Economic and Environmental Opportunities from Improved Resource Efficiency in Australian Industry

Background report for the Department of Environment & Heritage in the framework of the Productivity Commission Inquiry into Waste Generation and Resource Efficiency

15 February 2006

Martin Taylor
Rene van Berkel
Albena Bossilkov

Centre of Excellence in Cleaner Production
Curtin University of Technology
GPO Box U1987
Perth WA 6845
www.c4cs.curtin.edu.au
www.cleanerproduction.curtin.edu.au

Executive Summary

This report has been compiled by the Centre of Excellence in Cleaner Production (CECP) at Curtin University of Technology, Western Australia, to provide background information for the Commonwealth Department of Environment and Heritage (DEH) to assist with the preparation of its submission to the Productivity Commission (PC) Inquiry into Waste Generation and Resource Efficiency. The report examines the experiences of businesses and other organisations in applying resource efficiency concepts, and assesses the potential productivity benefits from their more widespread and vigorous promotion and application, as well as barriers to, and policy options for, the realisation of these potential benefits.

This report was prepared on the basis of information available in academic and professional literature and from policy initiatives and programs of State and national governments and international agencies. It is further informed by the extensive first hand experience of the authors in developing and implementing resource efficiency in businesses, in Australia and abroad.

Waste generation and resource efficiency (chapter 2)

The '*resources*' being considered are mainly those, which become, or have the potential to become, part of the municipal waste stream at the end of their useful life. The prime focus is therefore on *materials resource efficiency*, which involves reducing the amount of material used, and waste materials produced, over the entire lifecycle of a product or service. A combination of quantitative and qualitative waste prevention can contribute to three inter-related outcomes, namely: reduced accumulation of wastes; reduced hazards and risks of business operations and waste management; and, improved *eco-efficiency* of businesses.

'*Eco-efficiency*' is defined by the World Business Council for Sustainable Development (WBCSD) as "*being achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity*". The key eco-efficiency metric is value delivered per unit of physical resource consumption, which can be achieved by using smaller amounts of physical resources to make the same product, by turning non-product outputs to a valuable application, and by making the product more valuable to the consumer. Eco-efficiency is closely allied to other environmental management and corporate sustainability concepts.

Economic foundations (chapter 3)

Resource efficiency has profound economic dimensions. The use of material and other natural resources is costly for businesses and other economic actors. Direct costs are incurred from the purchase of materials, and the handling and disposal of non-product outputs. There is an economic rationale for materials resource efficiency for the macro-economic goal of growth of the national economy and for firm level competitiveness.

At the macro-economic level there has been a remarkable shift in economic growth engines over time. The initial shift was from Resource/Fossil Fuel Use (substitution of cheap fossil fuels for labour) to Scale/Learning (standardisation and skills to increase physical capacity

and scale of production). A shift to Value Creation/Dematerialisation is starting, where resource efficiency contributes to economic growth and reduction of environmental pressure.

There is also a business case for resource efficiency on the basis of a positive relationship between business competitiveness, environmental regulation, and elements of corporate sustainability, at the firm level. The realisation of this business case is challenged by market failures and organisational inertia. The environment needs to be addressed in the same way as other mounting business pressures. This explains why businesses that do well (i.e. those that are competitive in their sectors, successful in their markets and profitable to their shareholders), generally also achieve well in environmental management and sustainability performance. Initiatives to foster resource efficiency in business, should therefore aim at improving the capabilities of firms to succeed in light of ongoing change in environmental and sustainability requirements and expectations.

Environmental sustainability foundations (chapter 4***)***

Resource efficiency has multiple environmental benefits. On the input side of the economy, it minimises natural resource requirements for materials, energy and water, and so minimises indirectly the environmental impacts associated with the provision of these inputs (mining, harvesting, processing, transport). On the output side, it reduces emissions to the environment and their consequent environmental impacts.

Current business sustainability models have elements which overlap and complement one another. For example they all cover three cross cutting themes, namely: Fate of Materials – Zero Dissipation; Compatibility of Materials and Processes; and, Materials Intensity of Industrial Products and Processes. To achieve resource efficiency, businesses need to look beyond cost savings through minimisation of process wastes, and include value adding, and innovation and flexibility.

Opportunities for Australia (chapter 5)

The estimation of the economic value of greater resource efficiency in Australia was approached from three angles.

- Company examples demonstrate significant reductions of materials use and waste generation, achieved with comparatively minor investments, or with investments that provided solid economic returns or could be regarded as the cheapest environmental compliance option. The case study data lack details on, for example, transaction and opportunity costs associated with the implementation of resource efficiency, and the impact of the economic benefits on bottom line financial performance of the business.

- A conservative international benchmark for the value of the projected economic opportunity from resource efficiency was applied to turnover data for 135 Australian industry sectors. For 35 sectors, the average projected economic opportunity ranges between $50k/yr and $400k/yr per business.

- The eco-efficiency value matrix showed that key features of eco-efficiency aligned well with measures of business success, in particular for financial performance.

Barriers and motivators (chapter 6)

There is clear evidence of market, policy and organisational failures in regard to the uptake of resource efficiency. Markets insufficiently convert society's expectations for a clean environment into business opportunities for clean and resource-efficient products and services. The policy environment in which waste generators operate does not convey a sense of urgency to reduce waste nor does it provide clear direction on what needs to be achieved in the medium to long term. Low environmental awareness and sensitivity among waste generators/firms, and existing organisational inertia, add to the cost and complexity of implementing resource efficiency.

Given the complex interplay between market, policy and organisational failures, there is a need for a coordinated approach to improved resource efficiency. Business needs to improve its capabilities to make and deliver on the business case for waste prevention. Markets need to be properly framed so that they can deliver waste prevention and resource efficiency outcomes. Proactive and strategic government policy and programs can help.

Policy opportunities (chapter 7)

There is a major opportunity for governments to make resource efficiency easier by lowering the transaction costs, by providing information and technical or financial assistance. However, there is a trade off between making it easier for the government program (typically by developing a check list of universal measures) and maximising the business opportunity (which requires some in-depth consideration of each organisation's specific circumstances to find the solution that matches best with the operations, products and markets of the firm).

From a government perspective waste prevention efforts must address four ubiquitous failures and barriers associated with waste and materials policy:

- Inadequate information at decision-making levels of government;
- Lack of 'systems thinking' i.e. a whole-of-government approach;
- Lack of economic cost-benefit thinking across government; and,
- Lack of environmental awareness and sensitivity in non-environmental departments.

There is a range of regulatory, economic and suasive policy instruments which governments may use to influence waste prevention. To achieve waste prevention in businesses, the most effective economic instruments are subsidy removal, raw material charges, grants and deposit-refund schemes. The regulatory instruments likely to be most effective include Extended Producer Responsibility and liability assignment. Suasive instruments generally have very high or high generic, but limited specific, waste prevention potential.

Conclusions (chapter 8)

The key findings from the analysis presented in this report are as follows:

1. A proper assessment of the current materials use and resource efficiency performance of the Australian economy is not possible, due to the lack of consistent data sets on materials use and waste generation. The current best practice estimate puts the materials intensity of the Australian economy at around 175 tonnes/person/year. Even though there is a strong

belief that the intensity of materials use will decrease as the economy grows, there is no factual evidence that such dematerialisation will occur autonomously.

2. There is a strong economic rationale for resource efficiency. At the national level, there are compelling analytical grounds that resource efficiency can drive economic growth. At the firm level, resource efficiency can simultaneously deliver environmental and economic benefits. Its uptake is however hampered by market failures and organisational inertia. Market failures can be addressed by government intervention, while businesses need to approach the environment as a business problem.

3. Eco-Efficiency is the common term for resource efficiency in business. It is aimed at: increasing the value of goods and services; reducing the use of natural resource inputs; and reducing impact on nature. Eco-efficiency fits in the environmental sustainability model hierarchy at the level of activities businesses can take to achieve three cross cutting objectives for: the ultimate fate of materials; the compatibility of materials and processes and materials with nature; and the intensity of materials use in products and processes. In practical terms, eco-efficiency is principles driven and value focused, and employs lifecycle thinking to drive and deliver operational excellence and innovation.

4. The economic value of greater resource efficiency in Australia was confirmed from three different angles. Firstly, company examples provide some indication that total economic benefits from resource efficiency, including but not limited to material resource efficiency, could amount up to 1 to 3 % of annual turnover of the business. Secondly, a conservative international benchmark was used to estimate the value of the projected economic opportunity. For 35 sectors, covering over 18,000 businesses the projected total economic opportunity is $4.5 billion/year. Thirdly, the eco-efficiency value matrix indicated that key features of eco-efficiency at the company level align well with measures of business success, in particular in regards to financial performance.

5. The review of business barriers and motivators for resource efficiency provided clear evidence of market failure (e.g. inability to capture full cost and lack of information on alternatives), policy failure (e.g. inconsistency in policy and lack of waste and materials data) and organisational failure (e.g. organisational inertia). Their complex interplay calls for a coordinated approach. Proactive and strategic government policy can frame the market to deliver waste prevention and resource efficient outcomes and encourage businesses to apply their business tools and skills to environmental issues.

6. Governments have a number of economic, regulatory and suasive policy instruments available to reduce barriers to, and bolster motivators for, resource efficiency. International assessments confirm that the most effective economic instruments for businesses were subsidy removal, raw material charges, grants and deposit-refund schemes. The regulatory instruments likely to be most effective are Extended Producer Responsibility and other forms of liability assignment. Suasive instruments were assessed as having very high or high general, but limited specific, waste prevention potential.

In summary it can be *concluded*, that:

1. There is a growing level of expertise and experience of eco-efficiency within Australia to allow progress in decoupling economic growth, and its benefits, from the negative impacts of increasing resource flows.

2. Implementation of eco-efficiency builds upon and enhances, rather than distracts from, the focus on business success in particular in areas of financial performance and to a lesser extent in financial drivers.

3. Based on the proxy assessments undertaken for this study, the economic opportunity from greater use of eco-efficiency is significant, up to some 1-3 % of annual turnover at the firm level, or some $4.5 billion/year for the Australian economy.

4. A coordinated approach of government, business, consumers and other stakeholders is needed to simultaneously address the market, policy and organisational failures that currently impede the uptake of eco-efficiency.

Implications for Inquiry (chapter 9)

Overall implications across the range of issues raised by the Productivity Commission are:

- Waste management policy so far appears to have had limited impact on resource efficiency in industry, both because of the policy focus on municipal solid waste (to which industry contributes comparatively little), and because energy, water and hazardous substances take priority over solid waste in most industries' resource efficiency initiatives.
- Resource efficiency in industry should be defined as eco-efficiency. This term has currency in the industry sector. It also measures resource efficiency against multiple objectives, which can avoid a fixation on the waste management hierarchy that could otherwise compromise overall environmental and resource efficiency objectives.
- A multitude of training and information resources on eco-efficiency is available in Australia, but these appear to be underutilised. This may be due at least in part to their strong reliance on the environmental or sustainability consciousness of businesses. A stronger focus on the business case, in terms of costs and risks, is required to raise industry demand for eco-efficiency information and training.
- The split responsibility for different natural resources (materials, waste, energy, water) is a profound institutional and regulatory barrier for resource efficiency. A sole focus on regulatory barriers may lead to market and organisational failures being ignored, despite their obvious existence. Overall there is evidence that good business practices lead to resource efficient, successful and profitable businesses, which suggests that overall business competencies need to be fostered (in particular among small to medium sized enterprises).
- While priority and target setting for waste prevention and resource efficiency is conditional for its success, such is currently not possible due to severe constraints in available data for materials use and waste generation. The development of consistent data sets is currently also complicated by split regulatory and institutional responsibilities.

Table of Contents

1. Introduction

The Centre of Excellence in Cleaner Production (Curtin University of Technology, Perth, WA[1]) prepared this background report for the Commonwealth Department of Environment and Heritage (DEH) to inform its contribution to the Productivity Commission Inquiry into Waste Generation and Resource Efficiency. This report was compiled in January 2006 from readily available academic and professional literature and policy initiatives and programs of State and national governments and international agencies. Moreover it was informed by the extensive first hand experience of the authors in developing and implementing resource efficiency initiatives in businesses, in Australia and internationally[2].

This background report reviews the economic and environmental opportunities associated with improved resource efficiency in Australian industry. The detailed objectives are to:

- Provide an economic and environmental sustainability framework for the assessment of resource efficiency opportunities in Australian industry;
- Provide a preliminary estimate of the economic and environmental sustainability benefits of resource efficiency, using existing case studies and other information sources;
- Review the spectrum of barriers, motivators and policy opportunities to enhance resource efficiency in Australian industry; and,
- Provide recommendations to enhance resource efficiency, in particular with regard to the issues raised by the Productivity Commission as part of its Inquiry into Waste Generation and Resource Efficiency.

Resource efficiency is considered here within the mandate of the Productivity Commission (www.pc.gov.au/principles.htm). This report is therefore focused on using resource efficiency to improve the productivity and economic performance of the economy, to encourage the development of efficient and internationally competitive industries, to avoid unnecessary regulation, and to achieve a transition to ecologically sustainable development.

[1] Curtin's Centre of Excellence in Cleaner Production works to advance business contributions to sustainable development, in particular through applied research, teaching, technical assistance and information dissemination, and policy dialogue on cleaner production, eco-efficiency, industrial ecology, sustainable technology and sustainability management (www.c4cs.curtin.edu.au). The Centre was initially established with support from the WA Government to foster the uptake of cleaner production technologies and practices, in particular among small to medium sized enterprises, a role it continues to perform (www.cleanerproduction.curtin.edu.au). The Centre also convenes and administers the WA Sustainable Industry Group (WA SIG), a multi-stakeholder government, industry and community platform for advancing the business case and agenda for sustainable development (www.wasig.curtin.edu.au). The WA SIG is a member of the Regional Network of the World Business Council for Sustainable Development (www.wbcsd.org)

[2] Rene van Berkel is Australia's first full professor of Cleaner Production, and has 18 years experience in developing and implementing resource efficiency and environmental innovation related applied research, training and consultancy. He is widely regarded as one of the leading international scholars and practitioners, as for instance reflected in his status as Eco-Efficiency Champion for the World Business Council for Sustainable Development. Martin Taylor joined Curtin in 2005 after over 25 years environmental management experience in government and industry. In his role as environmental co-ordinator for the Chamber of Commerce and Industry of WA, he was responsible for the implementation of the Eco-Efficiency Agreement in WA and initiating the regional resource synergies initiative in the Kwinana Industrial Area. Albena Bossilkov joined Curtin in 2001 and has since been responsible for the development and delivery of technical assistance programs on cleaner production for small businesses, and more recently for developing tools and methodologies for regional resource synergies (or industrial ecology/symbiosis).

This background report is organised in six analytical chapters and two concluding chapters.

