–342	—	–368
					1997				
Oil									
EDR	–962	—	—	222	—	37	1 295	—	592
SDR	—	—	—	–222	—	—	—	—	–222
Condensate									
EDR	–296	—	—	74	—	—	—	—	–222
SDR	—	—	—	–74	—	111	1 258	—	1 295
Gas									
EDR	–1 326	—	—	1 716	—	39	2 652	—	3 081
SDR	—	—	—	–1 716	—	819	13 962	—	13 065
LPG									
EDR	–132	—	—	105	—	—	237	—	210
SDR	—	—	—	–105	—	26	1 473	—	1 394

Source: AGSO 1998b.

NATIONAL BALANCE SHEETS

Monetary estimates of energy mineral assets are available as a complement to the physical resource information; the *Australian National Accounts: National Balance Sheet, 1999–2000* (Cat. no. 5241.0) provides relevant estimates. Sectoral and national balance sheets are produced as part of Australia's System of National Accounts. The monetary estimates for subsoil assets are considered experimental in nature and must be considered in conjunction with physical estimates. Monetary estimates are useful to judge unit values and returns on subsoil assets for use as a guide to investments in particular industries (ABS 2000a).

Table 5.6 shows the net present value (NPV) of demonstrated energy assets within Australia. The NPV is the expected value of the resource based on current market value, with some modifications based on depletion and economic forces. A more detailed definition of net present value for an asset is defined in *Australian National Accounts: National Balance Sheet, 1999–2000* (Cat. no. 5241.0). In 1998 total sub-soil assets had an NPV of $103,361 million of which 73% was attributed to the NPV of energy assets ($75,903 million). In 1998 the two most significant energy assets were black coal and natural gas which accounted for 33% and 37% of total NPV of energy assets, respectively.

NATIONAL BALANCE SHEETS *cont.*

Table 5.6 shows a 102% increase in the value of energy assets over the period 1992 to 1998. The increase in the value of energy resources was due largely to increases in black coal and natural gas. Crude oil and uranium were the two energy assets to show a decrease in value since 1992. Australia tends to export lower value commodities and to supplement imports of higher value energy products with domestic production. Imports and exports of energy products are discussed further in chapter 2.

5.6 NET PRESENT VALUE OF ENERGY ASSETS, By Resource Type, at 30 June

	1992	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Resource category	$m	$m	$m	$m	$m	$m	$m
Black coal	3 282	8 164	7 830	12 824	11 706	16 363	25 019
Brown coal	169	288	428	488	541	663	659
Uranium	2 187	1 962	1 631	1 535	1 532	1 642	1 909
Crude oil	13 385	15 646	17 909	18 031	16 644	14 546	12 821
Condensate	2 575	3 196	3 399	4 292	4 553	5 496	5 501
Natural gas	14 770	18 597	20 247	25 476	26 384	28 424	27 904
LPG	1 253	912	1 168	1 682	1 851	2 244	2 090
Total energy assets	**37 621**	**48 765**	**52 612**	**64 328**	**63 211**	**69 378**	**75 903**

Source: ABS 2000a.

EXPLANATORY NOTES

INTRODUCTION—CHAPTER 1

1 The Energy Account is one of the physical accounts being developed by ABS as part of an environmental accounting system. It consists of stock tables, supply and use tables (collectively referred to as flow tables) and subsequent linkages with input-output monetary data.

2 Environmental accounts can facilitate an integrated approach to a range of issues that include:

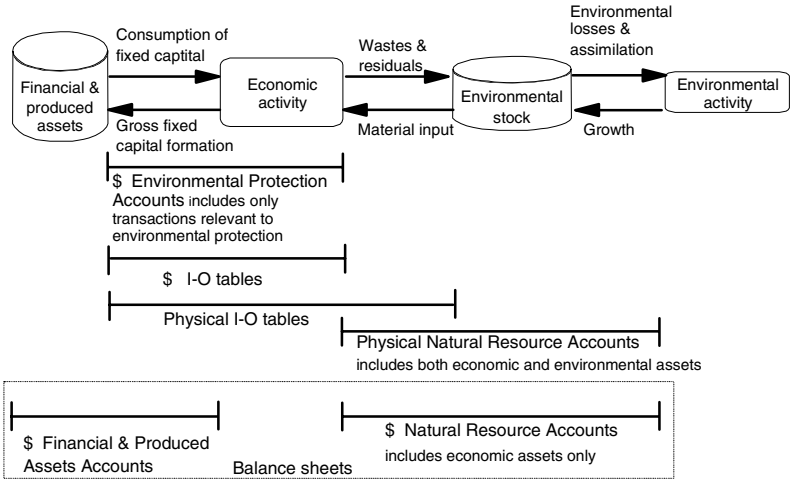
- a broader assessment of the consequences of economic growth;
- the contribution of sectors to particular environmental problems; and
- sectoral implications of environmental policy measures (for example, regulation, charges and incentives).

3 One of the advantages of an environmental account is that by linking together physical data and monetary data in a consistent framework it is possible to undertake scenario modelling. Issues that could be modelled include assessing the efficiencies in different sectors of the economy and the environment, and resource implications of structural change.

ENVIRONMENTAL ACCOUNTING FRAMEWORK

4 In order to integrate environmental and economic data the Energy Account has been developed following the guidelines in *System for Integrated Environmental and Economic Accounting* (UN 1993a) which is a complement to the *System of National Accounts 1993* (UN 1993b). Environmental accounts extend the boundaries of the System of National Accounts (SNA) framework to include environmental resources, which occur outside the production and asset boundaries typically measured in such an analysis. In the following diagram the relationship between environmental accounts and national accounts is illustrated.

RELATIONSHIP BETWEEN ENVIRONMENTAL ACCOUNTS AND NATIONAL ACCOUNTS



ENVIRONMENTAL ACCOUNTING FRAMEWORK *cont.*

5 Supply and use tables provide the framework to link core components of the National Accounts to physical information. These tables are a component of physical input-output (I-O) tables and allow the comparison of physical and monetary information through the economy and environment (ABS 1999c). Physical data are presented in supply and use tables in chapter 2. Physical input-output tables typically embody considerable sectoral and industry detail and can be explicitly linked to the monetary I-O tables. Experimental estimates of this linkage have been made in chapter 4.

6 Tables in chapter 5 measure mineral and petroleum energy resource assets. Typically environmental assets provide important goods and/or services to the economy. The environmental asset accounts which are presented here as stock tables include the level of resources available and changes in stock levels within a given time period due to both human and natural causes. Changes in stock levels overlap with the flows presented in the physical supply and use tables.

FLOW TABLE— CHAPTER 2

Scope

7 Chapter 2 presents flow tables which map the flow of energy products from the environment through the production process and consumption by final use. Flow tables have been developed for the 1992–93 to 1997–98 financial years and consist of two parts, the supply table and the use table. Table 3.1 is the supply table and shows the total amount of energy products, in quantity terms, available for use by industry or final demand. It represents the sum of domestic production and imports. The use tables show estimates of the distribution of supply across industries, as intermediate consumption, or for final use. These include exports, households and unallocated products, which consist of change in inventories and statistical discrepancies.

