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COMPLETING THE PICTURE - ENVIRONMENTAL ACCOUNTING IN PRACTICE

AUSTRALIA

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INQUIRIES

For further information about these and related statistics, contact Michael Vardon on Canberra (02) 6252 7348.

NOTES

ABOUT THIS ISSUE

This publication examines a number of complex issues facing policy makers in Australia, such as climate change and natural resource management, and illustrates how environmental accounts can be used to further improve the decision-making process. It also includes a range of accounts that highlight the various interactions between the environment and economy. These accounts are based on the System of Environmental–Economic Accounting which was elevated to an international statistical standard in early 2012.

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Australian Statistician

ABBREVIATIONS

ABS	Bureau of Meteorology
AQI	Air Quality Index
BoM	Bureau of Meteorology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EEA	Environment Expenditure Accounts
EPEA	Environment Protection Expenditure Accounts
EWES	Energy, Water and Environment Survey
GBR	Great Barrier Reef
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GDP	gross domestic product
GHG	Greenhouse Gas
GIS	Geographical Information System
GL	gigalitre
GVA	Gross value added
GVIAP	Gross value of irrigated agricultural production
IGVA	industry gross value added
IPCC	International Panel on Climate Change
IUCN	International Union for Conservation of Nature
LPG	liquefied petroleum gas
LULUCF	Land Use and Land Use Change and Forestry
MAP	Measures of Australia's Progress
MDB	Murray–Darling Basin
MDBA	Murray–Darling Basin Authority
NEPM	National Environment Protection Measure
NPEI	National Plan for Environmental Information
NPV	net present value
NRM	Natural Resource Management areas
NVIS	National Vegetation Information System
OECD	Organisation for Economic Co-operation and Development
PJ	petajoule
SEEA	System of Environmental Economic Accounting
SNA	System of National Accounts
TSA	Tourism Satellite Account
UNCEEA	United Nations Committee of Experts on Environmental–Economic Accounting
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
WGSSD	Working Group on Statistics for Sustainable Development

CHAPTER 1 INTRODUCTION

INTRODUCTION

The System of Environmental–Economic Accounting (SEEA) was adopted as an international statistical standard by the United Nations Statistical Commission at its 43rd meeting, held 28 February to 2 March 2012. As an international statistical standard the SEEA now has the same status as the System of National Accounts (SNA), from which key economic indicators such as GDP (gross domestic product) emerge. The adoption of the SEEA by the United Nation's peak statistical body is a significant milestone in the on–going development of information to support the needs of government, industry and the general public in the area of environmental policy.

In recognition of the SEEA adoption, the Australian Bureau of Statistics (ABS) produced this publication "*Completing the Picture – Environmental Accounting in Practice*" to inform government decision–makers, policy analysts, scientists, industry and other groups on how environmental accounts could be used and further developed in Australia.

The ABS program of environmental–economic accounts is evolving. Readers are invited to submit comments on this publication to help inform the future shape of the program. As resources permit, the ABS plans to continue to seek ways to expand the program, both in terms of the range of accounts produced and the frequency of their compilation.

BACKGROUND

The development of the SEEA has been 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. This has been due to 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. In the report "Beyond GDP" 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.*'[1]

The SEEA is a measurement framework that can provide 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.

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1 Stiglitz, 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

BACKGROUND *continued*

This publication is structured to provide an introduction to the SEEA, its potential uses and to describe what a regular set of environmental–economic accounts for Australia could look like. Chapter 1 introduces the SEEA, briefly explaining its key features and the following seven chapters provide some examples of how SEEA accounts can be applied to a selection of public policy issues in Australia that cut across environmental and economic domains. These are:

- Mitigating climate change (Chapter 2)
- Adapting to climate change (Chapter 3)
- Sustainability (Chapter 4)
- Managing the Great Barrier Reef Region (Chapter 5)
- Managing the Murray–Darling Basin (Chapter 6)
- Green growth (Chapter 7)
- Solid waste management (Chapter 8)

Each chapter is designed to be read as a stand–alone chapter and hence there is some overlap in the data presented. Chapters 2–8 do not contain large tables of data, which for ease of reading are instead included in the Appendix. In the Appendix the environmental accounts already produced by the ABS – water and energy accounts, as well as the natural resources appearing on the national balance sheet – are complemented by other SEEA accounts at various stages of development. In some cases the information presented in tables is labelled as 'experimental' to acknowledge that the output is the product of recent development work and should, at this stage, be considered experimental.

The tables contained in the publication show the potential for SEEA accounts to provide an integrating framework for many types of environmental and economic information.

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. An accounting approach distinguishes the SEEA from independent sets of 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 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. The power of the SEEA comes from its capacity to present information in both physical and monetary terms in a coherent manner.

WHAT IS THE SYSTEM OF ENVIRONMENTAL–ECONOMIC ACCOUNTING? *continued*

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 in the SEEA to provide a comprehensive view.

The SEEA is not designed to provide the richness and depth of statistics that exist in each specific area. 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 the embedded emissions through physical input–output analysis
6. Understanding where and when the benefits and costs of natural resource use accrue
7. Enabling international comparisons and reporting.

THE SEEA AS A SYSTEM

The SEEA consists of a coherent, consistent and integrated set of tables and accounts which each 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.

There are four main types of accounts in the SEEA framework. These accounts are added to 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
4. Ecosystem accounts

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

THE SEEA AS A SYSTEM *continued*

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, 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 or 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 yet part of the 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 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.

THE SEEA AS A SYSTEM *continued*

Each of the different types of accounts are connected within the SEEA framework but each one 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[2]. 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.

2 See Australian System of National Accounts. ABS cat. no. 5204.0.

VALUATION *continued*

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. The recognition of the value of these assets and services could provide important information to decision–makers and enable a comparison between different development alternatives.

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 no 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 time–series estimates that are necessary in 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 and other satellite accounts. This adds considerable value to both the 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

SEEA DEVELOPMENT AND IMPLEMENTATION *continued*

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 is working closely with the Queensland and Victorian governments on the development of 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.

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[3], a range of work by the European Environment Agency[4], the development of the Common International Classification of Ecosystem Services[5], the Australia Ecosystem Services: Key Concepts and Applications[6] and others in Australia and elsewhere. Much of this experience was brought together at an Expert Meeting on Ecosystem Accounts, held in London 5–7 December 2011[7].

3 UK National Ecosystem Assessment, 2011. http://uknea.unep–wcmc.org/Resources/tabid/82/Default.aspx

4 E.g. European Environment Agency, 2011. An Experimental framework for Ecosystem Capital accounting. http://www.eea.europa.eu/publications/an–experimental–framework–for–ecosystem

5 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

6 Department of Environment, Water, Heritage and the Arts, 2009. http://www.environment.gov.au/biodiversity/publications/pubs/ecosystem–services.pdf

7 Expert Group Meeting on Ecosystem Accounts. London 5–7 December 2011. http://unstats.un.org/unsd/envaccounting/seeaLES/egm/lod.htm

CHAPTER 2 MITIGATING CLIMATE CHANGE

INTRODUCTION

The Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Bureau of Meteorology (BoM) [8], and Academies of Science from around the world[9] have advised that the world is warming and high levels of carbon pollution risk environmental and economic damage.

Climate change is caused by increases in the total stock of greenhouse gases in the atmosphere. In 2009, the six greenhouse gases included in the Kyoto Protocol reached 439 ppm CO_2–equivalent[10], an increase of 160 ppm compared to pre–industrial levels.

Australia has adopted a range of responses to climate change[11]. The first pillar of Australia's response is to reduce Australia's greenhouse gas emissions and to meet this objective the Australian government is developing and putting in place relevant policies through its Clean Energy Future program.

AUSTRALIA'S CLEAN ENERGY FUTURE POLICIES

The objectives of the Clean Energy Future program are to *"…support Australian businesses and households to reduce their carbon pollution, to create the new green–collar jobs of the future and to transform our economy."* [12]

The Clean Energy Future policies aim to achieve this through:

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

Limiting greenhouse gas emissions into the atmosphere requires broad–based action across many sectors of the global economy. In Australia, it is a major national undertaking that involves households, businesses, communities and governments. There is a demand for reliable statistics that can support the measurement and analysis of the drivers and the social and economic consequences of climate change and the related mitigation (and adaptation) measures.

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8 E.g. CSIRO/Bureau of Meteroology, 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

9 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

10 Different greenhouse gases have different global warming potentials. A greenhouse gas equivalent measure (CO_2 equivalent) is used to enable aggregation of different gases to obtain a total global warming potential.

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

12 Department of Climate Change, 2012. *Reducing Australia's Emissions.* Online: http://www.climatechange.gov.au/government/reduce.aspx. Accessed 4 April 2012.

AUSTRALIA'S CLEAN ENERGY FUTURE POLICIES *continued*

The statistics required to provide the evidence for policy development and research cover a very wide range of scientific, economic and social data. No one statistical framework can hope to embrace such a range of information needs. The System of Environmental–Economic Accounting (SEEA) can serve as a useful high–level tool for monitoring, measuring and analysing the relationship between climate change policies and the economy because it was specifically designed to highlight the interaction between the environment and economic and human activity more generally.

As a statistical system the SEEA is comprehensive in that it encompasses all known aspects of the environment–economy interaction and uses concepts and classifications consistent with the Australian System of National Accounts and other economic data produced by the Australian Bureau of Statistics (ABS). The Australian implementation of SEEA to date is incomplete, but it already includes a number of key accounts relating to aspects of climate change including, energy, water and land use. Many of the primary data for these accounts are collected by other government agencies and assembled in SEEA accounts by the ABS.

This chapter focuses on the environmental–economic accounts that can help inform the Australian Government's climate change mitigation policies, namely: emissions accounts, energy accounts and environmental expenditure accounts. It also briefly touches on carbon accounts which are in development in Australia and around the world. Chapter 3 explores environmental–economic accounting in the context of climate change adaptation policies.

WHAT CAN ENVIRONMENTAL–ECONOMIC ACCOUNTS DO?

SEEA accounts can be used to help measure and inform research and policies on mitigation activities from various vantage points. Examples of questions the accounts can help answer include:

- are new technologies being implemented that reduce the environmental burden and to what extent?
- is there a structural change in the economy towards less polluting activities?
- is the energy and/or emissions intensity of Australia's economic activities improving?
- how much is spent on energy, and who is bearing the cost?
- how much is being spent on reduction/mitigation activities, and what activities are being taxed or receiving subsidies?
- what products or what consumption patterns are causing high impact?
- how are consumption patterns changing in response to policy actions?

The data presented below are taken from the ABS system of environmental–economic accounts. They complement data produced by the Department of Climate Change and Energy Efficiency and the Bureau of Resources and Energy Economics.

DECOUPLING GHG EMISSIONS

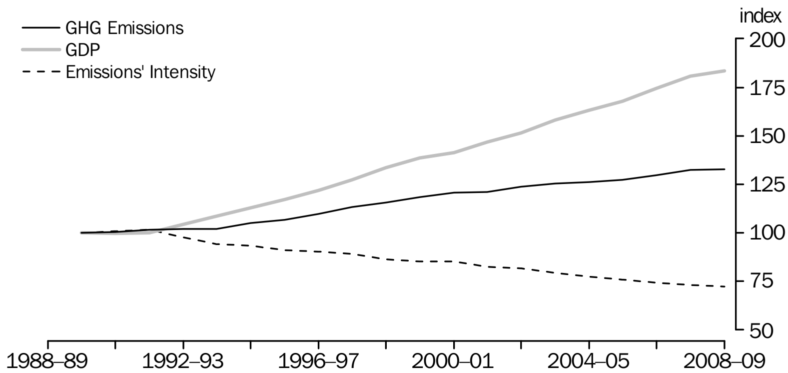
A carbon price is the first element of the Government's plan for a clean energy future, and is expected to trigger a broad transformation of the economy by breaking the link between greenhouse gas emissions and economic growth. Greenhouse gases (GHG) include carbon dioxide, methane, nitrous oxides and fluorinated gases.

DECOUPLING GHG EMISSIONS *continued*

In Australia, total emissions of GHG, excluding changes due to land use and land use change and forestry (LULUCF), have increased by 33% between 1989–90 and 2008–09[13] (see Figure 2.1). During the same period, economic activity as measured by gross domestic product (GDP) increased by 83%. The phenomenon, where the economy grows at a rate faster than the related pollution or resource use (e.g. water or energy) is known as decoupling. This can be caused by either a structural change in the economy (for instance, that the service industries have grown more strongly than higher emitting industries) or by the adoption of technological innovations by businesses and/or a combination of both. Overseas this type of analysis has been undertaken, for example by the statistical office of the Netherlands[14].

In the case of Australia, the decoupling is relative, as greenhouse gas emissions are increasing but at a lower rate than economic activity (as measured by GDP). Absolute decoupling would require greenhouse gas emissions to be stable or to decrease while economic activity increases.

2.1 TOTAL DIRECT GREENHOUSE GAS EMISSIONS AND GDP, (a)



(a) 1989–90=100

Source: Australian Bureau of Statistics, Department of Climate Change and Energy Efficiency.

Data from the National Inventory by Economic Sector[15] show that, in 2008–09, the Electricity, gas, water and waste services industry had the highest greenhouse gas emissions of any industry, followed by Agriculture, forestry and fishing and Manufacturing (see Figure 2.2). These three industries together account for 75% of emissions but around 15% of total gross value added and employment in the Australian economy. The Commercial and services industries account for 70% of all employment and about 55% of gross value added (see Figure 2.2). 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 in the National Inventory by Economic Sector Gas Accounts produced by the Department of Climate Change and Energy Efficiency, but is not presented here.

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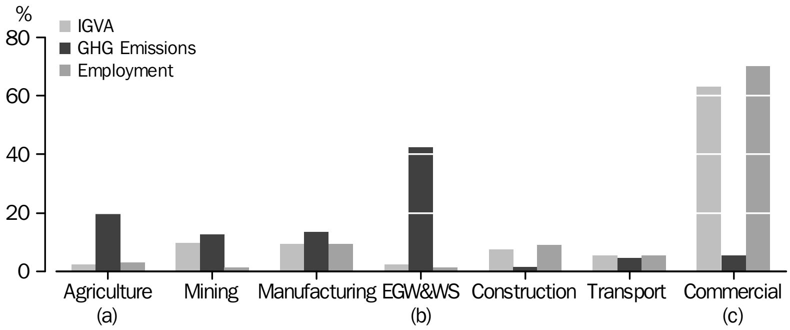
13 Based on data published by the Department of Climate Change and Energy Efficiency.
14 Statistics Netherlands, 2011. *Environmental Accounts of the Netherlands 2010.* http://www.cbs.nl/NR/rdonlyres/A3AF6855–3FF1–4344–8699–7C181A293979/0/2010c174pub.pdf
15 Department of Climate Change and Energy Efficiency.

DECOUPLING GHG EMISSIONS *continued*

2.2 ENVIRONMENTAL–ECONOMIC PROFILE, percentage of total industries—2008–09



(a) Includes agriculture, forestry and fishing
(b) Includes electricity, gas, water and waste services
(c) Includes the services industries.

Source: Australian Bureau of Statistics, Department of Climate Change and Energy Efficiency.

It should be noted that industry gross value added and employment data presented in the industry profiles are fully consistent with the System of National Accounts (SNA 2008). However, the estimate of GHG emissions is based on Kyoto Protocol Accounting (excluding land use, land use change and forestry (LULUCF). The Kyoto reporting follows the territorial principle while the National Accounts follows the resident principle. In particular, GHG emissions from international transport and CO_2 emissions from biomass used as fuel are excluded from the data on a Kyoto Protocol basis. There are also some differences with the national accounts in the assignment of emissions to individual industries (e.g. transport).

The ABS intends to use the greenhouse gas emissions data from the Department of Climate Change and Energy Efficiency to create a SEEA–style account for greenhouse gas emissions in the future. The SEEA–style accounts will also include the conceptual adjustments to the data to align it as closely as possible with the economic concepts and industries in the Australian System of National Accounts. A table reconciling the two accounts (i.e. the ABS SEEA based accounts and Department of Climate Change and Energy Efficiency's Kyoto protocol based accounts) will be produced as part of the set of environmental–economic accounts planned by the ABS.

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 data source used to develop and analyse policy. This 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).

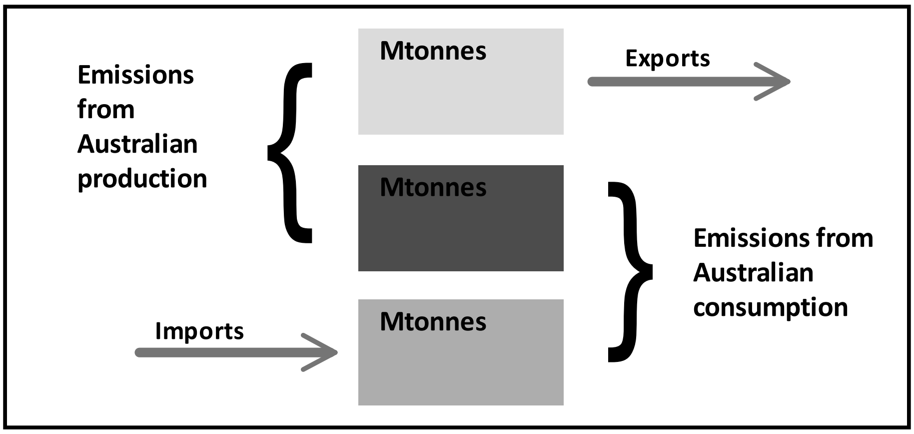
It is also possible to look at emissions occurring through the final consumption of goods and services by Australian households and governments. For example, the cumulated emissions from the production of manufactured food products, including from agricultural production, manufacturing processes, transport and retailing is attributed to the final consumer. This shifts the focus of the analysis to the emissions resulting from producing goods and services to meet final demand, including emissions embodied in imports and exports. Ultimately, industries exist to satisfy consumption in Australia and

GREENHOUSE GAS INDUCED BY FINAL DEMAND *continued*

abroad. The international transfer of environmental costs by a country can be addressed by considering its environmental balance of trade.

Figure 2.3 illustrates the relationship between the production and consumption approaches to measurement.[16]

2.3 PRODUCTION AND CONSUMPTION APPROACHES TO GHG MEASUREMENTS



The ABS is investigating the possibility of identifying and measuring emissions according to the consumption approach using environmentally extended input output analysis. What the analysis would show is 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. The ABS has published a similar analysis in the past.[17]

ENERGY USE AS A MAJOR DRIVING FACTOR OF GHG EMISSIONS

Energy derived from the burning of fossil fuels contributed 67% of Australia's greenhouse gas emissions in 2008–09 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 SEEA Central Framework allows the compilation of energy accounts and air emissions accounts on a consistent basis. 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. The process can have positive benefits for the producers and users of data. The confrontation

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

17 ABS, 2001. *Energy and Greenhouse Gas Emissions Accounts, Australia, 1992–93 to 1997–98.* ABS cat. no. 4604.0 http://www.abs.gov.au/ausstats/abs@.nsf/mf/4604.0

ENERGY USE AS A MAJOR DRIVING FACTOR OF GHG EMISSIONS *continued*

of data from different sources and the resolution of inconsistencies is an ongoing process in the ABS and other agencies.

The following information is drawn from the SEEA–based Energy Account Australia (ABS cat. no. 4604.0). It can be used for monitoring the overall development of the Australian energy industry and tracking the progress of policies to support clean technologies.

DOMESTIC CONSUMPTION OF ENERGY

In relation to Australia's greenhouse gas emissions, the main drivers are Australia's domestic consumption of energy and the sources from which that energy is derived.

Total domestic energy consumption in 2008–09 was 8,207 PJ, up nearly 5% from 2001–02. The main consumers of energy[18] in 2008–09 were Manufacturing (35%), Electricity, gas and water supply (32%) and households (12%).

In order to better understand the impact on greenhouse gas emissions from energy consumption, it is helpful to break total energy consumption further into its primary and secondary energy components. Primary energy products are forms of energy obtained directly from nature, including coal, natural gas, solar and wind energy, crude oil, uranium and biomass. Secondary energy products are derived from primary energy sources and include refined products (e.g. petrol, diesel and aviation fuels), electricity, liquid/gas biofuels and coal by–products. Greenhouse gas emissions from the direct combustion of primary fuels, notably coal and gas, are classified as scope 1 emissions, while emissions from the generation of purchased electricity are classified as indirect emissions. While the consumption of electricity is clean at the point of use, it is not at the point of generation (from combustion). Therefore, the greenhouse gas intensity of generation is highly dependent on the primary energy source used. In Australia, coal is still the principal primary energy source, accounting for 76% of electricity generation in 2008–09.

Australian domestic primary energy consumption in 2008–09 was 5,325 PJ which was virtually unchanged from 2001–02. However, there were significant changes in the use by industry and sector and the types of energy used. For example, large rises in energy consumption by Mining (88%), households (32%) and Electricity, gas and water (13%) were largely offset by falls in Manufacturing (7%). The use of natural gas rose 46%, while black coal fell nearly 10%. The use of biomass and solar energy rose 13% and 667% respectively (the latter from a very low base).

Figures 2.4 and 2.5 show the amount of energy consumed by selected Australian industries. Manufacturing was the largest consumer of primary energy in 2001–02 but the Electricity, gas and water industry was the largest consumer of primary energy in 2008–09.

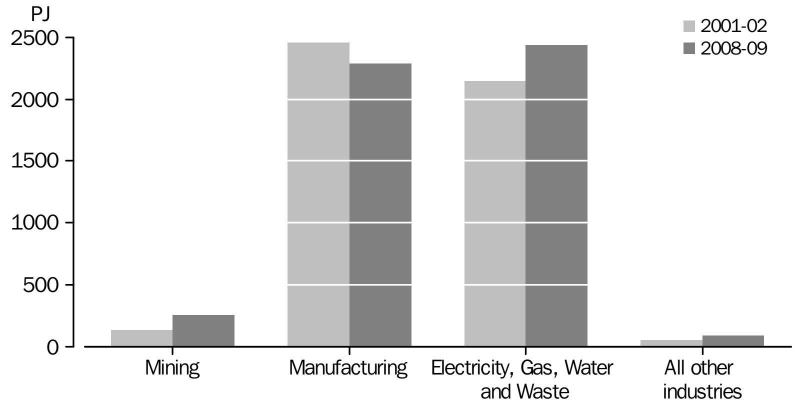
Households accounted for 26% of secondary energy consumption in 2008–09. The major industry consumers of secondary energy were Manufacturing (20%), Transport (17%) and Mining (8%).

Considerable energy losses occur in the transformation of primary energy into secondary energy. This applies particularly to electricity supply, where losses occur at the power station and in distribution. This is reflected in the data for secondary energy use by the Electricity, gas, water and waste industry in Figure 2.5.

18 Domestic energy consumption includes energy consumed by Australian industry, households and government.

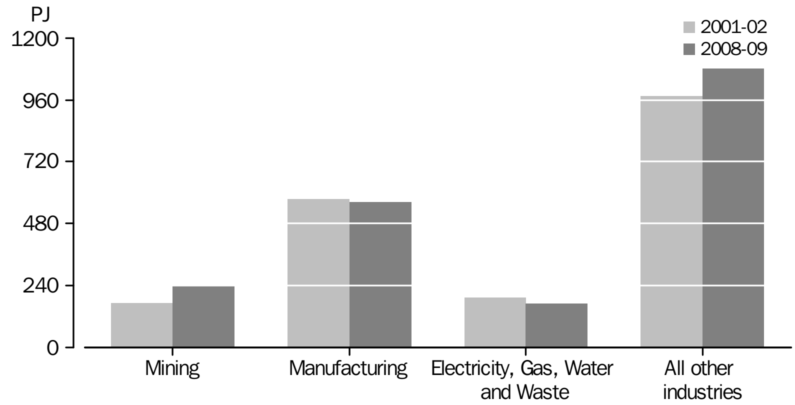
DOMESTIC CONSUMPTION OF ENERGY *continued*

2.4 PRIMARY ENERGY USE, for selected Australian Industries



Source: Energy Account, Australia 2008-09 (ABS cat. no. 4604.0)

2.5 SECONDARY ENERGY USE, for selected Australian Industries



Source: Energy Account, Australia 2008-09. (ABS cat. no. 4604.0)

AUSTRALIAN ENERGY SUPPLY

In 2008–09 Australian energy supply comprised of domestic production of 17,822 PJ and energy imports of 1,915 PJ. Over 77% or 13,803 PJ of domestic production (in energy terms) was exported in 2008–09. In particular most black coal and uranium is exported.

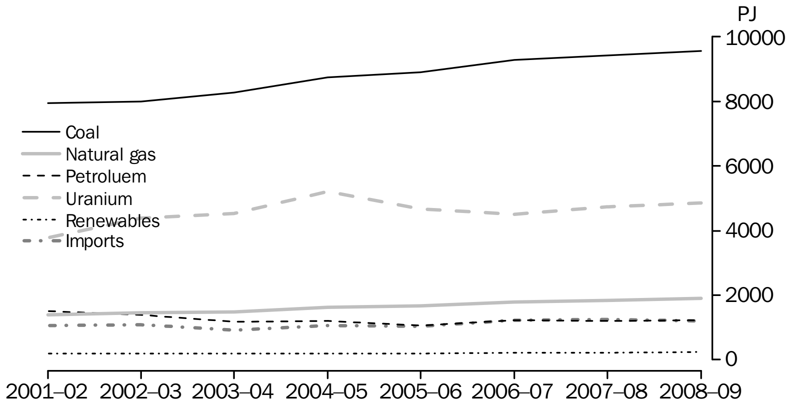
Over the period from 2001–02 to 2008–09, Australia's primary energy supply (domestic production plus imports) grew by an average of nearly 3% per annum. While Australia is more than self–sufficient for most energy products, a considerable proportion of crude oil and refined products supply is met by imports. Over the period crude and refined petroleum imports grew 36%[19].

Figure 2.6 shows a relatively consistent energy mix over this period. Coal accounts for 50% of energy production, a proportion that has changed little over the last decade. Petroleum's (crude oil, condensate and liquefied petroleum gas (LPG) proportion of energy production has decreased from 9% to 6%, while natural gas has slowly increased from 9% to 11%. In terms of energy content uranium accounts for approximately one quarter of total primary energy supply. Renewable energy has increased by 24% over the period but still represents just over 1% of total primary energy supply.

19 While Australia is a net importer of crude and refined petroleum, it exports large quantities of crude and some refined products.

AUSTRALIAN ENERGY SUPPLY *continued*

2.6 TOTAL SUPPLY OF PRIMARY ENERGY, AUSTRALIA—2001–02 to 2008–09

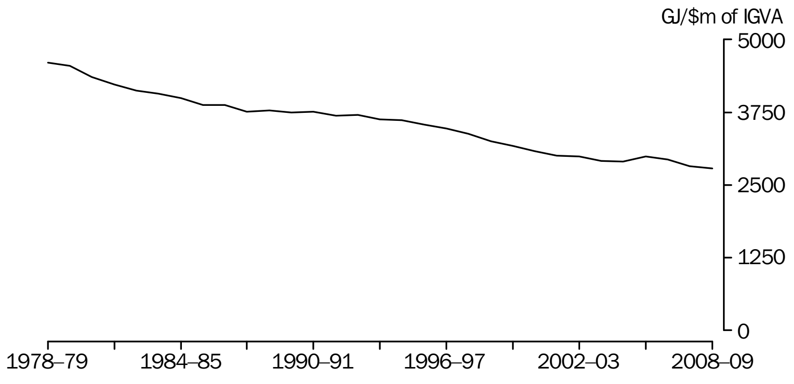


Source: Energy Account, Australia, 2008-09 (ABS cat. no. 4604.0)

ENERGY INTENSITY

Energy intensity – the use of energy per unit of economic production – is shown in Figure 2.7 below. The energy intensity of Australian industries has decreased by nearly 40% during the period from 1978–79 to 2008–09, indicating a more energy–efficient economy. Industries with high energy intensity would be expected to be most affected by increases in the cost of energy, including those resulting from the introduction of a carbon price.

2.7 ENERGY INTENSITY OF AUSTRALIAN INDUSTRIES(a)—1978–79 to 2008–09



(a) Excluding the Electricity Supply and Gas Supply subdivisions
Source: Energy Account, Australia 2008-09 (ABS cat. no. 4604.0)

ENERGY AND FOREIGN TRADE

Overall, Australia is a net energy exporter of fossil fuels[20], driven mainly by the export of coal and gas. In monetary terms in 2009–10, the net balance was $29b, that is, Australia exported more fossil fuel energy than it imported.

Coal, coke and briquettes were the most valuable energy export at $37b in 2009–10, representing over 64% of the total value of exports in that year. Since 2000–01, the value of exports of coal, coke and briquettes has increased by 236%. Over the same period, the value of gas exports has risen by 154% to reach $8.9b. The value of crude oil and refined

20 Fossil fuels defined by the Standard International Trade Classification categories 32, 33 and 34.

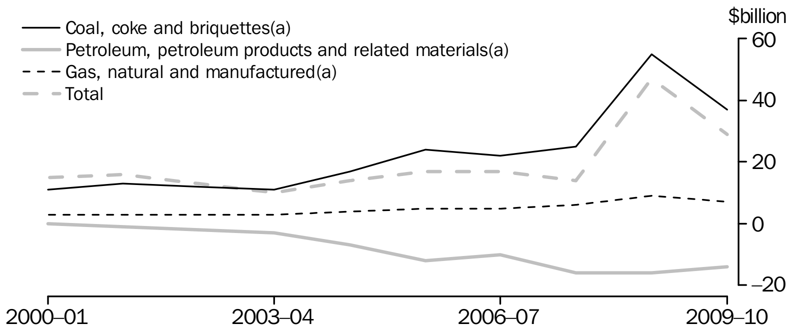
ENERGY AND FOREIGN TRADE *continued*

products exports was $11.4b in 2009–10, a similar value to 2000–01. These data are in current price terms, and therefore reflect changes in commodity prices as well as underlying volumes.

While Australia is a producer of crude oil, it consumes a significant proportion of imported crude and refined products (especially diesel and petrol). In 2009–10, crude oil and refined products accounted for over 94% of total energy imports. Crude oil and refined products imports over the 10 year period have grown by 150%, highlighting Australia's dependency on imported petroleum. The greater Australia's dependency upon imported energy, the more exposed Australia becomes to changes in global availability of petroleum.

Figure 2.8 shows the time trend in the trade balance for fossil fuel energy products.

2.8 TRADE BALANCE, for fossil fuel energy products



(a) Data from July 2005 onwards are presented on a SITC R4 basis. For full details, users should refer to the Information Paper: Impact of introducing Revision 4 of the Standard International Trade Classification, 2008 (ABS cat.no. 5368.0.55.10).

Source: International Trade in Goods and Services, Australia (ABS cat. no. 5368.0)

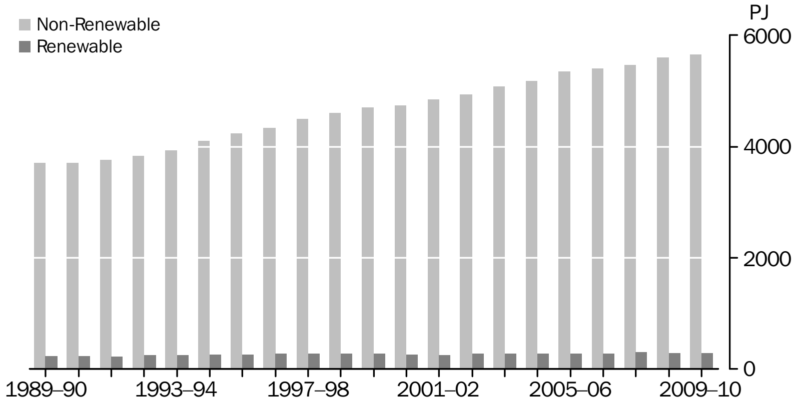
RENEWABLE ENERGY

Promoting innovation and investment in renewable energy is a key part of Government policy to reduce Australia's greenhouse gas emissions. Figure 2.9 to 2.11 use data from the ABS energy account to produce measures of the Australian energy industry as it progresses through this structural change.

Figure 2.9 presents Australian energy supply split by fossil fuel and renewable energy sources. Between 1989–90 and 2009–10, total energy consumption in Australia rose over 50% and while the energy sourced from renewables increased significantly, the growth in fossil fuel use was the main driver of the change.

RENEWABLE ENERGY
continued

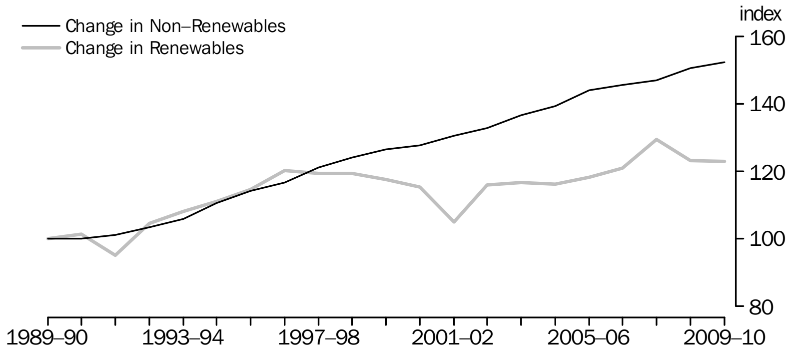
2.9 AUSTRALIAN PRIMARY ENERGY SUPPLY, renewable and non-renewable—1989–90 to 2009–10



Source: Bureau of Resource and Energy Economics 2011 Australian Energy Statistics Energy Update

Figure 2.10 shows the change in the use of fossil fuels versus renewables between 1989–90 and 2009–10. Over the period the use of energy sourced from fossil fuels jumped 52%.

2.10 CHANGES IN AUSTRALIAN RENEWABLE AND NON–RENEWABLE PRIMARY ENERGY SUPPLY—1989–90 to 2009–10



(a) 1998–90=100

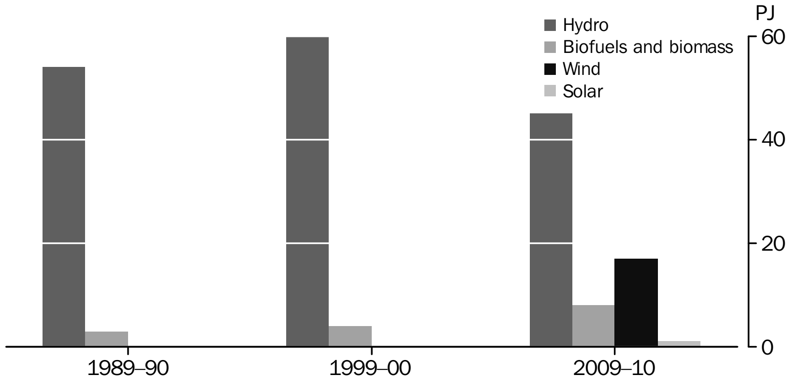
Source: Bureau of Resource and Energy Economics 2011, Australian Energy Statistics Energy Update 2011, Table C.

The consumption of energy from renewable sources increased by 23% between 1989–90 and 2009–10. However, its proportion of Australia's total net energy consumption remained largely unchanged, at around 5%. The largest source of renewable energy supply is biomass and biofuels, collectively accounting for 74% of renewable energy supply in 2009–10, followed by hydroelectric power at 16%. While biomass is the majority of total renewable energy supply, hydro energy is the largest contributor to renewable electricity generation.

RENEWABLE ENERGY *continued*

Figure 2.11 shows the amount of electricity generated from each renewable source as well as the percentage of total electricity generated from renewable sources. Historically, renewable electricity production has fluctuated based on the supply of hydroelectric power. In recent years wind energy has grown as a source of electricity, accounting for 24% of renewable electricity in 2009–10.

2.11 QUANTITY OF ELECTRICITY GENERATED FROM RENEWABLE SOURCES



Source: Bureau of Resource and Energy Economics 2011 Australian Energy Statistics Energy Update 2011, Table C.

MONETARY FLOWS OF ENERGY

Both energy and environmental expenditure accounts can be used to highlight the potential of environmental–economic accounts for analysing the impacts of a carbon price (on both pollution levels and economic activity), including providing baseline data for the time before the introduction of carbon pricing. Among other things, these accounts can identify the expenditures and the mix of energy products used in the main industry groups and households of the Australian economy.

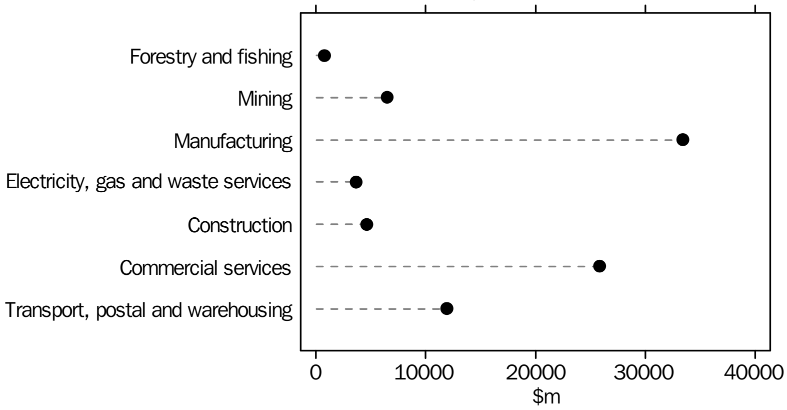
In 2008–09 expenditure by industries was $87b[21]. While not covering the entire economy, Figure 2.12 shows that the industries spending most on energy were: Manufacturing, Commercial services and Transport and storage.

Renewable energy represented less than 0.1% of the total expenditure (much being self–sourced). Diesel (26%), electricity (16%), gas (7%) and petrol (6%) are the key energy expenditures for Australian industries.

21 Industry expenditure data from Energy, Water and Environment Survey (EWES) survey does not cover all industries see Energy, Water and Environment Management (ABS cat. no. 4660.0) for details.

MONETARY FLOWS OF ENERGY *continued*

2.12 EXPENDITURES ON ENERGY, by industries—2008–09



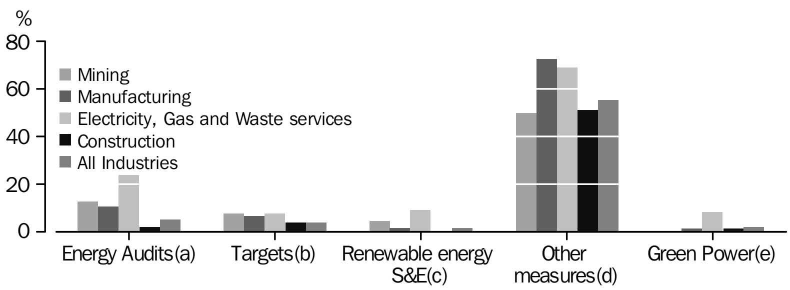
Source: Energy, Water and Environment Management, 2008-09 (ABS cat. no. 4660.0)

In addition to tracking expenditure on fuels and energy, a more complete suite of environmental–economic accounts could also track expenditures by various sectors of the economy on efforts to reduce carbon pollution. The ABS is investigating new statistics on emission trading and emission certificates under the framework of the System of National Accounts and the SEEA.

ENVIRONMENTAL EXPENDITURE ACCOUNTS

Environmental protection and natural resource expenditure accounts track financial transactions related to activities aimed at reducing environmental impacts or protecting our natural resources. Environmental expenditure accounts are not currently produced for Australia, but have been in the past (see ABS cat. no. 4603.0 Environmental Protection, Mining and Manufacturing Industries, 2000–01). Expenditures related to greenhouse gas mitigation would be an important component of these costs. Some energy reduction and energy efficiency measures employed by Australian industry are reported in Figure 2.13 below.

2.13 AUSTRALIAN BUSINESSES UNDERTAKING ENERGY REDUCTION/EFFICIENCY MEASURES—2008–09



(a) Energy Usage Audits
(b) Energy Performance targets or indicators
(c) Operated Renewable Energy systems or Equipment
(d) Other Energy Efficiency / energy reduction measures
(e) Purchased Green Power

Source: Energy, Water and Environment Management, 2008–09, (ABS cat. no. 4660.0)

ENERGY AND TRANSPORT–RELATED TAXES IN AUSTRALIA

Taxes on energy products and transport are one way for governments to influence the use of fossil fuels. The SEEA defines an environmental tax as a tax:

> ". . . *whose tax base is a physical unit (or a proxy of it) of something that has a proven, specific, negative impact on the environment*" *(SEEA 2012, paragraph 4.150).*

Energy and transport–related taxes in Australia are in two main groups:

- Franchise taxes on the use of goods and the performance of activities
- Excises and levies on the provision of goods and services

Figure 2.14 presents data for energy and transport–related taxes in Australia according to the SEEA. The largest contributors are taxes on crude oil and LPG. The monitoring and analysis of energy–related taxes, as well as subsidies and other transfer payments can help monitor Government policies and provide consistent time–series information for analytical purposes.

2.14 ENERGY AND TRANSPORT– RELATED TAXES, all levels of government—2000– 01 to 2009– 10
$m

	2000-01	*2004-05*	*2005-06*	*2006-07*	*2007-08*	*2008-09*	*2009-10*
Stamp duty on vehicle registration	1,387	1,918	1,922	2,004	2,207	2,026	2,116
Other(a)	2,646	3,497	3,672	3,911	4,179	4,432	4,846
Gas taxes	6	2	2	5	0	2	3
Petroleum products taxes	174	–	–	–	–	–	–
Crude oil and LPG	12,447	14,350	14,073	14,653	15,085	15,592	15,766
Total transport and energy taxes	20,693	25,182	25,262	26,488	27,857	28,510	29,694
% of total taxation revenue	**10%**	**9%**	**8%**	**8%**	**8%**	**8%**	**9%**

(a) Includes road transport and maintenance, heavy vehicle registration fees and other vehicle fees and taxes.
Source: Taxation Revenue, Australia, 2009–10 (ABS cat. no. 5506.0)

LAND AND REDUCING GREENHOUSE GAS EMISSIONS

The Carbon Farming Initiative (CFI) allows farmers, forest growers and land managers to earn carbon credits by storing carbon or reducing greenhouse gas emissions on the land.

The ABS has been funded by the Department of Agriculture, Fisheries and Forestry (DAFF) to undertake a biennial Land Management Practices Survey (LaMPS) to support evidenced–based policy and decision making in relation to the CFI. Outputs from the survey will be used along with other information in making common practice assessments under the CFI and will also contribute to an improved information base on management of Australia's agricultural land.

The first LaMPS will provide baseline data for 2011–12, with two subsequent surveys to be undertaken for 2013–14 and 2015–16. Outputs from the LaMPS will include data on on–farm land management practices such as livestock manure management, fertiliser management, feedstock management for intensive and extensive livestock operations, and pasture and cropping practices at regional levels.

While the survey has not been designed to produce environmental accounts, the results could be incorporated into SEEA accounts that could potentially be developed in the future, including accounts for forest and other wooded land, timber resources and carbon.

CARBON ACCOUNTING

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 greenhouse gas emissions. Under the guidance of the Intergovernmental Panel on Climate Change (IPCC), a flows based global accounting system was established[22]. 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.

A more comprehensive view of carbon accounting could extend the current flows–based accounting to cover both stocks and flows of carbon, and in particular consider the characteristics of different carbon stocks.

Large amounts of carbon flow naturally and continuously between the geosphere (e.g. fossil fuels), biosphere (e.g. plants and animals), and the atmosphere. This is commonly called the global carbon cycle, and it includes many complex interactions, with different types of carbon cycling at different speeds.

Within the biosphere, different ecosystems vary in their longevity and capacity to build and maintain carbon stocks. This presents a significant set of choices for decision makers. In relation to land, this could be competing claims for agriculture, settlement or preservation of ecosystems. Some ecosystems, if removed, may not have the capacity to regenerate and return to their earlier carbon stock levels. A set of carbon stocks accounts can provide policy makers with important information for making such decisions.

An experimental framework for a carbon asset account is presented in the Appendix. It is based on the carbon accounting being developed as part of the SEEA ecosystem accounts[23]. This account 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 (Oil, Gas, Black coal, Brown coal and Other) and to identify biocarbon (carbon in biomass) stocks in terrestrial and marine ecosystems by type (Natural, Semi–natural and Agricultural). There is potential to disaggregate further geocarbon and biocarbon. 'Accumulations in economy' are the stocks of carbon in products such as refined oil in storage, concrete, wood products, steel, bitumen and landfill.

Researchers and policy makers can use carbon stock accounts together with measures of carbon carrying capacity[24] and land use history to:

- Investigate the depletion of carbon stocks due to converting natural ecosystems to other land uses;
- 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;

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

23 See papers for the Expert Group Meeting on Ecosystem Accounts, London 5–7 December 2011. http://unstats.un.org/unsd/envaccounting/seeaLES/egm/lod.htm

24 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).

CARBON ACCOUNTING
continued

- Identify land uses that result in temporary carbon removal and storage.

Using available data for Australia a partial carbon asset account may be produced. More research is necessary to provide estimates of carbon in terrestrial and marine ecosystems. Disaggregating biocarbon stocks into Natural, Semi–natural and Agricultural also presents some methodological challenges that could possibly be addressed through a linked land cover account.

The development of a more comprehensive set of carbon accounts provides the opportunity for the statistical, economic and scientific communities to work more closely together on consistent standards, definitions, coverage and reporting periods across Australia and for the rest of the world.

CHAPTER 3 ADAPTING TO CLIMATE CHANGE

INTRODUCTION

The first pillar of Australia's climate change policies is reducing the amount of greenhouse gases released into the atmosphere, as discussed in Chapter 2. The second pillar of Australia's climate change policies is adaptation – that is, Australia's ability to adapt to climate changes which cannot be avoided.

The recently released State of the Climate Report[25] stated that it is clear that increasing greenhouse gas concentrations will result in significant further global warming. The report also acknowledges that uncertainties remain regarding future levels of greenhouse gas concentrations, and the precise timing and magnitude of changes, particularly at regional scales.

In 2007 the Council of Australian Governments endorsed a National Climate Change Framework to guide practical activities to adapt to climate change. This was followed in 2009 by Australia's fifth communication on climate change to the United Nations Framework Convention on Climate Change (UNFCCC), where adaptation was recognised as one of the Australian Government's climate change policy responses[26].

In 2011 the Productivity Commission began an inquiry into climate change adaptation[27]. The inquiry will review regulations and policies that may be barriers to effectively adapting to the impacts of climate change. It will also examine the costs and benefits of options to remove those barriers.

The Australian Government identified the following areas as the initial national priorities for adaptation to climate change:

- coastal management
- water
- infrastructure
- natural systems of national significance
- prevention, preparedness, response and recovery with regard to natural disasters
- agriculture

Other areas of importance include human health, energy, fisheries, forestry and tourism.