- The analytical part of the report starts with defining the scope of resource efficiency and its link to waste generation and to materials intensity of national economies (Chapter 2). The economic and environmental sustainability foundations for resource efficiency are covered in Chapters 3 and 4. These are applied to Australian industry to estimate the opportunity presented by greater resource efficiency (Chapter 5). Chapter 6 probes into barriers for resource efficiency and waste minimisation in businesses. Chapter 7 then reviews the policy context, with regard to general types of instruments and their perceived efficacy in fostering resource efficiency.

- The concluding part of the report is divided in two chapters. Chapter 8 captures the conclusions from the background report. The final chapter (chapter 9) draws out the important recommendations in regard to the issues raised by the Productivity Commission that relate to industry.

Supportive technical and analytical information is provided in the annexes to this report.

2. Waste generation and resource efficiency

From a materials perspective, resource efficiency is about reducing the waste and materials intensity of economic activity. This chapter defines the key concepts (section 2.1) and summarises the debate on materials intensity of economies (section 2.2).

2.1 Definitions

2.1.1 Resource efficiency

A dictionary definition of '*efficiency*' is '*producing a desired effect or outcome with the least effort or waste*'. When applied to resources the term '*Resource Efficiency*' means the use of smaller amounts of resources to produce the same product or service (www.ncsl.org/programs/energy/glossary). At its most basic, resource efficiency means getting the most out of the resources you have: input materials, water, energy and workforce. This is beneficial in many ways: reducing the amount of material used; reducing manufacturing costs; reducing waste materials and impact on the environment; and regulatory compliance (www.businessballs.com/environmentalmanagement.htm).

When considering this Productivity Commission Inquiry, which is into *Waste Generation and Resource Efficiency*, the '*resources*' are mainly those, which become, or have the potential to become, part of the municipal waste stream at any point in time and place. The prime focus is therefore on *materials resource efficiency*, which in its most basic form involves reducing the amount of material used and reducing waste materials over the entire lifecycle of a product or service, and so reducing environmental impact. This report will therefore imply *material resources* and *material resource efficiency* to distinguish this work from other dimensions of resource efficiency, such as energy efficiency and water efficiency, which are not part of this Inquiry. However, in many instances, material resource efficiency also achieves efficiency for these other types of resources, and vice versa.

Although it is not immediately clear in the Issues Paper (PC 2005), non-hazardous solid wastes ('*non-product outputs'*) that are generated by industries within, or close to, urban areas are included in wastes addressed in this report. Currently, such wastes are commonly disposed of at the same or similar processing facilities and landfills as used by local authorities for wastes collected from residential and commercial premises.

The Productivity Commission has an obvious mandate to consider '*economic efficiency'* which is a term that refers to the optimal production and consumption of goods and services. This generally occurs when prices of products and services reflect their marginal costs. Economic efficiency gains can be achieved through cost reduction, but it is better to think of the concept as actions that promote an increase in overall net value (which includes, but is not limited to, cost reductions) (www.businessballs.com/environmentalmanagement.htm).

2.1.2 Waste prevention

Resource efficiency is specifically considered to achieve waste prevention, which has been broadly defined as '*the avoidance of the creation of waste'* (e.g. WMB (2004)). This background report primarily targets prevention of industrial wastes, or '*wastes being generated by businesses and other waste generating organisations*'. This includes waste

generated in the service sectors (e.g. hospitality, health care, financial sector, transport, trade and retail) and by government agencies.

Waste prevention has both *quantitative* and *qualitative* dimensions (van Berkel 2005d). In quantitative terms it reduces the volume or mass of the residual waste, so that less waste material remains to be treated, recycled or disposed of after the implementation of quantitative waste prevention. Waste prevention in qualitative terms reduces the environmental risks of the waste stream and/or improves its recyclability, so that the remaining waste material is '*easier*' and less harmful to recycle, recover and/or dispose of.

Waste prevention contributes to (van Berkel 2005d):

1. *Reduction of whole of life-cycle accumulation of wastes:* i.e. less waste accumulates at any point in the waste lifecycle[3], including the environment;

2. *Reduction of hazards and risks of business operations and waste management* i.e. using and/or producing less toxics or hazardous substances in businesses, which reduces their potential emission into the environment at any stage of the waste lifecycle; and

3. *Improvement of eco-efficiency of businesses***:** i.e. businesses becoming more productive by using natural resources more efficiently and producing less waste.

In addition to strict waste and materials related benefits, more efficient use of material resources can have several other environmental benefits. Using less materials leads to reduced resource use and emissions from the production and supply of the materials to the process, and may also curb energy and water use in the process as less material needs to be heated, cooled or otherwise handled.

2.1.3 Eco-Efficiency

> *"Eco-efficiency catches at a glance the balance business strives toward: sound ecology and profitable business operations"*
>
> *Mr Bjorn Stigson,*
> *President World Business Council for Sustainable Development*
> *(Holliday et al (2002), pg 83)*

The concept of '*value*' has been incorporated into the term '*eco-efficiency*'. The World Business Council for Sustainable Development (WBCSD) coined the term in 1992. It defines eco-efficiency as "*being achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity*" (WBCSD 2000a).

WBCSD views '*material*' resource efficiency as one of the outcomes of pursuing the seven elements of eco-efficiency (see also 4.1). It interprets resource efficiency in terms of '*doing more with less'*. The key WBCSD metric is therefore value delivered per unit of physical resource consumption, (for example: *$ of sales/kg of material used*) (WBCSD 2000b).

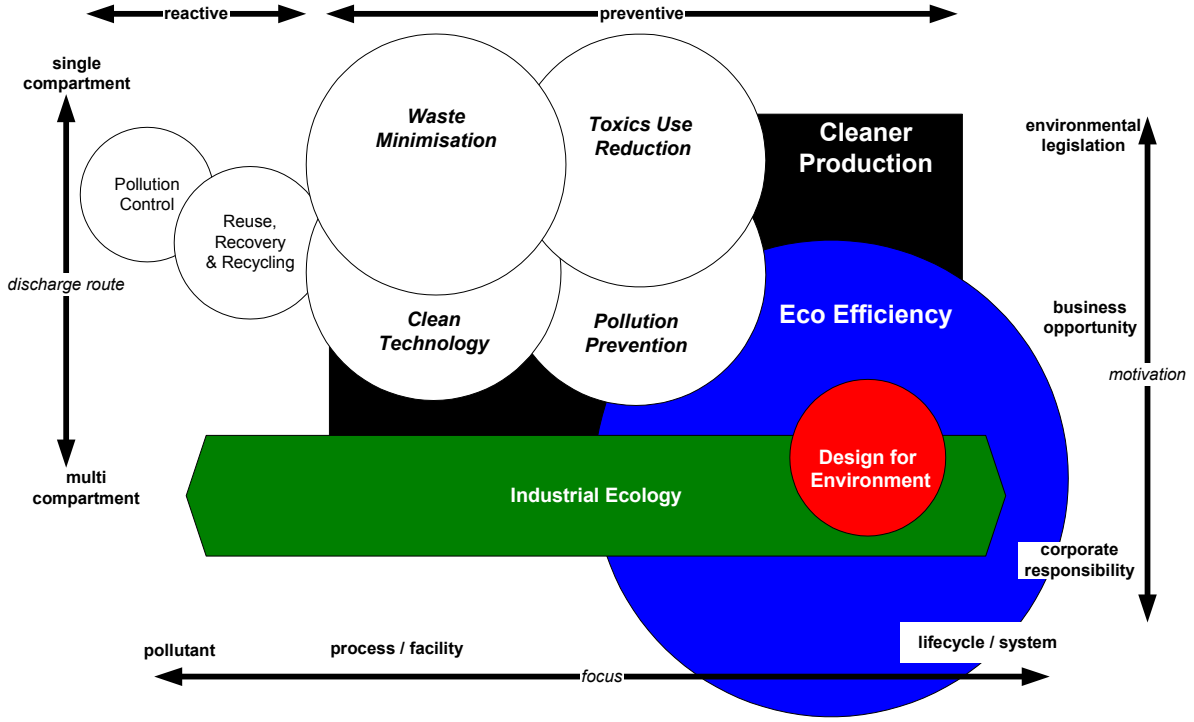
[3] The term waste life cycle is used to refer to all stages in the generation, collection, treatment and disposal of waste. It includes manufacturing of packaging and products that have the potential to end up in the waste stream.

$$\text{Eco-Efficiency} = \frac{\text{ECOnomic Value}}{\text{ECOlogical Impact}}$$

The WBCSD recognises that eco-efficiency can be improved by using physical resources more efficiently (making the same product with smaller amounts of physical resources), by reducing the impact on nature (turning non-product outputs into valuable by-product) and by increasing the product or service value (making the product or service more valuable to the consumer).

Eco-efficiency is closely linked to several other preventive environmental management strategies, such as cleaner production, pollution prevention, toxics use reduction and waste minimisation (van Berkel 2000) (see Figure 1). Cleaner production and eco-efficiency can be regarded as common descriptors for the most frequently used preventive approaches. Eco-efficiency and cleaner production are truly complementary concepts, with eco-efficiency focusing on the strategic dimension (‘*value creation’*) and cleaner production on the operational dimension (‘*production’*) (van Berkel 2000). The older preventive approaches are waste minimisation; pollution prevention and toxics use reduction. Their use tends to be geographically bound and to a certain extent regulated. The newer preventive approaches explicitly target reduction of environmental impacts along the product’s lifecycle, by focusing on product design (design for the environment) or on new approaches for value adding activities (eco-efficiency).

Figure 1: Eco-efficiency in relation to other preventive environmental management strategies (adapted from van Berkel (2000))



2.2 Materials intensity

Resource efficiency delivers goods and services with the least amount of (material) resources. This reduces the materials intensity of the good or service, and ultimately of the economy, as fewer materials are required per unit of economic activity. Conceptually materials intensity can be measured at either product or economy level. The term Materials Intensity Pro Service (MIPS) (Ritthoff *et al.* 2002) is used to quantify the life cycle materials use per unit of final service delivery of the product. For example the materials use for manufacturing (including materials production), use, maintenance and disposal of vehicle per 1,000 km of car use. A MIPS assessment can be regarded as an abridged Life Cycle Assessment (Guinnee *et al.* 2002). At the economy level, the total materials use can be divided by either size of the economy (materials intensity of GDP, e.g. kg of materials use per $ of GDP) or by size of the population (materials intensity per capita, i.e. ton per person per year) (Matthews *et al.* 2000).

Methods for materials flow accounting are still under development (Bringezu *et al.* 2002), which makes it difficult to compare data from different sources and over time[4]. Current best estimates put the materials use in Australia at around 175 tonnes per person per year (GoA 2002). Moreover the use of total materials use as indicator for environmental impact is bound by limitations. On one hand the movement of materials requires energy, causes emissions and land disturbance, and from this perspective total materials use is accepted as a proxy indicator indicative for several environmental impacts. However on the other hand, it is clear that some materials pose greater environmental, health and safety risks per unit of mass then other materials (compare for example pesticides versus road base materials).

Discussions on materials use efficiency are often grounded on the presumed existence of an environmental Kuznet curve (first hypothesised by World Bank (1992)). The underlying hypothesis is that resource depletion and pollution increase in the initial stages of development but then tend to fall as incomes rise (World Bank 1992; Bernardi *et al.* 1993; Cleveland *et al.* 1999). Even though there are some empirical data that show declining intensities of use for certain materials over time in mature economies, such studies generally rely on visual inspection of data trends, and due to a lack of proper statistical analysis (i.e. regression analysis) do not exclude competing hypotheses (Cleveland *et al.* 1999). The environmental Kuznet curve is therefore at best a *tentative* hypothesis on the relation between income and environmental quality.

[4] A comprehensive review of material flow studies and concepts is beyond the scope of this background document. A brief summary of recent analytical and theoretical work is provided in Annex I.

3. Economic foundations

> *"We are learning that the most effective way to address many of the world's most pressing problems is to mobilise the corporate sector in a context of rules, incentives, and partnerships where both companies and society can benefit… Innovative corporate practices in the area of the environment, then, will often enhance internal competitiveness. Products that address environmental scarcities will also have enormous market potential"*
>
> *Prof Michael Porter,*
> *Harvard Business School (Doering et al, pg 4)*

Resource efficiency has profound economic dimensions. The use of materials and other (natural) resources is costly for businesses and other organisations. Direct costs are incurred from the purchase of materials and disposal of the waste arising from packaging, off cuts and off-specification materials, intermediates and final products. However, these direct costs typically underestimate the total costs to the business, due to the hidden costs associated with materials and waste management, including the employee time spent on materials and waste handling, cost of appropriate storage space and loss of added value from off-specification intermediate and final products, etc.

Despite the obvious link between resource efficiency and cost of production at the business level, there continues to be a lively discourse regarding the economic impact of resource efficiency. The leading thinking and analysis is captured here at two economic scales: the national economy ('*macro*', in 3.1) and the individual firm ('*micro*', in 3.2). Section 3.3 combines these into an economic rationale for resource efficiency.

3.1 Economic development

3.1.1 Growth through dematerialisation

Ayres *et al* (2005) argued that predictions from the traditional neo-classical, one sector, growth model are not consistent with contemporary developments. Firstly, the contribution of capital investment to growth should slow and finally cease due to saturation. Secondly, technological progress is the only source of economic growth, but treated as exogenous to the model and therefore remains unexplained. Thirdly, economic convergence should occur as the neo-classical model predicts that poorer countries grow faster than richer ones.

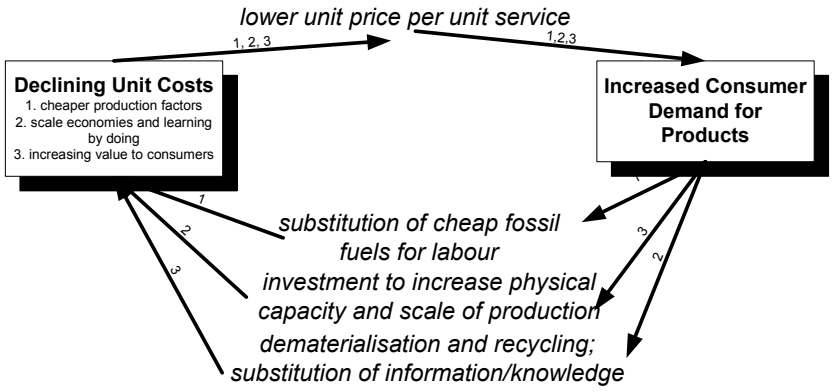
Given the wide recognition that technological progress has been, and continues to be, the major contributor to increasing productivity of human labour, it is necessary to look more at the specific mechanisms by which technological progress contributes to economic growth. Ayres *et al* (2005) identified three distinct feed back mechanisms, or economic *growth engines*:

1. *Resource Use (Fossil Fuel) Growth Engine:* technological progress has made fossil fuels steadily and dramatically cheaper and more convenient to use. Fossil fuel-derived energy and mechanical power substituted for work by animals and humans, and metals and new materials (plastics) have become more readily available. Their reduced costs spurred demand throughout all economic sectors.

2. *Scale-cum-Learning Growth Engine:* scale economics, standardisation, division of labour by specialisation, and '*learning-by-doing*' all lead to cost reduction which encourages increases in demand and vice versa. The growth rate is maintained by continuous changes in the product mix with increasing price elasticity (i.e. product innovation and marketing), and better learning mechanisms (education, communication, etc).