8 Chapter 2 also presents estimates on emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), that are associated with fuel combustion activities.

9 Fugitive emissions, though part of the energy sector, are not included in the analysis. This is because these emissions are not created from energy combustion. They are affected not by how many petajoules of energy are consumed by an industry, but by other factors concerning the production and transport of the product. Thus there is no direct relationship between the amount of fugitive emissions and the PJ value of energy consumed.

Coverage

10 Data are presented for Australia for the years 1992–93 to 1997–98.

Data sources

11 The energy supply tables consist of imports and production data for energy products. Imports were derived from ABS International Trade unpublished data. Production data were sourced from a number of organisations such as Australian Bureau of Agricultural and Resource Economics (ABARE), Australian Bureau of Statistics (ABS), Department of Industry Science and Resources, Electricity Supply Association of Australia, and the Australian Gas Association. Where more than one source was available, data were reconciled.

Data sources *cont.*

12 Data for the energy products use tables were sourced primarily from the fuel and electricity collection which is conducted by ABARE every two years as reported in *Australian energy consumption and production, historical trends and projections to 2009–10, ABARE Research Report 97.2* (ABARE 1997a), and *Australian energy: market developments and projections to 2014–15, ABARE Research Report 99.4* (ABARE 1999). Exports were derived from unpublished ABS International Trade data. Data on road transport activity by industries and households were derived from ABARE and ABS Survey of Motor Vehicle Usage data.

13 Greenhouse gas emissions of CO_2 (carbon dioxide), CH_4 (methane), and N_2O (nitrous oxide) were sourced from the National Greenhouse Gas Inventory (NGGI), unpublished and published data, 1993 to 1998.

Method of analysis

14 The supply and use tables are components of the input-output (I-O) framework. This framework is used widely by the ABS for economic analysis and is based on SNA93 (UN 1993b). The input-output framework describes the input of energy into economic activity, as well as the return flow of emissions from production and consumption activities back into the environment.

15 Industry data were aggregated according to the ABS Input-Output Industry Group Classification (IOIG). Appendix 1 provides a concordance between the ABS standard IOIG and the energy account IOIG classification.

16 Energy products have been split into primary and secondary energy products. Primary energy products here include carbon fuels, nuclear fuels, solar energy, waste fuels (e.g. bagasse). Secondary energy products are derived from primary energy sources and include electricity, refined petroleum products and other energy from transformation of primary energy sources. Hydro-electricity has been included as a secondary energy product.

17 Tables in chapter 2 describe the gross supply and use of energy products. That is, energy used in the transformation of a primary fuel to a secondary product has not been netted off. The analysis therefore describes the primary and secondary energy products separately.

18 The analysis of greenhouse gases has been done for the three major gases that were highlighted as a priority in the Kyoto Protocol (carbon dioxide, methane and nitrous oxide). Methane and nitrous oxide were standardised to a gigagram (Gg) of CO_2 equivalent (Gg CO_2-e).

19 A more detailed explanation of the method of analysis used will be available in a publication to be released by the ABS in 2001 titled *Concepts, Sources and Methods for Australia's Water and Energy Accounts*.

Data quality and reliability

20 In ABARE's fuel and electricity collection data are collected from more than 5,300 establishments with an annual energy consumption of one terajoule (TJ) or more. Information from the collection is supplemented by ABARE with data obtained from a variety of other sources which are listed in the appendices of their reports (ABARE 1997a and ABARE 1999).

21 The supply and use of hydro-electricity was calculated using proportions derived from total consumption of electricity and hydro-electricity as reported in ABARE (1999). The supply of solar energy was derived directly from the use data, in that, according to the conceptual basis behind I-O, supply is equal to use.

Data quality and reliability *cont.*

22 As mentioned previously greenhouse gas emissions data were sourced from the National Greenhouse Gas Inventory (NGGI). Where detailed figures were not available (e.g. food, beverages and tobacco manufacturing) emissions were also calculated using the energy consumption data provided by ABARE and multiplying these figures by the relevant emissions factors.

23 Greenhouse gas emissions were measured in gigagrams (Gg) and then converted to Gg of CO_2 equivalents (Gg CO_2-e) using global warming potentials (GWP) of 21 for CH_4 (methane) and 310 for N_2O (nitrous oxide). More detailed information on the methodology used to calculate greenhouse gas emissions from stationary and mobile sources are found in NGGIC (1996c and 1996d).

24 All products, industries and International Trade classifications (AHECC and HTISC) were concorded to ABS input-output classifications, namely the Input-Output Product Classification (IOPC) and Input-Output Industry Groups (IOIG). Some concordance problems between these classifications exist. This may affect data quality since data have been adjusted to overcome concordance mismatches.

25 Some IOPCs were modified after the 1994–95 financial year when SNA93 (UN 1993b) was introduced. The energy products affected were liquefied natural gas; liquefied natural petroleum gases; oil and gas n.e.c. and refinery products n.e.c. The former was split into liquefied natural gas and liquefied petroleum gases—natural, coal gas and similar etc. Refinery products n.e.c. was split into four categories. To maintain comparability and consistency across all financial years, liquefied natural gas was combined with liquefied petroleum gases—natural, coal gas and similar etc. The four products that refinery products n.e.c. was split into were combined into one group which was labelled refinery products n.e.c.

26 Data for the supply and use tables were reconciled to account for discrepancies in data sources. Where reconciliation was not possible, small statistical discrepancies were added with changes in inventories in the use table to form the final demand category 'unallocated products' in order to balance supply and use for each period. This allowed the ABS use data to remain consistent with the ABARE source data.

27 The original data for stocks, imports, exports, and production were converted from their units of quantity or volume to PJ using conversion factors published in ABARE Research Report 99.4 (ABARE 1999), *Gas Statistics Australia* (AGA 1998) and from advice provided by ABARE. Note that these conversion factors are averages and thus may not represent specific industry based conversion rates.

28 The ABS has allocated transport energy use and emissions by industry and household use, and not by activity. This will lead to some discrepancies with ABARE and other activity based information sources. Various indicators and estimation methods have been employed to extrapolate required data to the common base year (1994–95). The derived proportions were then applied to the other years. Total energy used by fuel type was reconciled to the ABARE totals.

29 Data on energy supply, use and associated greenhouse gas emissions were correct at the time of compilation. Some revisions have occurred since that time and these revised datasets have not been used in this publication. In most cases the revisions are minor and do not affect the overall analysis. Where revisions are known to be reasonably significant, they have been mentioned. For more information on revised estimates, see NGGI 2000, and ABARE.

