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Information Paper

Towards the Australian Environmental-Economic Accounts

Australia

2013

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AUSTRALIAN BUREAU OF STATISTICS

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PREFACE

Information Paper: Towards the Australian Environmental–Economic Accounts responds to the growing demand for integrated environmental–economic information and reflects an emerging maturity within the Australian Bureau of Statistics (ABS) environmental statistics program.

This release uses a theme based presentation to showcase the range of ABS environmental accounts which include: *Water Account, Australia; Energy Account, Australia; Waste Account, Australia (Experimental Estimates)*; and others. It also demonstrates the power of these accounts in supporting informed decision making on contemporary environmental issues. Accordingly, *Information Paper: Towards the Australian Environmental–Economic Accounts* provides a depth of commentary to explain environmental accounts and to describe their potential to inform environmental policy decisions.

The initial release of a new annual publication *Australian Environmental–Economic Accounts* later this year will be more data–focussed, representing the next stage of a fully integrated (though limited) set of environmental accounts for Australia.

The outputs contained in this information paper follow the principles outlined in the *System of Environmental and Economic Accounting* (SEEA). The *SEEA Central Framework* was adopted as an international statistical standard by the United Nations Statistical Commission early in 2012. The key characteristic of the SEEA is its capacity to integrate a range of data, expressed in both monetary and physical terms, in an integrated and systematic manner. The SEEA framework thus supports decision making that considers both environmental and socio–economic factors.

The ABS program of environmental accounts is evolving. Readers are invited to submit comments on this publication to help inform the future shape of the program to <*donna.grcman@abs.gov.au*>. As resources permit, the ABS plans to continue to seek ways to expand the program, both in the range of accounts produced and the frequency of their compilation.

Brian Pink
Australian Statistician

ABBREVIATIONS

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
AEEA	Australian Environmental–Economic Accounts
AES	Australian Energy Statistics
ANZSIC	Australian and New Zealand Standard Industrial Classification
ASNA	Australian System of National Accounts
AVPCC	Australian Valuation Property Classification Codes
BoM	Bureau of Meteorology
BREE	Bureau of Resources and Energy Economics
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEE	Department of Climate Change and Energy Efficiency
DLCD	Dynamic Land Cover Dataset
EDR	Economic Demonstrated Resources
EEA	Environmental Expenditure Accounts
EGW&W	Electricity, Gas, Water and Waste services industry
EPE	Environmental Protection Expenditure
EPEA	Environmental Protection Expenditure Account
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
GHG	Greenhouse Gas
GL	Gigalitre
GVA	Gross Value Added
I-O	Input-Output
IOIG	Input–Output Industry Group
IPCC	Intergovernmental Panel on Climate Change
LPG	Liquefied Petroleum Gas
LULUCF	Land Use and Land Use Change and Forestry
ML	Megalitre
NPEI	National Plan for Environmental Information
NRM	Natural Resource Management
NWA	National Water Account
OECD	Organisation for Economic Co-operation and Development
ppm	Parts per million
PJ	Petajoule
PPI	Producer Price Indexes
R&D	Research and Development
SA1	Statistical Area Level 1
SEEA	System of Environmental-Economic Accounting
SEEA-E	System of Integrated Environmental and Economic Accounting for Energy
SEEA-W	System of Environmental and Economic Accounting for Water
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
SNA	System of National Accounts
TPES	Total primary energy supply
UNCEEA	United Nations Committee of Experts on Environmental Economic Accounting
UNFCCC	United Nations Framework Convention on Climate Change
WAAEE	Waste Account Australia, Experimental Estimates

Introduction

Information Paper: Towards the Australian Environmental–Economic Accounts showcases the range of environmental–economic accounts ('environmental accounts') produced by the Australian Bureau of Statistics (ABS) and describes the power of these accounts in informing various environmental and socio–economic policy questions. A number of the critically important policy issues now faced within Australia relate directly to the effects of human activity on the environment. Environmental policy decisions are particularly challenging because they typically need to consider both the contribution of the environment to the wellbeing of humankind; and the way in which human interaction with the environment affects its capacity to support humanity's future wellbeing. Environmental accounts provide the information to support a consistent analysis of the contribution of the environment to the economy and of the impact of the economy on the environment. They provide information of relevance to both economists and physical scientists and thus support a multidisciplinary approach in addressing environmental problems.

ABS environment accounts are based on the *System of Environmental–Economic Accounting* (SEEA). The SEEA Central Framework was adopted as an international statistical standard by the United Nations Statistical Commission in 2012. The adoption of the SEEA by the United Nations' peak statistical body is a significant milestone in the ongoing development of information to support the needs of government, industry and the general public in the area of environmental policy.

The ABS publication *Completing the Picture: Environmental Accounting in Practice*[1] was released following the adoption of the SEEA and was designed to inform government decision makers, policy analysts, scientists, economists, industry and other groups on how environmental accounts could be used and further developed in Australia. *Information Paper: Towards the Australian Environmental–Economic Accounts* has grown out of *Completing the Picture: Environmental Accounting in Practice* but places greater emphasis on the information contained within environmental accounts (and related data) being produced by the ABS and others. In turn, a new publication *Australian Environmental–Economic Accounts* (AEEA) will be released later this year and will be a more data–focussed publication. It will also emphasise the capacity of environmental accounts to integrate data across the various environmental themes of water, energy, waste and so on. AEEA will more closely reflect the presentational structure of the accounts of the SEEA Central Framework – a style and structure similar to that of the *Australian System of National Accounts (ASNA)*[2]. It will represent the first stage of a fully integrated (though limited) set of environmental accounts for Australia.

Environmental accounts are, compared to the System of National Accounts (SNA), at the early stages of development and use. As such, *Information Paper: Towards the Australian Environmental–Economic Accounts* devotes considerable attention to explaining environmental accounts and describing their use in informing contemporary issues of environmental policy. It is expected that the amount of commentary included in the AEEA will be much less and, over time, will be further reduced as users become more familiar with the way environmental accounts are structured and come to understand how they can be applied to particular issues.

1 Completing the Picture – Environmental Accounting in Practice, May 2012. ABS cat. no. 4628.0.55.001
2 Australian System of National Accounts, November 2012. ABS cat. no. 5204.0

Introduction *continued*

The development of the SEEA was driven by a desire to have more complete and robust information on the economy and the environment and to better understand the interactions between the two. It reflects an increasing realisation that economic prosperity is dependent on the ability of the environment to supply natural resources and to absorb pollution, and that environmental policies impact on economic activity. The report "Beyond GDP" by the Stiglitz Commission noted:

'What we measure affects what we do; and if our measurements are flawed, decisions may be distorted. Choices between promoting GDP and protecting the environment may be false choices once environmental degradation is appropriately included in our measurement of economic performance. So too, we often draw inferences about what are good policies by looking at what policies have promoted economic growth; but if our metrics of performance are flawed, so too may be the inferences that we draw.'[3]

The SEEA is a measurement framework that provides a range of metrics that link information on the economy and the environment. This integration of information is achieved by the use of common frameworks, classifications and standards, providing an integrated database for policy analysis and decision making. Appendix 1 provides a more complete discussion of the SEEA, including a detailed description of the features and uses of this framework, as well as a report on the current state of SEEA development and implementation.

This publication provides an overview of the various environmental accounts currently produced by the ABS. Chapter 1 provides a summary of ABS achievements in implementing various environmental accounts. It also highlights the application of ABS environmental accounts and, in particular, the capacity of this framework to integrate information across environmental, economic and social domains to support various analyses.

The following eight chapters relate to specific themes:

- Water (Chapter 2)
- Energy (Chapter 3)
- Waste (Chapter 4)
- Greenhouse Gas Emissions (Chapter 5)
- Land and Ecosystem Accounting (Chapter 6)
- Natural Capital (Chapter 7)
- Households and the Environment (Chapter 8)
- Environmental Instruments and Economic Opportunities (Chapter 9)

Each chapter can be read as a stand–alone chapter and hence there may be some overlap in the data presented. For ease of reading, chapters 2 to 9 do not contain large tables of data. Instead, a number of links to further reading are provided which identify more complete information on specific ABS environmental accounts. For example, links are provided to the ABS *Water Account, Australia* and ABS *Energy Account, Australia*, and to the natural resources appearing on the national balance sheet of the ASNA. In some cases, the information presented within ABS environmental accounts is labelled as 'experimental' – this is the case, for example, for estimates related to environmental taxes, waste and greenhouse gas emissions embedded in categories of final demand. The label 'experimental' explicitly acknowledges that the output is the product of recent

3 Stiglizt, Sen and Fitoussi. 2009. Report of the Commission on the Measurement of Economic Performance and Social Progress. http://www.stiglitz–sen–fitoussi.fr/documents/rapport_anglais.pdf.

Introduction continued

development work and the results should be treated with some caution. Over time and as the data sources and methods improve the experimental labels should be removed.

Environmental accounts produced by the ABS

The ABS commenced compilation of environmental accounts in the early 1990s by developing monetary estimates for a number of environmental assets within scope of the SNA asset boundary. In particular, estimates for subsoil assets[4]; forests and land were developed within the national accounts area of the ABS and these are now an established part of the balance sheet within the ASNA. A dedicated environmental accounts area provides continuing momentum for the development of these accounts within the ABS and other agencies.

Figure 1.1 summarises the range of ABS environmental accounts used in this information paper. It indicates, by environmental domain, the broad types of accounts used. Stock measures describe a particular item at a point in time, for example, the economically demonstrated reserves of coal resources as at 30 June 2012 measured in physical terms (e.g. tonnes or petajoules) and/or monetary terms ($ million). Flow measures record an item for a period of time, again, in physical and/or monetary terms, for example, gigalitres of water used by hydroelectric power producers, or millions of dollars paid by manufacturers for electricity, during 2011–12.

In addition to the stock and flow information summarised in figure 1.1, this information paper has used various ABS estimates of environmentally related transactions. These transactions are not stock or flow measures of natural resources but nevertheless relate closely to the environment and can be expressed in monetary terms only. This publication presents ABS estimates for a number of such transactions, in particular, environmental taxes, environmental research and development expenditure and capital expenditure undertaken to reduce GHG emissions to air.

Figure 1.1 summarises the current state of environmental accounts, as described in this information paper. For example, monetary estimates of flows of water and of energy have been produced by the ABS in the past but are excluded because they do not appear in the most recent editions of *Water Account, Australia* and *Energy Account, Australia*. Nevertheless, the ABS aims to include monetary estimates of flows as a standard part of future editions of these publications. Over time, the ABS aims to extend the range and frequency of stock and flow information (in both monetary and physical terms) identified in figure 1.1.

4 SNA's 'subsoil assets' fall within the SEEA category of 'mineral and energy resources'

Environmental accounts produced by the ABS continued

Figure 1.1 Summary of ABS environmental accounts

	Frequency	Stock		Flow	
		Physical	Monetary	Physical	Monetary
Water[1]	Annual			☑	
Energy[2]	Annual	☑		☑	
Natural Capital	Annual	☑	☑	☑	
Waste	First issue			☑	☑
GHG Emissions	Under development				
Land	Annual[3]	☑	☑		

[1] Monetary flow estimates for water products will be published late in 2013.
[2] Monetary flow estimates for use of energy products will be published late in 2013.
[3] The land account for a given state or territory is expected to be updated every 3 to 4 years.

Integrating Environmental and Socio–economic statistics

The remainder of this chapter provides a brief demonstration of how the SEEA supports the integration of environmental and socio–economic information. A number of presentations are offered to demonstrate that environmental, economic and social data can be meaningfully integrated into a cohesive framework to provide analysts with an informed picture of Australia's progress against various areas of policy interest.

The measures presented in this chapter draw upon a range of assessment tools, methodologies and research by various Australian government and international agencies. At present the data are compiled by a number of agencies for a variety of purposes using a range of concepts, data sources and methods. Typically, the data being used were designed for a particular purpose and possible uses beyond the original purpose have not been considered.

In this chapter various data have been combined and presented even though some of these data sets may not be strictly consistent at the present time. However, by mapping the available data into the SEEA framework, over time a more reliable, consistent and comprehensive set of data for measuring sustainable development, as well as other issues of interest to policy analysts and decision makers, can be achieved. The process of compiling the data for this and other chapters in this publication demonstrates how changes to the way data are collected, processed, presented or accessed could result in a capacity to produce an improved and/or expanded set of environmental accounts.

The notion of decoupling used throughout this information paper is consistent with that used by the environment programs of both the United Nations and the Organisation for Economic Co–operation and Development (OECD)[5]. Decoupling is a notion that is applied in many fields, from algebra to electronics, but applies here specifically to sustainable development, both to resource decoupling, which means reducing the rate of resource use per unit of economic activity; and impact decoupling, which means reducing the amount of negative environmental impact per unit of economic activity. Absolute decoupling is said to occur when, over time, the environmentally relevant variable remains stable or falls, while the relevant measure of economic activity is

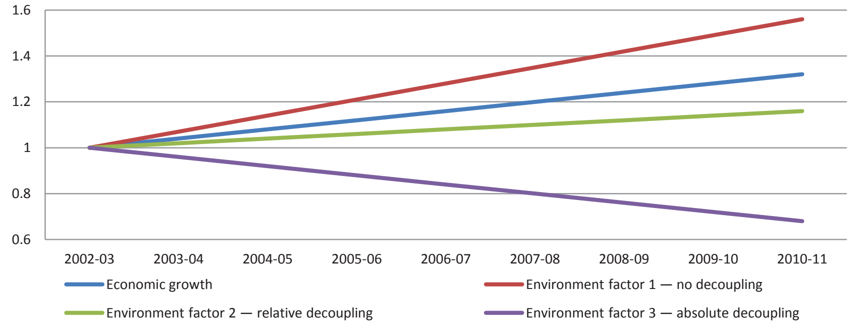
5 http://www.unep.org/resourcepanel/decoupling/files/pdf/Decoupling_Factsheet_English.pdf
http://www.oecd.org/environment/indicators–modelling–outlooks/1933638.pdf

Integrating Environmental and Socio–economic statistics continued

growing. Relative decoupling occurs when the growth rate of the environmentally relevant variable is positive, but is less than the growth rate of the economic variable.

In figure 1.2 below, the growth index for 'environment factor 1' exceeds that of the measure of economic growth and no decoupling occurs. 'Environment factor 2' records growth over the time series, but at a lesser rate than for economic growth and so decoupling is said to be relative. The measure of 'environment factor 3' is reducing over time, while positive growth is recorded for economic growth and therefore decoupling is said to be absolute.

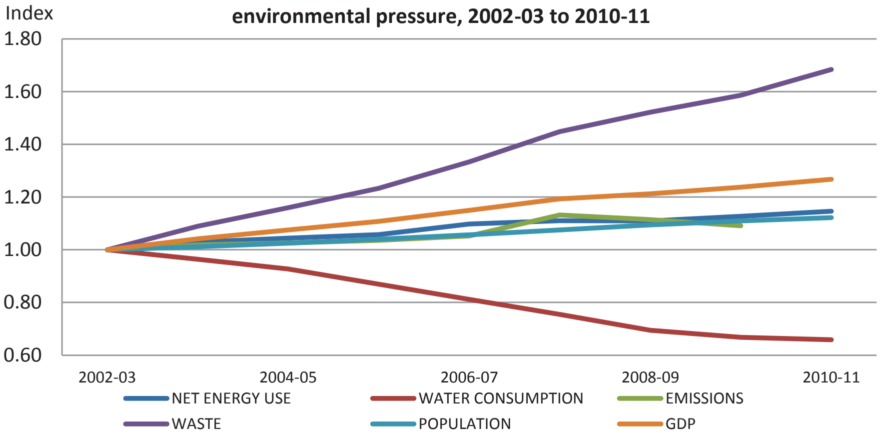
Figure 1.2 Relative and absolute decoupling



Note: Index: 1999-2000 = 1

Figure 1.3 integrates selected socio–economic data with selected measures of environmental pressure.

Figure 1.3 GDP, population and selected physical indicators of environmental pressure, 2002-03 to 2010-11



Note: Index: 2002-03 = 1

Sources: ABS; Department of Climate Change and Energy Efficiency; Department of Sustainability, Environment, Water, Population and Communities.

All the selected indicators of environmental pressure recorded increases in pressure over the period 2002–03 to 2010–11; with the sole exception of water consumption. Net energy use rose 15%, while greenhouse gas (GHG) emissions[6] increased by 9%. Of the selected indicators, waste recorded by far the largest increase over the period, rising 68%. In contrast, water consumption in Australia recorded a fall of 34% between 2002–03

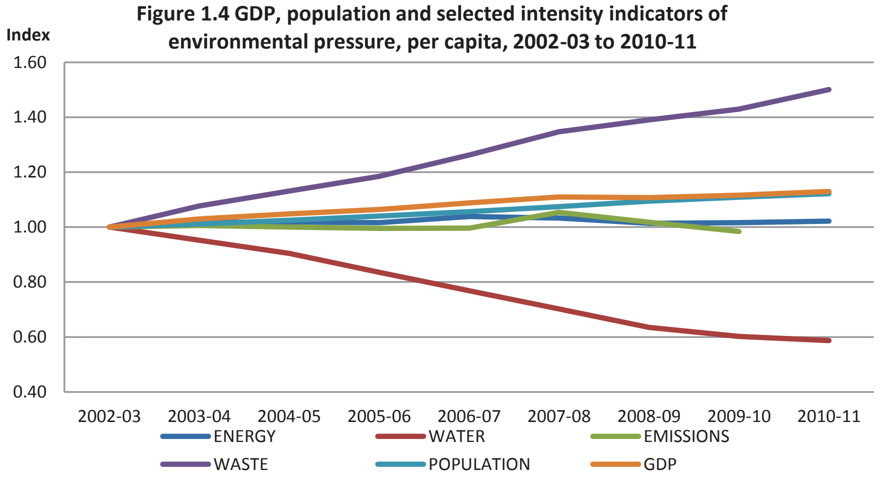
6 GHG emissions data are sourced from the Department of Climate Change and Energy Efficiency (DCCEE) and then adjusted onto a SEEA basis in order to ensure full comparability with the ASNA and related economic data. Chapter 5 provides a more complete explanation

Integrating Environmental and Socio–economic statistics continued

and 2010–11. Therefore, for the period 2002–03 to 2010–11, net energy use and GHG emissions both showed relative decoupling from economic growth; water use recorded an absolute decoupling from economic growth; and waste recorded no decoupling.

Figure 1.4 plots changes in selected intensity measures of environmental pressure in Australia. In this instance, intensity is expressed in terms of population, so that an increase in intensity represents an increase (or worsening) in measured environmental pressure per head of population. Between 2002–03 and 2010–11, Australia's resident population grew approximately 12% to 22.3 million. Figure 1.4 reveals a close correlation between Australia's per capita GHG emissions and per capita energy use over the same period[7]. This is unsurprising, given that the majority of Australia's GHG emissions can be attributed to energy production from fossil fuels.

Figure 1.4 GDP, population and selected intensity indicators of environmental pressure, per capita, 2002-03 to 2010-11



Note: Index: 2002-03 = 1
Sources: ABS; Department of Climate Change and Energy Efficiency; Department of Sustainability, Environment, Water, Population and Communities.

The level of waste generated per capita recorded the largest increase of any of the selected measures of environmental pressure per capita over the period, rising by over 50%. In 2010–11, 73% of waste generated came from industry, with the remainder coming from the household sector.

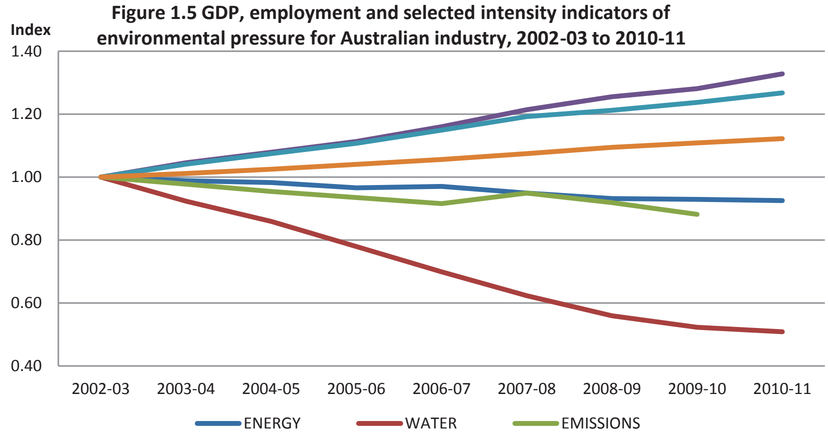
Per capita water use was the only selected indicator to record a fall between 2002–02 and 2010–11. Drought conditions of much over the period, led to restrictions on domestic water use, as well as a shift towards less water intensive crops by the agriculture industry.

Figure 1.5 focuses on Australian industry (i.e. it excludes energy, water, etc. used by households) and compares employment with various measures of intensity of use of environmental resources. In this case, the intensity measure represents the amount of a given resource consumed (or emissions generated) to produce one unit of economic production, i.e. gross domestic product (GDP). An increase in intensity therefore represents a decline in the efficiency of resource use.

7 DCCEE GHG emissions data are only available to 2009–10

Integrating Environmental and Socio–economic statistics continued

Figure 1.5 GDP, employment and selected intensity indicators of environmental pressure for Australian industry, 2002-03 to 2010-11



Note: Index: 2002-03 = 1
Sources: ABS; Department of Climate Change and Energy Efficiency; Department of Sustainability, Environment, Water, Population and Communities

Between 2002–03 and 2010–11, Australia's economic production as measured by GDP grew 27%, while the total number of people employed across all industries in Australia rose 12%. The decreasing trend in the intensities of energy and GHG emissions over the same period, were closely correlated, falling 7% and 12% respectively[8]. Of the selected measures of intensity, the level of water consumed per unit of economic production recorded the largest fall between 2002–03 and 2010–11, decreasing by almost 50%. The majority of the decline can be explained by a sharp fall in water consumed by the agriculture industry, which remains that the biggest consumer of water of any industry in Australia.

Environmental accounts can be used to jointly examine economic and environmental aspects of various issues for particular industries. The following provides examples for selected industries.

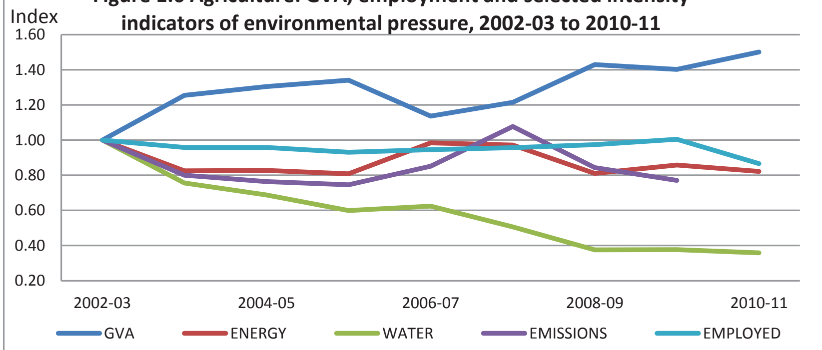
Agriculture

Figure 1.6 reports that energy intensity within the agriculture industry declined by 18% between 2002–03 and 2010–11. While economic production as measured by gross value added (GVA), within the agriculture industry grew by some 50%, its energy consumption rose 23%. Unlike most industries, agricultural energy consumption and output are not closely coupled. While energy consumption by the agriculture industry is relatively stable from year to year, shifts in weather conditions and prices can impact dramatically on the value of production in a given year, which explains the typically volatile time series of measured energy intensity seen for this industry.

8 Period ending 2009–10

Agriculture continued

Figure 1.6 Agriculture: GVA, employment and selected intensity indicators of environmental pressure, 2002-03 to 2010-11



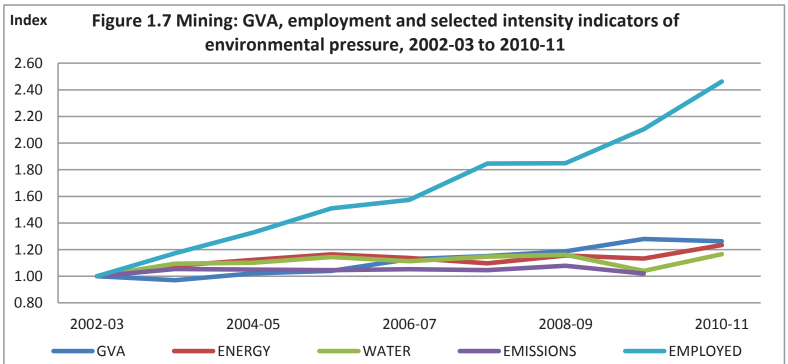
Note: Index: 2002-03 = 1
Sources: ABS; Department of Climate Change and Energy Efficiency; Department of Sustainability, Environment, Water, Population and Communities

Water intensity for the agriculture industry recorded a significant fall between 2002–03 and 2010–11, decreasing by 64%. Australian irrigators are highly responsive to changing patterns of water availability, for example, crops that require greater quantities of water to ensure production, like cotton and rice, are grown in lesser quantities in dry years. Furthermore, as figure 1.6 shows, the decline in total use of water by the agriculture industry has been accompanied by an increase in the GVA of agricultural production.

Mining

The value of economic production by the mining industry rose 26% between 2002–03 and 2010–11. This rise has also increased the industry's share of total economic production and in 2010–11 mining was the second largest industry in Australia[9]. Nevertheless, as figure 1.7 illustrates, growth in number of people employed by this industry has risen at a much faster rate than that recorded for GVA.

Figure 1.7 Mining: GVA, employment and selected intensity indicators of environmental pressure, 2002-03 to 2010-11



Note: Index: 2002-03 = 1
Sources: ABS; Department of Climate Change and Energy Efficiency; Department of Sustainability, Environment, Water, Population and Communities

The measured intensities of water, energy and GHG emissions for the mining industry all increased between 2002–03 and 2010–11. Energy intensity rose 23%, with a number of factors contributing to this increase. Australia's mining industry is increasingly dominated by relatively low value (dollar per tonne) commodities, such as coal, iron ore and bauxite. This generally means that a greater level of energy is needed for extraction and processing than for commodities with higher unit values (e.g. more tonnes have to be removed in order to achieve the same value of production). This is partly due to the

9 According to relative size of gross value added by industry, current prices (ABS cat. no. 5204.0)

Mining continued

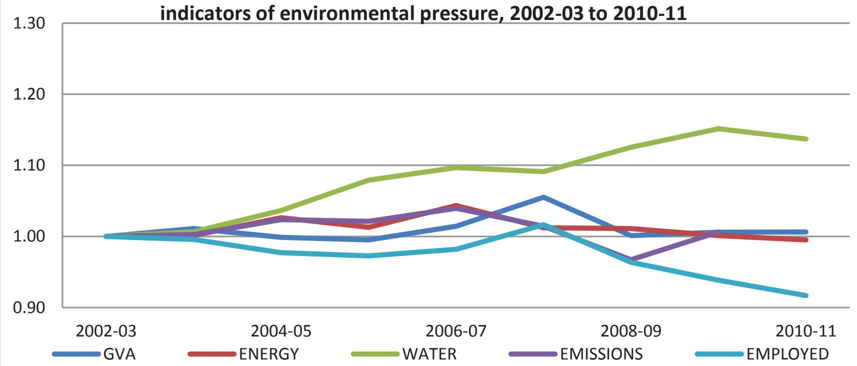
higher proportion of production now coming from open cut mines which require the removal of large quantities of overburden.

The recorded GHG emissions intensity remained largely unchanged between 2002–03 and 2010–11, while the intensity of water use rose by 16%. During this time water consumption by the mining industry increased by 47%.

Manufacturing

Integrating socio–economic data with measures of environmental pressure for the manufacturing industry reveals a mixed picture. Manufacturing, which has the highest energy intensity of any industry, recorded relatively little movement in energy intensity between 2002–3 and 2010–11. The value of economic production for the manufacturing industry was largely flat over the period. However, the manufacturing industry is diverse, consisting of many different processes with varying energy requirements. Changes in its energy intensity therefore depend heavily on changes in the structural makeup of the industry, in addition to changes in energy efficiency. For example, a shift away from basic primary processes towards less energy intensive transformations of primary materials would lead to a decline in overall energy intensity.

Figure 1.8 Manufacturing: GVA, employment and selected intensity indicators of environmental pressure, 2002-03 to 2010-11



Note: Index: 2002-03 = 1

Sources: ABS; Department of Climate Change and Energy Efficiency; Department of Sustainability, Environment, Water, Population and Communities

Figure 1.8 shows that, for the manufacturing industry, GHG intensity was largely consistent with energy intensity figures in recording little movement between 2002–03 and 2009–10. Water intensity for the manufacturing industry was the only measure of environmental pressure to rise over the period, increasing 14% in the eight years to 2010–11. The number of people employed by the manufacturing industry declined 8% over the same period.

Introduction

Water is a vital natural resource and changes in its availability impact upon the environment, the economy and society. Measures to manage and adapt to changes in water availability include improvement in the efficiency of irrigation systems, creation of tradable water markets, increased use of water saving technologies in industrial processes and in homes and, when necessary, restrictions on household water use (i.e. "water restrictions"). Other changes are likely to include production processes that are more adaptable to variable water availability and increased flood mitigation.

Two major publications account for water in Australia, emphasising different aspects of Australian water resources and the use of these resources by the Australian community; *Water Account, Australia* (ABS cat. no. 4610.0) and the Bureau of Meteorology publication, National Water Account (NWA).

The ABS publication is compiled in accordance with the System of Environmental and Economic Accounts for Water (SEEA–Water) and shows how much water is used by human activity It focuses on flows of water from the environment to the water supply industry and other economic activities, particularly agricultural production and the flows from the water supply industry to households and businesses. The ABS water accounts equate to the physical and monetary supply and use of water. *Water Account, Australia* was first released in 2000, for the reference years 1993–94 to 1996–97 and has been produced annually since 2008–09.

The Bureau of Meteorology publication is compiled in line with the Australian Water Accounting Standard 1 and focuses on the volume of water in the environment (natural and man–made), its availability, the rights to abstract water and the actual abstraction. This standard has been mapped to the key concepts and structure of the water asset account in the SEEA–Water[10].

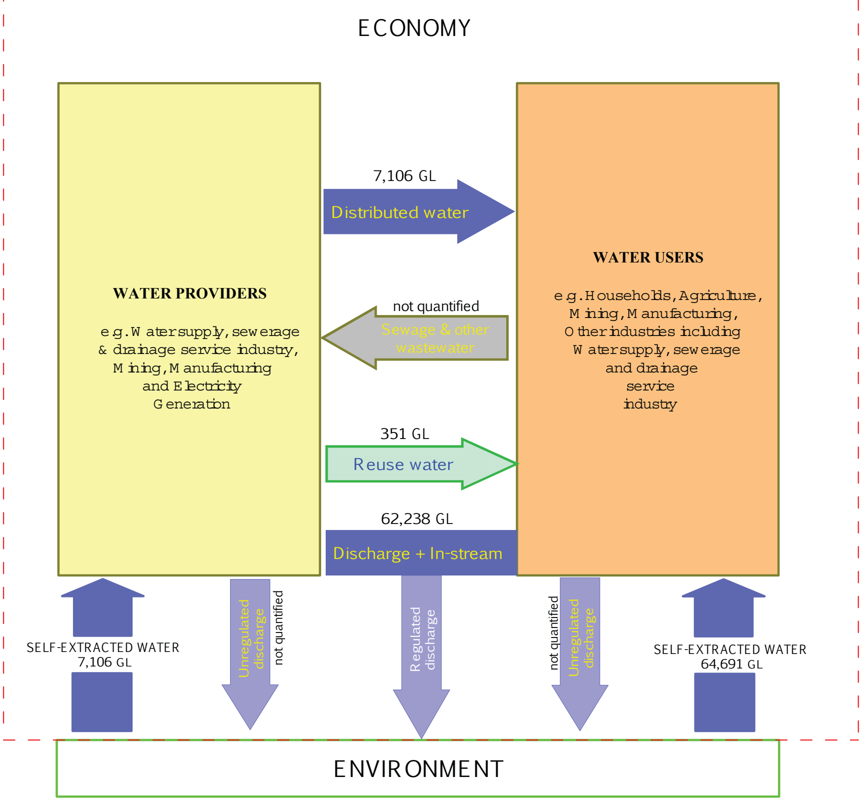
These publications are complementary, with the key overlapping feature being the "actual abstraction of water for economic, social, cultural and environmental benefit", a volume that flows from the National Water Account into the *Water Account, Australia*.

Figure 2.1 represents the physical flows of water within the Australian economy. The section bounded by the dashed line is the scope of *Water Account, Australia*. While in scope of the SEEA–Water supply and use accounts, rain–fed agriculture is not currently included in estimates of water use by the economy.

10 Vardon et al. in *Water Accounting: International Approaches to Policy and Decision–making,* pp. 42, 45–46, ed. Godrey & Chalmers, 2012.

Introduction continued

Figure 2.1 Physical flows of water in Australia



The beginning of this chapter outlines the importance of rainfall in the water account. This is followed by a description of the supply and use of water in physical terms; the consumption of water and water intensity.

Rainfall

Water supply and use in the Australian economy needs to be considered in the context of Australia's climate. Rainfall is important for analysing water availability to households and the economy, as it is the primary source for water stored in the landscape as surface water, particularly in dams and other water storages. Rainfall also determines that amount of recharge to groundwater.

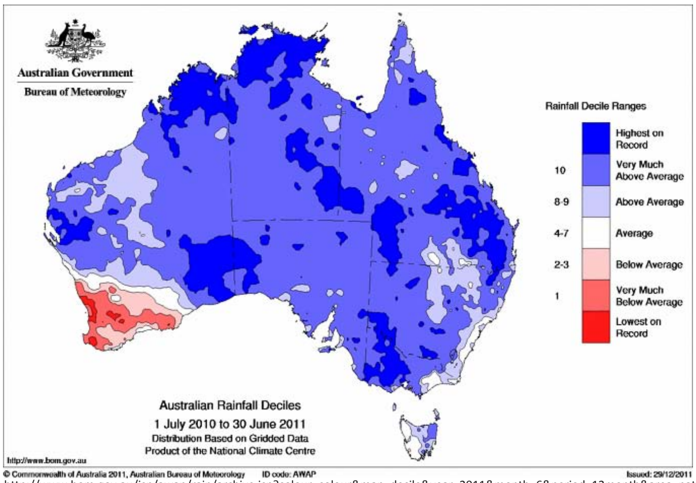
Australia's rainfall can vary significantly year–to–year, season–to–season and across geographical areas. Annual rainfall variability is greater for Australia than any other continental region. The assessment of water supply and use over time helps improve understanding around the impact of this variability. This publication includes comparisons for the three years from 2008–09 to 2010–11.

Rainfall over Australia averaged 708 mm during 2010–2011, very similar to 2009–10 (703 mm) and much higher than that for 2008–09 (461mm). There were large variations in national average rainfall both during the reference periods and geographically.

Figures 2.2 and 2.3 underline the variability in rainfall both across Australia's geography and from year to year.

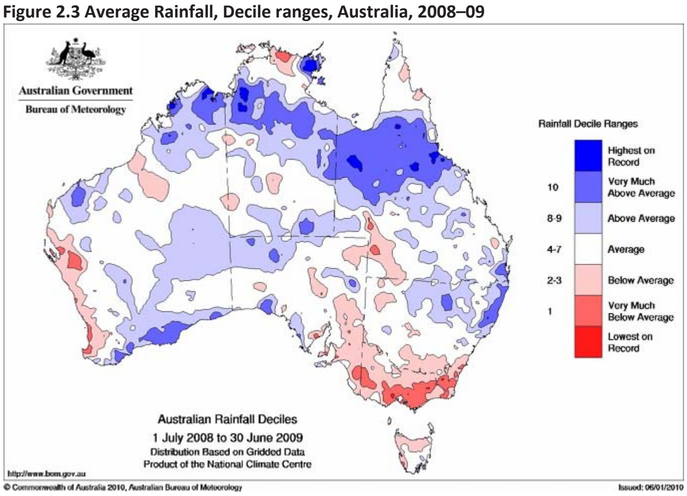
Rainfall continued

Figure 2.2 Average Rainfall, Decile ranges, Australia, 2010–11



http://www.bom.gov.au/jsp/awap/rain/archive.jsp?colour=colour&map=decile&year=2011&month=6&period=12month&area=nat

Figure 2.3 Average Rainfall, Decile ranges, Australia, 2008–09



http://www.bom.gov.au/jsp/awap/rain/archive.jsp?colour=colour&map=decile&year=2009&month=6&period=12month&area=nat

Water Supply and Use

Although ABS water accounting data has a history going back nearly 20 years, only the past three iterations are presented as a time series. Changes in collection of data, methods of deriving estimates, and the framework in which the accounts were presented prior to 2008–09 limit the extent to which it is possible to make comparisons with earlier water accounts.