3. *Value Creation Growth Engine:* sustainable future economic growth requires that resource productivity and labour productivity increase simultaneously, not at one another's expense. This requires adding value to, and extending the useful life of, durable products while also reducing the use of fossil fuels and other dissipative intermediates, i.e. through *dematerialisation.* The relatively high labour intensity of service, repair and remanufacturing appears to compromise labour productivity. However there is a reduction of the loss of value previously added to materials by prior production processes. In economic terms, the rate of depreciation of durable goods and physical capital is greatly reduced, which effectively means increasing the net growth rate.

Figure 2: Three growth mechanisms (adapted from Ayres et al (2005)).



1 = resource use growth engine
2 = scale-cum-learning growth engine
3 = value creating/dematerialisation growth engine

Figure 2 illustrates the feedback between physical and value dimensions of economic growth. Ayres *et al* (2005) modelled different combinations of learning, product differentiation and dematerialisation, which revealed remarkable changes in nature of growth and subsequent environmental pressure. Empirical data for model validation are not yet available. The analytical work however provides a macro-economic rationale why and how resource efficiency, contributes to economic growth and reduction of environmental pressure.

3.1.2 National environmental stewardship

The Environmental Sustainability Index (ESI[5]) (Esty *et al.* 2005) supported by the World Economic Forum is widely regarded as the international benchmark for national environmental stewardship[6]. It benchmarked 146 nations, and Australia achieved the 13th ranking (8th among the OECD counties), marginally ahead of New Zealand.

[5] The ESI integrates 76 data sets, tracking natural resource endowments, past and present pollution levels, environmental management efforts, and a society's capacity to improve its environmental performance, into 21 indicators of environmental sustainability, covering five components: environmental systems; reducing environmental stresses; reducing human vulnerability; social and institutional capacity; and global stewardship.

[6] Ecological Footprint Analysis (EFA) of nations is a competing benchmark for environmental performance. EFA is based exclusively on per capita resource consumption data, and then compares the estimated land area needed for the production of

The 2005 ESI found that economic success contributes to the potential of environmental success but does not guarantee it (YCELP/CIESIN/WEF 2005). However the relationship between ESI and GDP is weak (R^2=0.23[7]). Australia's ESI is comparatively high among the group of countries with a similar GDP, outperforming for example the UK, Netherlands, Belgium and Denmark, all countries with significantly higher population densities and lower natural resource endowments, and underperforming for example Switzerland, Iceland, Sweden and Finland, all countries like Australia with relatively lower population densities and higher natural resource endowments. Statistical analysis resulted in seven clusters of countries based on their environmental characteristics (YCELP/CIESIN/WEF 2005). Australia is one of the eight nations that "*have above average system score, low vulnerability, high capacity and moderate stresses and stewardship"* (along with New Zealand, USA, Canada, Iceland, Sweden, Norway and Finland) (Esty *et al.* 2005).

3.2 Business competitiveness

This section reviews the economics of resource efficiency from the perspective of an individual firm. A summary is given of the green and/or competitive debate (in 3.2.1), leading to ways individual firms can capture the value from resource efficiency and environmental innovations (in 3.2.2). It concludes with a more holistic but qualitative assessment of the business value created from corporate sustainability initiatives (in 3.2.3).

3.2.1 Green and/or competitive

There is a wealth of part complementary and part competing research into potential, or actual, trade offs between environmental quality, as a public good, and the private cost for firms to sustain the quality and integrity of this public good, with those private costs having a potentially detrimental impact on the firm's competitiveness.

Michael Porter of the Harvard Business School first hypothesised that "*strict environmental regulations do not inevitably hinder competitive advantage against foreign rivals, indeed they often enhance it*" (Porter 1991) (pg 96) (the Porter Hypothesis, or the *win-win hypothesis)*. In later work, Porter *et al* (1995) urged managers to accept that pollution should no longer be regarded as an inevitable by-product of manufacturing, but a sign of inefficient product and/or process design, i.e. *pollution = inefficiency*. They critiqued the static interpretation embedded in neoclassical economics, which ignores dynamic competition and neglects the opportunity cost of waste and pollution (including but not limited to wasted natural resources, wasted business effort and diminished product value).

Porter *et al* (1995) argued that environmental regulation is needed for a win-win outcome to:
1. Create pressure that motivates companies to innovate;
2. Improve environmental quality in cases in which innovation and the resulting improvements in resource productivity do not completely offset the cost of compliance;

these resources and assimilation of the associated wastes, with the available ecologically active land. EFA is solely based on environmental performance, but methodological concerns remain about the way resource use is linked to land use and the ability to consider differences in population densities Chambers, N., S. Simmons and M. Wackernagel (2000). Sharing Nature's Interest: ecological footprints as an indicator of sustainability. London, UK, Earthscan Publications..

[7] The correlation coefficient (R2) is 0.23. Common statistical descriptors for the correlation coefficient are '*strong correlation'* (R2> 0.80), '*moderate correlation*' (0.60< R2< 0.80) and '*weak correlation*' (0.30<R2<0.60).

3. Alert and educate companies about likely resource inefficiencies and potential areas for technological improvement;
4. Raise the likelihood that product innovations and process innovations in general will be environmentally friendly;
5. Create demand for environmental improvement until companies and customers are able to perceive and measure the resource inefficiencies of pollution better; and
6. Level the playing field during the transition period to innovation-based environmental solutions, ensuring that one company cannot gain position by avoiding environmental investments.

Porter *et al* (1995) argued in favour of new environmental regulation that fosters innovation and resource productivity, by being outcome focused, having longer term horizons, employing phase-in periods, giving regulatory process stability, being stricter rather than lax, and using market based instruments. Many of these policy innovations have since been further developed, and are covered in Chapter 7 of this report.

Landis-Gabel *et al* (1998) provided three different interpretations for the Porter Hypothesis, respectively that environmental regulations lead to:

1. *Enhanced competitiveness of producers of complementary products and services*: environmental regulation creates a market for providers of environmental technologies, goods and services. Even though a business opportunity is created for the environmental technology provider, the private economic costs of those ultimately subject to the environmental regulation increase.

2. *Relatively enhanced competitiveness of the regulated firms*: environmental regulation helps the regulated companies becoming more competitive. This assumes that regulated companies can achieve environmental benefit at lower additional costs then their competitors. Even if this advantage materialises, subject to uniform environmental regulations, this would be at an additional cost, albeit lower than for laggards. There is no absolute cost reduction.

3. *Absolute cost reduction for the regulated firms*: the firm achieves so many win-win opportunities that its total private costs are reduced. This is the truly win-win variant of the hypothesis, but this is controversial to some economists because it assumes there is widespread organisational failure in firms.

Landis-Gabel *et al* (1998) demonstrated that absolute cost reduction through new environmental regulation, is only possible where the cost reduction already existed prior to the environmental regulations but was not realised due to inertia in the firm's systems and routines. Such inertia blinds firms to changing conditions and thus emerging opportunities, and also makes adjustments slow, difficult and costly, even when the need has become apparent. A reaction to environmental regulation may review pre-existing opportunities to save money sufficient to pay compliance cost. This is '*win-win in a limited sense'* as there is no evidence that the savings repay both the compliance costs and the cost of the requisite changes in the company's operations, processes and/or products.

The bottom line is that neoclassical economists are wrong and that Porter might be right (Landis-Gabel *et al.* 1998). The neoclassic economists assume that firms are perfect and

markets are flawed. Firms, however, are also imperfect, as their rigid systems and routines, set up to cut costs, turn into a constraint to profit maximisation and change in these systems is complex, disruptive and costly. Porter is at least partially right as firms are flawed by organisational inertia. Through dynamic response to, for instance, environmental regulation, they can turn environmental threat into a business opportunity. However, it is unlikely that the cost savings can cover compliance and transition costs.

3.2.2 Making environmental performance pay

> *"A company's ability to succeed in the face of increasing environmental pressure will depend on the same factors that determine corporate success more generally, such as the structure of the firm's industry, its competitive position and its ability to manage technological and human resources…In the absence of leadership and vision, executives relying on analysis and management cannot seize all available opportunities; on the other hand, careful analytical thinking is clearly necessary to determine which of the many possible leaps of faith might lead to desirable results"*
>
> *Prof Forest Reinhardt, Harvard Business School (*Reinhardt (2000), pg 13-14).

Organisational inertia is a principal business barrier to resource efficiency and innovation. Reinhardt (1999) argued that managers need to go beyond the question "*does it pay to be green*?" and ask instead "*under what circumstances do particular kinds of investments deliver returns to shareholders?*" He outlined five approaches to integrate the environment into business (Reinhardt 1999; Reinhardt 2000). First, some companies can distance themselves from competitors by differentiating their products and commanding higher prices for them. Second, other companies may succeed in managing their competitors by helping to shape the rules so that marginal cost increases for competitors are higher. Third, companies may find efficiency opportunities and thereby cut costs of their production. Fourth, almost all firms can improve their risk management, and thereby reduce expenditure associated with accidents, lawsuits and boycotts. And, fifth, companies may be able to make systemic change and redefine competition in their markets.

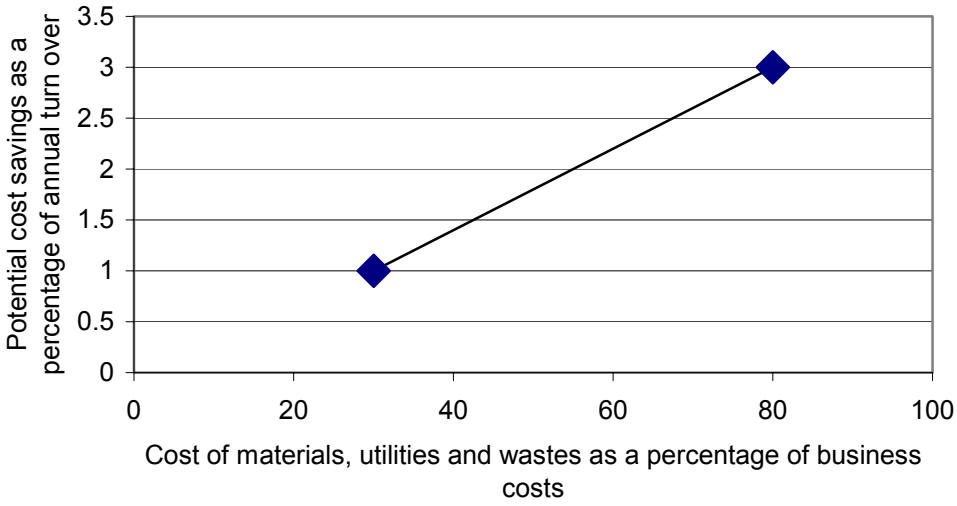
Reinhardt (2000) persistently argued that the environment should be approached as a business problem. Most businesses can therefore turn the environment into an opportunity. Doing so requires a focus on vision and strategy, as well as application of proven business tools. This is being addressed in current work in sustainability management[8], in particular in the areas of:

- *Corporate Sustainability Strategy*: by defining vision, objectives and strategy, firms can position themselves for competitive advantage by being environmentally and sustainability pro-active. Dunphy *et al* (2003) provide a sustainability phase model that outlines distinct performance levels organisations can aim to achieve, from active antagonism, through indifference, to a strong commitment and actively furthering sustainability values, not only within the organisation but within industry and society as a whole. Of particular significance in this context is the fact that resource efficiency has been singled out as a distinct performance level in the organisational transition towards corporate sustainability.

[8] A comprehensive review of business management tools for resource efficiency is beyond the scope of this background paper. Annex II however provides an overview of contemporary work on corporate sustainability strategy and environmental management accounting.

- *Environmental Management Accounting (EMA):* an EMA system can be thought of as a management accounting system that has been refined to capture the environmental performance of the organisation (Schaltegger *et al.* 2001; Deegan 2003). EMA has diverse benefits ranging from direct and tangible to indirect and intangible. A recent UK study of over 500 manufacturing businesses found that EMA is pivotal to structured approaches for resource productivity, which can help companies achieve cost savings of 1-3% of annual turnover, depending on the nature of their business operations (Envirowise 2002). Figure 3 shows the resulting relationship between cost savings from resource efficiency and the contribution of environmental costs to total business cost.

Figure 3: Typical cost savings as a percentage of annual turnover (source: Envirowise (2002).



3.2.3 Sustainability and business value

Better environmental management accounting practices enable consideration of environmental and resource efficiency issues in financial terms. However, it may not always be possible, or even necessary, to put a dollar value on the full range of business benefits from environment and sustainability performance.

John Elkington proposed a business value matrix (Dudock van Heel *et al.* 2001) to capture in a more comprehensive manner the business case for sustainable development. The matrix relates ten dimensions of sustainability performance to ten measures of business success.

- The ten *sustainable development dimensions* cover five areas, respectively: governance; general; environment; social; and stakeholder engagement.

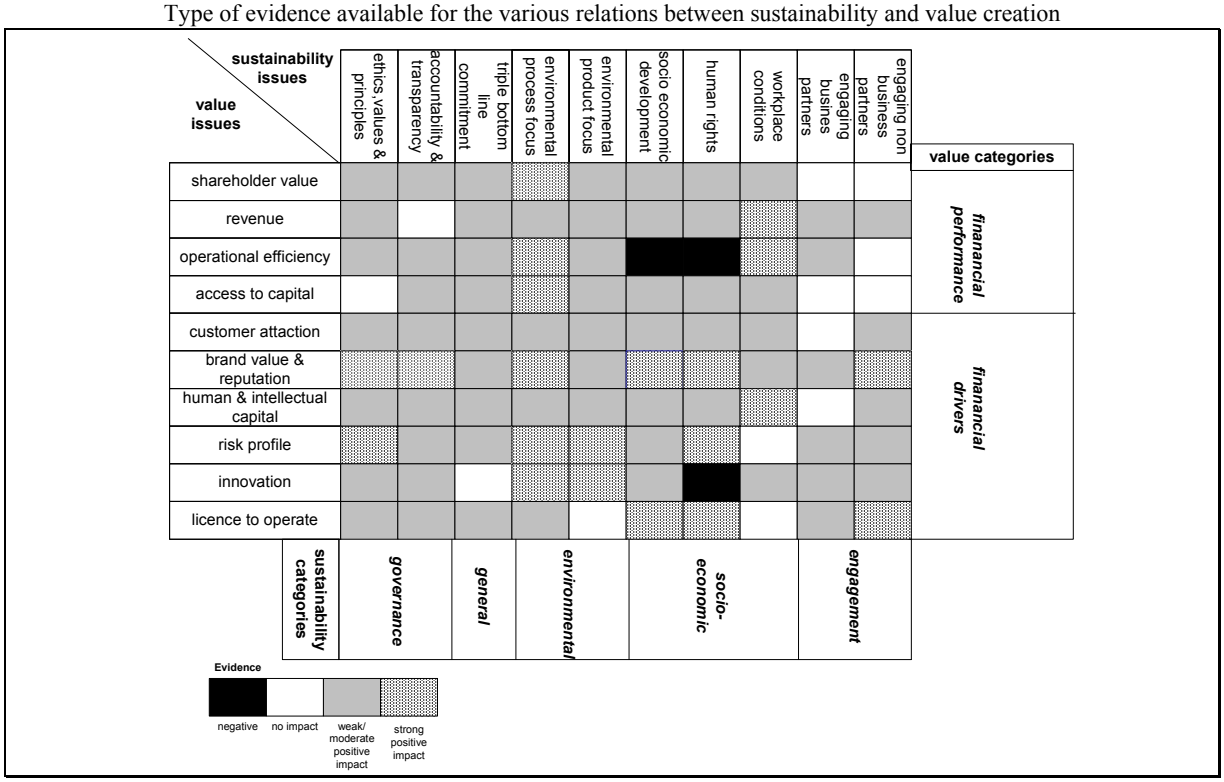
- The ten *business success measures* deal with financial performance and financial drivers.