Adaptation to climate change requires the implementation of a wide range of actions and measures. These include: changing agricultural production practices, enhancing water efficiency, changing building codes, and construction of barriers as well as improved engineering against floods[28]. Adaptation measures are undertaken by both the public and

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25 CSIRO and BoM 2012. State of the Climate 2012.
http://www.csiro.au/Outcomes/Climate/Understanding/State–of–the–Climate–2012.aspx
26 http://www.climatechange.gov.au/~/media/publications/international/Australia–fifth–national–communication.pdf
27 Productivity Commission 2011. Barriers to Effective Climate Change Adaptation.
http://www.pc.gov.au/projects/inquiry/climate–change–adaptation/issues
28 Adapting to Climate Change in Australia–An Australian Government position paper 2010
http://www.climatechange.gov.au/~/media/publications/adaptation/gov–adapt–climate–change–position–paper.pdf

INTRODUCTION *continued*

private sectors and include investments in infrastructure, new technology and policies to promote behavioural change.

ADAPTATION AND ENVIRONMENTAL–ECONOMIC ACCOUNTING

Reporting on adaptation to climate change poses a number of challenges. The measures of adaptation span social, economic and environmental issues. The System of Environmental–Economic Accounting (SEEA) could provide a valuable framework for measuring, organising and analysing statistics on adaptation to climate change. This chapter includes a number of examples of behaviours which could be used to adapt to climate change and the possible approaches for analysis of climate change adaptation. Analysis could focus on the management of an important environmental issue or resource that is impacted by climate change, for example biodiversity or water. Alternatively, structural changes in the economy in response to climate change could be analysed by recording the changes in industry activity, such as electricity supply or water supply. The international statistical community is working to develop a framework to measure expenditure on climate change adaptation, based on the SEEA[29]. The following sections examine how environmental accounts could be used to inform policy on adapting to climate change.

ADAPTING TO CHANGES IN WATER AVAILABILITY

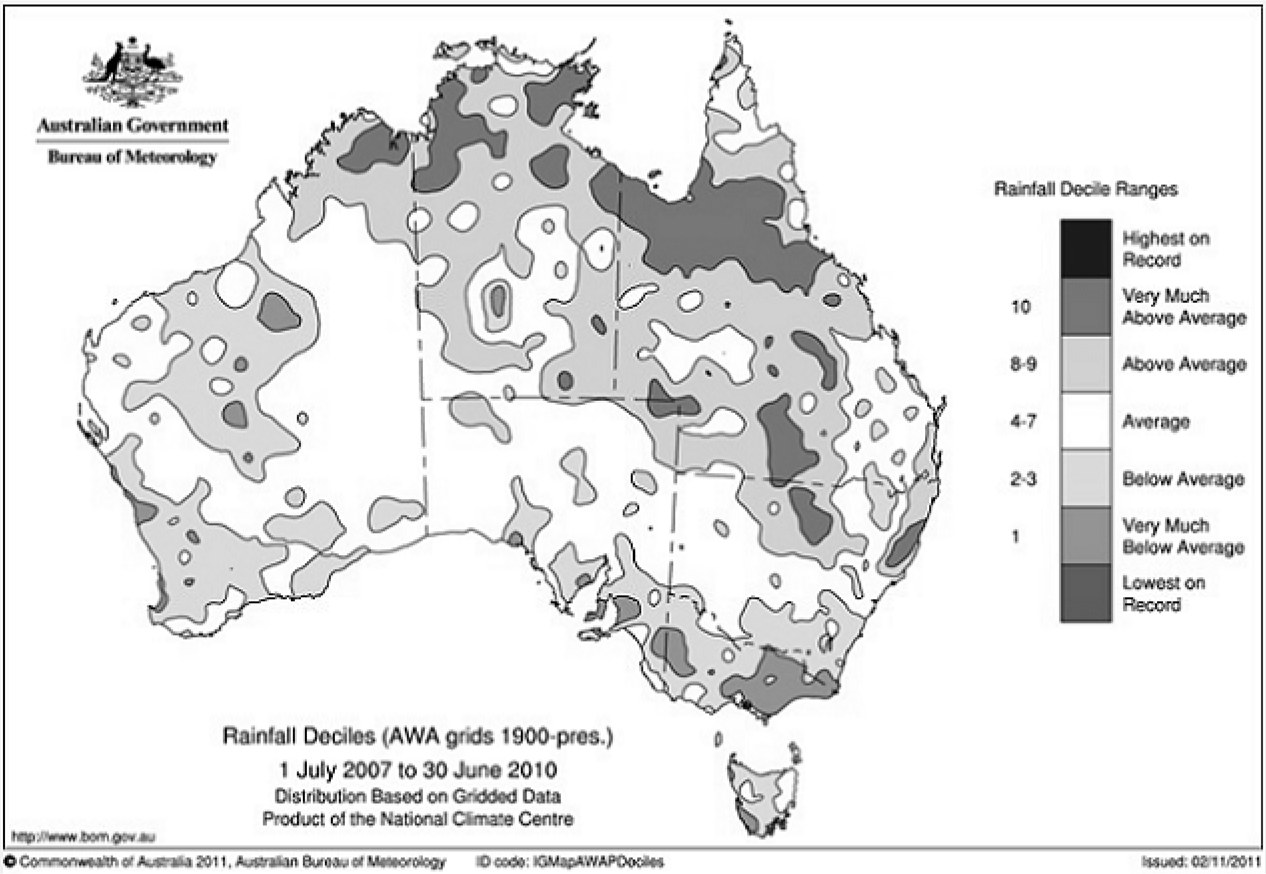
Water is a vital natural resource and changes in its availability will affect the environment and the economy, and impact on society. Measures to manage and adapt to changes in water availability include improvement in the efficiency of irrigation systems, creation of tradable water markets, and increased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

Figure 3.1 shows rainfall in Australia July 2007 to June 2010, compared to long–term averages (presented as deciles of historical rainfall).

Rainfall is important for analysing water availability as it determines how much of the resource is stored in the landscape as surface water, groundwater, and in dams and other storages. There was substantial variation in rainfall over the continent, with historically very low rainfall over much of southern and western Australia, with historically very high levels over much of Queensland and the Northern Territory (with the highest rainfall ever recorded in some regions).

29 Statistics Sweden, 2011. Climate Change Adaptation Expenditure – A proposal for a methodology to compile, define and classify national and EU economic information as statistics. http://www.scb.se/statistik/_publikationer/MI1301_2012A01_BR_MIFT1201.pdf

3.1 RAINFALL, Australia—Deciles: **July 2007 to July 2010**



Source: Water Account Australia 2009–10 (ABS cat. no. 4610.0).

ADAPTING TO CHANGES IN WATER AVAILABILITY *continued*

The Australian Bureau of Statistics (ABS) Water Account, Australia (cat. no. 4610.0) is useful in analysing the changes in water use likely to result from changes in water availability. The account provides information on the supply and use of water, detailing the use of water by different industries and the value of the water supplied (by the water industry) to industry and households. The presentation of both economic and physical information on the same basis make it particularly suited to analysing the economic efficiency of water use – and therefore of the likely economic impact of changes in water use resulting from changes in water availability.

WATER AND AGRICULTURE

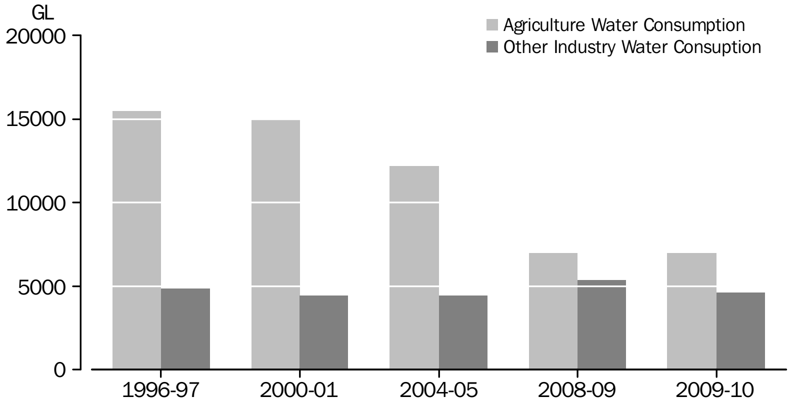
The agriculture industry is the largest consumer of water in Australia. Both rain–fed and irrigated agriculture are dependent on water availability. Understanding how agricultural production could be affected by changes in water availability is a national climate change adaptation priority.

The following series of graphs are derived from the ABS Water Account, Australia (ABS cat. no. 4610.0; see the Appendix). They illustrate how Australian irrigators have adapted to changing patterns of water availability. For example, in dry years crops that require greater quantities of water to ensure production, like cotton and rice, are not grown. It also shows that while total use of water in agriculture has declined, the gross value of irrigated agricultural production has increased.

WATER AND AGRICULTURE *continued*

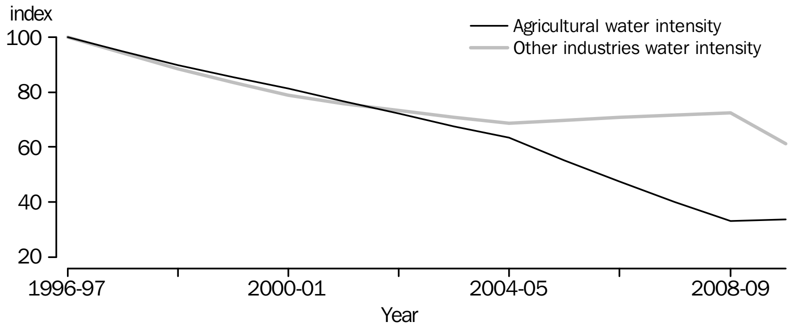
Figure 3.2 shows that water consumption by the agriculture industry fell by 55% between 1996–97 and 2009–10. In other industries, water consumption fell by 5% over the same period.

3.2 WATER CONSUMPTION – AGRICULTURE & ALL OTHER INDUSTRIES, 1996–2010



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

3.3 CHANGES IN WATER INTENSITIES OF THE AGRICULTURE AND ALL OTHER INDUSTRIES, 1996-97 to 2009-10



Notes: Industry Gross value Added in chain linked prices.
Intensity equals GL water / $m IGVA.
Index 1996-97=100.

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

Water intensity is a measure of the water consumed to produce one unit of economic output. It is calculated by dividing total water consumption by Industry Gross Value Added (GL/$m IGVA). The volume of water required by the agriculture industry to produce one unit of economic output fell by 66% between 1996–97 and 2009–10 to 0.29 GL/$m IGVA. The water intensity of all other industries also declined over the period, although to a lesser extent, falling by 39% (Figure 3.3).

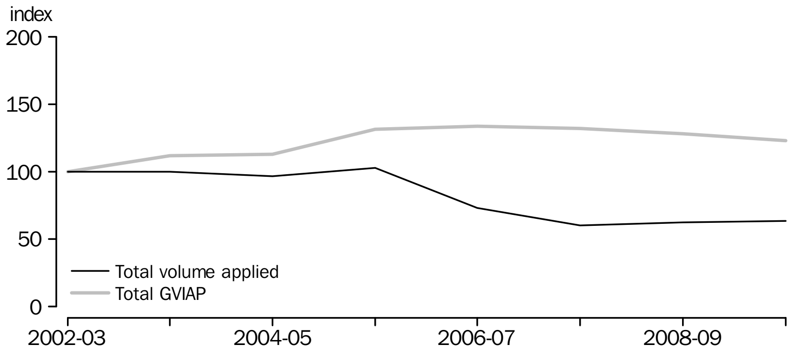
Gross Value of Irrigated Agricultural Production (GVIAP) refers to the gross value of agricultural commodities that are produced with the assistance of irrigation. The gross value of commodities produced is recorded at wholesale prices. Note that this definition of GVIAP does not refer to the value that irrigation adds to production, or the "net effect" that irrigation has on production – rather, it simply describes the gross value of

WATER AND AGRICULTURE *continued*

agricultural commodities produced with the assistance of irrigation. GVIAP is not a measure of productivity.

Figure 3.4 shows that GVIAP has increased by over 20% between 2002–03 and 2009–10. Over the same period, the water volume used in irrigation decreased by 40%. The decrease in water volume corresponds to the decline in cotton and rice production.

3.4 GROSS VALUE OF IRRIGATED AGRICULTURE(a)(b), Volume of Water Applied—2002–2010

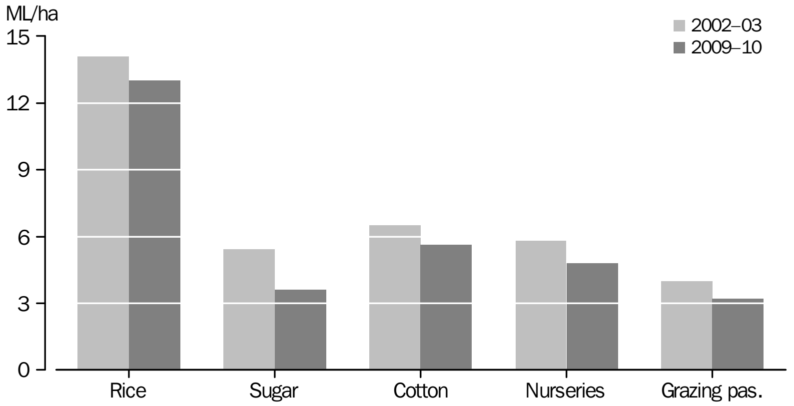


(a) Index 2002-03=100
(b) GVIAP in current prices
Source: Gross Value of Irrigated Agricultural Production, (ABS cat. no. 4610.055.008)

In Australia in 2009–10, the largest proportion of irrigated land was 'pasture for grazing' (542,000 hectares), with the volume of irrigation water applied (1,722 GL) representing 26% of the national total. Pasture for grazing requires relatively little water for a given area of land, compared to rice, sugar cane, cotton and nurseries. Figure 3.5 shows that between 2002–03 and 2009–10 the volume of water applied per hectare of irrigated land decreased for all commodities.

The crop types grown under irrigation vary across Australia. Victoria, South Australia, Western Australia, and Tasmania mainly irrigate pasture for grazing, while New South Wales and Queensland irrigate cotton and a range of other broadacre crops. The Northern Territory uses water mainly to irrigate orchards and plantation fruits.

3.5 WATER USE PER AREA IRRIGATED, selected crops

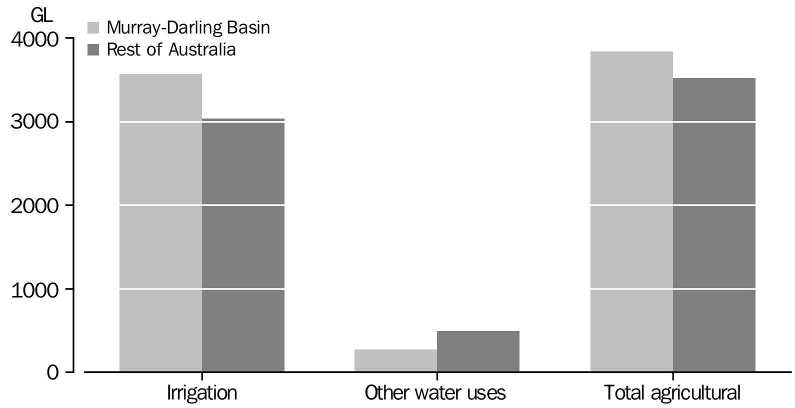


Source: Water use on Australian farms, (ABS cat. no. 4618.0)

WATER AND AGRICULTURE *continued*

The Murray–Darling Basin as a region rates specific mention in relation to climate change adaptation, because of its significant agricultural production, ecological significance and reliance on water. Figure 3.6 illustrates the use of water in agriculture, in the Murray–Darling Basin and elsewhere. In the Murray–Darling Basin, a greater proportion of agricultural water is used for irrigation than the balance of Australia. The use of environmental–economic accounting to inform decision–making related to the Murray–Darling Basin is explored in detail in Chapter 6.

3.6 WATER USE IN AGRICULTURE—2009–10



Source: Water use on Australian farms (ABS cat. no. 4618.0)

ADAPTING TO OTHER CHANGES IN NATURAL SYSTEMS

Increasing temperatures, changes to rainfall patterns and the frequency and severity of cyclones and other natural disasters will influence the types of human activity able to be undertaken in particular places. It is also recognised that these changes will impact on natural systems of international significance, such as the Great Barrier Reef. For example the June 2009 Great Barrier Reef Intergovernmental Agreement[30] makes special mention of the pressures arising from climate change. The use of environmental accounting to assist the management of the Great Barrier Reef is addressed in more detail in Chapter 5.

The impact of climate change on human activities can be seen in the use of land. ABS experimental Land Accounts for the Great Barrier Reef provide information on land cover and land usage, agricultural water use and the gross value of irrigated and non–irrigated agricultural production at a fine level of geographic disaggregation. These data can be combined with demographic information from the Census of Population and Housing to better understand the socio–economic context of land usage in a given region.

Agriculture, forestry and fisheries

In 2009–10, Agriculture, forestry and fisheries together contributed about 2% to industry gross value added in Australia and employed around 5% of all persons employed. These industries are particularly vulnerable to climate variability. For agriculture, climate variability could mean the development or instillation of new irrigation systems, or a change in agricultural production to crops, or livestock that can withstand hotter or colder, dryer or wetter climates than previously experienced.

30 Great Barrier Reef Intergovernmental Agreement
http://www.environment.gov.au/coasts/gbr/publications/pubs/gbr–agreement.pdf

Agriculture, forestry and fisheries continued

The Forestry and logging industry is relatively small component of Australia's economy. However, the importance of forested ecosystems and the potential of forests to contribute to carbon sequestration and storage make forestry very important for future generations[31]. Adaptation measures focus on increasing the forests' resilience to change by maintaining the diversity of species and the age structures of forest stands in the landscape[32].

The Fisheries industry is closely linked to ecosystem condition, which affects the distribution and abundance of marine organisms. Fishing, if undertaken unsustainably (i.e. overfishing) can cause pressures on fish stocks and climate change will change the balance of fish stocks. Internationally, measures proposed to aid in fisheries' adaptation to climate change include changing the types of species harvested, increasing imports of fish, and increasing production efficiencies and reducing waste[33].

Each of these industries relies on the direct input of natural resources. The supply and consumption of natural resources lend themselves to long–term measurement in an integrated environmental–economic framework and such long–term measurements are important in monitoring adaptation to climate change.

The Water supply industry

In 2009–10, the Water supply, sewerage and drainage services accounted for less than 1% of the industry gross value added and employed about 0.3% of persons employed in the country[34]. However, the availability of clean water is critical to the functioning of Australian society. The variations in rainfall as well as the changes in water temperature and water flows will affect the quality of available water. Also sea level rise, saline intrusion in coastal aquifers may increase, affecting the suitability for drinking water[35].

Because of the need to maintain water supplies to people in times of drought there has been an increase in the amount of water that has or can be supplied by desalinating water. Desalination of water in Australia has been undertaken for over a hundred years and was previously used mostly to provide water to remote areas for household consumption or use in mining, defence or tourism. Desalination is now undertaken or planned in several of Australia's capital cities, including Sydney, Melbourne, Adelaide and Perth. The ability to produce water reliably, independent of climate variations, is an important driver of the increasing interest in desalination. Between 2009 and 2013, 976 desalination plants were under construction and another 925 plants were proposed[36]. Producing water from desalination relies on upfront investments in desalination plants as well as on–going expenses and in particular of energy. The on–going energy costs generally make desalination expensive compared to water sourced from more traditional sources[37] .

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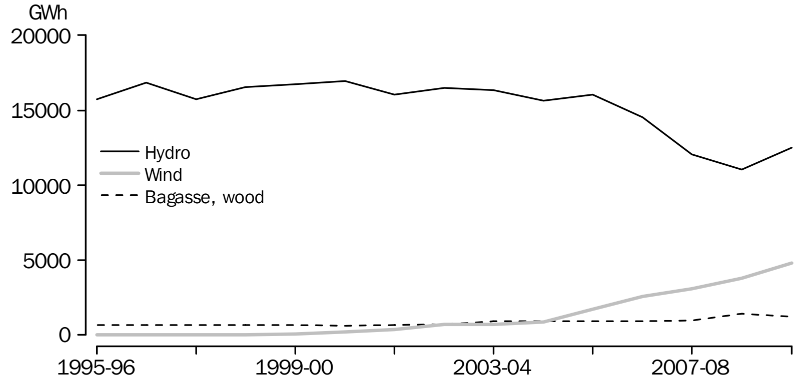
31 ABARES. Fast Facts Carbon in Australia's Forests http://adl.brs.gov.au/forestsaustralia/facts/carbon.html
32 European Commission (2009). WHITE PAPER Adapting to climate change: Towards a European framework for action – Impact assessment. Brussels, 1.4.2009 SEC(2009) 387.
http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009SC0387:EN:NOT
33 Ibid. p88.
34 Australian Industry, 2009–10 (ABS cat. no. 8155.0) http://www.abs.gov.au/ausstats/abs@.nsf/mf/8155.0
35 CSIRO, 2009. Desalination in Australia.
http://www.csiro.au/Outcomes/Water/Water–for–cities–and–towns/~/media/CSIROau/Flagships/Water%20for%20a%20Healthy%20Country%20Flagship/DesalinationInAustraliaReport_WfHC_PDF%20Standard.pdf
36 CSIRO, 2009. Desalination in Australia.
http://www.csiro.au/Outcomes/Water/Water–for–cities–and–towns/~/media/CSIROau/Flagships/Water%20for%20a%20Healthy%20Country%20Flagship/DesalinationInAustraliaReport_WfHC_PDF%20Standard.pdf
37 Productivity Commission, 2011. Australia's Urban Water Sector. Vol. 1.

Energy and renewable energy

In 2009–10 the Electricity supply industry accounted for about 2.5% of gross industry value added and accounted for 0.5% of total employees[38]. In 2009–10, renewable energy represented 2% of total primary energy supply (about 286 PJ)[39]. Part of Australia's plan for adapting to climate change is to increase the share of energy supplied from renewable sources[40].

Figure 3.7 shows the amount of electricity generated from each renewable source as well as the percentage of total electricity generated from renewable sources. Historically, renewable electricity production has fluctuated based on the supply of hydro power, but in recent years wind energy has become a larger source of electricity, accounting for 24% of renewable electricity in 2009–10.

3.7 QUANTITY OF ELECTRICITY GENERATED, from renewable sources: **1995–96 to 2009–10**



Source: ABARES, Table O: "Australian Energy Electricity Generation by Fuel Type, Physical Units (GWh)

Energy production and distribution will to some extent be vulnerable to climate variations. Electricity transmission wires are damaged through extreme weather events and there might also be increased losses in transmission due to higher temperatures. Internationally, measures to adapt have been proposed to involve a combination of new insurance products and public responses so that the energy services can keep the infrastructure up and running and maintain energy security[41].

Hydroelectric power plants are dependent on continued access to water. The variability of rainfall will impact on the production as well as the safety of dams and reservoirs. Investments in storage and increasing connectivity between grids to reduce losses are examples of measures to adapt to climate change.

38 Australian Industry, 2009–10 (ABS cat. no. 8155.0) http://www.abs.gov.au/ausstats/abs@.nsf/mf/8155.0
39 Energy Account, Australian 2009–10. (ABS cat. no. 4604.0).
http://www.abs.gov.au/ausstats/abs@.nsf/mf/4604.0
40 See for example, Australian Government, 2011. Clean Energy Australia.
http://www.cleanenergyfuture.gov.au/wp–content/uploads/2011/07/clean–energy–australia.pdf
41 European Commission, 2009. WHITE PAPER Adapting to climate change: Towards a European framework for action – Impact assessment. Brussels, 1.4.2009 SEC(2009) 387.
http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009SC0387:EN:NOT

Energy and renewable energy continued

Higher temperatures and storms can negatively affect the efficiency of photovoltaic power cells. On the other hand, increasing average wind velocities can improve the electricity production from wind turbines. Measures to adapt would include locating specific types of energy power generation to areas less vulnerable to high temperatures, storms or sea level rise as well as to take advantage of changed conditions (e.g. in the case of wind turbines).

Coastal management

Ports, airports, military facilities, as well as residential and other private infrastructure located in vulnerable coastal locations may require increased monitoring in the future. There will also be adverse impacts on coastal and estuarine ecosystems. The frequency of extreme sea level events (including storm surges) can increase with a modest sea level rise, making many existing coastal assets vulnerable.

Measurement indicators for coastal regions and for coastal management can be extracted from land accounts and in particular can answer questions like: how many people and what physical infrastructure would be affected by rising sea levels?

ABS has produced experimental Land Accounts that provide information on population, land cover and agricultural production in areas with bearing on the Great Barrier Reef[42]. One of the strengths of this style of account is that it incorporates a spatial aspect to the data. An expansion of this type of account to other areas of Australia and in particular to coastal regions could be used as a tool to understand which areas may be adversely affected by rising sea levels or increased frequency of storms and floods.

Data for coastal management crosses many statistical areas. The experimental land accounts for the Great Barrier Reef provide information on a range of areas, including: land cover, land use, land value, agricultural water use and the gross value of irrigated and non–irrigated agricultural production. These data can be combined with demographic information from the ABS Census of Population and Housing to better understand the socio–economic context of land use in this region. Chapter 5 is dedicated to the Great Barrier Reef and discusses how a variety of accounts, including land, water, emissions (water pollution), and biodiversity as well as tourism satellite accounts can inform management of this area.

Natural disaster preparation and management

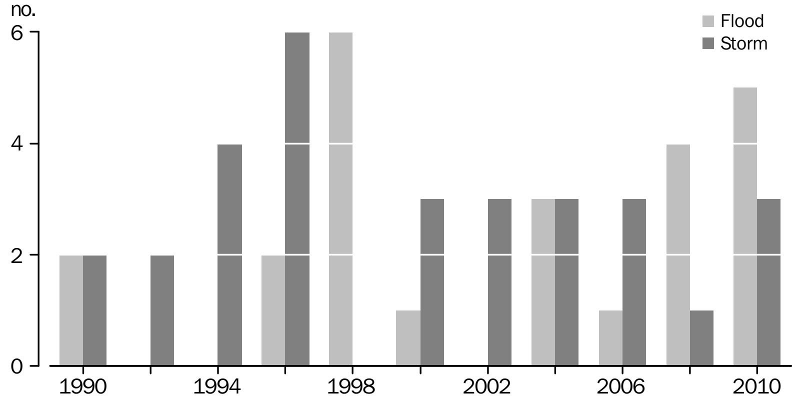
There is some evidence that climate change is already impacting the frequency and intensity of extreme events[43]. In the past 20 years Australia has suffered a number of natural disasters with a range of impacts on the population, the economy and the environment (Figure 3.8). Across Australia, storms and floods are a yearly feature.

42 Land Account, Great barrier Reef Region, Experimental Estimates. (ABS cat. no. 4609.055.001) http://www.abs.gov.au/ausstats/abs@.nsf/mf/4609.0.55.001

43 IPCC, 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Table SPM.2.

Natural disaster preparation and management continued

3.8 EXTREME WEATHER EVENTS—1990–2010



Source: CRED, www.emdat.be

Land accounts, such as those presently available for the Great Barrier Reef, can help natural disaster management and planning. Land accounts provide spatially explicit information on the population and number of businesses at a local level, which can be used to estimate the magnitude of socio–economic effects of natural disasters. As the land accounts use Geographical Information System (GIS) users can add their own spatial data and examine areas of particular interest. For example, areas close to coasts, rivers, or fire–prone land.

In addition to identifying vulnerable land areas and ecosystems through spatial information, it is also of interest to measure how much is spent on activities, technologies, infrastructure etc. related to reducing the impacts of climate change. The aggregation (and disaggregation) of data sets that accurately account for the costs and expenditures relating to adaptation measures can be used for the purpose of a wide range of policy analysis, particularly if integrated with physical measures and outcomes. The ABS has compiled Environment Protection Expenditure Accounts (EPEA) in the past, and expenditure accounts for climate change adaptation could be an extension of these estimates[44,45].

Tracking the monetary flow of adaptation to climate change

Environmental protection and natural resource expenditure accounts track financial transactions related to activities aimed at reducing environmental impacts or protecting our natural resources. Internationally work on developing new methodologies based on SEEA to create a separate set of statistics on expenditure for adaptation to climate change is progressing[46]. The methodology focuses on measures undertaken by the General Government but it is known that businesses are already starting adaptation activities[47].

44 ABS, 2002. Environment Protection, Mining and Manufacturing Industries, Australia, 2000–01. (ABS cat. no. 4603.0) http://www.abs.gov.au/ausstats/abs@.nsf/mf/4611.0
45 ABS, 2004. Environment Expenditure, Local Government, Australia, 2002–03. (cat. no. 4611.0) http://www.abs.gov.au/ausstats/abs@.nsf/mf/4611.0
46 Statistics Sweden, 2011. Climate Change Adaptation Expenditure – A proposal for a methodology to compile, define and classify national and EU economic information as statistics. http://www.scb.se/statistik/_publikationer/MI1301_2012A01_BR_MIFT1201.pdf
47 CSIRO. Adaptation benchmarking survey: initial report. Climate Adaptation National Research Flagship Working paper #4. http://www.csiro.au/files/files/px5a.pdf

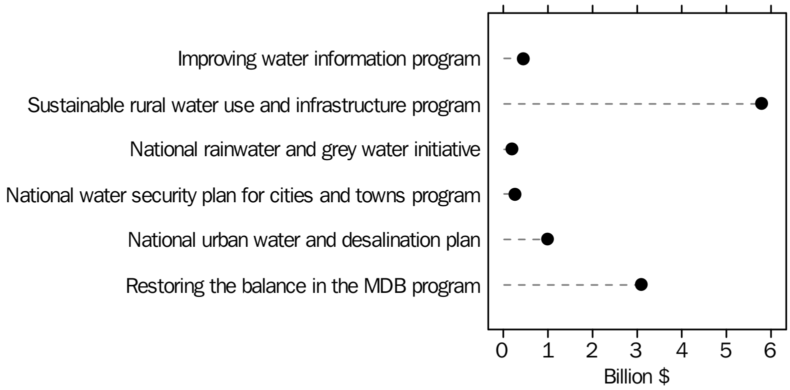
Tracking the monetary flow of adaptation to climate change continued

In the fifth national communication to the UNFCCC Australia stated that adaptation is already part of the financial budget. Investments in research to increase the understanding of the impacts of climate change has been made as well as investing in building adaptive capacity and increase efficient risk management[48]. At this point in time it is not possible to produce monetary statistics on adaptation, but an example is provided below showing what types of measures are being put in place and how much is invested.

Figure 3.9 shows some measures that the Australian government has flagged for funding through the Water for the Future program. This program is a 10 year initiative addressing four issues:

- taking action on climate change
- using water wisely
- securing water supply
- supporting healthy rivers

3.9 WATER FOR THE FUTURE PROGRAM, Adaptation Components—10 YEAR INITIATIVE



Source: Australian Government, Department of Climate Change, 2010: Australia's Fifth National Communication on Climate Change

48 P. 106, Australian Government (2011) Australia's 5th National Communication on Climate Change. http://www.climatechange.gov.au/~/media/publications/international/Australia–fifth–national–communication.pdf

CHAPTER 4 SUSTAINABILITY

INTRODUCTION

This chapter shows how the System of Environmental–Economic Accounting (SEEA) can be used to assess sustainability using a capital approach.

In August 2011 Martin Parkinson, the Secretary of the Treasury, said that:

"*...Sustainable wellbeing requires that at least the current level of wellbeing be maintained for future generations. In this regard, we can consider sustainability as requiring, relative to their populations, that each generation bequeath a stock of capital – the productive base for wellbeing – that is at least as large as the stock it inherited. … Running down the stock of capital in aggregate diminishes the opportunities for future generations. In one way or another, eroding the productive base will lead to lower future wellbeing. Note, though, that drawing down any one part of the capital base may be reasonable as long as the economy's aggregate productive base is not eroded.*"[49]

Natural capital is 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; the atmosphere; and, biological resources (e.g. forests, fish, other species and habitats). The System of National Accounts (SNA) includes estimates of the value of these resources where they fit the definition of an economic asset. An economic asset must have an identifiable owner and the owner must be able to hold or use these assets for economic gain.

The Australian Bureau of Statistics (ABS) currently includes experimental values for natural assets such as subsoil assets, timber in forests, fish and land on the National Balance Sheet[50]. The National Balance Sheet also includes the value of financial and produced assets (e.g. buildings, plant and machinery). The ABS is also investigating the valuation of other components of natural capital, for example water, carbon and biodiversity. The inclusion of these assets would provide a more complete assessment of Australia's natural capital and would complement the existing regularly produced estimates of the value of Australia's economic assets.

The capital approach to measuring sustainability may reasonably be extended to cover social and human capital. Existing estimates for these types of capital are considered experimental in nature and are discussed later in this chapter.

Th notion that one form of capital can be substituted for another, provided the overall aggregate or total value of the capital base is not reduced is known as weak sustainability[51].

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49 Parkinson, M., 2011, Sustainable Wellbeing – An Economic Future for Australia, The Shann Memorial Lecture, August 2011. Online: http://www.treasury.gov.au/documents/2134/PDF/shann.pdf
50 Australian Bureau of Statistics, 2011, Australian System of National Accounts, 2010–11 (cat. no. 5204.0).
51 United Nations, 2008, Measuring Sustainable Development: Report of the Joint UNECE/OECD/Eurostat Working Group on Statistics for Sustainable Development, New York and Geneva. Online: http://www.oecd.org/dataoecd/30/20/41414440.pdf

INTRODUCTION
continued

Weak sustainability[51] is a normative sustainable development goal specifying that the total per capita value of all capital stocks, or total national wealth per capita, should not decline over time in real terms. Weak sustainability incorporates an assumption of perfect substitutability between the various types of capital. The depletion of one stock of capital – petroleum reserves, say – can be fully compensated by investment in another stock – perhaps human capital. So long as this compensation is always undertaken, then society is free to pursue whatever mix of capital stocks best suits its needs. A strong undercurrent in this view is that technological progress can, over time, eliminate constraints imposed by scarcity of any particular capital stock. It is, in other words, the world view of the technological optimist.

Strong sustainability[51], on the other hand, assumes that substitution possibilities among capital stocks are limited, even in the face of technological progress, because of the critical nature of some assets and the services they produce. It therefore sets minimum levels for certain stocks of critical capital, below which they are not allowed to fall.

Strong sustainability recognises that the impact of humans on the environment is less marginal. Small changes in natural capital, even critical natural capital, may be reasonably easily dealt with through substitution or simply by accepting lower levels of ecosystem services. As changes become greater, however, we move closer to the point where substitution is a practical impossibility and where living with reduced service levels induces unbearable costs. The consequences of these non–marginal changes in natural capital are difficult to measure, in part because scientific knowledge of natural systems is not perfect. Careful tracking of natural capital stocks is therefore called for by the strong sustainability view. As noted, though, arguments can be made that critical forms of capital can be found in other categories, including social capital. Thus, the strong view of sustainable development should not be viewed as relevant only to environmental concerns.

If it is considered that capital stocks can be substituted for each other in order to deliver benefits to people, then a notion of weak sustainability is accepted. The practical implication of this notion for the measurement of sustainable development is that a single monetary aggregate, such as genuine savings or total national wealth, is a sufficient measure of sustainable development. Importantly, the SEEA can inform assessments of sustainability regardless of whether these are based on a weak or strong notion of sustainability.

The capital approach has some limitations for the measurement of sustainability[52,53]. The limitations of a monetary capital approach are described in a report by the United Nations Economic Commission for Europe (UNECE)/Organisation for Economic Co–operation and Development (OECD)/Eurostat Working Group on Statistics for Sustainable Development (WGSSD):

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52 Smith, R., 2008. Measuring the Sustainability of Well–Being: a Capital Approach. Paper prepared for the 30th general conference of The International Association for Research in Income and Wealth. Online: http://www.iariw.org/papers/2008/smith.pdf

53 United Nations, 2008. Measuring Sustainable Development: Report of the UNECE/OECD/Eurostat Working Group on Statistics for Sustainable Development. Online: http://www.oecd.org/dataoecd/30/20/41414440.pdf

INTRODUCTION *continued*

"To reach its full potential, the capital approach requires measurement of all capital stocks using a common unit. The only obvious choice of unit – money – is problematic for two reasons. First, it is difficult to uniquely determine all of the ways in which capital contributes to well–being. Those that cannot be identified obviously cannot be valued. Second, even for those contributions we can identify, it is sometimes difficult to translate their value into dollars. This is partly because functioning markets rarely achieve the ideal conditions economists impose upon them in their valuation methods and partly because the methods themselves remain underdeveloped in some cases.

There is in addition to the debate over the economics of valuation a debate over its ethical underpinnings. Certain observers place a question mark after the right of humans to exploit nature in a destructive manner, even if this, at least in the short run, may increase total national wealth. Clearly, aggregating nature along with other forms of wealth as though humans are indifferent to its existence so long as their well–being is assured is at ethical odds with this view.

A third limitation on valuation is the degree of substitutability among capital types. It is generally accepted that the various components of national wealth cannot always and without difficulty be replaced with each other. It is not so, for instance, that ecosystem services, which may be considered as one of the dividends of natural capital, can easily and always be replaced by increased income, the dividend of financial, produced or human capital. Capital services for which no substitute can be found are said to flow from critical capital stocks. To the extent that some capital stocks are indeed critical, the possibility of using a single monetary aggregate to measure sustainable development disappears. It would be wrong to aggregate values for non–critical capital with those for critical capital into a single measure. In doing so, essential information for sustainable development would be lost."[54]

POLICY FRAMEWORKS

The Australian government and Australia's state and territory governments have implemented a number of policies and programs aimed at addressing sustainability (Figure 4.1). These have similar objectives and in general aim to maximise the benefits of resource use over time. One of the common features of the policies listed in Figure 4.1 is the express need for consistent information on economic, environmental and social aspects of Australia.

54 United Nations, 2008. Measuring Sustainable Development: Report of the UNECE/OECD/Eurostat Working Group on Statistics for Sustainable Development. Online: http://www.oecd.org/dataoecd/30/20/41414440.pdf

4.1 EXAMPLES OF POLICY FRAMEWORKS AND INITIATIVES

Government	*Sustainability policy*
Australian	Sustainable Australia - Sustainable Communities Ecological Sustainable Development for Government Agencies
	The Treasury's strategic framework
	Clean Energy Future
New South Wales	Sustaining our environment
Victoria	Our Environment Our Future
Queensland	Toward Q2: Tomorrow's Queensland
South Australia	South Australia's Strategic Plan 2007: Goal 3 – Attaining sustainability
Western Australia	Hope for the Future: The Western Australian State Sustainability Strategy
Tasmania	Tasmania Together
Northern Territory	Territory 2030 plan
Australian Capital Territory	People Place Prosperity: a policy for sustainability in the ACT

POLICY FRAMEWORKS *continued*

Here we examine the Commonwealth Treasury's strategic framework[55], which sets out five dimensions for the evaluation of policy:

- The *set of opportunities* available to people. This includes not only the level of goods and services that can be consumed, but good health and environmental amenity, leisure and intangibles such as personal and social activities, community participation and political rights and freedoms.
- The *distribution* of those opportunities across the Australian people. In particular, that all Australians have the opportunity to lead a fulfilling life and participate meaningfully in society.
- The *sustainability* of those opportunities available over time. In particular, consideration of whether the productive base needed to generate opportunities (the total stock of capital, including human, physical, social and natural assets) is maintained or enhanced for current and future generations.
- The overall level and allocation of *risk* borne by individuals and the community. This includes a concern for the ability, and inability, of individuals to manage the level and nature of the risks they face.
- The *complexity* of the choices facing individuals and the community. Our concerns include the costs of dealing with unwanted complexity, the transparency of government and the ability of individuals and the community to make choices and trade–offs that better match their preferences."

The following sections take the Treasury's third dimension on sustainability and shows how the SEEA can be applied in this context. In particular, four questions are considered:

- What is the value of Australia's capital base?
- How much capital is available per person?
- What is the income generated from capital?
- How much is spent on maintaining or improving Australia's capital base compared to depletion of Australia's capital base?

55 See: (Parkinson 2011) Sustainable Wellbeing – An Economic Future for Australia, The Shann Memorial Lecture, August 2011, http://www.treasury.gov.au/documents/2134/PDF/shann.pdf

POLICY FRAMEWORKS *continued*

While this work focuses primarily on measures based on a capital approach, there is ongoing work on extending the capital approach to develop long term and quality of life based indicators.

What is the value of Australia's capital base?

The capital base of Australia could be viewed as comprising five asset types:

- Produced capital[56]
- Financial capital[57]
- Natural capital[58]
- Human capital[59]
- Social capital[60]

Figure 4.2 shows the current price value of these types of capital in Australia between 2000–01 and 2009–10. The value of the four types of natural capital for which estimates exist (land, subsoil assets, timber and fish) is approximately equal to that of the produced capital for the nation. The value of natural capital and produced capital in Australia both show an upward trend in the period from 2000–01 to 2009–10. During this period natural capital more than doubled in value from $1,528 billion to $4,574 billion.

4.2 AUSTRALIA'S CAPITAL BASE, current prices—as at 30 Jun

	2000-01	*2005-06*	*2006-07*	*2007-08*	*2008-09*	*2009-10*
Capital Estimate	$b	$b	$b	$b	$b	$b
Produced Capital(a)	2 251.2	3 271.5	3 554.0	3 843.4	4 048.0	4 227.9
Net Financial Assets with the rest of the world	–362.5	–528.7	–613.2	–658.5	–703.7	–776.9
Natural Capital(partial)	1 528.1	3 117.4	3 512.3	3 773.4	3 936.1	4 574.3
Human Capital	6 769.8	na	na	na	na	na
Social Capital	na	na	na	na	na	na

na not available
(a) Excludes plantation timber inventories, which are included under Natural Capital
Source: Australian System of National Accounts, 2010–11 (ABS cat. no. 5204.0)

The increases in the value of natural capital in current prices were due to increases in the value of land and of subsoil assets (both increased by 13% compounded per annum between 2000–01 and 2009–10). Over the same time produced capital increased by 7% compounded per annum while financial capital's net liability increased by 9% compounded per annum.

56 Produced capital is defined as non–financial assets that have come into existence as outputs from production processes that fall within the production boundary of the SNA. (SNA 2008)
57 Financial capital is defined as all financial claims, shares or other equity in corporations plus gold bullion held by monetary authorities as a reserve asset. For sustainable development, net financial assets with the Rest of the World are shown as net domestic financial assets are conceptually equal to zero as domestic assets equal domestic liabilities. (SNA 2008)
58 Four basic categories of natural capital are generally recognised: air, water (fresh, groundwater and marine), land (including soil, space and landscape) and habitats (including the ecosystems, flora and fauna which they both comprise and support). In this case subsoil assets, land, timber and wild fish are being used as an estimate of natural capital. Water, habitat and ecosystems and soil resources are not explicitly included..
59 Human capital was estimated in ABS (2008). Research Paper: Measuring Human Capital Flows for Australia: A Lifetime Labour Income Approach (ABS cat. no. 1351.0.55.023)
60 The framework for social capital in Australia is defined in ABS (2004). The values are from: ABS (2009). Research Paper: Exploring Measures of Low Social Capital (ABS cat. no. 1351.0.55.024).

What is the value of Australia's capital base? continued

Estimates of the value of water, renewable energy 'stocks' and carbon are not included in the value of natural capital although these could be considered economic assets in the SNA. While there are economic uses of water and an active market in water rights, valuation has proved problematic. The Net Present Value[61] (NPV) approach yields very low asset values for water as the urban water market is highly regulated and a resource rent is therefore not typically captured by the producer. Much of the economic benefits of water use are captured by intermediate users (e.g. agriculture) and final consumers (e.g. households) but these benefits do not feature in direct resource rent and NPV calculations[62].

For renewable energy, the profits made by electricity generators could be used to value the stocks of solar, wind and hydroelectric power resources. It is likely that at least some of this value is already captured in values of produced capital and the associated valuations of land and possibly water. For carbon, stocks are not separately valued at present although the various measures introduced or to be introduced as part of the Clean Energy Futures Act may enable carbon stocks to be separately valued in the future.

In comparison to current price estimates, volume measures of Australia's capital base remove the price bias from these estimates by fixing the price index at a particular point, usually the last point of the series and deflating the values of the asset over the preceding years. A chain volume measure represents values at constant purchasing power.

Volume measures reflect the real value of assets over time and are useful in a sustainability context to examine the impact of changes to the stock of assets. The main limitation with using volume measures is that it may be difficult to reconcile changes in some of the component series after chain volume measures have been applied.

Using volume measures as shown in Figure 4.3, preliminary natural capital estimates increased by 1% compounded per annum between 2000–01 and 2009–10, driven by subsoil assets (which increased by 3% compounded per annum) and land assets (increased by 1% compounded per annum). For the same period, produced capital increased by 4% compounded per annum in volume terms and financial capital (increased) by 6% compounded per annum.

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61 Where market values are not readily observable Net Present Value is the preferred technique for valuing assets. It is based on the expected return on the asset over its life. See (ABS, 2002, Accounting for the environment feature article in Australian National Accounts: National Income, Expenditure and Product ABS cat. no. 5206.0, June Quarter 2002) for more details on the NPV technique.

62 Comisari, P., Freeman, B., Feng, L. 2011. Valuation of water resources and water infrastructure assets. Presented at 17th meeting of the London Group on Environment Accounting. Online: http://unstats.un.org/unsd/envaccounting/londongroup/meeting17/LG17_12.pdf

What is the value of Australia's capital base? continued

4.3 AUSTRALIA'S CAPITAL BASE, volume measures—as at 30 Jun

	2000-01	2005-06	2006-07	2007-08	2008-09	2009-10
Capital Estimate	$b	$b	$b	$b	$b	$b
Produced Capital(a)	3 029.9	3 585.1	3 724.7	3 887.2	4 035.6	4 181.8
Net Financial Assets with the rest of the world	–437.4	–566.7	–638.6	–667.7	–703.6	–758.4
Natural Capital(partial)	4 151.8	4 421.8	4 483.9	4 552.8	4 619.5	4 678.2
Human Capital(b)	7 036.2	n.a.	n.a.	n.a.	n.a.	n.a.
Social Capital	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

(a) Excludes plantation timber inventories, which are included under National Capital
(b) Human capital estimates are in 2001 constant prices
Source: Australian System of National Accounts, 2010–11 (ABS cat. no. 5204.0)

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 WGSSD. The ABS produced experimental estimates of human capital in 2008[63] using this general approach. The estimates of human capital estimates are presented in Figure 4.4 for selected years between 1986 and 2001. Over this time period, human capital increased by 2% compounded per annum and per capita human capital increased by less than 1%.

4.4 HUMAN CAPITAL ESTIMATES, constant 2001 dollars

	Closing stock	Per capita
	$b	$
1981–86	4 945.5	309 000
1986–91	5 804.3	336 000
1991–96	6 486.7	354 000
1996–01	7 036.2	362 000

Source: Research Paper: Measuring Human Capital Flows for Australia: A Lifetime Labour Income Approach, 2010–11 (ABS cat. no. 1351.0.55.023)

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[64]. The low social capital estimate is derived from combining aspects of social capital (network type, support, trust, community involvement, and feelings of safety).

Low social capital was more prevalent in older age groups, up to 14% of the 60+ population in 2006. Low social capital was characterised by a lack of a social network (14%) and feelings of a lack of support from the community (13%). This age group did have the highest levels of trust with only 7% of the population with low trust. No data are readily available to test if social capital is increasing or declining over time, though the

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

What is the value of Australia's capital base? continued

methodology used to create low social capital estimates could be repeated for the general social survey results from 2001 and 2010.