Water supply

There are three ways in which water can be supplied to the economy:

1. Self–extracted;
2. Distributed; and
3. Reuse.

The ways in which water is supplied are not independent of one another and therefore cannot be added to estimate a total supply. Both distributed and reuse water are effectively subsets of self–extracted water. In addition the supply of water includes water which is returned to the environment after it has been used (i.e. regulated discharge). The following provides an outline of the types of water supply indicating their inter–relationships.

Water supply continued

Self–extracted water occurs when water is extracted directly from the environment (i.e. rivers, lakes, groundwater and other bodies) for use by industry and households alike. Self–extracted water is supplied by the environment free of charge in general. It is the source for distributed and reuse water. Most of the self–extracted water in Australia is used in–stream for electricity production and is returned to the environment (e.g. the river) as regulated discharge water. Some water that is extracted directly from the environment is distributed via water providers to industry and households, at which time it becomes distributed water.

Distributed water is supplied to industry and households through a natural (e.g. river) or man–made network (e.g. pipelines or open channels), where an economic transaction has occurred for the exchange of this water. It is sourced from self–extracted water.

Reuse water is water that is made available for use again without firstly being discharged to the environment (e.g. treated effluent, drainage, waste or storm water). It may occur as waste water from production processes as well as collected storm water. Reuse water may have been treated to some extent and it is ultimately sourced from self–extracted water. It excludes "on–site" recycling.

Regulated discharge water is water that has been sourced from self–extracted water, used and is returned to the environment. However its state may have been altered (e.g. temperature, quality) during this process or the return not match the natural flow of the body that existed prior to its use (e.g. stored for a period of time). This type of water is primarily seen in the water supply, electricity generation, mining and manufacturing industries. Figure 2.5 provides a comparison of the quantity of self–extracted water to regulated discharge water in megalitres (ML).

Figure 2.4 Water supply by type (ML), Australia, 2008-09 to 2010-11

	Self-extracted	Distributed	Reuse
2008-09	59,808,214	9,578,857	357,772
2009-10	64,076,308	9,405,342	373,987
2010-11	71,796,494	7,105,843	351,014

Source: Water Account, Australia (ABS cat. no. 4610.0)

Of the total volume of extracted water from the environment in 2010–11 (71,796, 494ML) (Figure 2.4) only 10% was supplied as distributed water to industry and households. The remainder of self–extracted water is either extracted as in–stream water for hydro–electricity generation or used by the industry or household that extracted the water.

The proportion of distributed water varied between States and Territories in 2010–11, from less than 1% in Tasmania (where 98% was extracted for hydro–electricity generation in–steam use) to 96% in the Australian Capital Territory.

Water supply continued

Figure 2.5 Self-extracted water and Regulated Discharge (ML), Australia, 2008-09 to 2010-11

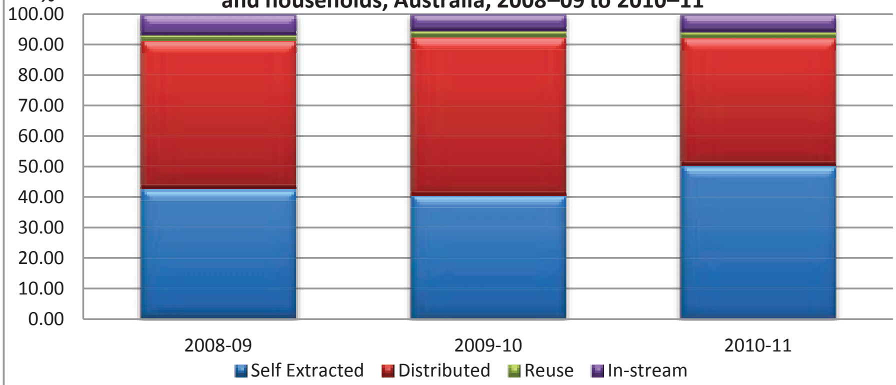
	Self-extracted	Regulated discharge
2008-09	59,808,214	47,939,788
2009-10	64,076,308	51,911,904
2010-11	71,796,494	62,237,821

Source: Water Account, Australia (ABS cat. no. 4610.0)

Water use

Water use describes all water that enters the economy for use by industry and households. Most of this water enters for only a very short time as in–stream use, for example in hydro–electricity generation. Other types of use include household use of water that has been distributed by the water supply industry, self–extracted use by farmers accessing water stored in dams on their properties, and the reuse of non–potable water supplied to households via purple taps[11]. Figure 2.6 shows the types of use outside of electricity and gas supply, and water supply industries.

Figure 2.6 Percentage of total water use by type, selected industries* and households, Australia, 2008–09 to 2010–11



*All industries except Electricity and Gas supply, and Water supply industries.

The reuse of water has increased slightly through each successive year, both in volume (235ML in 2008–09 to 256ML in 2010–11) and percentage of total use (1.9% to 2.1%). Although 2008–09 and 2009–10 were years with very different total average rainfall, the split between self–extracted and distributed water use changed only 3% (a decrease in self–extracted use from 46% to 43% of total use), while between 2009–10 and 2010–11, years with similar total average rainfall, the pattern of use swung to a 10% decrease in self–extracted water use. This may indicate a "lag" year after a prolonged drought, before industry and households begin to access increased surface water storage for self–extracted use. In–stream use by industries outside of the electricity and gas supply and water supply industries dropped from 7% of total use in 2008–09 to 6% of total use in 2010–11. Electricity and gas supply, and water supply industries are excluded from this graph as their use of water is both large and anomalous. Electricity and gas supply uses most of its water in–stream and the water supply industry uses its water by distributing it to other industries and households.

11 Purple taps are those that are connected to non-potable reuse water supply. Separately metered and distributed to regular mains water, this water can be used to water lawns, flush toilets, wash cars, and more. http://www.sewl.com.au/SiteCollectionDocuments/LearnAboutWater/TypesOfWater/RecycledWaterAndYourHome.pdf

Water consumption

Consumption of water differs from water use in that consumption does not involve water being returned to the environment, used in–stream or supplied to other users. Electricity, water and gas supply industries use far more water than all other industries and households combined. However a very large majority of this water is returned to the environment (e.g. as regulated discharge) or supplied to other users and is therefore not included in estimates of consumption. For example the water used to generate hydro–electricity is used (i.e. in–stream use) but because it is returned to the environment, and hence available to other users, it is not consumed.

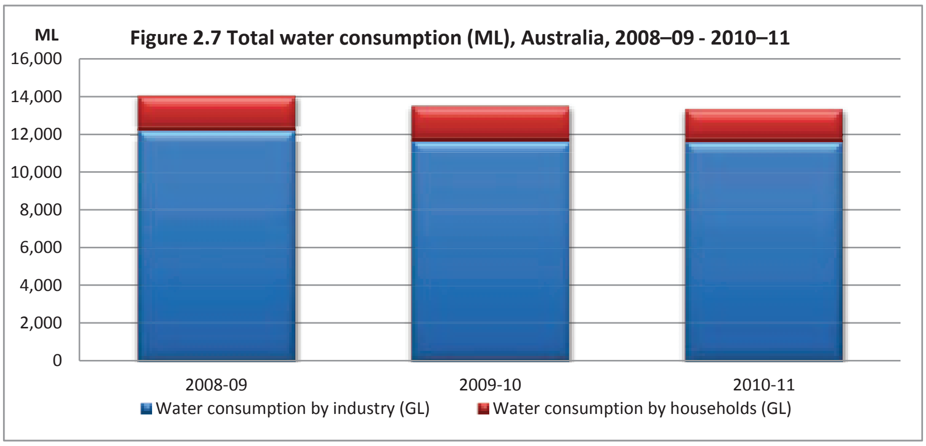
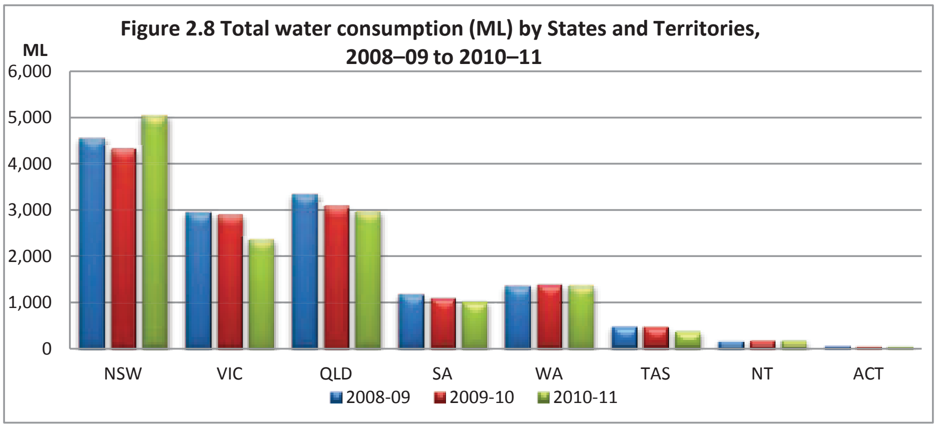


Figure 2.7 shows that total water consumption has declined steadily over the past three years. 2010–11 saw a total of 13,337ML consumed, a 5% reduction since 2008–09. The reduction has been driven by both households and industry. Households decreased from 1,818ML to 1,699ML (a 7% decrease), compared with industry water consumption decreasing from 12,242ML to 11,637ML (a 5% decrease).

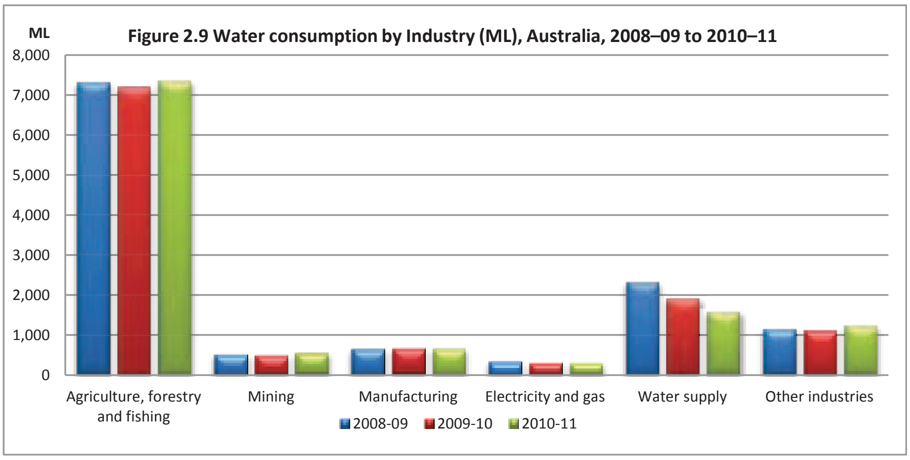
The share of total water consumption between households and industry has been stable at 87% by industry and 13% by households, varying by less than 1% over the three years.



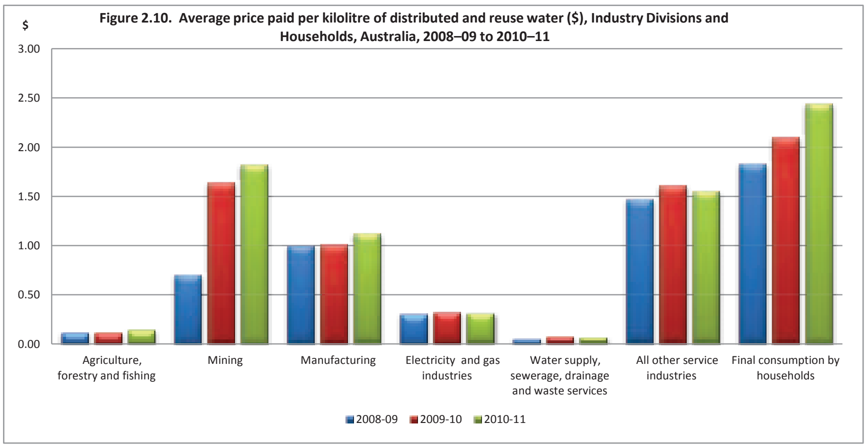
Total water consumption is decreasing in most states and territories, with the most notable exception being the large (17%) single year increase in consumption in NSW in 2010–11. This increase was driven by the increased consumption of self–extracted water for cotton and rice, the most heavily irrigated crops between 2009–10 and 2010–11. Victoria and Tasmania both consumed just over 20% less water in 2010–11 than in

Water consumption continued

2008–09, while QLD, SA and ACT all reduced consumption by over 10%. WA and NT recorded small increases in consumption over the three year period.



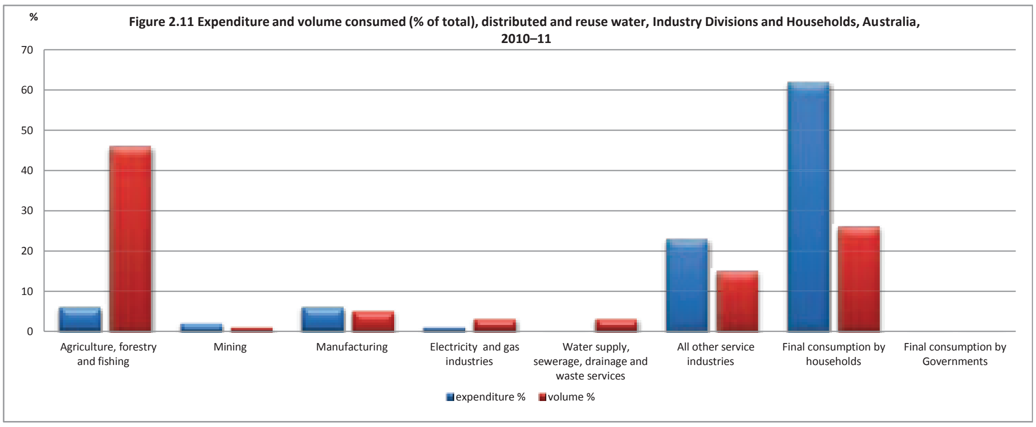
Agriculture, forestry and fishing continued to be the largest consumer of water throughout the three year period, consuming around 7.3 gigalitres of water each year (accounting for 55% of total and 63% of industry consumption in 2010–11). The water supply industry has experienced a drop in water consumption, from 2,317 ML in 2008–09 to 1,570ML in 2010–11 (32% decrease).

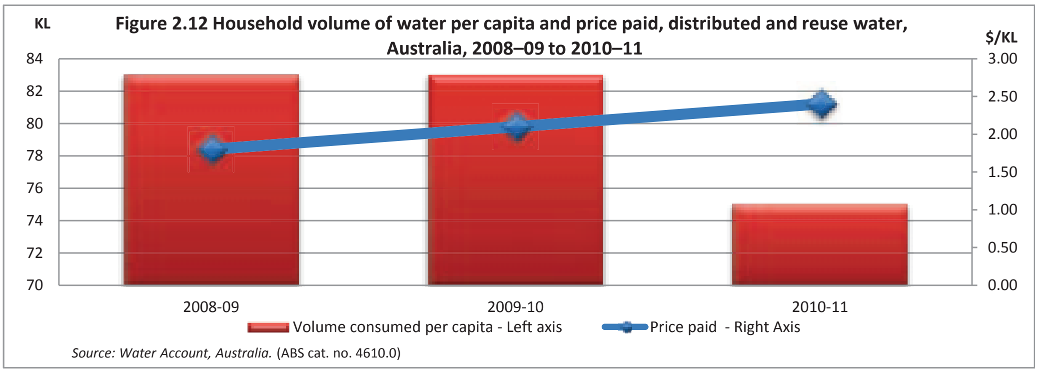


Prices paid per kilolitre (KL) of distributed and reuse water have risen for most industries. While data on types of distributed water (i.e. potable and non–potable) are not available for all industries and households, water paid for and used by agriculture is almost entirely non–potable. This may contribute to the price per kilolitre of the water being far less for agriculture, forestry and fishing than other users. Similarly, water used by agriculture is typically transported through open water–ways and channels, which reflects cheaper infrastructure than that required for potable water. In addition, the value of water associated with water entitlements and allocations used in agriculture are not currently available for inclusion in the total value of water supply and use.

Water consumption continued

Figure 2.11 compares relative consumption and expenditure on water across industries and households. Agriculture consumes the most water (46% of total) and pays comparatively less for it (6% of total), while households consume relatively little water (26%) and account for 62% of the national total water expenditure. These two groups combined represent around 70% of the nation's total expenditure on and consumption of water.



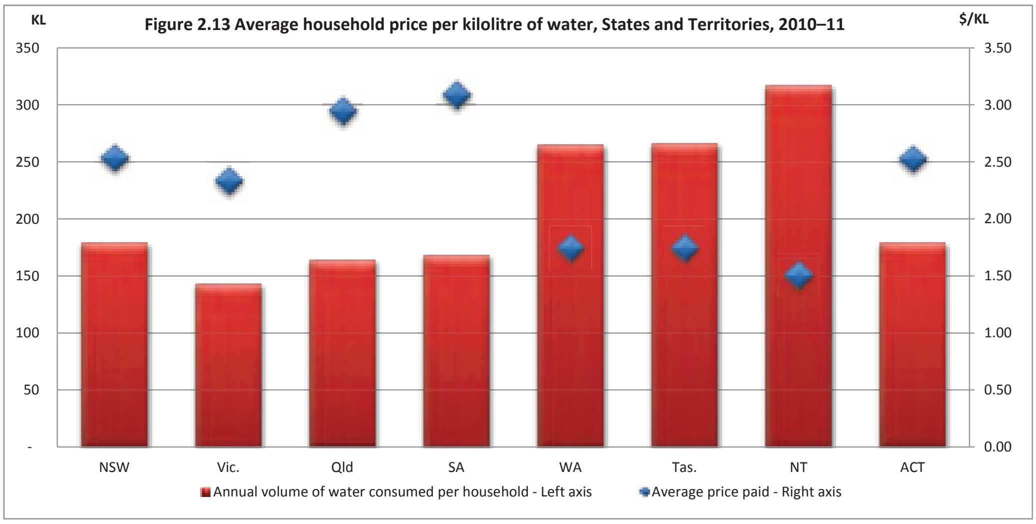


Rainfall, price and water restrictions influence the use of water across the states and territories.

The volume of water consumed per capita in Australian households has declined by 10% over the three year time period, from 83KL to 75KL, whereas the average price paid per kilolitre of water has risen steadily from $1.83 to $2.44, a 33% increase (Figure 2.12).

The volume of household water consumed per capita varies considerably between states and territories, and reflects the variation in distribution of rainfall (and subsequently the availability of water) across Australia. In 2010–11 Northern Territorian households consumed on average 136KL per person, whereas Victorian households consumed only 55KL per person.

The price paid per kilolitre compared to average consumption by households in different states (see figure 2.13) shows the relationship consumption and price paid, i.e. the higher the price of water, the lower the average volume consumed.

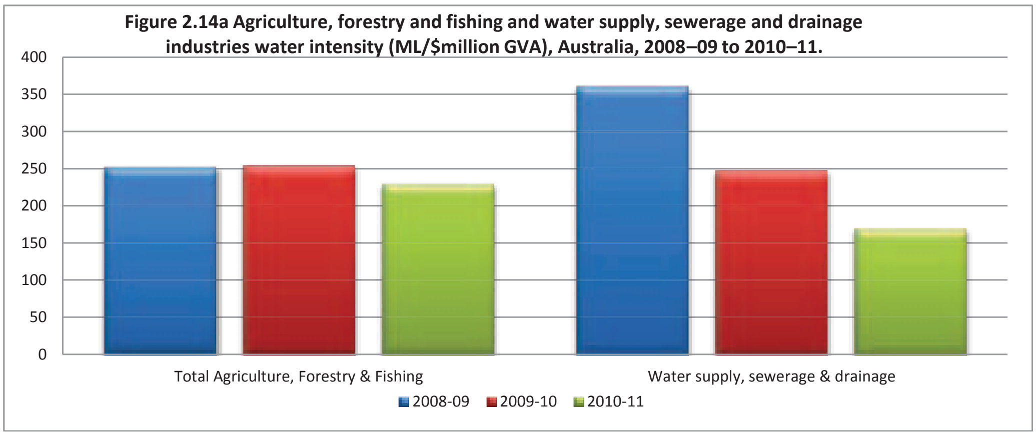


Water consumption continued

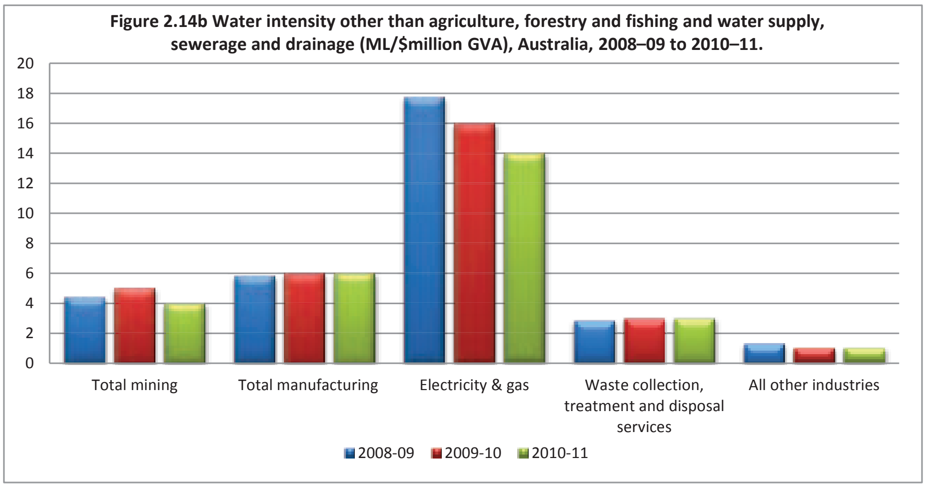
The average annual spend on water per household varies substantially between states. South Australian households pay on average $519 per year for their 168KL consumed, while Victorian households pay on average $335 per year for their 143KL consumed. Households in all other states and territories pay on average between $451 (ACT) and $482 (QLD) per year.

Water intensity

Water intensity is a measure of how much water is consumed to generate income. As with other environmental inputs to production (such as energy), a decrease in water consumption relative to industry GVA (and thus lowering of water intensity) is an indicator of a move towards environmental sustainability. The following two figures illustrate the water intensity by industry. It is necessary to split the figure as agriculture, forestry and fishing and water supply, sewerage and drainage water intensity is significantly greater than the remaining industries.



Water intensity for the agricultural, forestry and fishing and water supply, sewerage and drainage industries are the most significant consumers of water per GVA. Though decreasing, the agriculture, forestry and fishing division consumed nearly 229ML of water for every million dollars of GVA in 2010–11. The water supply, sewerage and drainage industry has decreased its water intensity by 53% from 2008–09 to 2010–11 by consuming 32% less water while increasing its GVA by over 40%.



Water intensity continued

Figure 2.14b presents water intensity for industries other than agriculture, forestry and fishing and water supply, sewerage and drainage. Electricity and gas consumed just under 14ML of water for every million dollars of GVA in 2010–11, 8% of that consumed by water supply, sewerage and drainage and 6% as much as the agriculture division.

Australia has abundant, high quality and diverse energy resources, which include both renewable and non–renewable resources. This chapter assesses the physical (petajoules) supply and use of energy and its different sources in the Australian economy over time. The first part of the chapter describes the suppliers and users of energy in Australia and also encompasses international trade in energy products. This is followed by a look at Australia's historical reliance on a carbon energy economy, through a comparison of fossil fuel and renewable energy sources over time. The final part of the chapter steps away from the direct supply and use of energy to investigate historical energy prices and efforts by households and business to conserve energy.

Introduction

Australia is the world's ninth largest energy producer, accounting for around 2.5% of world energy production and 5% of world energy exports[12]. The energy industry is a significant contributor to the Australian economy, accounting for around 5% of total GVA in 2009–10[13].

Demand for energy products has risen in recent years, driven by growing exports and domestic use, which can in turn affect the price and security of supply. Understanding developments and trends in the energy sector, therefore, helps policy makers to make better decisions about how the nation should invest for future energy demands.

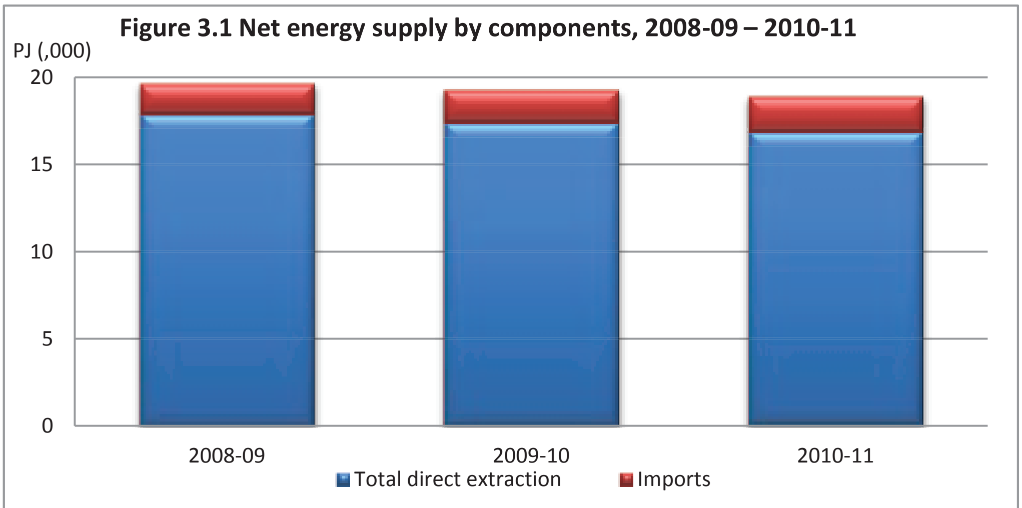
The supply and use of energy in this chapter is defined by product. Energy supply comprises: black coal, brown coal, natural gas, liquefied petroleum gas, crude oil, refined products[14], renewables and uranium. Energy use products comprise: black coal, coal by–products, natural gas, liquefied petroleum gas, crude oil, petrol, diesel, other refined products,[15] electricity and renewables.

The energy data contained in the first part are produced in accordance with the principles outlined within the System of Environmental–Economic Accounting for Energy (SEEA–Energy). Data on the physical supply and use of energy products data are primarily sourced from the Bureau of Resources and Energy Economics (BREE) *Australian Energy Statistics (AES) – Energy Update* publications. The ABS publication *Energy Account, Australia 2010–11* (ABS cat. no. 4604.0) provides data on the physical supply and use of energy over time within Australia. The ABS is currently developing the methodology to produce data on the monetary supply and use of energy products.

Supply and use of energy products

Net supply refers to energy products as they enter the economy, either by domestic extraction (e.g. mining production) or as imports. In the context of this paper, 'net' indicates the removal of energy supplied from secondary sources to avoid double counting.

12 BREE, Energy in Australia 2012, p. 3
13 BREE, Energy in Australia 2012, p. 1
14 Includes petrol, diesel, aviation fuel, kerosene, heating oil, fuel oil, refinery fuel and naptha
15 Includes aviation fuel, kerosene, heating oil, fuel oil, refinery fuel and naptha

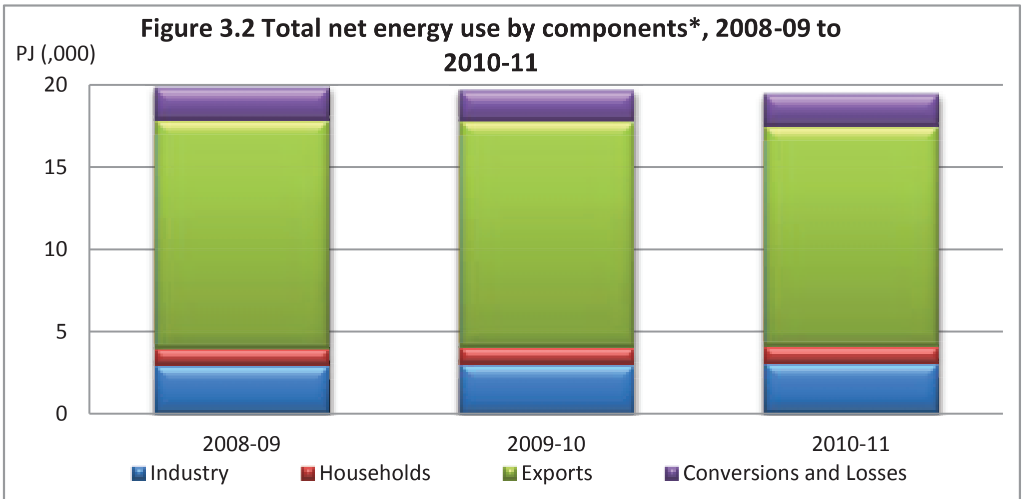


Source: Energy Account, Australia (ABS cat. no. 4604.0)

Supply and use of energy products continued

Australia's total net supply was 18,879 petajoules (PJ) over 2010–11, a decrease of 4.0% from 2008–09. Of this, 89% of domestic energy production was sourced domestically, down from 91% two years earlier. The imports share of total net supply rose from 9% (1,759 PJ) in 2008–09 to 11% (2,020 PJ) in 2010–11.

Net energy use consists of intermediate consumption by industry, final consumption by households, exports, inventory changes, conversions and losses. In the context of this paper, 'net' refers to energy consumed for final purposes.



* Changes in inventories not included

In 2010–11, 13,392 PJ of Australia's total energy use was exported, down 4% from two years earlier. Despite this, exports remained by far the most significant portion of net energy use maintaining around a 70% share throughout the period. Elsewhere, industry marginally increased its share, up 1% to 16%, while households' share of net energy use remained unchanged at approximately 5%.

Supply and use of energy products continued

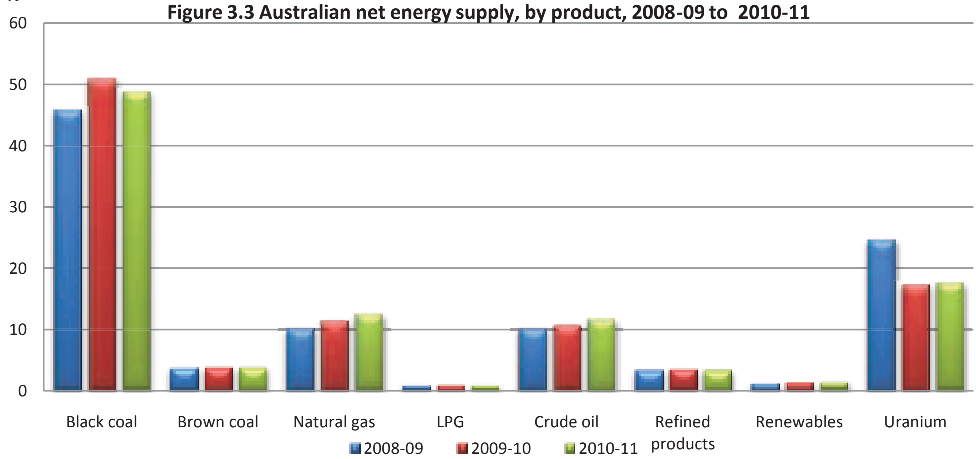
Net losses and conversions remained largely constant between 2008–09 and 2010–11, at around 10% of net use. Losses occur in the use of any energy product as well as in conversion from one energy product to another. Such transformations include fossil fuels and organic waste into electricity, crude oil into petroleum products, and the production of coke and coal by–products during steel making.

Over the past 20 years, energy supply has continued to increase at a faster rate than domestic energy use, with rapid growth in global demand for Australia's energy resources driving growth in domestic production. As a result, the share of domestic consumption in Australian energy production has declined, from an average of 49% in the 1980s to an average of 42% in the 1990s, and has continued to decline, to an average of 34% over the decade to 2009–10[16].

Supply of energy

Black coal remains the largest product contributor[17], accounting for almost half (49%) of Australia's net energy supply at the end of the period, even after a fall in production due to the Queensland floods between 2009–10 and 2010–11. A strong support for black coal production has been from strong overseas demand, particularly from China. Production of uranium, the second largest component of the net domestic energy supply, has fallen sharply from 25% in 2009–10 to 18% in 2010–11. In contrast, both natural gas and crude oil increased their share, to 13% from 10%, and to 12% from 10% respectively.

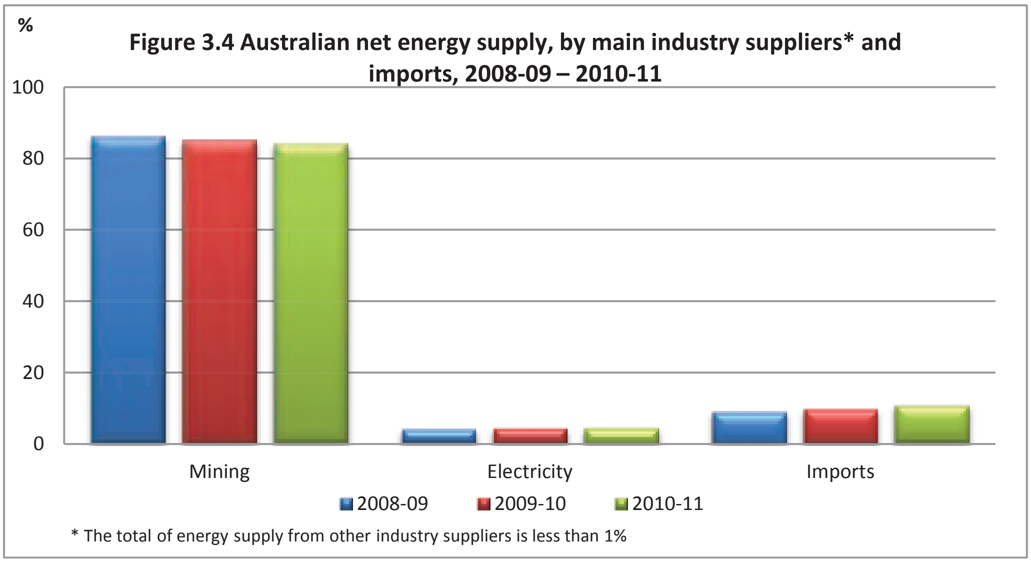
Figure 3.3 Australian net energy supply, by product, 2008-09 to 2010-11



Source: Energy Account, Australia (ABS cat. no. 4604.0)

While energy production from renewable sources rose 16% to 261 PJ in 2010–11, the rise came from a low base (234 PJ in 2008–09) and the contribution of renewable energy to the domestic energy supply remained at approximately 2%. While energy production from wind and solar sources has increased rapidly in recent years (increasing 50% between 2008–09 and 2010–11) the bulk of the domestic renewable energy supply continues to come from renewable fuel products and hydro–electricity (63% and 23% of renewable energy production respectively in 2010–11).