The correlations between each sustainable development dimension and business success measure were qualitatively assessed both on direction of the correlation (positive or negative) and its apparent strength (see Figure 4). It was concluded that evidence in favour of the business case continues to build and is particularly strong in certain areas of business

performance. However there still remains a significant gap between what is intuitively logical and what one can prove (Dudock van Heel *et al.* 2001).

Figure 4: Sustainable business value matrix (adapted from Dudock van Heel et al (2001))

Type of evidence available for the various relations between sustainability and value creation



3.3 The economic rationale

This chapter aimed to develop an economic rationale for materials resource efficiency, in the context of the macro-economic goal of growth of the national economy (in 3.1) and in the context of firm level competitiveness (in 3.2). The principal findings converge remarkably.

- The leading ecological economics research summarised in section 2.1 justifies a *macro-economic interest in resource efficiency*.
    - Firstly, the theoretical analysis by Ayres *et al* (2005) confirmed that dematerialisation, through the combined pursuit of labour and material resource productivity gains, is a currently undervalued engine of economic growth, i.e. *resource efficiency initiatives enhance economic growth*.
    - Secondly, empirical studies show that resource efficiency and better environmental performance are not automatically achieved as economies grow. The Environmental Sustainability Index (Esty *et al.* 2005), for example shows that at every level of development some countries handle their pollution control and natural resource management issues better than others (YCELP/CIESIN/WEF 2005).
- The firm level perspectives on the relation between business performance (most often narrowly defined as competitiveness), environmental regulation, and elements of

corporate sustainability, including resource efficiency and environmental performance, confirm that there is a *business case for resource efficiency*.

- Firstly, the Porter Hypothesis challenged traditional assumptions that it does not pay to be green. Subsequent critiques confirmed that win-win opportunities for simultaneous achievement of environmental and business benefits exist, because both markets and firms are – at least to some degree - flawed. Markets fail in translating consumer interest in a clean environment into business opportunities for firms. Firms need systems and routines to reduce their operating costs, but the rigidity of these same systems and routines may ultimately compromise the firm's ability to maximise its profits while also raising the costs and risks associated with change. Moreover, the way environmental regulation has traditionally been set up has not been conducive to businesses coming up with innovative, cost- and resource-efficient ways to improve their environmental performance.

- Secondly, Reinhardt challenged the persistent view that environment needs to be addressed differently to the other issues businesses face. The ability of firms to respond effectively to increasing environmental pressure ultimately depends on the same skills and capabilities they depend on to respond effectively to other mounting business pressures, in for example management of human resources and technological change.

Businesses that do well, i.e. those that are competitive in their sectors, successful in their markets and profitable to their shareholders, generally also perform well in environmental management and sustainability performance. This correlation between business and sustainability performance is unlikely to be causal. *Environmental or sustainability performance does not deliver business performance, nor vice versa*. Instead, the same firm capabilities (i.e. its systems, strategies, analytical skills and leadership) that deliver business performance will also deliver environmental sustainability performance. Initiatives to foster resource efficiency in business, should therefore aim at *improving the capabilities* of firms to succeed in light of ongoing change. Corporate strategy and management accounting are most frequently highlighted as the leverage points to improve firm capabilities, and thereby achieve more viable businesses, that offer more secure employment, reduced waste and emissions generation and better returns to owners/shareholders.

4. Environmental sustainability foundations

> *More Value with Less Impact*
>
> *The rise in world affluence holds promise for better lives and also comes with significant risks to ecosystems if prevailing patterns of consumption, energy consumption and waste persist. The need to reduce consumption and waste creates new opportunities for business to grow while at the same time helping people, economies, and ecosystems through the innovation of less wasteful processes, and life-enhancing goods and services"*
>
> *World Resources Institute in collaboration with*
> *United Nations Environment Program and*
> *World Business Council for Sustainable Development (Doering et al (2002), p 20)*

Resource efficiency has multiple environmental benefits. It minimises the use of materials, energy and water, and indirectly the environmental impacts associated with their provision (mining, harvesting, processing, transport). It also reduces emissions to land ('*waste*'), air ('*air emissions'*) and water ('*wastewater'*), and the subsequent environmental impacts caused by these emissions.

A range of resource efficiency concepts exists, which partially overlap and otherwise compete. This chapter addresses resource efficiency practices (in 4.1), objectives (in 4.2) and processes involved in their implementation (in 4.3).

4.1 Resource efficiency practices

Robert (2000) proposed to structure sustainability models at five levels, ranging from principles of the ecosphere to sustainable development performance. Table 1 summarises these hierarchical levels and provides a prominent resource efficiency practice at each level. This shows that eco-efficiency is the most appropriate level to foster resource efficiency in practice in firms.

Eco-efficiency is also known as the "*business practice of being resource efficient*" (van Berkel 2005c). The seven commonly used dimensions reflect a slight bias for application in the manufacturing, trade and services sectors [9] (DeSimione *et al.* 1997; WBCSD 2000a):

- Reduce the material intensity of goods and services;
- Reduce the energy intensity of goods and services;
- Reduce toxic dispersion;
- Enhance material recyclability;
- Maximise the sustainable use of renewable resources;
- Extend product durability; and,
- Increase the service intensity of goods and services.

[9] There is a growing body of evidence that eco-efficiency is similarly applicable to other sectors, for example mining and minerals processing (van Berkel, R. (2002a). Application of Cleaner Production Principles and Tools for Eco-Efficient Minerals Processing. Proceedings Green Processing 2002: International Conference on Sustainable Processing of Minerals, Cairns (Qld), Australia, Australian Institute of Mining and Metallurgy.) and agribusiness van Berkel, R. (2002b). The Application of Life Cycle Assessment for Improving the Eco-Efficiency of Supply Chains. From Farm to Fork: linking producers to consumers through value chains (Proceedings of the Muresk 75th anniversary conference), Perth (WA), Australia, Muresk Institute.)

Table 1: Sustainability model hierarchy applied to resource efficiency concepts and practices (derived from van Berkel (2005b))

Model Level	Aim	Practice	Definition	Principal Resource Efficiency Applications
1. Principles of Ecosphere	Capture the *rules* that govern the functioning of the ecosphere	Industrial Ecology	Study of the flows of materials and energy in industrial and consumer activities, of the effects of these flows on the environment, and of the influences of economic, political, regulatory and social factors on the flow, use and transformation of resources	Biomimicry, i.e. using nature as model, measure and mentor
2. Principles of Sustainability	Capture the *conditions* that product and production systems should meet to achieve sustainability	The Natural Step	Sustainable products and societies, should not subject nature to: systematically increasing concentrations of substances (1) extracted from the Earth crust and (2) produced by society and (3) systematically increasing degradation by physical means, nor (4) systematically undermine the ability of humans worldwide to meet their needs.	May invoke for example biomimicry, dematerialisation; detoxification and change of business models
3. Principles of Sustainable Development	Capture the *strategies* that can be deployed in products and processes to achieve the principles of sustainability	Green Chemistry	Concerned with the design, development and implementation of product- and process chemistries that reduce or eliminate the generation of hazardous and toxic substances	12 principles address: waste prevention; atom efficiency; safer synthesis, chemicals, solvents and chemistry; energy efficiency; derivate reduction; catalysis; product degradation; and process analysis
		Green Engineering	Incorporates environmental considerations in all stages of process design to achieve better and greener process plants	
4. Sustainable Innovations	Capture the *activities* that lead to the realisation of the principles of sustainable development	Eco-Efficiency	Delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle, to a level at least in line with the earth estimated carrying capacity	7 elements: reduction of material and energy intensity; reduction of toxic dispersion; enhancement of material recyclability; maximum use of renewable resources; extension of product durability and increase of service intensity
5. Sustainable Development Performance	Capture the *measures* that track progress in sustainable innovations	Eco-Efficiency Metrics	*Efficiency* (or productivity) indicators express the unit of productive outputs per unit of net environmental influence	Primary application in eco-efficiency initiatives
		Environmental Performance Indicators	*Intensity* indicators express the level of environmental impact per unit of productive output	Primary applications in public environment and sustainability reporting

Among these seven, three are most directly linked to material resource efficiency and waste minimisation, respectively: material intensity, material recyclability and extended product durability. However, application of the other elements will in many cases also contribute to greater material resource efficiency. For example, elimination of toxics from a product design will greatly assist in reuse, recycling and/or recovery of the product, which in turn minimises waste.

Eco-Efficiency links the total productive output (or value creation) of the organisation to its resource use and impacts on nature. This can be quantified in either *intensity* indicators or *efficiency* (also productivity) indicators.

- *Efficiency* indicators express the level of efficiency in utilising natural resources in terms of units of productive output per unit of net environmental influence (i.e. kg of pigment produced per ton of greenhouse gases emitted; $-value of pigment sales per kL of water consumed) (WBCSD 2000b).

- *Intensity* indicators express the level of environmental influence per unit of productive output, i.e. kg greenhouse gas emission per ton of alumina produced; water consumption per ounce of gold recovered (ISO 2000).

Intensity indicators are more commonly used in the environmental policy and management practice, with the ultimate aim of driving the intensity indicator down (lower intensity indicator is better for the environment). Efficiency indicators are more profoundly promoted in business circles, with the ultimate aim of driving the indicator up to achieve higher productivity (higher efficiency indicator is better for the environment and for the business).

4.2 Resource efficiency objectives

The preceding review of eco-efficiency practices clearly demonstrates that elements of the sustainability models both overlap and complement one another. This is best illustrated with what appears to be three cross cutting objectives or themes (van Berkel *et al.* 2004):

- *Fate of Materials – Zero Dissipation:* Materials used and/or produced in human-made industrial systems should not be allowed to accumulate in nature because of the likely negative impacts and risks caused from disturbance of the '*grand cycles'* (the natural cycles of energy, water, nutrients, etc. that underpin life on earth). Materials should either degrade rapidly in the environment, or be kept in closed circulation in the industrial system. Moreover, leakage of reagents, other auxiliaries or unusable by-products from the processes involved in production, use, recovery and reuse of materials should be avoided.

- *Compatibility of Materials and Processes*: Materials in industrial systems and the processes involved, should be compatible with the processes taking place in the life supporting eco-systems to minimise the risk of them disturbing natural processes. Reduction of the toxicity of materials and their processing residues and emissions, is of utmost importance under the compatibility criterion. Compatibility is however a broader agenda – it also includes for example the avoidance of physical destruction of the environment and protection of biodiversity.

- *Materials Intensity of Industrial Products and Processes*: The materials intensity of products and processes is a good proxy for their environmental impacts, i.e. the more material that is needed for a given product or service, the larger the environmental impact caused in the production stage of those materials. Therefore, the lighter closed materials cycles are, the lower their environmental impact.

Table 2 shows that these three themes align reasonably well with the two common sustainable materials objectives i.e. '*dematerialisation'* and '*detoxification*' (Geiser 2001) or their equivalents in quantitative and qualitative waste prevention (as in 2.2 (van Berkel 2005d)). Although they provide clear direction where innovation efforts should focus, they do not provide a basis for quantitative assessment of sustainability performance. This requires development and customisation of assessment tools, for example at the level of project contributions to sustainable development (IISD 2002) or life cycle assessment of the environmental burdens of products, materials and technologies (Guinnee *et al.* 2002).

Table 2: Cross-cutting sustainability themes (source: van Berkel (2005b))

Cross Cutting Sustainability Themes (source: (van Berkel *et al.* 2004)	*Intent*	Materials Resource Efficiency Objectives (modified from: Geiser (2001))	
		1. Detoxification	**2. Dematerialisation**
		Reduction of the toxic characteristics of materials used in products and processes	*Increasing the intensity of service derived from each unit of material used*
1. Fate of materials – zero dissipation	*Minimise dissipative losses of materials throughout their lifecycle*	The combination of these two elements reinforces the introduction of materials that are less toxic and can also be contained in industrial systems	Zero dissipation is achieved by keeping materials in use longer in the industrial system and enhancing their recovery and reuse after each use stage – these all contribute to dematerialisation
2. Compatibility of materials and processes	*Minimise the potential disruption of natural processes by industrial materials and process emissions*	Toxicity is only one of the potential causes of non-compatibility of industrial processes and materials with natural processes and living organisms	Compatibility of industrial materials and processes is also a function of the size of the materials flows, which can be addressed through dematerialisation.
3. Materials intensity of industrial products and services	*Minimise the throughput of materials through the industrial system*	Not related or mutually reinforcing.	These elements converge as dematerialisation through increased service intensity per unit of material use minimises the throughput of materials per service delivery, and vice versa.

4.3 Business processes

There is a relative paucity of empirical data on what differentiates more eco-efficient businesses from less eco-efficient businesses. One of the few in-depth studies is the longitudinal survey of source reduction activities in a selection of 29 chemical plants in the USA (Sarokin *et al.* 1985; Dorfman *et al.* 1992). The regression analysis showed that three program features demonstrated significant positive correlation with more source reduction, or eco-efficiency, initiatives. These were: environmental management accounting systems (at least tracking of full costs of wastes); shared leadership by environmental and production

management, and two-way employee participation (Dorfman *et al.* 1992). Later work has focused almost exclusively on the application of business analytical skills and tools. DeSimione *et al* (1997) for example, discuss nine levers for eco-efficiency initiatives: leadership; foresight; culture; management tools; life cycle management; research and development; production and operations; marketing and procurement; and after sales service and disposal. Stone (2005a; 2005b) sought to interpret differences in the uptake of cleaner production concepts in businesses in New Zealand in the context of organisational change theory. She argued in favour of customisation of eco-efficiency programs, so that the concepts and activities '*resonate*' better with the individual businesses. This could enhance organisational learning, leading to better alignment of stated business principles, corporate strategy and operations. Dunphy *et al* (2003) argue that traditionally eco-efficiency has been too narrowly focused on efficiencies via cost reduction, disregarding the efficiencies that can be achieved through value adding (commanding a better price for more sustainable products and services) and innovation and flexibility (redefining products and business models).

Table 3 lists five eco-efficiency features, or business processes, that correlate positively with eco-efficient outcomes. In short, it appears on that eco-efficiency is principles driven and value focused, and employs life cycle (or system's) thinking to drive and deliver operational excellence and innovation.