ELECTRICITY AND TRANSPORT — CHAPTER 3

Scope

30 This chapter presents some relevant information on the two activities that produce the bulk of Australia's greenhouse gas emissions—electricity generation and transport.

31 For electricity generation, fuel types, shares and their related efficiencies are described.

32 Transport as an activity versus transport as an industry is discussed and analysed, and motor vehicle use (energy use and associated greenhouse gas emissions) by the different industries and sectors is described.

Data sources

33 Data are from a number of organisations, including ABARE and the International Energy Agency (IEA). Energy use and greenhouse emissions attributed to motor vehicle use by the various industry groups and households were derived from ABARE and a number of ABS statistical series. These included: the *Survey of Motor Vehicle Usage, 1991, 1995, and 1998* (Cat. no. 9208.0); the *1983–84, Business Vehicles Survey and Transport Industry Survey, 1986–87 National Energy Survey, Energy Consumption in Australia* (Cat. no. 8217.0); and *Input-Output Tables* (Cat. no. 5209.0).

Data quality and reliability

34 Assumptions used to reclassify the ABARE data on fuels used for transport activity to their using industries and households relate to the use of earlier data to extrapolate to 1994–95. The derived proportions were then applied to the other years and to the emissions data. Sensitivity analysis ascertained that the allocations made based on the assumptions used could vary by a large margin yet would have only a small effect on the modelled results.

INPUT-OUTPUT ANALYSIS — CHAPTER 4

35 Chapter 4 presents experimental estimates based on input-output analysis of energy flows and greenhouse gas emissions. This analysis integrates physical input-output tables with Australia's monetary input-output tables. Monetary input-output tables and analyses are part of the Australian national accounts. They describe the production and subsequent use of all goods and services in the Australian economy. For more information on input-output tables and their uses see *Input-Output Tables* (Cat. no. 5209.0).

36 Input-output is a compilation methodology that provides a detailed basis for analysing industries and the products they produce. The benefits of input-output analysis are:

- that it provides a framework for checking the consistency of statistics obtained from different data sources;
- it serves as a coordinating framework, ensuring the consistency of the definitions and classifications used;
- it emphasises weaknesses in data; and
- analytically, input-output data can be integrated into macro-economic models in order to analyse the link between final users and industry outputs.

INPUT - OUTPUT ANALYSIS — CHAPTER 4 *cont.*

37 A supply table shows energy products supplied by industries or imported, while a use table shows energy products used by industries or final users. Therefore rows and columns in these two types of tables refer to products and producing/using industries, respectively. However, input-output analysis is done with symmetrical flow tables where both the rows and columns refer either to industries or to products. In the ABS, symmetrical input-output tables (to be referred to as analytical tables) are compiled as industry by industry tables.

38 A row in the use table shows disposal of a product's total supply, whether produced by the industry to which the product is *primary,* or produced by other industries. On the other hand, a row in an analytical able shows disposal of an industry's total output, including products primary to it as well as other products. A product is primary to an industry if it is all or predominantly produced by that industry. Its production by other industries is *secondary production* by those industries. An analytical table is compiled from a use table by transferring values of *secondary products* from the product rows of the use table to the respective producing industry rows in the analytical table. For the purpose of this publication, it was found that any secondary production of energy products was under reporting levels, and therefore insignificant, with specialisation and coverage ratios close to 100% for all energy industries. Thus it could be, and was, assumed the use of energy products was the same as use of output by energy industries. The construction of the analytical table was then a simple process of augmenting the existing monetary input-output analytical table (ABS 1999) with the energy producing and using industry rows and columns. The analytical table has competing imports indirectly allocated. This means that the values of imports have been added to the output values of industries, to which they would have been primary if they were produced in Australia. This total supply is then allocated to using industries and final users. In this table, therefore, the use of products by an industry or final user includes both domestically produced and imported supply.

39 Analytical tables have the benefit of being able to be used to derive direct and total requirement coefficients. Direct requirement coefficients (DRCs) calculate inputs as a ratio of the output of an industry to estimate the input requirements for any given output of an industry. Thus, for a given dollar amount of output, the required dollar amount of input, or the petajoule input, to create that output, can be calculated. The total requirement coefficients (TRCs) go beyond direct requirements and attempt to measure the indirect requirements required from other industries to produce a given level of output for a specific industry. For example, the mining industry may not directly require any inputs from agriculture but it requires inputs from chemicals which cannot be satisfied without input from agriculture. Therefore, there is an indirect requirement by mining for agricultural input. Thus TRCs attempt to measure these indirect requirements.

40 Direct and total requirement coefficients were produced using matrix algebra as described in Miller and Blair (1985). The theoretical energy model and assumptions have been detailed in Appendix 2.

STOCK TABLES — CHAPTER 5

Scope

41 Ideally a stock table will present estimates of the total stock of a resource available for extraction or harvest. Chapter 5 includes stock tables for those mineral and petroleum resources related to energy production which are potentially available for exploitation. Stock tables were compiled for the calendar years 1992 and 1997.

Coverage

42 The basis of the classification of resources was the Australian Geological Survey Organisation (AGSO) classification system. This classification system is not dependent on, or limited by, the physical location of the resources. As a result, resources contained in areas which are inaccessible due to legal and/or land use factors at the time of classification, are included in the stock table estimates (BMR 1984).

Data sources

43 Data for the stock table were supplied by the Australian Geological Survey Organisation (AGSO). AGSO used various sources to compile these estimates, including company reports supplied to the Australian Stock Exchange, personal interviews with company representatives and industry specific journals and magazines.

Method of analysis

44 As previously mentioned the framework for the Energy Account is based on physical resource accounting concepts from the *System for Integrated Environmental and Economic Accounts* (UN 1993a). The UN framework has been used as a basis to present mineral and petroleum energy resource information for each calendar year as well as volume changes between each year.

45 The Energy Account uses the same concepts as the *Minerals Account, Australia* (Cat. no. 4608.0) to present resource data. An AGSO classification known as the McKelvey Box was used (see figures 5.1 and 5.2). The McKelvey Box is used to classify resources based on the certainty that the resource exists and the best estimate of economic feasibility of producing them. The McKelvey Box splits the resources into economic demonstrated resources (EDR), sub-economic demonstrated resources (SDR) and inferred resources (IFR). The glossary and chapter 5 contains further explanations of these concepts.

46 Quantity stocks data provided by AGSO were converted to petajoules (PJ) using average conversion factors for most fuels (ABARE Research Report 99.4). For black coal, conversion factors derived from ABARE Research Report 99.4 for specific years were used. It should be noted that these conversion factors are averages and thus may not represent specific industry based conversion rates.

Assumptions

47 The stock tables use the same assumptions as the *Minerals Account, Australia* (Cat. no. 4608.0). The only differences are that resources presented in this publication are those related to energy production including: black coal; brown coal; uranium; oil; condensate; gas and LPG.