16 BREE, Energy in Australia 2012, p.4
17 As measured by energy (PJ) content



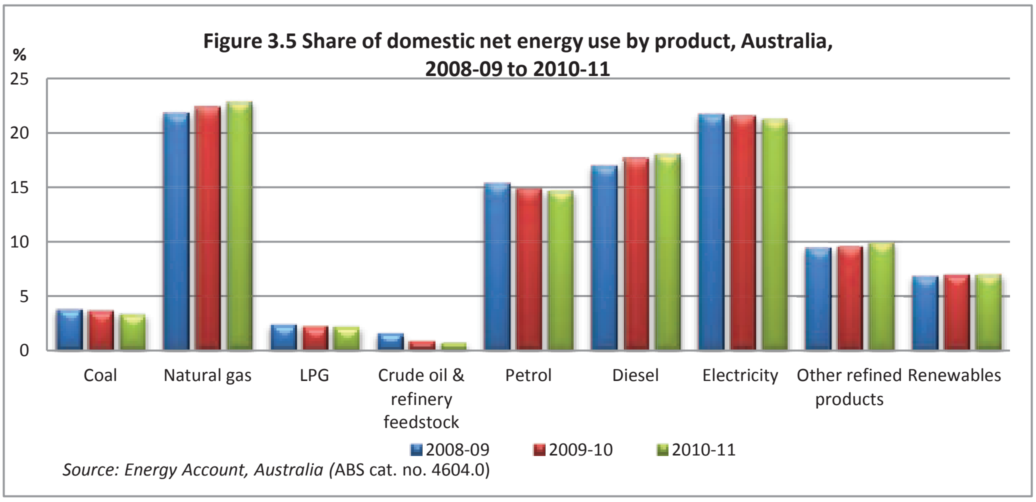
Supply of energy continued

The mining industry remained by far the largest contributor in 2010–11, providing 15,872 PJ or 84% of supply, after a fall of 2% from 2008–09 to 2010–11. Imports of energy increased steadily over the period, from 1,759 PJ in 2008–09 to 2,020 PJ in 2010–11, largely due to rising imports of crude oil and refinery feedstock (60% of imports).

With the exception of the mining industry and imports, most energy supplied is from industries producing energy for their own use. The electricity supply industry extracts its own brown coal as well as hydro and wind energy for producing electricity; manufacturing businesses use their own bagasse[18] and organic waste for heat, electricity or biofuel production; and households extract solar energy for hot water and electricity, as well as self–extracting a portion of their own wood.

Use of energy

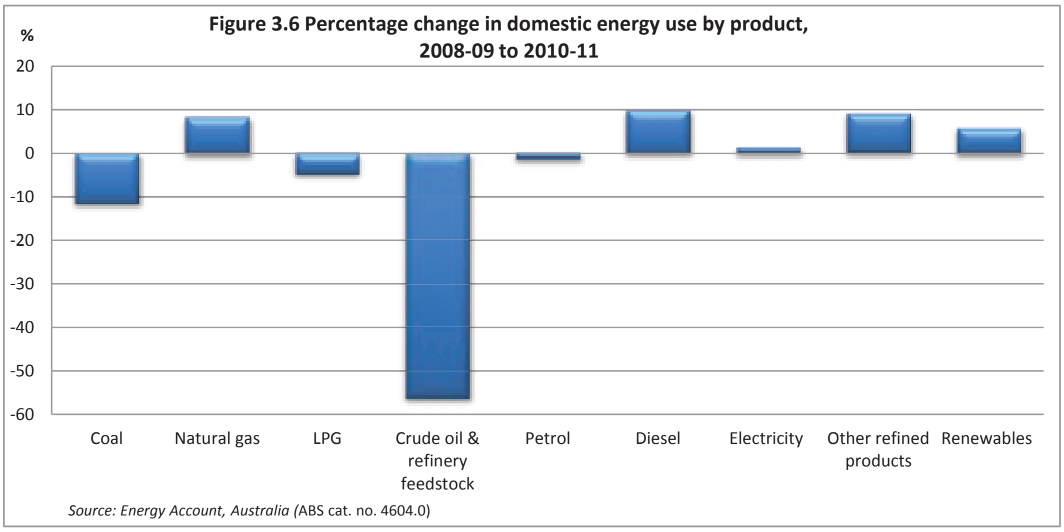
Australia's domestic energy consumption (i.e. industry and household energy use) was 4,120 PJ in 2010–11, an increase of 136 PJ (3%) from two years earlier. The economy grew 5% and the population grew 3% over the same period.



18 Bagasse refers to the dry pulpy residue left after the extraction of juice from sugar cane, which is used as fuel for electricity generators

Use of energy continued

Natural gas and electricity were the two main fuels consumed throughout the period, representing 24% and 22% of net energy use respectively in 2010–11. The decline in petrol's share of consumption from 15% in 2008–09 to 14% in 2010–11 was accompanied by an increase in diesel's share from 16% to 18% over the same timeframe. Net use of crude oil declined due to lower production of non–energy petroleum products such as bitumen, solvents, lubricants and greases.



The respective shares of net energy use for industry and households remained steady at approximately 75% to 25% respectively between 2008–09 and 2010–11. Over this period both Australian industry and households increased their energy use; industry increased by 4% to 3,097 PJ, while households' energy use increased 2% to 1,023 PJ.

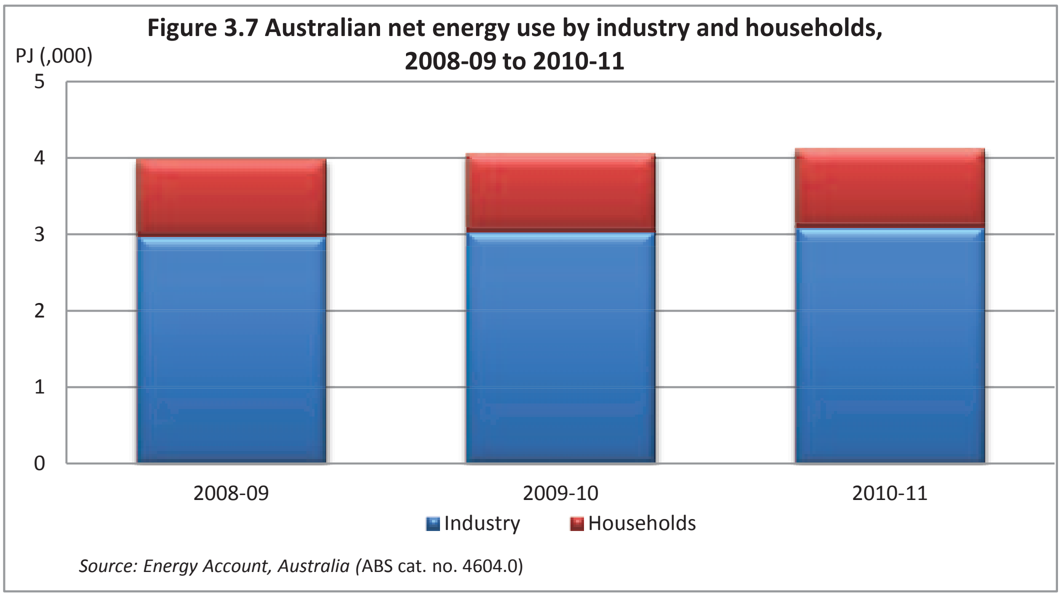
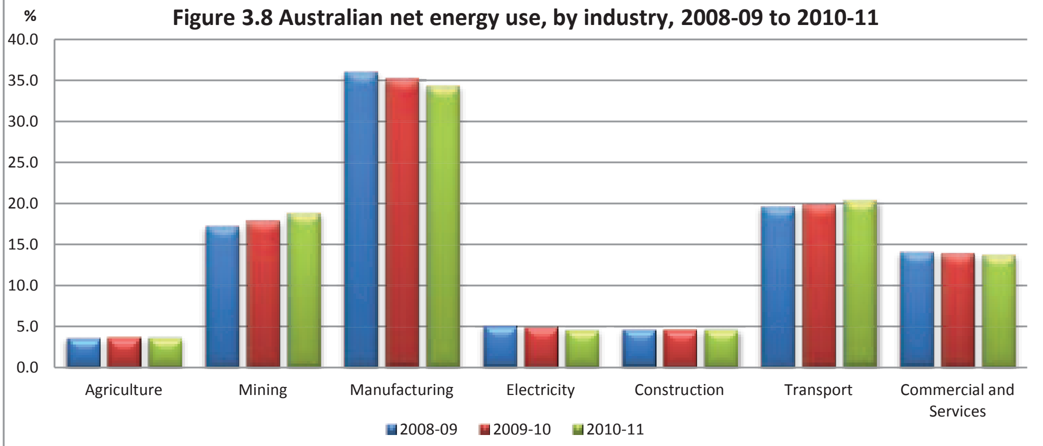


Figure 3.8 presents the share of net energy used in Australia by all industries. While energy consumption by manufacturing has decreased in the three years to 2010–11 it has remained the largest net energy user at 34% of energy consumed by Australian industry.

Figure 3.8 Australian net energy use, by industry, 2008-09 to 2010-11



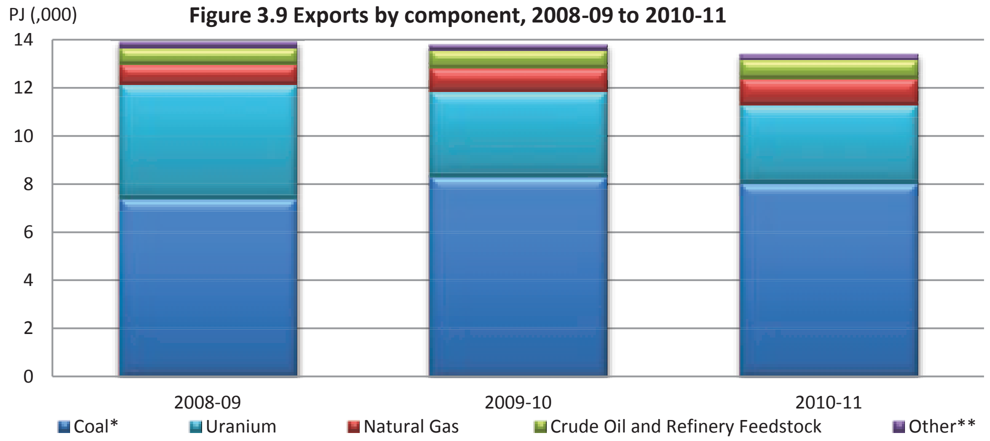
Source: Energy Account, Australia (ABS cat. no. 4604.0)

Use of energy continued

In contrast, both the mining, and transport, postal and warehousing industries marginally increased their share of net energy used by industry between 2008–09 and 2010–11; mining rose from 17% to 19%, while transport rose from 19% to 20%.

The export market is the single largest user of Australian energy products, accounting for 13,392 PJ (79%) of domestic energy extraction in 2010–11.

Figure 3.9 Exports by component, 2008-09 to 2010-11



* Includes black coal, brown coal, briquettes met coke and coal by-products

** Includes petrol, diesel, LPG, other refined fuels and product, electricity and renewables

Source: Energy Account, Australia (ABS cat. no. 4604.0)

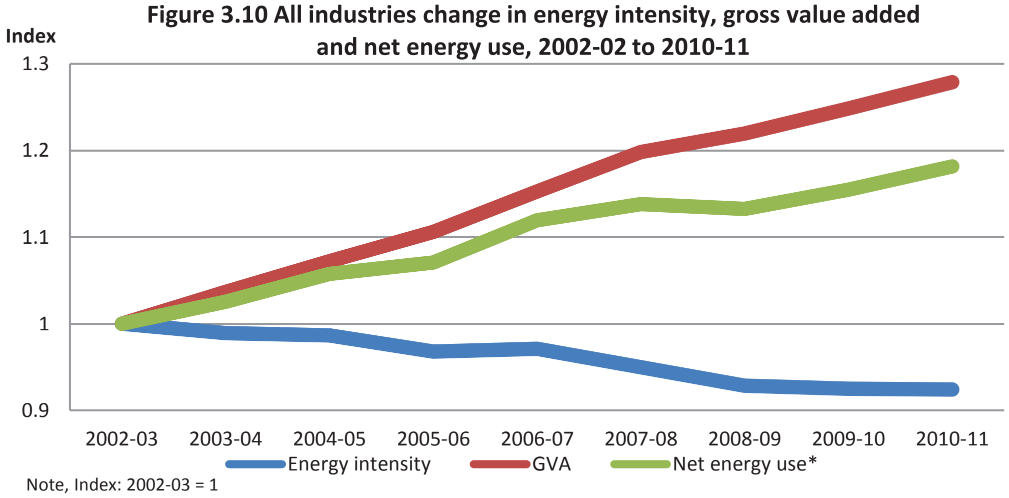
Coal and uranium combined make up the bulk of energy materials exported during 2010–11 (60% and 26% respectively). Natural gas exports rose 30% to 1,086 PJ from 838 PJ between 2008–09 and 2010–11, while crude oil and refinery feedstock exports increased 16% to 788 PJ from 678 PJ over the same period. The decline in total energy was driven by a decline in uranium exports, which fell 31% to 3,267 PJ from 4,754 PJ.

Energy intensity

The energy intensity of industry is the energy consumed to produce one unit of economic output. Energy intensity is measured in PJ of energy consumed per million dollars of GVA[19]. A decline in energy intensity is viewed as an improvement, as it indicates that less energy is used per unit of GVA.

19 ABS gross value added is sourced from the ASNA and is classified according to the Australian and New Zealand Standard Industrial Classification (ANZSIC) 2006.

Figure 3.10 All industries change in energy intensity, gross value added and net energy use, 2002-02 to 2010-11



Note, Index: 2002-03 = 1
* Gas and electricity industries not included
Source: Energy Account, Australia (ABS cat. no. 4604.0), *Australian System of National Accounts* (ABS cat.no. 5204.0)

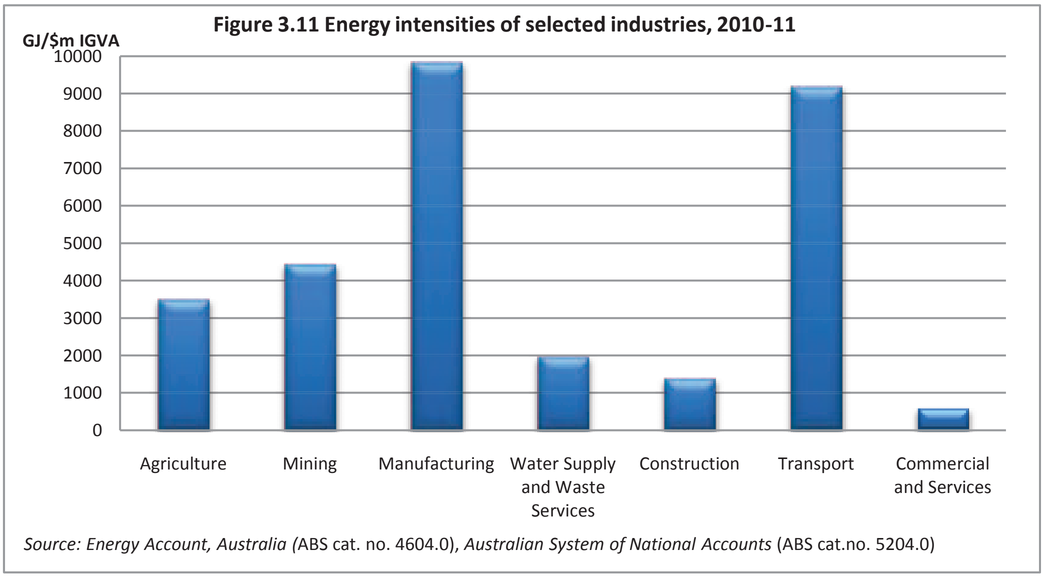
Energy intensity continued

For much of the period since the early 2000s, growth in energy consumption by industry has remained below the rate of economic growth. Over the period 2002–03 to 2010–11, energy consumption by industry grew 18%. In comparison, economic growth as measured by GVA grew by 28%. The 8% decline in the ratio of energy consumption to economic activity in the Australian economy during the same period represents an improvement in energy intensity.

The overall improvement in the energy intensity of Australian industry can be attributed to a number of factors, including energy efficiency improvements associated with technological advancement and structural change in the Australian economy towards less energy–intensive industries such as commercial and financial services.

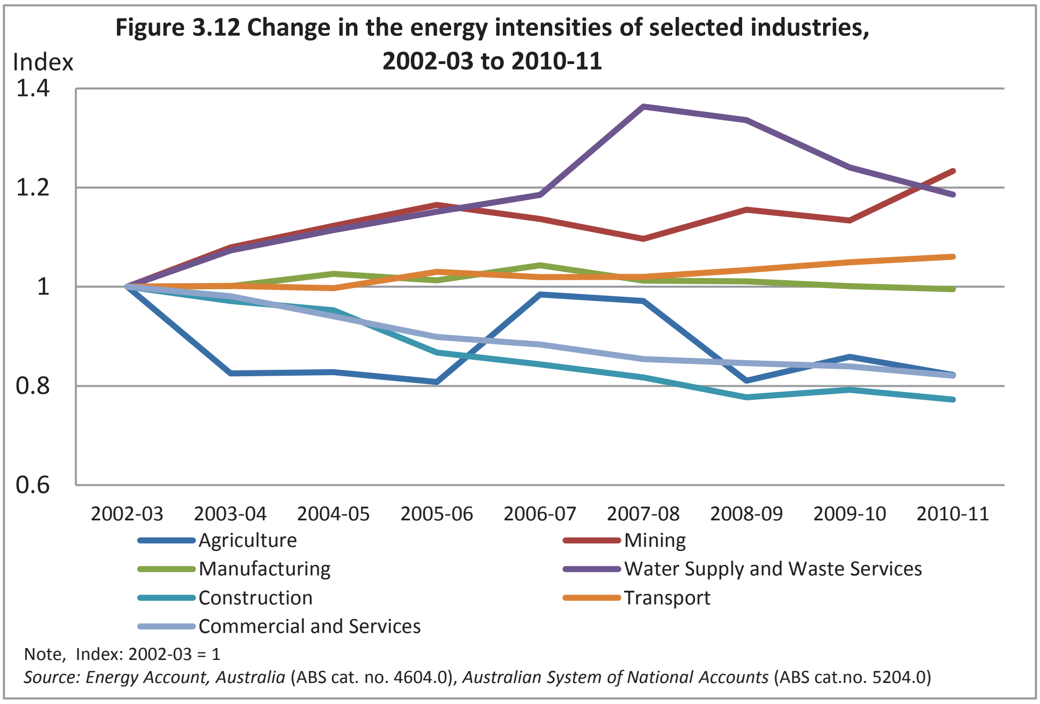
A high energy intensity figure does not necessarily imply that a given industry is using energy inefficiently. Most industries engaged in the physical transformation of raw materials will use more energy than service industries. As such, the differences in energy intensity between industries reflect different production processes and the respective need for energy in that production process.

As Figure 3.11 illustrates, the manufacturing industry is the most energy intensive industry within the Australian economy, followed by transport, postal and warehousing, and mining. The commercial and services industries, which include retail, health and education among others, are non–energy intensive industries.



Energy intensity continued

Figure 3.12 graphs the direction and magnitude of change in the energy intensities of selected industries.



The industries that showed the greatest decrease (i.e. improvement) from 2002–03 to 2010–11 were construction (23%), agriculture (18%) and commercial and services (18%). The increase in energy intensity in 2006-07 for agriculture coincided with severe drought conditions[20], which caused major declines in the volume and value[21] of agricultural production even as energy consumption increased in those years.

20 Coughlan et al., 2003, 'Impacts of 2002–03 El Nino on Australian climate', Bureau of Meteorology, Canberra
21 Value of Agricultural Commodities Produced, Australia, 2010–11 (ABS cat. No. 7503.0)

Energy intensity continued

The energy intensity of the mining, and the water supply and waste industries increased, however, between 2002–03 and 2010–11, recording rises of 23% and 19% respectively. The quantity of material that must be moved and processed is a key factor in the energy consumption of mining a given commodity. Factors likely to have contributed to the long term increase in energy intensity in mining included the compositional change to the industry towards less value added products, such as iron ore.

The energy intensity of manufacturing, Australia's largest industry consumer of energy, remained relatively stable over the 2002–03 to 2010–11 period. Transport, postal and warehousing, the next largest consumer of energy, increased its energy intensity by 6%.

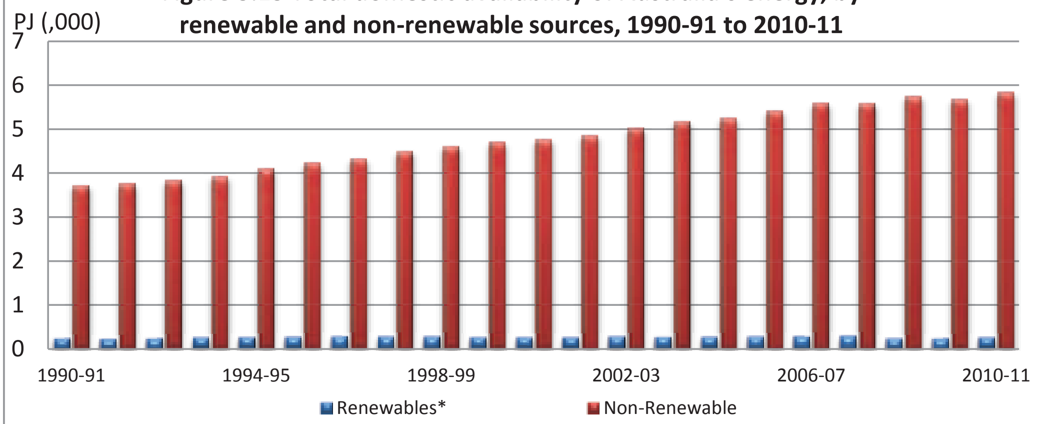
Australia's energy economy

This part of the paper looks at Australia's historical reliance on a carbon energy economy, comparing the use of fossil fuels versus renewables to produce energy in Australia over time. The information contained in the Bureau of Resource and Energy Economics, *Energy in Australia 2012* publication provides data used in this section.

The Australian Government has identified the crucial role technology plays in its efforts to reduce the nation's carbon pollution emissions and is investing more than $5 billion in developing and commercialising clean energy technologies[22]. Renewable energy is an essential part of Australia's low emissions energy mix and is important to Australia's energy sustainability. It plays a strong role in reducing Australia's greenhouse gas emissions, where it can replace higher energy sources, and helping Australia stay on track to meet its obligations set out in the Kyoto Protocol.

Figure 3.13 presents Australia's domestic primary energy supply split by fossil fuel and renewable energy sources. Total primary energy supply (TPES) is a measure of the total energy supplied within the economy and is equal to domestic production plus imports minus exports. TPES includes the supply of both primary[23] and secondary[24] fuels.

Figure 3.13 Total domestic availability of Australia's energy, by renewable and non-renewable sources, 1990-91 to 2010-11



*Includes wood, woodwaste, bagasse, biofuels, hydroelectricity and solar

Source: Bureau of Resources and Energy Economics

22 Department of Climate Change and Energy Efficiency website: http://www.climatechange.gov.au/government/reduce.aspx

23 Primary energy is an energy form found in nature that has not been subjected to any conversion or transformation process

24 Secondary energy refer to sources of energy that results from transformation of primary sources

Australia's energy economy continued

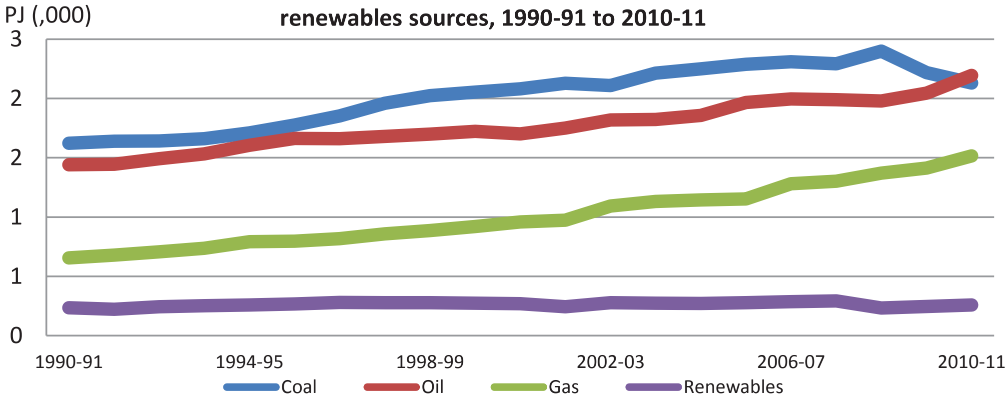
Australia's total domestic primary energy supply was 6100PJ, in 2010–11[25]. As Figure 3.13 shows, the majority of this (96%) came from non–renewable sources, with the remaining 4% sourced from renewables.

Total energy consumption in Australia has increased rapidly over the last two decades, rising 54% from 3,950PJ in 1990–91 to 6,100PJ in 2010–11. This is against the backdrop of a growing economy and population (the economy grew 5% and the population grew 3% over the same period). The growth in the use of fossil fuel energy sources, which increased 57% over this period, has supported the rise in energy consumption. Energy supplied from renewable sources also experienced an increase (9%), although to a lesser degree than fossil fuels, reducing the share of renewables in the total domestic primary energy supply from 6% in 1990–91 to 4% in 2010–11.

Total net energy consumption is a measure of the total energy used within the Australia. While the use of coal was the main energy source for much of the period, it has been surpassed by oil in recent years.

Australian oil consumption increased 52% over the 1900–91 to 2010–11 period. While coal consumption rose significantly over the same timeframe (31%), it fell sharply later in the period (11% between 2008–09 and 2010–11). The use of natural gas recorded the most significant rise over the 20 years to 2010–11, increasing over 230%.

Figure 3.14 Total energy consumption* in Australia, by fossil fuels and renewables sources, 1990-91 to 2010-11



*Total energy consumption in this context is the total quantity (in energy units) of primary and derived fuels consumed less the quantity of derived fuels produced.

Source: Bureau of Resources and Energy Economics

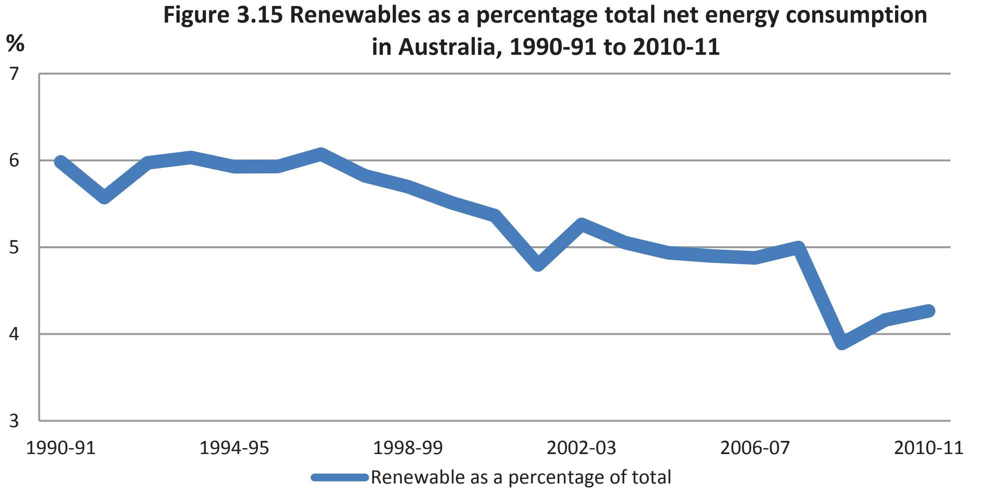
The change in the consumption of energy sourced from renewables was more modest, rising 10% over the period.

Renewables

Although Australia's energy consumption continues to increase, the rate of growth has been slowing in recent years. Energy consumption in Australia increased at 1.8% on average per annum in the 10 years between 2000–01 and 2010–11, compared with 2.2% per annum over the preceding decade.

25 Figure includes energy imports

Figure 3.15 Renewables as a percentage total net energy consumption in Australia, 1990-91 to 2010-11

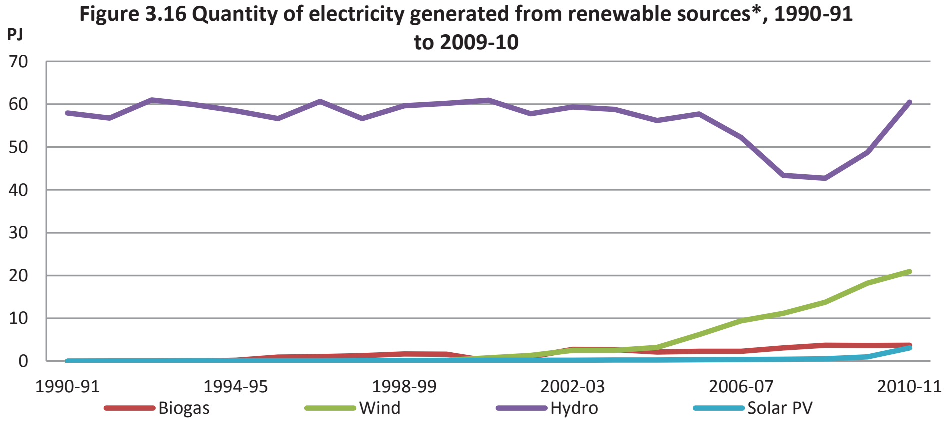


Source: Bureau of Resources and Energy Economics

Renewables continued

In 2010–11, 10% of electricity generated in Australia came from renewable sources. Hydro–power is by far the largest renewable energy source used to generate electricity in Australia, however, the energy source's dependency on water for production leave it sensitive to climate conditions. Between 1990–91 and 2003–04, hydro–power maintained its contribution to electricity generation at approximately 60PJ per annum. An extreme drought over the period 2004–05 to 2009–10, led to a 13% drop in production. Subsequent flood conditions affecting Australia's eastern states during 2010–11 coincided with a 24% recovery.

Figure 3.16 Quantity of electricity generated from renewable sources*, 1990-91 to 2009-10



* Bagasse excluded, due to a break in the data time series
Source: Bureau of Resources and Energy Economics

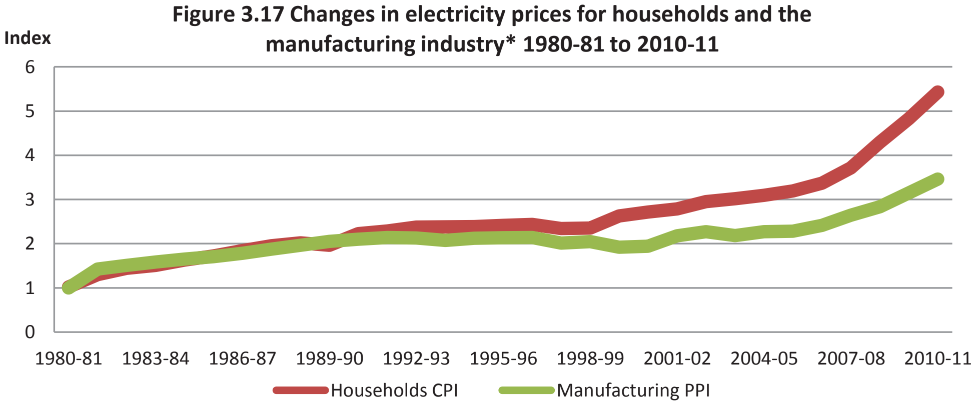
While the amount of electricity production from hydro–power in 2010–11 was largely unchanged from the level at the start of the period (1990–91), the energy source's market share of Australian renewable electricity generation has fallen considerably from 95% of all domestic renewable electricity production in 1990–91 to 66% in 2010–11. This is due largely to the growing influence of other renewable energy sources, particularly energy sourced from wind. Wind power is the second largest renewable energy source for electricity generation; as of 2009–10, it represented 23% of electricity generation from renewables.

Efforts to conserve energy by households and businesses

This section looks at historical electricity prices and efforts by households and businesses to conserve energy.

Retail electricity prices have been increasing at a faster rate in recent years. Figure 3.17 shows the change in electricity prices paid by households and the manufacturing industry between 1980–81 and 2010–11. In the two decades up to and including 2001, electricity prices for households and business rose 171% and 94% respectively, representing an average annual growth rate of 5% for households and 4% for the manufacturing industry in over the period. Since then, electricity prices paid by households and manufacturing have increased at a higher rate over the last 11 years (137% for households and 109% for manufacturing businesses). This equates to an average annual rise of 8% for households and 7% for manufacturing over the 11 year period.

Figure 3.17 Changes in electricity prices for households and the manufacturing industry* 1980-81 to 2010-11

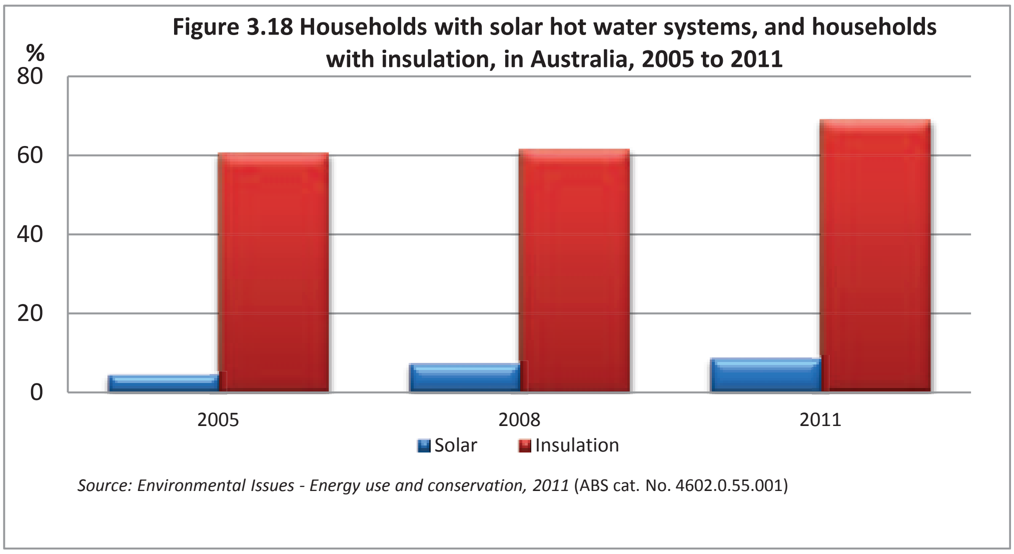


* Manufacturing Producer Price Index has been used due to the availability of data, and predominance of Manufacturing as an industry user of electricity.
Note, Index: 1980-81 = 1
Source: Producer Price Indexes, Australia, (ABS cat. No. 6427.0), *Consumer Price Index* (ABS cat.no. 6401.0)

Rising network charges have been the largest contributor to price rises[26], particularly during the 2007–08 to 2010–11 period. This is partly due to the removal of cross–subsidies from business to household customers in the 1990s[27].

Concerns by Australian households about rising energy costs have contributed to greater attention on ways in which households and individuals can limit their consumption of energy. Various factors influence the attitudes of households when considering energy use practices. In 2011, an estimated 70% of Australian households that installed insulation did so to 'achieve comfort', while more than one in ten (11%) did so because of government rebates[28]. Figure 3.18 presents information taken from the ABS Energy Use and Conservation survey 2011.

26 BREE, Energy in Australia 2012, p.40
27 BREE, Energy in Australia 2012, p.42
28 ABS Energy Use and Conservation survey 2011



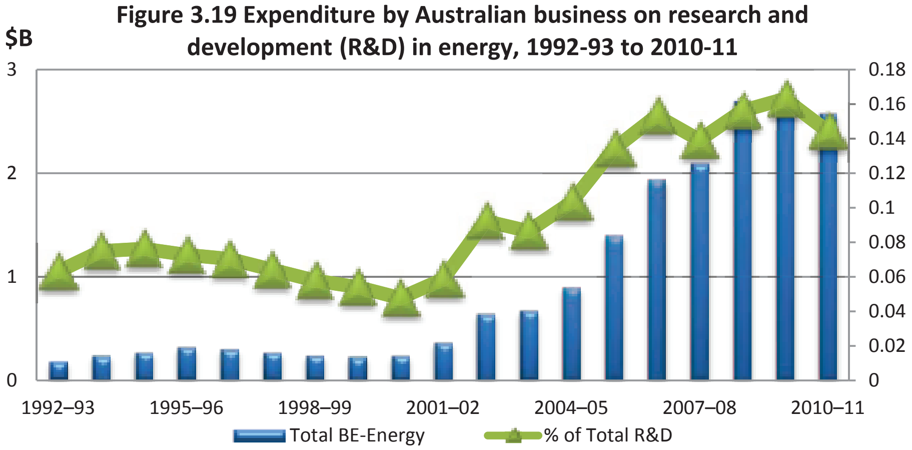
Efforts to conserve energy by households and businesses continued

The majority of Australian households (69%) had some form of insulation in 2011, up from 61% in 2005. At state and territory level, the Australian Capital Territory had the highest proportion of homes with insulation (81%), while the Northern Territory had the lowest (44%).