Table 3: Implementation features of eco-efficiency [10]

Eco-Efficiency Feature	Guiding Idea (3)	Description
1. Principles Driven (1)	The target is zero	Eco-efficiency is based on a world view that waste and pollution equal inefficiency, and are signs of deficient product and process design which ultimately should be eliminated
2. Value Focused	The aim is value	Eco-efficiency places environmental initiatives in the context of the creation and capture of value
3. Life Cycle Thinking	The environment matters	Eco-efficiency considers all environmental impacts associated with product or service delivery and use, regardless of where, when and how these occur
4. Operational Excellence (2)	The norm is continuous improvement	Eco-efficiency is achieved by the vigorous and systematic pursuit of continuous improvement of operations through cross functional learning
5. Innovation	The opportunity arises from creativity and flexibility	Eco-efficient innovation delivers the products and processes that meet tomorrow's rather than yesterday's environmental expectations

Notes:
(1) An environmental policy equivalent of the principles driven feature is the waste management hierarchy which stipulates that waste avoidance is preferred over subsequently reuse, recycling, resource recovery and ultimately waste disposal
(2) This includes concepts such as Total Productivity Management and Kaizen Engineering and Management (Imai 1997)
(3) The guiding ideas should be interpreted as visionary goals. It is understood that their realisation may by fundamentally impossible because of physical and chemical limits, and/or the current and perceived future state of technology and engineering and business practices.

[10] These features have emerged from the authors' extensive involvement in the design, execution and evaluation of eco-efficiency initiatives across a wide spectrum of industry sectors and sizes, in Australia and internationally.

5. Opportunities for Australia

The previous chapters provided an economic and environmental sustainability justification for resource efficiency. This chapter looks at the specific economic opportunities for Australian businesses. It combines a review of the practical achievements in selected companies (in 5.1) with projections for likely financial benefits from economy wide application of resource efficiency (in 5.2) and its potential to create and capture business value (in 5.3).

5.1 Achievements

Records of company level achievements intuitively provide the most compelling evidence that resource efficiency is valuable to Australian firms. There are however severe data limitations in this approach. Firstly, only few businesses have documented their resource efficiency achievements and their specific economic and environmental benefits. A brief review of public databases suggests that there are some 250 Australian company case studies. This does not allow for a meaningful extrapolation to the approximately 1.3 million non-agricultural enterprises in Australia. Secondly, the data in the case studies are very limited. The economic data that are provided are typically limited to an estimate of the investment cost, annual savings from avoided waste disposal, energy and water costs, and simple pay back period. Indirect and hidden operational costs and benefits, transaction and opportunity costs are not disclosed. Moreover as there are no standardised assumptions, even apparently simple economic figures cannot be compared in any meaningful way. Thirdly, there is concern that the case studies on public record may not be the most innovative examples and therefore underestimate the environmental and economic benefits that might be achievable with more comprehensive implementation of eco-efficiency (van Berkel *et al.* 2001).

Despite these limitations, Table 4 has been compiled to illustrate the nature and size of the benefits from resource efficiency at eight Australian firms. Each of these demonstrates that the respective company was able to find innovative ways to reduce and recover a previously discarded non-product output, with comparatively limited investments that either resulted in direct cost savings, or could be regarded as the cheapest compliance option. The information is generally insufficient to assess how important the cost saving is to the business. Only for two companies, was it possible to estimate the value of the total operational savings in relation to the operation's annual turnover, in the range of 3% for Tiwest Pigment Plant and in the range of 2% for Allviron. This provides anecdotal evidence that resource efficiency can have a measurable impact on financial bottom line performance.

Many of the companies that have provided case studies on public databases have been associated with a government sponsored resource efficiency program. This association can range from simple general awareness raising and focusing of internal project teams (for example for Alcoa and Tiwest) to extensive partnering involving research support (for example Siemens and Allviron) and even low cost finance for investments (in the case of Insulform). The association with government-sponsored programs is likely to imply that the case studies are not entirely representative for all Australian business. One can argue that companies self selected on their poor initial performance, opening a big window of opportunity for quick wins. However, one can also argue that only proactive companies would open up their businesses for external review, and program participants may therefore have self-selected on high initial performance, and thus have comparatively fewer opportunities for quick wins.

Table 4: Waste minimisation case studies

Company / Sector	Key Initiatives	Resource Efficiency Impacts	Economic Impacts	Barriers / Learnings
Alcoa World Alumina[11] Mining & Minerals Processing	• Better mining control to avoid impurities (incl organics) in bauxite • Reduction in fine material loss through technology changes • Changes to vessel descaling practices • Improved heat exchanger maintenance • Oxalate management	• More efficient processing with reduced health & safety and environmental concerns in treatment and disposal • Saved 200,000t/y product to landfill • Reductions in scale waste disposal • Reduced product loss, lower safety hazard • Reduced emissions, became process input for vanadium production	>$10m/y >$14m/y	Initial attitude that it was "too hard" and it "had all been tried before". Overcome by ongoing effort of the team, backed by management. Overall outcome has been a shift in management attitude from seeing environmental projects as a necessary cost of doing business to one of looking for opportunities to improve the business
Charles I.F.E Pty Ltd[12] Pig Farming	Treatment of piggery waste slurry to produce electricity and heat, clean water for reuse, mineralised water for irrigation, solids as fertiliser	Reduced water use, net electricity producer, eliminated odour, improved working conditions. Use in organic fertiliser improves turf growth and recovery from damage.	Annual savings: • electricity - $125,000; • water - $50,000; • fertiliser - $250,000. Total - $425,000 Payback period, 6 yrs	"The old farming philosophy of wasting nothing makes good business sense."
Tiwest Kwinana Pigment Plant[13] Non-Metallic Mineral Product Manufacturing	• Production of hydrochloric acid for sale and for ammonium chloride used in another Tiwest process • Recovery of rutile and coke from process effluent. • Use of alternative fuel	• Waste previously neutralised and discharged is converted to useful product and replacement of imports • Improved rate of conversion of raw materials • Improve chlorine efficiency	• Savings in the costs of ammonium chloride to Chandala, and lime for neutralisation • Savings of about $31,000/d for a cost of $6m Total savings from resource efficiency approach 3 % of annual turnover	These initiatives have been driven by cost, productivity and environmental compliance and improvement considerations. Barriers were the challenges of initiating new processes and ensuring that they are economical.

[11] http://www.deh.gov.au/settlements/industry/corporate/eecp/case-studies/alcoa.html
[12] http://www.deh.gov.au/settlements/industry/corporate/eecp/case-studies/charlesife.html
[13] http://www.deh.gov.au/settlements/industry/corporate/eecp/case-studies/tiwest.html

Insulform Pty Ltd[14] Motor Vehicle Component Manufacturing	Change of basic material used	• Offcuts and rejects recycled into new material with no loss of quality. • Better work environment. • Lower reject rate. • Better and cheaper product.	• Capital/installation $660,700 • Training costs-$30,000 TOTAL COSTS: $690,700 • Reduced waste disposal-$22,000 • Elimination of carbon filters $26,820 • Productivity $370,000 TOTAL SAVINGS: $418,820 PAYBACK PERIOD-1.6yrs	Productivity improvements were an incentive. Barriers included 'traditional' thinking of the company, its employees and suppliers; these were overcome by a program of internal and external training to communicate the benefits. Note: high level of partnering by VicEPA including no-interest loan.
Siemens Dematic[15] Logistics	• Replace wood pallets with steel • Laser cutter replacing press Other projects had energy and water focus	• 700t wood not going to landfill • Saved 2666t/y steel	• Cost $20k, savings $10k/y • Cost $1.2m, savings $0.8m/yr	The catalyst for these initiatives was Siemens' involvement with a metals industry 'cluster' facilitated by the Advanced Manufacturing Centre. Also partnership with NSW DEC
Allviron Pty Ltd[16] Plastic bag production	• Scrap recycling • Production changes • Cardboard recycling • Drum return		Total savings of $42k/y at no capital cost. Savings equal around 2% of annual turnover	No barriers, but required thinking "outside the square" as part of ongoing business improvement. Partnership with VicEPA.
Pilkington Australia Ltd and The Alex Fraser group[17] Glass manufacturer and Recycling company	Reduce, reuse, recycle of broken glass and off-spec material	Avoided 600t/y prescribed waste to landfill	Savings and sales $150,000/yr	Lessons learned: • Advantages of partnerships • Need for early involvement of regulators.
Viscount Plastics WA[18] Injection moulding of plastic containers	Focus on process improvements which achieve productivity targets	Reduced rejects from 1-2% down to <100ppm; all scrap recycled internally	Reduce usage of high-cost material; improve machine and operator efficiency; improve "delivery in full on time"	Requires shifting to pro-active, teamwork, continuous improvement and systems approach

[14] http://www.deh.gov.au/settlements/industry/corporate/eecp/case-studies/insulform.html
[15] http://www.environment.nsw.gov.au/resources/siemens.pdf
[16] http://www.epa.vic.gov.au/Business_Sustainability/allviron.asp
[17] http://www.epa.vic.gov.au/Business_Sustainability/pilkington.asp
[18] Presentation at 2005 Eco-efficient Entrepreneur Series, available at http://www.wasig.curtin.edu.au/wasig/wasigresources/eee2005/m6viscountplastics.pdf

Some of the programs aimed at fostering resource efficiency in Australian firms are[19]:

- *NSW Business Partnership* (Trewin 2005): The '*Profiting from Cleaner Production Industry Partnership Program*' engaged over 460 organisations in cleaner production projects, saved companies almost $10 million and delivered environmental savings that included 9,200 tonnes of raw materials and 8,900 tonnes reduction in waste to landfill (also energy and water savings). The costs included $2.7 million government contribution, matched by cash and in-kind effort by companies.

- *SA Greener Business Alliance* (Harris *et al.* 2005): The alliance between SA EPA, The Yalumba Wine Company, and ten of its suppliers delivered real eco-efficiencies, valued at $432,500 over 5 years. The benefits were achieved beyond the formal six-month project and further improvements are being identified through an ongoing process.

- *Western Australia* (van Berkel forthcoming-a): Since 1999, CECP has delivered cleaner production and eco-efficiency programs to businesses of all sizes, both individually, and in groups based on industry sectors or location or a shared interest in eco-efficiency and sustainability. Key programs included the small business technical assistance program (van Berkel 2004a), the learning by sharing program of the WA Sustainable Industry Group (including the Eco-Efficient Entrepreneur Series) and the WA Cleaner Production Statement (van Berkel forthcoming-a). Collectively these programs have been pivotal to putting eco-efficiency and sustainable development profoundly on the business and government agendas.

5.2 Projected opportunity

Although case studies like those summarised in Table 4 provide evidence at the company level, their use for projecting savings at the economy level is limited. The UK government-sponsored *Envirowise* program provides some guidance to estimate the potential improvement in a business's performance from waste minimisation (DETR 1997). The 10-year experience has provided the program with data for over 500 manufacturing businesses. The total waste costs for the UK industry are estimated to be at £13 billion/year, which is equivalent to around 4.5% of total annual turnover. A considerable portion could be saved, in some cases rather quickly and simply, through waste minimisation. Potential savings of £3 million, nearly 25% of waste costs, were identified, many of which could be achieved with no significant capital outlay. Follow up work specifically on environmental management accounting supported the working hypothesis that UK businesses can save between 1 and 3 percent of their annual turnover through resource efficiency initiatives (see also 3.3.3) (Envirowise 2002), depending largely on the relative environmental costs of the businesses. As a conservative estimate it is therefore here assumed that firms can on average save 1% of their annual turnover through resource efficiency initiatives. In doing so, it is worth noting that for the two case studies in Table 4 for which savings could be related to annual turnover, total savings mounted up to 2 and 3% of annual turnover (respectively for Allviron and Tiwest).

In a new effort to appreciate the annual worth of the economic opportunity from widespread uptake of resource efficiency, the 1% figure was applied to the sector level data (for 135 industry sectors) generated for the recent Triple Bottom Line Assessment of the Australian

[19] Additional information on these programs can be found in Annex III.

Economy (*Balancing Act*, 2005, (Foran *et al.* 2005)). Where data were available, 1% of the annual turnover for the sector was taken as the proxy annual worth of the projected economic opportunity that could be realised from the vigorous pursuit and implementation of resource efficiency.

Sectors with less than 10 businesses have been deleted from the analysis, as have the mining and primary agricultural production sectors. While it is recognised that some businesses in these sectors have made significant eco-efficiency improvements, many such improvements depend on sector-specific technology that cannot be readily adapted to other sectors or in some cases elsewhere within the sector. Moreover, given that the 1% was derived from manufacturing and related sectors, the value might not be applicable to primary sectors.

For each sector, an average value was calculated by dividing the dollar value of the economic opportunity by the number of businesses in the respective sector[20]. The results are presented in Table 5. They ware arbitrarily divided into four groups[21]:

1. *Very high economic opportunity* (economic opportunity greater than $400k/y per business): This group includes eight sectors, including two high value-adding sectors: Health Services (3rd out of 135) and Motor Vehicles and Parts (27th). It covers 1665 businesses with total annual turnover of $94 billion (total economic opportunity for this group is therefore projected to be $940 million per year).

2. *High economic opportunity* (economic opportunity between $200k/y and $400k/y per business): This group includes seven sectors, including one high value-adding sector Wholesale Trade (2nd). This group includes 8,490 businesses with $286 billion annual turnover (total economic opportunity for this group is therefore projected to be $2,860 million per year).

3. *Moderate economic opportunity* (economic opportunity between $100k/y and $200k/y per business). This group includes thirteen sectors with 3,430 companies having an annual turnover of $48b/y (total economic opportunity for this group is therefore projected to be $480 million/year).

4. *Low economic opportunity* (economic opportunity between $50k/yr and $10k/y per business). This group covers seven sectors with a total of 4,800 companies that generate an annual turnover of $30b/y turnover (total economic opportunity for this group is therefore projected to be $300 million/year).

Collectively these four groups cover 35 sectors (out of the 135 studied by (Foran *et al.* 2005)) with some 18,000 businesses. Although this is only a small share of the total of around 1.3 non-agricultural businesses, collectively these businesses comprise a large share of the Australian economy. Using the 1% proxy estimation, the annual worth of the economic opportunity from resource efficiency is projected to be $4.5 billion/year.

[20] The reason for incorporating the number of businesses in this way is in accordance with experience with several business improvement programs that demonstrates that, in most situations, the effort required to achieve improvements does not decrease with each business assisted. Each business requires assistance through the same steps because there is no effective way to short-circuit the learning process.
[21] Note: The data behind these tables is from 1994-5, so any detailed conclusions need to be tested against more recent information.

Table 5: Projected economic opportunity from eco-efficiency implementation (estimated from: Foran (2005), Envirowise (2002) and DETR (1997)).