48 The analysis in Chapter 5 has been supplemented with monetary estimates of energy mineral assets from *National Balance Sheets* (Cat. no. 5241.0.40.001). The monetary estimates are considered experimental and should be considered in conjunction with physical estimates.

FUTURE ISSUES AND ADDITIONAL INFORMATION

49 More detailed information on the methods used to derive the tables will be presented in the forthcoming publication *Concepts, Sources and Methods for Australia's Water and Energy Accounts* (Cat. no. 4612.0).

50 An earlier edition of the Energy Account is available for the 1993–94 year *Energy Accounts for Australia* (Cat. no. 4604.0). It presents basic statistics on stocks and production and consumption of energy resources.

RELATED PUBLICATIONS

51 For background information on the energy sector, as well as detailed information on the integration and application of physical and monetary accounting, please refer to the following ABS publications:

Australian National Accounts: National Income, Expenditure and Product (Cat. no. 5204.0)

Australian National Accounts: Input-Ouput Tables (Cat. no. 5209.0)

Australian National Accounts: Input-Output Tables (Commodity Details) (Cat. no. 5215.0)

Australian National Accounts: National Balance Sheet (Cat. no. 5241.0)

Electricity, Gas, Water and Sewerage Industries (Cat. no. 8208.0)

Electricity, Gas, Water and Sewerage Operations (Cat. no. 8226.0)

Environmental Issues: People's Views and Practices (Cat. no. 4602.0)

Environmental Protection Expenditure, Australia (Cat. no. 4603.0)

Fish Account, Australia (Cat. no. 4607.0)

Labour Force, Australia (Cat. no. 6203.0)

Manufacturing Production, Australia (Cat. no. 8301.0)

Mineral Account, Australia (Cat. no. 4608.0)

Mining Industry, Australia (Cat. no. 8402.0)

Motor Vehicle Census Australia (Cat. no. 9309.0)

Survey of Motor Vehicle Use, Australia (Cat. no. 9208.0)

Water Account for Australia, 1993–94 to 1996–97 (Cat. no. 4610.0)

Related statistics

52 Disaggregated input-output tables will also be available electronically via AusStats for the 1994–95 financial year. Inquiries about the electronic product should be made to ABS Client Services on 1300 135 070.

APPENDIX 1 CONCORDANCE

CONCORDANCE BETWEEN INPUT-OUTPUT INDUSTRY GROUPS AND INDUSTRY GROUPS USED IN PUBLICATION

The Input-Output Industry Groups (IOIG) used in this publication generally correspond to standard Australian Bureau of Statistics (ABS) IOIGs. Some IOIGs, however have been modified in order to maintain concordance with data sourced from outside the ABS. Table A1 shows the standard ABS groups concorded to the groups used for this publication.

A1 ENERGY ACCOUNT CLASSIFICATION BASED ON THE 1994–95 INPUT-OUTPUT INDUSTRY/PRODUCT CLASSIFICATION(a)

ENERGY ACCOUNT INDUSTRY/PRODUCT CLASSIFICATION		CORRESPONDING INPUT-OUTPUT INDUSTRIES/PRODUCTS	
Code	*Description*	*Code*	*Description*
	Primary energy		Primary energy
0300a(b)	Firewood	0300	Forestry and logging (part)
1100	Coal; oil and gas	1100	Coal; oil and gas
1302a(b)	Uranium	1302	Non-ferrous metal ores (part)
N(c)	Bagasse	—	No corresponding IO classification item
N(c)	Household (solar)	—	No corresponding IO classification item
	Secondary energy		Secondary energy
2501	Petroleum and coal products	2501	Petroleum and coal products
2701a (b)	Coke and coal by-products	2701	Iron and steel (part)
3601	Electricity supply	3601	Electricity supply
	Non energy		Non energy
0101–0200, 0300b, 0400	Agriculture, hunting and trapping; Forestry and fishing	0101	Sheep
		0102	Grains
		0103	Beef cattle
		0104	Dairy cattle
		0105	Pigs
		0106	Poultry
		0107	Other agriculture
		0200	Services to agriculture; hunting and trapping
		0300	Forestry and logging (part—exclude Firewood)
		0400	Commercial fishing
1101–1301, 1302(b), 1400–1500	Mining	1100	Coal; oil and gas
		1301	Iron ores
		1302	Non-ferrous metal ores (part—exclude Uranium)
		1400	Other mining
		1500	Services to mining
2101	Meat and meat products	2101	Meat and meat products
2102	Dairy products	2102	Dairy products
2103	Fruit and vegetable products	2103	Fruit and vegetable products
2104	Oils and fats	2104	Oils and fats
2105	Flour mill products and cereal foods	2105	Flour mill products and cereal foods
2106	Bakery products	2106	Bakery products
2107–2108	Confectionery and other food products	2107	Confectionery
		2108	Other food products
2109–2111	Beverages	2109	Soft drinks, cordials and syrups
		2110	Beer and malt
		2111	Wine and spirits
2112	Tobacco products	2112	Tobacco products

(a) See Appendix B Input-Output Industry Classification: 1994–95 Edition in terms of 1993 ANZSIC in *Australian National Accounts Input-Output Tables* (Cat. no. 5209.0).

(b) Partial concordance; the original Input-Output code has been split to create the new code.

(c) N = new code introduced since there is no corresponding Input-Output Industry/Product Classification item.