How much capital is available per person?

Sustainability from a capital perspective can be defined as non–declining per capita wealth over time. Per capita estimates of Australia's capital base are presented in Figure 4.5. The amount of produced capital, natural capital and financial assets (in real terms) was approximately $364,000 per capita in 2009–10. This represents an increase of 0.5% compounded per annum for the last nine years. Over the same period net national savings per capita has increased by an average of 10% compounded per annum.

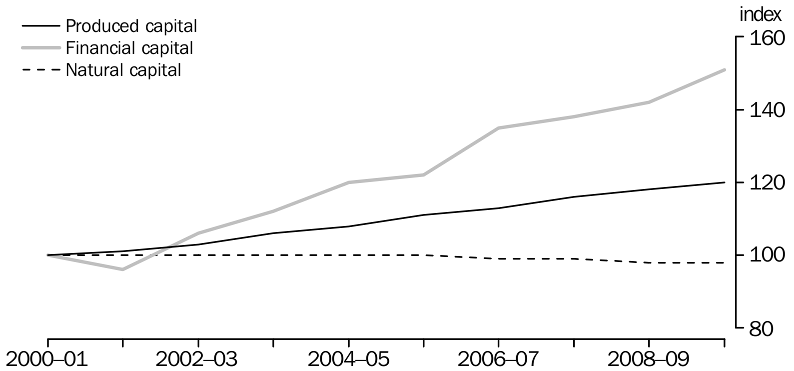
4.5 ESTIMATES OF AUSTRALIA'S CAPITAL BASE(a), volume measures, as at 30 Jun

	2000-01	2005-06	2006-07	2007-08	2008-09	2009-10
Capital Estimate	$	$	$	$	$	$
Produced Capital(b)	156 000	173 000	177 000	184 000	188 000	192 000
Net Financial Assets with the rest of the world	–22 000	–27 000	–30 000	–31 000	–32 000	–34 000
Natural Capital(partial)	214 000	214 000	213 000	212 000	210 000	210 000
Total	348 000	359 900	360 000	362 000	361 000	364 000
National Net Savings per capita	1 668	3 175	3 352	3 848	4 987	4 067

(a) Where available
(b) Excludes plantation timber inventories, which are included in natural capital
Source: Australian System of National Accounts (ABS cat.no. 5204.0)

The value of natural capital in per capita volume measures declined by less than 1% between 2000–01 and 2009–10. Over the same period per capita estimates of produced and financial capital in volume measures increased, respectively, by 2% and 5% compounded per annum (Figure 4.6).

4.6 PER CAPITA CAPITAL ESTIMATES, 2000–01 base year(a)



(a) 2000–01=100
Source: Australian System of National Accounts (ABS cat. no. 5204.0)

What is the income generated from Australia's capital?

One particular motivation for deriving a more complete picture of total capital for Australia is to examine the income derived from these assets. Income from natural assets can be measured in three ways:

What is the income generated from Australia's capital? continued

- *Rent on Natural Assets* (2008 SNA) – is commonly described as royalties and is typically the return to the General Government sector in exchange for allowing exploitation of certain natural resources.
- *Resource Rent* (2012 SEEA) – the net operating surplus earned from extracting a natural asset can be decomposed into: a return on produced capital; and the resource rent.
- *Return on Natural Assets* (2012 SEEA) – composed of the difference between depletion of natural assets and resource rent.

For Australia, estimates of Resource Rent and Return on Natural Assets are available for subsoil assets. Such estimates are not available for Land and other assets that support ecosystems services. A useful related indicator is 'depletion adjusted Net Operating Surplus', though depletion adjustments can also be applied to other national accounts aggregates such as Net Domestic Product, Net National Income and Net National Savings.

Experimental estimates for the value of depletion of subsoil assets and the degradation of agricultural land could be applied to various national accounts aggregates to deliver depletion–adjusted aggregates. Such aggregates would be presented in the context of a satellite account. For example, Figure 4.7 presents depletion–adjusted Net Operating Surplus which have lower values while having minimal impact on overall growth rates[65].

4.7 INCOME GENERATED FROM AUSTRALIA'S CAPITAL BASE

	TOTAL ECONOMY	FINANCIAL	NATURAL
	Depletion adjusted Net Operating Surplus	*Net primary income from non-residents*	*Rent on Natural Assets*(a)
	$b	$b	$b
2000–01	162.4	–19.5	2.7
2001–02	181.0	–20.2	2.7
2002–03	190.5	–22.3	2.8
2003–04	209.6	–24.3	2.6
2004–05	224.3	–34.1	3.6
2005–06	244.7	–38.6	4.8
2006–07	264.9	–48.4	5.2
2007–08	288.9	–50.0	5.8
2008–09	331.0	–46.1	9.5
2009–10	334.3	–47.8	7.7

(a) Unconsolidated, primarily general government.
Source: Australian System of National Accounts (ABS cat.no. 5204.0)

Adjusting national accounts aggregates for depletion typically results in small changes to the growth rates (0.1% or less). Net primary income to non–residents increased by 10% over the period 2000–01 to 2009–10. It peaked in 2007–08 and has fallen away recently with the global financial crisis. For the same period Rent on natural assets increased by 12%, compounded per annum, and peaked at $9.5 billion in 2008–09.

65 See also, ABS Year Book Australia, 2009–10 Environment Chapter, ABS cat. no. 1301.0 for more information on the use of depletion to adjust National Accounts estimates.

What is the income generated from Australia's capital? continued

Calculating direct income flows from natural assets and produced assets is challenging with current sources of information. Resource rent is available for subsoil assets (Figure 4.8), but these estimates are not necessarily a precise indication of the rent for the mining industry as they are calculated from the natural resource assets without strict regard to the sector or industry that extracts them. Similarly values for return on natural assets are unavailable. Figure 4.8 contains examples of possible aggregates that could be provided for subsoil assets if these data were to become available.

4.8 INCOME FROM SUBSOIL ASSETS

	Resource Rent	*Of which: Return on Natural Assets*
	$b	$b
2000–01	15.8	13.2
2001–02	16.8	13.8
2002–03	18.3	14.7
2003–04	20.2	16.1
2004–05	22.0	18.0
2005–06	25.4	21.1
2006–07	28.8	24.4
2007–08	35.2	30.2
2008–09	39.6	32.5
2009–10	44.1	38.4

Source: Australian System of National Accounts, 2010-11 (ABS cat. no. 5204.0); and based on data from ABS Year Book Australia, 2009-10 (ABS cat. no. 1301.0).

One aspect of sustainability is the distribution of income derived from the capital base across sectors and, within the household sector, between particular household types. This may be possible with existing data but has not yet been attempted by the ABS. Income from wealth may be a poor indicator of sustainability, since:

"*While economic wealth is an important measure of sustainable development from the capital perspective, it cannot stand alone. Economic wealth measures only the capital base that contributes to market income. While market income is an important contributor to well–being, it is far from alone. Well–being is also created by "consuming" non–market flows of goods and services such as breathtaking scenery on a smog–free day, positive relations with one's loved ones and the personal capacity to pursue self–fulfilment. The non–economic assets that produce these flows must be measured both because they are important in and of themselves, but also to ensure that in the pursuit of market income the capital base from which non–market well–being is derived is not eroded. To the extent that this was the case, gains in market income would be misleading in isolation as an indicator of sustainable development.*" [66]

How much is spent on maintaining or improving Australia's capital base compared to depletion of Australia's capital base?

Investment in produced capital is defined as total expenditures on products intended to be used for future production. This is the key distinction between financial investment and capital investment. Another key distinction is that expenditure related to intermediate consumption and to inventories is not included in investment.

66 United Nations, 2008. Measuring Sustainable Development: Report of the UNECE/OECD/Eurostat Working Group on Statistics for Sustainable Development. Online: http://www.oecd.org/dataoecd/30/20/41414440.pdf

How much is spent on maintaining or improving Australia's capital base compared to depletion of Australia's capital base? continued

A nation has the choice to invest in capital stocks or to spend on current consumption activity. One of the problems of this choice is that without sufficient information, investment has the risk of being random or of following a simple trend:

"*While concerns about dissimilarities among the various types of capital are legitimate, there are several reasons why the broad concept is nonetheless useful for measuring sustainable development. Firstly, it offers a basis for the important insight that development is not entirely stochastic or random but can be managed through investments in specific stocks. Furthermore, it provides a framework that explains why spending income on investments rather than current consumption is likely to enhance well–being in the future.*"[67]

In addition, investment in capital is important for achieving sustainable development:

"*... natural capital contributes to the production of marketed goods and/or provides environmental amenities, the economy will maintain a constant or increasing level of per capita well–being only if investments in other forms of capital exceed the monetary value of natural capital depletion on an economy–wide basis.*"

Values for regrowth in the environment are not available for Australia and replenishment of subsoil assets occurs in geological timeframes. However, environmental expenditure could be considered as a proxy for investment in natural capital. Environmental expenditure for both protection and conservation activities are important for improving environmental quality as economic activity takes place. Environmental expenditure benefits both market and non–market natural capital. Environmental expenditure is defined in the SEEA but recent estimates for Australia are unavailable. Data on environmental expenditure were compiled for Australia during the late 1990's and there is some limited information from a survey on the mining and manufacturing industry in 2000–01.

4.9 INVESTMENT IN CAPITAL, current prices

	PRODUCED	PRODUCED	FINANCIAL	NATURAL
	Gross fixed capital formation	*Gross fixed capital formation*	*Transactions in Net International Investment Position*	*Protection and conservation expenditure*(a)
	$b	$b	$b	$b
2000–01	163.1	9.5	17.8	n.a.
2001–02	181.6	11.2	20.2	n.a.
2002–03	206.2	13.9	38.4	n.a.
2003–04	226.5	15.5	46.7	n.a.
2004–05	247.7	17.5	58.3	n.a.
2005–06	277.5	27.9	54.6	n.a.
2006–07	299.1	34.4	60.9	n.a.
2007–08	336.4	44.2	72.2	n.a.
2008–09	351.1	52.7	38.8	n.a.
2009–10	356.0	49.4	55.1	n.a.

(a) Mining and manufacturing spent $1.5 billion on environment protection in 2000–01, Australia spent $8.9 billion in 1996–97 (ABS cat. no. 4603.0).

Source: Australian System of National Accounts, (ABS cat. no. 5204.0)

67 United Nations, 2008. Measuring Sustainable Development: Report of the UNECE/OECD/Eurostat Working Group on Statistics for Sustainable Development. Online: http://www.oecd.org/dataoecd/30/20/41414440.pdf

How much is spent on maintaining or improving Australia's capital base compared to depletion of Australia's capital base? continued

From Figure 4.9 we observe that investment has increased strongly over the past decade. Gross fixed capital formation (investment in produced capital) increased by 9% compounded per annum over the period from 2000–01 to 2009–10, largely from investment by mining in the latter part of the decade. Over the same period, transactions in net international investment position (financial investment) increased by 13% compounded per annum.

4.10 DEPLETION OF CAPITAL

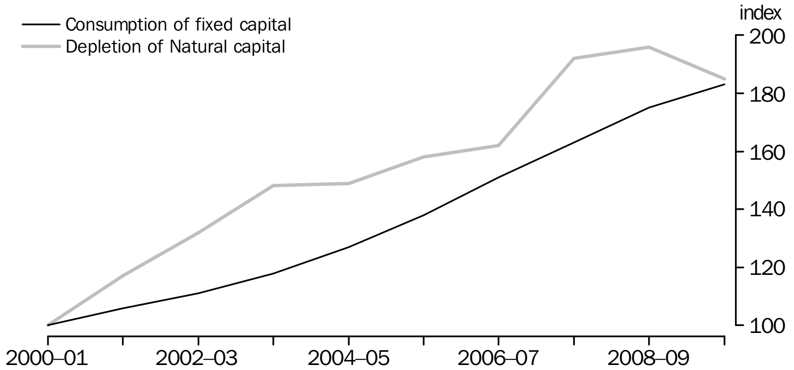
	PRODUCED	NATURAL
	Consumption of fixed capital	*Depletion*(a)
	$b	$b
2000–01	–113.1	–2.9
2001–02	–119.8	–3.4
2002–03	–126.0	–3.9
2003–04	–133.3	–4.4
2004–05	–143.8	–4.4
2005–06	–156.3	–4.7
2006–07	–170.7	–4.8
2007–08	–184.1	–5.3
2008–09	–198.5	–7.4
2009–10	–207.0	–6.1

(a) Includes value of soil depletion and lost profit due to soil degradation

Source: Australian System of National Accounts 2010-11 (ABS cat. no. 5204.0); and ABS, Year Book Australia (ABS cat. no. 1301.0).

Between 2000–01 and 2009–10 depletion of non–renewable assets increased by 9% compounded per annum. Depletion and consumption of fixed capital have both increased steadily over time and depletion peaked at $7.4 billion in 2008–09 (Figure 4.11). Monetary estimates of depletion are useful as indicators of resource use as they are a convenient way in which to integrate different asset types. Nevertheless, monetary and physical data are needed to conduct a full evaluation of sustainable development.

4.11 DEPLETION OF CAPITAL, 2000–01 base year



Note: Index: 2000–01=100

Source: Australian System of National Accounts, (ABS cat. no. 5204.0)

THE ROLE OF ENVIRONMENT EXPENDITURE IN SUSTAINABLE DEVELOPMENT

The Environmental Expenditure Accounts (EEA) of the SEEA are a tool for monitoring the amount of economic activity aimed primarily at protecting, restoring and conserving environmental quality which can impact on natural capital. These accounts focus attention on four key questions about expenditure:

- Who is financing environmental expenditure?
- Who is spending resources on the environment?
- Who produces goods and services for the environment? and,
- How does environmental expenditure flow through the economy?

Financing

The financing table in the EEA shows the flow of funds from the sectors that pay for environmental activity to those which receive funding for those activities. The primary use of this table is to quantify the funds available by sector to pay for environment activities.

Expenditure that is not self–financed will be largely accounted for by subsidies or grants from government allocated to industries, households or not–for–profit organisations.

Expenditure

The expenditure table identifies who directly spends money on environmental protection, whether the source of funding is self–finance or finance provided by another party (the financing information can be found in the Financing table). This table is useful for identifying who has control over the spending of money for environmental protection.

Production

The production table details the economic production pathway of environmental specific services. The table shows output of environmental (protection) specific services, as well as intermediate consumption, value added, and compensation of employees (SEEA 2012, paragraph 4.55).

Such information may be used to analyse the economic characteristics and performance of the environment protection industry. The figures are broken down by different types of producers, such as government producers and producers of environmental protection products for their own use.

Supply and use of environment specific goods and services

The supply and use tables detail the economic value of environment specific goods and services available to be consumed in the economy and the total usage of these goods and services.

- The supply side of the table shows total domestic production and imports of environment specific goods and services.
- The use side of the table shows consumption of environment specific goods and services, as inputs to production of other goods and services, as final consumption by households and government and as exports.
- By definition, total supply is equal to total use.

THE ROLE OF ENVIRONMENTAL TAXES AND SUBSIDIES IN MANAGING SUSTAINABLE DEVELOPMENT

There are a range of transactions, such as taxes and subsidies, which reflect efforts by governments on behalf of society, to influence the behaviour of producers and consumers with respect to the environment. Most of these environmental transactions are already recorded within the core national accounts framework but many cannot be easily identified due to the structure of the accounts or the types of classifications that

THE ROLE OF ENVIRONMENTAL TAXES AND SUBSIDIES IN MANAGING SUSTAINABLE DEVELOPMENT *continued*

are used. The SEEA provides a framework for separately identifying these environmentally related taxes and subsidies.

An environmental tax is a tax whose tax base is a physical unit (or a proxy of it) of something that has a proven, specific, negative impact on the environment (SEEA 2012). In practice, this definition is applied by looking at all of the various taxes levied in a country and making an assessment as to whether the tax base in each circumstance is something that has a negative environmental impact (SEEA 2012, paragraph 4.150). There are four categories of environmental taxes[68]:

- Energy taxes – Includes taxes on energy products used for both transport and stationary purposes. Taxes on fuel used for transport purposes should be shown as a separate sub–category of energy taxes. Energy products for stationary use include fuel oils, natural gas, coal and electricity. Taxes on carbon are regarded as an energy tax.
- Transport taxes – Includes taxes related to the ownership and use of motor vehicles, taxes on other transport equipment, related transport services and also taxes related to the use of roads.
- Pollution taxes – Includes taxes on measured or estimated emissions to air and water, and the generation of solid waste.
- Resource taxes – Includes taxes on water abstraction, extraction of raw materials and other resources (e.g. sand and gravel).

Of particular interest in recent times has been pollution taxes; especially those relating to greenhouse gas emissions. In order to reduce greenhouse gas emissions, Australia plans to set up a carbon permits trading scheme. Industries will be obliged to purchase carbon permits in order to discharge CO_2 into the atmosphere. SEEA 2012 includes a table to track the volume and value and carbon permits on the market.

Information on total numbers of permits and the use of such permits could provide important information for carbon emission policy. If the stock of permits declines over time, it is understood that carbon emissions have been reduced. From the different categories of permit use, policy makers can see if the market–incentive approach is effective in lowering levels of discharge of CO_2 and in prompting behavioural change.

In addition, the ABS can report tradable carbon permits in industry breakdowns, where most carbon–intensive industries can be identified and their emission scale closely tracked to assess the effectiveness of policies in place.

PHYSICAL ENVIRONMENTAL ASSETS

A representation of physical environment assets able to support assessments of sustainability is complex. There are many different asset types which have different characteristics, units of measurement and functions within the environment. A number of physical sustainable development indicators are being compiled using the guidance from the WGSSD by the Department of Sustainability, Environment, Water, Population and Communities in their measures of sustainability program.

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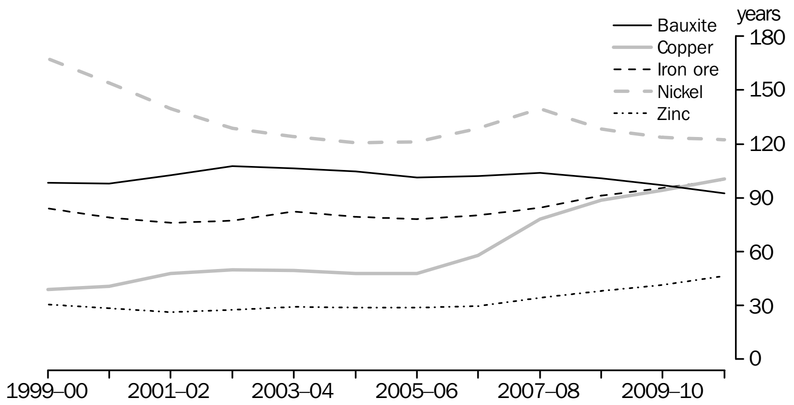
68 Note that payments to government for the use of land or natural resources are treated as rent – Rent, or resource rent, is the payment to government for the use of natural resources when the government is both owner and taxation authority (SEEA 2012) – and therefore are excluded from resource taxes. In the National Accounts of ABS, rent on natural assets is published in General Government Income Account and mostly, if not exclusively, composed of mining royalties.

PHYSICAL ENVIRONMENTAL ASSETS *continued*

Certain physical information from subsoil asset accounts can support assessments of sustainability, for example, the expected life of particular minerals for Australia as shown in Figure 4.12. While the expected resource life of these key metallic resources can be significantly affected by such things as new discoveries, such measures can at least demonstrate when there is a downward trend in the availability of a resource.

More detailed physical tables on environmental assets of interest to the economy are contained in Appendix 1.

4.12 EXPECTED RESOURCE LIFE OF SELECTED MINERALS, Five year moving average



Source: Australian System of National Accounts 2010-11, (ABS cat. no. 5204.0)

RELATIONSHIP TO OTHER REPORTS ON SUSTAINABILITY AND WELLBEING

Measuring Sustainability program

Department of Sustainability, Environment, Water, Population and Communities

The Measuring Sustainability program's objective is to promote a sustainable Australia by delivering reliable, relevant and accessible information on environmental, social and economic aspects of sustainability to decision makers and communities. A key mechanism will be the development and implementation of sustainability indicators for Australia to support consideration of sustainability issues in decision making and planning at national and community levels.

The System of Environmental–Economic Accounting provides a framework to ensure consistent basic data for environmental and economic variables, which can support delivery of programs such as the Measuring Sustainability program.

Measures of Australia's Progress

Australian Bureau of Statistics

Measures of Australia's Progress (MAP) is designed to help Australians address the question, 'Is life in Australia getting better?' MAP provides a digestible selection of statistical evidence in answer to this question. Australians can use this evidence to form their own view of how our country is progressing.

The range of key statistical measures that MAP presents demonstrates change. They are grouped under three broad headings: the society, the economy and the environment.

Measures of Australia's Progress continued

Within these broad domains several dimensions are addressed, such as health and work within the social domain, national income within the economic domain, and biodiversity within the environmental domain. Within most of these dimensions a headline indicator which directly addresses the notion of progress is used to tell a story about the extent of progress within that dimension.

CHAPTER 5 MANAGING THE GREAT BARRIER REEF REGION ...

INTRODUCTION

This chapter examines how environmental accounts can be used to answer policy questions relevant to the Great Barrier Reef. Some background information on the Great Barrier Reef is provided, along with the key policy issues and objectives identified in the Great Barrier Reef Marine Park Authority Corporate Plan, 2011–2014[69]. An outline is provided of how environmental–economic accounts, and in particular a biodiversity account linked to a land account, could be used to assist policy analysis and decision–making for the Great Barrier Reef.

BIODIVERSITY AND ECOSYSTEMS

Biodiversity is the variability among living things and the ecosystems they inhabit, and is composed of three levels: genes, species, and ecosystems[70]. Ecosystems consist of areas which contain dynamic complexes of biotic communities and their non–living environment interacting as a functional unit to provide environmental structures, processes and functions[71]. Australia's biodiversity contains many plants and animals found nowhere else on Earth.

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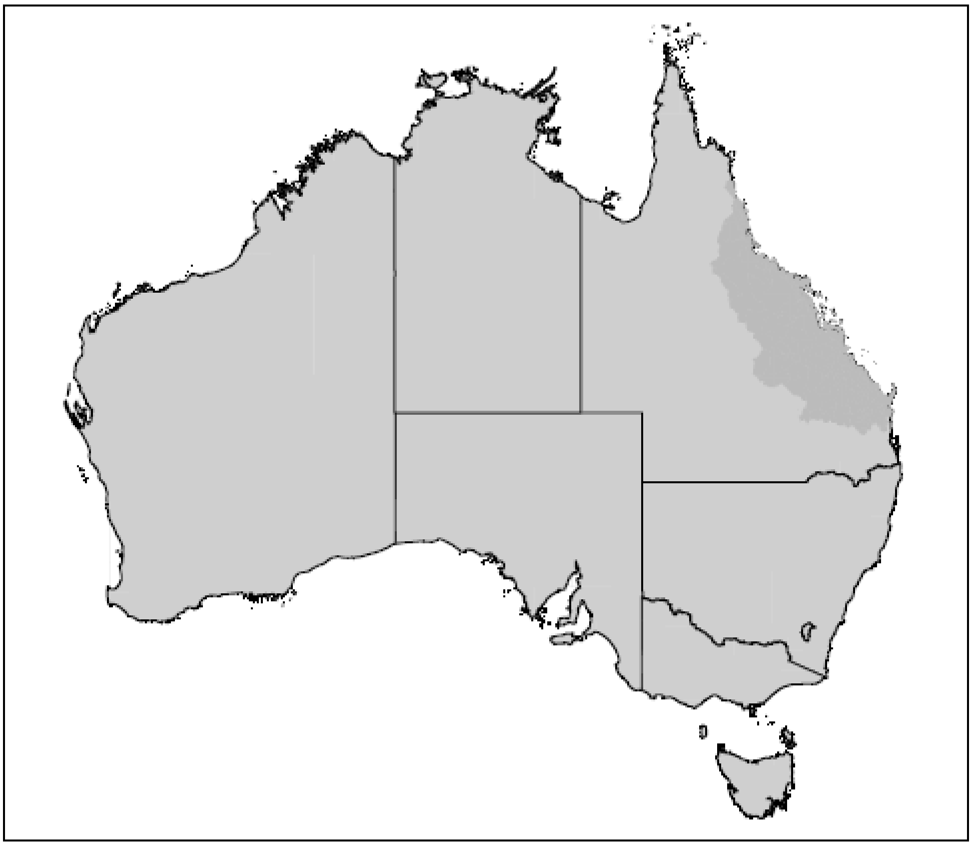
69 Great Barrier Reef Marine Park Authority (GBRMPA), Commonwealth of Australia. 2011. Corporate Plan 2011–2014.
http://www.gbrmpa.gov.au/__data/assets/pdf_file/0014/3281/GBRMPA__CorporatePlan_2011_14.pdf
70 International Union for Conservation of Nature (IUCN). 2012. About Biodiversity.
http://www.iucn.org/what/tpas/biodiversity/about/
71 System of Environmental–Economic Accounting (SEEA). 2012. Committee of Experts on Environmental Economic Accounting, Statistics Division / Department of Economic and Social Affairs, United Nations – SEEA Central Framework. http://unstats.un.org/unsd/statcom/doc12/SEEA%20Central%20Framework%20Ch1.pdf

5.1 MAP OF THE GREAT BARRIER REEF REGION



Source: Land Account: Great Barrier Reef Region, Experimental Estimates (ABS cat. no. 4609.0.55.001).

GREAT BARRIER REEF BACKGROUND

The Great Barrier Reef is a globally significant marine ecosystem, and is listed on the register of World Heritage sites[72]. It is the world's most extensive stretch of coral reef and is one of the richest in terms of faunal diversity, with over 450 species of hard corals, about 150 species of soft corals and sea pens, about 40 species of sea anemones, over 100 species of jellyfish, over 5 species of marine spider, more than 20 species of insects, 1,625 fish species (including 1,400 coral reef species), 133 species of sharks and rays, 6 species of threatened marine turtles, over 30 species of marine mammals, over 3,000 species of molluscs, about 500 species of worms, around 1300 species of crustaceans, 630 species of echinoderms, 14 breeding species of sea snake, and 215 species of birds[73]. The Great Barrier Reef provides habitat for a range of endangered and iconic species including major feeding grounds for the endangered dugong, nesting grounds for two endangered marine turtles, and is an important breeding ground for whales. The Great Barrier Reef consists of about 2,900 individual reefs; about 600 continental islands, and 300 coral and sand cays. It covers about 345,950 square kilometres, and the 28 river catchments that drain into the sea near the Great Barrier Reef cover over 38 million hectares. In 2006 there were just over one million people living in the Great Barrier Reef

72 United Nations Educational, Scientific, and Cultural Organisation (UNESCO). 2012. UNESCO World Heritage List – The Great Barrier Reef. http://whc.unesco.org/en/list/154

73 Great Barrier Reef Marine Park Authority (GBRMPA), Commonwealth of Australia. 2012 (a). About the Reef – Animals. http://www.gbrmpa.gov.au/about–the–reef/animals

GREAT BARRIER REEF BACKGROUND *continued*

catchment area[74]. There are five Natural Resource Management areas (NRMs) in the Great Barrier Reef region: Wet Tropics, Burdekin, Mackay Whitsunday, Fitzroy and Burnett Mary.

The Australian Government established the Great Barrier Reef Marine Park Authority (GBRMPA) in order to better manage the Great Barrier Reef and to meet environmental, economic and social objectives. Threats to the condition or health of the reef include climate change, declining water quality (from catchment run off), and the loss of coastal habitats (from coastal development and fishing impacts). Many of the threats are the result of actions beyond the boundaries of the Great Barrier Reef Marine Park (GBRMP). The GBRMP is a multiple use area which supports a range of communities and industries (such as tourism, fishing, and shipping), and a zoning plan covers the marine park and separates conflicting uses[75].

LINKING GREAT BARRIER REEF MANAGEMENT AND POLICY TO ENVIRONMENTAL ACCOUNTS

The GBRMP Act (1975) provides for the establishment, control, care and development of the GBRMP, and the Act confers responsibility for the management of the marine park to the GBRMPA[76]. In brief, the relevant objectives of GBRMP Act are: to provide for the long term protection and conservation of the environment; biodiversity and heritage values of the Great Barrier Reef region; to allow ecologically sustainable use of Great Barrier Reef region for various purposes; to encourage engagement in the protection and management of the Great Barrier Reef region; and, to assist in meeting Australia's international responsibilities in relation to the environment and protection of world heritage[77].

More specifically, the GBRMPA Corporate Plan (2011–2014) provides three objectives for management guidance, which are as follows:

- address key risks affecting the outlook for the Great Barrier Reef
- ensure that management delivers ecologically sustainable use of the Great Barrier Reef
- maintain a high performing, effective and efficient organisation

The following sections describe the environmental–economic accounts, including the land and biodiversity accounts that could be used in relation to each of these objectives. Material is drawn from the existing Australian Bureau of Statistics (ABS) Great Barrier Reef region land account as well as additional experimental environmental accounts and other information assembled from relevant government and non–government agencies.

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74 Australian Bureau of Statistics (ABS), Commonwealth of Australia. 2011. ABS Land Account: Great Barrier Reef Region, Experimental Estimates, 2011, (cat. no. 4609.0.55.001). http://www.abs.gov.au/AUSSTATS/abs@.nsf/ProductsbyCatalogue/E3B69DD549BA80A8CA2578420010FC34?OpenDocument

75 Great Barrier Reef Marine Park Authority (GBRMPA), Commonwealth of Australia. 2012 (b). Managing multiple uses. http://www.gbrmpa.gov.au/outlook–for–the–reef/Managing–multiple–uses

76 Great Barrier Reef Marine Park Authority (GBRMPA), Commonwealth of Australia. 2011. Corporate Plan 2011–2014. http://www.gbrmpa.gov.au/__data/assets/pdf_file/0014/3281/GBRMPA__CorporatePlan_2011_14.pdf

77 Great Barrier Reef Marine Park Authority (GBRMPA), Commonwealth of Australia. 2011. Corporate Plan 2011–2014. http://www.gbrmpa.gov.au/__data/assets/pdf_file/0014/3281/GBRMPA__CorporatePlan_2011_14.pdf

LAND VALUE

Land is an important asset and represents a large proportion of the value (36%) of Australia's economic assets. Practically all economic activities involve the use of land. At 30 June 2011, Australia's land was valued at $3,785 billion[78]. The land in the Great Barrier Reef region was valued at $71.9 billion at 30 June 2010[79]. The value of land depends on many factors, including location (e.g. proximity to major population centres; transport corridors; water sources; and the beach), land cover and land use.

The use and management of the land in the Great Barrier Reef region catchment has a significant impact on the condition of the Great Barrier Reef. For example, the use of land for agriculture will usually result in higher levels of sediment, nitrogen and phosphorous being carried by rivers to the Great Barrier Reef than if the land had been used for other purposes.

Land cover and land use accounts, linked to economic activity (in this case agriculture), can be used to monitor areas and activities that may impact on the reef as well as the economic cost and impact of constraining these activities.

LAND COVER

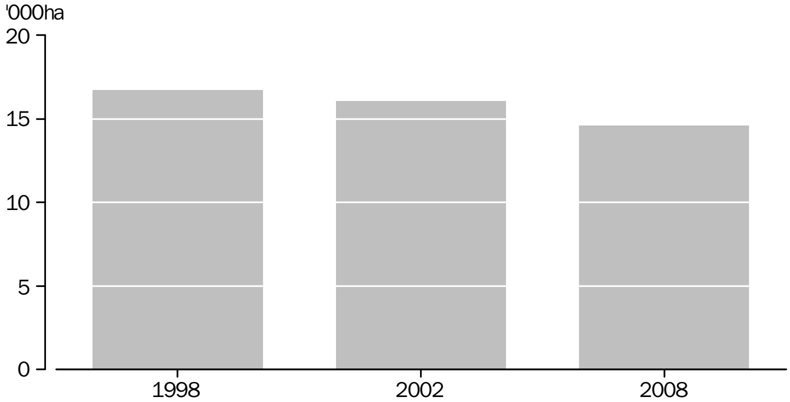
Since human settlement of Australia significant changes to land cover have occurred, but land cover has not changed significantly in the last ten years. However, in coastal areas where the majority (85%) of people in Australia live[80] the impact of land cover or land use changes may have significant impacts at a local and regional level.

An experimental land cover account was prepared by the ABS to assess what changes in land cover were occurring in the Great Barrier Reef, including the conversion of native vegetation to urban area. Forest extent dropped by 13% to 14.6 million hectares during the 10 year period ending 2008 (Figure 5.2). Pre–1750, 18.0 million hectares of eucalypt woodlands existed in the Great Barrier Reef region while in 2006 eucalypt woodlands covered 10.6 million hectares. Most of the forest has been converted to cleared, non–native vegetation and buildings which covered 14.3 million hectares or 37% of the Great Barrier Reef region in 2008[81].

78 Australian Bureau of Statistics (ABS), Commonwealth of Australia. 2011. ABS Australian System of National Accounts 2010–11, (cat. no. 5204.0). http://www.abs.gov.au/AusStats/abs%40.nsf/mf/5204.0
79 Australian Bureau of Statistics (ABS), Commonwealth of Australia. 2011. ABS Land Account: Great Barrier Reef Region, Experimental Estimates, 2011, (cat. no. 4609.0.55.001).
80 Australian Bureau of Statistics (ABS), Commonwealth of Australia. 2001. ABS Census of Population and Housing: Population Growth and Distribution, Australia, 2001, (cat. no. 2035.0). http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/2035.02001
81 ABS, Land Account: Great Barrier Reef Region, Experimental Estimates, 2011, (cat. no. 4609.0.55.001).

LAND COVER *continued*

5.2 FOREST EXTENT, Great Barrier Reef region—1998, 2002 and 2008



Source: Land Account, GBR, Experimental Estimates (ABS cat. no. 4609.0.55.001)

LAND USE

Land use is the activity that occurs on land, for example agriculture, forestry, mining and or residential. This differs from land cover, which is the physical surface of the earth, rather than the activity on the land. Often there is a relationship between land cover and land use, such as the case with agricultural crops, but this is not always so – for example, a forest can have multiple uses, such as being used to produce timber, used for conservation, or a combination of both. National parks and other reserve types are not representative of all land cover types, hence the cross classification of land use and land cover. As can be seen in Figure 5.3, the industry sector occupies the greatest area of land in the Great Barrier Reef region. The Burdekin and Fitzroy NRMs have the largest areas of land devoted to industry compared to the other NRMs in the Great Barrier Reef region.

5.3 LAND USE BY SECTOR

	Industry	Government	Unallocated(a)	Green Space	Water Bodies	Rail and Roads	Other Land Use(b)	Total
NRM region	ha	ha	ha	ha	ha	ha	ha	ha
Wet Tropics	780 119	84 274	322 903	910 565	16 652	20 200	32 130	2 166 844
Burdekin	10 702 348	213 490	2 247 603	451 855	100 858	25 700	339 631	14 081 486
Mackay Whitsunday	443 755	16 722	215 420	136 187	7 279	15 000	71 861	906 224
Fitzroy	10 688 026	424 906	2 397 531	1 741 070	90 679	50 300	220 915	15 613 426
Burnett Mary	2 704 727	91 978	1 253 996	1 165 857	41 545	40 400	21 314	5 319 818
Total Great Barrier Reef region	**25 318 976**	**831 371**	**6 437 453**	**4 405 534**	**257 013**	**151 600**	**685 853**	**38 087 799**

(a) Comprises land owned by households and cadastral parcels that could not be otherwise allocated.
(b) Land that could not be classified.

Source: ABS Land Account: GBR Region, Experimental Estimates, 2011 (ABS cat. no. 4609.0.55.001)

AGRICULTURAL LAND MANAGEMENT

Agricultural land management refers to the various agricultural practices undertaken on the land. In the ABS 2008–09 Land Management Practices in the Great Barrier Reef Catchments[82], information was collected on practices specific to particular agricultural activities. These included soil testing for nutrients, fertiliser use, chemical use (including weed, pest and disease control), riparian management, surface water management and irrigation water management. These practices affect the condition of the terrestrial and marine ecosystems. Figure 5.4 shows the reported land management practices within the NRM areas in the Great Barrier Reef region. The Wet Tropics NRM had the largest number of holdings growing sugar cane in 2008–09; the Burnett Mary NRM had the largest number of holdings engaged in horticulture and keeping beef cattle; and the Fitzroy NRM had the largest number of holdings that prepared land for broadacre crops and/or cotton. Specific land management practices which give more insight into the effect of the different agricultural pursuits on the environment are then given as percentages, such as for holdings which apply chemicals, which the Mackay Whitsunday NRM (at 81.6%) had the highest proportion of holdings for (out of the Great Barrier Reef region NRMs).

5.4 LAND MANAGEMENT PRACTICES, by NRM region—2008–09

	Wet Tropics	*Burdekin*	*Mackay Whitsunday*	*Fitzroy*	*Burnett Mary*	*Total Great Barrier Reef*
NUMBER						
Number of holdings	2 802.0	1 704.0	1 938.0	4 328.0	6 332.0	17 104.0
Holdings growing sugar cane	1 527.0	39.0	1 321.0	. .	747.0	4 253.0
Holdings growing vegetables, fruit, berries or nuts (horticulture)	547.0	192.0	32.0	106.0	793.0	1 670.0
Holdings that prepared (sprayed, cultivated or had sewn) land for broadacre crops and/or cotton between 1 July 2008 and 30 June 2009	78.0	105.0	45.0	1 126.0	954.0	2 308.0
Holdings keeping beef cattle	1 150.0	660.0	1 031.0	4 135.0	5 257.0	12 550.0
PERCENT						
Holdings undertaking soil testing for nutrients	34.9	21.8	36.7	6.5	12.5	18.3
Holdings applying fertiliser	68.7	46.2	70.1	10.7	34.5	39.3
Holdings using chemicals	77.3	72.4	81.6	50.1	57.8	63.2
Holdings actively controlling stock access to riparian areas	^ 15.9	^ 20.8	^ 19.4	^ 22.3	^ 21.4	20.4
Holdings ensuring at least 40% ground cover remained on paddocks at the end of the 2008 dry season	^ 43.6	^ 37.1	^ 43.1	^ 51.4	^ 39.4	43.3
Holdings irrigating between 1 July 2008 and 30 June 2009	23.7	49.3	48.4	8.2	25.3	25.7
Holdings reusing tail water	^ 2.3	27.5	31.2	^ 34.3	^ 14.3	20.2
Sugar cane holdings using zero till planters	4.0	20.9	*4.2	. .	*8.6	^ 7.0
Horticultural holdings using zero till planters	^ 3.0	^ 7.8	. .	^ 17.2	^ 5.2	5.4
Broadacre holdings using zero till land preparation	**6.7	^ 51.3	*2.7	^ 26.0	^ 11.1	^ 19.9
Beef cattle holdings able to provide an estimate of the extent of their ground cover at the end of the 2008 dry season	77.0	72.5	72.5	77.3	69.8	73.4
Holdings with ground cover greater than 70%	68.0	31.8	^ 41.1	^ 34.8	42.3	41.2

^ estimate has a relative standard error of 10% to less than 25% and should be used with caution

* estimate has a relative standard error of 25% to 50% and should be used with caution

** estimate has a relative standard error greater than 50% and is considered too unreliable for general use

. . not applicable

Source: ABS Land Management Practices in the Great Barrier Reef Catchments, Final, 2008-09 (cat. no. 4619.0.55.001)

82 Australian Bureau of Statistics (ABS), Commonwealth of Australia. 2009. ABS Land Management Practices in the Great Barrier Reef Catchments, Final, 2008–09, (cat. no. 4619.0.55.001). http://www.abs.gov.au/ausstats/abs@.nsf/mf/4619.0.55.001/

WATER

Water is a valuable resource for use in agriculture, other industries and by households. The agriculture, forestry and fishing industries in Australia, for example, generated $28,764 million in gross value added while consuming 7,187GL of water in 2009–10[83]. The gross value of agricultural production in the Great Barrier Reef region in 2009–10 was $4,480.61 million, and $1,999.76 million of this was irrigated agricultural production using 1,185.2 GL of water[84]. The Burdekin NRM had the highest agricultural water use in the Great Barrier Reef region, and the Wet Tropics NRM had the highest household water use in the Great Barrier Reef region. This possibly reflects the differences of attributes between NRMs such as the size of the NRMs (with the Burdekin being one of the largest NRMs in the Great Barrier Reef region[85]), the predominant land use in each NRM, the difference in population between the NRMs, and the difference in annual rainfall.

5.5 WATER CONSUMPTION IN THE GREAT BARRIER REEF REGION, 2008–09

	Agriculture	*Household*	*Other*	*Total*
NRM Region	ML	ML	ML	ML
Wet Tropics	165 063	38 584	37 511	241 158
Burdekin	495 430	22 040	97 911	615 381
Mackay Whitsunday	170 435	12 861	27 257	210 553
Fitzroy	233 517	26 404	115 240	375 161
Burnett Mary	202 925	30 968	69 724	303 617
Total Great Barrier Reef region	**1 267 370**	**130 857**	**347 643**	**1 745 870**

Source: ABS Water Account, Australia, 2008–09 (cat. no. 4610.0)

EMISSION ACCOUNTS

Human activities in the river catchments that drain into the Great Barrier Reef lagoon have a significant impact on the water quality of the region. For example, increases in urbanisation, infrastructure and industrial activities such as agriculture, mining and tourism, are all factors that impact on the water quality that flow to the Great Barrier Reef.

Environmental accounts can link changes in the land use and land cover of the Great Barrier Reef catchments to the water quality of the Great Barrier Reef, and provide a tool to assist in the management of the Great Barrier Reef catchments. For example, in the Great Barrier Reef land account[86], it can be seen that agriculture is by far the largest industry (in terms of area) being undertaken in the Great Barrier Reef catchments. Likewise, with the use of the vegetation cover change data (Figure 5.2), it can also be seen that there has been an associated reduction of native (forest) vegetation and an increase in agricultural activity occurring in the Great Barrier Reef catchments.

83 Australian Bureau of Statistics (ABS), Commonwealth of Australia. 2010. ABS Water Accounts, Australia, 2009–10, (cat. no. 4610.0). http://www.abs.gov.au/ausstats/abs@.nsf/PrimaryMainFeatures/4610.0
84 Australian Bureau of Statistics (ABS), Commonwealth of Australia. 2009. ABS Experimental Estimates of the Gross Value of Irrigated Agricultural Production 2000–01 – 2009–10, (cat. no. 4610.0.55.008). http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/1B68337DF0BC480FCA257956000E6DF5
85 Land Account: Great Barrier Reef Region, Experimental Estimates, 2011, (cat. no. 4609.0.55.001).
86 Land Account: Great Barrier Reef Region, Experimental Estimates, 2011, (cat. no. 4609.0.55.001).

EMISSION ACCOUNTS *continued*

The emissions or pollutants of particular concern in the Great Barrier Reef lagoon are suspended nutrients (nitrogen and phosphorous), pesticides and herbicides. These pollutants have been shown to harm the reef ecosystem and have been attributed to diffuse agricultural land uses such as grazing and growing sugarcane[87]. Recent government and industry programs have aimed to increase the use of land management practices in the Great Barrier Reef catchment to practices that demonstrate improved water quality. Figure 5.4 shows the land management practices which minimise pollutant loads, and shows that these practices are increasingly being adopted in the Great Barrier Reef catchments.

By combining data on land use, land cover, and land management with a variety of hydrological and other information, estimates of the pollutant emissions to water can be made. Such data can be presented in the form of an account, enabling the links between economic activities and the condition and use of natural resources to be linked. Figure 5.6 is an example of a regional (NRM level) water emission table.

5.6 CURRENT EMISSIONS, discharged to the Great Barrier Reef lagoon—2010

	Total suspended solids	*Total nitrogen*	*Total phosphorus*	*PS11 herbicide*
NRM Region	ktonnes/yr	tonnes/yr	tonnes/yr	kg/yr
Cape York	2 388	2 998	1 516	na
Wet Tropics	1 360	4 400	2 037	10 054
Burdekin	4 738	2 446	2 555	4 911
Mackay-Whitsundays	1 542	912	2 172	10 019
Fitzroy	4 109	1 672	4 142	2 269
Mary Burnnett	3 076	1 463	3 092	990
Total Great Barrier Reef region	**17 213**	**13 891**	**15 514**	**28 243**

Source: Brodie, J., Waterhouse, J., Lewis, S., Bainbridge, Z., and Johnson, J. 2010. Current loads of priority pollutants discharged from Great Barrier Reef catchments to the Great Barrier Reef. Australian Centre for Tropical Freshwater Research (ACTFR) report number 09/02.

THE VALUE OF THE GREAT BARRIER REEF

Estimating value of environmental assets can be problematic and is discussed in some detail in Chapter 4.

In the case of the Great Barrier Reef, while it has significant World Heritage and conservation values, it also contributes significantly to the Australian economy, supporting employment in industries including tourism, fisheries, transport and mining. The value of the fish and mineral resources that are or could be extracted from the Great Barrier Reef could form the basis for an estimate of the value of these natural resources using the net present value techniques described in the SEEA Central Framework.

Estimating the value of other aspects of the Great Barrier Reef pose some challenges but by estimating the contribution of tourism based on the Reef it may be possible to make an approximation of the value that can be attributed to the cultural and recreational services it provides to tourists. Such a value would be based on the economic transactions in the consumption and production of the goods and services.

87 Commonwealth Scientific Industry and Research Organisation (CSIRO), Commonwealth of Australia. 2009. Overview of CSIRO Water Quality Research in the Great Barrier Reef, 2003–2008. www.csiro.au/resources/GBR–Water–Quality–Overview

THE VALUE OF THE GREAT BARRIER REEF *continued*

Internationally agreed methodologies for these are still to be developed and are the subject of research in the development of the SEEA Experimental Ecosystem Accounts[88,89].

While a value for the Great Barrier Reef itself has not been established, the contribution of tourism to the regional, state or national economies can be estimated using a tourism satellite account. The ABS produces a Tourism Satellite Account for Australia[90] but not for particular states or regions, such as the Great Barrier Reef. Tourism satellite accounts provide more detail than simple tourism statistics (i.e. number of visitors, length of stay etc.) and quantify the monetary value of tourism to the economy (e.g. contribution to gross domestic product).

Tourism satellite accounts are generally produced worldwide by national statistical agencies at a national level using internationally recognised standards. These standards are based on the System of National Accounts (SNA), and utilise classifications, concepts and definitions compatible with the existing SNA and SEEA. In particular, supply–use tables are used to align tourists' consumption of goods and services with the industries which produce those goods and services. Tourism Research Australia uses the national methodological framework to produce estimates of the contribution to the economies of each of the Australian states and territories. While the GBRMPA has done so far, the Great Barrier Reef region.

Figure 5.7 presents a sample of the latest tourism data available for Australia, Queensland and the Great Barrier Reef region. It should be noted that while the concept of gross valued added is the same in each report, they have been produced by different organisations and for different reference periods and as such need to be used and compared with caution.