Solar water heaters use energy from the sun to heat water, which then flows to a storage tank, ready for use by households. Approximately 8% of Australian households used solar powered hot water systems in 2011, up from 4% in 2005. In 2011, the Northern Territory had the highest proportion of households using solar hot water systems (46%) followed by Western Australia (21%). Despite Victoria having the second lowest proportion of households using solar hot water in 2011, the state did record the highest increase in boilers powered by solar, rising 280% over the six years to 2011.

Research and development (R&D) expenditure in energy relates to investment into areas including energy resources (e.g. exploration for and mining of coal, uranium, oil, gas and geothermal energy), preparing and transforming energy resources (e.g. preparing oil and coal and using it to generate electricity) and other aspects of energy (e.g. renewable energy, energy distribution and storage, energy efficiency, waste management, and carbon capture and sequestration).

Figure 3.19 Expenditure by Australian business on research and development (R&D) in energy, 1992-93 to 2010-11



Source: Research and Experimental Development, Businesses, Australia (ABS, cat. No. 8104.0)

Efforts to conserve energy by households and businesses continued

In Australia, most of the R&D in energy is undertaken by private businesses. Business spending on energy related R&D increased at an average rate of 11% a year from 1992–93 to 2009–10. In 2010–11, after a decade of consistent growth, R&D into energy by Australian industry fell slightly to $2.6 billion. This represented around 14% of total business R&D expenditure in 2010–11, up from 5% in 2000–01.

Within the energy related industries, the mining industry was the largest investor in 2010–11, with spending of $1.4 billion or 55% of all business expenditure on energy R&D.

Introduction

The production and use of materials, goods and services have a range of environmental and economic consequences. The generation of waste is one byproduct of economic activity. Government, businesses and households are all involved in waste generation and waste managementî Waste management includes the provision of waste services – such as the recovery of materials, recycling, disposal to landfill, and the Ěaste Ñanagement āervices ĺndustry[29] is the primary provider of these services. However, government, businesses and households all play an active role in reducing, reusing, recovering and recycling materials, or paying others to recover or dispose of unwanted materials.

Australia's National Waste Policy was released in November 2009. The purpose of the policy was to set a "clear direction for Australia over the next 10 years, toward producing less waste for disposal, and managing waste as a resource to deliver economic, environmental and social benefits."[30]

Aims of the policy include avoiding the generation of waste, reducing the amount of waste going to landfill (including hazardous waste), managing waste as a resource and ensuring that waste management, disposal, recovery and re–use are undertaken in a safe, scientific and environmentally sound manner.

These policies address economic, environmental and social issues, and are in synergy with other environmental themes such as climate change, water, energy efficiency and land productivity.

Waste Account, Australia, Experimental Estimates (WAAEE)

The ABS, in consultation with a range of stakeholders, has developed an experimental waste account within the SEEA framework. The results are experimental and are published in WAAEE (ABS cat. no. 4602.0.55.005).

The WAAEE allows the relationship between Australia's economy and the environment to be further explored by integrating conventional socio–economic data with measures of environmental pressure.

In this chapter 'waste' includes 'solid waste' only and is defined as discarded materials that are no longer required by the owner or user. The unit discarding the material may or may not receive payment for it, but it excludes second hand products for which the product is used again for the same purpose for which it was conceived.

Figure 4.1 illustrates the cycle of waste through generation and management activities. Much of the waste management activities provide inputs to further production.

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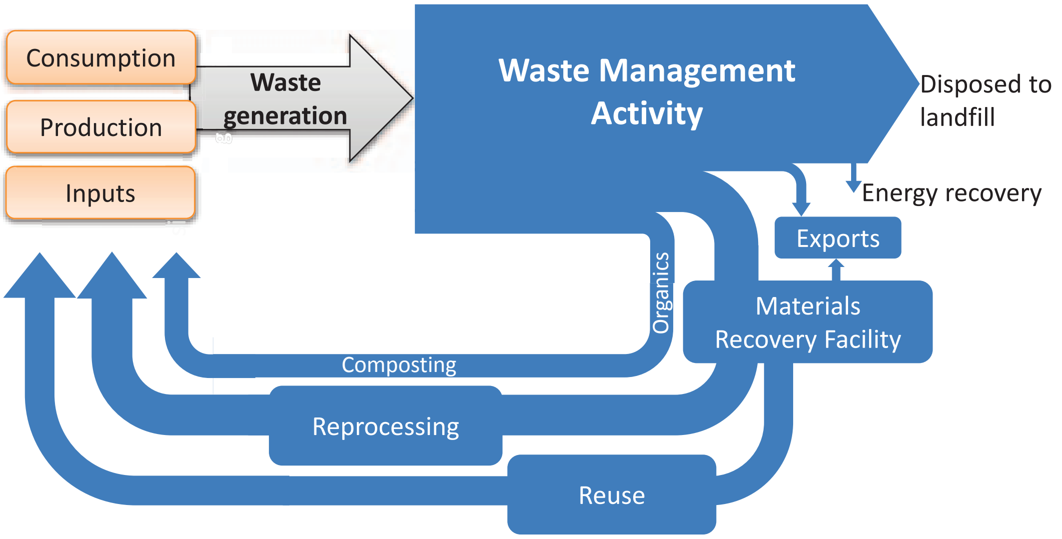
29 The ABS defines the Waste Management Industry as those businesses whose primary activity is provision of waste services; some businesses with other primary activities (e.g. construction) also provide waste services

30 National Waste Policy 2010. Department of Sustainability Environment Water Population and Communities

Figure 4.1 Waste generation and flow through the economy



Introduction continued

This physical and monetary integration of waste data enables analysts to examine the economic and social drivers and pressures linked to physical changes. The WAAEE complements the National Waste Report[31] and assists in analysing the effectiveness and impact of waste policies, particularly from an economic perspective.

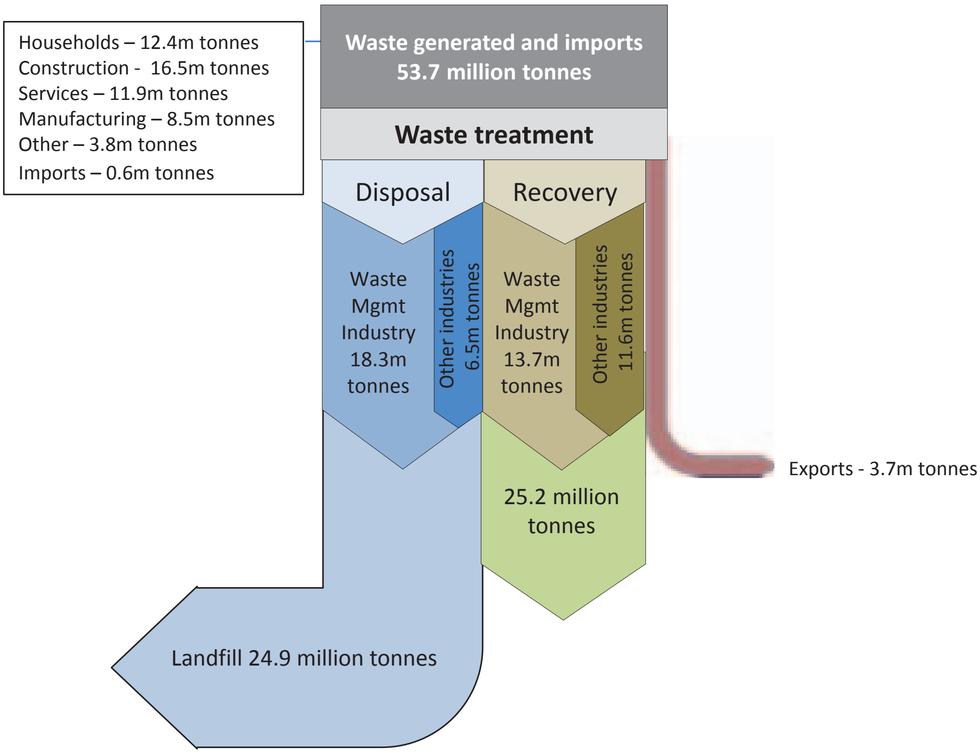
The rest of this chapter outlines the physical and monetary flows of waste in Australia in 2009–10.

Physical flows of waste

Waste supply and use tables in the account present aggregates of all available physical data (tonnes) in terms of the supply and use of solid waste. Figure 4.2 illustrates the physical flows of waste in Australia.

31 Environment Protection and Heritage Council, 2010. National Waste Report. Online: http://www.ephc.gov.au/sites/default/files/WasteMgt_Nat_Waste_Report_FINAL_20_FullReport_201005_0.pdf

Figure 4.2 Physical flow of waste in Australia, 2009-10



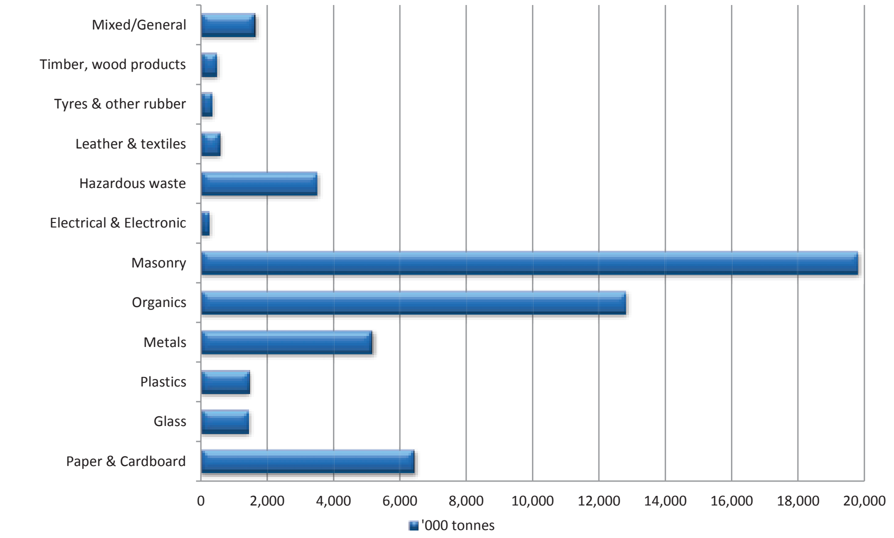
Source: WAAEE (ABS cat. no. 4602.0.55.005)

Waste generation (supply)

Figure 4.2 shows that a total of 53.1 million tonnes of waste was generated in Australia in 2009–10, and a further 0.6 million tonnes was imported. The construction industry contributed the most waste to this total, at 16.5 million tonnes. Households were the next biggest contributor at 12.4 million tonnes, followed by services industries, generating 11.9 million tonnes.

Of this generated and imported waste, 24.9 million tonnes was disposed to landfill, while 25.2 million tonnes of waste was recovered domestically and 3.7 million tonnes was exported.

Figure 4.3 Total supply of waste (generated plus imports), by waste material, Australia, 2009-10

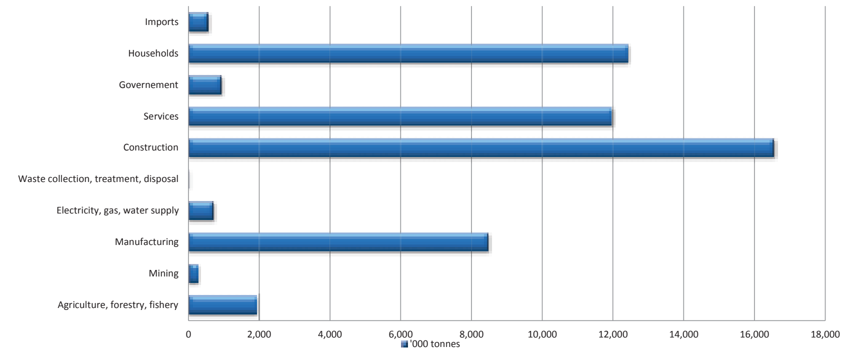


Waste generation (supply) continued

Masonry materials accounted for the largest volume of waste generated by the Australian economy in 2009–10 (37% or 19.8 million tonnes). Over 71% of this was generated by the construction industry, with a further 19% generated by the services industries. The next largest waste type generated by volume was organics (12.8 million tonnes in 2009–10). This includes food waste. Households are the single largest contributor to this waste type (46%), followed by services (26%), manufacturing (13.4%) and agriculture, forestry and fishing (13.7%)

Other major contributions to total waste generation were paper and cardboard (6.4 million tonnes) and metals (5.1 million tonnes). Households contributed 45% of the paper and cardboard waste stream, and manufacturing was responsible for nearly half (49%) of the total metals waste stream.

Figure 4.4 Total supply of waste (generated plus imports), by industry, government and households, Australia, 2009 -10



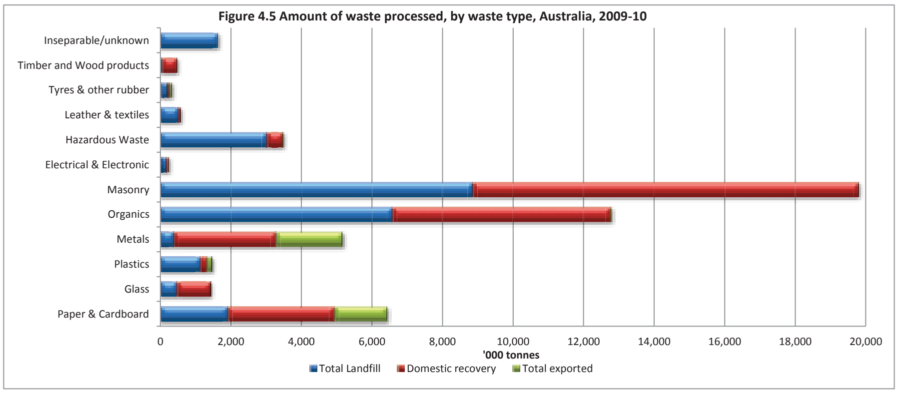
The construction industry generated 16.5 million tonnes of waste in 2009–10, with 14.1 million tonnes of this being masonry waste. This includes both the waste from the construction of new structures, and the waste generated from pulling down, gutting or modifying existing structures. Households generated 12.4 million tonnes of waste in

Waste generation (supply) continued

2009–10, more than 70% of which was made up of organics (47%) and paper and cardboard waste (23%).

Services is a large and diverse group of industries, including accommodation, arts and recreation and finance and insurance. Masonry and organics are the top two waste types by tonnage, and they accounted for just under 60% of the total waste generated by the services group in 2009–10.

Waste management (use)

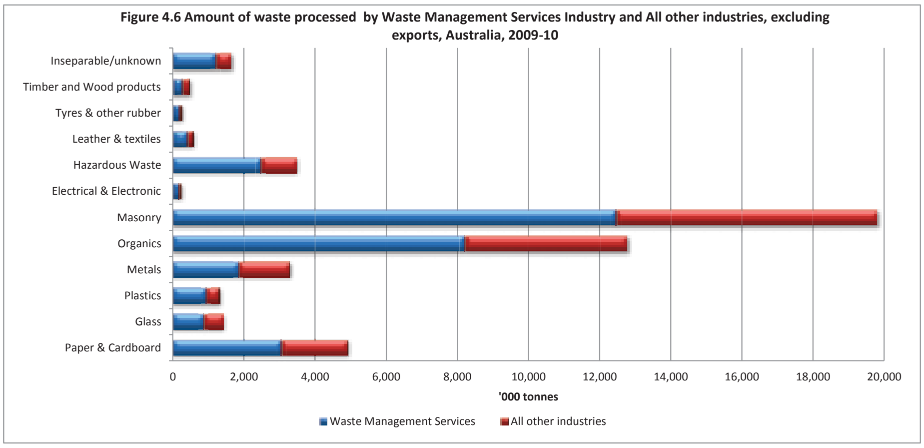


Different waste types showed very different profiles of use, or treatment.

The most recovered type of waste by weight was timber and wood products, 91% of which was recovered. Other waste types that were recovered included glass (67%); masonry (55%); organics (48%); and paper and cardboard (47%).

Some waste types are considered to be too costly or difficult to recover and this was especially evident with inseparable/unknown waste, with nearly all of it being sent to landfill in 2009–10. 501,000 tonnes (or 88%) of leather and textiles were sent to landfill, along with 3 million tonnes (86%) of hazardous waste and 1.1 million tonnes (77%) of plastic waste. While more than half of all masonry waste was recovered, 8.8 million tonnes (45%) of masonry waste was sent to landfill, the largest tonnage of all waste types.

A higher percentage of metals (36%) and paper and cardboard (23%) waste types were exported while masonry; electrical and electronic; leather and textiles; and timber and wood products waste were not exported at all.



Waste management (use) continued

The waste management services industry processes the majority of Australian waste (60%), but industries outside of the waste management services industry also played a major role, and were responsible for disposing or recovering 34% of Australia's waste in 2009–10. The remaining 7% of waste was exported. Of the 25 million tonnes of waste recovered domestically, 46% was recovered by businesses outside the waste management services industry.

Those waste types more likely to be processed outside the waste management services industry were (by weight) metals (44%); timber and wood products (44%); glass (39%); paper and cardboard (38%); masonry (37%) and organics (36%).

Monetary flows

The above explores the physical supply (generation) of waste in Australia, and the use (management) of this waste. These physical flows also have accompanying monetary flows. A Waste Account for Australia also explores these related monetary flows, adding value to understanding the entire picture of waste generation and management in Australia.

In summary, monetary supply and use tables for waste show:

- the supply of waste goods and services by industry ($m); and
- the use of waste goods and services by industry, government and households ($m).

Businesses (and government) supply (provide) waste management services which are used (consumed) by other businesses, government and households. Waste management services include income from a range of services relating to waste management including collection, transport, recycling, treatment, processing or disposal of waste.

Monetary flows for waste are complicated by the fact that some waste has a positive value. When the owner/discarder of the waste material receives an income for the waste, these goods are termed a waste product. These waste products are also supplied to the economy.

Table 4.1 shows the value of both waste management services, and waste products, for Australia for 2009–10.

Table 4.1 Supply of Waste Goods and Services by Industry 2009-10, $m (purchasers' prices)

	Industry output at basic prices									
		Other Industries								
	Waste Management Services(a)	Agriculture	Mining	Manu-facturing	Con-struction	Wholesale	Retail	Transport, Postal & Warehousing	All other service industries	Total supply at purchasers' prices
	$m	$m	$m	$m	$m	$m	$m	$m	$m	$m
Waste management services for:										
Non-recyclables	6,424	0	60	58	609	2	0	131	257	7,539
Recyclables	1,238	0	68	113	139	180	11	160	74	1,981
Total waste services	**7,662**	**0**	**127**	**170**	**748**	**182**	**11**	**291**	**331**	**(b)9,595**
Total waste products(c)	**2,232**	**34**	**225**	**723**	**114**	**547**	**550**	**0**	**48**	**(d)4,582**

(a) Includes Public Trading Enterprises and Local Government Authorities.
(b) Includes $74m of "taxes less subsidies on products".
(c) Income from sales of recyclable/recovered material. This is entirely comprised of trade and transport margins since these materials are considered to have been purchased at negligible cost.
(d) Includes $67m of imports.

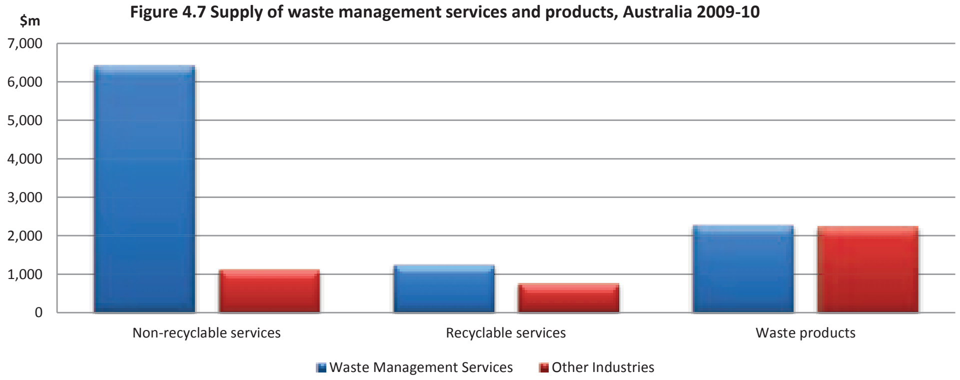
Monetary flows continued

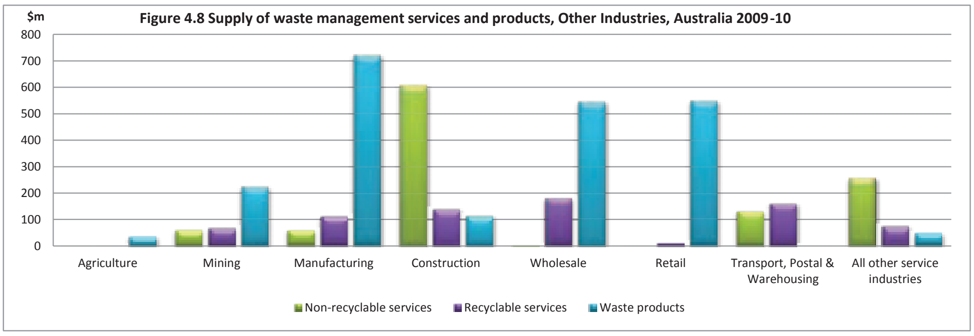
In 2009–10, the supply of waste management services was valued at $9,595m. The waste management services industry (including local government authorities) provided the majority (81%) of these services (mostly for non–recyclables waste services (Figure 4.7)). The remaining 19% of waste management services were provided by other (non–waste management) industries. A large proportion of this (40% or $748m) was provided by the construction industry (Figure 4.8).

In contrast, of the total value of waste products (recyclable/recoverable material) supplied to the economy in 2009–10 ($4,582m), half of this amount was provided by non–waste management businesses (Figure 4.7).

Over 80% of waste products supplied by non–waste management businesses came from three industries – manufacturing ($723m); retail ($550m); and wholesale ($547m) (Figure 4.8).

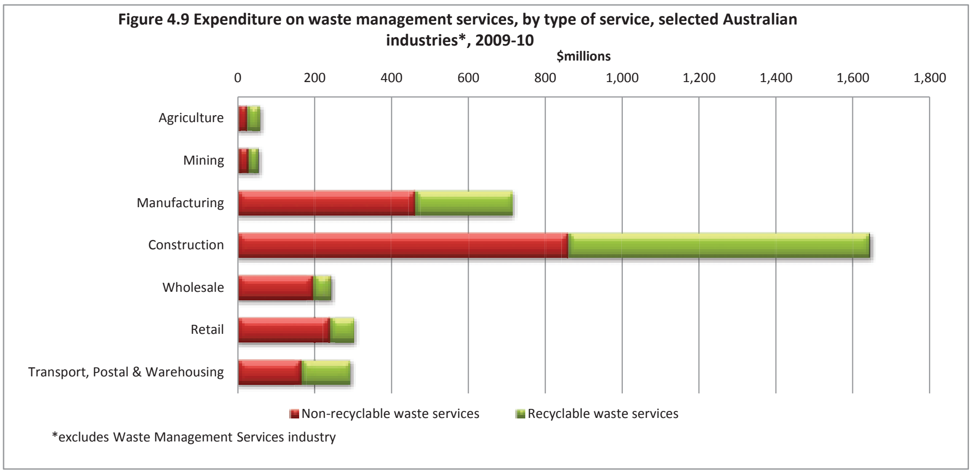
Figure 4.7 Supply of waste management services and products, Australia 2009-10





Monetary flows continued

Households spent $1.6 billion on waste management services which equates to $196 per household. Industry (including the waste management services industry) accounted for 83% of expenditure on waste management services in 2009–10 in Australia.



In 2009–10 the construction industry spent $1.64 billion or 1.7% of its GVA, on waste management services. This compares with less than 1% spent by all other industry divisions. Mining spent the least at 0.05% of GVA, or $52 million (excluding mineral waste).

Overall, 70% of all expenditure on waste management services was spent on non–recyclable services, with the remaining 30% spent on recyclable services. The proportion spent on the two types of services varied by industry. The wholesale industry spent the highest proportion of their total waste management services expenditure (81%, $194 million) on non–recyclable services and the agriculture industry spent the highest proportion (60%, $34 million) on recyclable services.

This chapter commences with an overview of those policy initiatives within Australia's Clean Energy Future program that are designed to reduce atmospheric GHG emissions. It then outlines how environmental–economic accounts can influence the design and operation of these policy initiatives and how SEEA–style accounts can inform the ongoing assessment of the impact of policy on biophysical phenomena and on economic performance. The chapter describes various policy questions related to GHG emissions that are potentially informed by ABS environmental–economic accounts, and follows this with examples of data currently produced by the ABS to provide a brief commentary on Australia's progress against its GHG emissions objectives. One particularly valuable form of analysis examines GHG emissions required to satisfy final demand for goods and services, so that for example, cumulated emissions from the manufacture of food products, including from agricultural production, manufacturing processes, transport and retailing, is attributed to the final consumer using data and structures embodied in ABS Input–Output (I–O) tables. Finally, this chapter describes SEEA–style carbon stock accounts, which support an understanding of GHG emissions within the context of a broader carbon stock accounting framework.

Introduction

The Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Bureau of Meteorology[32], and Academies of Science from around the world[33] have advised that the world is warming and high levels of carbon pollution risk environmental and economic damage.

The Intergovernmental Panel on Climate Change (IPCC) define climate change as: 'a statistically significant variation in the mean state of the climate or its variability, persisting for an extended period (typically decades or longer)'[34]. Climate change is caused by increases in the total stock of greenhouse gases in the atmosphere. In 2009, the six greenhouse gases measured by the accounting rules of the Kyoto Protocol reached a global level of 439 parts per million (ppm) CO_2–equivalent[35], an increase of 160 ppm compared to pre–industrial levels.

Australia has adopted a range of responses to climate change[36]. The first pillar of Australia's response is to reduce Australia's GHG emissions and, in order to meet this objective, the Australian Government is developing and putting in place relevant policies through its Clean Energy Future program.

32 E.g. CSIRO/Bureau of Meteorology, 2010. State of the Climate. Online: http://www.bom.gov.au/announcements/media_releases/ho/stateClimate2012.pdf; H. Cleugh, M. Stafford Smith, M. Battaglia and P. Graham, 2011. Climate Change: science and solutions for Australia. CSIRO Publishing, Collingwood. Online: http://www.publish.csiro.au/Books/download.cfm?ID=6558

33 E.g. National Research Council of the National Acadamies, 2009. Restructuring Federal Climate Research to Meet the Challenges of Climate Change, National Academy of Sciences, Washington D.C. Online: http://www.nap.edu/chapterlist.php?record_id=12595&type=pdf_chapter&free=1; Royal Society, 2010. Climate Change: a summary of the science. Online: http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2010/4294972962.pdf Royal Society, 2009. Preventing Dangerous Climate Change: The need for a global agreement. Online: http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2009/4294969306.pdf

34 Intergovernmental Panel on Climate Change (IPCC), Working group II: Impacts, Adaption and Vulnerability Online: http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=663

35 Different greenhouse gases have different effects on the climate system. A greenhouse gas equivalent measure (CO_2 equivalent) is used to enable aggregation.

36 Australian Government, 2012. Working together for a Clean Energy Future. Online: http://www.cleanenergyfuture.gov.au/. Accessed 4 April 2012.

Australia's Clean Energy Future policies

The objectives of the Clean Energy Future program are to "…support Australian businesses and households reduce their carbon pollution, to create the new green–collar jobs of the future and to transform our economy."[37]

The Clean Energy Future policies aim to achieve this through:

- introducing a carbon pricing mechanism;
- promoting innovation and investment in renewable energy;
- encouraging energy efficiency; and
- creating opportunities in the land sector to cut pollution.

Greenhouse gas emissions and the Australian economy

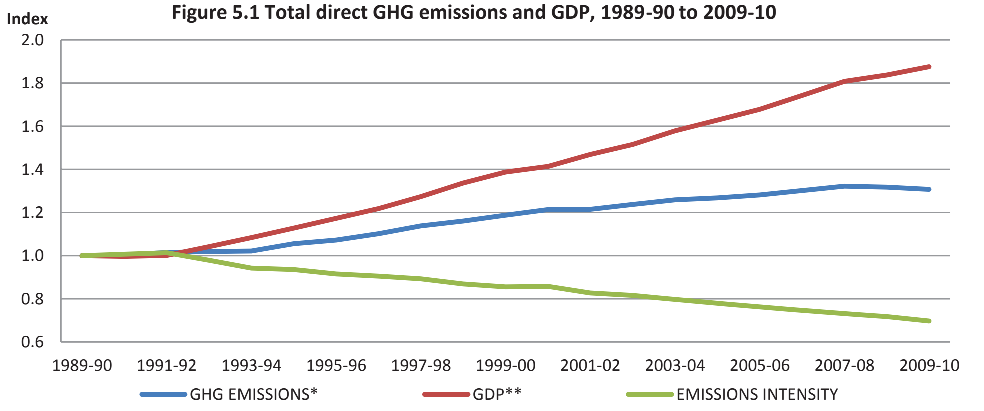
A carbon pricing mechanism is the first element of the Government's plan for a clean energy future, and is designed to trigger a broad transformation of the economy by breaking the link between emissions and economic growth.

Figure 5.1 shows that total greenhouse gases (carbon dioxide, methane, nitrous oxides and fluorinated gases) in Australia, excluding changes due to land use and land use change and forestry (LULUCF), increased by 24% between 1989–90 and 2009–10[38,39]. During the same period, economic activity as measured by GDP increased by 88%.

As mentioned in chapter one, the phenomenon where the economy grows at a rate faster than the related pollution is known as decoupling. This can be caused either by structural change in the economy (for instance, where the generally lower–emitting service industries have grown more strongly than higher emitting industries) or by the adoption of technological innovations by businesses or by a combination of both.

In the case of Australia, the decoupling is relative, as GHG emissions are increasing but at a lower rate than economic activity (as measured by GDP).

Figure 5.1 Total direct GHG emissions and GDP, 1989-90 to 2009-10

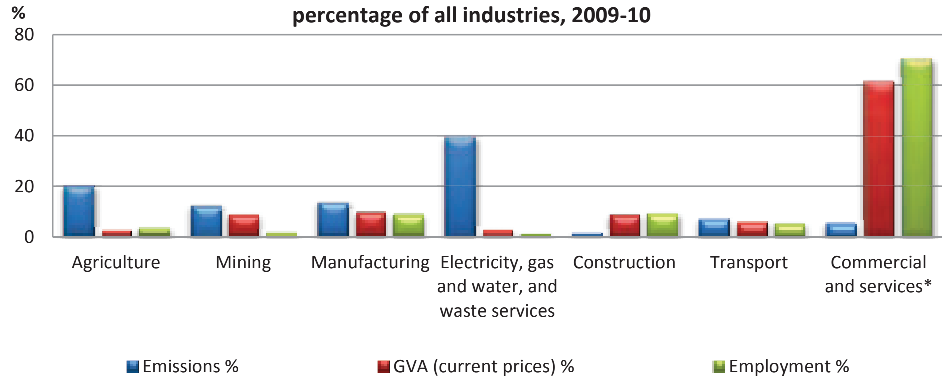


Sources: Department of Climate Change and Energy Efficiency; Australian System of National Accounts (ABS cat.no. 5204.0)

Figure 5.2 presents data on GHG emissions, labour force and economic production by industry[40].

37 Department of Climate Change and Energy Efficiency (DCCEE), 2012. Reducing Australia's Emissions. Online: http://www.climatechange.gov.au/government/reduce.aspx. Accessed 4 April 2012.
38 Based on data published by DCCEE. However, since estimates for LULUCF are available only for the most recent years, time series data contained in figure 5.1 exclude LULUCF in order to maintain a consistent series.
39 DCCEE inventories of GHG emissions are reported on a territory basis. Data in figure 5.1 have been adjusted onto a residence basis to support their full integration with various economic data.
40 Net CO_2 released from LULUCF is included in Kyoto Protocol data from 2007–08 onwards and has been included in the estimates contained in figure 5.2.

Figure 5.2 GHG emissions, GVA and employment for selected industries, percentage of all industries, 2009-10



*Commercial Services covers ANZSIC Divisions: F. Wholesale and G. Retail Trade; H. Accommodation; P. Food Services; Q. Education and Health Services; J. Information Media and Telecommunications; K. Finance and Insurance Services; and L. Rental, Hiring and Real Estate Services

*Sources: Department of Climate Change and Energy Efficiency; Australian System of National Accounts (*ABS cat.no. 5204.0*); Labour Statistics in Brief, Australia, 2012* (ABS cat. no. 6104.0)

Greenhouse gas emissions and the Australian economy continued

In 2009–10, the electricity, gas, water and waste services industry had the highest GHG emissions of any industry[41], followed by the agriculture, forestry and fishing industry and manufacturing (see figure 5.2). These three industries together accounted for 74% of emissions, but only 15% of total gross value added and 14% of employment in the Australian economy. Conversely, the commercial and services industries[42] accounted for 70% of all employment and about 62% of gross value added, but only 5% of emissions (see figure 5.2). However, these and other industries, as well as households, can be seen as indirectly responsible for the emissions of the electricity industry.

In view of this, various techniques have been used to apportion emissions from electricity generation to the industries using electricity, since the electricity produced is ultimately consumed by industries and households. This has been done using the National Inventory by Economic Sector Gas Accounts produced by Department of Climate Change and Energy Efficiency (DCCEE). This work is described below under 'Greenhouse gas induced by final demand'.

Greenhouse gas induced by final demand

The measure of greenhouse gas directly emitted by Australian industries and households and the changes in emissions levels over time is a key element of the data used in developing and evaluating policy. This measure is often referred to as the production approach as it measures emissions that occur directly from Australian production and directly from Australian households (e.g. the combustion of fossil fuels in private vehicles).

It is also possible to look at emissions occurring through the final consumption of goods and services by Australian households and governments. For example, the cumulated emissions from the production of manufactured food products, including from agricultural production, manufacturing processes, transport and retailing, is attributed to

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41 Data from the DCCEE National Inventory by Economic Sector provided the basis for estimates of GHG emissions produced by industry in Australia.

42 The 'Commercial and services' industries are comprised of the following Australian and New Zealand Standard Industrial Classification (ANZSIC) industry Divisions: Wholesale Trade; Retail Trade; Accommodation and Food Services; Information Media and Telecommunications; Financial and Insurance Services; Rental, Hiring and Real Estate Services; Professional, Scientific and Technical Services; Administrative and Support Services; Public Administration and Safety; Education and Training; Health Care and Social Assistance; Arts and Recreation Services; and Other Services.

Greenhouse gas induced by final demand continued

the final consumer. This shifts the focus of the analysis to the demand–side, that is, to the emissions required to satisfy final demand, including emissions embodied in imports and exports. Ultimately, industries exist to satisfy final consumption in Australia and abroad. The international transfer of environmental burdens by a country can be understood by considering its environmental balance of trade.

Figure 5.3 illustrates the relationship between the production and consumption approaches to measurement of GHG emissions.

Figure 5.3 Production and consumption approaches to GHG measurement*

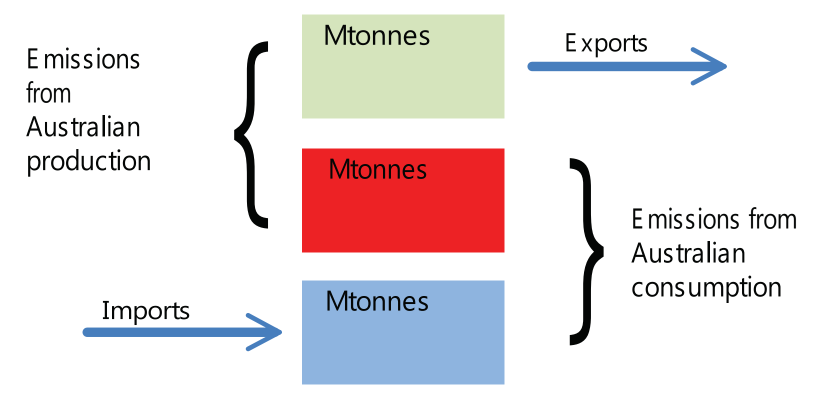


*Diagram based on Swedish Environmental Protection Agency report 5992, 2010. The climate impact of Swedish consumption.