CSIRO code	Sector description	Turn-over $b/y	No. Firms	Value-added Rank[22]	Projected Opportunity $k/firm/y	Resource Intensity Factor[23]
Very High						
Bm	Beer & malt	3	10	73	3,000	0.2
Dp	Dairy products	3.4	15	59	2,267	0.2
Mv	Motor vehicles & parts	13.6	80	27	1,700	0.1
Of	Oils & fats	2.2	30	125	733	0.6
Nf	Other non-Fe metal products	6.5	100	56	650	1.4
Hs	Health services	60	1,300	3	462	0.1
Rw	Railway equipment	1.2	30	121	400	0.1
Fc	Flour & cereal foods	4	100	83	400	0.3
Group Total	**Eight Sectors**	**94**	**1,665**		**940,000**	
High						
Pa	Paper containers & products	3.8	100	72	380	0.5
Bv	Soft drinks, cordials	3.3	90	89	367	0.3
Wt	Wholesale trade	260	7500	2	347	0.3
Ch	Basic chemicals	8.5	300	55	283	3.7
Fp	Fruit & vegetable products	4.4	200	71	220	0.5
Pt	Paints	2	100	93	200	0.1
Tx	Fibres, yarns & fabrics	4	200	79	200	0.1
Group Total	**Seven sectors**	**286**	**8,490**		**2,860,00**	
Medium						
Mp	Meat products	14.6	800	45	183	0.2
De	Soaps & detergents	1.8	100	115	180	0.1
Mn	Services to mining	5	300	51	167	0.4
Gp	Glass products	1.5	100	94	150	1.2
Mi	Other non-metal mineral products	1.4	100	113	140	2.4
Cn	Confectionery	1.7	130	107	131	0.2
Fd	Other food products	10	800	37	125	0.2
Ai	Aircraft	3	250	90	120	0.0
Hh	Household appliances	2.3	200	91	115	0.1
Oc	Other chemical products	1.6	150	99	107	0.1
Cp	Concrete products	3	300	66	100	0.1
Ct	Cosmetics and toiletries	1	100	117	100	0.1
Kn	Knitting mill products	1	100	114	100	0.2
Group Total	**Thirteen sectors**	**48**	**2,430**		**480,000**	
Low						
Tp	Textile products	2.4	300	101	80	0.5
Sg	Other mining	3	400	53	75	0.6
Ee	Electrical equipment	6.5	900	54	72	0.1
Ne	Publishing	10	1500	30	67	0.2
Sm	Structural metal products	2.6	500	52	52	0.2
Oe	Scientific equipment	5	1000	88	50	0.1
Lp	Leather products	1	200	128	50	0.2
Group Total	**Seven sectors**	**30**	**4,800**		**300,000**	
Grand Total	**35 Sectors**	**$458b/y**	**18,385**		**$4.58b/y**	

[22] Ranked out of 135 sectors; "Value-added" is CSIRO terminology not specifically defined in "Balancing Act" (Foran, 2005)

[23] The Resource Intensity Factor was calculated by dividing the Water use, Land disturbance and Primary Energy for the sector by the nation-wide average and summing. A score of 3 would indicate average use across the three resources. All sectors other than Basic Chemicals are below average. Note: Sectors with above average factors were in agriculture sectors (for water and land disturbance), and mining, minerals processing and primary energy production sectors (for energy)

Sectors for which the same approach yielded an economic opportunity smaller than $50k/yr were excluded. The analysis showed that for 15 sectors, having a total of around 280,000 businesses, the projected economic opportunity would be between about $10k/yr and $50k/yr. This group is dominated by service sectors with large number of businesses (including hospitality, education, retail trade). Given the roots of the 1% proxy value in the manufacturing sector, it would be more problematic to apply the proxy calculation across these sectors. However, it is clear that there may be a considerable economic opportunity for the numerous businesses in this group of sectors.

A number of qualifiers need to be made about this proxy assessment of the projected economic opportunity from resource efficiency for the Australian economy.

- The 1% improvement from the UK work is for all resources including energy and water. It is unknown how much non-hazardous material resources contribute to the total economic opportunity from resource efficiency. While it is unlikely that the economic opportunity can be realised by a sole focus on materials resource efficiency, it has already been pointed out that materials resource efficiency will often be accompanied by efficiency improvements in water, energy and other natural resources.

- The local cost for waste disposal (typically at least three times higher than in Australia) and energy (typically at least double) in the UK does influence the estimate. Although this will have some influence on the magnitude of economic opportunity in Australia, this is likely to be comparatively limited, as even for the UK it was estimated that most of the economic opportunity came from reduction of internal costs (a proxy value for UK is that total waste costs are 10 times higher than the waste disposal costs, or in other words, disposal costs represent only 10% of the total waste cost that can be avoided through resource efficiency (DETR 1997)). Moreover, the few Australian case studies for which information is available supports the view that the economic opportunity could be between 1-3% of annual turnover.

- Within each sector there is likely to be a significant variance around the average turnover value. Individual businesses may therefore shift between the groupings of average economic opportunity.

- For a range of reasons (including lack of data, but more significantly because of the small number of 'businesses' involved) most of the top-ten value-adding sectors do not make the priority list. In the case of solid waste, the building sectors and associated industry types probably warrant further consideration, particularly larger businesses. The Education sector is also a special case because of the flow-on effect of the instilled values and behaviours into all other sectors.

- This ranking suggestion should not be construed in any way as a criticism of existing Australian programs, which focus on SMEs. It is a suggested mechanism for future focussing of limited government resources on highest projected economic opportunities.

The assessment would be improved by using the detailed sector framework and economic information in the CSIRO "*Balancing Act*" report (Foran *et al.* 2005) with the addition of 'materials flow' data, so that materials can be assessed in the same level of detail as water and energy. As indicated elsewhere in this paper, the data collection task is considerable. If

the focus is on understanding (and then minimising) the flows at the point of final disposal to a municipal landfill, then direct contributions from all 135 sectors need to be assessed. To identify the best triple bottom line waste minimisation opportunities will require assessment of the sources of the materials e.g. the origin of packaging disposed of by a householder. In the case of some waste streams that are important from the viewpoint of either volume or impact, it may be necessary to track flows several steps back up the supply chain. Even if at each step there is an arbitrary cut-off on the basis of percentage contribution, or number of contributors, the number of data points rapidly becomes enormous (e.g. Foran *et al* (2005), Vol 1, page 22). Given the magnitude of the potential dollar savings and other benefits, funding of this data collection task is warranted but needs to be co-ordinated Australia-wide.

5.3 Business success

Management accounting, like other financial approaches, may fall short in capturing the full impact of corporate sustainability initiatives on business success (see also 3.2.3). The SustainAbility Think Tank therefore proposed a sustainability business value model (as in Figure 4) (Dudock van Heel *et al.* 2001). Even though eco-efficiency is only one item on the corporate sustainability agenda, it appeared useful to follow a similar approach for linking eco-efficiency to business success.

Figure 5 shows the resulting eco-efficiency value matrix. It maps the ten measures of business value against the five implementation features of eco-efficiency (as described in section 4.2). The figure shows that:

- There is a profound positive impact of 'operational efficiency' and 'value focus' on the financial performance measures. The impact of the other eco-efficiency features, in particular 'principles driven', 'life cycle thinking' and – to a lesser extent – 'innovation', on the financial performance measures is less clear, albeit there is no ground for *a priori* concern for a negative impact.

Figure 5: Eco-Efficiency Value Matrix: impact of eco-efficiency features on measures of business success

Business Success Measures (Dudock van Heel *et al.* 2001)	*Eco-Efficiency Features (see 4.2)*				
	Principles Driven	Value Focused	Life Cycle Thinking	Operational Excellence	Innovation
Financial Performance					
Shareholder Value	Unknown	**Positive**	Unknown	**Positive**	**Positive**
Revenue	Unknown	**Positive**	Unknown	***Strongly positive***	**Positive**
Operational Efficiency	Unknown	**Positive**	Unknown	***Strongly positive***	Unknown
Access to capital	Unknown	**Positive**	Unknown	**Positive**	**Positive**
Financial Drivers					
Customer Attraction	**Positive**	**Positive**	**Positive**	Unknown	Positive
Brand Value and Reputation	**Positive**	**Positive**	**Positive**	Unknown	Positive
Human and Intellectual Capital	***Strongly positive***	**Positive**	Unknown	Unknown	Positive
Risk Profile	Unknown	Unknown	**Positive**	**Positive**	Unknown
Innovation	**Positive**	**Positive**	**Positive**	**Positive**	***Strongly positive***
License to Operate	**Positive**	Unknown	Unknown	**Positive**	Positive

- Three eco-efficiency features, respectively 'principles driven', 'value focus' and 'innovation', have a positive impact on most of the measures for financial drivers (except for risk profile). The other eco-efficiency features, respectively 'life cycle thinking' and in particular 'operational excellence', contribute less profoundly to the financial drivers, but align relatively well with reduction of the organisation's risk profile.

Even though Figure 5 is based on expert judgement, it appears that key features of eco-efficiency at the company level align well with measures of business success, in particular in regards to financial performance. The analysis illustrates that eco-efficiency builds upon and enhances, rather than distracts from, the focus on business success.

5.4 Value of resource efficiency

This chapter aimed to estimate the economic value of greater resource efficiency in Australia. This was approached from three angles.

- The company examples summarised in section 5.1 all demonstrate significant reductions of materials use and waste generation, which were achieved with comparatively minor investments, or with investments that provided solid economic returns or could be regarded as the cheapest environmental compliance option. The data available from case studies lack details on for example transaction and opportunity costs associated with the implementation of resource efficiency, and the impact of the economic benefits on bottom line financial performance of the business. However, there is some indication that total economic benefits from resource efficiency, including but not limited to material resource efficiency, could mount up to 1-3% of annual turnover of the business.

- A conservative international benchmark for the value of the projected economic opportunity from resource efficiency was applied to turnover data for 135 Australian industry sectors. For 35 sectors, the average projected economic opportunity ranged between $50k/yr and $400k/yr per business. This covers over 18,000 businesses, with a projected total economic opportunity valued at $4.5 billion/year.

- An eco-efficiency value matrix was compiled to map ten measures of business value against the five implementation features of eco-efficiency. Key features of eco-efficiency at the company level turned out to align well with measures of business success, in particular in regards to financial performance. The analysis illustrated that eco-efficiency builds upon and enhances, rather than distracts from, the focus on business success.

Despite the obvious methodological and data limitations in each of these approaches, collectively they provide strong evidence that resource efficiency is a multi-billion dollar per year economic opportunity for Australia.

6. Barriers and motivators

> *" [..] companies have to be understood as social organisations, operating in a complex arena of opportunities, constraints and pressures, utilising heuristics to deal with imperfect information about themselves, their market and wider environment, and consisting of individuals and groups with their own agendas for change, both within the firm and beyond. If we are to unlock the reserves of latent innovation within firms and achieve a steadily increasing rate of improvement in energy and resource use efficiency and a steadily diminishing level of environmental impact, we must modify our regulatory and market systems in ways that will both shape the environmental behaviour of firms and encourage the development and dissemination of cleaner solutions"*
>
> *Prof Anthony Clayton, Alcan Professor of Carribean Sustainable Development, University of West Indies (Clayton (1999), pg 259-260)*

Chapter 5 confirmed that resource efficiency offers a profound opportunity to increase the productivity of the Australian economy. Its realisation is however challenged by barriers, or failures, in the way businesses operate and how they are influenced by government policy and market and consumer information. This chapter discusses barriers and motivators in greater detail. It covers Australian and international perspectives on barriers (in 6.1 and 6.2), and company level motivators (in 6.3) leading to an overall perspective on market, policy and organisation factors (in 6.4)

6.1 Australian studies

In the lead up to the development and implementation of Australia's national Cleaner Production Strategy (ANZECC 1998), Environment Australia commissioned the Australian Centre for Environmental Law, to investigate barriers, motivators and drivers for cleaner production (Gunningham *et al.* 1997). So far, this remains the only in depth review of business perceptions on the barriers and motivators to resource efficiency and waste minimisation.

The primary barriers were identified as follows (Gunningham *et al.* 1997):

- A lack of information and expertise, particularly among smaller firms;
- A resistance to cultural change on the part of management;
- Competing business priorities, especially the pressure for short term profits; and,
- High cost of new, cleaner technology.

Similarly, the study confirmed primary motivators and drivers as (Gunningham *et al.* 1997):

- Ability to share information through networking and business partnerships and access to external expertise, particularly for smaller firms;
- Desire to maintain good community relations, particularly for larger firms;
- Convergence of more efficient production processes with sophisticated cleaner production processes, such as environmental management systems; and,
- Access to financial incentives for investment in new, cleaner technology.

As part of its commitments under its Eco-Efficiency Agreement with the Commonwealth Government, the Australian Chamber of Commerce and Industry conducted an Eco-Efficiency survey (ACCI 2003). 330 businesses responded to the mail survey that was

distributed to the membership of ACCI between October and December 2002. The three most frequently mentioned barriers were:

- Cost of implementing improved operations (reported by 35% (small businesses) to 55% (large businesses) of the respondents);
- Lack of time (reported by 35% (large businesses) to 46% (medium businesses) of the respondents); and,
- Lack of commercial benefit from improved operations (reported by 33% (small businesses) to 43% (large businesses) of the respondents)

A remarkable finding was that all barriers are more frequently reported by medium businesses than by small businesses (with the exception of virtually equal occurrence of lack of knowledge on alternative ways of operating).

With regard to motivators, three stood out as the most common motivators for environmental performance in businesses. These are (ACCI 2003):

- Increased environmental awareness (reported by 52% (small businesses) to 68% (large businesses) of the respondents);
- Cost savings (reported by 39% (small businesses) to 56% (large businesses) of the respondents); and,
- Compliance with regulations (reported by 25% (small businesses) to 50% (medium and large businesses) of the respondents)

The trend appeared that motivators were less frequently experienced and reported by small companies than by their medium and large business peers.

Based on its experience in fostering cleaner production and eco-efficiency in Western Australia, the Centre of Excellence in Cleaner Production concluded that three (clusters of) barriers appeared to be most pertinent (e.g. van Berkel (2004a)):

1. *Misunderstandings regarding the nature and benefits of cleaner production*. Cleaner production (and/or eco-efficiency) is by many regarded (and even promoted) as an environmental strategy primarily aimed at waste reduction or even just compliance with environmental regulations, whereas in fact it is best viewed as a business improvement strategy with waste reduction as *ONE* of the likely environmental benefits (but in most cases not the primary driver for business to implement cleaner production).

2. *Moderate to low levels of environmental awareness and compliance, in particular among small to medium sized enterprises*. Environmental inspections of small and medium sized operations are sporadic, and therefore do not convey an urgency to comply. Moreover, environmental surveys repeatedly show that most small to medium sized business operators do not perceive their business as having a noteworthy impact on the environment (even though their energy, water and waste management bills attest to the contrary).

3. *Volatile nature of small business (including ownership and workforce)*. The small business sector is very volatile and cash-flow focused, which hampers the businesses' ability to systematically improve and benefit from approaches such as resource efficiency practices, quality management, customer-relationship building, product and service differentiation, etc.