5.7 TOURISM IN THE GREAT BARRIER REEF

	Australia	*Queensland*	*Great Barrier Reef region*
Reference period	2010-11	2008-09	2006-07
Gross value added ($m)	31 500	7 032	2 257
Employment ('000)	514	119	25

Source: ABS, Australian National Accounts: Tourism Satellite Account, 2010–11 (cat. no. 5249.0), Tourism Research Australia, 2011 and GBRMPA, 2009

BIODIVERSITY ACCOUNT

A biodiversity asset account aims to measure the amount and condition of the biodiversity for a specified region, in order to monitor and explain changes in biodiversity over time. The biodiversity accounts presented here use data provided by the Queensland Department of Environment and Resource Management, and presents species under the main Linnaean groupings. The biodiversity accounts presented in the

88 Pittini, M. 2011. Monetary Valuation for Ecosystem Accounting. http://unstats.un.org/unsd/envaccounting/seeaLES/egm/Issue10_UK.pdf
89 Eigenraam, M., Vardon, M., Hasker, J., Stoneham, G., and Chua, J. 2011. Valuation of Ecosystem Goods and Services in Victoria, Australia. http://unstats.un.org/unsd/envaccounting/seeaLES/egm/Issue10_Aus.pdf
90 ABS, Australian National Accounts: Tourism Satellite Account, 2010–11. (ABS cat. no. 5249.0).

BIODIVERSITY ACCOUNT *continued*

Appendix for Australia use the International Union for Conservation of Nature (IUCN) threat categories.

Figure 5.8 outlines the species status at a point in time (2000) for the Burdekin NRM, one of the Great Barrier Reef regions. It distinguishes species which occur in this particular NRM by whether they have been introduced, if they are native, if they are rare or endangered, and if they are protected. This table shows that most of the species in the Burdekin NRM are protected, native species. A table for a second point in time, for example one year later, could be combined with other information to create a biodiversity asset account for the region. This information is available for the Great Barrier Reef NRM regions for 2000 and 2011 (Figure 8.5), and data from the IUCN is available for Australia as a whole (refer to Appendix for current Australian species status and a biodiversity asset account). Species status tables can be constructed for all of the Great Barrier Reef NRMs.

5.8 BURDEKIN NRM SPECIES STATUS 2000

	INTRODUCED SPECIES	NATIVE SPECIES				
		Unprotected	*Protected*	*Rare and endangered*	*Total native species*	*Total species*
Animals						
Vertebrates						
-Mammals	15	2	112	20	114	129
-Birds	10	0	458	33	458	468
-Reptiles	2	0	202	26	202	204
-Amphibians	1	0	51	9	51	52
-Bony fish	4	56	0	0	56	60
-Cartilaginous fish	. .	. .	. .	. .	. .	. .
-Insects	0	11	2	0	13	13
Subtotal	32	69	825	88	894	926
Plants	***376***	***5***	***3 239***	***91***	***3 244***	***6 320***
-Subtotal	376	5	3 239	91	3 244	6 320
Fungi	***0***	***0***	***68***	***0***	***68***	***68***
-Subtotal	0	0	68	0	68	68
Protista	***0***	***0***	***148***	***0***	***148***	***148***
-Subtotal	0	0	148	0	148	148
Total	**408**	**74**	**4 280**	**179**	**4 354**	**4 762**

. . not applicable

Source: Queensland Department of Environment and Resource Management, 2012.

Figure 5.9 outlines a biodiversity asset account for the Burdekin NRM, and shows that there has been an overall increase in species in every category between 2000 and 2011. This table covers additions to the opening stock of categories, such as species being reclassified from other categories, the discovery of new species or re–discoveries of species thought to be extinct, or when a species is reclassified and split into two species. It also covers the reductions to the opening stock categories, such as species being reclassified from other categories (including extinctions), and, from a taxonomic perspective, merged into another existing species. Distinguishing human–induced changes from natural ones within the table is the aim, but it is not clear if the data currently available allow this. Additionally, species in the table could be grouped in a number of different ways, such as whether the species are terrestrial or marine.

5.9 BIODIVERSITY ASSET ACCOUNT FOR BURDEKIN NRM

	INTRODUCED SPECIES	NATIVE SPECIES				
Burdekin NRM		*Unprotected*	*Protected*	*Rare and endangered*	*Total native species*	*Total species*
Opening stock 2000	**408**	**74**	**4 280**	**179**	**4 354**	**4 762**
Additions						
-from lower threat categories (ie increased risk of extinction)	na	na	na	na	na	na
-from higher threat categories (ie reduced risk of exinction)	na	na	na	na	na	na
-discoveries of new species	na	na	na	na	na	na
-rediscoveries of extinct species	na	na	na	na	na	na
-reclassifications(a)	na	na	na	na	na	na
Total additions	na	na	na	na	na	na
Reductions						
-to lower threat categories (ie reduced risk of extinction)	na	na	na	na	na	na
-to higher threat categories (ie increased risk of exinction)	na	na	na	na	na	na
-reclassifications(b)	na	na	na	na	na	na
Total reductions	na	na	na	na	na	na
Net change	**121**	**34**	**353**	**30**	**387**	**508**
Closing stock 2011	**529**	**108**	**4 633**	**209**	**4 741**	**5 270**

na not available
(a) Where one existing species is now recognised as two or more distinct species
(b) Where two or more existing species are now recognised as one species
Source: Queensland Department of Environment and Resource Management, 2012.

GREAT BARRIER REEF POLICY LINKS TO ENVIRONMENTAL ACCOUNTS

This chapter has provided an overview of the environmental accounts that could be used to inform policy for the Great Barrier Reef. These accounts are based around the central themes of land use, land cover, water, agricultural management, emissions, tourism, and biodiversity. Together these accounts have the potential to assist the agencies involved in managing the Great Barrier Reef region achieve their objectives. These accounts can be useful tools for monitoring, analysis, measuring, and informing policy objectives.

More specifically, the data provided in these accounts can assist in identifying and addressing the key risks that might affect the outlook for the Great Barrier Reef. This includes the provision of essential data required to support the Great Barrier Reef Marine Park Authority developing responses to climate change. The collection of data based on the themes of land use and land cover, water, agricultural management, emissions, tourism and biodiversity mean that the data can also significantly contribute towards the protection of the coastal ecosystems that support the Great Barrier Reef. As an ecosystem–based set of accounts, they will better enable emerging risks to be addressed, and help assist with the maintenance of the Great Barrier Reef Marine Park as a World Heritage site.

BIODIVERSITY IN THE NATIONAL ACCOUNTS

The Australian System of National Accounts (ASNA) follows the international standards set out in the 2008 System of National Accounts (2008 SNA). The main focus of the SNA

BIODIVERSITY IN THE NATIONAL ACCOUNTS *continued*

is to measure economic stocks and flows which form the domestic economy. There are some components of biodiversity which are already in scope of the SNA:

- Timber from native forest
- Fishing and hunting of commercial species (e.g. kangaroos)
- Government and private expenditure on protection, restoration and conservation of biodiversity
- Expenditure on activities relating to visiting natural areas (e.g. tourism)

While these are in scope of the SNA not all of the expenditures are explicitly recognised or separately identified. For example, the value of pollination by bees is not explicitly recognised but part of this value is captured in the value of agricultural production. Similarly the value of some natural assets, like the Great Barrier Reef, is at least partly captured by the businesses that service the visitors to these places.

Some of the values of biodiversity, and of ecosystems services more generally, are embedded in the price of land in the National Balance Sheet. It may therefore be possible to separate out the value of different assets, including biodiversity, contained by the land.

Australia's Biodiversity Conservation Strategy 2010–30[91] recognises that national biodiversity accounting has an important role in demonstrating the extent and condition of biodiversity in Australia. Such accounts would support public policy and evaluation and ensure that the value of biodiversity is realistically reflected alongside Australia's national economic and social indicators.

91 Natural Resource Management Ministerial Council (NRMMC). 2010. Australia's Biodiversity Conservation Strategy 2010–2030. http://www.environment.gov.au/biodiversity/strategy/index.html

CHAPTER 6 MANAGING THE MURRAY–DARLING BASIN

INTRODUCTION

The Australian government has developed policies and programs which can be informed by the national level environmental–economic accounts (as described in Chapters 2 to 4). Environmental–economic accounting can also be applied at the sub–national level such as state or regional levels, to focus on areas of particular significance. The Great Barrier Reef region (covered in the previous chapter) and the Murray–Darling Basin are examples of regional applications.

Often described as the nation's 'food bowl', agricultural production in the Murray–Darling Basin and the land and water resources that support these activities, are of critical importance to Australia. Information derived from the System of Environmental–Economic Accounts (SEEA) framework, and in particular the integration of environmental and economic information in both physical and monetary terms, can help monitor and evaluate the management of the Murray–Darling Basin to achieve a range of social, economic and environmental objectives.

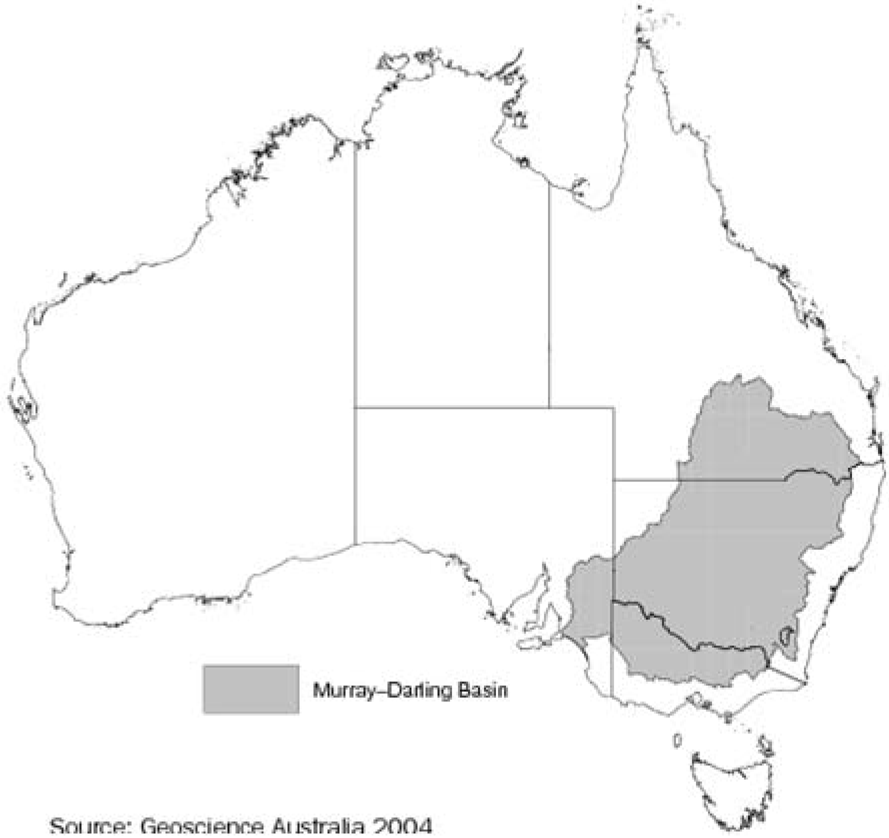
Integrated environmental–economic accounts highlighting physical land cover and land use, physical and monetary water accounts, and the measurement of productivity in agriculture for the region are some examples of the type of accounts that are currently being produced and can be used to inform policy decisions relating to the Murray–Darling Basin and are outlined below.

CHARACTERISTICS OF THE MURRAY–DARLING BASIN

The Murray–Darling is the longest river system in Australia and ranked fifteenth in the world in terms of length. The Murray–Darling Basin covers an area of 1.06 million square kilometres (14% of Australia's land area) and contains more than twenty major rivers as well as important groundwater systems[92]. It drains one–seventh of the Australian land mass and spans four states – New South Wales, Victoria, Queensland and South Australia – as well as the Australian Capital Territory (Figure 6.1 Map of Murray–Darling Basin).

92 MBDA 2010, Guide to the Proposed Basin Plan – Overview, Murray–Darling Basin Authority, Publication no. 60/10, vol. 1, Murray–Darling Basin Authority, Commonwealth of Australia.

6.1 MAP OF THE MURRAY–DARLING BASIN



Source: Geoscience Australia 2004

CHARACTERISTICS OF THE MURRAY–DARLING BASIN *continued*

The Murray–Darling Basin supports a wide range of complex and dynamic ecosystems, including river red gum forests, over 77,000 km of rivers, 25,000 wetlands, floodplain forests and the Coorong and Lower Lakes. The Murray–Darling Basin also has great cultural significance for indigenous people and the broader community with two million people (or around 10 % of the Australian population) living within the region (ABS 2006 Population Census). Adelaide (with a population of over 1.2m people) while being outside the Murray–Darling Basin is dependent on Basin Water. The Murray–Darling Basin is Australia's most important agriculture region, accounting for $15 billion (40%) of the total gross value of agricultural production[93]. Irrigation is an integral part of agriculture in the region with the Murray–Darling Basin containing 65% of Australia's irrigated farms. Agricultural production also supplies raw materials for much of the region's manufacturing activity as well as many businesses beyond, catering for both the domestic and overseas markets.

The settlement and development of the Murray–Darling Basin, primarily for agriculture, has placed considerable pressure on the natural environment. In particular, the clearing of native vegetation and the regulation of water flows, through the construction and operation of large dams for irrigation, has led to concerns about the ability of the Murray–Darling Basin to support a growing population and economy while maintaining the environment. In recognition of the need to better manage the Murray–Darling Basin to meet a range of social, economic and environmental objectives the Australian

93 Gross Value of Irrigated Agricultural Production, 2000–01 to 2009–10, (ABS cat. no. 4610.0.55.008), Australian Bureau of Statistics, Canberra.

CHARACTERISTICS OF THE MURRAY–DARLING BASIN *continued*

Government established the Murray–Darling Basin Authority (MDBA) and developed a Basin wide plan.

THE MURRAY–DARLING BASIN MANAGEMENT AND GOVERNING POLICIES

In November 2011 the MDBA released the "Proposed Murray–Darling Basin Plan" for consultation, outlining its plan to secure the long–term ecological health of the Murray–Darling Basin. The purpose of the plan is to provide integrated management of the Murray–Darling Basin's water resources in a way that promotes the objectives of the Water Act 2007. The MDBA has developed four outcomes:

- Environmental watering plan – Water dependent ecosystems in the Basin would be more able to withstand short – and long–term changes in watering regimes resulting from a more variable changing climate
- Water quality and salinity management plan – use of Basin water resources would not be adversely affected by water quality, including salinity levels
- Water trading rules – there would be improved clarity in water management arrangement in the Basin, providing improved certainty of access to the available resources
- Water resource planning – Basin entitlement holders and communities would be better adapted to reduced availability of water

ENVIRONMENTAL–ECONOMIC ACCOUNTING FOR THE MURRAY–DARLING BASIN

There is a wealth of statistics available on the Murray–Darling Basin, however they are typically not integrated, come from a variety of sources, are spread over a number of years and are for different geographical boundaries. Environmental–economic accounts for the Murray–Darling Basin would provide a consistent, integrated framework from which to derive regular integrated environmental and economic information for the region.

Land accounting

Beyond the assessment of ownership and use of land as part of economic production, some issues that can be considered in the context of land accounts include – the impacts of urbanisation, the intensity of crop and animal production, afforestation and deforestation, the use of water resources, and other direct and indirect uses of land.

Land use is the activity which occurs on land, for example agriculture, forestry, mining and residential. Land use has a major effect on the condition of natural resources – for example land and water quality and the abundance of native species. There is also a strong link between land use and the economic and social benefits obtained. In the Murray–Darling Basin, 84% of land is used for agricultural production. A summary of major land use activities in the Murray–Darling Basin region identified in 2008 are shown in Figure 6.2.

Land accounting continued

6.2 THE MAJOR LAND USE ACTIVITIES IN THE MURRAY–DARLING BASIN REGION—2008

Land use activity	Area (Hectares)	Total area of the region (%)
Total agricultural land	88 911 879	83.7
Irrigated agriculture	2 463 174	2.3
Dryland cropping and horticulture	13 216 120	12.4
Grazing native or modified pastures	73 232 585	69.0
Production and plantation forestry	3 413 900	3.2
Conservation and natural environments	11 041 052	10.4
Intensive uses (e.g. urban)	1 531 516	1.4
Mining and waste	55 100	0.1
Water (lakes and rivers)	1 246 687	1.2
TOTAL	**106 200 134**	**100.0**

Source: MDBA, 2009, Socio-Economic Context for the Murray-Darling Basin, Descriptive report, MDBA Technical Report Series: Basin Plan: BP02, September 2009. http://www.mdba.gov.au/files/publications/socio-economic-context-report-b2.pdf

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[94]. Some land uses, have a characteristic land cover pattern, for example, land used to grow wheat is covered by wheat. However, for other land uses the relationship between cover and use may not be so obvious. For example grasslands may be used for agriculture (e.g. cattle grazing) but they could also be used for conservation (e.g. a national park). Similarly a forest may be used for forestry (e.g. providing timber) or could be used for conservation purposes.

Figure 6.3 gives a summary of land cover change from pre–1750 to 2006. A detailed account of the land cover for pre–1750 and 2006 is given in the Appendix. Data on land cover has been extracted from the National Vegetation Information System (NVIS) and has been derived from a variety of methods, such as field surveys and combining information from a number of years. As such, the data should be interpreted cautiously and with reference to the information on the methods associated with the NVIS[95].

6.3 LAND COVER CHANGES IN THE MURRAY–DARLING BASIN,PRE–1750 TO 2006 (HECTARES)

	PRE–1750				2006
Land cover	Opening stock	Additions	Reductions	Net change	Closing stock
Forests(a)	107 675 960	na	na	-42,630,295 (-40%)	65 045 665
Inland aquatic (freshwater, salt lakes, lagoons)	257 502	na	na	-58,358 (-23%)	199 144
Naturally bare (sand, rock, claypan, mudflat)	3 230	na	na	4,606 (+143%)	7 836
Unclassified native vegetation	—	na	na	50 192	50 192
Regrowth, modified native vegetation	—	na	na	1 181 158	1 181 158
Cleared, non–native vegetation, buildings	—	na	na	25 361 625	25 361 625

— nil or rounded to zero (including null cells)
na not available
(a) Includes forests, woodlands and shrublands
Source: National Vegetation Information System (NVIS).

94 SEEA 2012, The System of Environmental – Economic Accounting. United Nations, OECD, Eurostat, World Bank and IMFhttp://unstats.un.org/unsd/envaccounting/seearev/chapterList.asp?volID=1, viewed January 2012.
95 *http://www.environment.gov.au/erin/nvis/about.html.*

Land accounting continued

The changes in land cover between pre–1750 and 2006 (Figure 6.3) could be due to human activities or natural causes. By continuing systematic measurement of land cover in combination with other information on human activities, the drivers of changes over time can be better understood and, a more regular and complete picture of the Murray–Darling Basin land can be developed.

An integration of land cover and land use is useful in developing a more complete picture of the Murray–Darling Basin. The dynamic land cover data has been used to create a land cover account for the Murray–Darling Basin for 2008. This has been compiled from satellite images between 2000 to 2008. A sample table of dynamic land cover by land use is shown in the Appendix.

Land use and land values

Land use has a significant influence on land values. For example, land with greater access to water resources (either higher rainfall or access to ground or surface water) will normally attract a higher price than land with fewer water resources or land with salinity or other environmental degradation. The Australian Bureau of Statistics (ABS) values land at the national level on an annual basis, but does not estimate values for land at the regional level.

Forest accounts

Forests (including woodlands) are an important environmental asset being diverse, dynamic and complex ecosystems, proving habitat for flora and fauna. They also contain valuable renewable resources, such as timber that provides inputs for construction and production of paper and other products, as well as important ecosystem services such as maintaining water quality and recreational use. Much of the Murray–Darling Basin's native forests are in national parks and other reserves, and large areas of state forests are also reserved for conservation[96].

The extent of forest in the Murray–Darling Basin for 2008 and 2011 are presented in the Appendix. Changes in the stock of forests due to afforestation and deforestation are one indicator of the health of ecosystems – an expected outcome of the Basin Plan. The monetary value of timber in Australian forests is reported annually in the ABS Australian System of National Accounts (cat. no. 5204.0), however regional estimates are not compiled.

WATER ACCOUNTING

Water accounts are one of the most common forms of environmental account implemented internationally[97] and are applied at a variety of levels, from individual business, to geographic regions up to national level. In Australia water accounts are used in the analysis of water issues at the national and regional levels[98 99 100].

96 MDBC, 2012, http://kids.mdbc.gov.au/encyclopedia/forestry.html, viewed February 2012.
97 Vardon, M., Martinez–Lagunes, R. Gan, H. and Nagy, M. 2012. The System of Environmental–Economic Accounting for Water: Development, Implementation and Use. Pp. 32–57 in Water Accounting: International Approaches to Policy and Decision–making. Ed by J. Godfrey and K. Chalmers. Edward Elgar.
98 Apples D, Douglas R and Dwyer G. 2004, Responsiveness of demand for irrigation water: A focus on the Southern Murray–Darling Basin, Productivity Commission working paper, http://unstats.un.org/unsd/envaccounting/seeaw/seeawdraftmanual.pdf.
99 Foran, B., Lenzen, M., Dey, C., 2005. Balancing Act – A Triple Bottom Analysis of the Australian Economy. CSIRO, Canberra. http://www.cse.csiro.au/research/futures/balancingact/index.htm
100 Productivity Commission 2012, Australia's Urban Water Sector. http://www.pc.gov.au/projects/inquiry/urban-water/report

WATER ACCOUNTING *continued*

Effective water management requires an understanding of the benefits of current allocations of water, anticipation of future water demands, and evaluation of different policy options for meeting those demands. Management options include increasing the effective supply of water from efficiency improvements, wastewater reuse, demand management, and other measures.

Policy analyses using water accounts can address a broad range of issues, such as:

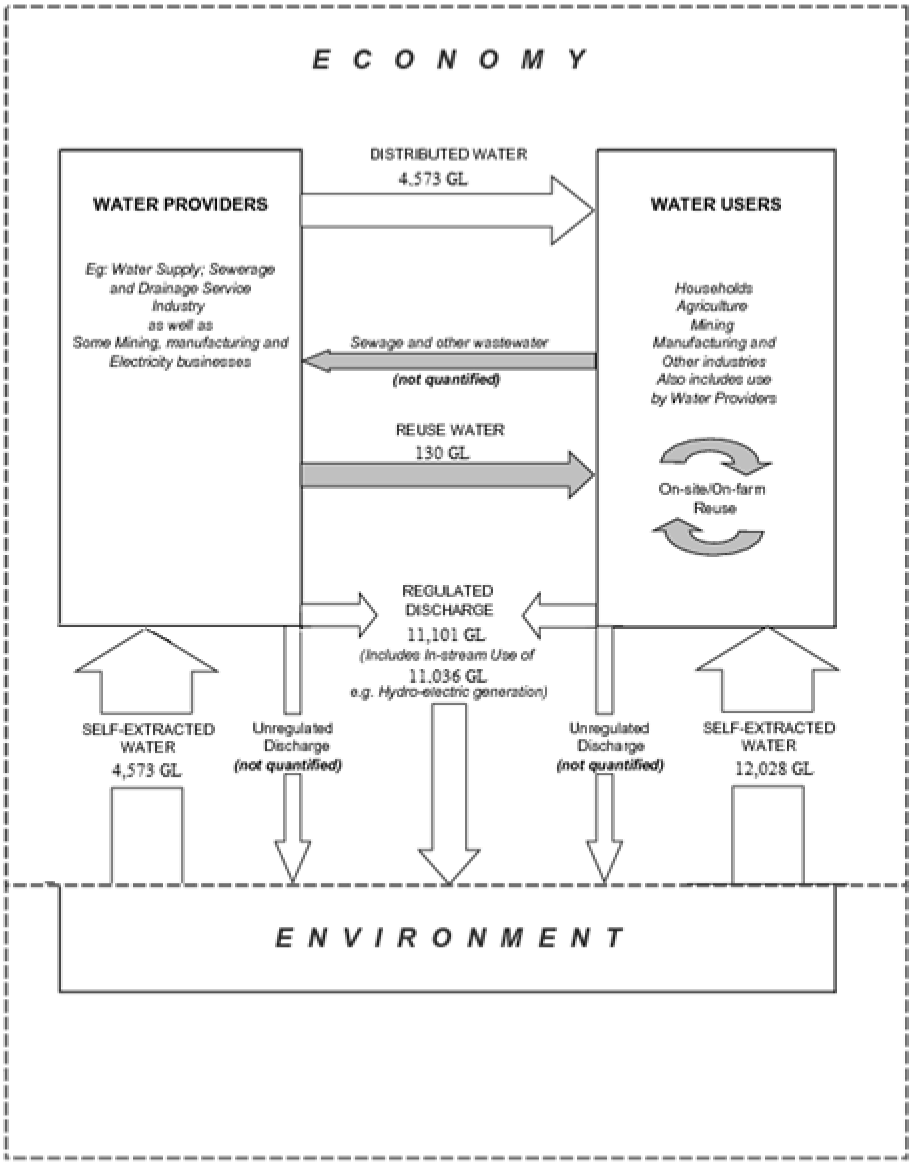
- Likely future water demands under alternative economic development scenarios
- Effect on changes in agriculture, energy, forestry and other activities
- Social and economic impact of pricing reform for water and wastewater
- Opportunities for water demand management and other water conservation measures
- Costs and benefits of treating different sources of water pollution
- Climate change adaptation

Supply and use of water

Figure 6.4 summarises the supply and use of water in the Murray–Darling Basin for 2009–10[101]. Total distributed water supplied to economic units by all water suppliers was 4,573 GL, a 2% decrease from 4,666 GL in 2008–09[102]. Total supply of reuse water was 130 GL, a 12% increase from 116 GL in 2008–09. Total use of self–extracted water was 16,601 GL, this represents a 9% increase from 15,250 GL in 2008–09. Examples of physical and experimental monetary supply and use of water tables are presented in the Appendix. These accounts illustrate how water is used in industries and households and can be used to guide Murray–Darling Basin communities to adapt to changes in water availability.

101 Water Accounts Australia, 2009–10 (ABS cat. no. 4610.0).
102 Water Accounts Australia, 2008–09 (ABS cat. no. 4610.0).

6.4 WATER SUPPLY AND USE IN THE MDB

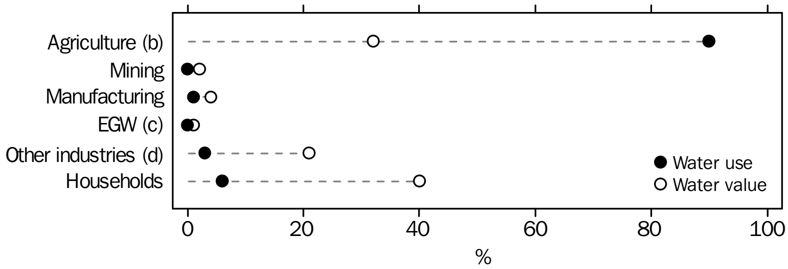


Supply and use of water continued

Figure 6.5 illustrates the proportion of physical and monetary use of distributed water across industries and households in the Murray–Darling Basin region.

Supply and use of water continued

6.5 DISTRIBUTED WATER USE AND VALUE(a), by industry—MDB—2009–10



Notes: (a) Experimental estimates;
(b) Agriculture, aquaculture, forestry and fishing;
(c) ANZSIC06 Div D excluding subdivision 28 and group 261;
(d) ANZSIC06 divisions E to S

Source: ABS data available on request.

Figure 6.6 provides details of physical and monetary supply and use of distributed (urban and rural) water for 2009–10 and 2008–09 in the Murray–Darling Basin. Figure 6.6 includes only the water supply and sewerage services industry (referred to as the water supply industry) in the supply side as no monetary data is currently available for other industries also supplying water. The water supply industry supplies the majority of the water, however a small amount is also supplied by the electricity generation, mining and manufacturing industries. No monetary values are assigned to self–extracted water and hence it is also excluded from Figure 6.6.

There was a 6% increase in the volume of water supplied by the water supply industry between 2008–09 and 2009–10 to 3,120 GL. The revenue earned by selling water to other economic units by the water supply industry rose by 11% over the same period. Different industries pay different prices for the water they receive. The agriculture industry used 90% of the total volume of water supplied however only represented 32% of the total water expenditure. By contrast, households used 6% of the total volume of water but contributed 40% of the total expenditure. The reason for the disparity is that the agriculture industry mainly receives rural water, which does not require the same level of treatment as in the case of urban potable (drinking) water. There was also a small (4%) decrease in the volume of water used by households between 2008–09 and 2009–10 and expenditure increased by 11% over the same period. A similar trend was also seen in other industries. Monetary estimates of water use are at basic prices, i.e. subsidies and taxes on products are not included as no data are available at a regional level.

Supply and use of water continued

6.6 PHYSICAL AND MONETARY SUPPLY AND USE OF WATER FOR THE MURRAY-DARLING BASIN—2009–10 and 2008–09

	Volume of water	Percent of total	Value of water(a)(b)	Percent of total	Water rate
	GL	%	$m	%	$/kL
2009–10					
Supply					
Water supply industry(c)	3 120	99	867	100	0.28
Use					
Intermediate consumption by industries					
Agriculture, forestry, fishing	2 823	90	280	32	0.10
Mining	14	1	14	2	1.01
Manufacturing	22	1	34	4	1.55
Electricity and Gas Supply	12	—	12	1	1.01
Other industries	95	3	185	21	1.95
Final consumption					
Households	173	6	343	40	1.98
Total use	**3 138**	**100**	**867**	**100**	**0.28**
2008–09					
Supply					
Water supply industry	2 931	99	783	100	0.27
Use					
Intermediate consumption by industries					
Agriculture, forestry, fishing	2 623	89	268	34	0.10
Mining	9	—	6	1	0.61
Manufacturing	22	1	29	4	1.34
Electricity and Gas Supply	15	1	13	2	0.86
Other industries	102	3	147	19	1.44
Final consumption					
Households	180	6	320	41	1.78
Total use	**2 951**	**100**	**783**	**100**	**0.27**

— nil or rounded to zero (including null cells)
(a) Value of water refers to revenue earned by selling water (in the supply side) and expenditure on water (in the use side)
(b) Monetary estimates should be considered experimental
(c) Includes only the Water supply industry as no data available for other industries that supplied water to other economic units.
Source: ABS data available on request

The combined physical and monetary supply and use tables highlight industries that are using the most water and what economic benefits (e.g. industry value added) are obtained from this use. Revenue earned from supplying water can be used to determine the productivity of the water supply industry.

Water assets

Unlike other natural resources, such as forests or mineral deposits that are subject to relatively slow rates of natural changes, water is in continuous movement through the water cycle. In the case of the Murray–Darling Basin, where water resources are shared among several jurisdictions, water asset accounts can explicitly identify information on the part of the water resources occurring in each jurisdiction and the origin and destination of water flows between jurisdictions.

Water assets continued

The water asset accounts describe the stocks of water resources and changes over time. The structure of a water asset account consists of the opening balance or stock of water, increases in stocks due to human activities (e.g. returns) and natural causes (e.g. inflows, precipitation), decreases in stocks due to human activities (e.g. abstraction) and natural causes (e.g. evaporation/evapotranspiration, outflows etc.) and closing stock of water. These accounts are particularly relevant because they link water use by the economy (represented by abstraction and returns) and natural flows of water to the stocks of water in a particular geographical location. These types of accounts are currently constructed by the Bureau of Meteorology (BoM) although the presentation of the accounts is not the same as in the SEEA. A SEEA style asset account could be constructed from this data[103].

A century of construction of dams, weirs, and barrages has enabled 35,000 GL of water to be stored within the Murray–Darling Basin. An account of the value of the water infrastructure assets is important for measuring productivity of the water supply industry. Currently there is insufficient data and differences in asset valuation methods used by water suppliers to value their assets and hence a water infrastructure asset account for the Murray–Darling Basin cannot currently be produced. However, the ABS has given consideration to this matter and is planning to produce values for the water infrastructure assets in the future at the national level[104]. This could also guide the production of a similar account for the Murray–Darling Basin.

Water trading

One of the expected outcomes of the proposed Murray–Darling Basin Plan is for an efficient water trading regime to be achieved by reducing barriers to trade and creating greater transparency for users of the water market[105]. The water trading activity in the Murray–Darling Basin accounts for between 70% and 80% of all water traded in Australia (by volume) and is the focus of water market reforms and market monitoring. Most water trading occurs in the southern part of the Murray–Darling Basin[106]. Trade in the region predominantly involves surface water entitlements (80–90%). However, groundwater is still important to Murray–Darling Basin markets, particularly as a source when there is low surface water availability[107].

Water rights represent an economic instrument that governments have used to manage water use and to give incentives for increasing water use efficiency. The nature of water rights varies within and between jurisdictions in their duration, security, flexibility, divisibility and transferability. In Australia water rights are traded as water entitlements or water allocations.

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103 Vardon, M., Martinez–Lagunes, R. Gan, H. and Nagy, M. 2012. The System of Environmental–Economic Accounting for Water: Development, Implementation and Use. Pp. 32–57 in Water Accounting: International Approaches to Policy and Decision–making. Ed by J. Godfrey and K. Chalmers. Edward Elgar.
104 Comisari P, Feng L and Freeman B, Valuation of water stock resources and water infrastructure assets, paper presented at the UN's 17th London Group meeting, 14 September 2011, Stockholm, Sweden.
105 MBDA 2010, Guide to the Proposed Basin Plan – Overview, Murray–Darling Basin Authority, Publication no. 60/10, vol. 1, Murray–Darling Basin Authority, Commonwealth of Australia.
106 NWC 2011(a), Australian Water Markets: Trends and drivers 2007–08 to 2009–10, National Water Commission, Commonwealth of Australia, 2011. http://nwc.gov.au/__data/assets/pdf_file/0005/17609/AWMR-companion-09-10_FA-1.pdf, viewed February 2012.
107 NWC 2009, National Water Commission Australian Water Markets Reports, 2008–2009, National Water Commission, Commonwealth of Australia, 2009.

Water trading continued

Water entitlements refer to a perpetual or ongoing entitlement to exclusive access to a share of water from a specified consumptive pool, while water allocation is the specific volume of water allocated to water access entitlements in a given year. Water allocation can vary from year to year, mainly dependent on rainfall, but does not exceed the maximum amount specified in the associated entitlement. This terminology is consistent with the Australian Water Markets Report published by the National Water Commission.

Figure 6.7 shows the water entitlements in the Murray–Darling Basin for 2009–10 and 2010–11. The most reliable data available is for tradeable entitlements of surface water within the Murray–Darling Basin and this data forms the basis of Figure 6.7. Surface water represents around 80–90% of total water (the other major category is ground water). From 2008, the Australian government under the 'Restoring the Balance' program has commenced a series of water "buybacks", in order to return over–allocated or overused water systems to environmentally sustainable levels of extraction[108].

6.7 WATER ENTITLEMENTS IN THE MURRY–DARLING BASIN(a)

	2009–10	*2010–11*
	GL	GL
Total entitlements – opening stock	12 192	13 313
Entitlements held by Australian Government		
Opening stock	65	724
Acquired through buyback(b)	659	255
Other changes in volume	—	—
Closing stock	724	979
Entitlements held by all other entities		
Opening stock	12 127	12 589
Loss due to Government buyback	–659	–255
Other changes in entitlement	210	493
Other changes in volume(c)	911	608
Closing stock	12 589	13 435
Total entitlements – closing stock	**13 313**	**14 414**

— nil or rounded to zero (including null cells)
(a) This figure is for tradeable entitlements of surface water only.
(b) This is the financial year in which the entitlements were registered. As registration can be a lengthy process, it may include entitlements for which the transaction took place during a previous financial year but not registered until the current financial year.
(c) Includes 911GL from QLD in 2009–10, and 608GL from NSW in 2010–11, in both instances those amounts were not in scope in previous years.
Source: Australian Water Markets Reports 2010–11 and 2009–10.

Water allocation is the amount made available each year to the water entitlement holder. Depending on rainfall and amount of water in storage, a new allocation is announced each year. At present no data is available to construct a full stock and flow account with opening and closing balances of water allocations. However, as all unused allocations automatically expire at the end of the year, it is expected that the closing stock is always netted to nil. The allocations have been treated as a flow account for the purpose of this paper. Accounting for the trade of allocations, the buyers and sellers of the allocations

108 NWC 2011(b), National Water Commission Australian Water Markets Reports, 2010–11, National Water Commission, Commonwealth of Australia, 2011.

Water trading continued

and how the water traded is being used, would provide another level of detail for the water accounts.

Water intensity of households

The water intensity of households is a measure of the water consumed annually per head of population. Figure 6.8 gives the household water intensity in the Murray–Darling Basin for 2009–10 and 2008–09. Water used by Murray–Darling Basin households decreased from 2008–09 to 2009–10 by 7 GL, however the expenditure increased from $320m to $343m. Thus the water intensity decreased during this period. This could be an indication that people used water more efficiently.

6.8 HOUSEHOLD WATER USE INTENSITY, MURRAY-DARLING BASIN—2009–10 and 2008–09

Year	*Expenditure*(a)	*Water used*(b)(c)	*Population*(c)(d)	*Water usage*	*Water use intensity*
	$m	GL	As at 30 June	$/kL	GL/person
2009–10	343	173	2 187 406	1.98	79
2008–09	320	180	2 160 900	1.78	83

(a) Experimental estimates.
(b) Source of physical water estimates: Water Accounts Australia, 2009–10 (Cat. No. 4610.0).
(c) Regional Population Growth, Australia, (Cat. No. 3218.0).
(d) Based on ABS, Regional Population Growth, Australia (Cat. No. 3218.0).

Water productivity in industries

Water productivity can be defined as economic output (e.g. Gross Domestic Product – GDP or Industry Gross Value Added – IGVA) generated per one unit of water consumed. However, as economic aggregates such as industry value added are not available at regional level this is not currently possible. Some data on the gross value of irrigated agricultural production and some productivity measures are presented below (Figure 6.11).

AGRICULTURE

One of the Murray–Darling Basin Plan objectives is "sustainable industries demonstrating leadership in water–use efficiency, cutting–edge technologies, new crops and innovative land and water management suited to the Australian environment". The agriculture industry is the dominant industry in the Murray–Darling Basin, and this section explores the agriculture industry in the region.

Land use and land management

Figure 6.9 presents land use and management by agricultural businesses in the Murray–Darling Basin for 2007–08 and 2009–10. The area of agricultural holdings decreased slightly (–0.4%) in this period and the number of agricultural businesses decreased by 5%. The area of land used for crops decreased by 3% while the area of land used for grazing increased by 2%. The ABS Population Census showed that between 2001 and 2006, employment in crop growing decreased while employment in cattle and other livestock farming increased[109].

109 ABS 2008, Water and the Murray–Darling Basin: A Statistical Profile, (cat. no. 4610.0.55.007), Australian Bureau of Statistics, Canberra.

6.9 LAND USED IN AGRICULTURAL PRODUCTION, Murray–Darling Basin—2007–08 to 2009–10

	2007–08				2009–10
Land area ('000 Ha)	Opening stock	Additions	Reductions	Net change	Closing stock
Area of holding	95 562	—	—	-367 (-0.4%)	95 195
Land used for crops	16 825	—	—	-450 (-3%)	16 375
Land used for grazing	73 731	—	—	1,101 (+1%)	74 832
Forestry plantation	161	—	—	-39 (-24%)	122
Other agricultural purposes	190	—	—	-121 (-64%)	69
Other land not used for agriculture production	1 573	—	—	453 (+29%)	2 026

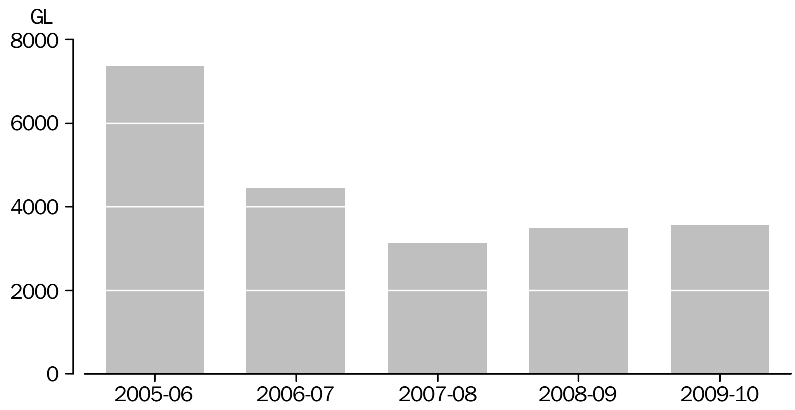
— nil or rounded to zero (including null cells)

Source: *Land Management and Farming in Australia* (ABS cat. No. 4627.0)

Productivity in the irrigated agriculture industry in the Murray–Darling Basin

Figure 6.10 illustrates the volume of irrigated water used in agriculture production from 2005–06 to 2009–10. The irrigated agriculture land area decreased by 42% from 2005–06 to 2007–08 but was fairly steady between 2007–08 to 2009–10. The volume of irrigated water used decreased by 57% from 2005–06 to 2007–08 and increased by 13% from 2007–08 to 2009–10.

6.10 AGRICULTURAL WATER USE, MDB—2005–06 to 2009–10



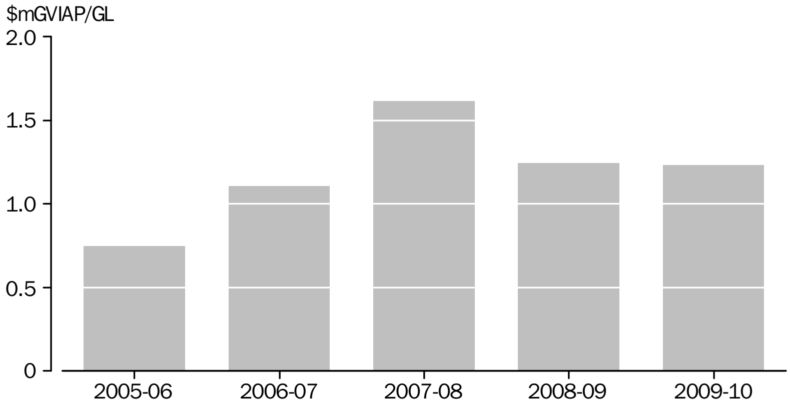
Source: Gross Value of Irrigated Water Production (ABS cat. no. 4610.0.55.008)

Gross value of irrigated agriculture production (GVIAP) can be used to construct a water productivity measure for irrigated agriculture. GVIAP is the measure of economic output and the water productivity indicator is expressed as $ GVIAP/GL. $ GVIAP should be expressed in chain volume terms (changes in commodity prices are removed) where the objective is to draw conclusions about changes in economic efficiency over time. Chain volume measures for GVIAP are not available at this time. Figure 6.11 illustrates the $ GVIAP/GL from 2005–06 to 2009–10 where GVIAP is measured in the prices at current at the time. As the results will reflect commodity price changes over the period, it should be interpreted as income receipts per GL rather than as an indicator of water efficiency. GVIAP can be calculated for different agricultural commodities and these are reported in Appendix.

Productivity in the irrigated agriculture industry in the Murray–Darling Basin continued

It is important that the economic aggregate, GVIAP in this case, being used is measured in constant prices (e.g. the price with the effect of inflation removed) in order to compare the changes over time. No constant prices measures are available for the GVIAP at this time.

6.11 WATER PRODUCTIVITY OF IRRIGATED AGRICULTURE, MDB—2005–06 to 2009–10



Source: Gross Value of Irrigated Agriculture Production (ABS cat. no. 4610.0.55.008)

It is useful to investigate the drivers behind the changes in water productivity. The volume of irrigated water applied depends on both the water availability from suppliers, seasonal rainfall and water saving measures used. Water availability has declined since 2000–01 in the Murray–Darling Basin[110]. However, the impact upon agricultural production (in volume and fiscal terms) is not proportional with reduced water availability. Switching agricultural products grown and changes in irrigation practices have sustained the value of irrigated agricultural production during this period of reduced water availability. Over half of agricultural businesses have changed their irrigation practices in order to better manage water use[111].

Other accounts for understanding agriculture in the Murray–Darling Basin

Several other accounts could aid the understanding of the environmental and economic aspects of the agriculture industry in the Murray–Darling Basin. In addition to the land and water accounts the following accounts could be added:

- Water emissions accounts – which would record the amount of sediment, fertilizer (nitrogen, phosphorous and potassium), herbicides and pesticides entering waterways
- Air emission accounts – which would record the amount of greenhouse gases released into the atmosphere
- Environmental protection expenditure accounts – which would record the spending by governments, individuals and industry on managing and protecting the environment

110 NWC 2011(a), Australian Water Markets: Trends and drivers 2007–08 to 2009–10, National Water Commission, Commonwealth of Australia, 2011. http://nwc.gov.au/__data/assets/pdf_file/0005/17609/AWMR-companion-09-10_FA-1.pdf, viewed February 2012.

111 ABS 2010, Energy, water and environmental management 2008–09, (cat. no. 4660.0), Australian Bureau of Statistics, Canberra.

Other accounts for understanding agriculture in the Murray–Darling Basin continued

Including this additional information in an expanded set of environmental–economic accounts for the Murray–Darling Basin would be useful for monitoring and evaluating the progress of the agricultural water use efficiency and innovative land and water management practices.

CHAPTER 7 GREEN GROWTH

INTRODUCTION

This chapter examines how green growth can be defined and measured using environmental–economic accounting. The chapter first outlines definitions of green growth and the green economy and then presents data on some of the measures proposed by the Organisation for Economic Co–operation and Development (OECD) in its 2011 report 'Towards green growth: Monitoring progress'. The OECD report explicitly recognises the System of Environmental–Economic Accounting (SEEA) as a measurement framework for green growth.

The measures presented in this chapter draw on many assessment tools, calculations and research by various Australia government and international agencies. At present the data are compiled by a range of different agencies for a variety of purposes using a large number of concepts, data sources and methods. Each compilation of data was designed for particular purposes and use beyond the original purpose was not usually considered.

In this chapter the available data have been combined and presented even though they may not be strictly consistent at the present time. By mapping the available data into the SEEA framework over time a more reliable, consistent and comprehensive set of data for measuring green growth, as well as other issues of interest to policy analysis and decision–makers, can be achieved. The process of compiling the data for this and other chapters in this publication has revealed where some changes to the way data are collected, processed, presented or accessed could result in an increased ability to produce an expanded set of environmental accounts.

Much of the data in this chapter are presented in other chapters of this publication. The multiple presentations of data are an indication of how information from a comprehensive system of environment accounts could be used to serve more than one purpose.

DEFINING AND MEASURING GREEN GROWTH

The terms green growth and green economy have been used in a variety of ways and there remains some confusion about their definition. Internationally, the term green growth has been defined by the OECD:

'*Green growth is about fostering economic growth and development while ensuring that the quality and quantity of natural assets can continue to provide the environmental services on which our well–being relies. It is also about fostering investment, competition and innovation which will underpin sustained growth and give rise to new economic opportunities*'[112].