The ABS has developed experimental estimates that identify and measure emissions according to the consumption approach using environmentally extended input–output analysis. This analysis shows how much greenhouse gas emissions are produced by Australian resident businesses and households; how much of these emissions are associated with goods and services leaving the country through exports; how much emissions are generated elsewhere through imports; and how much emissions are occurring both nationally and internationally in order to meet the demands of Australian consumption.

Figure 5.4 presents the direct and indirect emissions induced by final demand category for 2008–09. These experimental estimates show that of the 759 Mt of GHG emissions induced by the Australian economy, 531 Mt (or 70%) were induced to satisfy domestic final demand, while 228 Mt (or 30%) of GHG emissions were induced by exports. Approximately 90% of emissions induced under the mining category (and 41% of emissions induced under the manufacturing category) are induced by exports. In 2008–09, mining and manufacturing were the two most significant contributors to total GHG emissions induced by exports from Australia.

Of total emissions induced by categories of final use, 45% related to household final consumption expenditure (mainly through 'manufacturing–food, beverages and tobacco', 'electricity, gas, water and waste services' and 'commercial and other services').

FIGURE 5.4 Experimental estimates of direct and indirect GHG emissions induced by categories of final demand (MT): 2008–09

	Household final consumption	Government final consumption	Investment and change in inventories	Total domestic use	Exports	Total use
Direct and indirect emissions -						
Agriculture, forestry and fishing	13	0	5	19	37	56
Mining	2	0	5	7	68	75
Manufacturing						
Food, beverages and tobacco	43	0	1	45	27	72
Textile, Wood, paper and printing	6	0	1	7	1	8
Petroleum, coal and chemical products	15	2	2	19	12	31
Non-metallic mineral products	1	0	0	1	0	1
Metal products	1	0	3	4	43	47
Machinery and equipment	17	0	34	51	6	57
Total manufacturing	83	2	41	126	90	217
Electricity, gas, water and waste services	76	0	19	95	0	95
Construction	0	0	60	60	0	60
Transport						
Road	5	1	1	6	4	10
Other transport	19	3	0	23	15	38
Total transport	24	3	1	29	19	48
Commercial and services	101	36	13	150	13	162
Total direct and indirect emissions by Final use category	**299**	**42**	**144**	**485**	**228**	**712**
Direct Emissions by households	46			46		46
Total direct and indirect emissions Australia	**345**	**42**	**144**	**531**	**228**	**759**

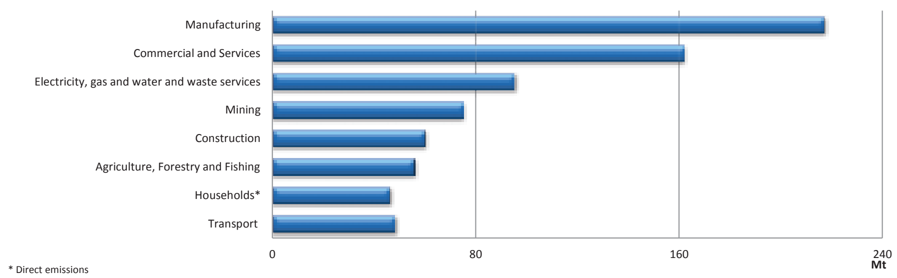
Greenhouse gas induced by final demand continued

While figure 5.4 provides a summary of the data results from this modelling exercise, the following figures each aim to draw out particular elements of the summary data.

Figure 5.5 shows the induced emissions by final demand according to the industry producing the final demand products. The most significant contributors are the manufacturing, and commercial and services[43] industries.

43 The 'Commercial and services' industries are comprised of the following ANZSIC industry Divisions: Wholesale Trade; Retail Trade; Accommodation and Food Services; Information Media and Telecommunications; Financial and Insurance Services; Rental, Hiring and Real Estate Services; Professional, Scientific and Technical Services; Administrative and Support Services; Public Administration and Safety; Education and Training; Health Care and Social Assistance; Arts and Recreation Services; and Other Services

Figure 5.5 Experimental estimates of GHG emissions induced by final demand, by industry, 2008-09



* Direct emissions
Source: ABS Input-Output modelling of GHG emissions induced by categories of final demand

Greenhouse gas induced by final demand continued

Note that emissions induced by final demand relate only to those emissions associated with the final consumption expenditure of households and governments, and of gross capital formation and exports. It includes emissions embodied in intermediate inputs but excludes the emissions associated with that industry output subsequently consumed as an intermediate input by other industries. For example, the total emissions produced by the electricity generation industry are much larger than emissions induced by its final demand. This is because much of the output of the electricity generating industry is consumed as an intermediate input by other industries and therefore recorded as part of emissions induced by these other industries. Similarly, the transport industry records induced emissions that are less than the total emissions produced by this industry. Direct emissions by households relates to emissions arising from households' transport activities, combustion of gas for heating and petrol used for lawn mowers, etc.

Figure 5.6 provides a breakdown of GHG emissions induced by final demand for various manufacturing products. Typically, domestic demand is the main driver of induced GHG emissions across the various manufacturing industries – the notable exception is the manufacture of metal products[44] which reports a large proportion related to exports. The observations shown in figure 5.6 are consistent with Australia's export profile.

Figure 5.6 Experimental estimates of GHG Emissions embodied in Manufacturing Products (Mt), 2008-09

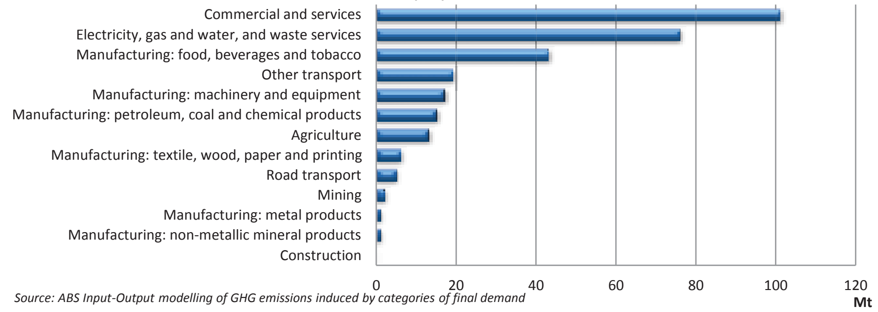
Source: ABS Input-Output modelling of GHG emissions induced by categories of final demand

44 'Manufacture of metal products' is the sum of the following ANZSIC Subdivisions: Primary Metal and Metal Product Manufacturing; and Fabricated Metal Product Manufacturing

Greenhouse gas induced by final demand continued

Figure 5.7 reveals that for induced GHG emissions for household final consumption the highest induced emissions for 2008–09 relate to goods and services produced by the commercial and services industry (101 Mt); electricity, gas, water and waste services (76 Mt); and food, beverage and tobacco product manufacturing (43 Mt).

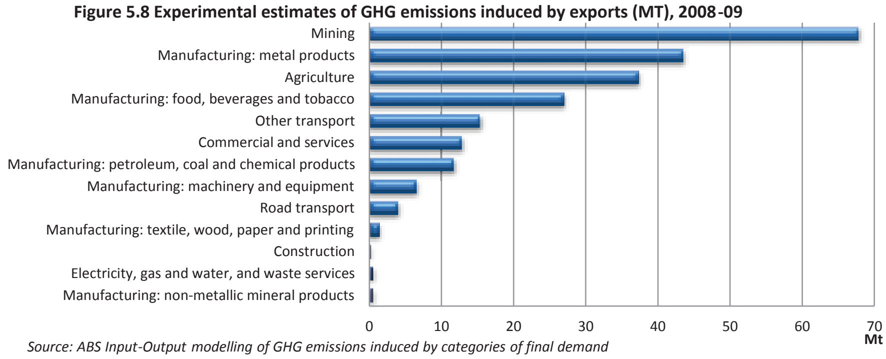
Figure 5.7 Experimental estimates of GHG emissions induced by household final consumption (Mt), 2008-09



Source: ABS Input-Output modelling of GHG emissions induced by categories of final demand

Figure 5.8 shows that among Australia's exports in 2008–09, emissions were induced to the greatest extent by goods and services produced by the mining industry (68 Mt); metal products manufacturing (43Mt); agriculture, forestry and fishing (37Mt); and food, beverage and tobacco product manufacturing (27Mt).

Figure 5.8 Experimental estimates of GHG emissions induced by exports (MT), 2008-09



Source: ABS Input-Output modelling of GHG emissions induced by categories of final demand

The following paragraphs provide further insight to the sources and methods used by the ABS in developing modelled estimates of greenhouse gases induced by categories of final demand.

This study uses the 2008–09 suite of I–O tables for the Australian economy in conjunction with data for GHG emissions by industry as supplied by DCCEE to model a consumption–based (i.e. final demand–side) view of Australia's GHG emissions. It uses the standard environmentally extended Leontief model to bridge the gap between the production and final demand sides of the economy. Importantly, it brings into focus the global GHG emissions implications of Australian consumption, regardless of whether that consumption is satisfied by domestic production or by imported products.

Greenhouse gas induced by final demand continued

For the purposes of this study, the scope of emissions extends to all GHG emissions under the Kyoto framework comprising all IPCC energy sectors[45] (including stationary energy and transport); industrial processes; solvent and other product use; agriculture; waste; and LULUCF. It uses the *Australian Greenhouse Emissions Inventory*[46] as its primary data source but reallocates transport and electricity activity data onto an Australian and New Zealand Standard Industrial Classification (ANZSIC) industry basis, i.e. transport activity undertaken by a producing unit in the mining industry is allocated to mining and not to the transport industry. The DCCEE emissions data are available in respect of 40 sectors, i.e. at the 3–digit ANZSIC level for manufacturing and at 2–digit ANZSIC for the other industries, while the Australian I–O matrix uses a 111 Input–Output Industry Group (IOIG) classification. A key decision faced in undertaking this work was whether to model induced GHG emissions across the 40 sectors of the DCCEE presentation or across the 111 IOIG–based industries of the Australian I–O tables. The decision to use the 111 IOIG industries was adopted partly in order to avoid the aggregation error inherent in the alternative approach, which was to construct a smaller I–O table to match the 40 sectors of the DCCEE emissions data. A further reason was to ensure the modelled data were fully compatible with the SEEA and SNA frameworks.

The ABS performed a number of other adjustments to the emissions data from the *National Greenhouse Inventory by Economic Sector.* These adjustments are designed to support full integration and comparability with data of the SEEA and the SNA. The specific adjustments required to convert DCCEE data onto a SEEA basis relate to emissions induced by travellers while abroad; international bunkering (related to international transport, principally shipping and aircraft) and the reallocation of electricity emissions from an activity basis to an ANZSIC industry basis. The first two adjustments are necessary because the scope of the SEEA relates to the activities of all units that are resident of the economic territory, while Kyoto Protocol–based data relate to emissions taking place in a defined territory. The two bases differ because Australian residents may emit GHG abroad and similarly non–residents may emit within the Australian territory. Electricity GHG emissions data are reallocated from an activity basis to a standard ANZSIC industry classification basis. For example, the electricity self–generated by an enterprise in the manufacturing industry is included in the manufacturing industry, not the electricity generation industry.

The sum result of these various adjustments is a body of GHG emissions information that can be directly compared and integrated with estimates produced according to the SNA and the SEEA. This better informs decision–making across environmental and economic domains and substantially enhances the usefulness of the various data sets involved.

Nevertheless, the approach used here has two important assumptions that potentially affect the quality of the results. Firstly, in respect of GHG emissions, imported products are assumed to be produced using production functions that are identical to those used for locally produced products of the same type. Given the reliance on coal for electricity generation in Australia, the likely impact of this assumption is an overstatement of emissions embodied in imports. If this is the case, the data produced here will

45 The IPCC uses a definition of sectors, which is not consistent with the SNA
46 From 1 July 2008 a registered corporation above a threshold is required to report the amount of GHG emissions and energy produced or consumed by facilities under the operational control of its group members (which may include subsidiaries, joint ventures or partnerships) during a reporting year

Greenhouse gas induced by final demand continued

understate reported net exports of emissions. The assumption could be removed by incorporating global production functions and regional I–O models, though this would involve a considerable amount of additional data and would complicate the model significantly. The second important assumption is that all consumers of electricity pay the same price per unit for their electricity. Neither of these assumptions is expected to be entirely valid, but to date no rigorous analysis of possible biases in the results has been undertaken. In both cases, the assumptions can potentially be addressed through the use of more sophisticated models to take these factors into account, subject to the availability of data and resources, these developments may possibly be reflected in future editions of this work.

Energy use as a major driving factor of GHG emissions

Energy derived from the burning of fossil fuels contributed 67% of Australia's GHG emissions in 2009–10 and fugitive emissions (e.g. gas escaping from coal mines and oil wells) from fuels contributed a further 7% (Kyoto Protocol basis including LULUCF). Given the dominance of fossil fuel combustion as a source of emissions, energy policy and research is directed at a re–engineering of industry production processes to be more energy efficient and to rely more on renewable sources of clean energy. In addition, there are policy issues around the future availability and prices of petroleum products.

The basis of much climate change mitigation policy in Australia is centred on economic instruments such as taxes. There are clear inter–relationships between policies that utilise economic instruments involving prices and taxes, and physical flows of various energy products and of related GHG emissions. In order to understand and to manage these inter–related phenomena, it is essential that our information on economic performance, energy supply and use, and flows of GHG emissions be directly comparable. The SEEA Central Framework directs the compilation of energy accounts and GHG emissions accounts in a way that allows direct comparison and integration of these sets of information with each other and with economic information of the SNA.

Information drawn from the SEEA–based *Energy Account, Australia* (ABS cat. no. 4604.0) can be used for monitoring the overall development of the Australian energy industry and in tracking the progress of policies to support clean technologies. Data produced within *Energy Account, Australia* are directly comparable with data from the broad suite of SNA and SEEA–based outputs. The production of GHG emissions accounts on a SEEA basis delivers a body of data that can be seamlessly integrated with information contained in *Energy Account, Australia*.

In practice, however, the data for energy and air emissions may come from different sources which are prepared using different concepts to meet different regulatory needs of governments. In this case, the SEEA has a role as a data integrating framework. Experience has shown that the resolution of inconsistencies is often a difficult and time consuming process, but it can be done – with positive benefits for the producers and users of data. The confrontation of data from different sources and the resolution of inconsistencies is an ongoing process within the ABS and other agencies.

Carbon stock accounts

The initial focus of the United Nations Framework Convention on Climate Change (UNFCCC) was to reduce fossil fuel emissions, this being the single biggest source of human induced GHG emissions. Under the guidance of the IPCC, a flows based global accounting system was established[47]. Since the initial global climate change negotiations, land–based mitigation opportunities have received increasing attention by policy makers and researchers, for example the Australian Government's Carbon Farming Initiative.

Further thinking on the topic has recognised the need for a holistic view of carbon that extends the current flows–based framework to recognise the unique characteristics of different stocks of carbon.

A carbon stock framework

Large amounts of carbon flow naturally and continuously between the geosphere, biosphere, and the atmosphere. This is commonly called the global carbon cycle, and it includes many complex interactions, with different stocks of carbon cycling at different speeds.

Emissions from fossil stocks are effectively a one–way emission, as they require geological timeframes to return to an inactive state. In this way emissions from the geosphere are not equivalent to, and cannot be simply mitigated by, their capture in the biosphere.

Within the biosphere, different ecosystems vary in their longevity and capacity to rebuild and maintain carbon stocks. This presents a significant set of trade–offs for decision makers. In relation to land this is because of competing claims for human food and settlement and because some ecosystems may not have the capacity to return to their earlier carbon stock levels. A set of carbon stocks accounts will provide policy makers and the public with important information in making the trade–off decisions.

An experimental framework for a carbon stock account was presented in Appendix 1 to *Completing the Picture* (ABS Cat. No. 4628.0.55.001). Guided by the structure and principles of SEEA–style accounting, it provides comprehensiveness in the recording of the opening and closing stock of carbon with the various changes between the beginning and end of the accounting period recorded as either additions to the stock or reductions in the stock. Carbon reservoirs are disaggregated to two levels to enable reporting of the stock levels and changes for different types of geocarbon, i.e. oil, gas, black coal, brown coal and other and to tag biocarbon (carbon in biomass) stocks to terrestrial and marine ecosystem type, i.e. natural, semi–natural and agricultural).

Researchers and policy makers can use carbon stock account information together with measures of carbon carrying capacity[48] and land use history to investigate the depletion of carbon stocks from converting natural ecosystems to other land uses; to prioritise land for restoration of biocarbon stocks through reforestation, afforestation, revegetation, restoration or improved land management with their differing trade–offs against food and fibre production; and identify land uses that result in only temporary carbon removal and storage.

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47 IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories. http://www.ipcc–nggip.iges.or.jp/public/2006gl/index.html

48 The mass of biocarbon able to be stored in the ecosystem under prevailing environmental conditions and natural disturbance regimes, but excluding anthropogenic disturbance (Gupta, R.K. and Rao, D.L.N., 1994, Potential of wastelands for sequestering carbon by reforestation. Curr Sci 66:378–380)

A carbon stock framework continued

DCCEE, the Australian National University and the ABS are currently collaborating on an information paper related to carbon stock accounts. The paper will further refine the framework of carbon stock accounts, develop estimates to partially populate a carbon stock account for Australia, and explore some of the analytical capabilities of these accounts.

Beyond this information paper, more research will be necessary to provide estimates of terrestrial and marine ecosystem stock levels. This embryonic stage opens a major opportunity to develop, with the science community, consistency in standards, definitions, coverage and reporting periods. Disaggregating biocarbon stock reservoirs into categories of 'natural', 'semi–natural' and 'agricultural' presents methodological challenges that could possibly be addressed through a linked land cover account. The benefits for policy making are likely to be substantial.

Introduction

This chapter introduces the land and ecosystem accounts of the SEEA and on reports on the experimental land accounts produced by the ABS.

The SEEA Central Framework describes accounts for land cover and land use in monetary and physical terms. That is the land has both an area, as measured in hectares, as well as a price, as measured in dollars per hectare. Land cover or land use accounts in monetary and physical terms have been produced for three regions of Australia, namely:

- the Great Barrier Reef region (*Land Account: Great Barrier Reef Region, Experimental Estimates* (ABS cat. no. 4609.0.55.001));
- the Murray–Darling Basin (*Completing the Picture: Environmental Accounting in Practice*, Chapter 6, Managing the Murray–Darling Basin (ABS cat. no. 4628.0.55.001)); and
- the state of Victoria (*Land Account, Victoria, Experimental Estimates* (ABS cat. no. 4609.0.55.002)).

The SEEA Central Framework also describes accounts for soil and timber resources both of which are associated with land accounts but as yet none of these accounts have been produced by the ABS.

The SEEA Experimental Ecosystem Accounts provides guidance on accounting for ecosystem condition. In this *"ecosystem condition reflects the overall quality of an ecosystem asset, in terms of its characteristics*[49]*"*. Characteristics include the living (e.g. flora and fauna) and non–living (e.g. soil and water) components of ecosystems and their interactions as well as other things related to the location of ecosystems such as climate and topography. Condition can be measured in two ways. The first is by assessing the extent of ecosystem service flows, and the second by assessing the physical characteristics of the components of ecosystems.

An example of the measurement of condition using physical characteristics is soil condition which can be measured according to its type, depth, extent and levels of soil degradation (e.g. acidification, salinity and sodicity). Alternatively, the condition of biodiversity can be measured by the extent of ecosystems or the number, distribution and abundance of species occurring within ecosystems. Such data are typically resource intensive to collect.

Accounting for ecosystem condition is still in the early stages of development in Australia, but a range of activity is occurring. For example:

- Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) ecosystem services key concepts and applications[50]
- The Department of Agriculture, Forestry and Fisheries discussion paper on ecosystem services[51]
- The Wentworth Group of Concerned Scientists is conducting trials in the Natural Resource Management areas of Australia using measurement of the physical characteristics of ecosystems (e.g. biodiversity, soil, carbon and water)[52]

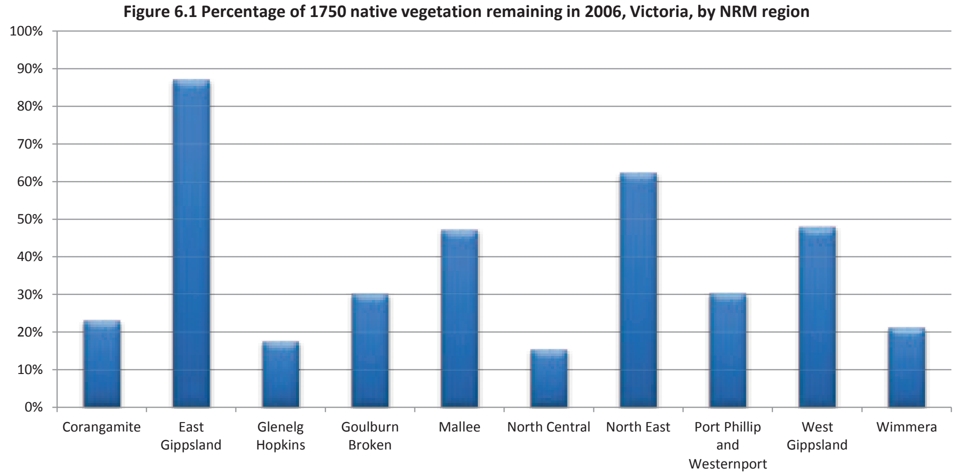
49 Para 2.34, SEEA Experimental Ecosystem Accounting
50 http://www.environment.gov.au/biodiversity/publications/pubs/ecosystem–services.pdf
51 http://www.daff.gov.au/natural–resources/ecosystem–services/ecosystem–services–report
52 Accounting for Nature (2008) and Trials of Environmental Asset Condition (2001) http://www.wentworthgroup.org/

Introduction continued

- Ecosystem Services Framework of the South East Queensland Catchment Management Authority[53]
- Victorian Department of Sustainability and Environment have produced a set of experimental ecosystem accounts, including an estimate of condition using the metric “habitat hectares”.

The starting point for accounting for ecosystem conditions at the ABS is to determine the extent of different land cover types. These can be measured using remote sensing techniques and hence are amendable to large scale estimation and regular (i.e. annual) production. The *Land Account, Victoria, Experimental Estimates* (ABS cat. no. 4609.0.55.002) provides a series of tables showing land cover for the years 1750 and 2006, for each natural resource management region as there is a correlation between native vegetation extent and number of species (Brooks et al 2002[54]). The area of native vegetation may be used to predict the number of species in a particular region and provides an indication of biodiversity that region. Figure 6.1 shows the percentage of native vegetation remaining in 2006 compared to 1750 for each of the NRM regions of Victoria.

Figure 6.1 Percentage of 1750 native vegetation remaining in 2006, Victoria, by NRM region



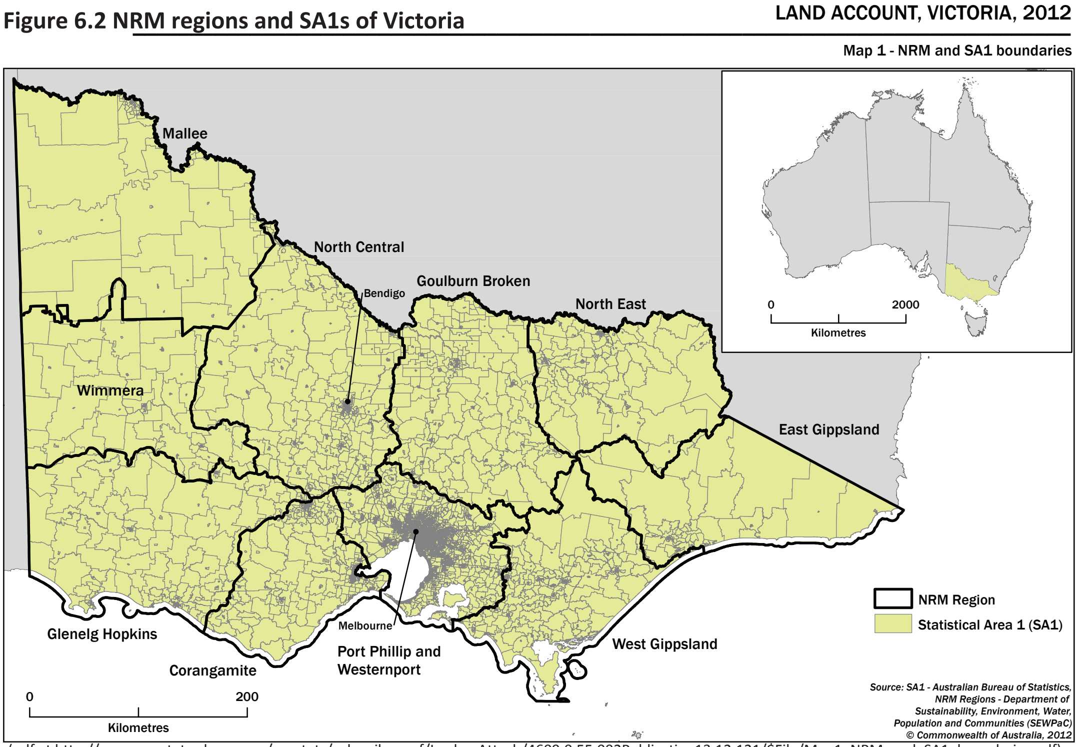
Land Account, Victoria, Experimental Estimates (ABS cat. no. 4609.0.55.002) is the first iteration of the account, consequently no further timeseries data can be presented. It provides environmental, economic and social information about land in Victoria.

Two geographical classifications are used in the account. The full suite of account data is presented only by Natural Resource Management (NRM) region, and more focused profile data are presented by ABS defined Statistical Areas Level 1 (SA1). NRMs are defined as having a common natural resource element that binds them, commonly (but not always) river basins. SA1s are built from aggregations of Mesh Blocks which are designed by the ABS to capture small groups of population, or common land use (e.g. parkland). Victoria consists of 10 NRMs and over 13,000 SA1s and these are shown in figure 6.2.

53 http://www.ecosystemservicesseq.com.au/

54 Brooks, T.M, Mittermeier, R.A., Mittermeier, C.G, da Fonseca, G.A.B., Rylans, A.B., Konstant, W.R., Flick, P., Pilgrim, J., Oldfield, S., Magin, G., Hilton–Taylor, C. (2002). Habitat loss and extinction in the hotspots of biodiversity. Conservation Biology 16(4): 909–923

Figure 6.2 NRM regions and SA1s of Victoria



(pdf at http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/LookupAttach/4609.0.55.002Publication13.12.121/$File/Map1_NRM_and_SA1_boundaries.pdf)

Land cover classification

The Land Account uses an international standard classification of land cover, ISO–19144–2:2012, *Land Cover Meta Language*[55]. This has been adapted to suit Australian land cover by Geoscience Australia in conjunction with the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) to create the Dynamic Land Cover Dataset (DLCD) and a corresponding map of Australia spatially displaying the DLCD cover types. The DLCD reduces the number of categories in the classification to reflect only those ground cover types found in Australia.

For this publication, the full classification has been aggregated to seven categories of land cover Figure 6.3 shows the concordance between the complete DLCD and the AEEA categories.

55 This classification is also slated to be used in future SEEA Ecosystems work

Land cover classification continued

Figure 6.3 Concordance between Australian Dynamic Land Cover and presented categories

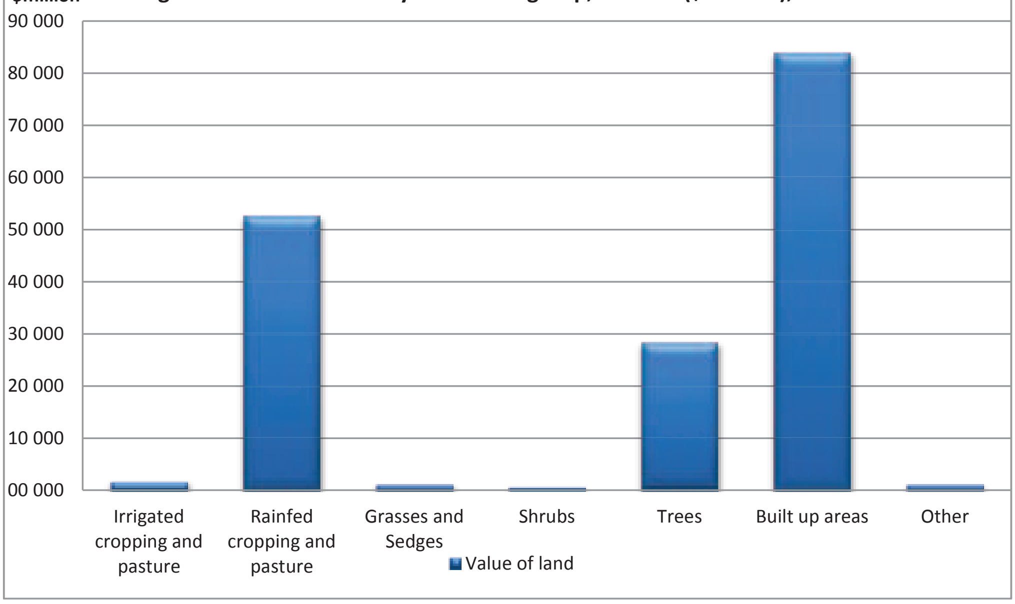
Australian Dynamic Land Cover	AEEA presentation
Built Up Areas	Built Up Areas
Rainfed Cropping	Rainfed cropping and pasture
Rainfed Pasture	
Alpine Grasses - Open	Grasses and Sedges
Hummock Grasses - Open	
Sedges - Open	
Tussock Grasses - Open	
Hummock Grasses - Sparse	
Tussock Grasses - Sparse	
Trees - Closed	Trees
Trees - Open	
Trees - Scattered	
Trees - Sparse	
Irrigated Cropping	Irrigated cropping and pasture
Irrigated Pasture	
Shrubs - Closed	Shrubs
Shrubs - Open	
Chenopod Shrubs - Open	
Shrubs - Scattered	
Shrubs - Sparse	
Chenopod Shrubs - Sparse	
Extraction Sites	Other
Inland Water bodies	
Salt Lakes	
Wetlands	

Value of Land

The total rateable value of land (based on a land valuation file from the State of Victoria) in Victoria as at June 2012 is valued at $1,047 billion and covers approximately 23 million hectares. In the land account, land value can be presented according to:

- type of land cover;
- industry activity occurring on the land (by ANZSIC division);
- NRM region; and/or
- type of land use.

Figure 6.4 Value of land by land cover group, Victoria ($ million), 2012



Value of Land continued

Figure 6.4 shows that Victoria's land value is dominated by built up areas, with 50% of the state's land value represented by this category. The next two significant are rainfed cropping and pasture (31.2%) and tree cover areas (16.8%).

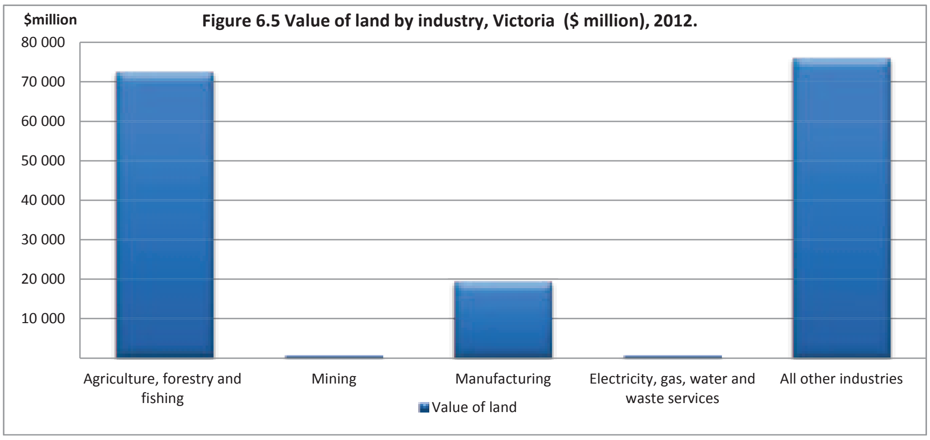
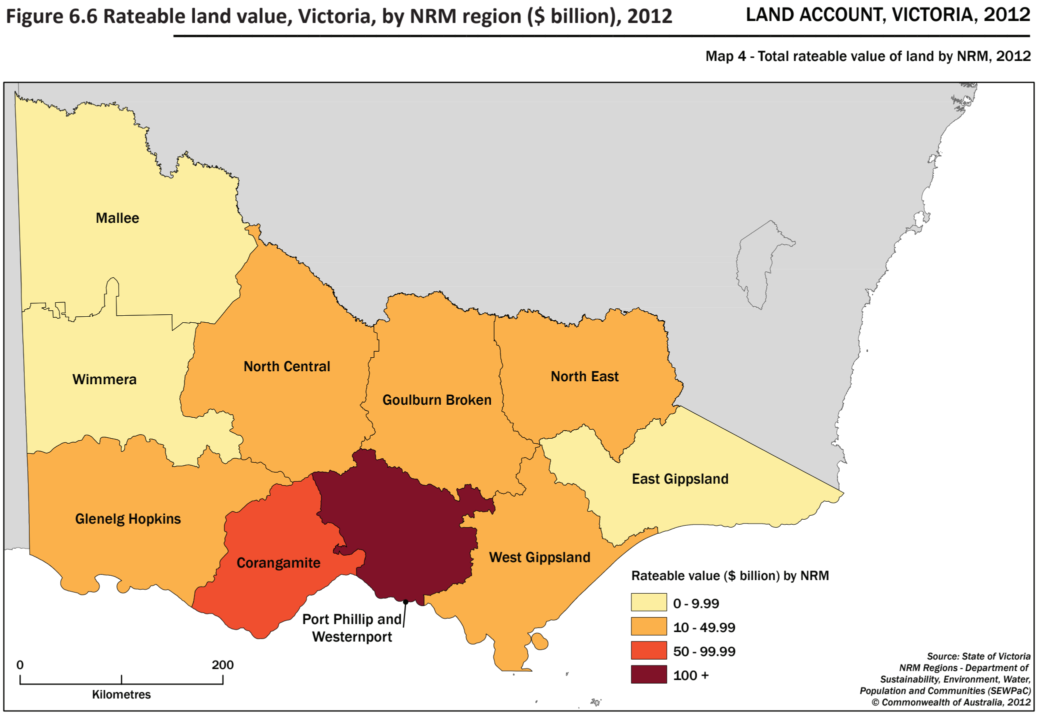


Figure 6.5 Value of land by industry, Victoria ($ million), 2012.

Taking an industry viewpoint of land value in figure 6.5 (i.e. excluding households) shows that three industry divisions (or clusters of divisions in the case of all other industries) hold almost all of the land value in Victoria. Together, agriculture and all other industries hold nearly 89% of land value (43% and 45% respectively) while another 11% is held by manufacturing, leaving less than 1% of value to mining and electricity, gas, water and waste services.

The most significant contributor to all other industries is retail trade, with 17% of the total land value ($30b).

Figure 6.6 Rateable land value, Victoria, by NRM region ($ billion), 2012



(pdf at http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/251063F0AFAD4A90CA257ADA000E47AE/$File/map4_total_rateable_value

Value of Land continued

Figure 6.6 shows that the vast majority of Victoria's land value is contained within the Port Phillip and Westernport NRM region. This NRM region includes Melbourne where the land is valued at $874 billion, or 83% of the value of all land in Victoria. Of this, $773 billion is attributable to land used for residential purposes, and another $45 billion and $33 billion for commercial and industrial purposes respectively. The land used for each of these purposes in Port Phillip and Westernport is individually valued higher than the entire land value of any other NRM region. Although it contributes less than 2% of total land value in the region, the land used for primary production in Port Phillip and Westernport, valued at over $17 billion, represents 23% of the state total for this land use, (i.e. agriculture, horticulture, forestry, etc.), more than for any other NRM.

Land in the Corangamite NRM is the second highest valued in the state at $61 billion. This NRM includes Geelong, Victoria's second largest city and $46 billion (or 75% of its total value) is attributable to land used for residential purposes.