A1 ENERGY ACCOUNT CLASSIFICATION BASED ON THE 1994–95 INPUT-OUTPUT INDUSTRY/PRODUCT CLASSIFICATION(a) *continued*

ENERGY ACCOUNT INDUSTRY/PRODUCT CLASSIFICATION		CORRESPONDING INPUT-OUTPUT INDUSTRIES/PRODUCTS	
Code	*Description*	*Code*	*Description*
	Non energy *continued*		Non energy *continued*
2201–2206	Textile, clothing and footwear, leather	2201	Textile fibres, yarns and woven fabrics
		2202	Textile products
		2203	Knitting mill products
		2204	Clothing
		2205	Footwear
		2206	Leather and leather products
2301–2402	Wood and wood products; paper products, printing and publishing	2301	Sawmill products
		2302	Other wood products
		2303	Pulp, paper and paperboard
		2304	Paperboard containers; paper bags and sacks
		2401	Printing and services to printing
		2402	Publishing; recorded media and publishing
2502	Basic chemicals	2502	Basic chemicals
2503–2509	Other chemicals; rubber and plastic	2503	Paints
		2504	Medicinal and pharmaceutical products; pesticides
		2505	Soap and detergents
		2506	Cosmetic and toiletry preparations
		2507	Other chemical products
		2508	Rubber products
		2509	Plastic products
2601	Glass and glass products	2601	Glass and glass products
2602	Ceramic products	2602	Ceramic products
2603–2604	Cement, lime, plaster and other concrete products	2603	Cement, lime and concrete slurry
		2604	Plaster and other concrete products
2605	Other non-metallic mineral products	2605	Other non-metallic mineral products
2701b(b)	Iron and steel	2701	Iron and steel (part—excluded coke and coal by-products)
2702	Basic non-ferrous metals and products	2702	Basic non-ferrous metals and products
2703–2705	Fabricated metal products	2703	Structural metal products
		2704	Sheet metal products
		2705	Fabricated metal products
2801–2810	Transport equipment and other machinery	2801	Motor vehicles and parts; other transport equipment transport equipment
		2802	Ships and boats
		2803	Railway equipment
		2804	Aircraft
		2805	Photographic and scientific equipment
		2806	Electronic equipment
		2807	Household appliances
		2808	Other electrical equipment
		2809	Agricultural, mining and construction machinery; lifting and material handling equipment
		2810	Other machinery and equipment
2901–2903	Other manufacturing	2901	Prefabricated buildings
		2902	Furniture
		2903	Other manufacturing
3602	Gas supply	3602	Gas supply
3701	Water supply; sewerage and drainage services	3701	Water supply; sewerage and drainage services
4101–4102	Construction	4101	Residential building construction
		4102	Other construction
4501, 5101, 5401–5402	Wholesale and retail trade; repairs	4501	Wholesale trade
		5101	Retail trade
		5401	Mechanical repairs
		5402	Other repairs
6101	Road transport	6101	Road transport
6201, 6601	Rail, pipeline and other transport; services to transport and storage	6201	Rail, pipeline and other transport
		6601	Services to transport; storage

(a) See Appendix B Input-Output Industry Classification: 1994–95 Edition in terms of 1993 ANZSIC in *Australian National Accounts Input-Output Tables* (Cat. no. 5209.0).

(b) Partial concordance; the original Input-Output code has been split to create the new code.

A1 ENERGY ACCOUNT CLASSIFICATION BASED ON THE 1994–95 INPUT-OUTPUT INDUSTRY/PRODUCT CLASSIFICATION(a) *continued*

ENERGY ACCOUNT INDUSTRY/PRODUCT CLASSIFICATION		CORRESPONDING INPUT-OUTPUT INDUSTRIES/PRODUCTS	
Code	*Description*	*Code*	*Description*
	Non energy *continued*		Non energy *continued*
6301	Water transport	6301	Water transport
6401	Air and space transport	6401	Air and space transport
7101	Communication services	7101	Communication services
7301–7803	Finance and insurance, ownership of dwellings, property and business dwellings	7301	Banking
		7302	Non-bank finance
		7303	Financial asset investors
		7401	Insurance
		7501	Services to finance, investment and insurance
		7701	Ownership of dwellings
		7702	Other property services
		7801	Scientific research, technical and computer services
		7802	Legal, accounting, marketing and business management services
		7803	Other business services
8101-8201	Government administration and Defence	8101	Government administration
		8201	Defence
8401-8701	Education, health and community services	8401	Education
		8601	Health services
		8701	Community services
5701, 9101–9601	Accommodation and cafes, other services	5701	Accommodation, cafes and restaurants
		9101	Motion picture, radio and television services
		9201	Libraries, museums and the arts
		9301	Sport, gambling and recreational services
		9501	Personal services
		9601	Other services

(a) See Appendix B Input-Output Industry Classification: 1994–95 Edition in terms of 1993 ANZSIC in *Australian National Accounts Input-Output Tables* (Cat. no. 5209.0).

APPENDIX 2

THEORETICAL ENERGY MODEL AND ASSUMPTIONS

THEORETICAL MODEL

The theoretical energy model in this publication is based on input-output analytical methods, allowing domestic production and imports to be analysed separately. It has as its foundation the following identities and input-output tables structures and variables:

1.1 Supply = Domestic production + Imports

or $S = X + M$

1.2 Supply = Use

or $S = U$

1.3 Use = Intermediate consumption + Household final consumption
+ General government final consumption
+ Gross capital formation (Private, Public enterprise and General government gross fixed capital formation; and Change in inventories)
+ Exports

or $U = Z + H + G + K + E$

1.4 Referring to an input-output table with indirect allocation of competing imports at basic prices, and the associated direct requirements coefficients matrix (Matrix A) (for example, Cat. no. 5209.0 input-output Table 8 and Table 9 respectively), and using the same terms as 1.1 to 1.3. above, the following equations are derived:

$Z = AX$

$S = U = AX + H + G + K + E$

$M = S - X = AX + H + G + K + E - X$

1.5 In the theoretical energy model, the assumption is made that usage of imports has the same usage pattern as domestically produced goods with the exception that there are no exports and no general government final consumption of imports.

Based on this assumption, define

M_r = Imports as a proportion of Supply, excluding supply used by General government final consumption and Exports

$= M/(S - G - E)$

$= M/(AX + H + K)$

Then $M = M_r(AX + H + K)$

1.6 Now the equations in 1.1 to 1.5 above give

$$X = Z + H + K + G + E - M$$

$$= AX + H + K + G + E - M_r(AX + H + K)$$

$$= AX - M_rAX + H - M_rH + K - M_rK + G + E$$

Rearranging this gives the following:

$$X = [I-(I-M_r)A]^{-1}(I-M_r)(H+K) + [I-(I-M_r)A]^{-1}(G+E)$$

Let $D = [I-(I-M_r)A]^{-1}$

Then $X = D[(I-M_r)(H+K) + (G+E)]$

This is the equation for the domestic production part of the model.

1.7 From 1.5 and 1.6 above, the imports part of the model can be derived as follows:

$$M = M_r(AX + H + K)$$

$$= M_r\{A(D[(I-M_r)(H+K) + G+E]) + (H + K)\}$$

$$= [M_rAD(I-M_r) + M_r](H+K) + M_rADG + M_rADE$$

1.8 From item 1.6 above, domestic production (of energy) induced by final demand is calculated by the following equations:

Domestic production induced by Household final consumption and Gross capital formation is

$$D(I-M_r)(H+K) = [I-(I-M_r)A]^{-1}(I-M_r)(H+K)$$

Domestic production induced by General government final consumption and Exports is

$$D(G+E) = [I-(I-M_r)A]^{-1}(G+E)$$

1.9 From 1.7 above, imports (of energy) induced by final demand is calculated by the following equations:

Imports induced by Household final consumption and Gross capital formation is

$$[M_rAD(I-M_r) + M_r](H+K)$$

Imports induced by General government final consumption and Exports is

$$M_rADG + M_rADE$$

1.10 Similarly, other variables (such as primary input, employment, energy used or emissions produced by domestic industries) induced by final demand can be calculated using the model in 1.8 above. This is the traditional method model, and for energy used (or emissions produced) induced by final demand can be calculated as follows:

Let $\mathbf{P}$ = vector of industries' energy intensity or emissions coefficients, defined as $(\mathbf{V/X})$ where $\mathbf{V}$ is the vector of energy used (or emissions produced) and $\mathbf{X}$ is the vector of domestic production. Then

$\mathbf{PD(I-M_r)(H+K)}$ is energy used (or emission produced) induced by Household final consumption and Gross capital formation; and

$\mathbf{PD(G+E)}$ is energy used (or emission produced) induced by General government final consumption and Exports.