Similarly the United Nations Environment Program (UNEP) defines a green economy as:

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112 Page 9. OECD, 2011. Towards green growth: Monitoring Progress. OECD Indicators http://www.oecd.org/dataoecd/37/33/48224574.pdf

DEFINING AND MEASURING GREEN GROWTH *continued*

'*An economy that results in improved human well–being and reduced inequalities over the long term, while not exposing future generations to significant environmental risks and ecological scarcities. It is characterised by substantially increased investments in economic sectors that build on and enhance the earth's natural capital or reduce ecological scarcities and environmental risks. These investments and policy reforms provide the mechanisms and the financing for the reconfiguration of businesses, infrastructure and institutions and the adoption of sustainable consumption and production processes. Such reconfiguration leads to a higher share of green sectors contributing to GDP, greener jobs, lower energy and resource intensive production, lower waste and pollution and significantly lower greenhouse gas emissions.*'[113]

The conceptual underpinnings of both initiatives are similar, but there are some differences, particularly in emphasis, between the two.

This can be seen in UNEP's focus on defining "green sectors" of the economy, with a selection of industrial processes (e.g. those using less energy) and the production of particular goods (e.g. solar panels) identified as green. The separate identification of these activities allows the contribution of "green sectors" to the economy to be measured.

In defining the terms green growth and green economy the need for better information on the environment and its relationship with the economy to support policy development and to monitor progress has been highlighted. Both the UNEP and OECD advocate the wider use of environmental accounting for such measurement. The OECD explicitly says that measurement efforts should, where possible, be directly derived from the SEEA framework[114].

The SEEA has a number of accounts that can be used to monitor green growth. The first are the natural resource accounts, which show the availability and use of natural resources, such as water, minerals and fossil fuels, and how this use varies over time and between different industries. Examples of this are presented later in the chapter.

The second type of account focuses on the production and use of goods and services in the economy that can be defined as being for the purpose of environmental protection or natural resource management or "green". The two accounts that can be used for measuring this are the Environmental Protection Expenditure Account (EPEA) and the Environmental Goods and Services Sector account.

The environmental goods and services sector account identifies the producers of a suite of goods and services that are defined as being for environmental purposes. Examples of these goods and services could include wastewater treatment, photovoltaic cells, recycled paper, water saving devices (e.g. dual flush toilets and reduced flow shower heads) and public transport systems. The producers of these goods and services form the "environment" industry and the contribution of this industry to the economy, for example gross domestic product, can be calculated. This type of approach is in line with the UNEP's notion of a "green" sector.

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113 UNEP, 2011. Green Economy Report. http://www.unep.org/greeneconomy/Portals/88/documents/ger/ger_final_dec_2011/Green%20EconomyReport_Final_Dec2011.pdf

114 Page 13, OECD, 2011. Towards green growth: Monitoring Progress. OECD Indicators http://www.oecd.org/dataoecd/37/33/48224574.pdf

DEFINING AND MEASURING GREEN GROWTH *continued*

Environmental protection and resource management expenditures represent the use of all goods and services for the purposes of environmental protection. This includes the goods produced by the environmental goods and services sector, but also includes other goods and services which were not primarily produced for environmental protection, but which are used for this purpose. For example, the value of wire used to fence an environmentally sensitive area (e.g. river bank) would be counted in the environmental protection expenditure account as this is the purpose for which is was used. However, it would not be counted in the environmental goods and services sector account as the wire itself is not an environmental good.

Neither environmental protection expenditure accounts or an environmental goods and services sector account are produced by the Australian Bureau of Statistics (ABS) at present. Environmental protection accounts were produced in the past[115 116], and the ABS is currently investigating if it is possible to create these again.

The remainder of the chapter presents data for the indicators of green growth based on those suggested by the OECD. Additional indicators from environmental accounts and other data sources are also possible and a few of these have been identified and added. For example, measures of natural resource use efficiency, and expenditure on environmental research and development.

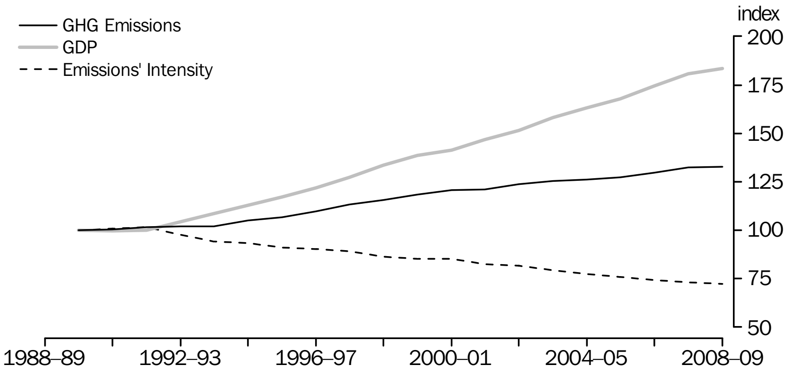
The themes identified by the OECD Green Growth strategy are separated into four dimensions, namely: environmental efficiency; natural resource base; environmental quality; and policy response and economic opportunities. These four dimensions are used to structure the remainder of the chapter.

ENVIRONMENTAL EFFICIENCY

Greenhouse gas emissions

For the Australian economy, direct greenhouse gas emissions' (GHG) rose by 33% between 1990 and 2009. Over the same period, the economic performance of the economy as measured by Gross Domestic Product (GDP) rose sharply, recording an increase of 83%. As a result, GHG intensity fell by approximately 28% between 1990 and 2009.

7.1 TOTAL DIRECT GREENHOUSE GAS EMISSIONS AND GDP, (a)



(a) 1989–90=100

Source: Australian Bureau of Statistics, Department of Climate Change and Energy Efficiency.

115 ABS, 2002. *Environment Protection, Mining and Manufacturing Industries, Australia, 2000–01*, (cat. no. 4603.0).

116 ABS, 2004. *Environment Expenditure, Local Government, Australia, 2002–03*, (cat. no. 4611.0).

Greenhouse gas emissions continued

Total direct greenhouse gas emissions refer to emissions generated from sources within the boundary of, and as a result of, the reporting organisations' activities[117]. Emissions are reported under the Kyoto accounting rules and exclude net CO_2 emissions from land use, land use change and forestry (LULUCF)[118].

Greenhouse gas emissions' intensity is calculated by dividing total GHG emissions by annual GVA. It measures greenhouse gases in gigagrams (Gg) emitted to produce one unit of economic output.

Emissions are categorised based on the Intergovernmental Panel on Climate Change (IPCC) approach. The method attributes emissions to countries according to where the emissions physically occurred. This is known as the territory approach. An alternative approach is the residence approach, which is used in the SEEA and System of National Accounts (SNA). In the residence approach emissions are attributed to the country where the economic owner of the unit making the emissions is resident. For example, emissions by aircraft owned by an Australian company but located in another country would be attributed to Australia in the residence approach, but to the other country in the territory approach. This example also highlights two other differences between the Kyoto accounting and the SEEA accounting approaches.

Firstly, international transport is excluded from Kyoto accounting, but included in the SEEA. Secondly emissions from transport are defined on an activity basis in Kyoto accounting, but an industry basis in the SEEA. As an example, emissions from trucks owned by manufacturers and used for distributing products would be attributed to transport in the Kyoto approach, but would be attributed to the manufacturing industry in the SEEA. These differences may be small, but they mean that direct comparison of economic data for industries from the SNA cannot strictly be made with the data from Kyoto based reporting.

The ABS is working with Department of Climate Change and Energy Efficiency, and other data producers and data users to overcome this discrepancy via the production of a SEEA greenhouse gas emission account to bridge between the System of National Accounts (SNA) and the Kyoto accounting approach.

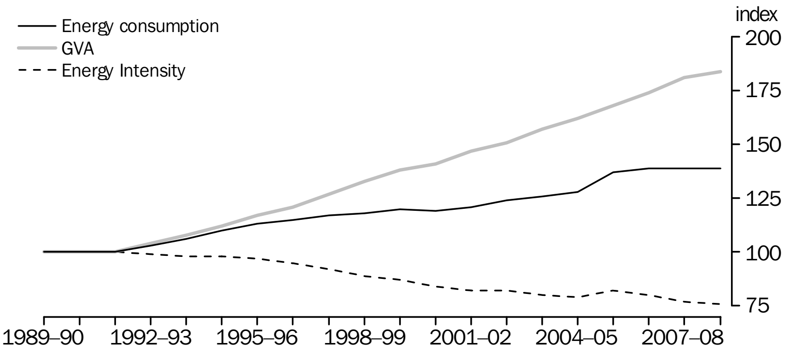
Energy consumption and intensity

The energy intensity of an industry is the energy consumed to produce one unit of economic output. Energy intensity is measured in petajoules of energy consumed per million dollars of Gross Value Added[119] (GVA). A decline in energy intensity is viewed as an improvement, as it indicates that less energy is used per unit of GVA.

117 The National Inventory accounts for emissions from electricity at the point where the emissions occur, which means the power station where electricity is produced, not the point where the electricity is used. Therefore, emissions associated with electricity used in the industry, residential and commercial sectors are included under energy production.
118 While the exclusion of LULUCF removes the majority of sink categories from the data, it should be noted that net emissions are reported for the waste sector when accounting for methane captured.
119 ABS gross value added is sourced from the Australian System of National Accounts (ASNA) and is based on the Australian and New Zealand Standard Industrial Classification (ANZSIC) 2006.

Energy consumption and intensity continued

7.2 NET ENERGY AND GVA, Consumption and Intensity



Note: Index: 1989-90=100

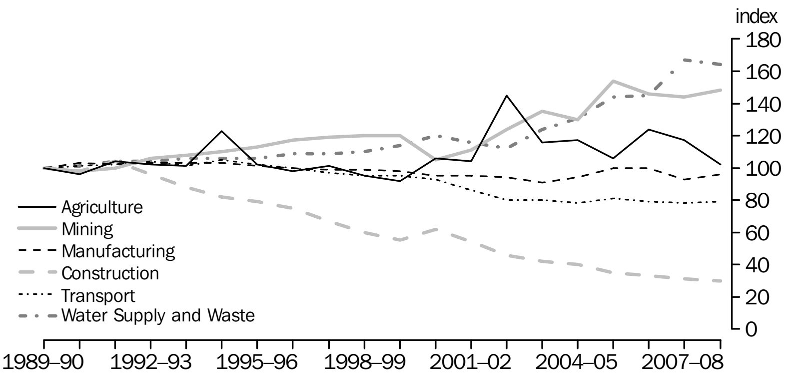
Source: Australian System of National Accounts (ABS cat. no. 5204.0); Energy Account (ABS cat. no. 4604.0)

Since the early 1990s, growth in energy consumption by industry has remained below the rate of economic growth. Over the period 1989–90 to 2008–09, energy consumption by industry grew 39%. In comparison, economic growth as measured by GVA grew by 84%. The 24% decline in the ratio of energy consumption to economic activity in the Australian economy during the 20 years to 2008–09 represents an improvement in energy intensity.

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

Disaggregating the Australian economy into industries enables more comprehensive analysis. A high intensity figure does not necessarily imply that an industry is using energy inefficiently. By nature, most industries engaged in the physical transformation of raw materials will use more energy than service industries.

7.3 NET ENERGY INTENSITY, By selected industries



Note: Index: 1989–90=100

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

Energy consumption and intensity continued

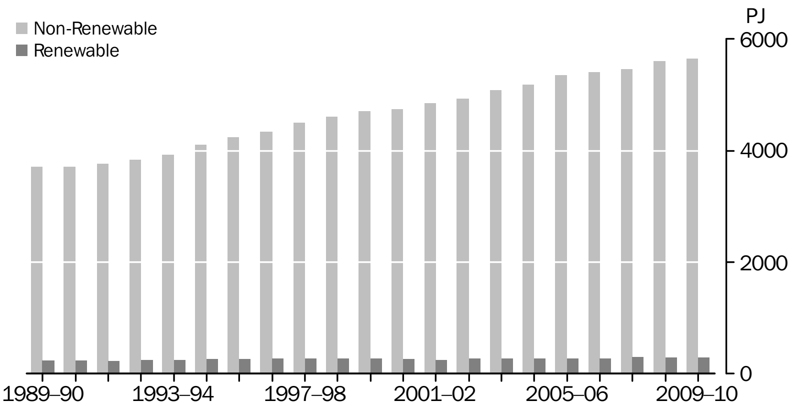
The direction and magnitude of change in energy intensity has varied between industries since the early 1990s. The majority of industries have recorded an improvement in energy intensity. The industries that showed the greatest improvement were Construction (70%) and Transport (21%). The energy intensity of the Mining, and the Water Supply and Waste industries increased between 1989–90 and 2008–09, with each recording rises of 48% and 64% respectively.

Manufacturing was the largest absolute consumer of energy over the period, followed by the Transport industry. Both of these industries recorded improvements in energy intensity over the period. Agriculture recorded a slight increase in the amount of energy it consumed per unit of economic production (2%), although its impact on the overall energy intensity of Australian industry was minimal since it was a relatively small consumer of energy.

RENEWABLE ENERGY

Australia has abundant and diverse energy resources that supply domestic and world markets. Australia's total domestic primary energy supply was 5945 PJ, in 2009–10[120]. As Figure 7.4 shows, the majority of this (95%) came from non–renewable sources, with the remaining 5% sourced from renewables.

7.4 AUSTRALIAN PRIMARY ENERGY SUPPLY, Renewable and Non–renewable



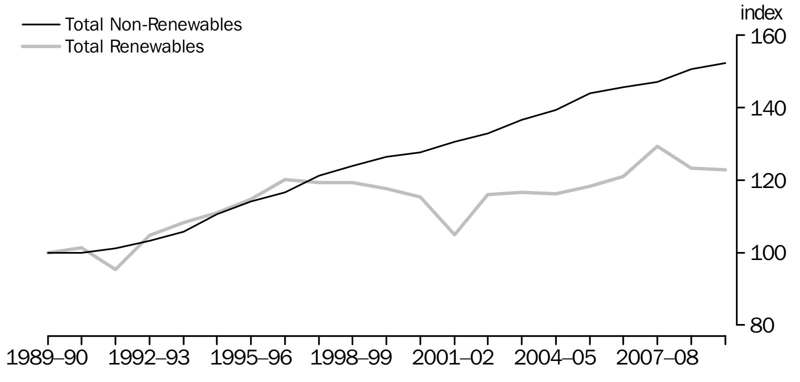
Source: Australian Bureau of Agricultural and Resource Economics and Sciences

Between 1989–90 and 2009–10, net energy consumption[121] in Australia rose from 3946 PJ to 5945 PJ, an increase of 51%. The bulk of this rise was due to an increased use of fossil fuels, which rose from 3713 PJ to 5657 PJ or 52%. Energy from renewable sources also experienced an increase (23%), but its contribution to Australia's total net energy consumption remained largely unchanged at around 5%.

120 Figure includes imports.
121 Total net energy consumption is equal to total primary energy supply at an aggregated level. As such, total net energy consumption and total primary energy supply are used interchangeably.

RENEWABLE ENERGY
continued

7.5 AUSTRALIAN RENEWABLE AND NON–RENEWABLE ENERGY SUPPLY



Note: Index:1989-90=100

Source: Australian Bureau of Agricultural and Resource Economics and Sciences

A large proportion of Australia's total primary energy supply is used in the production of electricity. In 2009–10, 8% of electricity generated in Australia came from renewable sources (see Figure 7.6).

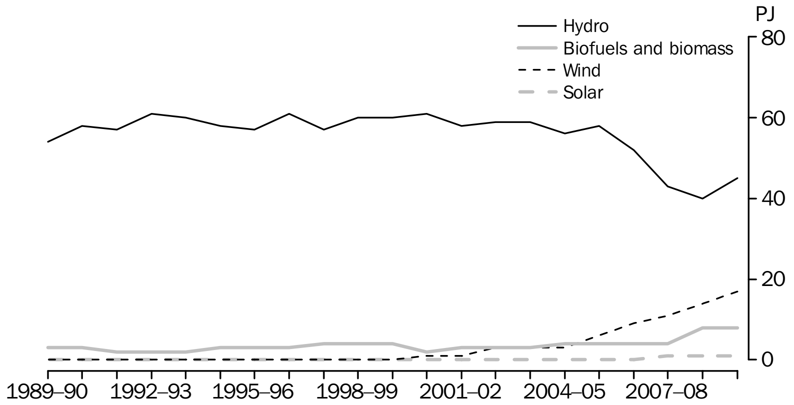
7.6 PROPORTION OF ELECTRICITY GENERATED BY RENEWABLE ENERGY

Source: Australian Bureau of Agricultural and Resource Economics and Scences

Hydro–power is by far the largest renewable energy source used to generate electricity in Australia, contributing 64% of the total amount in 2009–10. Despite this, drought conditions through the mid–to–late 2000s resulted in a fall in the amount of hydro–electric energy produced, dropping to 45 PJ in 2009–10 compared to an average of 58 PJ from 1989–90 to 1999–2000. In 2009–10 wind power overtook biofuels and biomasse to become the second largest renewable energy source for electricity generation contributing 24%.

RENEWABLE ENERGY
continued

7.7 ELECTRICITY GENERATED, by renewable energy sources

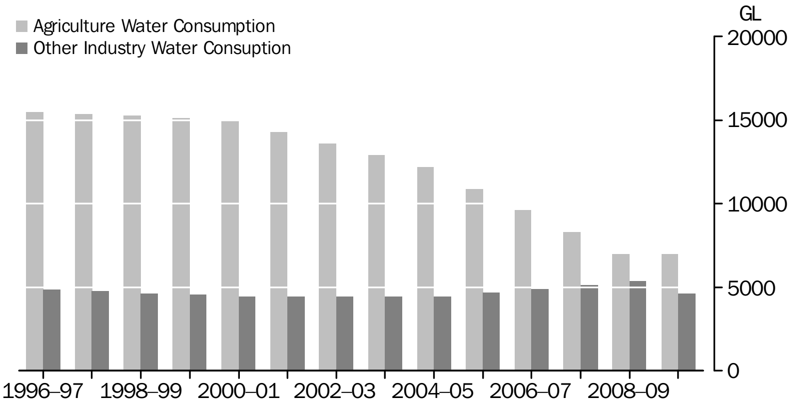


Source: Australian Bureau of Agricultural and Resource Economics and Sciences

The location of renewable energy facilities in Australia reflects the climatic characteristics of different regions. Hydroelectricity capacity in Australia is mostly located in New South Wales, Tasmania and Victoria. Wind farms are most common in South Australia and Victoria. Almost all bagasse fuelled energy production facilities are located in Queensland, where sugar is grown and the refining plants are located.

WATER

7.8 WATER CONSUMPTION

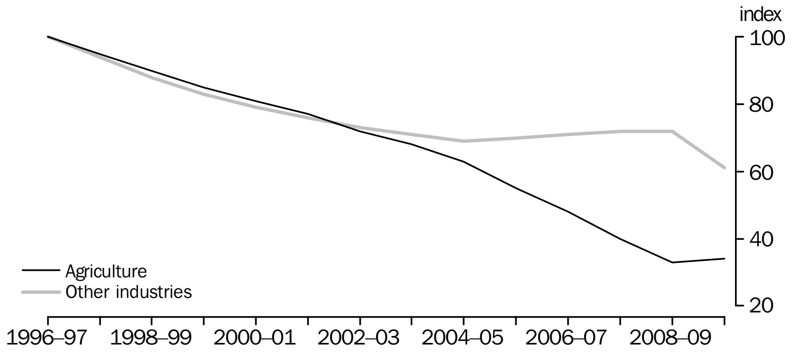


Source: Water Account, (ABS cat. no. 4610.0)

The Agricultural industry is the largest consumer of water in Australia, representing 60% of all water consumed by industry in 2009–10. Water consumption by Agriculture fell significantly between 1996–97 and 2009–10 declining 55%. Some of the fall is explained by drought conditions through the early–to–mid 2000s. While water consumption by other industries also fell slightly over the same period (–5%), the value of agricultural production did not fall by the same amount, meaning an increase in agricultural water use efficiency from an economic point of view. This could be an example of Agriculture's relatively higher level of elasticity to water availability, as farmers move to less water intensive products in reaction to strained water supplies (e.g. in dry years they do not grow cotton or rice).

WATER *continued*

7.9 WATER INTENSITY



Note: Index: 1996-97=100

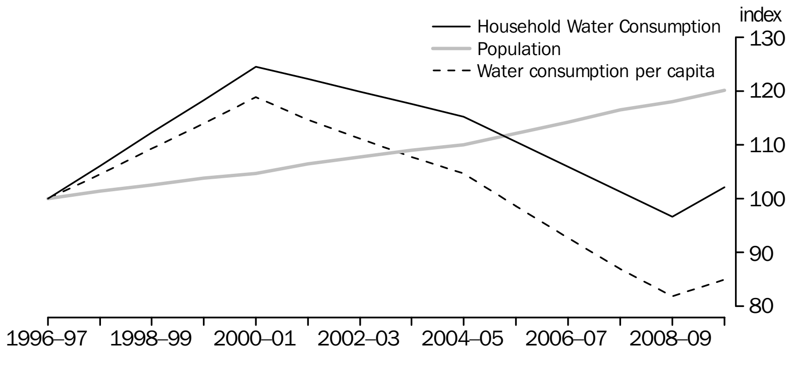
Source: Water Account, (ABS cat. no. 4610.0); Australian System of National Accounts (ABS cat. no. 5204.0)

Water intensity is a measure of the water consumed to produce one unit of economic output. It is calculated by dividing total water consumption by Industry Gross Value Added (GL/$m IGVA). A decline in water intensity is an improvement in water efficiency. The number of GL required by the Agriculture industry to produce one unit of economic output fell by 66% between 1996–97 and 2009–10 to 0.29 GL. The water intensity of all other industries also declined over the period, although to a lesser extent, recording a fall of 39%.

Water consumption and water intensity of households

Water consumption by households posted an increase of 25% between 1996–97 and 2000–01, but severe drought conditions through the early–to–mid 2000s meant that household water consumption fell, decreasing 18% between 2000–01 and 2009–10.

7.10 HOUSEHOLD WATER CHARACTERISTICS, Consumption and population growth



Note: Index: 1996-97=100

Source: Water Account, (ABS cat. no. 4610.0); Australian Demographic Studies (ABS cat. no. 3101.0)

Household water intensity is a measure of the water consumed annually per head of population. Australia's population grew 20% between 1996–97 and 2009–10 to reach 22.2 million people. In this same period the water intensity of Australian households fell 15%, meaning less water was needed for households per head of population in 2009–10 than in 1996–97.

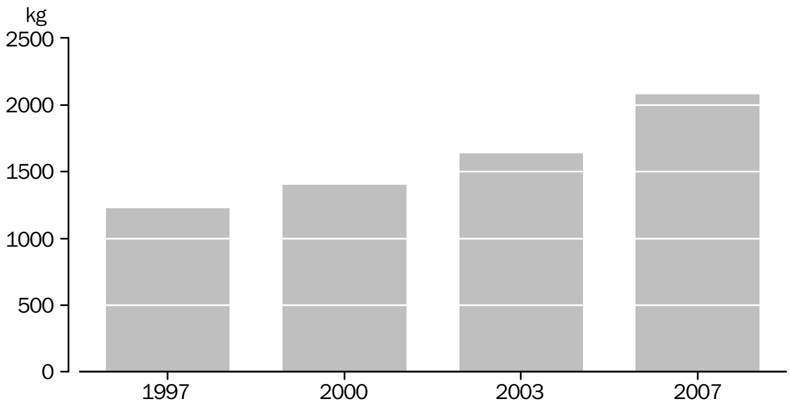
Water consumption and water intensity of households continued

Water consumption in the Australian economy needs to be viewed in the context of Australia's climate. Mean annual rainfall in Australia varies substantially across the continent. Large areas of the country have annual rainfall levels comparable with Europe and North America. However, a key feature of Australia's rainfall is its variability from year–to–year, season–to–season and region–to–region. Annual rainfall variability for Australia is greater than in any other continental region (Smith, 1998). Across the country as a whole, rainfall in 2001–02 and 2004–05 was significantly less than 1999–2000 and 2009–10; 2001–02 in particular recorded less than half the levels of the higher rainfall years. The below average rainfall through the early–to–mid 2000s also led to drought conditions in some parts of Australia, the consequences of which included urban water restrictions and reduced availability of water for irrigators.

WASTE

Between 1996–97 and 2006–07, the volume of waste produced per person in Australia grew at an average annual rate of 5.4%. Australians generated approximately 1,200kg of waste per person in 1996–97 and this increased to 2,100kg per person in 2006–07.

7.11 WASTE GENERATED PER CAPITA

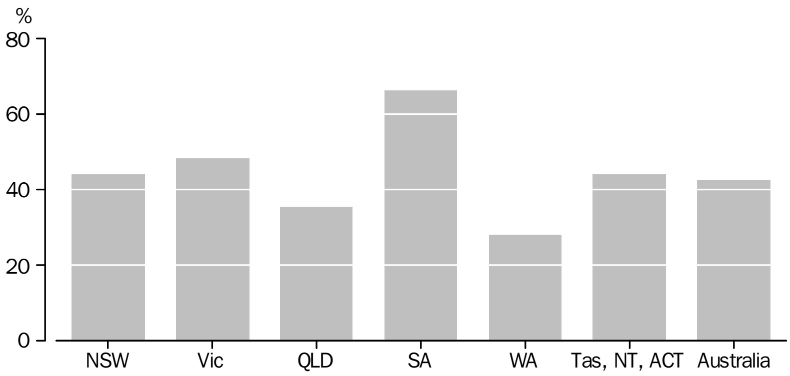


Source: ABS, Department of Sustainability, Environment, Water, Population and Communities

The day–to–day management of waste is primarily the responsibility of the state, territory and local governments. The role of the Australian Government in waste management has evolved in recent years and it is now increasingly engaged in national waste policy development. A particular focus is on developing harmonised national approaches for significant waste issues, which provide cost effective, fit for purpose solutions.

WASTE *continued*

7.12 WASTE DIVERTED FROM LANDFILL (a), Australia, States and Territories—2009–10



(a) see publication for scope definition

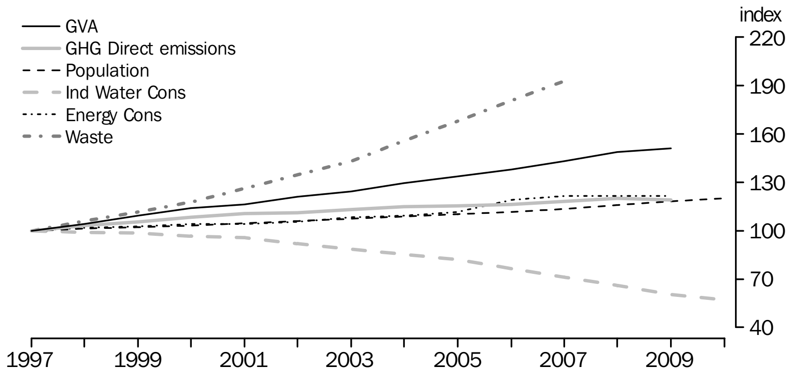
Source: Wate Management Services, Australia (ABS cat. no. 8698.0)

Landfills can have impacts on air, water and land quality. Emissions of gas (mainly the greenhouse gas methane) from landfill sites are caused by decomposing organic waste. Water moving through landfill waste has the potential to contaminate nearby surface and ground water. Potentially hazardous substances can also be transported by water or air to the surrounding soil.

INTEGRATING ENVIRONMENT AND SOCIO–ECONOMIC MEASURES

Figure 7.13 integrates readily available socio–economic data with some measures of environmental pressure. The socio–economic data used is population and GVA[122]. Indicators of environmental pressure are greenhouse gas emissions, water consumption, energy consumption, and waste production. The water and energy data are drawn from the ABS environmental accounts and the greenhouse gas emissions' data are from the Department of Climate Change and Energy Efficiency.

7.13 MEASURES OF AUSTRALIA'S PROGRESS—1997–2010



Note: Index:1997=100

Source: ABS, Department of Climate Change and Energy Efficiency

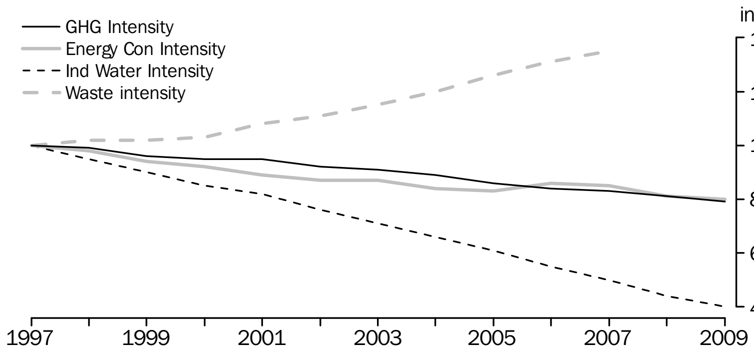
122 GVA used in place of GDP to ensure consistency with other datasets such as the intensity measures, which use GVA in their composition.

INTEGRATING ENVIRONMENT AND SOCIO–ECONOMIC MEASURES *continued*

Australia's economic production as measured by GVA rose by 51% over the period. At the same time, the measures of environmental pressure all increased, with the exception of water consumption. Energy consumption rose 21%, greenhouse gas emissions increased 19% and waste production[123] by 93%. In contrast, water consumed by industry experienced a notable fall of 43% over the period, which can be partly explained by the reduction in the availability of water due to natural events (i.e. the drought).

Figure 7.14 charts the change in a given measure of environmental pressure per unit of economic production (GVA). It illustrates a close correlation between Australia's greenhouse gas emissions' intensity and energy intensity. This is unsurprising, given that the majority of Australia's emissions can be attributed to energy production from fossil fuels.

7.14 AUSTRALIA'S PROGRESS, Intensity measures



Notes: Index:1997=100

Source: ABS, Department of Climate Change and Energy Efficiency

Waste intensity was the only measure of environmental pressure to increase over the period (35%). International evidence suggests that economic growth contributes to growth in waste generated per person[124]. Australians are among the highest users of new technology, and waste from obsolete electronic goods (e–waste) is one of the fastest growing types of waste[125].

Specific industries – Mining

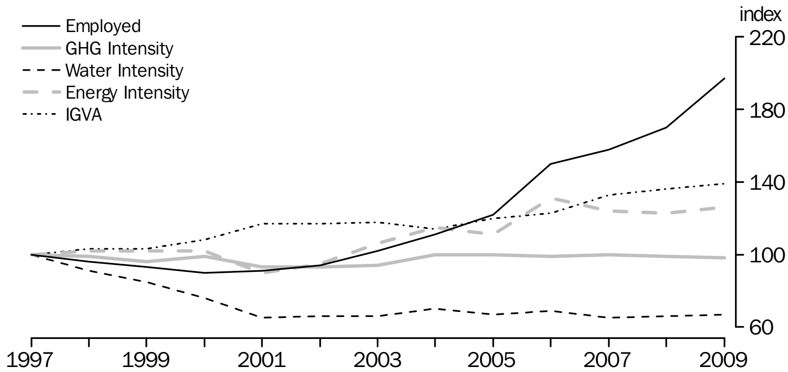
Environmental accounts can be used to examine the economic and environmental aspects of particular industries. As an example of this we present in brief some information for the mining industry. Similar information is available for other industries (e.g. the agriculture, manufacturing, transport).

Figure 7.15 looks at the relationship between several economic and environmental measures not the mining industry.

123 Waste data recorded over four periods (1997, 2000, 2003 2007) from 1997 to 2007.
124 Productivity Commission, 2006, Inquiry Report No. 38.
125 ABS, 2010, Measures of Australia's Progress, Waste generated per person.

Specific industries – Mining continued

7.15 MINING INDUSTRY, Integrated measures



Note: Index: 1997=100

Source: ABS, Department of Climate Change and Energy Efficiency

Economic growth in mining, as measured by IGVA, has risen steadily between 1997 and 2009 from $65bn to $91bn. The mining industry's portion of total GVA rose to represent 8.4% in 2009. Mining is now the third largest industry in Australia. The increase has been accompanied by a larger rise in the number of employed persons working in the industry, from 86,000 in 1990 to 170,000 in 2009.

The environmental measures for the mining industry present a mixed picture. The energy consumed per unit of economic production (energy intensity) has risen by 26% since 1997. A number of factors contribute to the increase. Firstly, Australia's mining industry is increasingly dominated by relatively low value (dollar per tonne) commodities, such as coal, iron ore and bauxite. This requires a greater level of energy for extraction and processing than commodities with higher unit values (e.g. more tonnes have to be removed in order to achieve the same value of sales). Part of this is due to the higher proportion of production coming from open cut mines, which require the removal of large quantities of overburden to expose the commodity. Greenhouse gas emissions intensity has remained largely unchanged between 1997 and 2009. The intensity of water consumption initially fell between 1997 and 2001, but remained largely unchanged thereafter.

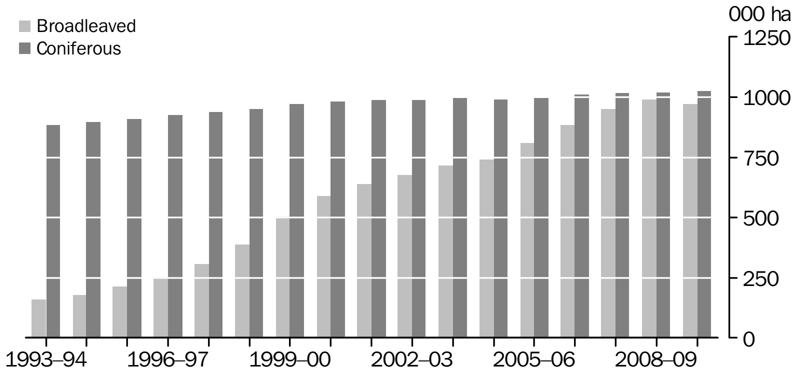
THE NATURAL RESOURCE BASE

Timber

The total area for hard wood (broad–leaved) and soft wood (coniferous) plantations almost doubled to reach 2 million hectares between 1994 and 2010. As Figure 7.16 shows, the majority of this change was due to the expansion in the area of broadleaved plantations. Between 1994 and 2000 hard wood timber plantation areas increased from 159,000 hectares to 973,000 hectares. The area of soft wood plantations remained relatively stable. A fall in price led to the market value of Australia's soft wood resource falling by 45% between 1994 and 2010.

Timber continued

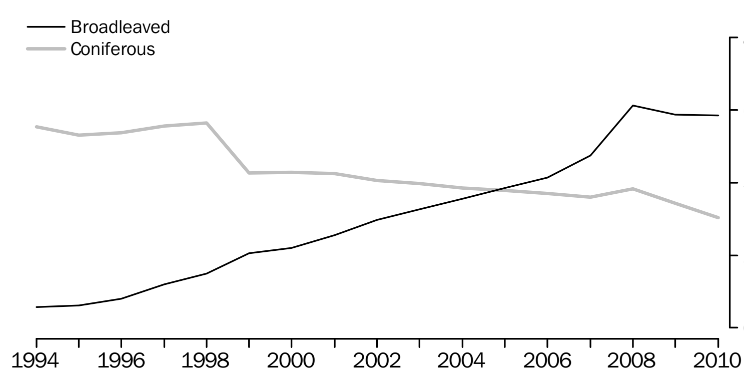
7.16 ECONOMIC DEMOSTRATED STOCK OF TIMBER, Physical



Note: Figures are experimental and should be treated with caution.

Source: ABS data available on request.

7.17 VALUE OF TIMBER RESOURCES, Monetary



Note: Figures are experimental and should be treated with caution.

Source: ABS data available on request.

Fish

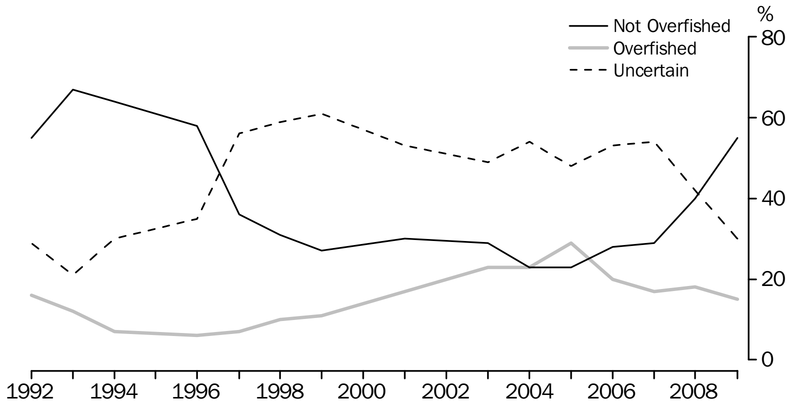
Australia has the world's third largest economic exclusion zone covering 11 million square kilometres. Figure 7.18 summarises biological and economic information for Australia's wild fish stocks, species or groups of species (all referred to as 'stocks' hereafter) during the period of 1992–2009. The number of stocks assessed increased considerably over the period, starting at 56 in 1992 to 101 in 2009. Fish stocks are classified into categories: not overfished or subject to overfishing, overfished and subject to overfishing, and uncertain statuses, with reference to their respective biomass[126].

The number of overfished stocks peaked at 19 (or approximately 30% of the total number of stocks) in 2005. This was followed by a recovery in the number of fish stocks 'not overfished' to 56 in 2009. The number of stocks classified as uncertain fell from 1999 onwards and 22 stocks were removed from the uncertain status between 2007 and 2009.

126 Not overfished: The stock's biomass is deemed adequate to sustain the stock in the long term; Overfished: The stock's biomass may be inadequate to sustain the stock in the long term; Uncertain: There is an inadequate level of stock specific information for which to determine a status.

Fish continued

7.18 AUSTRALIAN FISHERIES BIOLOGICAL STOCK STATUS



Source: Australian Bureau of Agricultural and Resource Economics - Bureau of Rural Sciences, ABS

Energy (non–renewable)

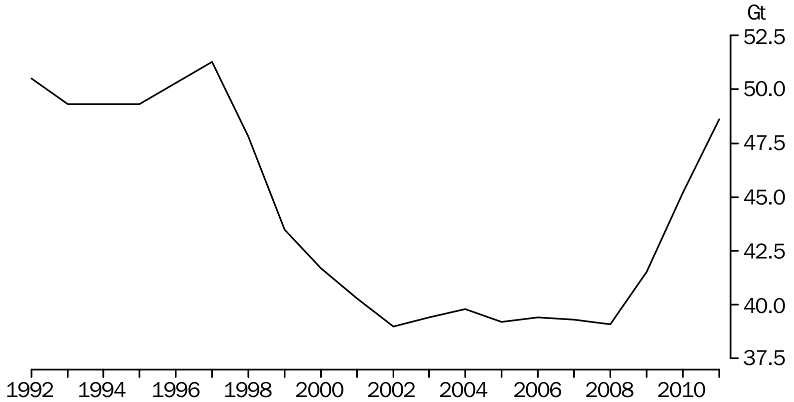
Australia has abundant energy resources. The country holds an estimated 38% of world uranium resources, 9% of the coal stocks and 2% of the planet's natural gas resources[127].

In terms of economically demonstrated resources (EDR)[128], Australia's largest energy stocks by value in 2011, are black coal ($145 b), followed by natural gas ($124 b) and uranium ($3.1 b). Figures 7.19 to 7.24 show the trend in the economically demonstrated reserves of black coal, uranium and natural gas resources in Australia. The series profiles physical volumes with economic values[129].

Black coal

The economic value of the stock of black coal more than doubled during the period 1998 to 2011, from $67 b to $145 b. This is largely as a result of price increases.

7.19 BLACK COAL, Economically demonstrated resources



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

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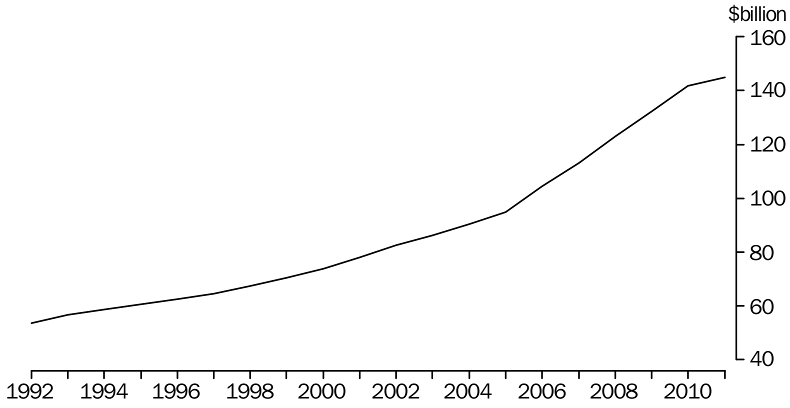
127 Geoscience, Oil and Gas Resources of Australia (OGRA) Report 2009.

128 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.

129 Economic value is determined using NPV of future cash–flows from the resource. This approach values value to asset as a whole, in terms of the EDRs, production, cost including normal return to capital, mine production and so on.

Black coal continued

7.20 BLACK COAL, Value of economically demonstrated resources—as at 30 June



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

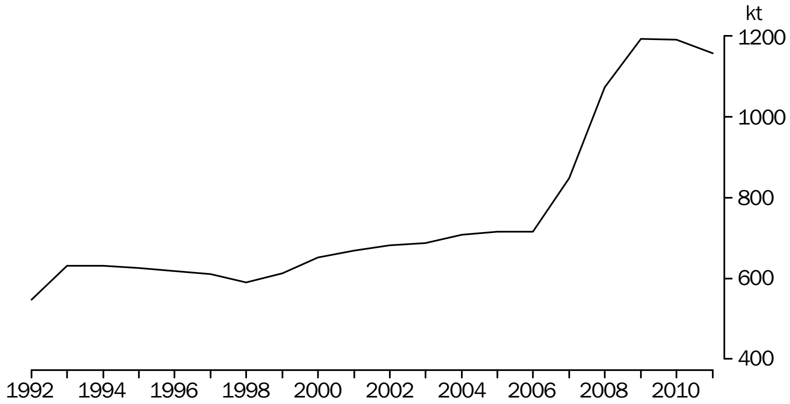
As at the end of 2008, Australia had 6% of the world's recoverable black coal EDR and ranks sixth behind the United States of America (31%), Russia (21%), China (13%), India (8%) and South Africa (7%).

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 processing.

Uranium

Australia has the world's largest economically demonstrated stocks of uranium and is the third largest producer of uranium internationally. Between 1998 and 2001, the value of Australia's uranium deposits increased from $1.81 b to $3.1b. This was driven by rising market prices and new EDR discoveries.

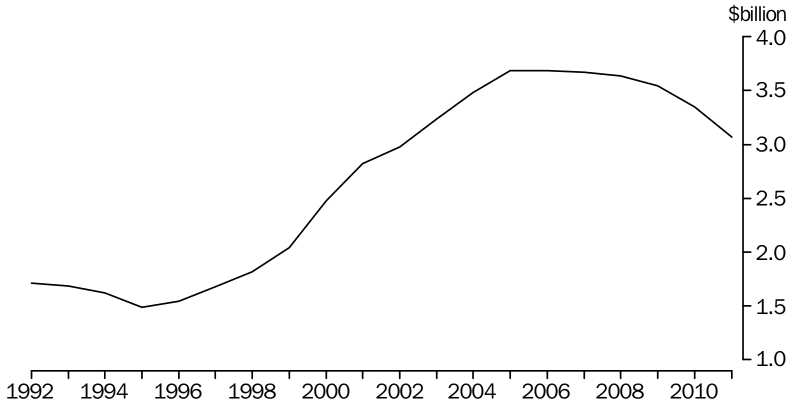
7.21 URANIUM OXIDE, Economically demonstrated resources—as at 30 June



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

Uranium continued

7.22 URANIUM OXIDE, Value of economically demonstrated resources—as at 30 June



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

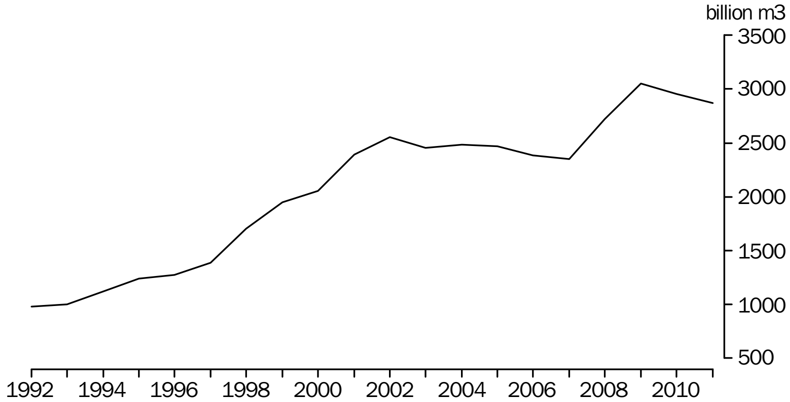
Major uses for uranium are as fuel in nuclear power reactors to generate electricity, in the manufacture of radioisotopes for medical applications and in nuclear science research using neutrons from reactors.

Natural gas

Australia has significant gas resources, and it represents the country's third largest energy resource after coal and uranium (Geoscience Australia, 2010).

The economically demonstrated volume of natural gas in Australia was around 3000 billion cubic metres in 2011. At current production rates, there are sufficient gas resources to last 86 years.

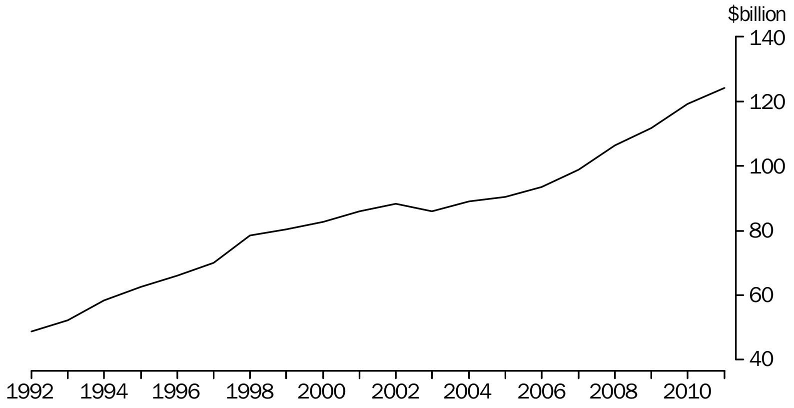
7.23 NATURAL GAS, Economically demonstrated resources—as at 30 June



Source: Australian System of National Accounts, (ABS cat. no. 5204.0)

Natural gas continued

7.24 NATURAL GAS, Value of economically demonstrated resources—as at 30 June



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

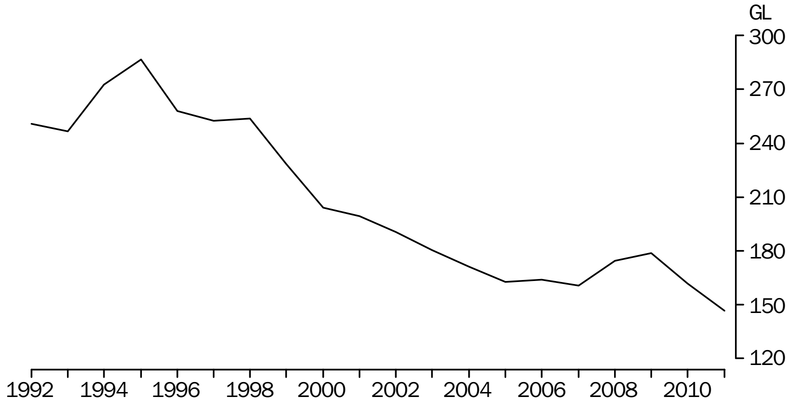
Petroleum

Australia has about 0.3 per cent of world petroleum reserves. Most of Australia's petroleum resources are condensate and liquefied petroleum gas (LPG) associated with offshore gas fields. In 2011, Australia's identified petroleum resources were made up of 340 GL of condensate, 147 GL of crude oil and 151 GL of LPG.