Land values contained within the experimental land account for Victoria are consistent with the value of land for Victoria contained with the national balance sheet of the ASNA (ABS cat. no. 5204.0).

Area of Land

Figure 6.7 Area of land by type of use, Victoria

Australian Valuation Property Classification Code	Hectares	% of total area
Primary production total	12,766,759	56
Residential	1,108,107	4.9
Commercial	30,909	0.1
Industrial	45,967	0.2
Extractive industries	21,717	0.1
Infrastructure and utilities (industrial)	92,611	0
Community services	4,340	0.0
Sport, heritage and culture	33,671	0.1
National Parks, conservation areas, forest reserves and natural water reserves	3,638,186	16.0
Non-active assessments and header records	2,527	0.0
Transport easements	655,862	2.9
Unallocated	4,370,233	19.2

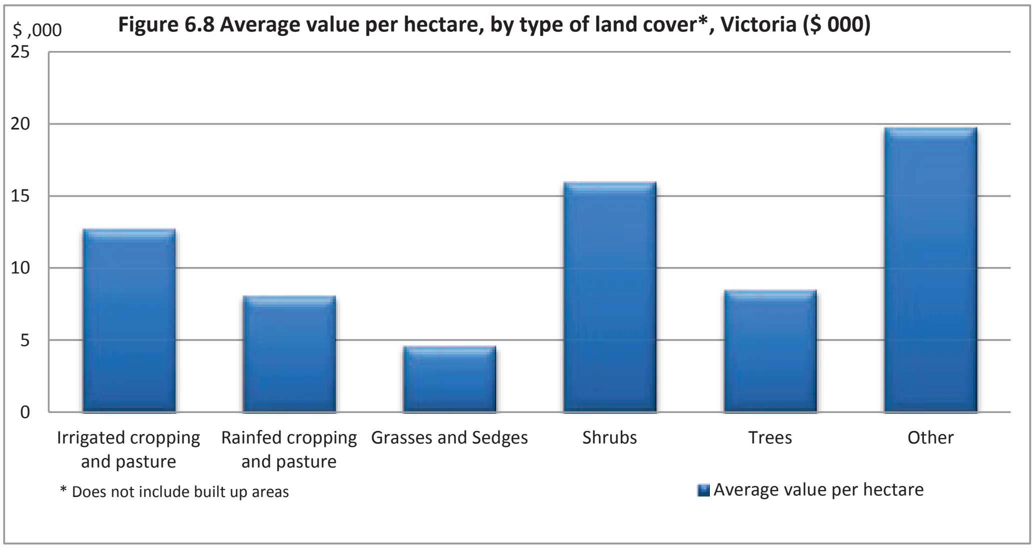
Victoria's land is dominated by three use categories that make up over 91% of the state's area. Primary production activities, including agriculture, aquaculture and horticulture use 56.1% of Victoria's land, while national parks and other conservation areas cover 16.0%. 19.2% of Victoria's land was not classified under the Australian Valuation Property Classification Codes (AVPCC)î

The remaining use types share in just 9% of the state's land use. Land used for residential purposes covers 4.9% of the state, while transport easements (roads and other transport corridors) cover 2.9% of the state. All remaining uses of land each account for less than one half of one per cent of Victoria's land area.

Average value of land

BY LAND COVER GROUP

As expected, built up areas contain easily the most valuable land per hectare in Victoria, with the average hectare valued at $3,560,000.



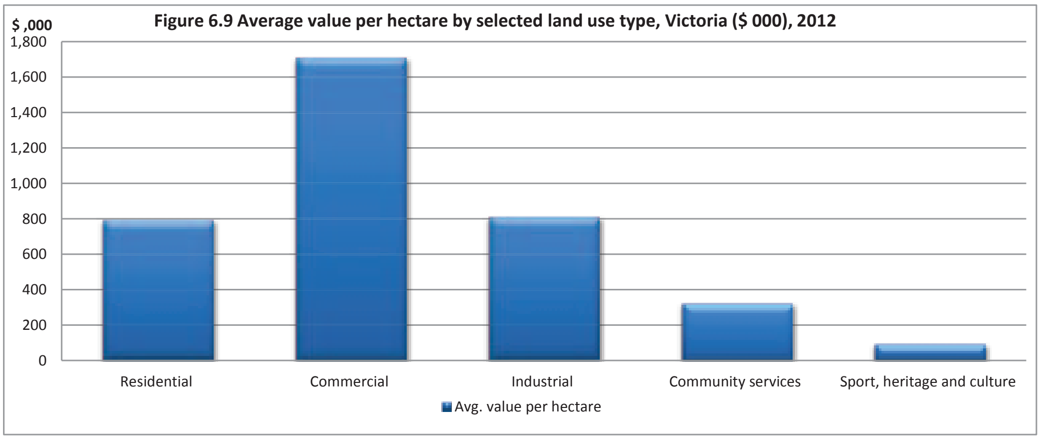
Average value of land continued

BY LAND COVER GROUP *continued*

Figure 6.8 presents the remaining land cover types, and shows that land covered in shrubs reports the next highest value of the land cover groups at an average of $16,000 per hectare. Land covered by shrubs amounts to less than one half of one per cent of Victoria's area.

When "shrubs" is broken into its components, land covered in scattered shrubs is the most valuable, averaging $88,000 per hectare. Forty–three per cent of scattered shrub land by area and 68% by value lie in the Westernport and Port Phillip NRM regions, its proximity to built up areas being the probable explanation for its high value. The shrubs group of covers also contains Victoria's least valuable land cover type, closed shrubs, valued on average at only $280 per hectare.

BY USE



BY USE *continued*

As shown in figure 6.9, land being used for commercial purposes is, on average, valued at over $1,709,000 per hectare in Victoria, more than double the value of land used for any

Average value of land continued

other purpose. The average value for a hectare of industrial and residential land is similar, at $809,000 and $792,000 respectively. Community services and sport, heritage and culture are the next most valuable use types per hectare valued at $322,000 and $92,000 per hectare respectively.

Not shown in figure 6.9 is land used for primary production, which is valued at just under $6,000 per hectare, the lowest of all land use types. Within this group the average value of land across the state varies from $1,000 per hectare for land of native vegetation and agricultural cropping, up to $19,000 per hectare used for horticultural vegetable and fruit crops. Land used for primary production that has been improved (with, for example, sheds, cages, greenhouses, etc.) is the most valuable in this group, valued on average at $20,000 per hectare for livestock use and $21,000 for special purpose horticultural use.

This chapter identifies and categorises the various stocks of natural resources in Australia and generates estimates of the physical extent and monetary value of these assets. The chapter is divided into two sections. The first part of the chapter looks at the natural resource stock in relation to the other forms of measured capital within the Australian economy. A range of information considered useful for managing these natural resource stocks is presented later in the chapter, including data on the physical and economic valuations of these stocks, together with estimations of life of the respective resources under current production levels.

The forms of capital within the economy

National assets can be categorised according to several forms of "capital", including:

- Produced capital (the built infrastructure, such as machinery, roads, etc. that help the economy and society function);
- Natural capital (such as ecosystems, and natural resources such as land, minerals and forests);
- Human capital (the knowledge and skills of the population); and
- Social capital (such as trust in government and in business, or attachment to social groupings).

Human and social capital estimates are not part of the SEEA Central Framework. At present they are constructed using experimental frameworks. For example, the Fraumeni–Jorgensen lifetime income approach is adopted by the Working Group on Statistics for Sustainable Development. The ABS produced experimental estimates of human capital in 2008[56] using this general approach.

The ABS has not attempted a comprehensive monetary estimate of social capital. Instead the ABS has developed an estimate of "low social capital" which may be an indicator for the total stock of social capital[57]. The low social capital estimate is derived from combining aspects of social capital (i.e. network type; support; trust; community involvement; and feelings of safety).

Figure 7.1 Australia's capital base, chain volume measures*

	2000-01	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Capital Estimate	$b	$b	$b	$b	$b	$b	$b	$b
Produced Capital	3,088	3,668	3,813	3,978	4,131	4,278	4,438	4,628
Inventories of plantation standing timber	10	10	10	12	10	10	10	9
Net financial assets with rest of the world	-463	-604	-677	-702	-727	-789	-797	-861
Natural Capital	4,144	4,368	4,418	4,480	4,538	4,590	4,648	4,718
Land	3,636	3,831	3,869	3,906	3,943	3,981	4,018	4,054
Subsoil assets	485	530	549	581	606	621	640	653
Native standing timber	2	2	2	2	2	2	2	2

*Reference year for chain volume measures is 2010-11
Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

Figure 7.1 shows the value using chain volume measures of the different types of capital in Australia between 2000–01 and 2011–12. The economic value of the Australia's natural capital increased 14% over the period 2000–01 to 2011–12 to $4,718 billion. The value of produced capital increased to a greater degree (50%), although its economic value remains less than natural capital at $4,628 billion as at 30 June 2012.

56 ABS, 2008. Research Paper: Measuring Human Capital Flows for Australia: A lifetime Labour Income Approach (ABS cat. no. 1351.0.55.023)
57 ABS, 2009. Research Paper: Exploring Measures of Low Social Capital (ABS cat. no. 1351.0.55.024)

The forms of capital within the economy continued

Net financial assets with the rest of the world reflects the asset balance between Australia's overseas interests and non–residents' interests in Australian assets, and covers such financial instruments as equity and gold stocks. Since 2000–01, investment in Australian assets has exceeded Australian investment abroad with the difference continuing to increase.

Figure 7.2 presents per capita estimates of Australia's capital base on a chain volume measures basis. This approach provides the value of Australia's capital base available for each Australian resident. The value of produced capital on a per capita basis has increased in approximate terms from $160,000 in 2000–01 to $204,000 in 2011–12. In contrast, the total economic value of Australia's stock of natural resources increased over the same period, but fell by 3.3% on a per capita basis over the same period. This equates to a loss in the natural resource stock value per capita of approximately $7,000. This in part reflects that the value of Australia's natural resources rose at a slower rate than that of the resident population (14% compared 16% respectively).

Figure 7.2 Australia's capital base per capita, chain volume measures*

	2000-01	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2010-12
Capital Estimate	$	$	$	$	$	$	$	$
Produced Capital	160,232	177,235	181,415	186,023	189,675	193,875	198,800	204,015
Net Financial Assets with Rest of the World	-24,013	-29,167	-32,218	-32,818	-33,386	-35,739	-35,693	-37,970
Natural Capital	215,004	211,026	210,227	209,475	208,382	208,023	208,225	207,983
National Net Savings	1,900	2,500	3,200	3,400	3,900	5,100	4,000	4,001

*Reference year for chain volume measures is 2010-11
Sources: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

Australia's natural capital is an integral input to the production process of industries such as manufacturing, farming, mining, construction and urban development, with the regular supply of natural resources needing to be managed to ensure a consistency of supply. For naturally regenerating resource, such as forests, this means sustainable harvesting, while for minerals it means that new supplies of natural resources or substitutes need to found. Estimates of depletion of natural capital reflect the extent to which the income from natural resources is being generated sustainably. In addition, for every use there is sometimes a cost involved, such as pollution, soil degradation, salinity, pests, loss of biodiversity and habitat, declining water quality and quantity, which are not always obvious for many years.

Natural capital estimates should comprise all the economic and social value of natural resources in Australia, and are generally recognised as being composed of: land (including soil and landscape features such as hills and mountains); subsoil assets (e.g. minerals and fossil fuels); water (fresh water and groundwater); oceans; atmosphere; and biological resources (e.g. forests, fish, other species and habitats).

The ASNA and the SEEA Central Framework include the value of environmental assets that have direct economic values. For example land, timber, minerals and fossil fuels are included in the National Balance Sheet[58]. Valuation is based on market transactions or, where these are unavailable, the net present value of future expected income resulting from the use of these assets is recommended.

58 Australian System of National Accounts, 2011–12 (ABS cat. no. 5204.0)

The forms of capital within the economy continued

Some environmental assets and many ecosystem services are, however, not transacted in markets, although the value of some services may be included in the value of goods and services traded in markets. For example, the value of pollination is embedded in the value of agricultural crop production, while tourism operators derive income from the people visiting natural attractions such as Uluru and the Great Barrier Reef. The development of standardised methods for identifying and separately distinguishing the value of environmental assets and ecosystem services is an on–going area of work.

Work on valuing the social value of the environment, is highly experimental and is not included in this ABS publication. Techniques for valuing social aspects of the environment are based on the concepts of welfare economics and include the methods on willingness to pay, contingent valuation and revealed preferences[59].

Figure 7.3 presents the measurement in chain volume terms of the value of Australia's natural capital base, which continues to be dominated by land (86% of total value in 2011–12), followed by subsoil (14% of total value in 2011–12). Both forms of timber (plantation and native) largely unchanged in value over the same period.

Figure 7.3: Australia's natural resource base, chain volume measures*

	2000-01	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Capital Estimate	$b	$b	$b	$b	$b	$b	$b	$b
Land	3,635.8	3,831.2	3,868.6	3,906.2	3,943.0	3,980.6	4,017.8	4,053.5
Subsoil	484.6	530.1	548.5	581.2	606	620.5	640	652.9
Inventories of plantation standing timber	9.9	9.7	10.3	11.6	10.4	9.8	9.5	8.8
Native standing timber	1.7	2	2	2	1.8	1.7	1.8	1.9

*Reference year for chain volume measures is 2010-11
Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

Economically demonstrated resources

Australia is a leading producer of minerals for the world and produces some 22 minerals in significant amounts from more than 300 operating mines[60]. Minerals are produced in all six states and the Northern Territory. Australia is also in the global top five of mineral producers and has a large resource stock for most of the world's key minerals products.

Figure 7.4 World ranking of Australia's mineral production and resources, 2009

Commodity	Production Rank	Resource Rank
Bauxite	1	2
Black Coal	4	5
Brown Coal	5	1
Copper	6	2
Diamond	5	3*
Gold	2	2
Iron Ore	2	2
Lead	2	1
Lithium	2	3
Manganese Ore	2	4
Nickel	4	1
Niobium	Not Known	2
Rutile	1	1
Silver	5	1
Tantalum	Not Known	2
Uranium	3	1
Zinc	2	1

* Industrial diamond
Source: Geoscience Australia

59 See SEEA Experimental Ecosystem Accounting. Online: https://unstats.un.org/unsd/envaccounting/seea.asp
60 http://www.ga.gov.au/minerals/basics.html; http://www.ga.gov.au/minerals/mineral-resources/aimr.html

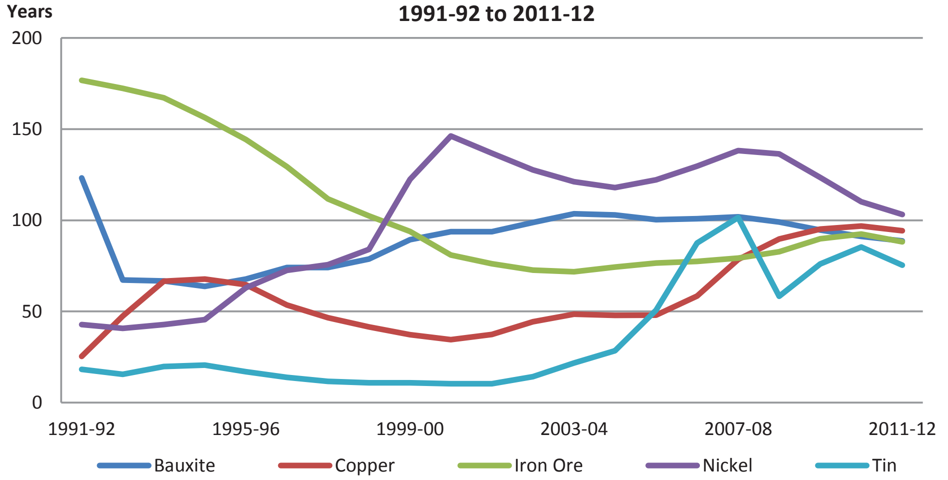
Economically demonstrated resources continued

Minerals are also an important part of the Australian economy, accounting for a significant portion of GDP; by value they represent Australia's largest group of export products.

Metallic minerals

Subsoil asset accounts provide physical information on the expected life of particular mineral assets for Australia (Figure 7.5), to give a broad indication of how long presently identified resources will last, given current conditions (i.e. prices, technology, production levels, etc.). Increases in the expected resource life of a given mineral resource come from new discoveries and extraction methods, which make deposits economically viable that previously were not.

Figure 7.5 Resource life of selected minerals, five year moving average, 1991-92 to 2011-12



Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

The resource life of Australia's stock of iron ore has experienced the greatest change over the last 20 years, falling from 177 years in 1991–92 to 88 years in 2011–12. Depletion has been driven by increasing demand for iron ore from overseas, particularly the developing world, which is outstripping new discoveries. In contrast, new discoveries of tin within Australia have increased its expected resource life from 18 years to 75 years over the period 1991–2 to 2011–12.

Energy resources

Australia has about 0.3 per cent of the world's petroleum reserves. These encompass crude oil, condensate (a liquid mixture of pentane and heavier hydrocarbons that is recoverable from a gas well through a separation system), naturally occurring liquefied petroleum gas (LPG) and natural gas.

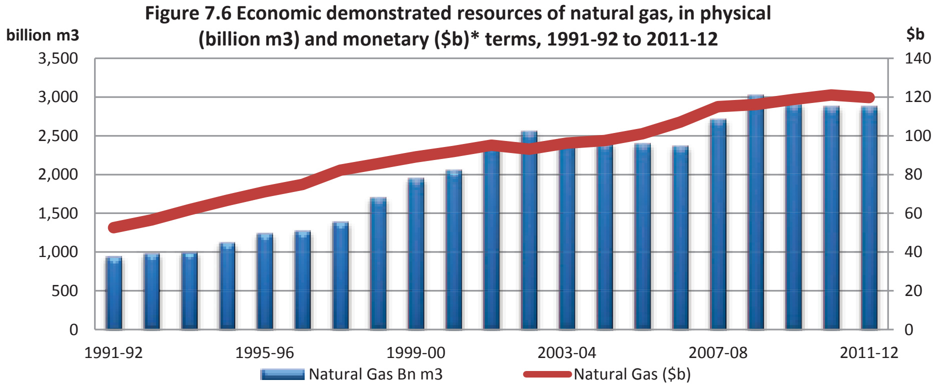
In 2011–12, Australia's identified petroleum resources consisted of 153 GL of crude oil, 310 GL of condensate, 138 GL of LPG and 2,878 billion m^3 of natural gas. Western Australia contains the majority of Australia's reserves: 92% of conventional gas reserves, 62% of economic demonstrated resources of crude oil and 76% of condensate resources.

Energy resources continued

NATURAL GAS

Australia has significant natural gas resources, and it represents the country's third largest energy resource, in terms of energy content, after coal and uranium[61]. Most estimated recoverable reserves of natural gas and conventional gas are located off the west and north–west coast of Australia.

Figure 7.6 Economic demonstrated resources of natural gas, in physical (billion m3) and monetary ($b)* terms, 1991-92 to 2011-12

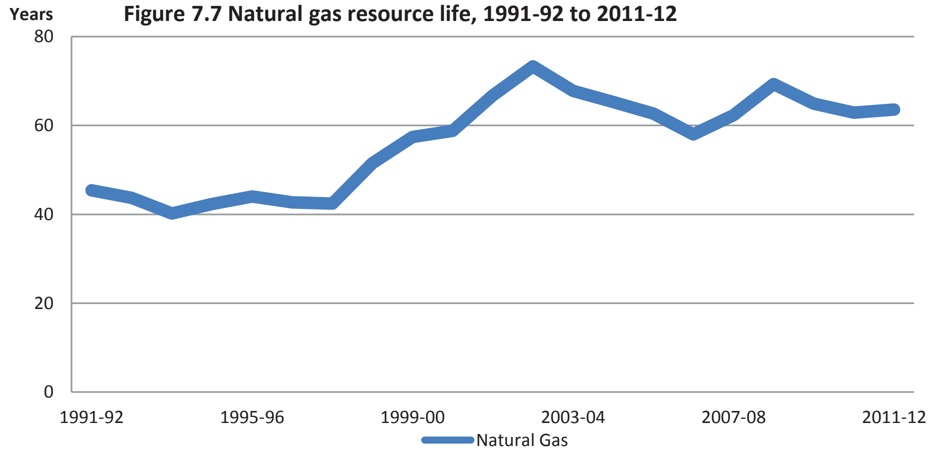


* Monetary estimates are in constant prices

Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

As Figure 7.6 shows, Australia's economically demonstrated resources (EDR)[62] of natural gas have increased more than threefold (306%) over the past 20 years. At June 2012, the EDR of natural gas totalled 2,878 billion m^3. At current production rates, existing gas reserves are projected to last 64 years (Figure 7.7).

Figure 7.7 Natural gas resource life, 1991-92 to 2011-12



Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

61 Geoscience Australia, 2010, http://www.ga.gov.au/minerals/basics.html http://www.ga.gov.au/minerals/mineral-resources/aimr.html

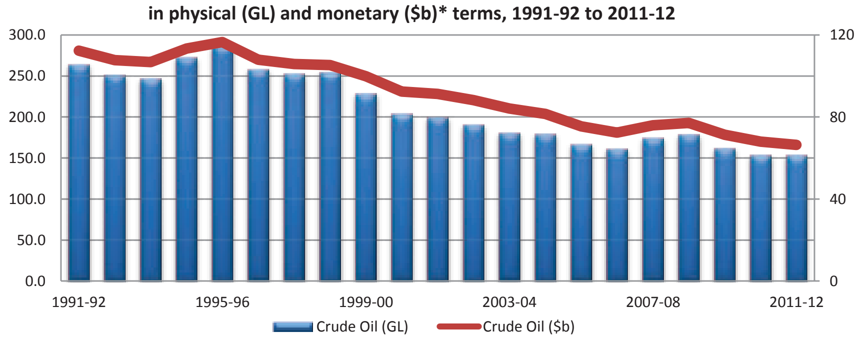
62 EDR is a measure of the resources that are established, analytically demonstrated or assumed with reasonable certainty to be profitable for extraction or production under defined investment assumptions. Classifying a mineral resource as EDR reflects a high degree of certainty as to the size and quality of the resource and its economic viability.

Energy resources continued

CRUDE OIL

Australia's stock of crude oil represents less than 5% of world resources and Australia's economy relies increasingly on imports to meet demand. Imports increased by 8% between 2009–10 and 2010–11. This was driven by crude oil and refinery feedstock, which accounted for 61% of imports and increased 16% over the period. Despite having relatively smalls stocks, Australian crude oil is typically low in sulphur and of the light variety of liquid fuels, which have a higher value due to their lower wax content.

Figure 7.8 Economically demonstrated resources of crude oil, in physical (GL) and monetary ($b)* terms, 1991-92 to 2011-12

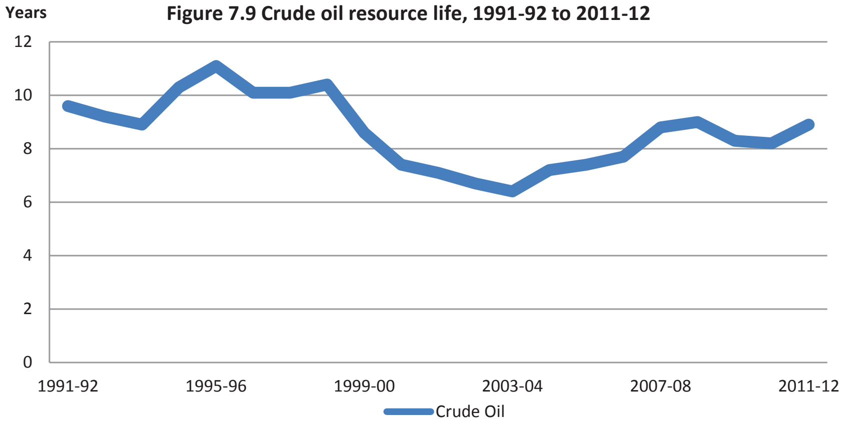


* Monetary estimates are in constant prices

Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

After peaking at $116bn in 1995–96, the value of Australia's crude oil resources has steadily declined to $66bn in 2011–12. This is in line with the physical stock of crude oil, which fell from 287 GL in 1995–96 to 154 GL in 2011–12.

Figure 7.9 Crude oil resource life, 1991-92 to 2011-12



Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

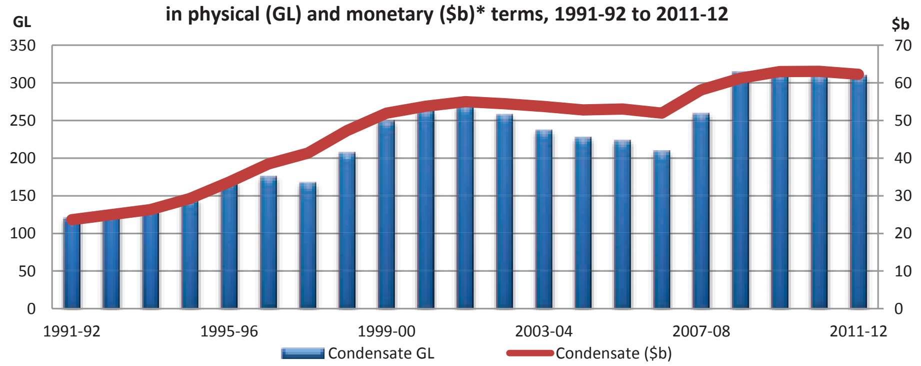
As Figure 7.9 illustrates, based on the current rates of production, Australia crude oil resources have an estimated resource life of nine years.

Energy resources continued

CONDENSATE

Figure 7.10 shows that Australian condensate resources were around 310 GL in 2011–12. The economic value of condensate stocks increased from $24bn in 1991–92 to approximately $62bn in 2011–12.

Figure 7.10 Economically demonstrated resources of condensate, in physical (GL) and monetary ($b)* terms, 1991-92 to 2011-12

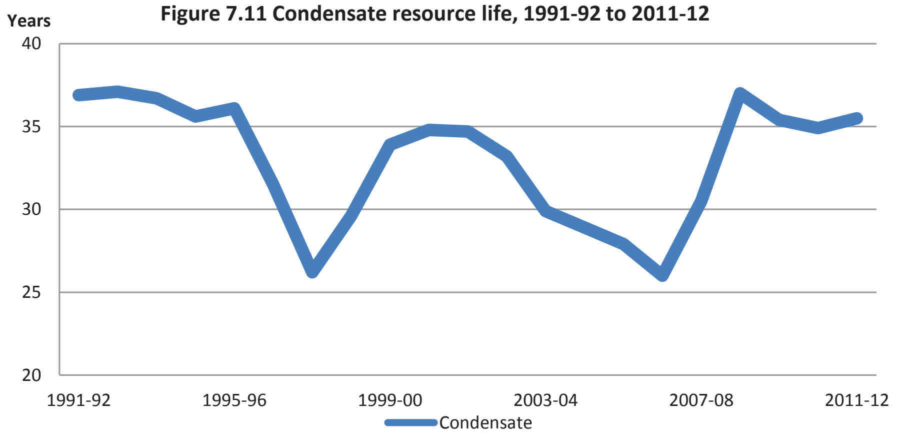


* Monetary estimates are in constant prices

Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

New EDR discoveries of condensate during 2006–07 to 2008–09 have resulted in an increase in its resource life. At current production levels, Australia's stocks of condensate have an approximate lifespan of 36 years (Figure 7.11).

Figure 7.11 Condensate resource life, 1991-92 to 2011-12



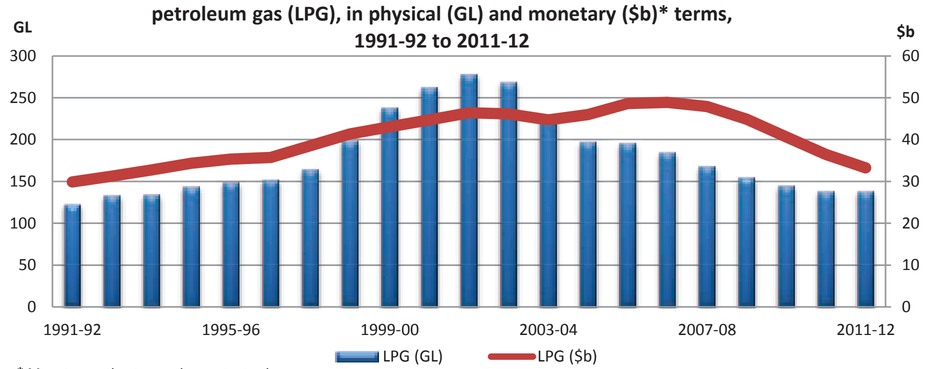
Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

Energy resources continued

NATURALLY OCCURRING LIQUEFIED PETROLEUM GAS

LPG is a mixture of lighter hydrocarbons, such as propane and butane, and is normally a gas at the surface. It is usually stored and transported as a liquid under pressure. LPG has lower energy content per volume than condensate and crude oil.

Figure 7.12 Economically demonstrated resources of naturally occuring liquid petroleum gas (LPG), in physical (GL) and monetary ($b)* terms, 1991-92 to 2011-12

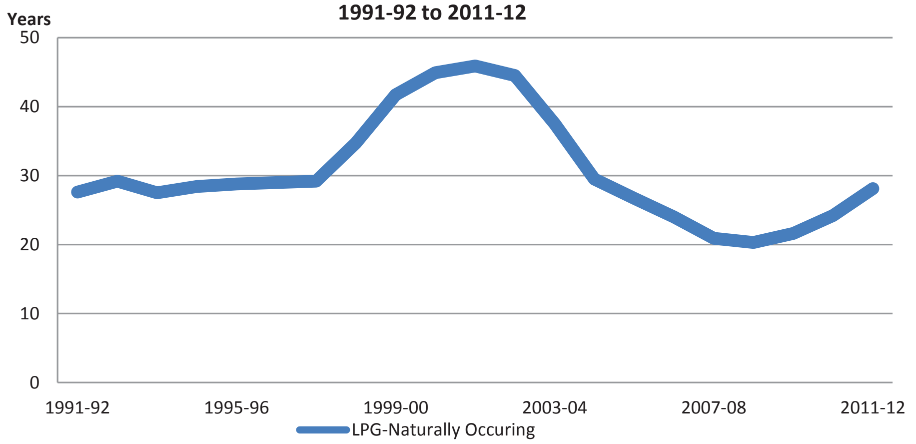


* Monetary estimates are in constant prices

Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

Between 1991–92 and 2001–02, Australia's naturally occurring LPG resources increased by 119% from 123 GL to 269 GL. Increased production of the resource in the ten years following 2001–02 has resulted in 2011–12 stocks of the resources falling back to just above 1991–92 levels (138 GL).

Figure 7.13 Naturally occuring liquid petroleum gas (LPG) resource life, 1991-92 to 2011-12



Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

As figure 7.13 shows, at current production rates, naturally occurring LPG has a resource life of 28 years.

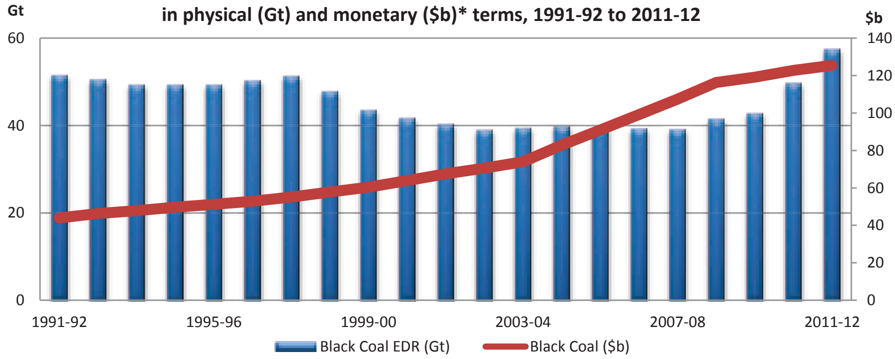
Energy resources continued

BLACK COAL

Black coal is primarily used for electricity generation and the production of coke, which is integral to the production of iron and steel. Black coal is also used as a source of heat in the manufacture of cement and food products.

Approximately 10% of the world's black coal resources are located in Australia[63]. A large proportion of these resources are high–quality bituminous coal, characterised by low sulphur and low ash content. Most states in Australia have black coal resources, with significant quantities of high–quality black coal in New South Wales and Queensland.

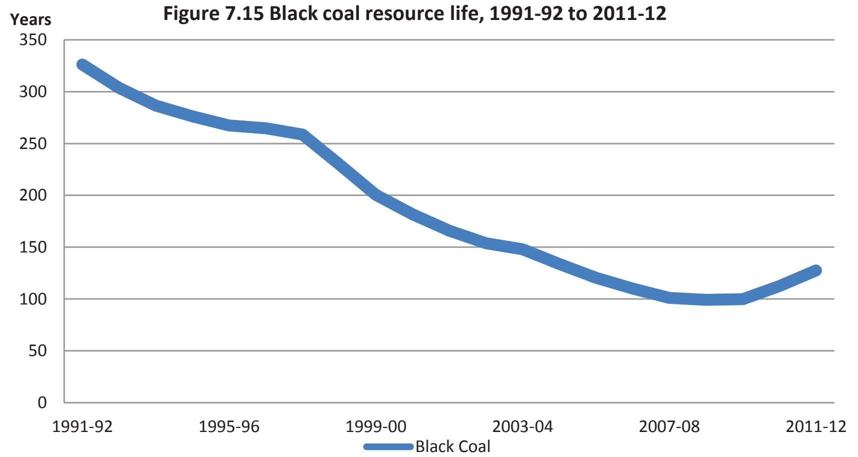
Figure 7.14 Economically demonstrated resources of black coal, in physical (Gt) and monetary ($b)* terms, 1991-92 to 2011-12



* Monetary estimates are in constant prices
Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

The economic value of the stock of black coal has almost tripled over the period 1991–92 to 2011–12, rising 184% from $44 billion to $125 billion (Figure 7.14). The increase in the stock of black coal resources was more modest rising from 52Gt to 58Gt. As Figure 7.15 illustrates, the resource life of black coal has declined from 326 years in 1991–92 to 127 years in 2011–12. This has coincided with increased levels of production in response to overseas demand.

Figure 7.15 Black coal resource life, 1991-92 to 2011-12



Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

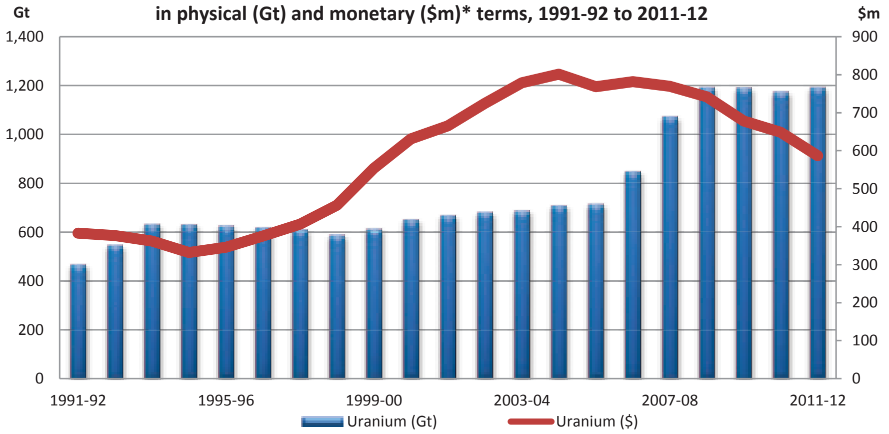
63 BREE, Energy in Australia 2012, p.9

Energy resources continued

URANIUM OXIDE

With 33 per cent of the world's uranium resources, Australia has the world's largest economically demonstrated stocks of this resource and is the third largest producer of uranium internationally. Major uses for uranium are as fuel in nuclear power reactors to generate electricity, in the manufacture of radioisotopes for medical applications and in nuclear science research using neutrons from reactors.