UNDERLYING ASSUMPTIONS AND INTERPRETATION OF INPUT-OUTPUT RELATIONSHIPS

2.1 The basic assumptions in input-output analysis include the following:

- there is a fixed input structure in each industry, described by fixed technological coefficients (evidence from comparisons between input-output tables for the same country over time have indicated that material input requirements tend to be stable and change slowly; however, requirements for primary factors of production, that is labour and capital, are probably less constant);
- all products of an industry are identical or are made in fixed proportions to each other;
- each industry exhibits constant returns to scale in production;
- unlimited labour and capital are available at fixed prices; that is, any change in the demand for productive factors will not induce any change in their cost (in reality, constraints such as limited skilled labour or investment funds lead to competition for resources among industries, which in turn raises the prices of these scarce factors of production and of industry output generally in the face of strong demand); and
- there are no other constraints, such as the balance of payments or the actions of government, on the response of each industry to a stimulus.

Input-output relationships therefore describe average effects, not marginal effects, and thus do not take account of economies of scale, unused capacity or technological change. Generally, average effects are expected to be higher than the marginal effects.

The input-output tables underlying the energy and emissions analysis only take account of one form of interdependencies, namely the sales and purchase links between industries. Other interdependence such as collective competition for factors of production, changes in commodity prices which induce producers and consumers to alter the mix of their purchases and other constraints which operate on the economy as a whole are not generally taken into account.

The combination of the assumptions used and the excluded interdependencies means that some analytical results are higher than would realistically be the case. In other words, they tend to overstate the potential impact of final demand stimulus. The overstatement is potentially more serious when large changes in demand and production are considered.

However, implications of the above assumptions used in input-output modelling are smaller for the type of study made in this publication, which is a study of 'significance' in the context of the existing 1994–95 economy. For example, it determined the most energy intensive industry, the final demand sector responsible for the most greenhouse gas emissions and so on. Other studies such as forecasting analysis would be more affected by, for example, the application of average, rather than marginal, effects that input-output variables offer.

2.2 Other assumptions used in the energy model include the following:

- The production functions and fuels used overseas are similar to those for Australia.
- Assumptions used to reclassify the ABARE data on fuels used for transport activity to their using industries and households. These relate to the use of earlier data to extrapolate to 1994–95. Sensitivity analysis ascertained that the allocations made based on assumptions used could vary by a large margin and would have only small effect on the modelled results.

MORE INFORMATION

The energy and emissions models derived from the theoretical model in section 1 above, and associated methodology and mathematical estimation techniques will appear in the forthcoming publication *Concepts, Sources and Methods for Australia's Water and Energy Accounts* (Cat. no. 4612.0).

APPENDIX 3 ENERGY INTENSITY AND ENERGY EFFICIENCY

INTRODUCTION

Traditionally (but not in this publication) changes in aggregate energy intensity have been interpreted as a measure of change in energy efficiency. The term 'energy efficiency' has strong normative connotations and if used, should be defined carefully. The issue of the appropriate definition of the term 'energy efficiency' was addressed in Cox, Ho Trieu, Warr and Rolph (1997). In that report it was suggested that the term should be restricted to a physical measure of the amount of energy consumed in a physical process. For example, it is possible to assess the efficiency with which fuel moves a given weight of car a given distance. Conversely, aggregate energy intensity is typically defined simply as the total amount of energy consumed per unit of output, which itself is usually measured in dollars. Importantly, knowledge of aggregate energy intensities tells us nothing about energy efficiency. For example, differences in energy intensities between economies may simply reflect differences in the mix of more or less energy intensive sectors within each economy. Similarly, energy efficiency so defined tells us nothing about economic efficiency. For example, differences in energy efficiency in a given activity between economies may be due to differences in fuel prices and have no bearing on economic efficiency whatsoever.

FACTORISATION

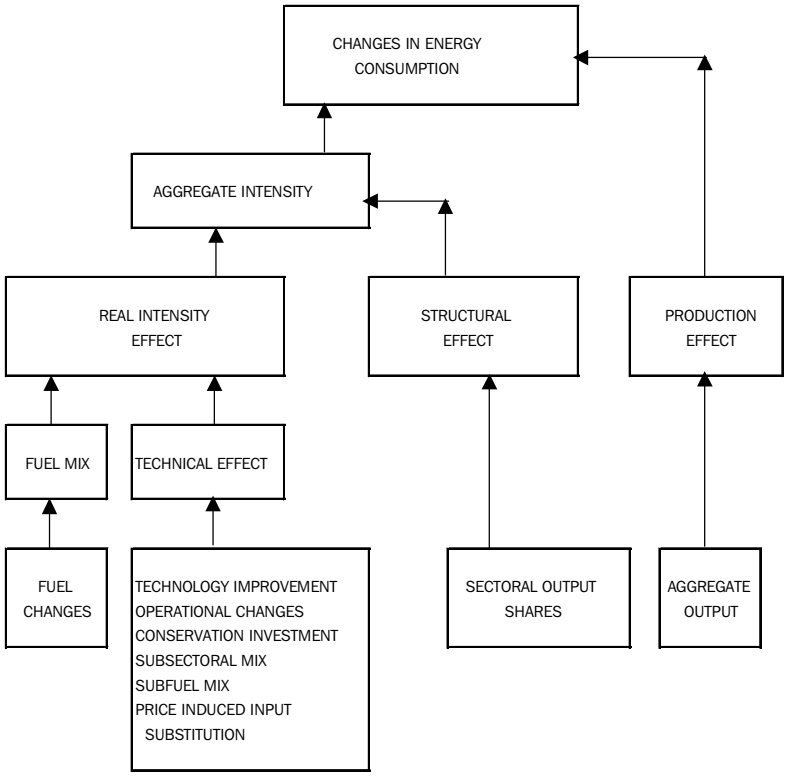
It can be instructive to examine changes in energy use over time and isolate the specific factors that lie behind those changes. This can be done using a technique known as 'factorisation' whereby a change in total energy use is split into the different factors that made up the change (Harris and Thorpe 2000). The diagram on the following page shows an outline of the components of changes in energy use.

Following Harris and Thorpe (2000), changes in total energy consumption can first be factored (or decomposed) into 'production' effects and 'aggregate energy intensity' effects. The production effect shows the impact on total energy consumption of changes in the level of total output (economic growth). The aggregate energy intensity effect shows the impact on total energy consumption of changes in the energy consumed per unit of output.