Crude oil

Australia's resources of crude oil represent a small proportion of world resources (less than 5%). Stocks of crude oil decreased between 1995 and 2011. The value of this resource peaked in 1995 at around $76 b in 1995 and declined afterwards to be $42 b in 2011.

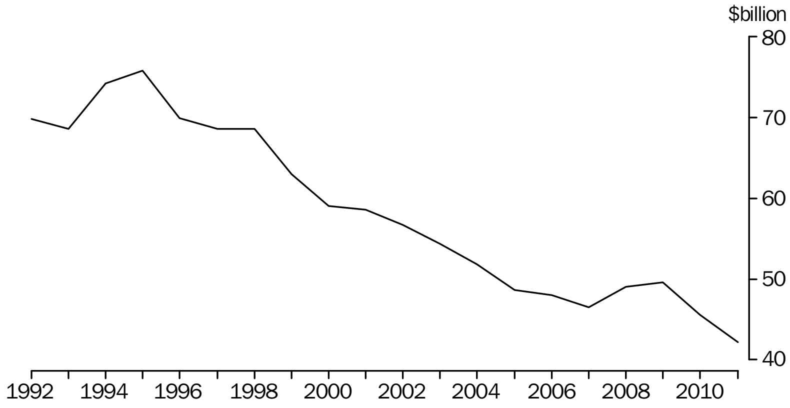
7.25 CRUDE OIL, Economically demonstrated resources—as at 30 June



Source: Australian System of National Accounts, (ABS cat. no. 5204.)

Crude oil continued

7.26 CRUDE OIL, Value of economically demonstrated resources—as at 30 June

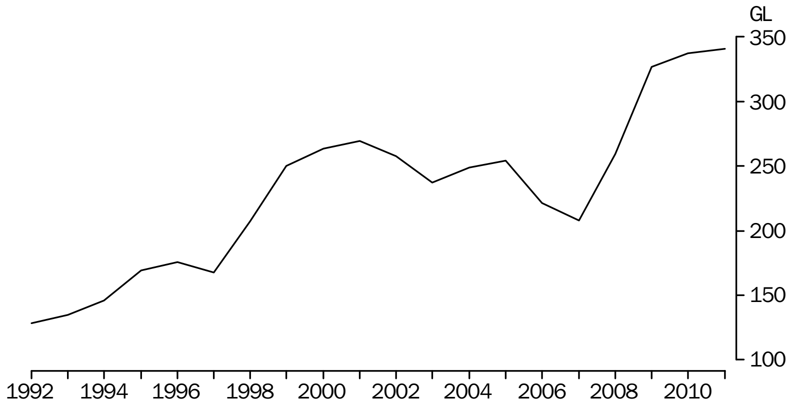


Source: Australian System of National Accounts, (ABS cat. no. 5204.0)

Condensate

Australian condensate resources were around 340 GL in 2011. The value of condesate stocks increased from $20bn in 1997 to reach $39bn in 2011.

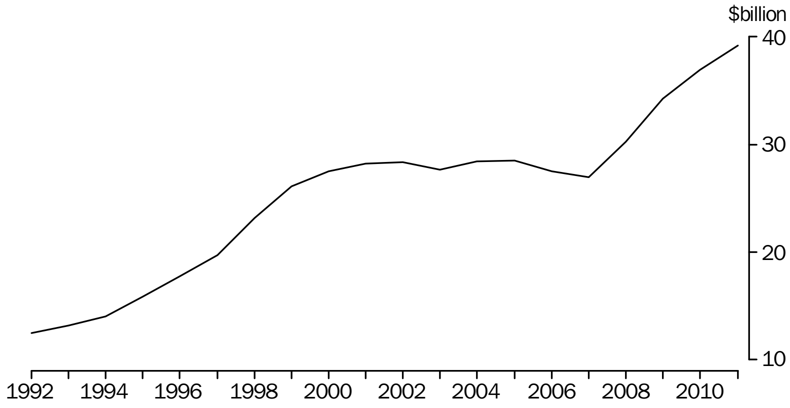
7.27 CONDENSATE, Economically demonstrated resources—as at 30 June



Source: Australian System of National Accounts, (ABS cat. no. 5204.0)

Condensate continued

7.28 CONDENSATE, Value of economically demonstrated resources—as at 30 June

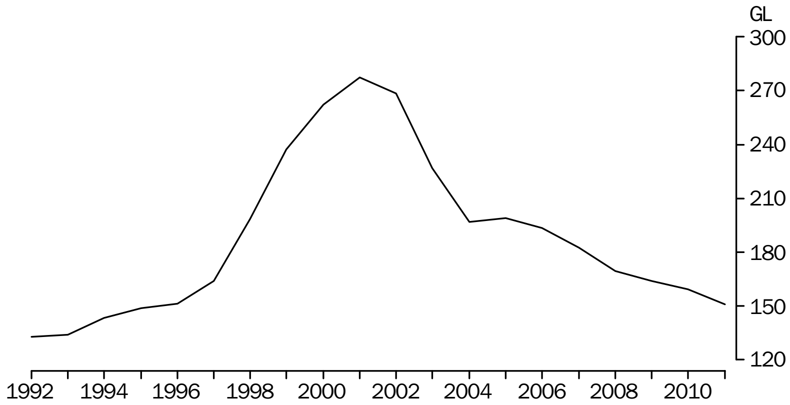


Source: Australian System of National Accounts, (ABS cat. no. 5204.0)

Liquefied petroleum gas

Domestic stocks of liquefied petroleum gas (LPG) rose from 87 GL in 1985 to 156 GL in 2011.

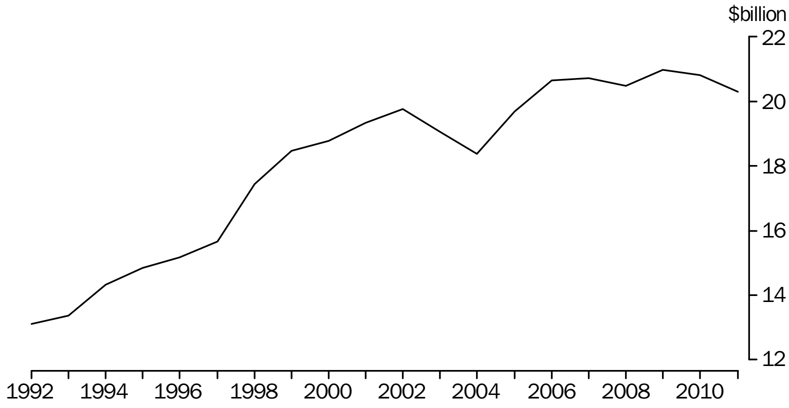
7.29 NATURALLY OCCURING LPG, Economically demonstrated resources—as at 30 June



Source: Australian System of National Accounts, (ABS cat. no. 5204.0)

Liquefied petroleum gas continued

7.30 NATURALLY OCCURRING LPG, Value of economically demonstrated resources—as at 30 June



Source: Australian System of National Accounts, (ABS cat. no. 5204.0)

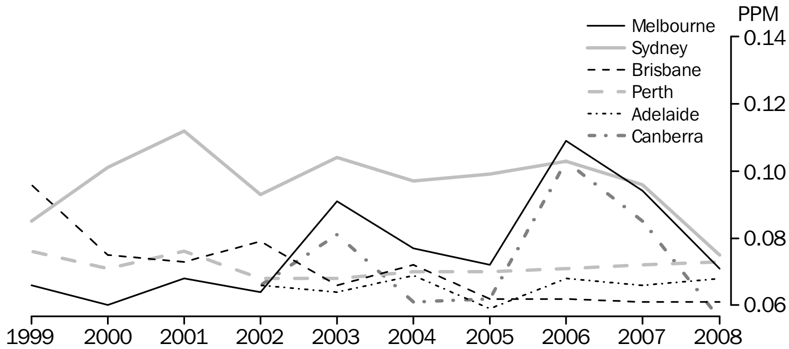
ENVIRONMENTAL QUALITY

Air quality

Air quality in Australia is assessed using national ambient air quality standards, which are set for pollutants in the National Environment Protection Measure (NEPM). The Air Quality Index (AQI) rates air quality using these standards and categorises air quality in different areas from the highest 'Very Good' and the lowest rating 'Very Poor'[130].

Ozone is one of five gases commonly used by governments internationally to test air pollution. Ozone levels in the state capitals profiled remained largely stable over the assessment period. Occasionally peak ozone levels approached or exceeded the national standards in some Australian cities.

7.31 AIR QUALITY, Ozone concentrations



Note: Four hour average Maximim Ozone Levels; NEPM standard is 0.08 PPM

Source: Department of Sustainability, Environment, Water, Population and Communities, Bureau of Meterology

Sydney generally experienced higher ozone levels than other major cities in Australia. Levels exceeded the NEPM standards in most years during the assessment period meaning Sydney generally achieved a poor AQI rating for peak ozone concentrations.

130 Very Good if pollution levels are less than a third of the standard; Good if levels are between one–third and two–thirds of the standard; Fair if levels are between two–thirds and 99 per cent of the standard; and Poor to Very Poor if levels are 100 per cent of the standard or more.

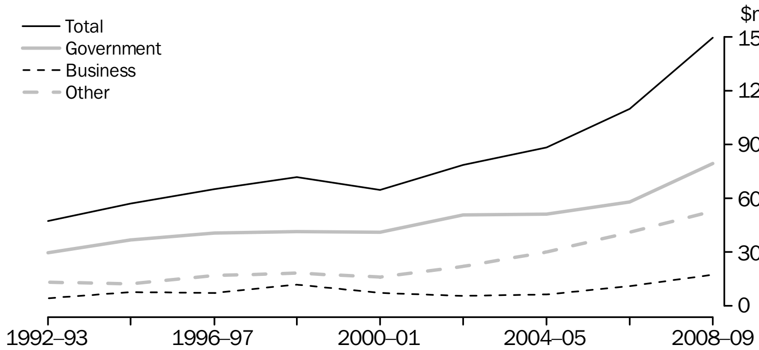
Air quality continued

Other cities only occasionally experienced ozone levels close to or exceeding the NEPM standard. These cities largely achieved a good to fair AQI ratings, but Melbourne achieved a poor AQI rating in some years.

POLICY RESPONSE AND ECONOMIC OPPORTUNITIES

Environmental research and development

7.32 ENVIRONMENTAL RESEARCH AND DEVELOPMENT



Note: Other comprises of higher education and private non-profit organisations

Source: *Research and Experimental Development, All Sector Summary, Australia (ABS cat. no. 8112.0)*

Gross expenditure (investment) on environmental research and development (R&D) as a percentage of total gross expenditure within all sectors of the Australian economy fell from 7% in 1992–93 to 5% in 2008–09. In absolute terms, however, investment 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 jumping by over 400%. Spending by other institutions (higher education and non–profit organisations) also rose sharply increasing by over 400% 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, due to the government's focus on helping the country's industries become more sustainable, and with it more internationally competitive.

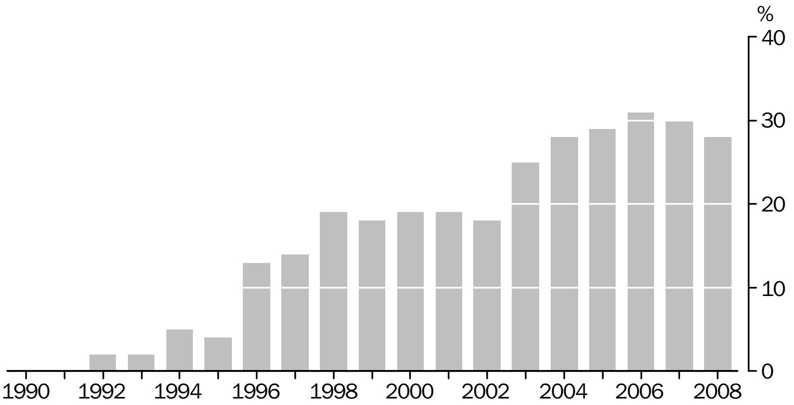
The main areas of environmental R&D included environmental policy frameworks, and environmental knowledge and management of the environment. Another element of R&D in the area relates to environmental protection expenditure (EPE). EPE is spending, mainly by companies, where the primary aim is to decrease damage to the environment. 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.

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 can also be emitted during the treatment and processing of wastewater and sewage, or during the incineration of waste.

Recovery of landfill emissions for economic uses continued

7.33 LANDFILL EMISSIONS RECOVERY, Proportion recovered

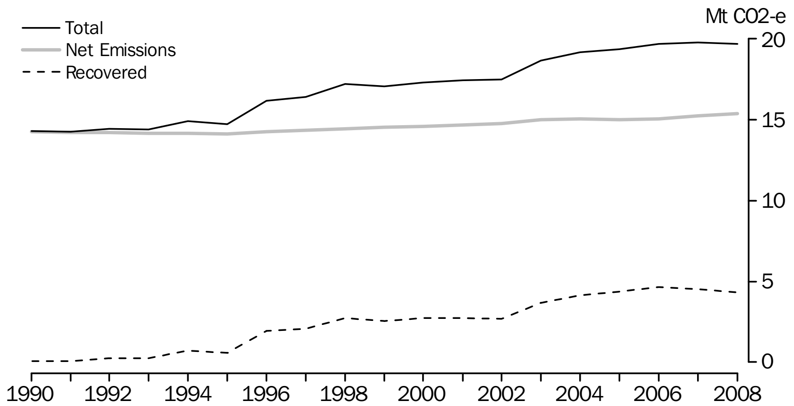


Source: DCCEE, National GHG Inventory, May 2010.

Recent years have seen significant declines in the total volume of greenhouse gases emitted by the waste sector. Between 1990 and 2008, net emissions from the waste sector declined by 20%. The waste sector's contribution to Australia's total greenhouse gas inventory has also declined, from 4.3% in 1990 to 2.6% in 2008[131].

Declines in waste emissions have been largely due to increases in the volume of greenhouse gases captured at Australia's landfills. In 1990, less than one per cent of all landfill emissions were recovered. By 2008, this figure had increased to 28%. During this same period, the total volume of emissions being generated at Australian landfills only experienced a moderate increase (8%). Consequently, net emissions from Australian landfills have fallen by 22% between 1990 and 2008 (from 14.2 million tonnes of carbon dioxide equivalent emissions to 11.1 million tonnes).

7.34 LANDFILL EMISSIONS RECOVERY, Composition of emissions



Source: DCCEE, National GHG Inventory, May 2010.

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

131 Department of Climate Change and Energy Efficiency, National greenhouse gas inventory, May 2010.

CHAPTER 8 SOLID WASTE MANAGEMENT

INTRODUCTION TO SOLID WASTE MANAGEMENT

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.*"[132]

Specific aims of the policy are to:

- avoid the generation of waste
- reduce the amount of waste going to landfill (including hazardous waste)
- manage waste as a resource
- ensure that waste management, disposal, recovery and re–use are undertaken in a safe, scientific and environmentally sound manner

In addition, it is envisaged that this policy will also complement and contribute to:

- a reduction in greenhouse gas (GHG) emissions (energy conservation and energy production)
- water efficiency
- productivity of the land
- supporting jobs
- investment in future long term economic growth

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

Waste management is a complex issue and poses a number of measurement challenges. The production and use of materials, goods and services have a range of environmental and economic consequences. Waste management is a broader area than provision of waste services – recovery of materials, recycling, disposal to landfill, etc. which are provided primarily by the Waste Management Industry[133]. Government, businesses and households are all involved in waste generation and waste management – either by actively reducing, reusing, recovering, recycling materials, or paying others to recover or to dispose of unwanted materials.

While the issue of waste measurement is complex, simple indicators have been sought for policy development and evaluation. Environmental–economic accounts provide a systematic way of compiling information from disparate sources from which indicators may be calculated.

Indicators should have several properties; timeliness, underpinned by good–quality data; unambiguous better and worse directions (e.g. higher numbers are worse; lower

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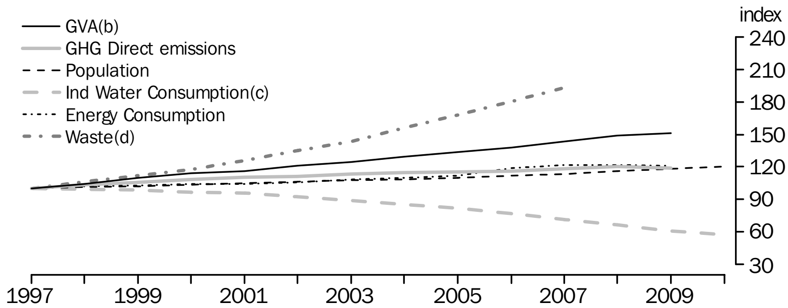
132 *National Waste Policy 2010*. Department of Sustainability Environment Water Population and Communities.
133 The ABS defines the Waste Management Industry as those businesses whose primary activity is provision of waste services; some businesses with other primary activities (e.g. construction) also provide waste services.

INTRODUCTION TO SOLID WASTE MANAGEMENT *continued*

numbers are better), and the ability to be interpreted by the general reader[134]. For waste the total mass of solid waste generated could be an indicator of the environmental impact of production and consumption patterns. Other indicators could be derived from the hazards posed by different types of waste and be used to evaluate changes in the dangers waste poses to human health and the environment.

In addition, the relationship between Australia's economy and the environment can be further explored by integrating conventional socio–economic data with measures of environmental pressure. Figure 8.1[135] highlights potential interconnections between economic growth and waste generation. Greenhouse gas emissions, water consumption, energy consumption, and waste production all represent measures of environmental pressure; population and Gross Value Added (GVA)[136] provide socio–economic indicators.

8.1 MEASURES OF AUSTRALIA'S PROGRESS(a)—1997–2010



(a) Index: 1997=100
(b) GVA, gross value added
(c) Ind Water Consumption is water consumption by industry
(d) Waste, waste generation

Source: ABS, Department of Climate Change and Energy Efficiency

Figure 8.1 shows that the majority of indicators of environmental pressure increased between 1997 and 2009. The population of Australia rose by 18% over this period, while gross value added increased by 51%. Energy consumption rose 21%, while greenhouse gas emissions increased by 19%. Waste production in Australia increased by 93% between 1997 and 2007, while in contrast, water consumed by industry decreased by 39%.

The System of Environmental–Economic Accounting (SEEA) Central Framework integrates information on the environment and economy and could provide a useful conceptual basis for assessing many waste policy objectives. The Australian Bureau of Statistics (ABS), in consultation with a range of stakeholders, is specifically developing an experimental waste account to test the usefulness of this particular component of the

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134 "*What Makes a Good Progress Indicator?*", 2010. *Measures of Australia's Progress, 2010* (cat. no.1370.0).
135 Detailed sources: *ABS Water Account* 2009–10, 2008–09, 2004–05, 2001–02, 1993–94 to 1996–97. (cat. no. 4610.0); *Measures of Australia's Progress,* 2010. (cat. no. 1370.0) (data sourced from Hyder, 2009 *Waste and Recycling in Australia – 2009*, for the Department of Environment, Water, Heritage and the Arts); *Australian System of National Accounts 2010–11*, (cat. no. 5204.0). Table 5; *Australian Demographic Statistics, June 2011*. (cat. no. 3101.0); *Energy Account, Australia 2008–09*. (cat. no. 4604.0); The Department of Climate Change and Energy Efficiency, *Australian National Greenhouse Gas Accounts (April 2011)*, *National Greenhouse Gas Inventory – Accounting for the Kyoto Target, December Quarter, 2010*, http://ageis.climatechange.gov.au/
136 Gross Value Added used in place of Gross Domestic Product (GDP) to ensure consistency with other datasets such as the intensity measures, which use GVA in their composition.

INTRODUCTION TO SOLID WASTE MANAGEMENT *continued*

SEEA accounts to provide information for developing and reviewing waste policy objectives.

WHAT IS A WASTE ACCOUNT?

A waste account provides information on 'solid waste' only; discarded materials that are no longer required by the owner or user. It has become standard practice internationally, including in the SEEA, to include liquid waste under the heading of solid waste[137]; for international consistency, the ABS follows this practice. Solid waste excludes wastewater (such as sewage and industrial effluent) and small particulate matter and gasses released into the atmosphere, which are a part of water and air emissions accounts, respectively.

A waste account would contain a series of tables showing information on the generation of waste, the disposal of waste to landfills or to recycling facilities, and the supply of recycled materials in the economy. It would also incorporate related financial flows of waste, such as payments for waste disposal, taxes, subsidies and revenues associated with waste management, as well as disposal and recovery costs.

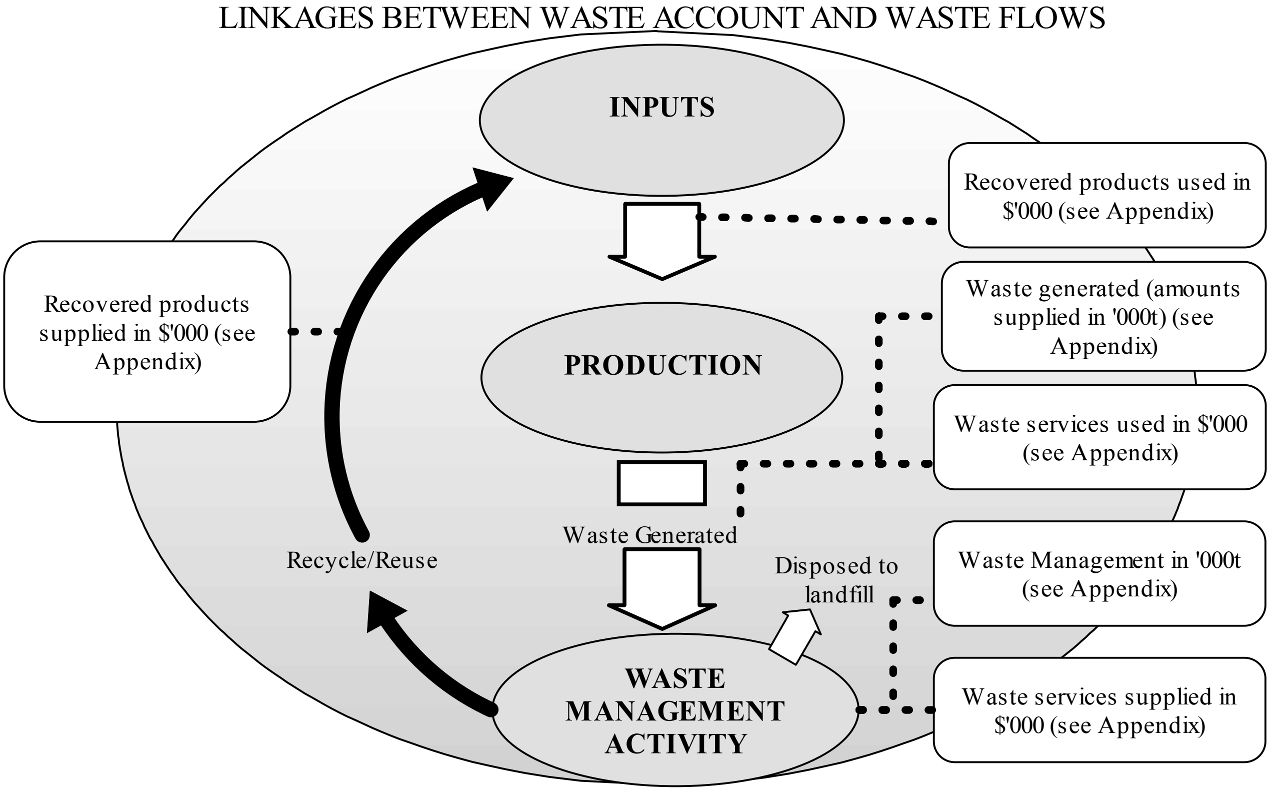
Data in the waste account would be linked to the System of National Accounts (SNA) along with other relevant information. Proposed tables for inclusion in the Australian waste account are presented in the Appendix.

Figure 8.2 links the proposed waste account tables to the relevant part of the waste process it is representing, namely:

- *Waste generated* ('000 tonnes) – represents Australia's total supply of solid waste. It shows the physical volume and types of waste being generated, by industry and sector (including imports).
- *Waste management* ('000 tonnes) – captures the physical volume of various waste types recovered, treated or disposed, by industry and sector (including exports).
- *Waste services used* ($'000) – shows spending on waste management services in Australia, by source.
- *Waste services supplied* ($'000) – shows provision and value of waste management services, by source.
- *Recovered products supplied* ($'000) – identifies the value of recovered material/products that is supplied back to the economy, by source and material type (including imports).
- *Recovered products used* ($'000) – shows the amount of recovered material used, by source (including exports).

137 System of Environmental–Economic Accounting 2012, section 3.84. Online: http://unstats.un.org/unsd/envaccounting/seearev/Chapters/SEEA_CentralFramework_Ch1–6.pdf

8.2 WASTE ACCOUNT LINKED TO WASTE GENERATION AND FLOW THROUGH THE ECONOMY (SEE APPENDIX)



WHAT IS A WASTE ACCOUNT? *continued*

This physical–monetary integration of waste data enables analysts to examine the economic and social drivers and pressures linked to physical changes. The waste account will complement the National Waste Report[138] and assist in analysing the effectiveness and impact of waste policies, particularly from an economic perspective.

HOW CAN A WASTE ACCOUNT ASSIST?

One of the National Waste Policy's key areas is providing evidence, with the objective of developing "capacity to effectively collect consistent, accurate and meaningful national waste and resource recovery data to inform policy and decisions".

The planned ABS waste account would be consistent with this objective. It would complement the National Waste Report by linking waste data to the main source of national economic information, the national accounts, as well as information on other environmental issues (e.g. water and energy use by industry and households). A waste account would also help to identify data gaps and deficiencies and provide a framework to help underpin integrated waste data by using consistent concepts, terminology and classifications.

For example, the waste accounts could be used to:

- examine the generation of waste in relation to economic performance and how this changes over time (e.g. tonnes of waste generated per $1000 of industry valued added)
- examine the effectiveness or efficiency of waste management expenditure (e.g. tonnes of waste disposed per $1000 of waste management expenditure)

138 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

HOW CAN A WASTE ACCOUNT ASSIST? *continued*

- assess the economic impact on industries affected by changes to waste management policy
- determine the amount of waste diverted from landfill and the contribution of recycling to the economy (e.g. contribution of recycling to GDP and mass and value of recycled materials supplied to the economy)
- identify gaps and deficiencies in waste measurement data
- provide data that may be used to model the impact of changes in the economy on waste generation (e.g. growth of the economy or changes in the price of waste disposal)

Some specific policy aims and objectives, identified in the National Waste Policy 2010, are presented below together with discussion of how a comprehensive waste account could assist in addressing these policies.

Measuring the management of waste

In 2009, "98% of Australian households participated in some form of recycling and 86% of households reused waste"[139].

According to the ABS' 2009–10 survey of the Waste Management Services industry, the main materials recovered or reprocessed at facilities other than landfills were metals (2.2 million tonnes), and paper and cardboard (1.7 million tonnes). Figure 8.3 shows the amount of different materials recovered as a proportion of total amounts of these materials received at waste management facilities, excluding landfills. Ninety percent of paper and cardboard received at these facilities is recovered, compared with less than 10% of rubber and tyres. Overall, nearly one quarter of the materials received at these facilities (just over 4 million tonnes) is finally disposed to landfill.

8.3 MATERIAL RECOVERY, Facilities other than landfill(a)—% of materials recovered—2009–10

(a) Organics refers to non-food organic waste

Source: Waste Management Services, Australia, 2009-10 (ABS cat. no. 8698.0).

Over time a waste account would be able to answer questions such as:

- is the level of different materials sent to landfill increasing or decreasing over time?
- which industries are the main sources of waste production?
- is materials recovery increasing? If so, which materials?
- what are the size and composition of the material recovery industry?
- who is bearing the cost of waste disposal and material recovery?

139 *Environmental Issues: Waste Management and Transport Use" March 2009.* (ABS cat. no. 4602.0.55.002)

Measuring the management of waste continued

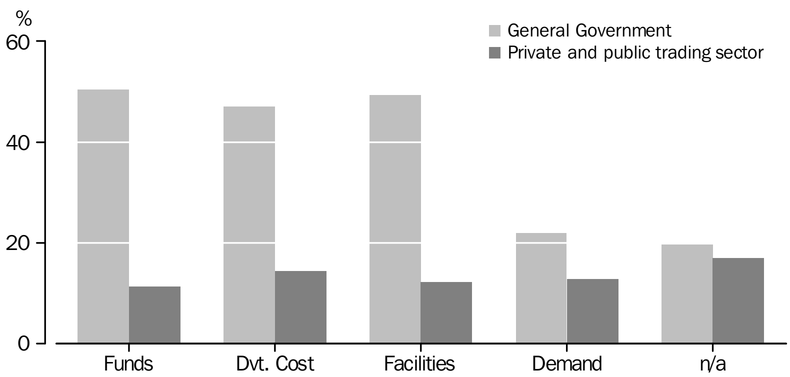
- is the value of recovered materials increasing? If so, of which materials?
- are more recovered materials returned to the economy and who is using them?

As the industry groupings and accounting concepts used in a waste account are consistent with those used in national accounting, several economic efficiency indicators may be derived. For example, 176 tonnes of waste were received by the waste management industry at landfills for each $m of gross value added in 2009–10[140] (Note that gross value added here includes income from all the activities of the waste management industry, not just land filling). Changes in this figure may indicate changes in income of the waste management industry from other sources, such as recycling. In the same year, there were 1.5 employees per 1000 tonnes of waste disposed of. Those industries with high expenditure on waste disposal, relative to their other production costs, have strong economic incentives to reduce their waste generation in order to reduce their waste disposal costs. As such, they would be more likely to respond to efforts to assist them in reducing waste generation, to decrease their waste disposal costs. A waste account would help to identify these industries.

Supporting the reduction of waste

The ABS publication, Waste Management Services, Australia, 2009–10[141], identified factors that significantly hampered the ability of businesses in the waste management industry to increase resource recovery. The main factors were: cost of development or implementation (14.4%), lack of customer demand (12.8%), and lack of facilities or infrastructure (12.2%). Almost 83% of private and public trading sector businesses reported at least one factor. For the general government sector, the main factors were: lack of access to additional funds (50.5%), lack of facilities or infrastructure (49.3%), and cost of development or implementation (47%) (see figure 8.4).

8.4 CONSTRAINTS IN EFFORTS TO INCREASE RECOVERY(a)—2009–10



(a) Businesses could report more than one hampering factor

Source: Waste Management Services, Australia, 2009-10 (ABS cat. no. 8698.0).

A waste account would provide consistent economic and physical data on:

- the waste 'market' and, in particular, which sectors (i.e. private or government) and industries are providing these services
- what services are being provided and the value of these services

140 Waste Management Services, Australia, 2009–10, 2011, (ABS cat. no. 8698.0).
141 Waste Management Services, Australia, 2009–10, 2011, (ABS cat. no. 8698.0).

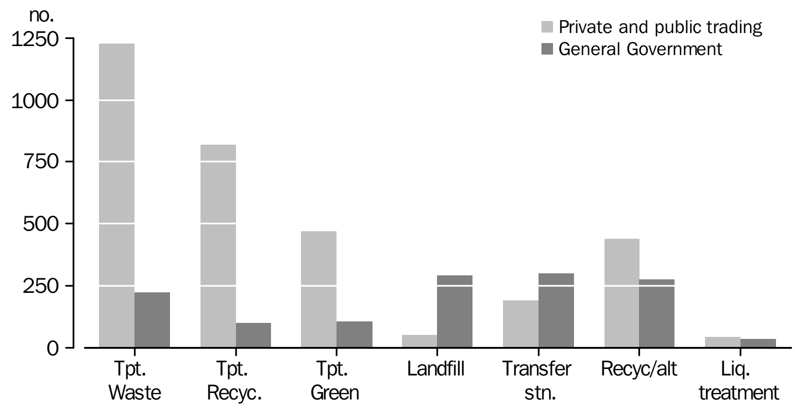
Supporting the reduction of waste continued

- which industries have the greatest demand for waste services
- whether waste recovery is becoming more profitable

The data collated in a waste account would provide policy makers with detailed information on different streams of waste (e.g. construction waste, hazardous waste, paper and cardboard etc.). This would aid in the understanding of industry dynamics to meet specific policy goals. The National Waste Report makes special mention of waste from construction and demolition projects[142]. Waste accounts could be used to examine the costs of waste disposal and the income received by the waste industry from different streams of waste e.g. construction and demolition. Comprehensive regular waste accounts could show how these relationships change over time, and explore in further detail issues such as revenue for recyclables per tonne, by waste source.

Other ABS data would also complement a waste account. The activities undertaken by waste management industry businesses are shown in Figure 8.5. There are significant differences between the public and private trading sector and the general government sector. Within the public and private trading sector, more businesses undertake transport of recycling than operate landfills or transfer stations.

8.5 ACTIVITIES BY BUSINESSES IN THE WASTE MANAGEMENT INDUSTRY—2009–10



Source: Waste Management Services, Australia, 2009-10 (ABS cat. no. 8698.0).

Note: Tpt. waste represents collection and transport of waste; Tpt. recyc. represents collection and transport of recyclables; Tpt. Green represents collection and transport of green waste; Landfill represents landfill operation; Transfer stn. the operation of a transfer station or waste depot ; Recyc/alt the operation of a recycling or alternative waste treatment facility; and Liq. treatment the treatment of liquid waste.

Producing an integrated measurement framework

The National Waste Policy 2010 identifies the need to produce a comprehensive nationally integrated system for identification, classification, collection, treatment, disposal and monitoring of hazardous substances and waste that aligns with international obligations.

This framework is required to:

- monitor amounts of hazardous waste and who is generating it

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

Producing an integrated measurement framework continued

- report the cost of managing hazardous waste and who bears this cost
- understand how hazardous waste is disposed of: domestic treatment, landfill or export

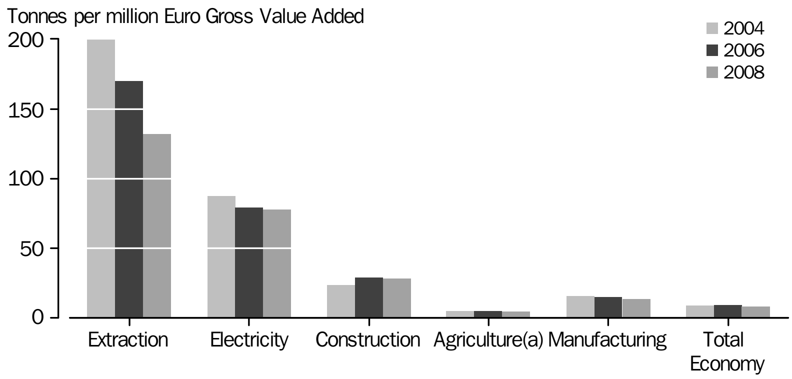
Better management of hazardous waste, including a reduction in the hazardous content of waste, is a central component of the National Waste Report[143]. In 2009, most (82%) households disposed of hazardous waste by including it with the usual (non–recycled) municipal garbage[144].

Using a waste account, the relationship between economic output and hazardous waste generation could be evaluated at an industry–level. Policy can be appropriately targeted at industries with high levels of hazardous waste generation, and/or increasing (or non–declining) hazardous waste intensity. By linking information on waste to the System of National Accounts aggregate, indicators of waste intensity can be produced (e.g. tonnes of waste per $million GDP).

EXAMPLE 1 OF EUROPEAN INTENSITIES ON HAZARDOUS WASTE BY INDUSTRY[145]

Data for Australia are not yet available but an example from the European Union is shown in Figure 8.6. It shows that hazardous waste generated per unit Gross Value Added is decreasing in the industries presented. This type of break–down of intensity by industry could assist policy makers targeting the reduction of hazardous waste generation. The high rate of hazardous waste generation by the mining and quarrying industry would appear to make it an important target for policies to reduce hazardous waste generation.

8.6 HAZARDOUS HAZERDOUS WASTE INTENSITIES, EU–27



(a) Includes Agriculture, Forestry and Fishing

Source: Eurostat, National Accounts and Environment Statistics, accessed 28/03/2012

Pursuing sustainability

A Waste account could monitor the levels of organic material going to landfill, and measure expenditure and revenue in relation to recovered organic material. It could also be integrated with greenhouse gas emissions accounts, water accounts and energy accounts to better assess overall 'sustainability'.

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143 *National Waste Policy 2010.* Department of Sustainability Environment Water Population and Communities.
144 *Environmental Issues: Waste Management and Transport Use, March 2009.* (cat. no. 4602.0.55.002).
145 Industry classification following the *Nomenclature statistique des activiés économiques dans la Communauté européenne* (NACE or the Statistical Classification of Economic Activities in the European Community)

Pursuing sustainability continued

Compilation of a waste account at regular intervals would provide a measure of the size and value of the waste "industry" and, in particular, help to identify and monitor the growth of the "recycling industry". Exports relating to recovered products would also be measured and allocated to the appropriate categories.

8.7 SELECTED ENVIRONMENTAL AND ECONOMIC DATA FOR THREE INDUSTRIES

Industry	*Gross Value Added*	*Water Use*	*Energy Use*	*Greenhouse Gas Emissions*	*Waste Generation*	*Recycling Rate*
	$M	ML	PJ	Mt CO_2(e)	kt	%
Agriculture, Forestry and Fishing	28 764	6 987 334	109	nya	nya	nya
Mining	96 105	489 313	543	nya	nya	nya
Manufacturing	107 707	658 312	1 034	nya	nya	nya

nya not yet available

Source: Table values taken from Australian National Accounts, Table 33 (ABS cat. no. 5206.0); Energy Account Australia (ABS cat. no. 4604.0); Water Account, Australia (ABS cat. no. 4610.0).

Figure 8.7 presents information on the use of natural resources along with information on the generation of greenhouse gas emissions and solid waste generation, to provide a broader picture of each industry's environmental impact. Where relative impact is important, indicators of intensity (i.e. relative to economic output) could also be derived, as shown in figure 8.8.

8.8 ENVIRONMENTAL INTENSITY MEASURES: DERIVED FROM FIGURE 8.7

Industry	*Water Intensity*	*Energy Intensity*	*Greenhouse Intensity*	*Waste Generation Intensity*	*Waste Landfill Intensity*
	L per $ of gross value added	MJ per $ of gross value added	tonnes of CO_2(e)	kg per $ of gross value added	kg to landfill per $ of gross value added
Agriculture, Forestry and Fishing	243.0	3.8	nya	nya	nya
Mining	5.1	5.7	nya	nya	nya
Manufacturing	6.1	9.6	nya	nya	nya

nya not yet available

Other related indicators, such as hazardous waste intensity or electricity consumption per unit of economic output, could be derived. The accounting framework affords flexibility to derive indicators and to combine data from different accounts. Tables such as expenditure on waste per $1000 of output for each industry could be aggregated. It is possible for waste intensity to decrease, while the absolute level of waste generation increases. While measures of intensity can be analytically valuable they must be considered in conjunction with the total amount of waste generation.

Extensions to waste accounts: Input–output analysis

A potential sophisticated use of a waste account would be an input–output analysis, whereby each industry's use of other industries' products is examined. Products may be consumed in the production of other goods and services, e.g. wood, glue and varnish may be used in making a table – this is termed intermediate consumption; or they may be used as final consumption by households, governments or not–for–profit institutions. Input–output analysis serves to distinguish between the two types of consumption and

Extensions to waste accounts: Input–output analysis continued

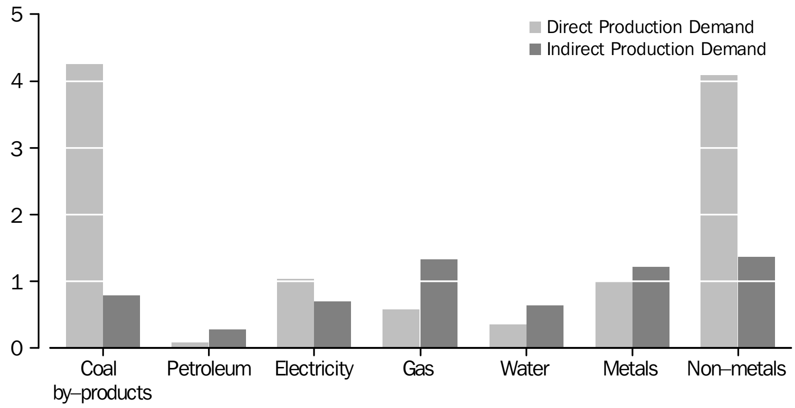
to trace total intermediate consumption in production of a good or service, since most goods and services use many goods and services that are themselves produced from other intermediate inputs. Applied to waste, input–output analysis may be used to distinguish the total waste generated through the supply chain in production of particular goods and services, or of particular industries.

For example, many different industries use waste collection and disposal services. More importantly, Input– output analysis also includes indirect usage, through goods 'embodied' in other goods they use, since waste generation may occur before the final stage of a manufacturing process or service delivery. Monetary input–output analysis is undertaken regularly by the ABS. A Waste Account would provide physical units of waste generation, which could be used as a basis for input–output analysis of waste generation (using mass units).

EXAMPLE 2: RESULTS OF A PHYSICAL INPUT–OUTPUT ANALYSIS IN PORTUGAL

Figure 8.9 shows waste generation – including indirect waste generation – by selected industries in Portugal, relative to their economic output. It shows that in some cases, e.g. the metals industry, a large majority of waste generation is indirect, i.e. it is generated in the manufacture of inputs to production. For example, a steelworks may not generate very large quantities of waste, but the extraction of ore and coal, and the manufacture of chemicals used as inputs to the production of steel by the steelworks all result in waste generation: waste from these activities would be included in the indirect figures below.

8.9 TONNES OF WASTE GENERATED PER MILLION ESCUADOS OF GVA—1992



Source: E.J.G. Barata, 2002. Solid waste generation and management in Portugal.

In summary, the SEEA framework provides a consistent structure for presenting data on waste. It allows the generation of waste and its treatment at materials recovery facilities or disposal at landfills to be analysed. Waste accounts also present monetary information in parallel with the physical (mass, tonnes) information: the costs of waste disposal and the economic structure of the waste industry. This facilitates analysis by policy makers and allows stakeholders to better understand who is generating, treating and disposing of waste as well as who bears the costs of waste treatment. Waste accounting, consistent

Extensions to waste accounts: Input–output analysis continued

EXAMPLE 2: RESULTS OF A PHYSICAL INPUT–OUTPUT ANALYSIS IN PORTUGAL *continued*

with the principles of the System of National Accounts ensures that the data are compiled in a way that is useful for economic modelling.

APPENDIX 1 TABLES

ENVIRONMENTAL ACCOUNTING TABLES

The preceding chapters provided an explanation of the SEEA and demonstrated how a range of public policy issues could be informed by environmental accounts. The set of tables included in this appendix represent the accounts themselves.

A range of Australian organisations produce environmental accounts. These include the Bureau of Meteorology (National Water Account and NPEI responsibilities), Department of Climate Change and Energy Efficiency (DCCEE) (GHG emissions accounts), Bureau of Resources and Energy Economics (BREE) (Energy Balances) and the Wentworth Group (Regional Accounts). While the degree varies, each of these accounts has links to the SEEA. In some cases there are relatively minor conceptual differences, in others the differences are more substantial and often due to particular legislative reasons.

A variety of environmental accounts have been compiled by the ABS. These accounts are at different stages of maturity and some accounts that have been compiled in the past, such as environment protection expenditure accounts, are no longer produced. Others, such as the natural resources on the National Balance Sheets, energy and water accounts are in regular annual production.

In some cases, such as for Water Accounts, the ABS undertakes substantial primary data collection activity to support the production of accounts. In other cases the ABS does not undertake the primary data collections. For example, in the case of the Energy and Greenhouse Gas Emission accounts (in development), the ABS reconfigures existing data from the energy balances compiled by the BREE, and emissions data collected by the DCCEE, to match with SEEA and SNA concepts.

The SEEA–based accounting tables presented here are by no means exhaustive. They do however illustrate the potential for an Australian System of Environmental–Economic Accounts (ASEEA) to provide an integrating framework for many types of environmental and economic information. Where possible, the tables have been populated with data. However in cases where no or limited information is currently available, an empty or partially filled table has been provided.

The tables in this appendix are organised using the same structure as the accounts in the SEEA framework.

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

LIST OF TABLES

STOCK ACCOUNTS continued

31. Metallic minerals stock account – physical (gt), Australia, 2001 to 2011

32. Non–metallic minerals stock account ($), Australia, 2001 to 2011

33. Non–metallic minerals stock account (megatonnes), Australia, 2001 to 2011

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34. Dynamic land cover by state and territory ('000 hectares), Australia, 2008

35. Land use by state and territory ('000 hectares), Australia, 2010

36. Experimental land cover account ('000 hectares), Murray–Darling Basin (MDB), pre–1750 to 2006

37. Experimental land cover by state and territory (hectares), Murray–Darling Basin (MDB), 2008

38. Experimental land cover by land use (hectares), Murray–Darling Basin (MDB), 2008

39. Experimental Forest Extent and Change (hectares), Murray–Darling Basin (MDB), 2008 and 2011

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40. Timber Resources stock account – physical (hectares, cubic metres), Australia, 2001 to 2010

41. Timber Resources stock account – monetary ($ billions), Australia, 2001 to 2010

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42. Aquatic Resources Stock Account – physical ('000 tonnes), Australia, 2001 to 2010

43. Aquatic Resources Stock Account – monetary ($ millions), Australia, 2001 to 2010 (Experimental)

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44. Carbon Stock Account, Australia – Illustrative only

ECOSYSTEM ACCOUNTS

45. Ecosystem asset account, Australia, 2010–2011 – Illustrative only

46. Ecosystem services account, Australia – Illustrative only

BIODIVERSITY

47. Status of native species, Australia, 2011

48. Biodiversity Asset Account, Australia, 2010–11

1 HYBRID ENVIRONMENTAL–ECONOMIC ACCOUNT, Australia—2010–11

				ELECTRICITY, GAS, WATER AND WASTE SERVICES			
	Agriculture	*Mining*	*Manufacturing*				
Physical measures							
Water consumption (GL) (a)	7 187	489	658	297	na	1 893	10
Energy use (PJ) (a)	109	543	1 034	146	na	(b)	(b)
Greenhouse gases emissions (Million tonnes of CO_2-E)	na	na	na	na	na	na	na
Water emissions (Million tonnes)	na	na	na	na	na	na	na
Solid waste generation (Million tonnes)	na	na	na	na	na	na	na
Monetary measures							
Output at basic prices ($ Millions)	na	na	na	na	na	na	na
Industry value added ($ Millions)	35 803	122 919	107 965	30 786	na	(b)	(b)
Taxes ($ Millions)	na	na	na	na	na	na	na
Environmental taxes	na	na	na	na	na	na	na
Subsidies ($ Millions)	na	na	na	na	na	na	na
Environmental subsidies	na	na	na	na	na	na	na
Intermediate consumption ($ Millions)	na	na	na	na	na	na	na
Purchase of water	na	na	na	na	na	na	na
Purchase of energy	na	na	na	na	na	na	na
Environmental protection air	na	na	na	na	na	na	na
Environmental protection water	na	na	na	na	na	na	na
Environmental protection solid waste	na	na	na	na	na	na	na
Consumption of fixed capital ($ Millions)	9 253	23 658	19 816	10 639	na	(b)	(b)
Depletion of environmental assets ($ Millions)	na	na	na	na	na	na	na
Assets ($ Millions)							
Produced assets	na	na	na	na	na	na	na
For water supply	na	na	na	na	na	na	na
For energy supply	na	na	na	na	na	na	na
For environmental protection	na	na	na	na	na	na	na
Financial assets	na	na	na	na	na	na	na
Environmental assets (a)	na	na	na	na	na	na	na

na not available

Note: (a) 2009–10 data.
(b) Included in Total Electricity and gas.