Figure 7.16 Economically demonstrated resources of uranium, in physical (Gt) and monetary ($m)* terms, 1991-92 to 2011-12

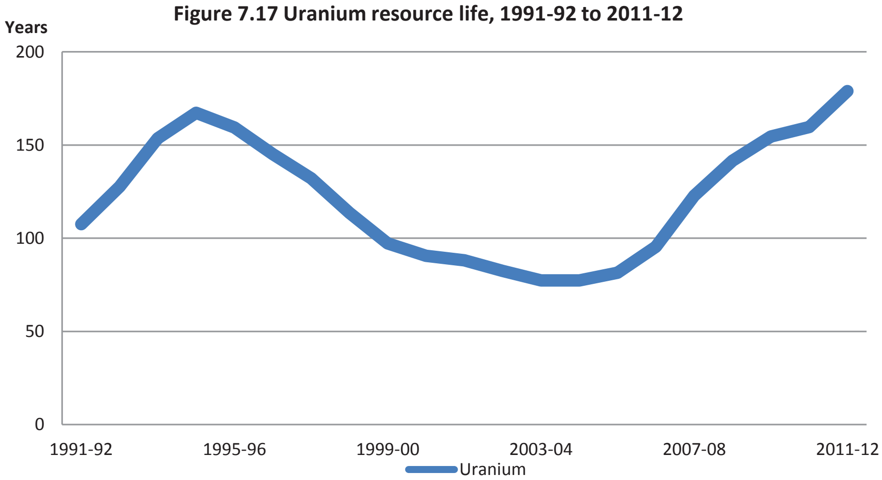


* Monetary estimates are in constant prices

Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

Between 1994–95 and 2004–05 the value of Australia's proven uranium deposits increased from $362m to over $800m (Figure 7.16), driven by new EDR discoveries. Since then the economic value of the stock has fallen against a backdrop of falling market prices.

Figure 7.17 Uranium resource life, 1991-92 to 2011-12



Source: Australian System of National Accounts 2011-12 (ABS cat. no. 5204.0)

New discoveries of uranium in recent year have led to an increase in its resource life, with a resource life of 179 years as at 2011–12, up from 77 year in 2003–04.

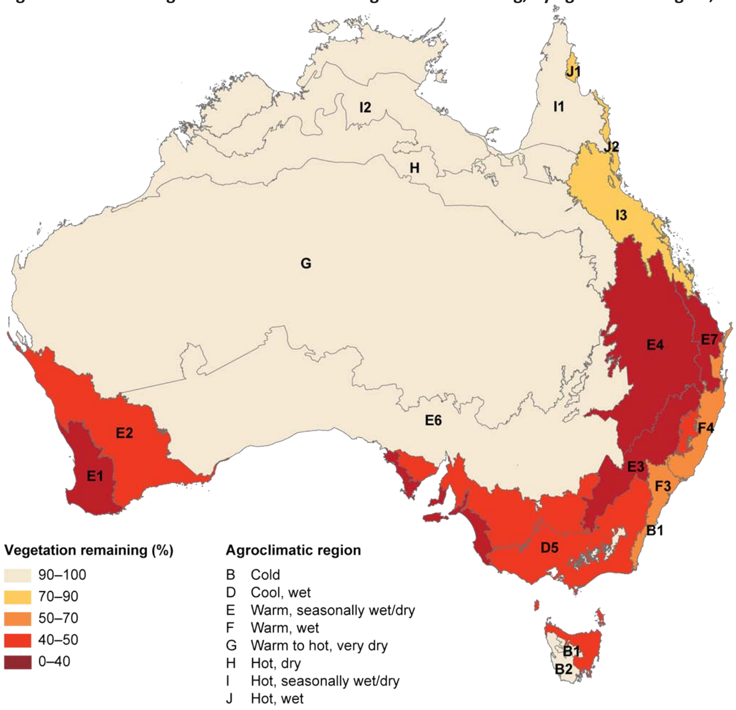
Energy resources continued

NATIVE VEGETATION

Native vegetation refers to all indigenous terrestrial or aquatic plants in an area, incorporating all living and non–living components. This includes Australia's diverse natural vegetation and permanent native plantings for biodiversity and sustainable land management purposes. In the context of native vegetation, indigenous refers to vegetation that is within its natural geographical area.

Native vegetation in many parts of Australia has been cleared or has become degraded and fragmented due to human activity, with 13% of the estimated original extent of Australia's native vegetation completely converted to other land uses (predominantly agriculture). A further 62 per cent has been subject to varying degrees of disturbance and modification[64]. The remaining 25% of the estimated original extent of native vegetation remains intact. Figure 7.18 presents information on the native vegetation remaining currently in Australia.

Figure 7.18 Percentage of Australian native vegetation remaining, by agroclimatic region, 2011



Source: Environmental Resources Information Network, Australian Government Department of Sustainability, Environment, Water, Population and Communities, 2011

*Source: Department of Sustainability, Environment, Water, Population and Communities**

* Australia's Native Vegetation Framework, National framework to guide the ecologically sustainable management of Australia's native vegetation, 2012, COAG standing council on environment and water

64 State of the Environment 2011 Committee, Australia state of the environment 2011, Independent report to the Australian Government Minister for Sustainability, Environment, Water, Population and Communities, Department of Sustainability, Environment, Water, Population and Communities, Australian Government, Canberra

Energy resources continued

TIMBER

The total area covered by broadleafed (hardwood) and coniferous (softwood) plantations almost doubled to reach 2 million hectares between 1994 and 2010. As Figure 7.19 shows, the majority of this change was due to the expansion in the area of broadleafed plantations.

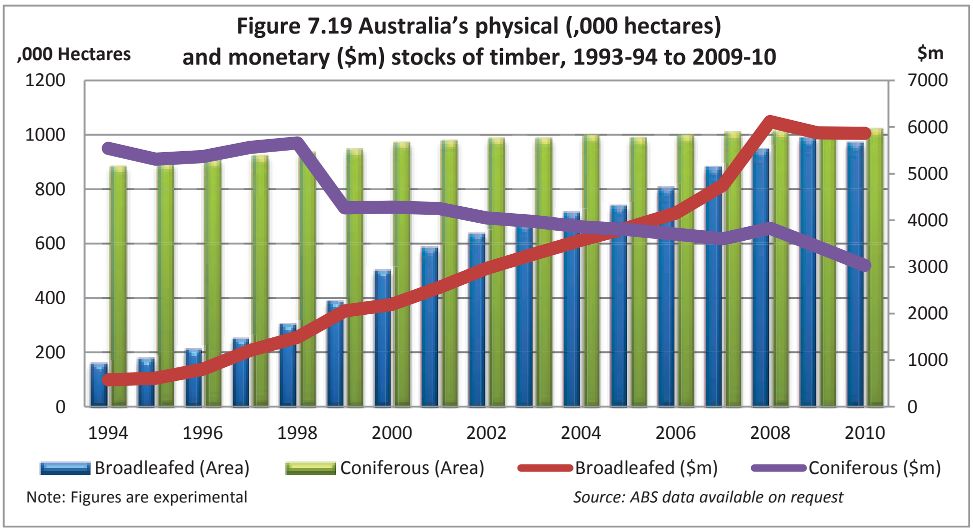


Figure 7.19 Australia's physical (,000 hectares) and monetary ($m) stocks of timber, 1993-94 to 2009-10

Between 1994 and 2010 broadleafed timber plantation areas increased from 159,000 hectares to 973,000 hectares. The area of coniferous plantations remained relatively stable. The market value of Australia's softwood resource fell by 45%, to $3.0 billion from $5.5 billion, between 1994 and 2010.

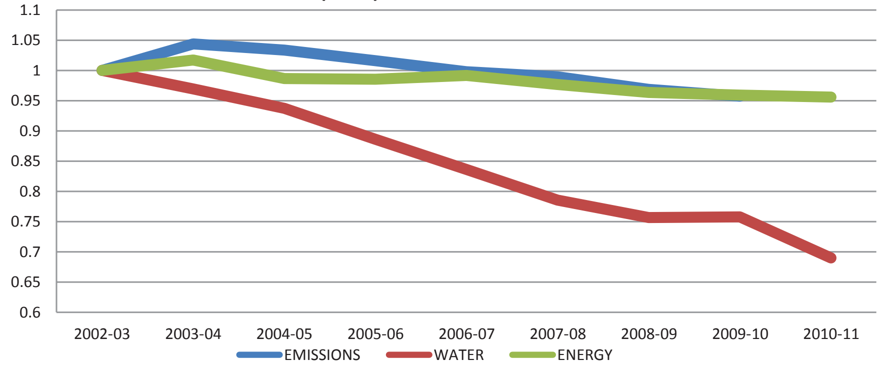
Introduction

Households are an integral part of the accounts described in the previous chapters of this publication. While not always explicitly measured, their impact on aspects of the environment is clear as they represent the large majority of final consumers (and are thus the driving force behind the production) of most produced goods in the economy.

The ABS regularly collects information from households on a wide variety of topics, mostly through surveys with a limited sample, and every five years via the Census of Population and Housing. Some of these data can be used to populate environmental accounts. There also exists other information that can inform decision and policy–making regarding environmental issues. This chapter presents a small selection of such household data according to the accounts presented in this information paper.

Integrated household data

Figure 8.1 Household resource intensity, water and energy consumption and waste emissions per capita, 2002-03 to 2010-11, Australia

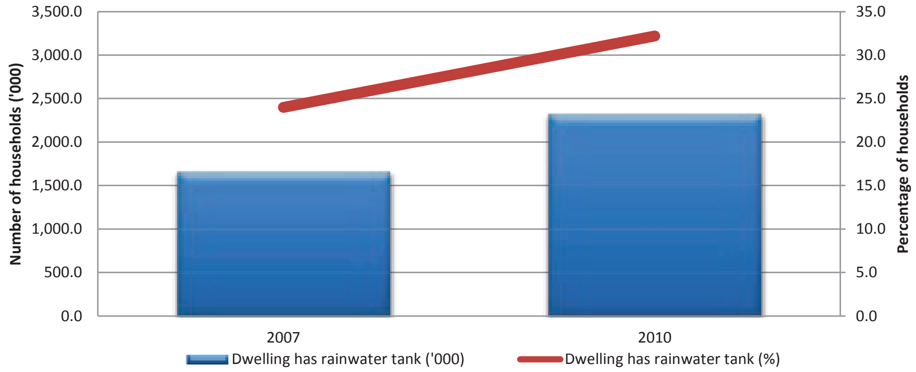


Sources: Water Account, Australia (ABS cat. no. 4610.0), *Energy Account, Australia* (ABS cat. no. 4604.0), *DCCEE National Inventory by Economic Sector*

Figure 8.1 illustrates intensity measures related to water use, energy use and GHG emissions for Australian households. Each intensity measure decreased between 2002–03 and 2010–11 ranging from a 4% decrease per capita in GHG emissions generation and energy consumption, to a 31% decrease in water use per capita over the 8 year period (note that GHG emissions figures are not available for 2010–11).

Water

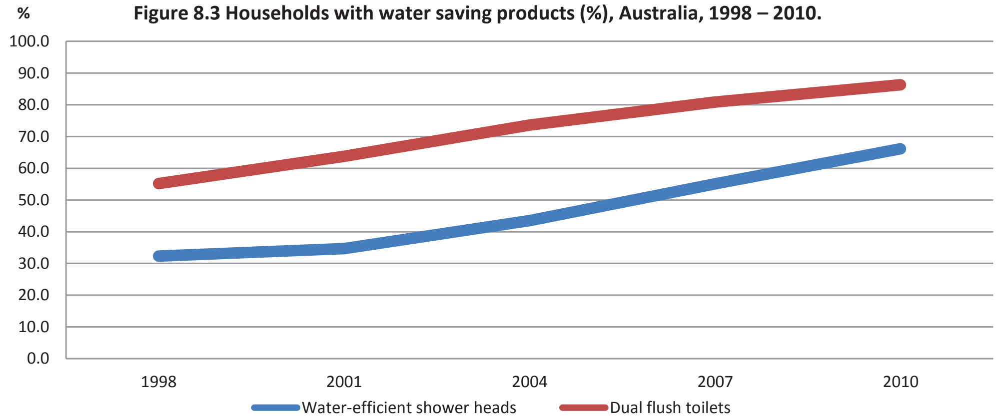
Figure 8.2 Dwellings with rainwater tanks ('000s) and percentage of suitable dwellings with a rainwater tank, Australia, 2007 and 2010.



Source: *Environmental Issues: Water use and Conservation, Mar 2010* (ABS cat. no. 4602.055.003)

The period between 2007 and 2010 saw the end of a drought in Australia and the beginning of a comparatively strong La Nina event, bringing higher than average rainfall to much of Australia. Australian households continued to install rainwater tanks during this period, with the number of tanks increasing 40% to over 2.3 million, and for dwellings that are suitable for rainwater tank installation, the proportion rose from 24% to over 32%.

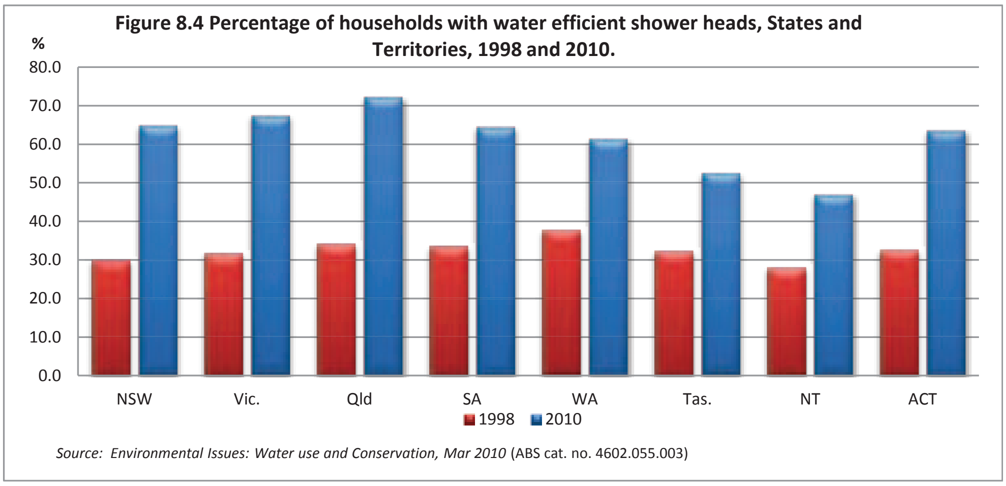
Figure 8.3 Households with water saving products (%), Australia, 1998 – 2010.



Source: *Environmental Issues: Water use and Conservation, Mar 2010* (ABS cat. no. 4602.055.003)

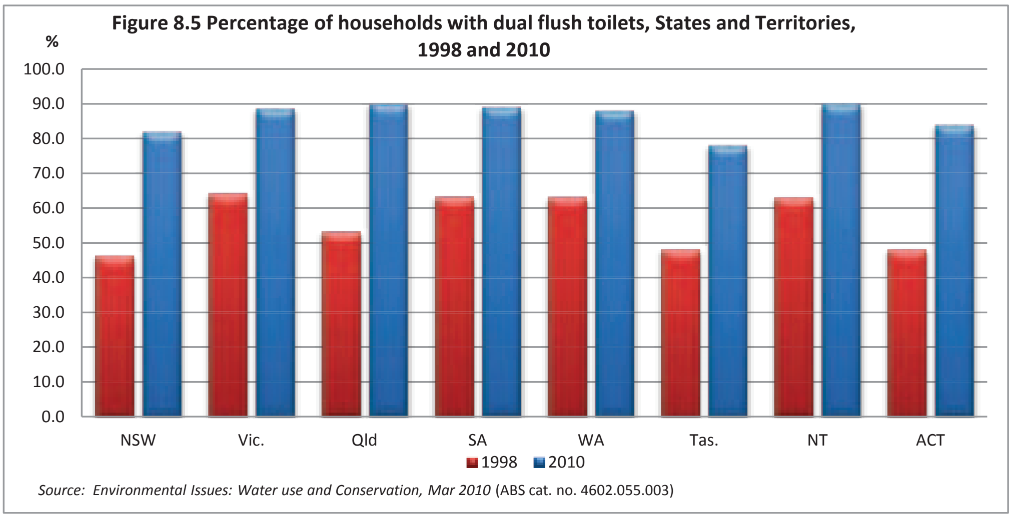
Water saving products for households, such as water–efficient shower heads and dual flush toilets, are now subject to rebate or swap schemes in most states and territories. Water saving device uptake is linked to changes in overall water consumption per capita in households and this is discussed in Chapter 2.

Figure 8.4 shows the changes over the period by state and territory for water efficient shower heads. The largest increase was seen in New South Wales with a 116% increase over the time period, while the smallest increase was seen in Western Australia with a 63% increase.



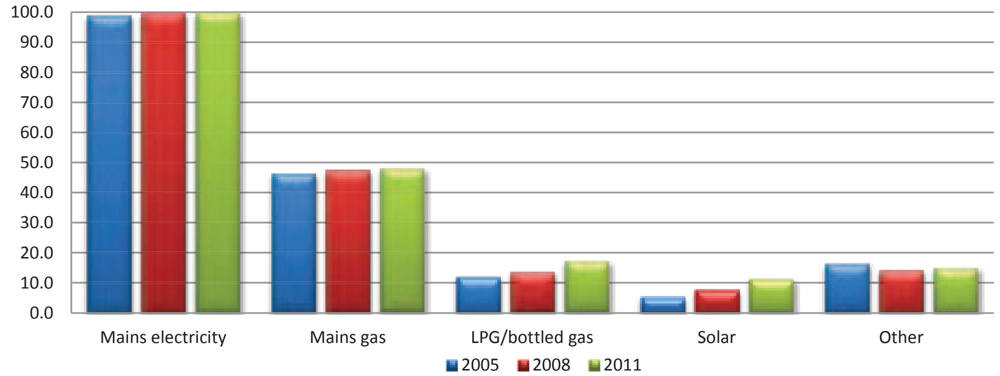
Water continued

Figure 8.5 illustrates the increase in dual flush toilets in state and territory households in the reference period. The percentage of households with dual flush toilets became more even across states and territories, the range of percentages dropping by more than half from 28% in 1998 to 12% in 2010.



Energy

Figure 8.6 Sources of energy used by households, Australia, 2005, 2008 and 2011



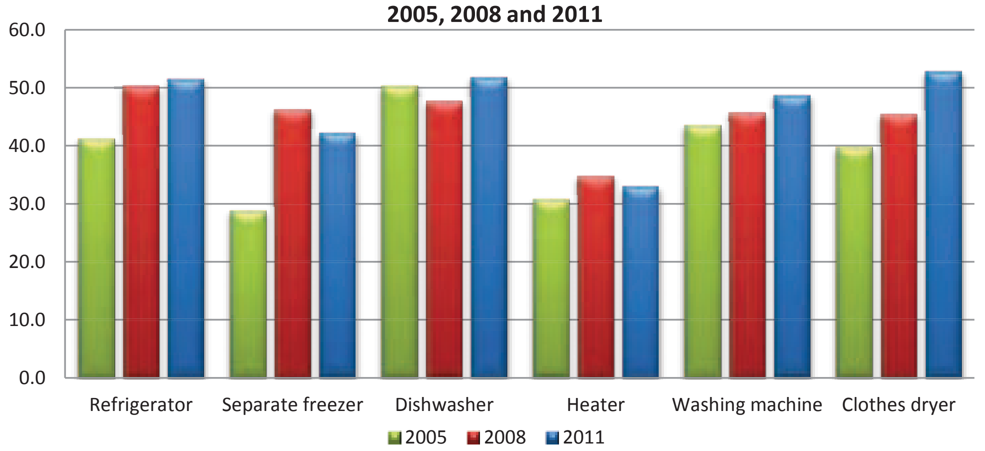
Source: Environmental Issues: Energy Use and Conservation, Mar 2011 (ABS cat. no. 4602.055.001)

Figure 8.6 shows that mains electricity use inside households rose from just under 99% in 2005 to 99.8% in 2011. The use of solar energy by households in Australia rose more than for any other energy source, from 5% in 2005 to 11% in 2011. The federal government's Solar Homes and Communities plan had been in place for five years to 2005 and was phased out in 2009 and was replaced by the Solar Credits scheme. The small–scale renewable energy scheme and feed–in tariffs are also currently available to households in Australia. The three years to 2008, the period under the Solar Homes and Communities plan, saw an increase from 5% to 8% of households using solar energy, while for the three years to 2011, the period including a combination of the Solar Homes and Communities plan and the current Solar Credits scheme, saw an increase from 8% to 11%.

The proportion of households using LPG/bottled gas increased from 12% in 2005 to over 17% of households reporting this as an energy source used inside the home in 2011. LPG/bottled gas is often used for cooking where mains natural gas is not available.

'Other' energy sources includes wood and oil, and their use is especially prevalent in Tasmania, where 39% of households reported using other energy sources in 2011.

Figure 8.7 Energy star rating considered when buying an appliance, Households that purchased an appliance in the last 12 months, Australia, 2005, 2008 and 2011



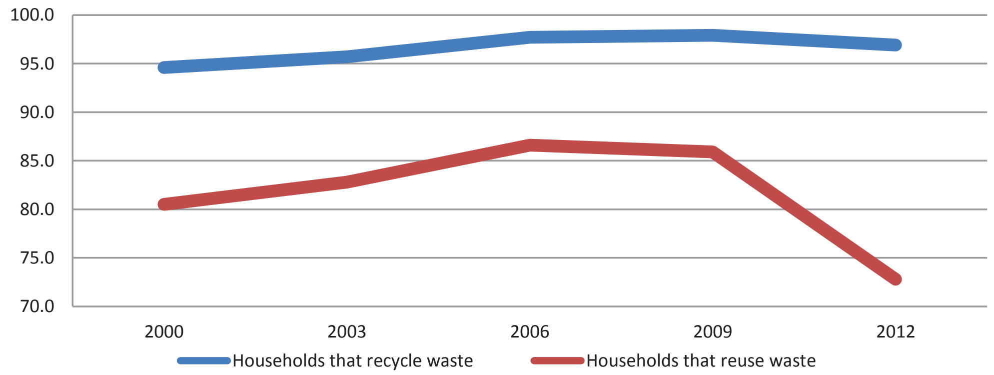
Source: *Environmental Issues: Energy Use and Conservation, Mar 2011* (ABS cat. no. 4602.055.001)

Energy continued

Figure 8.7 shows that when making a clothes drier purchase, consideration was given to its energy efficiency in 53% of cases, the highest percentage among all appliances and an increase of 33% in 6 years.

Waste

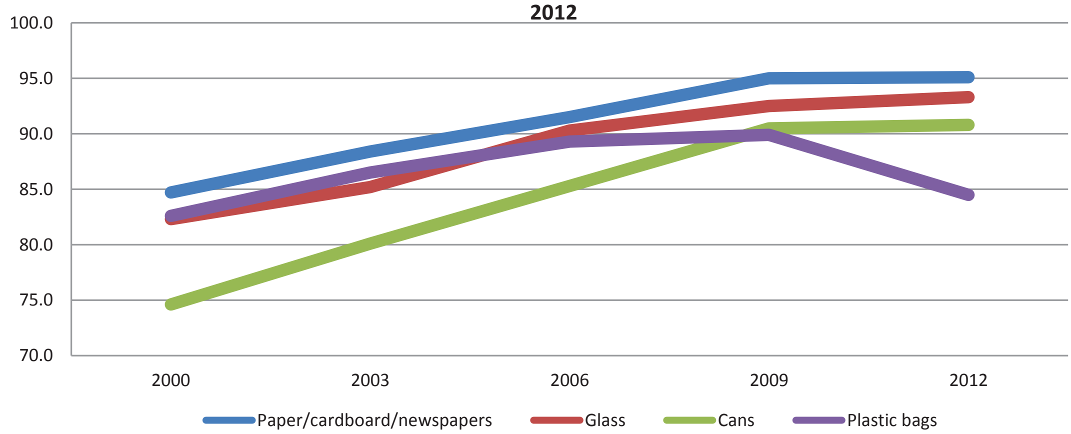
Figure 8.8 Households that recycle and reuse waste (%), Australia, 2000-2012



Source: *Environmental Issues: Waste Management, Transport and Motor Vehicle Usage, Mar 2012* (ABS cat. no. 4602.0.55.002)

Figure 8.8 shows a slow and consistent increase in the percentage of households recycling and reusing waste through the 10 years to 2010. This trend was reversed with a large decline in households that reuse waste, from 86% in 2009 to 73% in 2012 and by a smaller 1% drop in households that recycle. Figure 8.9 suggests a possible explanation for these recent falls.

Figure 8.9 Proportion of households that recycle selected product types, Australia, 2000 – 2012



Source: Environmental Issues: Waste Management, Transport and Motor Vehicle Usage, Mar 2012 (ABS cat. no. 4602.0.55.002)

Waste *continued*

Recycling rates for most waste types were either stable during the time period or slowly increasing. Plastic bag recycling rates dropped from 89% in 2009 to 85% in 2012, a three year period during which, three states and territories (SA, NT and ACT) introduced plastic bag bans. Fremantle, WA became the first local council to adopt a plastic ban early in 2013, while local councils in other states and the state government of Tasmania are currently assessing legislation to implement plastic bag bans. Data are not available for NT and ACT in 2012, but SA showed a large decrease in the proportion of households that reused or recycled plastic bags, from 86% down to 78%. The drop in plastic bag use, and subsequent reuse is a contributing factor in the overall drop in households that reuse any type of waste in 2012 as seen in figure 8.8.

CHAPTER 9 ENVIRONMENTAL INSTRUMENTS AND ECONOMIC OPPORTUNITIES

Introduction

Economic progress and environmental sustainability are commonly viewed as competing objectives. While economic activity is a significant driver of environmental pressure, economic instruments such as environmental taxes can be used to alter human behaviour and help to deliver improved environmental outcomes. In addition, some forms of economic activity have a positive impact on the environment, for example, various environmental protection activities and certain types of R&D activity. By fostering these types of activities, an economy is able to decouple economic growth and adverse environmental outcomes.

This chapter presents a range of data on environmentally related economic instruments, and on activities that generate both economic output and positive environmental outcomes. The chapter first looks at government initiatives, with a focus on environmental taxes. The recent ABS paper *Environmental Taxes in Australia – Experimental New Statistics* (ABS cat. no. 4629.0.55.001) provides the basis for discussion. Areas measured include environmental taxation revenues over time, as well as an industry (plus households) breakdown of the level of environmental taxes paid. Environmental subsidies and permits are touched on, however, data on these areas are still in the early stages of development.

Economic opportunities resulting from protecting and managing the environment are then examined, focusing on innovation and technology; indicators profiled include environmental R&D expenditure by the public and corporate sectors. There is currently a dearth of statistics on economic growth originating from environmental protection activities. However, what data there are can be used to gauge the extent of economic activity arising from the demand for environmental protection based products. In line with this, measures are underpinned by previously unpublished data sourced from the *ABS Economic Activity 2010–11 survey* and cover aspects of air emissions management by industry.

Data sources for indicators

The indicators presented in this chapter are supported by a number of the accounts from the SEEA Central Framework. The two main accounts are the Environmental Protection Expenditure Account (EPEA) and the Environmental Goods and Services Sector account. Both focus on the production and use of goods and services in the economy that can be defined as being for the purpose of environmental protection, natural resource management or "green". Neither the environmental protection expenditure accounts nor an environmental goods and services sector account are produced by the ABS at present.

The ABS has published experimental estimates of environmental tax revenues in *Completing the Picture – Environmental Accounting in Practice* (cat. no. 4628.0.55.001). A more comprehensive investigation of environmental taxes was contained in the recent ABS discussion paper *Environmental taxes in Australia – Experimental new statistics* (ABS cat. no. 4629.0.55.001). These statistics were compiled in accordance with the SEEA Central Framework and as such provide statistics coherent with the information contained in the ASNA, as well as the suite of other environmental accounts[65] produced by the ABS. Statistics on environmental taxes have the potential to

65 Energy Account, Australia (ABS cat. no. 4604.0); Water Account, Australia (ABS cat. no. 4610.0), Waste Account, Australia (ABS cat no. 4602.0.55.005)

Data sources for indicators continued

inform environmental policy and decision making. In particular, environmental taxes can be used to achieve improved outcomes for the environment as well as to provide incentive for innovation[66].

Environmental taxes

Economic activity places various stresses on the environment, including, by producing waste; emitting pollutants into the air and water; and using natural resources. Society's contribution to environmental problems can also be created in an indirect way; for example, by consuming goods and services in which emissions are discharged during the production process. One of the policy instruments to reduce environmental damage is to impose taxes on harmful products and activities.

According to the SEEA Central Framework "an environmental tax is a tax whose tax base is a physical unit (or a proxy of it) of something that has a proven, negative impact on the environment"[67] thereby increasing the price on activities and products that are harmful to the environment. Environmental taxes encourage consumers and producers to adjust their consumption and production patterns to achieve cost reductions and, as a consequence of the changes in consumption and production, better environmental outcomes. Monitoring these taxes can provide useful information for assessing how economic instruments can achieve these changes.

There are at least 125 types of taxes in Australia[68]. Of these, the majority are levied by the Australian Commonwealth government. In 2009–10, almost 15 million individuals, companies, partnerships or trusts lodged a tax return in Australia, with individuals representing the largest tax payer category at 85% of the total number of tax payers.

In 2010–11 environmental taxes amounted to $26 billion or 7% of total tax revenues and equated to 2% of GDP. Environmental taxes as a proportion of GDP have decreased in the past 10 years (see Figure 9.1). The largest contributor to tax revenue from environmental taxes is excise duty on crude oil and LPG, accounting for 65% by value of total environmental taxes in 2010–11.

66 OECD 2010: Taxation, Innovation and the Environment
67 SEEA 2012, para. 4.150
68 Discussion paper: Environmental taxes in Australia – experimental new statistics (ABS cat. no. 4629.0.55.001)

Figure 9.1 Environmental Taxation Revenue, Australia, 2000– 01 to 2010–11, $M, Current Prices

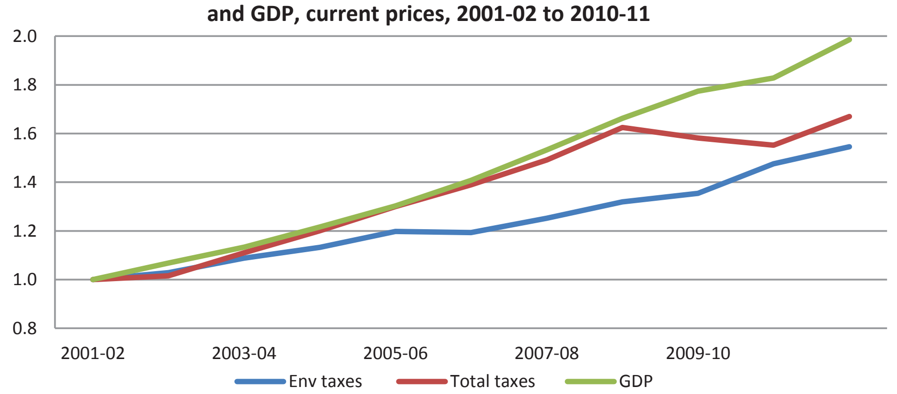
	2000-01	2005-06	2010-11
Crude oil, LPG, gas and petroleum products	12 453	14 075	16 305
Petroleum products taxes	174	—	—
Ozone protection and synthetic GHG (a)	1	1	1
Renewable energy certificates (b)	—	90	980
Stamp duty on vehicle registration	1 387	1 922	2 167
Road maintenance and heavy vehicles duty (import)(c)	2 646	3 672	5 294
Luxury car tax (d)	172	324	489
Passenger motor vehicles duty (import)(a)	na	na	780
Total environmental taxes	**16 833**	**20 085**	**26 016**
% of GDP (e)	3	2	2
% of total tax rev (e)	8	7	7

na Not applicable, no tax implemented at that point in time
(a) Department of Sustainability, Environment, Water, Population and Communities
(b) Clean Energy Regulators
(c) Also includes transfer fees, motor vehicle weight/Engine capacity tax.
(d) Government budget 2011
(e) Not including Renewable energy certificates as the aggregates GDP and total tax revenues exclude these.
Source: Taxation revenue 2010-11 (ABS cat.no. 5506.0)

Environmental taxes continued

Figure 9.2 plots changes in current price estimates of total taxes, environmental taxes and GDP between 2001–02 and 2010–11. Over this period, total taxes rose faster than environmental taxes, while GDP grew more rapidly than either of these categories of taxes.

Figure 9.2 The change in taxes, environmental taxes and GDP, current prices, 2001-02 to 2010-11



Note: Index: 2000-01 = 1
Source: Australian System of National Accounts 2011-12 (ABS cat. No. 5204.0); *Taxation revenue, Australia, 2010-11* (ABS cat. no. 5506.0)

Figure 9.3 presents information on environmental taxes broken down by industry and households for 2000–01, 2005–06 and 2010–11. Industry pays approximately 67% of environmental taxes while household's share is about 33%. Households account for 30% of total energy taxes and 44% of total transport taxes.

Figure 9.3 Environmental taxes by industry and households, 2000– 01 to 2010– 11, $m			
	2000-01	2005-06	2010-11
Agriculture	552	667	776
Mining	759	925	1522
Manufacturing	4371	4904	5105
EGW&W	180	316	1406
Construction	299	396	1128
Transport	2194	2780	3287
Services	2542	3230	4189
Households	5756	6864	8603
Not allocated (a)	181	3	1
Total	**16833**	**20085**	**26016**

(a) Gas franchise taxes and Petroleum products franchise taxes, Ozone Protection and synthetic GHG

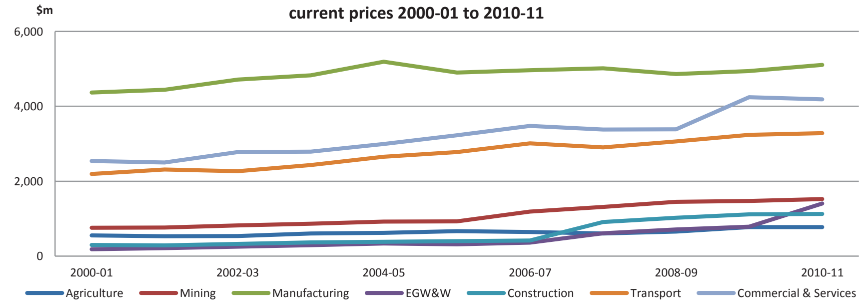
Source: Discussion paper: Environmental taxes in Australia – experimental new statistics (ABS cat. No. 4629.0.55.001)

Environmental taxes continued

The manufacturing industry made the highest contribution to energy taxes paid by any industry (39%) in 2010–11, while services contributed most to total transport taxes paid by industry (62%).

In 2010–11, the Agriculture industry paid around 3% of energy taxes, but accounted for 23% of GHG emissions. However, one third of these GHG emissions stem from changes in land use and deforestation, which do not relate to the use of energy products. Conversely, GHG emissions from the electricity, gas, water and waste services industry (EGW&W) account for close to 40% of total GHG emissions by Australian industry, but this industry contributes only 10% of energy taxes.

Figure 9.4 Environmental taxes by industry, current prices 2000-01 to 2010-11



Source: Discussion paper: Environmental taxes in Australia – experimental new statistics (ABS cat. No. 4629.0.55.001)

Figure 9.4 presents information on environmental taxes paid by industries between 2000–01 and 2010–11. The manufacturing industry was the most significant industry contributor to environmental taxes paid throughout this period. The EGW&W industry saw the most significant relative rise in the amount paid towards environmental taxes, recording an increase of 680%. An increase in taxes related to energy activities over the period represented the bulk of this rise. Despite this, the amount of environmental taxes paid by the EGW&W industry per annum was less than the manufacturing, commercial and services, mining and transport industries throughout the decade preceding 2010–11.

Economic opportunities arising from sustainable growth

At present, there are limited statistics on economic growth originating from the provision of environmental protection services. The definition of these services is problematic and collecting data in this area typically requires either specialised surveys, or detailed information on productive activities. Although no recent and comprehensive data for these activities are available, information is available for various categories of environmental protection expenditure. These data provide valuable information for policy–makers in a number of important areas.