In Australia the production effect (economic growth) has been by far the most dominant contributor to Australia's rising rate of energy consumption. Harris and Thorpe (2000) estimate that, if left unchecked, the production effect would have resulted in Australia's energy consumption more than doubling between 1973–74 and 1997–98. As it was, a reduction in Australia's aggregate energy intensity tempered this increase to around 84%.

Changes in aggregate energy intensity can be further decomposed into 'structural mix' and 'real energy intensity' effects. The structural mix effect shows the impact on aggregate energy intensity of shifts in the mix of activities that make up total output. The real energy intensity effect itself can be decomposed into 'fuel mix' effects and 'technical' effects. The fuel mix effect shows the impact on real energy intensity of changes in the mix of fuels used, while the technical effect accounts for all remaining changes, such as changes in technical 'know how'.

FACTORED COMPONENTS OF CHANGES IN ENERGY USE



In Australia, structural changes were the main factor leading to reductions in aggregate energy intensities since 1973–74. Changes in the fuel mix, which constrained energy consumption growth by some 5% between 1973–74 and 1997–98, was the other main factor. Interestingly, Harris and Thorpe (2000) found the technical effect actually led to a slight increase in real energy intensities over this period.

Knowledge of these aggregates is valuable and facilitates comparisons over time and across countries. However, it should be noted that these comparisons are made with the following proviso. Decomposition analysis can explain how the aggregate energy intensity might have changes or may differ between countries, but it cannot explain why these changed or differences occur. Consequently, differences in aggregate energy intensities, particularly between countries, need to be interpreted carefully and any conclusions drawn restricted to the 'hows' (and not 'whys').

GLOSSARY

Bagasse Residue of the sugar cane milling process.

Carbon dioxide (CO_2) equivalents A measure used to compare the emissions from various greenhouse gases based upon their global warming potential (see below). The carbon dioxide equivalent for a gas is derived by multiplying the tonnes of the gas by the associated global warming potential.

Combined cycle Combined cycle electricity generation involves recovering thermal energy from the normal gas-turbine cycle which is then used to drive an electric energy generator. This significantly improves energy efficiency in comparison to open cycle gas turbines.

Condensate A liquid mixture of pentanes and heavier hydrocarbons that are contained in the vapour phase in natural gas in the reservoir and become liquid at standard field separation conditions.

Conversion loss The amount of energy lost in the transformation of a primary fuel to a derived (secondary) energy product.

Crude oil A mixture of hydrocarbons, existing in the liquid state both in natural underground reservoirs and at atmospheric pressure after passing through surface separating facilities.

Cumulative energy Total energy content of a product. Includes direct plus indirect plus embedded energy.

Direct energy Energy consumed directly, either by industry in the process of producing goods and services, or by the final user such as households (e.g. use of motor vehicle fuels), or direct export of energy products such as coal and uranium.

Economic resource This term implies that, at the time of determination, profitable extraction or production under defined investment assumptions has been established, analytically demonstrated or assumed with reasonable certainty.

EDR Economic Demonstrated Resources. These are resources that, at the time of determination, profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty.

Embedded energy Energy used to produce Australian imports. It assumes the production functions and fuels used overseas are similar to those for Australia..

Embodied energy The total amount of energy that has been used to produce a product. Energy embodied in a product is said to be used indirectly by the final user.

Environmental account An information system and framework that links the economic activities and uses of a resource to changes in the natural resource base, thus linking resource use with the System of National Accounts.

Exports The exports of goods represents the quantity of goods sent to other countries or for which ownership changes from residents to non-residents.

Final use(r) Sector that finally consumes a product, as opposed to an intermediate user. Final use includes: household final consumption; government final consumption; gross fixed capital formation; exports; and changes in inventories. See *Input-Output Tables* (Cat. no. 5209.0) for more information.

Flow accounts General term used in environmental accounting for a framework which presents information on the physical flows of resources throughout the economy. Flow accounts published for energy include supply and use tables and supply tables for greenhouse gas emissions.

Fossil fuel Any natural fuel derived from decomposed or partly decomposed organic matter.

Fuel mix effect One of two components of the real intensity effect. It is the change in energy consumption resulting from changes in the mix of fuel inputs. Because the energy efficiency of a given process often depends on the fuel used, changes in the fuel mix will generally lead to an overall efficiency change.

Gas oil or fuel oil Includes: heating oil, automotive diesel oil, and industrial diesel oil.

Gigagram One billion (or 10^9) grams (g). Equivalent to one thousand tonnes.

Gigajoule One billion (or 10^9) joules (J). A joule is the standardised scientific unit of measurement of work and energy.

Global warming potential (GWP) Emissions for each gas are expressed as carbon dioxide equivalents, which have been calculated using the concept of global warming potentials (GWPs). Aggregate emissions are then obtained by summing the emissions of various greenhouse gases.

Greenhouse gases vary in their radiative activity and in their atmospheric residence time. Using GWPs, the integrated effect of emissions of the various greenhouse gases can be compared. This is because GWPs represent the relative warming effect (i.e. cumulative radiative forcing) of a unit mass of the gas when compared with the same mass of carbon dioxide over a specific period.

Consistent with the National Greenhouse Gas Inventory (AGO 2000), this report expresses the emissions of carbon dioxide, methane and nitrous oxide in terms of their 'carbon dioxide equivalent'. This is calculated by multiplying the actual mass of emissions by the appropriate GWP published by the IPCC (IPCC 1997).

GWPs are revised from time to time as knowledge about the influence of different gases and processes on climate change increases. GWPs also vary with the time horizon being considered: by convention, the 100-year horizon is used in policy analyses. The GWPs used in this document are 1 for carbon dioxide, 21 for methane and 310 for nitrous oxide.

Greenhouse gases Those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation. The 3 key greenhouse gases are carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4).

Gross capital formation Gross capital formation is measured by the total value of the gross fixed capital formation, changes in inventories and acquisitions less disposals of valuables for a unit or sector.

Gross energy Total energy including that derived from primary as well as secondary energy sources. See also net energy.

Gross fixed capital formation Gross fixed capital formation is measured by the total value of a producer's acquisitions, less disposals, of fixed assets during the accounting period plus certain additions to the value of non-produced assets (such as subsoil assets or major improvements in the quantity, quality or productivity of land) realised by the productive activity of institutional units.

Gross value Refers to the gross value of commodities produced. It is the value placed on recorded production at the wholesale prices realised in the market place.

Household final consumption Measures the consumption of goods by households and producers of nonprofit services to households. It includes the consumption of durable and non-durable goods.

Identified resources Specific bodies of energy-bearing material whose location, quantity, and quality are known from specific measurements or estimated from geological evidence. Identified resources include economic and sub-economic components. To reflect degrees of geological assurance, identified resources can be subdivided into the following categories: economic demonstrated resources (EDR), sub–economic demonstrated resources (SDR) and inferred resources (IFR).

IFR Inferred Resources. These are resources for which quantitative estimates are based largely on broad knowledge of the geological character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repetition, of which there is geological evidence. This evidence may include comparison with deposits of similar type. Bodies that are completely sealed may be included if there is specific geological evidence of their presence.