1 HYBRID ENVIRONMENTAL–ECONOMIC ACCOUNT, Australia—2010–11 *continued*

	Service industries	*Total industry*	*Rest of the world*	*Households*	*Government*	*Total*
Physical measures						
Water consumption (GL) (a)	1 075	11 609	na	1 868	na	13 476
Energy use (PJ) (a)	1 117	2 947	na	1 015	na	3 962
Greenhouse gases emissions (Million tonnes of CO_2-E)	na	na	na	na	na	na
Water emissions (Million tonnes)	na	na	na	na	na	na
Solid waste generation (Million tonnes)	na	na	na	na	na	na
Monetary measures						
Output at basic prices ($ Millions)	na	na	na	na	na	na
Industry value added ($ Millions)	892 205	1 189 679	na	109 606	na	1 299 285
Taxes ($ Millions)	na	na	na	na	na	357 917
Environmental taxes	na	na	na	na	na	na
Subsidies ($ Millions)	na	na	na	na	na	na
Environmental subsidies	na	na	na	na	na	na
Intermediate consumption ($ Millions)	na	na	na	na	na	na
Purchase of water	na	na	na	na	na	na
Purchase of energy	na	na	na	na	na	na
Environmental protection air	na	na	na	na	na	na
Environmental protection water	na	na	na	na	na	na
Environmental protection solid waste	na	na	na	na	na	na
Consumption of fixed capital ($ Millions)	97 847	217 294	na	na	na	217 294
Depletion of environmental assets ($ Millions)	na	na	na	na	na	–5 785
Assets ($ Millions)						
Produced assets	na	na	na	na	na	4 448 900
For water supply	na	na	na	na	na	na
For energy supply	na	na	na	na	na	na
For environmental protection	na	na	na	na	na	na
Financial assets	na	na	–781 100	na	na	–781 100
Environmental assets (a)	na	na	na	na	na	4 564 947

na not available

Note: (a) 2009–10 data.
(b) Included in Total Electricity and gas.

2 AUSTRALIAN NET SUPPLY OF ENERGY, Australia—2009–10

	Black coal	Brown coal	Briquettes	Coke	Coal by-products (a)	Natural gas	Crude oil and refinery feedstock
Supply by industry	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Agriculture, forestry and fishing	—	—	—	—	—	—	—
Mining	9 827	—	—	—	—	2 005	946
Manufacturing							
Food, beverages, textiles	—	—	—	—	—	—	—
Wood, paper, printing	—	—	—	—	—	—	—
Petroleum and chemical products	—	—	—	—	—	—	—
Iron and steel	—	—	—	—	—	—	—
Non-ferrous metals	—	—	—	—	—	—	—
Other manufacturing	—	—	—	—	—	—	—
Total Manufacturing	—	—	—	—	—	—	—
Electricity, gas, water and waste	—	744	—	—	—	—	—
Construction	—	—	—	—	—	—	—
Transport							
Road	—	—	—	—	—	—	—
Rail	—	—	—	—	—	—	—
Air	—	—	—	—	—	—	—
Water	—	—	—	—	—	—	—
Total Transport	—	—	—	—	—	—	—
Commercial services							
Wholesale and retail trade	—	—	—	—	—	—	—
Accommodation(b)	—	—	—	—	—	—	—
Communication(c)	—	—	—	—	—	—	—
Other(d)(e)	—	—	—	—	—	—	—
Total Commercial and services	—	—	—	—	—	—	—
Total supply by industry	9 827	744	—	—	—	2 005	946
Supply by households	—	—	—	—	—	—	—
Imports	—	—	—	—	—	226	1 056
Net supply	9 827	744	—	—	—	2 231	2 002

— nil or rounded to zero (including null cells)

(a) Includes blast furnace gas, coal tar, benzene/toluene/xylene feedstock and coke oven gas.

(b) Includes Accommodation and food services.

(c) Includes Information media and telecommunications, Financial and insurance services, Rental, hiring and real estate services, Professional, scientific and technical services.

(d) Includes Administrative and support services, Public administration and safety, Education and training, Health care and social assistance, Arts and recreational services, Other services.

(e) Includes General government.

Note: Any discrepancies between totals and sums of components in this publication are due to rounding.

Source: Energy Account, Australia, 2009–10 (cat. no. 4604.0)

2 AUSTRALIAN NET SUPPLY OF ENERGY, Australia—2009–10 *continued*

	Petrol	Diesel	Other refined fuels and products(a)	LPG	Biofuels	Wood and wood waste	Bagasse
Supply by industry	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Agriculture, forestry and fishing	—	—	—	—	—	45	—
Mining	—	—	—	111	—	—	—
Manufacturing							
Food, beverages, textiles	—	—	—	—	—	—	88
Wood, paper, printing	—	—	—	—	—	29	—
Petroleum and chemical products	—	—	—	—	11	—	—
Iron and steel	—	—	—	—	—	—	—
Non-ferrous metals	—	—	—	—	—	—	—
Other manufacturing	—	—	—	—	—	—	—
Total Manufacturing	—	—	—	—	11	26	88
Electricity, gas, water and waste	—	—	—	—	10	—	—
Construction	—	—	—	—	—	—	—
Transport							
Road	—	—	—	—	—	—	—
Rail	—	—	—	—	—	—	—
Air	—	—	—	—	—	—	—
Water	—	—	—	—	—	—	—
Other transport, storage and services	—	—	—	—	—	—	—
Total Transport	—	—	—	—	—	—	—
Commercial services							
Wholesale and retail trade	—	—	—	—	—	—	—
Accommodation(b)	—	—	—	—	—	—	—
Communication(c)	—	—	—	—	—	—	—
Other(d)(e)	—	—	—	—	—	—	—
Total Commercial and services	—	—	—	—	—	—	—
Total supply by industry	—	—	—	111	21	74	88
Supply by households	—	—	—	—	—	29	—
Imports	132	335	236	29	—	—	—
Net supply	132	335	236	139	21	103	88

— nil or rounded to zero (including null cells)

(a) Excludes non-fuel petroleum products such as bitumen, lubricants, solvents and greases.

(b) Includes Accommodation and food services.

(c) Includes Information media and telecommunications, Financial and insurance services, Rental, hiring and real estate services, Professional, scientific and technical services.

(d) Includes Administrative and support services, Public administration and safety, Education and training, Health care and social assistance, Arts and recreational services, Other services.

(e) Includes General government.

Note: Any discrepancies between totals and sums of components in this publication are due to rounding.

Source: Energy Account, Australia, 2009–10 (cat. no. 4604.0)

2 AUSTRALIAN NET SUPPLY OF ENERGY, Australia—2009–10 *continued*

	Electricity	*Hydro energy*	*Solar energy*(a)	*Wind energy*	*Uranium*	*Total*
Supply by industry	PJ	PJ	PJ	PJ	PJ	PJ
Agriculture, forestry and fishing	—	—	—	—	—	45
Mining	—	—	—	—	3 363	16 252
Manufacturing						
Food, beverages, textiles	—	—	—	—	—	88
Wood, paper, printing	—	—	—	—	—	29
Petroleum and chemical products	—	—	—	—	—	11
Iron and steel	—	—	—	—	—	—
Non-ferrous metals	—	—	—	—	—	—
Other manufacturing	—	—	—	—	—	—
Total Manufacturing	—	—	—	—	—	128
Electricity, gas, water and waste	—	45	1	17	—	818
Construction	—	—	—	—	—	—
Transport						
Road	—	—	—	—	—	—
Rail	—	—	—	—	—	—
Air	—	—	—	—	—	—
Water	—	—	—	—	—	—
Other transport, storage and services	—	—	—	—	—	—
Total Transport	—	—	—	—	—	—
Commercial services						
Wholesale and retail trade	—	—	—	—	—	—
Accommodation(b)	—	—	—	—	—	—
Communication(c)	—	—	—	—	—	—
Other(d)(e)	—	—	—	—	—	—
Total Commercial and services	—	—	—	—	—	—
Total supply by industry	—	45	1	17	3 363	17 243
Supply by households	—	—	10	—	—	39
Imports	—	—	—	—	—	2 014
Net supply	—	45	11	17	3 363	19 296

— nil or rounded to zero (including null cells)
(a) Includes solar electricity and solar hot water.
(b) Includes Accommodation and food services.
(c) Includes Information media and telecommunications, Financial and insurance services, Rental, hiring and real estate services, Professional, scientific and technical services.
(d) Includes Administrative and support services, Public administration and safety, Education and training, Health care and social assistance, Arts and recreational services, Other services.
(e) Includes General government.

Note: Any discrepancies between totals and sums of components in this publication are due to rounding.

Source: Energy Account, Australia, 2009–10 (cat. no. 4604.0)

3 AUSTRALIAN NET USE OF ENERGY, Australia—2009–10

	Black coal	Brown coal	Briquettes	Coke	Coal by-products (a)	Natural gas	Crude oil and refinery feedstock
Net use by industry	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Agriculture, forestry and fishing	—	—	—	—	—	—	—
Mining	4	—	—	—	—	314	—
Manufacturing							
Food, beverages, textiles	12	—	3	—	3	36	—
Wood, paper, printing	4	—	—	—	—	25	—
Petroleum and chemical products	6	—	—	1	1	119	37
Iron and steel	1	—	—	2	30	27	—
Non-ferrous metals	50	—	—	3	1	122	—
Other manufacturing	27	—	—	—	—	70	—
Total Manufacturing	99	—	3	6	34	399	37
Electricity, gas, water and waste	—	—	—	—	—	14	—
Construction	—	—	—	—	—	3	—
Transport							
Road	—	—	—	—	—	2	—
Rail	—	—	—	—	—	—	—
Air	—	—	—	—	—	—	—
Water	—	—	—	—	—	—	—
Other transport, storage and services	—	—	—	—	—	18	—
Total Transport	—	—	—	—	—	20	—
Commercial and services							
Wholesale and retail trade	—	—	—	—	—	5	—
Accommodation(b)	—	—	—	—	—	17	—
Communication(c)	—	—	—	—	—	9	—
Other(d)(e)	—	—	—	—	—	17	—
Total Commercial and services	—	—	1	—	—	48	—
Total net use by industry	104	—	4	6	34	798	37
Net use by households	—	—	—	—	—	144	—
Inventory changes	11	2	—	2	–1	–113	–93
Exports	8 327	—	—	—	—	972	668
Conversions and losses(f)	1 387	742	–4	–8	–34	429	1 390
Total net use(g)	8 443	2	4	8	34	1 801	613

— nil or rounded to zero (including null cells)
(a) Includes blast furnace gas, coal tar, benzene/toluene/xylene feedstock and coke oven gas.
(b) Includes Accommodation and food services.
(c) Includes Information media and telecommunications, Financial and insurance services, Rental, hiring and real estate services, Professional, scientific and technical services.
(d) Includes Administrative and support services, Public administration and safety, Education and training, Health care and social assistance, Arts and recreational services, Other services.
(e) Includes General government.
(f) Negative numbers indicate net production of fuels.
(g) Net use of individual energy products do not sum to total energy use due to exclusion of conversions

Note: Any discrepancies between totals and sums of components in this publication are due to rounding.

Source: Energy Account, Australia, 2009–10 (cat. no. 4604.0)

3 AUSTRALIAN NET USE OF ENERGY, Australia—2009–10 *continued*

	Petrol	Diesel	Other refined fuels and products(a)	LPG	Biofuels	Wood and wood waste	Bagasse
Net use by industry	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Agriculture, forestry and fishing	7	92	—	2	—	—	—
Mining	2	147	8	3	1	—	—
Manufacturing							
Food, beverages, textiles	3	6	1	4	—	2	34
Wood, paper, printing	2	4	—	1	1	29	—
Petroleum and chemical products	2	2	27	1	—	—	2
Iron and steel	—	1	1	—	—	—	—
Non-ferrous metals	—	3	51	—	—	1	—
Other manufacturing	9	16	4	3	1	1	—
Total Manufacturing	17	33	85	9	2	34	35
Electricity, gas, water and waste	3	9	—	—	—	—	—
Construction	39	96	1	5	—	—	—
Transport							
Road	4	153	—	5	8	—	—
Rail	—	29	—	—	—	—	—
Air	2	—	246	—	—	—	—
Water	—	2	33	—	—	—	—
Other transport, storage and services	4	18	—	6	—	—	—
Total Transport	10	202	279	11	8	—	—
Commercial and services							
Wholesale and retail trade	33	25	—	3	—	—	—
Accommodation(b)	4	1	—	7	—	—	—
Communication(c)	30	18	—	3	—	—	—
Other(d)(e)	26	18	—	4	—	—	—
Total Commercial and services	93	63	—	17	—	1	—
Total net use by industry	170	642	373	48	10	34	35
Net use by households	457	82	—	47	—	57	—
Inventory changes	14	11	8	14	—	—	—
Exports	8	7	94	75	—	—	—
Conversions and losses(f)	–517	–408	–238	–45	11	12	53
Total net use(g)	649	743	474	184	10	92	35

— nil or rounded to zero (including null cells)
(a) Excludes non-fuel petroleum products such as bitumen, lubricants, solvents and greases.
(b) Includes Accommodation and food services.
(c) Includes Information media and telecommunications, Financial and insurance services, Rental, hiring and real estate services, Professional, scientific and technical services.
(d) Includes Administrative and support services, Public administration and safety, Education and training, Health care and social assistance, Arts and recreational services, Other services.
(e) Includes General government.
(f) Negative numbers indicate net production of fuels.
(g) Net use of individual energy products do not sum to total energy use due to exclusion of conversions

Note: Any discrepancies between totals and sums of components in this publication are due to rounding.

Source: Energy Account, Australia, 2009–10 (cat. no. 4604.0)

3 AUSTRALIAN NET USE OF ENERGY, Australia—2009–10 *continued*

	Electricity	Hydro energy	Solar energy(a)	Wind energy	Uranium	Total
Net use by industry	PJ	PJ	PJ	PJ	PJ	PJ
Agriculture, forestry and fishing	8	—	—	—	—	109
Mining	64	—	—	—	—	543
Manufacturing						
Food, beverages, textiles	22	—	—	—	—	125
Wood, paper, printing	18	—	—	—	—	84
Petroleum and chemical products	24	—	—	—	—	222
Iron and steel	14	—	—	—	—	75
Non-ferrous metals	133	—	—	—	—	365
Other manufacturing	31	—	—	—	—	163
Total Manufacturing	241	—	—	—	—	1 034
Electricity, gas, water and waste	121	—	—	—	—	146
Construction	—	—	—	—	—	144
Transport						
Road	—	—	—	—	—	171
Rail	8	—	—	—	—	38
Air	—	—	—	—	—	247
Water	—	—	—	—	—	36
Other transport, storage and services	5	—	—	—	—	51
Total Transport	14	—	—	—	—	544
Commercial and services						
Wholesale and retail trade	54	—	—	—	—	121
Accommodation(b)	27	—	—	—	—	57
Communication(c)	77	—	—	—	—	137
Other(d)(e)	47	—	—	—	—	114
Total Commercial and services	206	—	—	—	—	429
Total net use by industry	653	—	—	—	—	2 947
Net use by households	217	—	10	—	—	1 015
Inventory changes	—	—	—	—	–188	–331
Exports	—	—	—	—	3 551	13 702
Conversions and losses(f)	–870	45	1	17	—	1 963
Total net use(g)	870	—	10	—	3 363	19 296

— nil or rounded to zero (including null cells)
(a) Includes solar electricity and solar hot water.
(b) Includes Accommodation and food services.
(c) Includes Information media and telecommunications, Financial and insurance services, Rental, hiring and real estate services, Professional, scientific and technical services.
(d) Includes Administrative and support services, Public administration and safety, Education and training, Health care and social assistance, Arts and recreational services, Other services.
(e) Includes General government.
(f) Negative numbers indicate net production of fuels.
(g) Net use of individual energy products do not sum to total energy use due to exclusion of conversions

Note: Any discrepancies between totals and sums of components in this publication are due to rounding.

Source: Energy Account, Australia, 2009–10 (cat. no. 4604.0)

4 WATER SUPPLY, Australia—2009–10

	SUPPLY			
	Self-extracted	*Distributed*	*Reuse*	*Regulated discharge*
	ML	ML	ML	ML
Agriculture, forestry and fishing				
Agriculture				
Nursery and floriculture production	—	—	—	—
Mushroom and vegetable growing	—	—	—	—
Fruit and tree nut growing	—	—	—	—
Sheep, beef cattle and grain farming	—	—	—	—
Other crop growing	—	—	—	—
Dairy cattle farming	—	—	—	—
Poultry farming	—	—	—	—
Deer farming	—	—	—	—
Other livestock farming	—	—	—	—
Total	—	—	—	—
Aquaculture	—	—	—	370 709
Forestry and logging	—	—	—	—
Fishing, hunting and trapping	—	—	—	—
Agriculture, forestry and fishing support services	—	—	—	—
Mining				
Coal Mining	—	6 470	np	41 758
Oil and Gas Extraction	—	883	np	57 574
Metal Ore Mining	—	np	np	149 173
Non-Metallic Mineral Mining & Quarrying	—	96	np	6 478
Exploration and Other Mining Support Services	—	np	np	22 700
Total	—	21 099	np	277 683
Manufacturing				
Food, Beverage and Tobacco Product	—	5 532	np	62 894
Textile, Leather, Clothing and Footwear	—	—	np	1 387
Wood, Pulp, Paper and Converted Paper Product	—	—	np	52 209
Printing (incl. the Reproduction of Recorded Media)	—	—	np	137
Petroleum, Coal, Basic Chemical and Chemical Product	—	np	np	23 208
Polymer, Rubber and Non-Metallic Mineral Product	—	—	np	4 703
Primary Metal, Metal and Fabricated Metal Product	—	np	np	54 861
Transport Equipment, Machinery and Equipment	—	1	np	70
Furniture and Other	—	—	np	8
Total	—	13 108	np	199 478
Electricity, gas, water and waste services				
Electricity and gas supply	—	253 691	np	49 470 540
Water supply, sewerage and drainage services	—	9 117 444	373 987	1 593 494
Waste collection, treatment and disposal services	—	—	np	—
Other industries	—	—	np	—
Environment	64 076 308	—	—	—
Total	**64 076 308**	**9 405 342**	**373 987**	**51 911 904**

— nil or rounded to zero (including null cells)

np not available for publication but included in totals where applicable, unless otherwise indicated

Source: Water Account, Australia, 2009–10, (cat. no. 4610.0)

5 WATER USE, Australia—2009–10

	Self-extracted	Distributed	Reuse	In-stream use	Consumption
	ML	ML	ML	ML	ML
Agriculture, forestry and fishing					
Agriculture					
Nursery and floriculture production	23 333	32 838	4 385	—	60 555
Mushroom and vegetable growing	283 952	139 746	15 361	—	439 059
Fruit and tree nut growing	327 075	777 709	11 098	—	1 115 883
Sheep, beef cattle and grain farming	1 339 271	1 255 805	53 553	—	2 648 630
Other crop growing	630 587	759 299	19 303	—	1 409 189
Dairy cattle farming	551 353	644 096	20 229	—	1 215 678
Poultry farming	np	9 703	np	—	16 644
Deer farming	np	350	np	—	574
Other livestock farming	51 984	26 966	2 172	—	81 122
Total	3 214 660	3 646 514	126 160	—	6 987 334
Aquaculture	371 654	959	27	370 709	1 931
Forestry and logging	2 208	74 181	3 033	—	79 422
Fishing, hunting and trapping	2 501	1 491	—	—	3 991
Agriculture, forestry and fishing support services	62 195	52 288	271	—	114 755
Mining					
Coal Mining	92 643	21 011	926	32 323	75 787
Oil and Gas Extraction	78 762	1 126	—	45 461	33 545
Metal Ore Mining	387 210	np	8 120	125 550	299 499
Non-Metallic Mineral Mining & Quarrying	34 748	3 580	6	2 091	36 146
Exploration and Other Mining Support Services	65 110	np	5	21 223	44 336
Total	658 474	69 530	9 057	226 648	489 313
Manufacturing					
Food, Beverage and Tobacco Product	154 975	144 328	7 046	49	300 767
Textile, Leather, Clothing and Footwear	1 061	10 231	950	1	12 242
Wood, Pulp, Paper and Converted Paper Product	np	39 420	np	—	80 951
Printing (incl. the Reproduction of Recorded Media)	6	4 337	3	—	4 346
Petroleum, Coal, Basic Chemical and Chemical Product	30 741	49 244	np	5 569	77 462
Polymer, Rubber and Non-Metallic Mineral Product	np	22 115	648	np	32 804
Primary Metal, Metal and Fabricated Metal Product	83 369	52 588	12 896	np	139 408
Transport Equipment, Machinery and Equipment	707	8 324	285	—	9 316
Total	323 270	331 571	29 990	13 411	658 312
Electricity, gas, water and waste services					
Electricity and gas supply	49 793 040	379 604	19 721	49 642 147	296 527
Water supply, sewerage and drainage services	9 117 444	2 445 182	104 630	656 922	1 892 890
Waste collection, treatment and disposal services	6 760	2 841	1	—	9 603
Other industries	326 762	734 006	77 990	64 063	1 074 695
Household	197 340	1 667 175	3 106	—	1 867 621
Environment	—	np	np	—	—
Total	**64 076 308**	**9 405 342**	**373 987**	**50 973 900**	**13 476 395**

— nil or rounded to zero (including null cells)

np not available for publication but included in totals where applicable, unless otherwise indicated

Source: Water Account, Australia, 2009–10, (cat. no. 4610.0)

6 REVENUE–FROM NET WATER SALES AND SERVICES, by industry, Australia(a)—2009–10

	DISTRIBUTED WATER(b)		BULK WATER		TOTAL WATER SUPPLIED	SERVICES(c)	TOTAL REVENUE EARNED
	Urban	*Rural*	*Urban*	*Rural*			
	$m	$m	$m	$m	$m	$m	$m
Agriculture, forestry and fishing	—	—	—	—	—	—	—
Mining	na	—	—	—	—	—	—
Manufacturing	na	—	—	—	—	—	—
Electricity, gas and waste	na	—	—	—	—	—	—
Water supply(d)	5 491	339	1 077	31	6 938	5 519	12 457
Other industries	—	—	—	—	—	—	—
Imports	—	—	—	—	—	—	20
Taxes	—	—	—	—	—	—	107
Subsidies	—	—	—	—	—	—	–64
Trade and transport margins	—	—	—	—	—	—	—
Total supply(a)	**5 491**	**339**	**1 077**	**31**	**6 938**	**5 519**	**12 521**

— nil or rounded to zero (including null cells)
na not available
(a) At purchaser's price.
(b) Includes reuse water.
(c) Wastewater, sewerage and drainage services.
(d) Includes sewerage and drainage services industry.
Source: Water Account, Australia, 2009–10 (ABS cat. no. 4610.0)

7 EXPENDITURE–RELATED SERVICES, by industry, Australia(a)—2009—10

	DISTRIBUTED WATER(b)		BULK WATER(c)	TOTAL WATER SUPPLIED	SERVICES(d)	TOTAL USE
	Urban	*Rural*				
	$m	$m	$m	$m	$m	$m
Intermediate consumption						
Agriculture, forestry and fishing	51	309	—	359	2	362
Mining	99	—	—	99	11	110
Manufacturing	364	—	—	364	411	775
Electricity, gas, water and waste(e)	104	—	1 115	1 218	15	1 233
Electricity generation	71	—	—	71	3	74
Water supply, sewerage and drainage	—	—	1 115	1 115	—	1 115
Other industries	1 423	—	—	1 423	1 350	2 773
Total intermediate consumption	2 041	309	1 115	3 464	1 789	5 253
Final consumption						
Final consumption by households(f)	3 488	—	—	3 488	3 769	7 256
Final consumption by Government	—	—	—	—	—	—
Total final consumption	3 488	—	—	3 488	3 769	7 256
Exports	na	na	na	na	na	11
Total use	—	—	—	—	—	12 521

— nil or rounded to zero (including null cells)
na not available
(a) At purchaser's prices.
(b) Includes reuse water.
(c) Includes urban and rural.
(d) Wastewater, sewerage and drainage services.
(e) Includes all industries in Electricity, gas, water and waste services not elsewhere classified.
(f) Includes social benefits paid in kind by Governments.

Source: Water Account, Australia, 2009–10 (ABS cat. no. 4610.0)

8 WATER SUPPLY AND USE (MEGALITRES), Murray–Darling Basin—2009–10

	SUPPLY			
	Self–extracted	*Distributed*	*Reuse*	*Regulated discharge*
	ML	ML	ML	ML
Agriculture, forestry and fishing	0	0	0	1 066
Agriculture				
Nursery and floriculture production	0	0	0	na
Mushroom and vegetable growing	0	0	0	na
Fruit and tree nut growing	0	0	0	na
Sheep, beef cattle and grain farming	0	0	0	na
Other crop growing	0	0	0	na
Dairy cattle farming	0	0	0	na
Poultry farming	0	0	0	na
Deer farming	0	0	0	na
Other livestock farming	0	0	0	na
Total	0	0	0	na
Aquaculture	0	0	0	1 066
Forestry and logging	0	0	0	0
Fishing, hunting and trapping	0	0	0	0
Agriculture, forestry and fishing support services	0	0	0	0
Mining	0	np	np	3 257
Manufacturing	0	np	np	10 511
Electricity, gas, water and waste services	0	4 566 778	130 412	11 085 922
Electricity and gas supply	0	11 600	0	10 759 396
Water supply, sewerage and drainage services	0	4 555 178	130 412	326 526
Waste collection, treatment and disposal services	0	0	na	na
Other industries	0	0	na	na
Household	0	0	0	0
Environment	16 600 874	0	0	0
Total	16 600 874	4 573 122	130 412	11 100 756

na not available

np not available for publication but included in totals where applicable, unless otherwise indicated

Source: Water Account, Australia, 2009–10 (ABS cat. no. 4610.0)

8 WATER SUPPLY AND USE (MEGALITRES), Murray–Darling Basin—2009–10 *continued*

	USE				
	Self–extracted	*Distributed*	*Reuse*	*In–stream use*	*Consumption*
	ML	ML	ML	ML	ML
Agriculture, forestry and fishing	1 149 667	2 765 469	57 571	1 066	3 971 641
Agriculture					
Nursery and floriculture production	3 847	10 531	211	0	14 589
Mushroom and vegetable growing	79 178	72 854	1 617	0	153 648
Fruit and tree nut growing	94 318	783 075	1 468	0	878 860
Sheep, beef cattle and grain farming	587 176	1 006 953	33 796	0	1 627 925
Other crop growing	196 229	376 656	13 417	0	586 302
Dairy cattle farming	151 838	447 620	5 896	0	605 354
Poultry farming	np	np	np	0	4 582
Deer farming	np	np	np	0	96
Other livestock farming	12 807	21 190	642	0	34 639
Total	1 127 068	2 721 864	57 064	0	3 905 996
Aquaculture	1 097	982	18	1 066	1 031
Forestry and logging	30	1 372	0	0	1 402
Fishing, hunting and trapping	178	98	0	0	276
Agriculture, forestry and fishing support services	21 294	41 153	489	0	62 936
Mining	49 110	5 855	np	np	42 612
Manufacturing	36 732	20 010	np	np	56 524
Electricity, gas, water and waste services	15 315 305	1 525 063	51 907	11 018 859	1 306 637
Electricity and gas supply	10 760 076	11 648	0	10 759 396	728
Water supply, sewerage and drainage services	4 555 178	1 513 391	51 907	259 463	1 305 835
Waste collection, treatment and disposal services	51	24	0	0	74
Other industries	38 387	83 568	11 334	0	133 289
Household	11 675	173 158	16	0	184 848
Environment	0	np	np	0	0
Total	16 600 874	4 573 122	130 412	11 035 733	5 695 552

np not available for publication but included in totals where applicable, unless otherwise indicated

Source: Water Account, Australia, 2009–10 (ABS cat. no. 4610.0)

9 WATER SUPPLY AND USE ($ MILLIONS), Murray–Darling Basin—2009–10 (Experimental)

	SUPPLY					
	Urban distributed water ($m)	Rural distributed water ($m)	Bulk water (urban and rural) ($m)	Total supply of water ($m)	Waste water & Sewerage ($m)	Total revenue from water and services ($m)
Agriculture, Forestry & Fishing	—	—	—	—	—	—
Mining	na	—	—	—	—	—
Manufacturing	na	—	—	—	—	na
Electricity, gas, water and waste	645	222	70	937	487	1 424
Electricity generation	na	—	—	—	—	na
Water supply, Sewerage & Drainage	645	222	70	937	487	1 424
Other industries	—	—	—	—	—	—
Total Industries	645	222	70	937	487	1 424
Final consumption by households	—	—	—	—	—	—
Final consumption by governments	—	—	—	—	—	—
Total final consumption	—	—	—	—	—	—
Total @ basic prices	645	222	70	937	487	1 424

	USE					
	Urban distributed water ($m)	Rural distributed water ($m)	Bulk water (urban and rural) ($m)	Total expenditure on water	Total expenditure on Waste water & Sewerage ($m)	Total expenditure on water and services
Agriculture, Forestry & Fishing	58	222	—	280	—	280
Mining	14	—	—	14	1	15
Manufacturing	34	—	—	34	58	92
Electricity, gas, water and waste	12	—	70	82	1	83
Electricity generation	12	—	—	12	1	13
Water supply, Sewerage & Drainage	—	—	70	70	—	70
Other industries	185	—	na	185	90	275
Total Industries	302	222	70	594	151	745
Final consumption by households	343	—	—	343	336	679
Final consumption by governments	—	—	—	—	—	—
Total final consumption	343	—	—	343	336	679
Total @ basic prices	645	222	70	937	487	1 424

— nil or rounded to zero (including null cells)

na not available

Note: For the methodology, see: http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4610.0Explanatory%20Notes12009-10?OpenDocument.

Source: New estimates based on the ABS Water Account, 2009–10 (cat no. 4610.0).

10 DIRECT GREENHOUSE GAS EMISSIONS–ENVIRONMENTAL ACCOUNTS BASIS, (Mt CO_2-e)

	GREENHOUSE GAS EMISSIONS (MT CO_2-E)					
	2003-04	*2004-05*	*2005-06*	*2006-07*	*2007-08*	*2008-09*
Emissions by industries-						
Agriculture, forestry and fishing						
Mining						
Coal mining						
Oil and gas extraction						
Other mining						
Total mining						
Manufacturing						
Food, beverages and tobacco						
Wood, paper and printing						
Petroleum, coal and chemical products						
Non-metalic mineral products						
Metal products						
Other manufacturing						
Total manufacturing						
Electricity, gas, water and waste services						
Construction						
Transport						
Road						
Other transport						
Commercial and services						
Total emissions by industries						
Emissions by households						
Transport						
Non-transport						
Total emissions by households						
Total emissions - environmental accounts basis						
Reconciliation with Kyoto Protocol accounting -						
Emissions on Kyoto Protocol basis						
plus Emissions from international transportation						
plus Net emissions by travellers abroad						
plus CO_2 emissions from biomass						
plus Afforestation and reforestation offsets						
equals emission on environmental accounts basis						

Note: (1) The environmental accounts basis has a wider scope and some different accounting treatments to the Kyoto Protocol accounting to align it with the concepts in the national accounts. A reconciliation between the two accounting approaches is provided at the bottom of the table.(2) Bagasse, wood and wood waste combusted as fuel. (3) Kyoto Protocol Accounting allows for the annual binding of CO2 in planting of new areas of forest and reforestation to be recorded as an offset to emissions. The environmental accounts record actual emissions gross of any offsets. This only affects Australian data for the commitment period (2008–2012).
This table is intentionally left blank and is included for illustrative purposes only.

11 DIRECT AND INDIRECT GREENHOUSE GAS EMISSIONS INDUCED BY FINAL USE, (Mt CO_2-e)

	Household and Government Final Consumption	*Investment*	*Total domestic use*	*Exports*	*Total use*
Indirect emissions-					
Agriculture, forestry and fishing					
Mining					
Manufacturing					
Food, beverages and tobacco					
Wood, paper and printing					
Petroleum, coal and chemical products					
Non-metalic mineral products					
Metal products					
Other manufacturing					
Total manufacturing					
Electricity, gas, water and waste services					
Construction					
Transport					
Road					
Other transport					
Commercial and services					
Total indirect emissions					
Direct emissions by households					
Total direct and indirect emissions					

Note: This table is intentionally left blank and is included for illustrative purposes only.

12 WASTE SUPPLY–GENERATED (TONNES), Australia

	GENERATION OF SOLID WASTE								
	Manufacturing	*Mining*	*Construction*	*Waste Management*	*Other Industries*	*General Government*	*Households*	*Imports of Solid Waste*	*Total Supply*
Paper & Cardboard									
Glass									
Plastics									
Metals									
Organics									
Construction									
Demolition									
Electrical & Electronic									
Solid Hazardous Waste									
Liquid Waste									
Mixed/General									
Total									

Note: This table is intentionally left blank and is included for illustrative purposes only.

13 WASTE USE–MANAGEMENT (AMOUNTS USED/TREATED/DISPOSED–USE (TONNES)), Australia

	WASTE MANAGEMENT		OTHER INDUSTRIES					
	Landfill	*Recovery facility*	*Manufacturing*	*Mining*	*Construction*	*Other*	*Exports of solid waste*	*Total use*
Paper & cardboard								
Glass								
Plastics								
Metals								
Organics								
Construction								
Demolition								
Electrical & electronic								
Solid hazardous waste								
Liquid waste								
Mixed/general								
Total								

Note: This table is intentionally left blank and is included for illustrative purposes only.

14 SUPPLY OF WASTE SERVICES AND RECOVERED PRODUCTS ($), Australia

	INDUSTRIES			
	Waste Management	*Manufacturing*	*Mining*	*Construction*
Non–recyclable waste services				
Recyclable waste services				
Total waste services				
Recyclable / recoverable material				
Paper & cardboard				
Organic material				
Other				
Total recyclable / recoverable material				

Note: This table is intentionally left blank and is included for illustrative purposes only.

	INDUSTRIES *continued*				
	Other Industries	*Total Industries*	*Local Government*	*Imports*	*Total supply*
Non–recyclable waste services					
Recyclable waste services					
Total waste services					
Recyclable / recoverable material					
Paper & cardboard					
Organic material					
Other					
Total recyclable / recoverable material					

Note: This table is intentionally left blank and is included for illustrative purposes only.

15 USE OF WASTE SERVICES AND RECOVERED PRODUCTS ($), Australia

	INDUSTRIES			
	Waste Management	*Manufacturing*	*Mining*	*Construction*
Non-recyclable waste services				
Recyclable waste services				
Total waste services				
Recyclable/ recoverable material				
Paper & cardboard				
Organic material				
Other				
Total recyclable/ recoverable material				

Note: This table is intentionally left blank and is included for illustrative purposes only.

	INDUSTRIES *continued*					
	Other Industries	*Total Industries*	*Government*	*Households*	*Exports*	*Total use*
Non-recyclable waste services						
Recyclable waste services						
Total waste services						
Recyclable/ recoverable material						
Paper & cardboard						
Organic material						
Other						
Total recyclable/ recoverable material						

Note: This table is intentionally left blank and is included for illustrative purposes only.

16 PRODUCTION OF ENVIRONMENTAL PROTECTION SERVICES ($), Australia

	Label	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
Output of environmenta protection services	A												
Intermediate consumption	B=C+D												
–Environmental protection specific services	C												
–Other goods and services	D												
Gross Value Added	E=A-B												
Compensation of employees	F												
Taxes less subsidies on production	G												
Consumption of Fixed Capital (i.e. depreciation)	H												
Net Operating Surplus	I=E-F-G-H=(A-B)-F-G-H												

Note: This table would be produced for each of the domains: air protection; climate protection; waste water; solid waste; soil, groundwater and surface water; biodiversity and landscape; research and development for environmental protection; and resource management.
This table is intentionally left blank and is included for illustrative purposes only.

17 SUPPLY AND USE OF ENVIRONMENTAL PROTECTION SPECIFIC SERVICES ($), Australia

	Item Label & Derivation	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
SUPPLY							
Output at Basic Prices	A						
Taxes less subsidies on products	B						
Trade and Transport Margins	C						
Output at Purchasers' Prices	D = A+B+C						
Imports	E						
Total Supply	F=D+E=(A+B+C)+E						
USE							
Specialist Producers							
Non–specialist producers							
Households & not-for-profit institutions							
Government							
Gross fixed capital formation							
Exports							
Total Use							

Note: This table would be produced for each of the domains: air protection; climate protection; waste water; solid waste; soil, groundwater and surface water; biodiversity and landscape; research and development for environmental protection; and resource management.
This table is intentionally left blank and is included for illustrative purposes only.

17 SUPPLY AND USE OF ENVIRONMENTAL PROTECTION SPECIFIC SERVICES ($), Australia *continued*

	2006	2007	2008	2009	2010	2011
SUPPLY						
Output at Basic Prices						
Taxes less subsidies on products						
Trade and Transport Margins						
Output at Purchasers' Prices						
Imports						
Total Supply						
USE						
Specialist Producers						
Non–specialist producers						
Households & not-for-profit institutions						
Government						
Gross fixed capital formation						
Exports						
Total Use						

Note: This table would be produced for each of the domains: air protection; climate protection; waste water; solid waste; soil, groundwater and surface water; biodiversity and landscape; research and development for environmental protection; and resource management.
This table is intentionally left blank and is included for illustrative purposes only.

18 TOTAL EXPENDITURE ON ENVIRONMENTAL PROTECTION

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Environmental protection specific services												
Intermediate Consumption												
Final Consumption												
Gross fixed capital formation												
Connected Products												
Intermediate Consumption												
Final Consumption												
Gross fixed capital formation												
Adapted Goods												
Intermediate Consumption												
Final Consumption												
Gross fixed capital formation												
Capital formation for characteristics activities												
Grants/subsidies/etc. not included in the above												
Environmental protection subsidies/grants etc. to the rest of the world (net).												
Total national expenditure on environmental protection												

Note: This table would be produced for each of the domains: air protection; climate protection; waste water; solid waste; soil, groundwater and surface water; biodiversity and landscape; research and development for environmental protection; and resource management.
This table is intentionally left blank and is included for illustrative purposes only.

19 ENVIRONMENTAL PROTECTION EXPENDITURE & NATIONAL RESOURCE MANAGEMENT FINANCING, Australia

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
FINANCING OF EPE AND NRM												
Government												
Corporations												
Households												
Total National Expenditure												
ROW												
Total												
RECEIVERS OF FINANCE												
Government												
Corporations												
Houesholds												
Not–for–profit institutions												
Rest of the World												
Total												
NATIONAL EPE AND NRM (AIR, CLIMATE, WASTE WATER, SOLID WASTE, NRM, R&D, MINING SOIL/SW/GW)												
Corporations												
Government												
Not–for–profit institutions												
Households												
Total National Environment Expenditure												
Transfers to ROW (net)												

Note: This table would be produced for each of the domains: air protection; climate protection; waste water; solid waste; soil, groundwater and surface water; biodiversity and landscape; research and development for environmental protection; and resource management.
This table is intentionally left blank and is included for illustrative purposes only.

20 ENVIRONMENTAL TRANSFERS ($), Australia

Payments made by	*Government*	*Corporations*	*Households*	*NPISH*	*Rest of the world*
Government					
Corporations					
Households					
NPISH					
Rest of the world					

Note: This table is intentionally left blank and is included for illustrative purposes only.

21 ACCOUNT FOR TRADEABLE EMISSION PERMITS, Australia

	Corporations	*General Government*	*Households*	*NPISH*(a)	*Rest of the World*	*Total*
Opening stock of permits						
Permits allocated free of charge						
Permits purchased						
Permits sold						
Losses (cancelled permits)						
Permits surrendered to offset emissions						
Closing stock of permits						

(a) Non-profit institutions serving households.

Note: This table is intentionally left blank and is included for illustrative purposes only.

22 ENVIRONMENTAL TAXES BY TYPE OF TAX ($), Australia

			TAXES ON INCOME				
	Taxes on products	*Other taxes on production*	*Corporations*	*Households*	*Other current taxes*	*Capital taxes*	*Total*
Type of environmental tax							
Energy taxes							
Carbon taxes							
Taxes on fuel used for transport							
Other energy taxes							
Transport taxes							
Pollution taxes							
Resource taxes							
Total environmental taxes							
Nonenvironmental taxes							
Total taxes							
Share of environmental taxes							

Note: This table is intentionally left blank and is included for illustrative purposes only.

23 OIL STOCK ACCOUNT—MONETARY ($), Australia—2001 to 2011

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
	$m	$m	$m	$m	$m	$m	$m	$m	$m	$m	$m
Opening value of stock	31 316	38 378	42 877	45 261	50 457	54 056	61 669	66 143	82 454	109 437	103 351
Additions to stock of resources	na	na	na	na	na	na	na	na	na	na	na
Discoveries	na	na	na	na	na	na	na	na	na	na	na
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock of resources	na	na	na	na	na	na	na	na	na	na	na
Extractions	na	na	na	na	na	na	na	na	na	na	na
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Revaluation of the stock of resources	na	na	na	na	na	na	na	na	na	na	na
Closing value of stock	38 378	42 877	45 261	50 457	54 056	61 669	66 143	82 454	109 437	103 351	104 107

na not available

Source: ABS, Australian System of National Accounts, 2010–11 (cat. no. 5204.0)

24 OIL STOCK ACCOUNT–PHYSICAL (GIGALITRES), Australia—2001 to 2011

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
	GL	GL	GL	GL	GL	GL	GL	GL	GL	GL	GL
Opening value of stock(a)	729.5	746.5	717.0	644.5	617.0	615.5	579.0	551.0	603.5	669.8	659.0
Additions to stock of resources	na	na	na	na	na	na	na	na	na	na	na
Discoveries(b)	58.0	12.6	–30.1	14.5	37.9	1.2	8.8	88.9	103.7	26.8	17.7
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock of resources	na	na	na	na	na	na	na	na	na	na	na
Extractions(c)	41.0	42.1	42.4	42.0	39.4	37.7	36.8	36.4	37.4	37.6	38.3
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Closing value of stock(a)	**746.5**	**717.0**	**644.5**	**617.0**	**615.5**	**579.0**	**551.0**	**603.5**	**669.8**	**659.0**	**638.4**

na not available
(a) Economic demonstrated resource (EDR)
(b) Calculated as residual
(c) 5 year lagged moving average of production

Source: ABS, Australian System of National Accounts, 2010–11 (cat. no. 5204.0), table 62

25 COAL-PEAT STOCK ACCOUNT – MONETARY ($) , Australia —2001 to 2011

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
	$m	$m	$m	$m	$m	$m	$m	$m	$m	$m	$m
Opening value of stock	36 899	42 963	42 947	42 079	46 224	53 325	64 589	70 717	84 787	150 402	144 199
Additions to stock of resources	na	na	na	na	na	na	na	na	na	na	na
Discoveries	na	na	na	na	na	na	na	na	na	na	na
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock of resources	na	na	na	na	na	na	na	na	na	na	na
Extractions	na	na	na	na	na	na	na	na	na	na	na
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Revaluation of the stock of resources	na	na	na	na	na	na	na	na	na	na	na
Closing value of stock	42 963	42 947	42 079	46 224	53 325	64 589	70 717	84 787	150 402	144 199	151 462

na not available

Source: ABS, Australian System of National Accounts, 2010–11 (cat. no. 5204.0), table 62.

26 COAL–PEAT STOCK ACCOUNT–PHYSICAL (GIGATONNES), Australia—2000 to 2011

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
	Gt	Gt	Gt	Gt	Gt	Gt	Gt	Gt	Gt	Gt	Gt
Opening value of stock(a)	79.4	78.0	76.6	76.9	77.3	76.6	76.8	76.6	76.4	78.7	82.3
Additions to stock of resources	na	na	na	na	na	na	na	na	na	na	na
Discoveries(b)	–1.1	–1.1	0.6	0.7	–0.4	0.6	0.2	0.2	2.8	4.1	3.8
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock of resources	na	na	na	na	na	na	na	na	na	na	na
Extractions(c)	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Closing value of stock(a)	78.0	76.6	76.9	77.3	76.6	76.8	76.6	76.4	78.7	82.3	85.6

na not available
(a) Economic demonstrated resource (EDR).
(b) Calculated as residual.
(c) 5 year lagged moving average of production.
Source: ABS, Australian System of National Accounts, 2010–11 (cat. no. 5204.0), table 62.

27 NATURAL GAS STOCK ACCOUNT – MONETARY ($), Australia—2001 to 2011

	2000–01	*2001–02*	*2002–03*	*2003–04*	*2004–05*	*2005–06*	*2006–07*	*2007–08*	*2008–09*	*2009–10*	*2010–11*
	$m	$m	$m	$m	$m	$m	$m	$m	$m	$m	$m
Opening value of stock	59 008	60 040	58 785	58 761	63 698	66 500	66 591	68 139	76 500	122 614	119 280
Additions to stock of resources	na	na	na	na	na	na	na	na	na	na	na
Discoveries	na	na	na	na	na	na	na	na	na	na	na
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock of resources	na	na	na	na	na	na	na	na	na	na	na
Extractions	na	na	na	na	na	na	na	na	na	na	na
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Revaluation of the stock of resources	na	na	na	na	na	na	na	na	na	na	na
Closing value of stock	60 040	58 785	58 761	63 698	66 500	66 591	68 139	76 500	122 614	119 280	130 815

na not available

Source: ABS, Australian System of National Accounts, 2010–11 (cat. no. 5204.0), table 62.