6.2 International assessment

> "[] *governments are realizing that perhaps the single most important reason contributing to the waste challenge is the fact that producers and consumers have not been required to pay the full social and environmental costs of the wastes they are responsible for creating."*
>
> *OECD Working Party on Pollution Prevention and Control (OECD (2000), pg 25)*

OECD ((2000), pg 25) concluded that from a government perspective, waste prevention efforts must address four failures and barriers in the prevailing waste and materials policies.

1. *Inadequate information*: also known as '*information failure*'. Examples exist on many levels. Databases on waste generation and disposal are generally deficient. A general lack of accepted waste prevention performance indicators is another example. Moreover, non-existing or poorly conceived environmental labelling also add to information failure.

2. *Lack of 'systems thinking'*[24]*:* Most countries have a patchwork of waste-related programmes at various geographic scales, points in the life cycle of materials, and kinds of waste. Solutions to problems are often piecemeal, and the risk for incoherence is high. In some countries, the regulation of new materials is much simpler and less costly than that of waste materials, favouring the use of new materials over the re-use of old ones.

3. *Lack of economic cost-benefit thinking*: waste disposal authorities are often required to prove financial profitability, i.e. that for any waste management scheme, private costs are outweighed by private benefits/revenues. The requirement should however be that the introduction of such a scheme reduces overall net *social* costs (i.e. private plus external costs).

4. *Lack of environmental awareness/sensitivity*: lack of knowledge, sensitivity or appreciation of waste generation and its environmental implications at the household, corporate/industrial, or governmental level. While incomplete information (see point 1) will tend to make individuals or organisations "less aware" about the implications of their actions, this does not by necessity lead to the conclusion that "good" environmental information will produce desirable results in a market where public or private consumers are not receptive to, and do not act upon, such information.

OECD highlighted the dilemmas in applying traditional cost benefit analysis. Even though it is needed to provide a market signal to waste producers, full costs of treatment and disposal are typically underestimated due to problems in estimating full private and social costs of waste disposal over sufficiently long, sustainable, time frames ([25]). Moreover, even if waste costs could be quantified, the overriding environmental policy objective would still be to avoid waste. Importantly, OECD notes, alike other authors (Landis-Gabel *et al.* 1998), that "*Waste prevention targets may reflect political decisions, not cost-benefit calculations" (OECD 2000).*

[24] The OECD reference to *'systems thinking'* might be interpreted as the combination of '*whole of government approach*' (i.e. the coordinated involvement of government agencies at different hierarchal levels and serving different public interests) and '*life cycle thinking'* (i.e. the coordination of policies, measures and incentives at different stages in the lifecycle of a product, material or waste).

[25] Standard discounting practices result in future operational costs beyond about eight years typically producing zero discounted cash flows, and thereby being excluded from the cost benefit analysis.

OECD (2000) concluded that "*these failures and barriers are ubiquitous but vary in severity and extent from country to country*" (pg 25). An in depth review of the specific Australian situation was beyond the scope of the preparation of this background paper. However, on the basis of waste management and reduction policies in several states (e.g. Western Australia (DCT/WAMA 1993; DEP/SRAC 2001; WAste2020 2001; WMB 2004), Victoria (VicEPA 1998; GoV 2005), South Australia (GoSA 2005; Zero Waste SA 2005), it appears that each of the four key failures and barriers are also at play in Australia.

6.3 Motivators

There is growing recognition that it might be more fruitful to focus on enhancing motivators than removing barriers (Kemp *et al.* 2004) (Harris *et al.* 2004). After all, there is convincing evidence that companies manage to overcome the barriers, once they have recognised the benefits. Moreover, it is in human nature to find excuses, or barriers, for things that are not perceived to be in one's own interest. Of course, the renewed focus on motivators does not ignore that barriers exist, and may need fixing. However if fixing the barriers does little to influence decision-making of firms, it will not lead to greater uptake of resource efficiency.

A firm's motivation for resource efficiency is primarily influenced by:

- *Compelling business case* (i.e. recognition that resource efficiency delivers value to the business, or in other words "*is it worth doing?"*); and,
- *Ease of implementation* (i.e. the expected level of effort required and risks to be assumed in the development and implementation of resource efficiency, or in other words "*is it doable?*").

In regards to the *business case* for resource efficiency, it appears to be profoundly undervalued, on the basis of perception or facts.

1. *Firms being unaware what impact poor environmental management and performance can have on their short- term profitability and long-term value and viability.*
   This is often hidden in statements like "*competing business priorities*". Environmental issues can however only compete with other business priorities if these have been analysed as business issues in the first place. The *perception* that there is no business case for resource efficiency and/or waste prevention is commonly rooted in:
   - *Lack of management accounting*: underestimating environmental costs as a result of deficient management accounting systems;
   - *Lack of environmental business risk assessment*: absence of an up to date inventory of the environmental aspects and risks of the business, and an assessment of their potential impact on the environment and on the continued viability of the business;
   - *Resistance to change* and/or failure to recognise that business conditions (including government and community expectations) have changed over time; and,
   - *Uncertainty over environmental priorities*: scepticism about environmental motives of government, communities and market partners.

   Broadly speaking these are failures in the company's internal management and information systems and procedures that require enhancements of the company's capabilities, which will benefit resource efficiency as well as contribute to overall profitability and viability of the business.

2. *Firms that have relatively low environmental and resource costs and business risks.* These firms are aware of their cost and risk exposure, and made an informed decision that resource efficiency is not a business priority. The fact that there is no business case for resource efficiency and/or waste prevention is then rooted in factors outside the firm's own sphere of influence, for example:
   - Low costs of resource inputs and waste disposal;
   - Low regulatory compliance risk;
   - Low environmental awareness among customers, suppliers and other stakeholders.

   Lifting the business case is then dependent on changes external to the company, for example profound changes in market and customer expectations, changing resource prices and availability, or changes in regulatory regime.

In regard to *ease of implementation*, there is a similar situation in that the firm's assessment of the level of effort, and hence transaction costs, required for identification and implementation of resource efficiency, can be based on perception or facts. There is a significant opportunity for government to make resource efficiency easier, through providing information and technical assistance, and potentially even financial assistance. However, there is a trade off between making it easier and maximising the business opportunity. The former typically leads to check list type of approaches of what everyone should be able to do. The latter typically requires some in depth consideration of the firm's specific circumstances to find the solution that matches best with the products, operations and markets of the firm.

6.4 Moving forward

This chapter reviewed studies of business barriers and motivators for resource efficiency. Overall, there is clear evidence of market, policy and organisational failures.

- *Market failure:* markets insufficiently articulate society's expectations for a clean environment into business opportunities for clean and resource efficient products and services. It includes:
  - Inability of the market to capture the full private and social costs of waste management, recycling schemes, and the subsequent low cost of waste management; and,
  - Relatively high transaction and opportunity costs for implementation of resource efficiency and waste minimisation, as a result of lack of impartial, easy to access, information on alternative waste minimisation practices and technologies.

- *Policy failure:* the policy environment in which waste generators operate does not convey a sense of urgency to reduce waste nor does it provide clear direction on what needs to be achieved in the medium to long term. It includes:
  - Inadequate information on waste generation and materials use;
  - Patchy and insufficiently coordinated policies and programs between and within jurisdictions, and focussing on different parts of the various waste life cycles; and,

- *Organisational failure*: lack of environmental awareness and sensitivity among waste generators/firms and existing organisational inertia that add to the cost and complexity of successful implementation of resource efficiency.

Given the complex interplay between market, policy and organisational failures, it is unlikely that a single strategy or policy can make a significant impact. Clearly more information on alternative waste prevention options is generally beneficial, but unlikely to change business behaviour so long as the business case for waste prevention is not properly appreciated. There is thus a need for a coordinated approach. Business needs to improve its capabilities to make and deliver the business case for waste prevention. Markets need to be properly framed so that they can deliver waste prevention and resource efficiency outcomes. Proactive and strategic government policy can help.

7. Policy opportunities

This chapter focuses on the government policy options available to foster the uptake of resource efficiency in industry. It starts with some observations regarding the Australian experience in resource efficiency policies (in 7.1). Next, the international experience is captured, from both the business (WBCSD) and the government perspectives (OECD) (in 7.2).

7.1 Australian experience

The early Australian work on barriers and motivators for cleaner production (Gunningham *et al.* 1997) has had a major impact on policies and strategies for resource efficiency and waste minimisation around Australia. It has justified a reliance on information dissemination strategies and voluntary agreements, through case studies, sector specific methods and tools, eco-efficiency agreements, etc., as for instance reflected in the Australian national cleaner production strategy. The National Strategy (ANZECC 1998) examined the international and national experience in cleaner production, and proposed a framework for continuing Australian activities, through discussing a series of aims, objectives and strategic options, in four major themes:

1. *Information* must be readily accessible, and effectively provided to enable industry, governments and the community to make appropriate decisions.

2. *Adequate management and analysis tools and systems* should be readily available for industry to be able to adopt cleaner production.

3. *Regulatory systems* must be designed to provide incentive structures for the adoption of cleaner production. To be fully effective, they should also acknowledge the role of industry self-regulation, as well as Government enforcement.

4. *The market for goods and services* must be strengthened by eliminating market-distorting practices or where this is not possible, compensating for them.

Even though some elements have been implemented in some jurisdictions, coordinated implementation has never been achieved. This has been symptomatic of a lack of policy consistency, creating yet another barrier towards implementation of resource efficiency

It has become increasingly evident from Australian programs that a sole reliance on information dissemination strategies has limited potential to effect changes in businesses practices and uptake of resource efficiency. This is understandable for at least three inter-related reasons (UNEP 1994; Clayton *et al.* 1999; Lindhqvist 2001; van Berkel 2004a):

- *The generally low effectiveness of information strategies to change individual and organisational behaviour* (also encountered in other areas such as kerbside recycling, household energy efficiency, public transport, road safety and health promotion).

- *The appeal to environmental consciousness*. Information and education materials have typically focused on environmental and legal risks associated with poor environmental performance (i.e. the impact of leaching from waste dumps, the fines incurred from non

compliance). However, surveys repeatedly show that many business owners in particular in the SME sector, do not see their businesses as having significant impact on the environment, and are therefore not susceptible to environmental messages.

- *The dual role of government (in particular environmental agencies)*. Most programs have been sponsored and/or delivered by or on behalf of environmental agencies, and given that government is principally viewed as a regulator, this well-intended advice may not be accepted and acted upon by the regulated firms.

The inability of the currently prevailing information strategies, to achieve a step-change in the number of businesses pursuing resource efficiency initiatives, as well as in the depth and comprehensiveness of initiatives implemented by the forward looking companies, is of concern, with no clearly preferred path forward (van Berkel 2004a). Some have argued in favour of the application of *community based social marketing strategies (*e.g. McKenzie-Mohr (2003), but their reliance on simple changes everyone can make, further compromises the rigour of eco-efficiency implementation, and thereby the potential competitive advantages. A competing approach involves application of insights from *innovation studies*, which would suggest improving the depth and rigour of implementation among the most interested firms, thereby bolstering their competitive advantage, and invoking a market pull for their competitors to invest in eco-efficiency (Kemp *et al.* 2004)

7.2 International perspectives

> *"[] governments will have difficulties in achieving a significant de-coupling of waste generation from growth in GDP unless they direct rigorous attention to three core activities:*
> *1) quantitative waste prevention target setting,*
> *2) the selection and implementation of appropriate instruments, and*
> *3) the evaluation of waste prevention program performance in environmental, economic and social terms"*
>
> *OECD Working Party on Pollution Prevention and Control (OECD (2000) page 58)*

OECD (2000) argued the case for *strategic waste prevention,* i.e. "a (government) policy concept that concretely situates waste prevention within a longer-term resource management and sustainable development perspective." We support this approach, but agree with the OECD position that this does not decrease the need for continuing effort on waste minimisation and increasing resource efficiency. Also we note that all the elements of a strategic waste prevention policy approach apply equally at the waste minimisation level.

The elements are (OECD 2000):

1. *Integrated life cycle approach*: In government's case this means integration horizontally across government and vertically with all levels. It means establishing implementation partnerships with stakeholder groups, and includes actions along the life cycle of the materials use and waste generation. Institutional funding and expertise needs to be secured to guarantee consistency and efficacy of program delivery and implementation.

2. *Leveraging stakeholder knowledge*: Need to involve business and industry, public interest groups, academia, other agencies and all levels of government.

3. *Policy and program assessment and review*: policies and programs need regular review so that they evolve with changes in waste generation drivers (population, affluence/consumption patterns, technology).

4. *Developing and sharing practical experience*: in the OECD framework this applies to working with other nations.

The OECD identified 24 possible instruments to influence waste prevention. These are grouped under regulatory, economic and suasive as shown in Table 6.

Table 6: Waste prevention policy instruments (source OECD (2000))

Regulatory	Economic / Market-based	Suasive / Partnership
• Extended producer responsibility via product take-back (may also qualify as suasive) • Liability assignment • Pollutant release and transfer registers (may also qualify as suasive) • Disposal ban • Virgin material depletion quota • Virgin material import ceilings • Facility standards/permits	• User fees • Subsidy removal • Raw material charge • Grants (R&D, infrastructure) • Deposit-refund • Landfill tax • Tax incentives • Advance treatment fee • Material exchanges	• Setting waste prevention targets • Greener public procurement guidelines • Design for environment (DfE) • Technical assistance • Education and information provision • Public-private partnerships • Corporate environmental reporting (may also qualify as regulatory) • Eco-labelling • Environmental management systems

The choice of instruments to address a particular waste issue needs to be assessed in view of the overall government framework and the '*essential function*' of each instrument. Aspects to be considered might be environmental effectiveness, economic efficiency, innovative advancement, political acceptability and ease of administration ((OECD 2000), pg 70-71). For businesses, the most effective economic instruments were subsidy removal, raw material charges, grants and deposit-refund schemes. The regulatory instruments likely to be most effective included Extended Producer Responsibility and other forms of liability assignment, with the latter being focussed on minimising damage from hazardous substances. Suasive instruments were assessed as having very high or high general, but limited waste–specific, prevention potential. It needs to be reinforced here that the assessment was of *waste prevention potential* not pollution control, environment protection, health impact prevention, etc. OECD also stresses the importance of setting performance targets, and monitoring the outcomes of programs against these targets.

This is supported by Australian experience set out in the previous chapters, that direct regulation is the most effective mechanism for addressing specific identified health and pollution issues (or economic issues), particularly where specific sources of the impact or poor performance can be identified and targeted for action (e.g. controlled waste regulations.) Where sources of the problem are more diffuse, or the issue is related to moving "beyond compliance", suasive instruments such as education partnerships are more appropriate.

The WBCSD also recognises that governments can implement a policy that encourages economic growth and favours reduction of resource use and avoidance of pollution with incentives for eco-efficiency. Such policy measures to leverage business initiatives for more eco-efficiency can include (WBCSD (2000a), pg 24-25):

1. *Identifying and eliminating perverse subsidies:* where unsustainable practices are still supported with subsidies, these should be reduced and eventually removed.