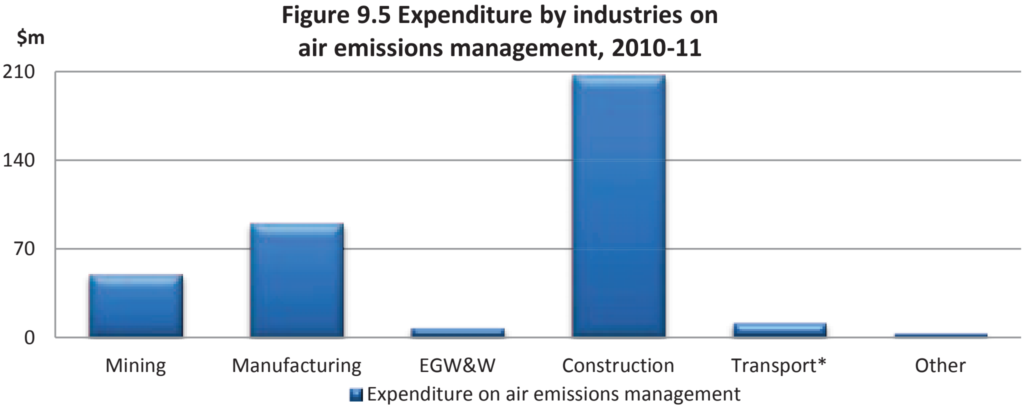
Air emissions management activities

Air emissions management in this context relates to efforts by industry to ameliorate air quality problems through economic activities and processes such as:

- energy consumption that requires the burning of fossil fuels (oil, gas and coal) and results in the release of climate changing greenhouse gases and air pollution;
- the release of fumes, odours and emissions from products or processes that are used; and
- the use of motor vehicles for transportation of goods[69].

Air emissions management can include activities such as managing air quality inside an economic unit's premises (e.g. ensuring air conditioning systems do not contain Legionnaires disease), as well as reducing the emissions of pollution due to economic production (e.g. reducing the amount of smoke or fine particle pollution emitted from chimneys).

Figure 9.5 Expenditure by industries on air emissions management, 2010-11



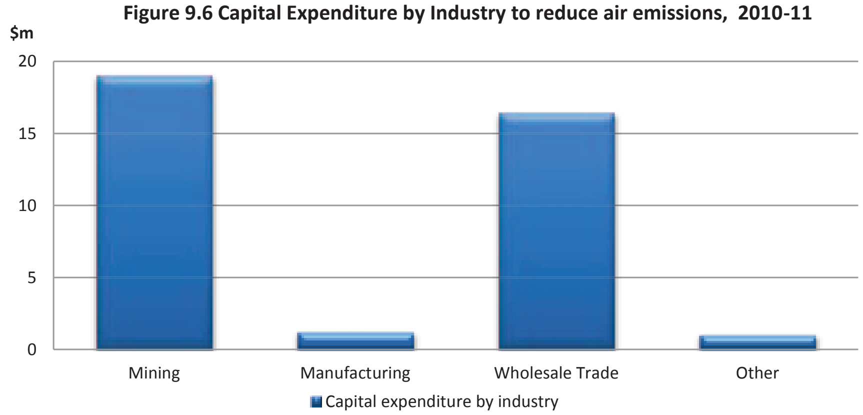
* Transport includes postal and warehousing
Source: *ABS Economic Activities Survey, 2010-11*, unpublished data

Figure 9.5 illustrates that construction, followed by manufacturing and mining were the largest contributors to total industry spending on air emissions management during 2010–11.

Figure 9.6 presents the capital expenditure by industry to reduce air emissions. Australian industry's spending on capital to reduce its contribution to air emissions exceeded $37.6m during 2010–11. However, this represented less than 1% of total capital expenditure by Australian businesses during the same period.

69 Environment and Heritage, NSW Government http://www.environment.nsw.gov.au/sustainbus/smallfactair.htm

Figure 9.6 Capital Expenditure by Industry to reduce air emissions, 2010-11



Source: *ABS Economic Activities Survey*, 2010-11, unpublished data

Air emissions management activities continued

The mining and wholesale trade industries were the biggest contributors to capital expenditure aimed at reducing air emissions, together contributing 94% of all industry spending in this area. Within the mining industry, the vast majority of expenditure was by the metal ore, and coal mining subdivisions of the industry.

Wholesale trade was the second biggest individual investor in equipment to reduce its emissions to air, spending roughly $16.4m during 2010–11. The wholesale trade industry largely comprises businesses engaged in the purchase and on selling, and the commission based buying and selling of goods, without significant transformation, to other businesses.

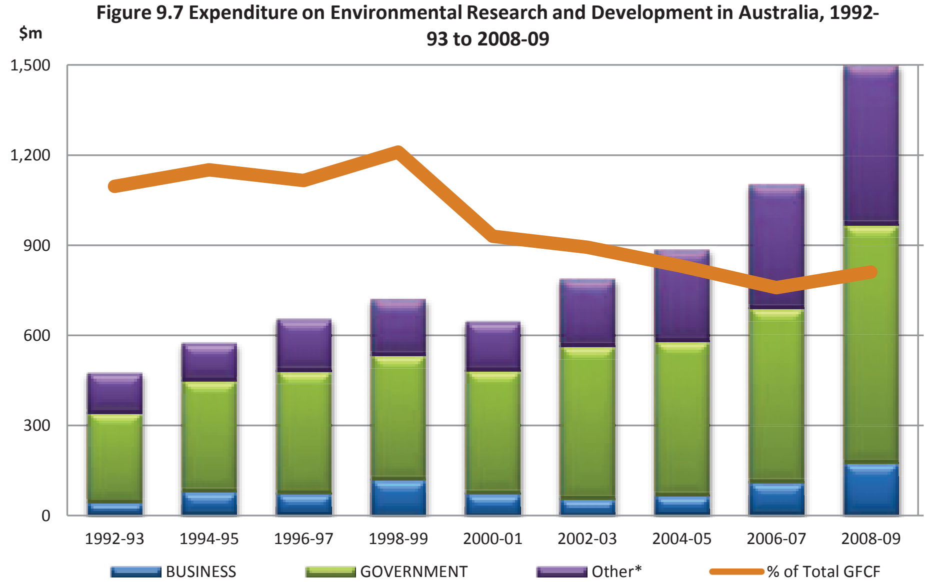
Environmental research and development (R&D)

Technology developments and innovation are important drivers for growth and productivity in the economy. They are also important for managing energy and material flows successfully and have a bearing on policies intended to preserve natural resources and materials and minimise pollution burden. R&D is a key element of attempts to decouple environmental pressure from economic growth.

Innovation is clearly central to moving an economy onto a more sustainable growth trajectory. Businesses have an important role to play in adopting greener management approaches; developing and using new technologies; carrying out R&D and delivering innovation. Businesses, along with governments, also play an important role in providing consumers with the information needed to make purchasing choices that reduce the environmental impact of consumption.

The most significant items of environmental R&D include policy frameworks, and knowledge and management of the environment. Another element of R&D in this area relates to environmental protection expenditure (EPE). This includes expenditure to reduce or prevent emissions to air or water, to dispose of waste materials, to protect soil and groundwater, to prevent noise and vibration, or to protect the natural environment.

Figure 9.7 Expenditure on Environmental Research and Development in Australia, 1992-93 to 2008-09



* Includes higher education and non-profit organisations
Source: Research and experimental development, All sector summary, Australia (ABS cat. No. 8112.0)

Environmental research and development (R&D) continued

Figure 9.7 shows that expenditure on environmental R&D as a percentage of total gross fixed capital formation (GFCF) across all sectors of the Australian economy fell from 7% in 1992–93 to 5% in 2008–09. In absolute terms, however, expenditure in environmental R&D has recorded a steady rise over the same period, with spending by government (both Commonwealth, and State and Territory) increasing by over two and a half times and investment by business increasing by over 300%. Spending by other institutions (higher education and non–profit organisations) also rose sharply increasing by over 300% between 1992–93 and 2008–09.

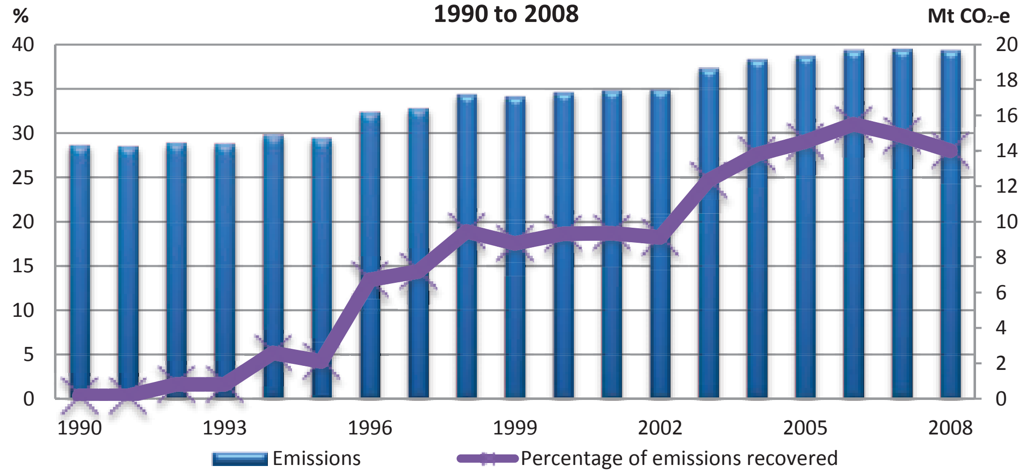
Australian authorities have provided broad–based support for R&D, notably through tax breaks, which have proved beneficial to environmental R&D investment. In May 2007, the Australian government further boosted R&D investment with a 10–year, $1.4 b package. The initiative was particularly supportive of environmental research, with the objective of fostering a more sustainable and internationally competitive business sector.

Recovery of landfill emissions for economic uses

A significant by–product of waste disposal is gas emissions into the atmosphere. When organic waste decomposes in landfills, it releases methane and other greenhouse gases, contributing to climate change. Similarly, greenhouse gases are also emitted during the treatment and processing of waste water and sewage, and during the incineration of waste.

Gas captured at Australian landfills can be utilised for many different purposes. Typically it is used as a fuel for electricity generation, but it can also be used to fuel nearby industrial facilities, or processed and sold to gas providers.

Figure 9.8 Landfill emissions recovery, proportion recovered, 1990 to 2008



Source: Measures of Australia's Progress, 2010 (ABS cat. No. 1370.0)

Recovery of landfill emissions for economic uses continued

Figure 9.8 presents information on the level of landfill emissions, together with the proportion recovered over time in Australia. Total landfill emissions in Australia rose by roughly 38% between 1990 and 2008. However the greater use of methods to recover greenhouse gases from landfills for use in the production of energy means the change in net emissions related to landfill management has been more modest (8%). In 2008, around 28% of landfill emissions in Australia were recovered compared to less than 1% in 1990.

What is the System of Environmental–Economic Accounting?

The SEEA is an accounting framework that records as completely as possible the stocks and flows relevant to the analysis of environmental and economic issues. The accounting approach of the SEEA is different from groupings of independent statistics on environmental and economic issues because it demands coherence and consistency with a core set of definitions and treatments. As such the SEEA provides a framework to combine a wide range of source data to create aggregates, indicators and trends across the broad spectrum of environmental and economic issues.

The SEEA has its roots in the *System of National Accounts* (SNA). The SNA is a framework that measures economic activity and organises a wide range of economic data into a structured set of accounts. It defines the concepts, classifications and accounting rules needed to do this. The SNA measures economic activity in monetary terms and such valuation is usually based on market transactions. In a limited number of cases where market transactions do not occur but the transactions are very similar to market transactions, the value is approximated using a range of internationally agreed techniques. The SEEA extends the SNA by recording environmental data that are usually available in physical or quantitative terms in conjunction with the economic data in monetary terms from the SNA. Much of the power of the SEEA comes from its capacity to present information in both physical and monetary terms in a coherent manner.

The integration of information concerning the economy and the environment requires a multi–disciplinary approach. The SEEA thus brings together, in a single framework, information on water, minerals, energy, timber, fish, soil, land and ecosystems, pollution and waste, production, consumption and investment. Each of these areas has specific and detailed measurement approaches that are integrated within the SEEA to provide a comprehensive view.

The SEEA is not designed to replicate or replace the richness and depth of data that currently exists in each specific area of environmental study. Rather it is the linkages and connections developed in the SEEA that provide an additional and broader perspective and hence add value to the detailed information already available.

The broad and integrated nature of the SEEA makes it a relevant framework for the analysis of a wide range of current environmental policy issues; from the management of individual natural resources, to the consideration of the prospects for decoupling economic growth from adverse environmental impacts.

Apart from these specific applications, the SEEA can also be used for:

1. deriving a range of indicators concerning environmental–economic issues such as energy use, water consumption, depletion of natural resources, etc;
2. trend analysis through the use of common definitions and standards;
3. providing a framework for organising existing data and for assessing its quality and completeness;
4. monitoring the state of the environment and its relationship to the economy;
5. following changes in trade patterns and emissions embedded in categories of final demand through physical input–output analysis;
6. understanding where and when the benefits and costs of natural resource use accrue; and
7. enabling international reporting and comparisons.

The SEEA as a system

The SEEA consists of a coherent, consistent and integrated set of tables and accounts each of which focus on different aspects of the interaction between the economy and the environment or on the changing state of the environment. The tables and accounts are based on internationally agreed concepts, definitions, classifications and accounting rules.

The SEEA as a system continued

There are four main types of accounts in the SEEA framework. These accounts can be integrated with the existing monetary stock and flow accounts of the SNA:

1. Physical flow accounts;
2. Functional accounts for environmental transactions;
3. Asset accounts in physical and monetary terms; and
4. Ecosystem accounts.

The first three types of accounts form the core of the SEEA and are known as the accounts of the SEEA Central Framework. Ecosystem accounts will be described in a second part of SEEA known as SEEA Experimental Ecosystem Accounts. The four main types of accounts are briefly described below.

Physical flow accounts record flows of natural inputs from the environment to the economy, flows of products within the economy and flows of residuals generated by the economy. These flows include water and energy used in production (e.g. of agricultural commodities) and waste flows to the environment (e.g. solid waste to landfill).

Functional accounts for environmental transactions record the many transactions between different economic units (i.e. industries, households and governments) that concern the environment. The relevant transactions are identified by first defining the set of environmental activities, i.e. those activities that reduce or eliminate pressures on the environment and that aim to make more efficient use of natural resources. Examples include investing in technologies designed to prevent or reduce pollution, restoring the environment after it has been polluted, recycling, conservation and resource management. Environmental activities are classified as being either environmental protection activities or resource management activities.

Asset accounts in physical and monetary terms measure the natural resources available and changes in the amount available. Asset accounts focus on the key individual components of the environment: mineral and energy resources; timber resources; fish/aquatic resources; other biological resources; soil resources; water resources; and land. They include measures of the stock of each environmental asset at the beginning and end of an accounting period and record the various changes in the stock due to extraction, natural growth, discovery, catastrophic loss and other reasons.

The compilation of asset accounts in physical terms can provide valuable information on resource availability and may help in the assessment of sustainability. A particular feature of the SEEA asset accounts is the estimation of depletion of natural resources in physical and monetary terms. For non–renewable resources the quantity of depletion is equal to the quantity of resource extracted but for renewable resources the quantity of depletion must take into account the underlying population, its size, rate of growth and associated sustainable yield.

Ecosystem accounts are a developing area and not part of the SEEA international statistical standard. Ecosystems are areas containing a dynamic complex of plant, animal and micro–organism communities and their non–living environment interacting as a functional unit. Ecosystem accounts are structured to summarise information about these areas, their changing capacity to operate as a functional unit and their delivery of benefits to humanity.

The benefits received by humanity are known as ecosystem services. They are delivered in different forms and are grouped into three broad categories. The first category of ecosystem services is provisioning services. These are the benefits received from the natural inputs provided by the environment such as water, timber, fish and energy resources. The second category is regulatory services. These include the benefits provided when an ecosystem operates as a sink for emissions and other residuals, when an ecosystem provides flood mitigation services or when an ecosystem provides

The SEEA as a system continued

pollination services to agriculture. The third category is cultural services. These are the benefits provided when an ecosystem such as a forest, provides recreational, spiritual or other benefits to people.

Each of the different types of accounts is connected within the SEEA framework but each focuses on a different part of the interaction between the economy and the environment. Examples of the relationships between the different accounts include:

- Asset accounts and ecosystem accounts focus on the stock and changes in the stock of environmental assets, with asset accounts focusing on the individual components and ecosystem accounts focusing on the interactions between these components.
- Changes in the stock are most often the result of economic activity which in turn is the focus of physical flow accounts. Measurement of flows of natural inputs in the physical supply and use tables is consistent with the measurement of extraction in the asset accounts and the measurement of provisioning services in ecosystem accounts.
- Measurement of flows of residuals to the environment as recorded in physical supply and use tables is an important consideration in the measurement of ecosystem services, particularly regulatory services.
- Measures of the flows of natural inputs and residuals can also be related to transactions recorded in functional accounts for environmental protection and resource management, including investment in cleaner technologies and flows of environmental taxes and subsidies. For example, payments for emission permits recorded in functional accounts can be related to the flows of emissions recorded in the physical supply and use tables.
- The effectiveness of the expenditure for environmental purposes may, ultimately, be assessed by changes in the capacity of ecosystems to continue their delivery of ecosystem services as recorded in ecosystem accounts.

These examples serve to highlight the many and varied relationships between the accounts, each taking a different perspective. Throughout the SEEA these relationships are supported by the use of common concepts, definitions and classifications.

VALUATION

One of the most difficult aspects of environmental decision–making is how to make trade–offs between the environmental assets that deliver a range of non–market goods and services, including ecosystem services, against development alternatives for which there are clear economic values. The SNA and the SEEA Central Framework include the value of environmental assets that have direct economic values. For example land, timber, fish, minerals and fossil fuels are included in the national balance sheet[70]. Valuation in the SNA and the SEEA Central Framework is based on market transactions or, where these are unavailable, the net present value of future expected income resulting from the use of these assets is recommended.

However, some environmental assets and many ecosystem services are not transacted in markets, although the value of some services may be included in the value of goods and services traded in markets. For example, the value of pollination is captured in the value of agricultural crop production, while tourism operators derive income from the people visiting natural attractions such as Uluru and the Great Barrier Reef.

The development of standardised methods for identifying and separately distinguishing the value of environmental assets and ecosystem services is an on–going area of work in the SEEA Experimental Ecosystem Accounts. The recognition of the value of these assets and services will provide important information to decision–makers and enable comparisons between different development alternatives.

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70 See Australian System of National Accounts (ABS cat. no. 5204.0)

THE SEEA AS A CO–ORDINATING FRAMEWORK FOR ENVIRONMENTAL–ECONOMIC STATISTICS

The SEEA stands apart from individual sets of environmental statistics in a number of ways. While sets of environmental statistics are usually internally consistent, there is, usually for good reason, often little consistency between one set of statistics and another. Environmental statistics are often collected with a particular regulatory or administrative purpose in mind and the way in which they are structured is specific to this need.

In contrast, the SEEA is an integrated system of accounts in which, to the fullest extent possible, there is consistency between one account and another in terms of concepts, methods, definitions and classifications. In addition, implementation of such an integrated system aims for consistency across time. This is of the utmost importance in developing the comparable timeseries estimates that are necessary in informing the policy process. The final important difference between environmental statistics and the SEEA is the latter’s explicit goal of achieving compatibility with the economic information of the SNA, including that contained within satellite accounts of the SNA. This adds considerable value to both environmental and the economic information, as it facilitates their analysis within a common framework.

The SEEA is different from traditional sets of environmental statistics in important ways, but it also relies upon them for the basic statistics required in its implementation. Ideally, these statistics would be readily available in a format that allowed their direct incorporation into the system. For example, data on air emissions from industrial sources would ideally be classified according to the industrial classification used in the SEEA. This would allow their simple incorporation into physical flow accounts and combined accounts.

It is likely that over time, as the SEEA becomes better known and adopted, there will be changes to the way in which environmental statistics are collected and structured, and in particular the adoption of common classifications and definitions of concepts. For this to occur there must be a spirit of collaboration and respect between those producing environmental accounts and those collecting data. The former group must understand that collecting data for environmental accounts may be a secondary concern for those responsible for providing information to, for example, a regulatory programme. The latter group must be convinced of the importance of having highly structured and consistent data within an accounting framework. The SEEA can serve as a guiding framework for the development of environmental information systems that are more compatible with economic statistics.

SEEA DEVELOPMENT AND IMPLEMENTATION

The ABS has been working closely with a range of institutions nationally and internationally on the development and implementation of environmental accounting. In Australia, the ABS, the Department of Sustainability, Environment Water, Population and Communities and the Bureau of Meteorology are collaborating on the National Plan for Environmental Information (NPEI), the State of the Environment Report as well as the planning for national environmental accounts. The NPEI is a particularly important initiative as environmental accounts must be underpinned by regular and reliable environmental information. Also at the national level the ABS is working with the Department of Resources Energy and Tourism and the Department of Climate Change and Energy Efficiency on issues relating to the data needed for regular SEEA–based energy and greenhouse gas emissions accounts. At the state level the ABS has worked closely with the Queensland and Victorian governments in developing pilot land accounts, with a view to developing land accounts in other states as resources and data permit. The ABS is also contributing to the development of environmental accounting in the catchment management authorities as well as to research by academics into biodiversity, carbon and ecosystem accounting.

SEEA DEVELOPMENT AND IMPLEMENTATION *continued*

Internationally the ABS has been working with the international statistical community to develop the SEEA, chiefly through the process established by the United Nations Statistical Commission and the United Nations Committee of Experts on Environmental–Economic Accounting (UNCEEA). The UNCEEA is currently chaired by the ABS and has representatives from the national statistical offices of other countries as well as international agencies – Food and Agricultural Organisation, International Monetary Fund, Organisation for Economic Cooperation and Development, United Nations Statistics Division, and World Bank.

The development of ecosystem accounts for the SEEA has been a focus of research in recent times. This work is building on the SEEA Central Framework as well as Australian and international experience. For example, the United Kingdom's National Ecosystem Assessment[71] a range of work by the European Environment Agency[72], the development of the Common International Classification of Ecosystem Services[73], the Australia Ecosystem Services: Key Concepts and Applications[74] and others in Australia and elsewhere. Much of this experience has been brought together through a series of international meetings of the Expert Group on Ecosystem Accounts, held most recently in Melbourne 16–18 May 2012[75]. The United Nations Statistical Commission at its 44th session held early in 2013 welcomed the work on SEEA experimental ecosystem accounting as an important first step in developing a statistical framework for ecosystem accounting and requested that the UNCEEA develop a program of further work to progress this topic.

71 UK National Ecosystem Assessment, 2011. http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx
72 E.g. European Environment Agency, 2011. An Experimental framework for Ecosystem Capital accounting. http://www.eea.europa.eu/publications/an-experimental-framework-for-ecosystem
73 Haines–Young, R. 2010. Proposal for a Common Classification of Ecosystem Goods and Services (CICES) for Integrated Environmental and Economic Accounting. http://www.nottingham.ac.uk/cem/pdf/UNCEEA-5-7-Bk1.pdf
74 Department of Environment, Water, Heritage and the Arts, 2009. http://www.environment.gov.au/biodiversity/publications/pubs/ecosystem-services.pdf
75 Expert Group Meeting on Ecosystem Accounts. Melbourne 16–18 May 2012. http://unstats.un.org/unsd/envaccounting/seeaLES/egm2/lod.htm

GLOSSARY

ANZSIC	The Australian and New Zealand Standard Industrial Classification (ANZSIC) is the standard classification used in Australia and New Zealand for the collection, compilation, and publication of industry statistics.
Bagasse	Residue of the sugar cane milling process.
Black coal	A sedimentary organic rock consisting of anthracite, bituminous and sub–bituminous rank coals. Black coal is primarily used as a solid fuel to raise steam to generate electricity and to produce coke for steelmaking.
Biofuels	Produced from renewable organic sources or 'feedstocks', biofuels include ethanol and biodiesel, and are commonly used as a fuel in transportation.
Briquettes	Made from brown coal through a process of crushing, drying and the addition of a binding agent, to produce a compact, high energy fuel easily transported and commonly used for industrial and domestic heating.
Brown coal	Also known as lignite, is a low rank, brownish–black coal with a high moisture content of around 60%.
Chain Volume Measure	For certain types of economic analysis it is useful to examine estimates of the principal flows of goods and services in the economy revalued in such a way as to remove the direct effects of price change over the relevant period. These estimates are obtained by first weighting together the elemental volume indexes from the previous financial year to the current financial year, where the weights are calculated using the current price value shares of the previous financial year. Second, the resulting aggregate year–to–year volume indexes are linked together to form a time series. Third, the time series is referenced to the current price estimates of the reference year.
Coal by–products	Include blast furnace gas (from iron and steel processing), coal tar and benzene/toluene/xylene (BTX) feedstock and coke oven gas (from the coke making process).
Condensate	A liquid mixture of pentanes and heavier hydrocarbons that form part of the vapour phase of natural gas in the reservoir and become liquid under standard field separation conditions. Treated as crude oil in Energy Account, Australia.
Construction	The process which involves adding structure to real property or the building or assembling of infrastructure. It includes the additions, alterations, reconstruction, installation and maintenance and repairs of buildings and other structures.
Conversion loss	Energy lost in the transformation of energy into a different 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.
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Distributed water	Distributed water is water supplied to a user including through a natural (e.g. river) or non–natural network (piped or open channel), and where an economic transaction has occurred for the exchange of this water. The majority of distributed water is supplied by the water supply, sewerage and drainage services industry (ANZSIC Division 28). Distributed water can include potable, mains and raw water but does not include reuse or bulk water.
Drainage water	Excess surface or subsurface water collected and conveyed from irrigated lands. It may be captured for reuse or conveyed for downstream demands.
Economically demonstrated resources	Economically demonstrated resources (EDR) is used to measure the physical extent of a given resource. EDR is a measure of the resources that are established, analytically demonstrated or assumed with reasonable certainty to be profitable for extraction or production under defined investment assumptions. Classifying a mineral resource as

EDR reflects a high degree of certainty as to the size and quality of the resource and its economic viability.

Electricity The flow of electrical power or charge. It is commonly derived from burning organic matter, especially coal and natural gas. Other sources include hydroelectricity, solar photovoltaic, wind and nuclear.

Electrical and Electronic waste (or Ewaste) Waste electrical and electronic equipment that is dependent on electric currents or electromagnetic fields in order to function (including all components, subassemblies and consumables which are part of the original equipment at the time of discarding. Ewaste may include (a) consumer/entertainment electronics (e.g. televisions, DVD players and tuners) (b) devices of office, information and communications technology (e.g. computers, telephones and mobile phones) (c) household appliances (e.g. fridges, washing machines and microwaves) (d) lighting devices (e.g. desk lamps) (e) power tools (f) devices used for sport and leisure including toys (e.g. fitness machines and remote control cars).

Energy intensity A measure of the energy consumed to produce one unit of economic output, measured in this publication in gigajoules of energy per million dollars of Industry Gross Value Added (GJ/$m IGVA)

Environmental–economic 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. See also SEEA.

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

Final use Use that finally consumes a product, as opposed to an intermediate use. Final use includes: household final consumption; government final consumption; exports; and changes in inventories.

Forest Vegetation with a minimum 20 per cent canopy cover, potentially reaching 2 metres high and a minimum area of 0.2 hectares.

Flow accounts A framework which presents information on the physical flows of resources throughout the economy.

Fossil fuel Any natural fuel derived from decomposed or partly decomposed organic matter (eg. oil, natural gas and coal).

Gigalitre One thousand million litres

Gross domestic product – GDP Is the total market value of goods and services produced in Australia within a given period after deducting the cost of goods and services used up in the process of production but before deducting allowances for the consumption of fixed capital. Thus gross domestic product, as here defined, is 'at market prices'. It is equivalent to gross national expenditure plus exports of goods and services less imports of goods and services. Farm product is that part of gross domestic product which arises from production in agriculture and services to agriculture. It is equivalent to the value added of ANZSIC 06 subdivision 01 'Agriculture' plus taxes less subsidies on products primary to this subdivision. Non-farm product arises from production in all other industries.

Gross energy Is the energy contained in primary energy (energy sourced directly from nature) as well as the energy derived from it. See also net energy.

Groundwater Water occurring below the ground's surface.

Gross value added – GVA The value of output at basic prices minus the value of intermediate consumption at purchasers' prices. The term is used to describe gross product by industry and by sector. Basic prices valuation of output removes the distortion caused by variations in the incidence of commodity taxes and subsidies across the output of individual industries.

Hazardous waste	Hazardous, special, listed or prescribed wastes, that are potentially harmful to human health or the environment, requiring special treatment. Examples include waste oils, organic chemicals, contaminated earth, medical wastes, asbestos, acids, reactive chemicals, pesticides and radioactive material.
Hydropower	A process in which flowing water is harnessed to generate power, especially electricity.
In–stream use	The use of freshwater in situ (e.g. within a river or stream). Can include recreation, tourism, scientific and cultural uses, ecosystem maintenance, hydro–electricity and commercial activities, and dilution of waste. The volume of water required for most in–stream uses cannot be quantified, with the exception of hydro–electricity generation.
Inseparable/unknown	General waste consists of non–hazardous materials which have been discarded and cannot be re–used or recycled. General waste is also known as putrescible or mixed waste. General waste can include food waste, wax cardboard, tissue paper and soiled containers.
Intermediate use	Intermediate use 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.
IPCC	International Panel on Climate Change
Kilolitre	One thousand litres
Land cover	Refers to the physical surface of the earth, including various combinations of vegetation types, soils, exposed rocks and water bodies as well as anthropogenic elements, such as agriculture and built environments. Land cover classes can usually be discriminated by characteristic patterns using remote sensing.
Land use	The purpose to which the land cover is committed. Some land uses, such as agriculture, have a characteristic land cover pattern. These usually appear in land cover classifications. Other land uses, such as nature conservation, are not readily discriminated by a characteristic land cover pattern. For example, where the land cover is woodland, land use may be timber production or nature conservation.
Landfill	A site used for disposal of solid material (i.e. is spadeable) by burial in the ground between layers of earth.
Liquefied natural gas (LNG)	Natural gas which has been refrigerated to a liquid state, which greatly reduces its volume and enables its transport by sea–going vessels.
Liquefied petroleum gas (LPG)	A combination of propane and butane, along with trace amounts of other compounds, recovered in either natural gas extraction or oil refining. The gases are transformed into a liquid to assist in transport.
Masonry materials	Masonry materials include asphalt, bricks, concrete, clay, fines, rubble and soil. Waste produced by demolition and building activities, including road and rail construction and maintenance and excavation of land associated with construction activities.
Megalitre	One million litres
Natural gas	A combustible mixture of hydrocarbon gases. While natural gas is formed primarily of methane, its composition can vary widely, commonly including ethane, propane, butane and pentane.
Natural Resource Management regions	56 regions across Australia based on catchments and bioregions. Ten of these regions fall within Victoria.

Native vegetation Native vegetation refers to all indigenous terrestrial or aquatic plants in an area, incorporating all living and non–living components. This includes Australia's diverse natural vegetation and permanent native plantings for biodiversity and sustainable land management purposes. In the context of native vegetation, indigenous refers to vegetation that is within its natural geographical area.

Net supply of energy Net supply refers to energy products as they enter the economy, either by domestic extraction (e.g. mining production) or as imports. In the context of this paper, 'net' indicates the removal of energy supplied from secondary sources to avoid double counting.

Net use of energy Net energy use consists of intermediate consumption by industry, final consumption by households, exports, inventory changes, conversions and losses. In the context of this paper, 'net' refers to energy consumed for final purposes.

NGERS The National Greenhouse and Energy Reporting System, which commenced in relation to the 2008–09 reference period, is a framework for the mandatory reporting of greenhouse gas emissions, energy consumption and energy production by Australian businesses exceeding specified thresholds of emissions or energy consumption.

Organic waste Component of the waste stream from plant or animal sources that is readily biodegradable, e.g. paper and cardboard, food waste, biosolids, green waste and timber.

Other volume changes Quantify changes in resources that occur between one period and another.

Output Consists of those goods and services produced within a business that become available for use outside that business, plus any goods and services produced for own final use.

Petajoule (PJ) A petajoule is equal to one million gigajoules, or 10 to the power of 15 joules. Petajoules are typically used to measure national or industry energy production and consumption. The energy supply and use data present in this publication are in petajoules (PJ).

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

Potable water Treated water that is suitable for human consumption, e.g. drinking water

Purchasers' price The amount paid by the purchaser, excluding any deductible tax, in order to take delivery of a unit of a good or service at the time and place required by the purchaser. The purchaser's price of a good includes any transport charges paid separately by the purchaser to take delivery at the required time and place

Recovery rate Proportion of waste received at facilities other than landfill that was recovered for recycling or reprocessing. Equal to the amount recovered divided by the sum of the amount sent for disposal and the amount recovered. Waste that is transferred is not included in this calculation.

Recovered or reprocessed Process of converting or modifying waste into useful material or energy so that they do not need to be disposed. Also referred to as materials or resource recovery. Includes sorting, separating and baling.

Recycling A resource recovery method involving the collection and processing of waste for use as a raw material in the manufacture of the same or similar non–waste product.

Refined products Includes products derived from crude oil and other refinery feedstock e.g. automotive gasoline and diesel, aviation gasoline and turbine fuel, kerosene and heating oil, industrial diesel and fuel oil, naphtha and petroleum coke used as fuel.

Regulated discharge Water discharged to the environment after use where that discharge does not match the natural flow regime of the receiving water body. For example, wastewater discharged into a river, ocean or land outfall by a sewerage service provider is considered a regulated discharge. Water discharged from a household is not considered to be a regulated discharge because it is usually discharged into a sewerage system, rather than directly to the environment.

Renewables A source of energy that is not depleted by use, such as water, wind, or solar power.

Residuals All solid, liquid and gaseous wastes. The incidental and undesirable outputs from production and consumption processes within the economy.

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 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.

Resource life The length of time a presently identified economically demonstrated resource stock will last at current production levels. Increases in the resource life of a given mineral resource come from new discoveries and extraction methods, which make deposits economically viable that previously were not.

Reuse water Drainage, waste or storm water that has been used again without first being discharged to the environment. It may have been treated to some extent. It excludes "on–site" recycling.

Self–extracted water Water extracted directly from the environment for use (including rivers, lakes, groundwater and other bodies). Some of this water may be then distributed via water providers to others. Excludes water supplied by water suppliers via regulated systems.

Solar energy Solar energy in the Energy Account Australia refers to solar energy used for electricity generation (by photovoltaic conversion or solar thermal generation) and solar energy used to heat water in solar hot water systems.

Solid waste Waste materials ranging from municipal garbage to industrial waste, but excluding gaseous, liquid, hazardous, clinical and intractable wastes.

Statistical Areas Level 1 (SA1s) The smallest region for which a wide range of census data will be released. SA1s have an average population of approximately 400 and are built from whole Mesh Blocks.

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.

Subdivision A subdivision is a sub–industry within the Australian and New Zealand Standard Industrial Classification. ANZSIC Subdivisions generally reflect distinct production processes related to material inputs, production equipment and employee skills. For example, coal mining is a subdivision within the mining division.

Surface water Water flowing or held in streams, rivers and other wetlands in the landscape.

System of Environmental–Economic Accounting The System of Environmental–Economic Accounting (SEEA). It is a framework used to develop environmental accounts by integrating environmental information into an accounting framework. The SEEA 2012 handbook provides the conceptual basis for developing a framework to describe the inter–relationship between the natural environment and the economy. See also Environmental–economic account.

System of National Accounts 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.

Total supply Australian output plus imports.

Uranium A heavy, radioactive metallic element, used as a source of nuclear energy.

Waste (a) any substance that is discarded, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment;

(b) any discarded, rejected, unwanted, surplus or abandoned substance;

(c) any otherwise discarded, rejected, unwanted, surplus or abandoned substance intended for sale or for recycling, reprocessing, recovery, or purification by a separate operation from that which produced the substance.

Waste water Any water that has been used once and cannot be used again without treatment, for example untreated effluent, sewage water and trade waste.

Water provider A business or organisation that provides a reticulated water supply, irrigation water, reuse/recycle water and/or bulk water supply service. Water providers may be government or private and often operate water storage, purification and supply services. They may also provide sewerage or drainage services.

Wind power The conversion of wind energy into electricity using wind turbines.

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