Induced Energy or greenhouse gases that have been used indirectly by a final user (via the consumption of a product) are said to be *induced* by the final user.

Industry Refers to input-output industry groups.

Industry value added Industry value added represents the value added to the intermediate inputs used by that industry. When taxes on production and imports (payroll tax, wholesale sales tax, and other such taxes and subsidies) paid and received by the industry are deducted, the result is the *industry's factor incomes*. This is the sum of the industry's compensation of employees, gross operating surplus and gross mixed income. An industry's output at basic prices equals its factor incomes plus the value of its intermediate inputs. Basic prices valuation of output removes the distortion caused by variations in the incidence of taxes and subsidies on products and imports across the output of individual industries and imports. For details of these concepts and definitions, see *Australian National Accounts: Concepts, Sources and Methods* (Cat. no. 5216.0). From 1997–98, IVA has replaced IGP as the official measure of the contribution by industries to GDP.

Input–Output A compilation method which provides a description of the inter-industry flows of goods and services within the economy, and the structure and inter-relationship of industries.

Intermediate consumption Intermediate consumption consists of goods and services consumed as inputs by a process of production, excluding fixed assets whose consumption is recorded as consumption of fixed capital. The goods or services may be either transformed or used up by the production process.

Liquefied natural gas (LNG) Natural gas which has been processed and then refrigerated to the very low temperatures needed to reach the liquid state.

Liquefied petroleum gas (LPG) Consists of propane, butane and isobutane and petroleum and is derived by processing, through a low pressure gas separation plant, the natural gas produced from either gas or oil reservoirs.

McKelvey box classification For classifying resources into categories based on the certainty that the resource exists and the best estimate of economic feasibility of producing them.

National accounts Systematic summary of national economic activity (income and expenditure). At a detailed level it shows a statistical picture of the structure of the economy.

Net energy Total net energy accounts for the transformation process of a primary energy product to a secondary energy product and related conversion losses. In this way, estimates for total net energy avoids double-counting the amount of converted primary energy. See also gross energy.

Net present value SNA93 recommends that where no market prices are available in the case of assets for which the returns are spread over a lengthy period (as with sub-soil assets), a rate of discount should be used to calculate the present value of the expected future returns.

Other volume changes Other volume changes are concerned with quantifying changes in resources that occur between one period and another. In this publication OVC has been quantified for energy mineral and energy petroleum resources.

Petajoule One million times a billion (or 10^{15}) joules.

Petroleum Naturally occurring hydrocarbon or mixture of hydrocarbons as oil or gas, or in solution found in sedimentary rocks.

Primary energy source Are those forms of energy that are obtained directly from nature. They include both non-renewable and renewable energy. Primary energy sources include firewood, coal, crude oil, natural gas, liquefied natural petroleum gases, uranium, bagasse and solar energy. In this publication hydro-electricity is treated as a secondary energy product.

Production effect The change in energy consumption resulting from a change in the overall level of production, other things being equal.

Purchasing Power Parity A purchasing power parity is a price relative which measures the number of units of countrys Bs currency that are needed in country B to purchase the same quantity of an individual good or service as 1 unit of country As currency will purchase in country A.

Refined products Includes fuel products and non-fuel products. Fuel products include automotive gasoline and diesel, aviation gasoline and turbine, kerosene and heating oil, industrial diesel and fuel oil, and others such as naphtha and petroleum coke used as fuel. Non-fuel products include solvents, lubricants, bitumen, waxes and others such as sulphur and petroleum coke.

Resource A concentration of naturally occurring solid, liquid, or gaseous materials in or on the earth's crust and in such form that its economic extraction is presently or potentially (within a 20–25 year time frame) feasible. The definition does not intend to imply that exploitation of any such material will take place in that time span, but only that its possibility might reasonably be considered.

Sales gas Derived by processing the natural gas produced from either gas or oil reservoirs. It contains mainly methane, ethane, minor amounts of other hydrocarbon gases and some carbon dioxide.

SDR Sub–economic Demonstrated Resources. These are resources which do not meet the criteria of economic; and include paramarginal and submarginal categories.

Secondary energy source Are products that have been derived from a primary energy source. Include: refined petroleum products; coal by-products; coke; and electricity.

SEEA SEEA is the System for Integrated Economic and Environmental Accounting. It is a framework used to develop environmental accounts by integrating environmental information into an accounting framework. The SEEA publication provides the conceptual basis for developing a framework to describe the inter-relationship between the natural environment and the economy (UN 1993a).

Structural effect The changes in energy consumption resulting from a change in the mix of industrial output, for example, a contraction in energy intensive sectors.

System of National Accounts (SNA) The System of National Accounts (SNA) is an international framework which can be used to develop a comprehensive, consistent and flexible set of macroeconomic accounts (UN 1993b).

Technical effect The other component of the real intensity effect. It includes the effects of technology improvement, operational changes, price induced input substitution and conservation investment.

Terajoule One trillion (or 10^{12}) joules.

Total intermediate usage Indicates the amount of goods and services which are used up in the process of production.

Total supply Australian production plus imports.

Uranium Radioactive grey heavy metallic element, that is used as a source of nuclear energy.

UNITS AND CONVERSIONS

INTRODUCTION

The following includes units and conversions that were used in the chapters in the energy account. More detail on the measurements used and calculation methods can be found in the glossary and explanatory notes.

DECIMAL PREFIXES

10^{1}	deca (deca)	10^{-1}	deci (d)
10^{2}	hecto (h)	10^{-2}	centi (c)
10^{3}	kilo (k)	10^{-3}	milli (m)
10^{6}	mega (M)	10^{-6}	micro (μ)
10^{9}	giga (G)	10^{-9}	nano (n)
10^{12}	tera (T)	10^{-12}	pico (p)
10^{15}	peta (P)	10^{-15}	femto (f)

CONVERSION FACTORS

To convert:	PJ	Mtoe	GWh
From:	*multiply by:*		
PJ	1	2.388×10^{-2}	278
Mtoe	41.868	1	11 630
GWh	0.0036	8.6×10^{-5}	1

GREENHOUSE GAS EMISSIONS

Greenhouse gas emissions were measured in gigagrams (Gg) and then converted to Gg of CO_2 equivalents (Gg CO_2-e) using global warming potentials (GWP) of 21 for CH_4 and 310 for N_2O.

LIST OF REFERENCES

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ABS	Australian Bureau of Statistics
ACA	Australian Cogeneration Association
AGA	Australian Gas Association
AGO	Australian Greenhouse Office
AGSO	Australian Geological Survey Organisation
BMR	Bureau of Mineral Resources
BRS	Bureau of Resource Sciences
DPIE	Department of Primary Industries and Energy
IEA	International Energy Agency
NGGIC	National Greenhouse Gas Inventory Committee

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