28 NATURAL GAS STOCK ACCOUNT–PHYSICAL (BILLION CUBIC METRES), Australia—2001 to 2011

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm
Opening value of stock(a)	2 056.0	2 395.0	2 557.5	2 455.0	2 484.5	2 467.5	2 384.5	2 353.0	2 721.5	3 051.0	2 950.5
Additions to stock of resources	na	na	na	na	na	na	na	na	na	na	na
Discoveries(b)	374.0	198.4	–67.6	65.7	19.8	–44.8	9.3	412.0	375.1	–51.5	–29.9
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock of resources	na	na	na	na	na	na	na	na	na	na	na
Extractions(c)	35.0	35.9	34.9	36.2	36.8	38.2	40.8	43.5	45.6	49.0	51.3
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Closing value of stock(a)	2 395.0	2 557.5	2 455.0	2 484.5	2 467.5	2 384.5	2 353.0	2 721.5	3 051.0	2 950.5	2 869.3

na not available
(a) Economic demonstrated resource (EDR).
(b) Calculated as residual.
(c) 5 year lagged moving average of production.

Source: ABS, Australian System of National Accounts, 2010–11 (cat no. 5204.0), Table 62.

29 SUBSOIL ASSETS STOCK ACCOUNT—MONETARY ($), Australia—2001 to 2011

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
	$b	$b	$b	$b	$b	$b	$b	$b	$b	$b	$b
Opening value of stock	173.3	196.5	207.3	215.1	239.6	262.5	302.9	335.8	385.5	615.8	590.5
Additions to stock of resources	na	na	na	na	na	na	na	na	na	na	na
Discoveries	na	na	na	na	na	na	na	na	na	na	na
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock of resources	na	na	na	na	na	na	na	na	na	na	na
Extractions	na	na	na	na	na	na	na	na	na	na	na
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Net transactions in stock	na	na	na	na	na	na	na	na	na	na	na
Revaluation of the stock of resources	**23.2**	**10.8**	**7.8**	**24.4**	**23.0**	**40.4**	**32.8**	**49.7**	**230.3**	**–25.3**	**33.8**
Closing value of stock	196.5	207.3	215.1	239.6	262.5	302.9	335.8	385.5	615.8	590.5	624.3

na not available

Source: ABS, Australian System of National Accounts, 2010–11 (cat no. 5204.0), Table 59.

30 METALLIC MINERALS STOCK ACCOUNT–MONETARY ($), Australia—2001 to 2011

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
	$b	$b	$b	$b	$b	$b	$b	$b	$b	$b	$b
Opening value of stock	39 865	48 525	55 633	62 576	73 131	82 689	104 245	124 968	135 907	223 463	215 047
Additions to stock of resources	na	na	na	na	na	na	na	na	na	na	na
Discoveries	na	na	na	na	na	na	na	na	na	na	na
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock of resources	na	na	na	na	na	na	na	na	na	na	na
Extractions	na	na	na	na	na	na	na	na	na	na	na
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Revaluation of the stock of resources	na	na	na	na	na	na	na	na	na	na	na
Closing value of stock	48 525	55 633	62 576	73 131	82 689	104 245	124 968	135 907	223 463	215 047	228 670

na not available

Source: Australian System of National Accounts, 2010–11 (cat no. 5204.0), Table 62

31 METALLIC MINERALS STOCK ACCOUNT–PHYSICAL (GIGATONNES), Australia—2001 to 2011

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
	Gt	Gt	Gt	Gt	Gt	Gt	Gt	Gt	Gt	Gt	Gt
Opening value of stock(a)	3 132.9	2 936.4	2 908.4	2 930.9	3 097.8	3 201.2	3 228.6	3 790.4	4 825.2	5 324.1	5 273.2
Additions to stock of resources	na	na	na	na	na	na	na	na	na	na	na
Discoveries	na	na	na	na	na	na	na	na	na	na	na
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock of resources	na	na	na	na	na	na	na	na	na	na	na
Extractions(b)	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Closing value of stock(a)	2 936.4	2 908.4	2 930.9	3 097.8	3 201.2	3 228.6	3 790.4	4 825.2	5 324.1	5 273.2	5 225.4

na not available
(a) Economic demonstrated resource (EDR)
(b) 5 year lagged moving average of production

Source: Australian System of National Accounts, 2010–11 (cat no. 5204.0), Table 62

32 NON–METALLIC MINERALS STOCK ACCOUNT–MONETARY ($), Australia—2001 to 2011

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
	$m	$m	$m	$m	$m	$m	$m	$m	$m	$m	$m
Opening value of stock	6 177	6 591	7 072	6 433	6 092	5 932	5 826	5 806	5 807	9 836	8 578
Additions to stock of resources	na	na	na	na	na	na	na	na	na	na	na
Discoveries	na	na	na	na	na	na	na	na	na	na	na
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock of resources	na	na	na	na	na	na	na	na	na	na	na
Extractions	na	na	na	na	na	na	na	na	na	na	na
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Revaluation of the stock of resources	na	na	na	na	na	na	na	na	na	na	na
Closing value of stock	6 591	7 072	6 433	6 092	5 932	5 826	5 806	5 807	9 836	8 578	9 222

na not available

Source: Australian System of National Accounts, 2010–11 (cat no. 5204.0), Table 62

33 NON–METALLIC MINERALS STOCK ACCOUNT–PHYSICAL (MEGATONNES), Australia—2001 to 2011

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
	Mt	Mt	Mt	Mt	Mt	Mt	Mt	Mt	Mt	Mt	Mt
Opening value of stock(a)	532.5	616.9	610.0	608.9	611.5	611.9	615.2	622.9	623.0	605.8	592.8
Additions to stock of resources	na	na	na	na	na	na	na	na	na	na	na
Discoveries(b)	87.5	–3.8	2.1	5.7	3.5	6.4	11.0	3.3	–14.0	–9.9	–3.5
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock of resources	na	na	na	na	na	na	na	na	na	na	na
Extractions(c)	3.1	3.1	3.2	3.1	3.1	3.1	3.3	3.2	3.2	3.1	3.0
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Closing value of stock(a)	616.9	610.0	608.9	611.5	611.9	615.2	622.9	623.0	605.8	592.8	586.3

na not available
(a) Economic demonstrated resource (EDR)
(b) Calculated as residual
(c) 5 year lagged moving average of production

Source: Australian System of National Accounts, 2010–11 (cat no. 5204.0), Table 62

34 DYNAMIC LAND COVER BY STATE AND TERRITORY, ('000 hectares)—Australia—2008

NRM region	*NSW*	*VIC*	*QLD*	*SA*	*WA*	*TAS*	*NT*	*ACT*	*AUST*
Extraction Sites	0.7	0.2	9.4	0.2	—	—	—	—	10.3
Bare Areas	—	—	3.9	—	12.5	—	3.6	—	20.1
Inland Waterbodies	437.1	243.6	485.9	273.3	789.4	201.7	208.1	1.6	2 640.8
Salt Lakes	163.4	4.5	521.0	3 995.0	3 795.0	0.4	631.5	—	9 110.7
Irrigated Cropping	78.9	2.2	71.9	0.6	0.1	3.3	0.6	—	157.6
Irrigated Pasture	27.5	197.4	1.8	22.2	0.2	69.2	0.2	0.1	318.6
Irrigated Sugar	28.4	—	431.7	—	0.3	—	2.8	—	463.3
Rainfed Cropping	9 895.9	4 257.3	2 052.3	5 322.9	13 179.5	5.5	80.0	0.5	34 793.9
Rainfed Pasture	10 048.4	6 673.9	5 658.3	2 726.6	2 239.6	840.3	1 305.6	22.4	29 515.1
Rainfed Sugar	—	—	51.3	—	—	—	—	—	51.3
Wetlands	3.1	0.7	102.0	7.5	14.3	—	205.5	—	333.0
Forbs - Open	0.1	0.1	—	—	—	—	—	—	0.2
Forbs - Sparse	0.3	0.1	—	—	—	—	—	—	0.4
Tussock Grasses - Closed	—	—	557.0	—	64.7	—	57.6	—	679.3
Alpine Grasses - Open	9.8	5.2	—	—	—	—	—	—	15.0
Hummock Grasses - Open	1 153.6	4.0	3 429.5	5 680.2	7 513.1	—	5 158.0	—	22 938.4
Sedges - Open	50.1	21.8	—	1.1	—	0.2	—	0.2	73.5
Tussock Grasses - Open	2 870.8	276.6	8 165.9	956.4	2 819.0	17.5	6 941.8	1.2	22 049.1
Grassland - Scattered	83.9	—	3 208.5	920.5	—	—	194.6	—	4 407.5
Tussock Grasses - Scattered	1.7	—	0.7	—	—	—	—	—	2.4
Grassland - Sparse	5.8	—	13.6	7.0	—	—	0.1	—	26.5
Hummock Grasses - Sparse	8 211.9	139.5	22 737.9	29 999.8	112 781.7	9.7	45 196.7	0.7	219 077.9
Tussock Grasses - Sparse	1 457.1	36.8	10 452.7	801.4	1 015.2	1.9	1 915.0	—	15 680.1
Shrubs - Closed	1 092.7	15.5	2 540.4	472.8	3 400.3	0.5	2 988.6	—	10 510.8
Shrubs - Open	19.9	0.7	0.5	11.6	23.2	0.1	0.3	—	56.4
Chenopod Shrubs - Open	589.4	10.5	9.4	23.7	—	—	—	—	633.0
Shrubs - Scattered	812.4	2.9	1 259.7	395.2	2 718.7	7.2	978.3	—	6 174.4
Chenopod Shrubs - Scattered	59.9	—	525.9	156.0	—	—	159.5	—	901.3
Shrubs - Sparse	5 531.3	72.6	17 455.9	38 085.2	48 883.5	16.8	11 574.2	1.4	121 620.8
Chenopod Shrubs - Sparse	1 891.7	15.0	2 688.1	1 738.9	9 454.0	—	3 703.8	—	19 491.4
Trees - Closed	6 768.0	2 848.4	5 811.2	271.6	1 876.8	2 762.6	887.6	9.4	21 235.7
Trees - Open	9 980.2	3 353.8	17 767.8	683.4	2 938.3	2 275.4	7 785.9	93.3	44 878.0
Trees - Scattered	5 921.8	810.8	13 670.6	2 791.8	17 381.7	12.6	11 603.9	0.2	52 193.4
Trees - Sparse	12 919.6	3 753.7	53 223.8	3 083.3	21 770.6	590.8	33 153.5	104.6	128 599.9
TOTAL	**80 115.4**	**22 747.6**	**172 908.6**	**98 428.2**	**252 671.6**	**6 815.7**	**134 737.3**	**235.8**	**768 660.3**

— nil or rounded to zero (including null cells)

Source: Figures based on satellite imaging composites from 2000 to 2008 released in 2008. Lymburner L. Tan P. Mueller N.Thackway R. Thankappan M. Islam A. Lewis A. Randall L. Senarath U 2011 The National Dynamic Land Cover Dataset - Technical report Geoscience Australia https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=71069

35 LAND USE BY STATE AND TERRITORY, ('000 hectares), Australia—2010

	NSW	VIC	QLD	SA	WA
Conservation and Natural Environments	12 270.8	4 955.0	13 430.6	39 589.4	56 669.0
Production from Relatively Natural Environments	33 466.4	3 219.8	151 844.5	40 562.7	176 487.1
Production from Dryland Agriculture and Plantations	30 238.7	12 306.9	3 190.3	10 791.0	19 021.7
Production from Irrigated Agriculture and Plantations	1 443.2	828.6	1 084.2	253.8	53.1
Intensive Uses	1 546.8	1 084.9	1 059.2	2 594.0	269.3
Water	1 103.6	342.6	2 303.4	4 620.4	109.0
Total	**80 069.6**	**22 737.8**	**172 912.3**	**98 411.3**	**252 609.3**

Source: Figures based on satellite imaging and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), 2010, Catchment Scale Land Use Mapping for Australia, ABARES, Canberra

	TAS	NT	ACT	Other Territories	National
Conservation and Natural Environments	3 426.8	74 078.0	131.9	5.9	204 557.6
Production from Relatively Natural Environments	1 601.0	59 452.6	2.2	—	466 636.3
Production from Dryland Agriculture and Plantations	1 441.4	404.7	74.5	0.0	77 469.3
Production from Irrigated Agriculture and Plantations	128.8	19.9	0.2	—	3 811.8
Intensive Uses	88.6	347.5	24.4	0.7	7 015.5
Water	108.7	456.5	2.0	0.1	9 046.2
Total	**6 795.4**	**134 759.2**	**235.2**	**6.7**	**768 536.7**

— nil or rounded to zero (including null cells)

Source: Figures based on satellite imaging and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), 2010, Catchment Scale Land Use Mapping for Australia, ABARES, Canberra

36 EXPERIMENTAL LAND COVER ACCOUNT ('000 HECTARES), Murray–Darling Basin (MDB)—pre-1750 to 2006

	OPENING STOCK	ADDITIONS			
	pre–1750	*Managed expansion*	*Natural expansion*	*Upward reappraisals*	*Total additions*
	'000ha	'000ha	'000ha	'000ha	'000ha
Forests and woodlands	93 250.8	na	na	na	na
Rainforests and Vine Thickets	96.1	na	na	na	na
Srublands and Forblands	15 259.7	na	na	na	na
Heathlands	39.3	na	na	na	na
Grasslands	8 129.2	na	na	na	na
Unclassified native vegetation	—	na	na	na	na
Regrowth, modified native vegetation	—	na	na	na	na
Inland aquatic–freshwater, salt lakes, lagoons	257.5	na	na	na	na
Naturally bare–sand, rock, claypan, mudflat	3.2	na	na	na	na
Cleared, non–native vegetation, buildings	—	na	na	na	na
Unknown/no data	5.1	na	na	na	na

	REDUCTIONS				NET CHANGE FROM PRE–1750 TO 2006		CLOSING STOCK
	Managed regression	*Natural regression*	*Downward reappraisals*	*Total reductions*			*2006*
	'000ha	'000ha	'000ha	'000ha	'000ha	% Change	'000ha
Forests and woodlands	na	na	na	na	–41 792.9	–45.0	51 458.0
Rainforests and Vine Thickets	na	na	na	na	–57.2	–59.0	39.0
Srublands and Forblands	na	na	na	na	–870.1	–6.0	14 389.6
Heathlands	na	na	na	na	–1.6	–4.0	37.6
Grasslands	na	na	na	na	–1 584.9	–19.0	6 544.3
Unclassified native vegetation	na	na	na	na	50.2	—	50.2
Regrowth, modified native vegetation	na	na	na	na	1 181.2	—	1 181.2
Inland aquatic–freshwater, salt lakes, lagoons	na	na	na	na	–58.4	–23.0	199.1
Naturally bare–sand, rock, claypan, mudflat	na	na	na	na	4.6	143.0	7.8
Cleared, non–native vegetation, buildings	na	na	na	na	25 361.6	—	25 361.6
Unknown/no data	na	na	na	na	4 951.8	96 637.0	4 956.9

— nil or rounded to zero (including null cells)

na not available

Note: 1. It should be noted that all the land data presented here have been derived from various external data sources using various methods. Total land areas for the MDB have been derived using a concordance of National Resource Management (NRM) regions falling more than 50% within the MDB region. Therefore the total land areas may vary from actual land areas, hence the estimates should be considered experimental.

2. Data have been sourced using the National Vegetation Information System. For details of methodology please see: http://www.environment.gov.au/erin/nvis/about.html

37 EXPERIMENTAL LAND COVER BY STATE AND TERRITORY(a), (hectares) Murray–Darling Basin (MDB)—2008(b)

Land cover type	MDB - NSW	MDB - VIC	MDB - QLD	MDB - SA	ACT	MDB - Total (c)
Total Extraction sites	***29***	***50***	***64***	***0***	***0***	***143***
Extraction Sites	29	50	64	0	0	143
Total Water	***474 945***	***116 699***	***166 360***	***103 654***	***1 634***	***863 292***
Inland Water bodies	312 267	114 158	60 772	102 833	1 634	591 665
Salt Lakes	162 678	2 541	105 588	821	0	271 627
Total Irrigated agriculture	***17 769***	***72 997***	***7 543***	***4 332***	***57***	***102 698***
Irrigated Cropping	3 953	186	4 218	178	0	8 535
Irrigated Pasture	5 673	72 811	14	4 153	57	82 709
Irrigated Sugar	8 142	0	3 311	0	0	11 454
Total Rainfed agriculture	***18 566 824***	***7 024 155***	***2 349 035***	***1 629 759***	***22 907***	***29 592 680***
Rainfed Cropping	9 858 839	3 888 678	1 045 273	900 836	507	15 694 132
Rainfed Pasture	8 707 985	3 135 477	1 303 498	728 924	22 401	13 898 284
Rainfed Sugar	0	0	264	0	0	264
Total Wetlands	***2 184***	***442***	***1 991***	***285***	***0***	***4 903***
Wetlands	2 184	442	1 991	285	0	4 903
Total Forbs	***178***	***43***	***0***	***0***	***0***	***221***
Forbs – Open	0	43	0	0	0	43
Forbs – Sparse	178	0	0	0	0	178
Total Grasslands	***13 753 183***	***430 964***	***8 870 620***	***1 593 764***	***1 991***	***24 650 523***
Alpine Grasses – Open	2 705	5 181	0	0	0	7 886
Hummock Grasses – Open	1 153 594	3 989	1 075 210	109 984	0	2 342 776
Tussock Grasses – Open	2 861 438	264 654	1 207 580	289 082	1 227	4 623 981
Grassland – Scattered	83 858	0	17 705	71	0	101 634
Tussock Grasses – Scattered	1 748	0	671	0	0	2 419
Grassland – Sparse	5 752	0	4 960	0	0	10 711
Hummock Grasses – Sparse	8 190 551	124 256	5 766 992	1 170 971	735	15 253 505
Tussock Grasses – Sparse	1 453 537	32 884	797 503	23 657	29	2 307 609
Total Sedges	***28 730***	***14 437***	***43***	***14***	***193***	***43 417***
Sedges – Open	28 730	14 437	43	14	193	43 417
Total Shrublands	***9 977 672***	***89 224***	***5 682 071***	***287 583***	***1 392***	***16 037 942***
Shrubs – Closed	1 092 479	15 250	1 048 292	27 382	0	2 183 403
Shrubs – Open	19 882	200	278	407	0	20 766
Chenopod Shrubs – Open	589 446	10 476	9 370	10 662	0	619 953
Shrubs – Scattered	811 519	257	659 909	8 899	0	1 480 583
Chenopod Shrubs – Scattered	59 887	0	67 059	0	0	126 947
Shrubs – Sparse	5 512 785	48 020	3 042 513	198 166	1 392	8 802 876
Chenopod Shrubs – Sparse	1 891 674	15 022	854 650	42 068	0	2 803 413
Total Trees	***23 344 185***	***5 877 147***	***14 358 536***	***2 025 171***	***207 593***	***45 812 632***
Trees – Closed	708 928	712 774	42 582	18 069	9 441	1 491 795
Trees – Open	5 192 604	1 623 715	1 317 499	116 342	93 321	8 343 481
Trees – Scattered	5 904 187	793 321	5 110 994	923 629	221	12 732 352
Trees – Sparse	11 538 466	2 747 337	7 887 461	967 131	104 610	23 245 005
TOTAL	**66 165 699**	**13 626 158**	**31 436 263**	**5 644 563**	**235 767**	**117 108 450**

(a) It should be noted that all the land data presented here have been derived from various external data sources using various methods. Total land areas for the MDB have been derived using a concordance of National Resource Management (NRM) regions falling more than 50% within the MDB region. Therefore the total land areas may vary from actual land areas, hence the estimates should be considered experimental.

(b) For the methodology in dynamic land cover data please refer to: Lymburner, L., Tan, P., Mueller, N., Thackway, R., Thankappan, M., Islam, A., Lewis, A., Randall, L., Senarath, U, 2011, The National Dynamic Land Cover Dataset - Technical report, Geoscience Australia, https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=71069

(c) There is a difference in the "Total" column when comparing table 37 with table 38. This is due to the different grid sizes in the raw data used to cross classify, in table 38, Dynamic Land Cover and Australian Land Use Mapping and the internal re-sampling that is applied to undertake the match before zonal operations are performed in ArcMap.

38 EXPERIMENTAL LAND COVER BY LAND USE(a)(b)(c)(d), (hectares) Murray–Darling Basin (MDB)—2008

	ALUM PRIMARY CLASS						
	Conservation and Natural Environments	Production from Relatively Natural Environments	Production from Dryland Agriculture and Plantations	Production from Irrigated Agriculture and Plantations	Intensive Uses	Water	Total
Land cover type	Ha	Ha	Ha	Ha	Ha	Ha	Ha
Total Extraction sites	—	*42*	*41*	—	*16*	*2*	*100*
Extraction Sites	—	42	41	—	16	2	100
Total Water	*55 961*	*286 284*	*102 659*	*26 631*	*11 857*	*378 722*	*862 114*
Inland Waterbodies	30 033	80 229	100 475	26 465	11 603	341 648	590 454
Salt Lakes	25 928	206 054	2 184	166	254	37 074	271 660
Total Irrigated agriculture	*3 079*	*2 396*	*28 016*	*60 788*	*3 733*	*2 930*	*100 941*
Irrigated Cropping	641	1 061	4 819	1 552	286	133	8 491
Irrigated Pasture	2 163	499	15 074	57 781	2 940	2 564	81 020
Irrigated Sugar	276	836	8 123	1 455	508	233	11 430
Total Rainfed agriculture	*877 809*	*4 086 051*	*21 680 125*	*1 723 605*	*620 789*	*323 602*	*29 311 980*
Rainfed Cropping	300 407	1 366 079	12 468 832	1 040 495	276 760	169 138	15 621 712
Rainfed Pasture	577 402	2 719 903	9 211 281	682 960	344 001	154 457	13 690 004
Rainfed Sugar	—	69	13	150	27	6	265
Total Wetlands	*610*	*732*	*1 813*	*1 275*	*165*	*346*	*4 940*
Wetlands	610	732	1 813	1 275	165	346	4 940
Total Forbs	*175*	—	*1*	—	—	*57*	*233*
Forbs – Open	44	—	—	—	—	—	44
Forbs – Sparse	132	—	1	—	—	57	189
Total Grasslands	*1 257 770*	*20 958 871*	*2 134 821*	*74 524*	*96 947*	*214 154*	*24 737 086*
Alpine Grasses – Open	6 569	—	—	—	219	—	6 788
Hummock Grasses – Open	57 450	2 275 457	1 565	15	4 106	8 948	2 347 540
Tussock Grasses – Open	173 367	2 756 768	1 538 214	57 008	42 510	60 655	4 628 521
Grassland – Scattered	21 225	76 483	146	606	226	2 941	101 626
Tussock Grasses – Scattered	150	1 357	754	143	23	27	2 452
Grassland – Sparse	33	10 331	15	—	6	274	10 658
Hummock Grasses – Sparse	958 579	13 802 784	394 431	9 224	41 536	117 406	15 323 960
Tussock Grasses – Sparse	40 399	2 035 692	199 698	7 528	8 323	23 904	2 315 543
Total Sedges	*37 416*	*119*	*1 652*	*182*	*721*	*155*	*40 245*
Sedges – Open	37 416	119	1 652	182	721	155	40 245
Total Shrublands	*586 982*	*15 064 295*	*264 125*	*11 376*	*39 574*	*101 119*	*16 067 471*
Shrubs – Closed	92 040	2 038 543	43 109	321	5 438	9 408	2 188 858
Shrubs – Open	489	17 904	1 474	771	65	113	20 815
Chenopod Shrubs – Open	18 466	541 306	51 101	2 953	2 831	4 051	620 707
Shrubs – Scattered	49 411	1 421 296	3 072	636	2 529	5 008	1 481 950
Chenopod Shrubs – Scattered	1 296	120 222	481	84	180	4 934	127 196
Shrubs – Sparse	362 318	8 276 225	87 898	5 211	20 890	66 466	8 819 007
Chenopod Shrubs – Sparse	62 963	2 648 800	76 991	1 401	7 643	11 142	2 808 940
Total Trees	*8 703 280*	*22 409 421*	*12 468 441*	*569 514*	*799 475*	*400 377*	*45 350 508*
Trees – Closed	641 779	333 990	358 788	34 986	43 826	10 290	1 423 660
Trees – Open	2 629 650	2 050 068	3 035 551	169 803	223 850	83 589	8 192 511
Trees – Scattered	1 820 958	9 555 849	1 203 909	18 632	61 469	68 988	12 729 804
Trees – Sparse	3 610 892	10 469 514	7 870 193	346 094	470 331	237 511	23 004 533
Total	**11 523 126**	**62 808 210**	**36 681 692**	**2 467 895**	**1 573 276**	**1 421 462**	**116 475 660**

— nil or rounded to zero (including null cells)

(a) It should be noted that all data presented here have been derived from cross classification of the land use and dynamic land cover data sets which have been derived from various external data sources using various methods. Total land areas for the MDB have been derived using a concordance of National Resource Management (NRM) regions falling more than 50% within the MDB region. Therefore the total land areas may vary from actual land areas, hence the estimates should be considered experimental.

(b) There is a difference in the "Total" column when comparing table 37 with table 38. This is due to the different grid sizes in the raw data used to cross classify, in table 38, Dynamic Land Cover and Australian Land Use Mapping and the internal re-sampling that is applied to undertake the match before zonal operations are performed in ArcMap.

(c) For the methodology in dynamic land cover data please see: http://www.ga.gov.au

(d) For the methodology in land use please see: Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)., 2010, Catchment Scale Land Use Mapping for Australia, ABARES, Canberra; http://adl.brs.gov.au/landuse/index.cfm?fa=main.classification

39 EXPERIMENTAL FOREST EXTENT AND CHANGE (HECTARES)(a), Murray–Darling Basin (MDB)—2008 and 2011(b)

	OPENING STOCK	ADDITIONS			
	2008	*Managed expansion*	*Natural expansion*	*Upward reappraisals*	*Total additions*
	Ha	Ha	Ha	Ha	Ha
Forest Type					
Rainforest and vine thickets	29 747	n.a.	n.a.	n.a.	n.a.
Eucalyptus tall open forest	223 511	n.a.	n.a.	n.a.	n.a.
Eucalyptus open forest	3 384 877	n.a.	n.a.	n.a.	n.a.
Eucalyptus low open forest	87 964	n.a.	n.a.	n.a.	n.a.
Eucalyptus woodlands	5 698 736	n.a.	n.a.	n.a.	n.a.
Acacia forests and woodlands	1 641 176	n.a.	n.a.	n.a.	n.a.
Callitris forests and woodlands	985 403	n.a.	n.a.	n.a.	n.a.
Casuarina forests and woodlands	746 822	n.a.	n.a.	n.a.	n.a.
Melaleuca forests and woodlands	81	n.a.	n.a.	n.a.	n.a.
Other forests and woodlands	109 177	n.a.	n.a.	n.a.	n.a.
Eucalyptus open woodlands	781 128	n.a.	n.a.	n.a.	n.a.
Acacia open woodlands	648 725	n.a.	n.a.	n.a.	n.a.
Mallee woodlands and shrublands	3 854 527	n.a.	n.a.	n.a.	n.a.
Low closed forest and tall closed shrubland	75	n.a.	n.a.	n.a.	n.a.
Acacia shrublands	564 224	n.a.	n.a.	n.a.	n.a.
Other shrublands	123 112	n.a.	n.a.	n.a.	n.a.
Heath	33 927	n.a.	n.a.	n.a.	n.a.
Tussock grasslands	332 977	n.a.	n.a.	n.a.	n.a.
Hummock grasslands	20 389	n.a.	n.a.	n.a.	n.a.
Other grasslands, herblands, sedgelands and rush	84 891	n.a.	n.a.	n.a.	n.a.
Chenopod shrublands, samphire shrubs and forbland	64 205	n.a.	n.a.	n.a.	n.a.
Unclassified native vegetation	4 525	n.a.	n.a.	n.a.	n.a.
Regrowth, modified native vegetation	177 467	n.a.	n.a.	n.a.	n.a.

(a) It should be noted that all the land data presented here have been derived from various external data sources using various methods. Total land areas for the MDB have been derived using a concordance of National Resource Management (NRM) regions falling more than 50% within the MDB region. Therefore the total land areas may vary from actual land areas, hence the estimates should be considered experimental.

(b) For the methodology please refer to: http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4609.0.55.001Explanatory%20Notes12011?OpenDocument; also http://www.climatechange.gov.au/

Note: n.a. not available

39 EXPERIMENTAL FOREST EXTENT AND CHANGE (HECTARES)(a), Murray–Darling Basin (MDB)—2008 and 2011(b) *continued*

	REDUCTIONS				NET CHANGE FROM 2008 TO 2011		CLOSING STOCK
	Managed regression	*Natural regression*	*Downward reappraisals*	*Total reductions*			*2011*
	Ha	Ha	Ha	Ha	Ha	% Change	Ha
Forest Type							
Rainforest and vine thickets	n.a.	n.a.	n.a.	n.a.	–1 077	–3.6	28 670
Eucalyptus tall open forest	n.a.	n.a.	n.a.	n.a.	–7 422	–3.3	216 089
Eucalyptus open forest	n.a.	n.a.	n.a.	n.a.	5 854	0.2	3 390 731
Eucalyptus low open forest	n.a.	n.a.	n.a.	n.a.	1 934	2.2	89 898
Eucalyptus woodlands	n.a.	n.a.	n.a.	n.a.	120 338	2.1	5 819 074
Acacia forests and woodlands	n.a.	n.a.	n.a.	n.a.	–5 097	–0.3	1 636 078
Callitris forests and woodlands	n.a.	n.a.	n.a.	n.a.	28 123	2.9	1 013 526
Casuarina forests and woodlands	n.a.	n.a.	n.a.	n.a.	25 317	3.4	772 139
Melaleuca forests and woodlands	n.a.	n.a.	n.a.	n.a.	22	27.0	103
Other forests and woodlands	n.a.	n.a.	n.a.	n.a.	–22 677	–20.8	86 500
Eucalyptus open woodlands	n.a.	n.a.	n.a.	n.a.	23 893	3.1	805 021
Acacia open woodlands	n.a.	n.a.	n.a.	n.a.	–11 745	–1.8	636 980
Mallee woodlands and shrublands	n.a.	n.a.	n.a.	n.a.	–166 557	–4.3	3 687 970
Low closed forest and tall closed shrubland	n.a.	n.a.	n.a.	n.a.	2	2.1	76
Acacia shrublands	n.a.	n.a.	n.a.	n.a.	36 811	6.5	601 035
Other shrublands	n.a.	n.a.	n.a.	n.a.	9 091	7.4	132 203
Heath	n.a.	n.a.	n.a.	n.a.	–1 101	–3.2	32 826
Tussock grasslands	n.a.	n.a.	n.a.	n.a.	102 124	30.7	435 101
Hummock grasslands	n.a.	n.a.	n.a.	n.a.	2 936	14.4	23 325
Other grasslands, herblands, sedgelands and rush	n.a.	n.a.	n.a.	n.a.	–3 153	–3.7	81 738
Chenopod shrublands, samphire shrubs and forbland	n.a.	n.a.	n.a.	n.a.	70 916	110.5	135 121
Unclassified native vegetation	n.a.	n.a.	n.a.	n.a.	447	9.9	4 971
Regrowth, modified native vegetation	n.a.	n.a.	n.a.	n.a.	6 668	3.8	184 135

(a) It should be noted that all the land data presented here have been derived from various external data sources using various methods. Total land areas for the MDB have been derived using a concordance of National Resource Management (NRM) regions falling more than 50% within the MDB region. Therefore the total land areas may vary from actual land areas, hence the estimates should be considered experimental.

(b) For the methodology please refer to: http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4609.0.55.001Explanatory%20Notes12011?OpenDocument; also http://www.climatechange.gov.au/

Note: n.a. not available

40 TIMBER RESOURCES STOCK ACCOUNT, PHYSICAL, (hectares, cubic metres) Australia—2001 to 2010

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Timber resources – Plantation										
Opening stock										
Broadleaved *('000 ha)*	588	638	676	716	740	807	883	950	991	973
Coniferous *('000 ha)*	980	988	988	1 001	990	1 001	1 010	1 014	1 020	1 024
Total opening stock(a) *('000 ha)*	1 569	1 628	1 666	1 716	1 739	1 818	1 903	1 973	2 020	2 009
Additions to stock										
Growth in stock (new areas planted)										
Broadleaved *('000 ha)*	74	49	31	46	66	67	76	66	43	21
Coniferous *('000 ha)*	10	5	11	7	6	11	11	6	6	3
Reclassifications *('000 ha)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total additions to stock *('000 ha)*	84	54	42	54	72	78	87	72	50	24
Reductions in stock										
Removal										
Broadleaved *(m3)*	975	1 112	1 594	1 819	2 936	3 779	4 052	4 270	4 746	4 564
Coniferous *(m3)*	12 697	13 356	13 911	14 589	14 196	14 379	14 590	15 157	13 314	14 436
Felling residues *(m3)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Natural losses *(m3)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Catastrophic losses *(m3)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Reclassifications *(m3)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total reductions in stock *(m3)*	13 672	14 468	15 505	16 408	17 132	18 159	18 641	19 428	18 060	19 000
Closing Stock of timber – plantation(b) *('000 ha)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Timber resources – Native										
Opening stock										
Broadleaved *('000 ha)*	n.a.	n.a.	162 080	n.a.	n.a.	n.a.	n.a.	147 397	n.a.	n.a.
Additions to stock										
Natural growth										
Broadleaved *('000 ha)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Reclassifications *('000 ha)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total additions to stock *('000 ha)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Reductions in stock										
Broadleaved *(m3)*	10 802	9 831	10 314	10 090	9 866	8 575	8 551	8 940	7 739	6 617
Felling residues *(m3)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Natural losses *(m3)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Catastrophic losses *(m3)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Reclassifications *(m3)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total reductions in stock *(m3)*	10 802	9 831	10 314	10 090	9 866	8 575	8 551	8 940	7 739	6 617
Closing Stock of timber – native(b) *('000 ha)*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

(a) Total includes plantations where type is unknown

(b) Total cannot be computed due to difference in unit type

Note: n.a. not available

Source: Australian Forest and Wood Product Statistics, ABARES

41 TIMBER RESOURCES STOCK ACCOUNT - MONETARY ($ BILLIONS), Australia—2001 to 2010

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
	$b	$b	$b	$b	$b	$b	$b	$b	$b	$b	$b
Timber resources–Plantation											
Opening stock of timber resources	6.5	6.8	7.0	7.3	7.4	7.6	7.9	8.4	9.9	9.3	9.4
Additions to stock											
Growth in stock	na	na	na	na	na	na	na	na	na	na	na
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock											
Removals	na	na	na	na	na	na	na	na	na	na	na
Natural losses	na	na	na	na	na	na	na	na	na	na	na
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Net transactions in stock	0.3	na	0.1	—	—	–0.2	0.4	1.3	–1.2	–0.6	–0.4
Revaluation of the stock	—	0.2	0.2	0.2	0.3	0.4	0.1	0.3	0.6	0.6	0.6
Closing stock of resources	6.8	7.0	7.3	7.4	7.6	7.9	8.4	9.9	9.3	9.4	9.6
Timber resources–Natives											
Opening stock of timber resources	1.9	1.9	2.0	2.1	2.3	2.2	2.1	2.1	2.1	1.9	1.7
Additions to stock											
Growth in stock	na	na	na	na	na	na	na	na	na	na	na
Upwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total additions to stock	na	na	na	na	na	na	na	na	na	na	na
Reductions in stock											
Removals	na	na	na	na	na	na	na	na	na	na	na
Natural losses	na	na	na	na	na	na	na	na	na	na	na
Catastrophic losses	na	na	na	na	na	na	na	na	na	na	na
Downwards reappraisals	na	na	na	na	na	na	na	na	na	na	na
Reclassifications	na	na	na	na	na	na	na	na	na	na	na
Total reductions in stock	na	na	na	na	na	na	na	na	na	na	na
Net transactions in stock	—	—	—	—	—	—	—	—	—	—	—
Revaluation of the stock	–0.1	0.1	0.2	0.2	—	–0.1	—	—	–0.2	–0.2	–0.1
Closing stock of resources	1.9	2.0	2.1	2.3	2.2	2.1	2.1	2.1	1.9	1.7	1.7

— nil or rounded to zero (including null cells)
na not available

Source: ABS, Australian System of National Accounts, 2010–11 (cat. no. 5204.0), Table 59, at current prices

42 AQUATIC RESOURCES STOCK ACCOUNT–PHYSICAL ('000 TONNES)(a), Australia—2001 to 2010

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
Opening Stock	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Additions to stock										
Natural Growth	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Upward reappraisals	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Reclassifications(b)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total additions to stock	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Reductions in stock										
Gross catch	196	200	215	232	236	197	189	182	172	172
Natural losses	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Catastrophic losses	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Uncompensated seizure	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Downward reappraisals	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Reclassifications(b)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total reductions in stock	196	200	215	232	236	197	189	182	172	172
Other changes in volume										
Change in total allowable catch(c)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total Other changes volume	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Closing Stock	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

(a) Includes wild fishing but does not include aquaculture, as data is not available. Aquaculture should otherwise be included per the SEEA.

(b) This entry is included as a residual, as the data is not available.

(c) Total allowable catch is the legislated quota set by the relevant authorities, and may change from period to period.

Note: n.a. not available

Source: ABARES, Australian Fisheries Statistics 2010 (annual compilation fro 2000–2010)

43 AQUATIC RESOURCES STOCK ACCOUNT, MONETARY ($ MILLIONS)(a), Australia—(Experimental)—2001 to 2010

Monetary asset account - natural aquatic resources	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
	$m	$m	$m	$m	$m	$m	$m	$m	$m	$m
Opening Stock(b)	3,595	4,024	6,378	8,907	7,577	4,651	6,141	9,770	8,278	11,916
Additions to stock										
Natural Growth	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Upward reappraisals	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Reclassifications(c)	2,246	4,586	2,302	2,205	n.a.	3,410	6,050	452	997	n.a.
Total additions to stock	2,246	4,586	2,302	2,205	n.a.	3,410	6,050	452	997	n.a.
Reductions in stock										
Gross catch	1,817	1,784	1,655	1,499	1,491	1,462	1,452	1,382	1,392	1,344
Natural losses	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Catastrophic losses	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Uncompensated seizure	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Downward reappraisals	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Reclassifications(c)	n.a.	n.a.	n.a.	n.a.	1,532	n.a.	n.a.	n.a.	n.a.	1,021
Total reductions in stock	1,817	1,784	1,655	1,499	3,022	1,462	1,452	1,382	1,392	2,364
Other changes in volume										
Revaluations(d)	n.a.	-448	1,883	-2,036	96	-458	-969	-563	4,032	-505
Change in total allowable catch(e)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total Other changes volume	n.a.	-448	1,883	-2,036	96	-458	-969	-563	4,032	-505
Closing Stock	4,024	6,378	8,907	7,577	4,651	6,141	9,770	8,278	11,916	9,047

(a) Includes wild fishing but does not include aquaculture, as data is not available. Aquaculture should otherwise be included per the SEEA.
(b) Estimated using the Net Present Value method.
(c) This entry is included as a residual, as the data is not available.
(d) Takes into account the changes in the average monetary value of fish from year to year, and changes in the discount rate used in the NPV calculation.
(e) Total allowable catch is the legislated quota set by the relevant authorities, and may change from period to period.

Note: n.a. not available

Source: Gross catch taken from ABARES, Australian Fisheries Statistics 2010 (annual for 2000-2010); Opening and Closing stock are new estimates based on unpublished ABS data

44 CARBON STOCK ACCOUNT, Australia

	GEOLOGICAL/GEOCARBON					BIOLOGICAL/BIOCARBON		
Tonnes of carbon	*Rocks*	*Oil*	*Gas*	*Coal*	*Other*	*Terrestial Natural*	*Terrestial Semi-natural*	*Terrestial Agriculture and other*
Opening stock								
Additions to stock								
Natural expansion								
Managed expansion								
Upwards reappraisals								
Reclassifications								
Imports								
Total additions to stock								
Reductions in stock								
Managed contraction								
Natural contraction								
Catastrophic losses								
Downwards reappraisals								
Reclassifications								
Exports								
Total reductions in stock								
Closing stock								

Tonnes of carbon	*Marine Natural*	*Marine Semi-natural*	*Marine Agricultural and other*	*Atmosphere*	*Water in Oceans*	*Inventories*	*Fixed assets*	*Australian TOTAL*
Opening stock								
Additions to stock								
Natural expansion								
Managed expansion								
Upwards reappraisals								
Reclassifications								
Imports								
Total additions to stock								
Reductions in stock								
Managed contraction								
Natural contraction								
Catastrophic losses								
Downwards reappraisals								
Reclassifications								
Exports								
Total reductions in stock								
Closing stock								

Note: This table is intentionally left blank and is included for illustrative purposes only.

45 ECOSYSTEM ASSET ACCOUNT(a), Australia—2010–2011

	Units(b)	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT	Australia
Opening stock 2010(c)										
Land	'000 ha									
Forest	'000 ha									
Timber	'000 m3									
Water	GL									
Carbon	'000 tonnes									
Biodiversity										
Vertebrates	no. of species									
Vascular plants	no. of species									
Net flows										
Land	'000 ha									
Forest	'000 ha									
Timber	'000 m3									
Water	GL									
Carbon	'000 tonnes									
Biodiversity										
Vertebrates	no. of species									
Vascular plants	no. of species									
Closing stock 2011										
Land	'000 ha									
Forest	'000 ha									
Timber	'000 m3									
Water	GL									
Carbon	'000 tonnes									
Biodiversity										
Vertebrates	no. of species									
Vascular plants	no. of species									

(a) Assets may be identified for any spatially defined area, for example, the 56 NRM regions of Australia.

(b) Units are indicative.

(c) In this account, the condition of stocks is not considered.

Note: This table is intentionally left blank and is included for illustrative purposes only.

46 ECOSYSTEM SERVICES ACCOUNT(a), Australia

	Units	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT	Australia
ECOSYSTEM SERVICES(b)										
PROVISIONING SERVICES										
Nutrition										
Food - terrestrial	'000 tonnes									
Freshwater	GL									
Materials										
Biotic (e.g. timber, fodder, medicines)	'000 tonnes									
Abiotic (e.g. minerals and fossil fuels)	'000 tonnes									
Renewable energy										
Biotic (e.g. biofuels)	PJ									
Abiotic (e.g. wind, solar, hydro)	PJ									
REGULATION AND MAINTENANCE										
Regulation of wastes(c)										
Flow regulation										
Air flow regulation(c)										
Water flow regulation(c)										
Mass flow regulation(c)										
Regulation of physical environment										
Atmosphere(c)										
Water quality(c)										
Pedogenesis and soil quality(c)										
Regulation of biotic environment										
Lifecycle maintenance and habitat protection(c)										
Pest and disease control(c)										
Gene pool protection(c)										
CULTURAL SERVICES										
Symbolic										
Aesthetic and heritage(c)										
Religious and spiritual(c)										
Intellectual and experiential										
Recreational and community activities(c)										
Information and knowledge(c)										
Information for cognitive development(c)										

(a) Services may be supplied by any spatially defined area, for example, the 56 NRM regions of Australia.
(b) Ecosystem services are based on draft Common International Classification of Ecosystem Services (CICES).
(c) Metric for measuring service to be determined.
Note: This table is intentionally left blank and is included for illustrative purposes only.

47 STATUS OF NATIVE SPECIES(a), Australia—2011

	Extinct	*Extinct in the wild*	*Critically endangered*	*Endangered*	*Vulnerable*
Animals					
Mammals	19	0	10	20	25
Birds	0	0	2	20	29
Reptiles	0	0	8	10	25
Amphibians	3	0	15	18	14
Insects	0	0	9	11	18
Total animals	***22***	***0***	***44***	***79***	***111***
Plants					
Plants	1	0	4	17	46
Total plants	***1***	***0***	***4***	***17***	***46***
Other					
Fungi	na	na	na	na	na
Protista	na	na	na	na	na
Total other	na	na	na	na	na
Total	**23**	**0**	**48**	**96**	**157**

	Lower risk: conservation dependent	*Near threatened*	*Data deficient*	*Least concern*	*Total*
Animals					
Mammals	0	32	36	205	347
Birds	0	28	na	605	684
Reptiles	0	10	12	137	202
Amphibians	0	9	11	153	223
Insects	0	10	18	69	135
Total animals	na	***89***	***77***	***1 169***	***1 591***
Plants					
Plants	7	24	3	322	424
Total plants	***7***	***24***	***3***	***322***	***424***
Other					
Fungi	na	na	na	na	na
Protista	na	na	na	na	na
Total other	na	na	na	na	na
Total	**7**	**113**	**80**	**1 491**	**2 015**

na not available

(a) Species status according to IUCN Red List categories.

Source: The International Union for Conservation of Nature Red List of Threatened Species, 2012, http://www.iucnredlist.org/.

48 BIODIVERSITY ASSET ACCOUNT, Australia(a)—2010–11

	Extinct	*Extinct in the wild*	*Critically endangered*	*Endangered*	*Vulnerable*
Opening stock 2010(b)	23	0	46	96	157
Additions					
- from lower threat categories	n.a.	n.a.	n.a.	n.a.	n.a.
- from higher categories	n.a.	n.a.	n.a.	n.a.	n.a.
- discoveries of new species	n.a.	n.a.	n.a.	n.a.	n.a.
- rediscoveries of extinct species	n.a.	n.a.	n.a.	n.a.	n.a.
- reclassifications	n.a.	n.a.	n.a.	n.a.	n.a.
Total additions	***0***	***0***	***2***	***0***	***0***
Reductions					
- to lower threat categories	n.a.	n.a.	n.a.	n.a.	n.a.
- to higher categories	n.a.	n.a.	n.a.	n.a.	n.a.
- reclassifications	n.a.	n.a.	n.a.	n.a.	n.a.
Total reductions	***n.a.***	***n.a.***	***n.a.***	***n.a.***	***n.a.***
Net change	0	0	2	0	6
Closing stock 2011	23	0	48	96	157

	Lower risk: conservation dependent	*Near threatened*	*Data deficient*	*Least concern*	*Total*
Opening stock 2010(b)	7	112	78	1 302	1 821
Additions					
- from lower threat categories	n.a.	n.a.	n.a.	n.a.	n.a.
- from higher categories	n.a.	n.a.	n.a.	n.a.	n.a.
- discoveries of new species	n.a.	n.a.	n.a.	n.a.	n.a.
- rediscoveries of extinct species	n.a.	n.a.	n.a.	n.a.	n.a.
- reclassifications	n.a.	n.a.	n.a.	n.a.	n.a.
Total additions	***0***	***1***	***2***	***189***	***194***
Reductions					
- to lower threat categories	n.a.	n.a.	n.a.	n.a.	n.a.
- to higher categories	n.a.	n.a.	n.a.	n.a.	n.a.
- reclassifications	n.a.	n.a.	n.a.	n.a.	n.a.
Total reductions	***n.a.***	***n.a.***	***n.a.***	***n.a.***	***n.a.***
Net change	0	1	2	189	388
Closing stock 2011	7	113	80	1 491	2 015

(a) Biodiversity assets accounts may be prepared for any spatially defined area. For example, the states and territories and the 56 NRM regions of Australia.

(b) Animals and plants, excludes fungi and protista.

Note: n.a. not available

Source: The International Union for Conservation of Nature Red List of Threatened Species, 2012, http://www.iucnredlist.org/.

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