2. *Internalising environmental costs:* in several economic sectors, considerable costs caused by environmental pollution are still not included in the price of goods and services, due to lacking policy frameworks. Until this is changed, the market will continue to send the wrong signals and polluters will have no incentive to change and adapt the performance of their products and processes.

3. *Shifting tax from labour and profit to resource use and pollution:* to avoid destructive economic effects, tax shifts should be implemented in a predictable way, avoiding an increase in the overall tax burden.

4. *Developing and implementing economic instruments*: these include emissions trading as an incentive for companies to implement eco-efficiency measures.

5. *Promoting voluntary initiatives and negotiated agreements*: governments should negotiate agreements and support voluntary initiatives designed to promote sustainability in particular sectors or market areas.

In particular the first three points are a remarkable departure from mainstream environmental and economic policy in Australia as well as internationally. It was beyond the scope of the preparation of this background report to take stock of specific examples in the different Australian jurisdictions. Regardless however, there appears ample evidence that these recommendations would apply to Australia. For example, the common practice to use landfill levies as a proxy for environmental costs of landfill, is both inconsistent with recommendations 1 (the landfill levies are typically used to subsidise recycling, which might be acceptable to establish recycling industries, but should from an economic point of view not be maintained over prolonged periods of time) and 2 (the landfill levy does not reflect the full societal costs of landfill, and thereby prevents businesses from internalising the full costs of landfill (as also highlighted by OECD)).

In more recent work, the WBCSD integrated this in a vision for sustainability through the market, addressing all three pillars of sustainable development. This is captured in seven keys for sustainability through the market, including: innovation, eco-efficiency, stakeholder partnerships, consumer choice, market framework conditions, recognition of the worth of the earth and making markets work for all (WBCSD 2001).

8. Conclusions

This report explored the current and potential contribution of materials resource efficiency in Australian industry to maintaining, and where possible improving, productivity and competitiveness, while reducing the intensity of use of materials and of the generation of waste. Despite its focus on materials and waste, resource efficiency will generally have multiple environmental benefits, in particular reducing the use of all natural resources (including energy and water) and reducing the impact on nature (by minimising emissions to land, air and water).

The key findings from the analysis presented in this report are as follows:

1. A proper assessment of the current materials use and resource efficiency performance of the Australian economy is not possible, due to the lack of consistent data sets on materials use and waste generation. The current best practice estimate puts the materials intensity of the Australian economy at around 175 tonnes/person/year. Even though there is a strong belief that the intensity of materials use will decrease as the economy grows, there is no factual evidence that such dematerialisation will occur autonomously.

2. There is a strong economic rationale for resource efficiency. At the national level, there are compelling analytical grounds that resource efficiency can drive economic growth. At the firm level, resource efficiency can simultaneously deliver environmental and economic benefits. Its uptake is however hampered by market failures and organisational inertia. Market failures can be addressed by government intervention, while businesses need to approach the environment as a business problem.

3. Eco-Efficiency is the common term for resource efficiency in business. It is aimed at: increasing the value of goods and services; reducing the use of natural resource inputs; and reducing impact on nature. Eco-efficiency fits in the environmental sustainability model hierarchy at the level of activities businesses can undertake to achieve three cross cutting objectives for: the ultimate fate of materials; the compatibility of materials and processes and materials with nature; and the intensity of materials use in products and processes. In practical terms, eco-efficiency is principles driven and value focused, and employs lifecycle thinking to drive and deliver operational excellence and innovation.

4. The economic value of greater resource efficiency in Australia was confirmed from three different angles. Firstly, company examples provide some indication that total economic benefits from resource efficiency, including but not limited to material resource efficiency, could amount up to 1 to 3 % of annual turnover of the business. Secondly, a conservative international benchmark was used to estimate the value of the projected economic opportunity. For 35 sectors, covering over 18,000 businesses the projected total economic opportunity is $4.5 billion/year. Thirdly, the eco-efficiency value matrix indicated that key features of eco-efficiency at the company level align well with measures of business success, in particular in regards to financial performance.

5. The review of business barriers and motivators for resource efficiency provided clear evidence of market failure (e.g. inability to capture full cost and lack of information on alternatives), policy failure (e.g. inconsistency in policy and lack of waste and materials data) and organisational failure (e.g. organisational inertia). Their complex interplay calls

for a coordinated approach. Proactive and strategic government policy can frame the market to deliver waste prevention and resource efficient outcomes and encourage businesses to apply their business tools and skills to environmental issues.

6. Governments have a number of economic, regulatory and suasive policy instruments available to reduce barriers to, and bolster motivators for, resource efficiency. International assessments confirm that the most effective economic instruments for businesses were subsidy removal, raw material charges, grants and deposit-refund schemes. The regulatory instruments likely to be most effective are Extended Producer Responsibility and other forms of liability assignment. Suasive instruments were assessed as having very high or high general, but limited specific, waste prevention potential.

In summary it can be *concluded*, that:

1. There is a growing level of expertise and experience of eco-efficiency within Australia to allow progress in decoupling economic growth, and its benefits, from the negative impacts of increasing resource flows.

2. Implementation of eco-efficiency builds upon and enhances, rather than distracts from, the focus on business success in particular in areas of financial performance and to a lesser extent in financial drivers.

3. Based on the proxy assessments undertaken for this study, the economic opportunity from greater use of eco-efficiency is significant, up to some 1-3 % of annual turnover at the firm level, or some $4.5 billion/year for the Australian economy.

4. A coordinated approach of government, business, consumers and other stakeholders is needed to simultaneously address the market, policy and organisational failures that currently impede the uptake of eco-efficiency.

The inability of the currently prevailing information strategies, to achieve a step-change in the number of businesses pursuing resource efficiency initiatives, as well as in the depth and rigour of initiatives implemented by the forward looking companies is of concern, with no clearly preferred path forward. Some have argued in favour of the application of *community based social marketing strategies*, but their reliance on simple changes everyone can make, further compromises the rigour of eco-efficiency implementation, and thereby the potential competitive advantages. A competing approach involves application of insights from *innovation studies*, which would suggest improving the depth and rigour of implementation among the most interested firms, thereby bolstering their competitive advantage, and invoking a market pull for their competitors to invest in eco-efficiency.
.

9. Implications for the inquiry

This section assesses the implications of the analysis in this paper for the questions and issues raised by the Productivity Commission in its Issues Paper (PC 2005). Detailed comments on specific issues are summarised in Table 7.

Overall implications across the range of issues raised by the Productivity Commission are:

- Waste management policy so far appears to have had limited impact on resource efficiency in industry, both because of the policy focus on municipal solid waste (to which industry contributes comparatively little), and because energy, water and hazardous substances take priority over solid waste in most industries' resource efficiency initiatives.

- Resource efficiency in industry should be defined as eco-efficiency. This term has currency in the industry sector. It also measures resource efficiency against multiple objectives, which can avoid a fixation on the waste management hierarchy that could otherwise compromise overall environmental and resource efficiency objectives.

- A multitude of training and information resources on eco-efficiency is available in Australia, but these appear to be underutilised. This may be due at least in part to their strong reliance on the environmental or sustainability consciousness of businesses. A stronger focus on the business case, in terms of costs and risks, is required to raise industry demand for eco-efficiency information and training.

- The split responsibility for different natural resources (materials, waste, energy, water) is a profound institutional and regulatory barrier for resource efficiency. A sole focus on regulatory barriers may lead to market and organisational failures being ignored, despite their obvious existence. Overall there is evidence that good business practices lead to resource efficient, successful and profitable businesses, which suggests that overall business competencies need to be fostered (in particular among small to medium sized enterprises).

- While priority and target setting for waste prevention and resource efficiency is conditional for its success, such is currently not possible due to severe constraints in available data for materials use and waste generation. The development of consistent data sets is currently also complicated by split regulatory and institutional responsibilities.

Table 7: Response to specific matters related to industry raised by the Productivity Commission (PC 2005)

Page	Issue	Comment
10	Impact of current solid waste management policy on industry resource efficiency	Solid waste policy is focussed on the management of municipal solid wastes, which is a small proportion of the materials resources flows. Many current efforts by state and local governments use artificially high costs to drive otherwise uneconomic recycling and waste prevention programs immediately prior to final disposal. This diverts industry attention from seeking the best eco-efficiency measures, which may involve other resources such as energy and water.
14	Data issues	There are inadequate data on material flows across the Australian economy. Significant effort is required to collect data of adequate detail, even for small geographical areas (e.g. regional synergies efforts in Kwinana and Gladstone (van Berkel 2005a)). There is a geometric increase in the collection and interpretation task when a large number of SMEs are involved with range of inputs and wastes.
15	Waste management hierarchy – sequence or options?	From an industry viewpoint, the "hierarchy" should be a series of options to be assessed by each business or sector against eco-efficiency objectives (and compared with options for other resources).
17	Definitions of 'resource efficiency'	CECP recommends the WBCSD definition of eco-efficiency because it incorporates both financial and environmental aspects of resource efficiency in a well-understood business framework (WBCSD 2000a). The approach also comes with some 15 years of documented experience and significant success in a range of countries, business sectors and organisation sizes.
20	Negative externalities of product life cycles	Business has come to accept that externalities do exist and need to be tackled but in a way that does not distort the competitive basis of the economy which delivers a wide range of affordable goods and services to consumers. The main externalities that can be assigned to individual industrial premises or sectors have been progressively addressed, predominantly through pollution control and environmental legislation. The cumulative / aggregated impacts of increased consumption, nationally and for world, have not been tackled – the part of the eco-efficiency definition related to "at least in line with the earth's carrying capacity". However, waste minimisation measures, in the restricted areas covered by this Inquiry, will not significantly affect this. Municipal authorities should resist the temptation to be seen to be doing something, if that something diverts business attention from other resource efficiency improvements identified by a more holistic approach
21	Market Power issues	There is a potential for a monopoly operator in one part of supply chain to prevent improvement in resource efficiency e.g. owner of disposal process artificially lowering landfill prices to ensure short-term returns by preventing diversion of a significant waste stream to recycling. However, better data on resource flows, coupled with a business network motivated to improve business values is the best mechanism for identifying and combating such behaviour.
23	Achieving efficient levels of waste	Physical laws (conservation of mass and energy, thermodynamics) mean that there will always be non-product output. Given the economic and environmental cost of energy and water use, and the increasing imbalance in Australia between production of basic materials for export and importing of consumer goods, recycling is likely to become less rather than more practicable.
23	Improving sustainability	Can only be achieved if aggregated consumption decreases i.e. Australia achieves a decoupling of economic and population growth from materials and energy consumption. Current trends are all in the opposite direction.
22	Institutional and regulatory barriers to improved resource efficiency	The main regulatory barrier is the separation of responsibilities for different resources (materials, water, energy, wastes) across the three levels of government. There is no defined location with responsibility for ensuring the achievement of eco-efficiency overall.

Page	Issue	Comment
23	Indicators and targets	Indicators and targets for resource efficiency are certainly needed but they need to be multi-dimensional (e.g. eco-efficiency metrics). They will be irrelevant unless there is adequate data provided by a monitoring system, and there is adequate transparent feedback on the effectiveness of programs.
25	Energy recovery	Should be part of the overall solution to eco-efficiency improvement; however, proposals will need to overcome significant community resistance based on poor environmental outcomes in the past. Technology that is less inherently polluting (e.g. rotary kilns) is also likely to be less energy efficient (than fluidised bed technology for example). Energy production from mixed waste is less efficient than purpose-designed energy recovery from high-energy waste streams e.g. used tyres or waste wood in cement kilns.
25	Is recycling always an efficiency improvement?	No, not if all resources are considered. Many waste streams require significant capital, energy and labour input for recycling. Care is also needed to ensure that the final stage of recycling versus disposal does not result in loss of significant efficiencies further up the life-cycle, e.g. by preventing the use of composites and laminates that significantly reduce the weight of goods, save energy during manufacture, transport and use, and add value for the consumer
26	Impact of landfill pricing	For highest efficiency, only the costs of operating an environmentally acceptable landfill operation should be recovered. Externalities need to be accounted for equitably at the points where they occur throughout a product's lifecycle. This sends the correct message to those who can most effectively address the problem.
27	Extended Producer Responsibility	Properly designed EPR programs have resulted in dramatic reductions in waste generation for products as diverse as packaging, cars and whitegoods in a number of countries in Europe, North Asia and elsewhere (OECD 2001). In the Australian context care is needed to prevent that environmental benefits form collection and returning of consumer goods are not eroded by high energy and materials costs given the low population density.
30	Education and Training available	High quality, broad-based or sectoral or resource-specific programs are, or can be made, available. However, there is currently a low demand from resource users and waste producers because resource efficiency is perceived a low business priority. There is risk inherent in artificially raising the priority within businesses (especially SMEs) from the single perspective of reducing waste going to landfill. This is one advantage of the eco-efficiency approach – companies are more likely to engage in a process where they are free to select their highest resource efficiency priorities.
31	National Coordination	Coordination is desperately needed horizontally across departments and vertically across levels of government – policy has not followed this course to date, resulting in lack of coordination and determination to make resource efficiency happening (policy failure). Available resources have never been adequate to assess the main resource flows, identify the most productive mechanisms for improving resource efficiency, and funding programs for delivering those improvements. Given the significant economic benefits that have been demonstrated by the limited programs to date, a major increase in resources is justified.

Annex I: Materials Use

Materials intensity can be estimated with Material Flow Analysis (MFA), one of the principal study methods in industrial ecology (van Berkel forthcoming-b). MFA examines the throughput of process chains comprising of extraction or harvest, chemicals transformation, manufacturing, distribution, consumption, recycling and disposal of materials (Bringezu *et al.* 2002). To quantify the inputs and outputs of those processes, MFA develops accounts in physical units (usually in terms of tonnes). The accounts can be generated for chemically defined substances (for example, carbon or carbon dioxide) on the one hand and natural or technical compounds or 'bulk' materials (for example wood, coal) on the other hand. MFA at the national level is still in its early stages of development. Boxes I.1 and I.2 summarise current findings from Australia and Europe.

Material intensity studies combine the outcomes of MFA with economic studies (Cleveland *et al.* 1999). Solid empirical studies are still comparatively rare. Among the few empirical studies on trends in materials intensity of economies, is the major comparative study coordinated by the World Resources Institute which included five nations: Austria, Germany, The Netherlands, Japan and the USA over the period 1975-1996 (Matthews *et al.* 2000). The results demonstrated relative dematerialisation of consumption (as reflected in declining material flows per unit of economic activity (GDP)). This was however not yet accompanied by dematerialisation of society (as reflected in ongoing small increases in material flows per capita (with the exception for Germany, whose figures have however been influenced by the reunification after the fall of the Berlin Wall). Compounded by the absolute growth in population, this results in the materials throughput continuing to increase in absolute terms, by between 16 and 28% over the 20-year time frame (for respectively The Netherlands and USA).

Box I.1: Materials Flow Analysis in Australia

Some information is available on the major flows of materials in Australia, for example as presented in the 2001 State of the Environment Report (GoA 2002). Some of the key implications for this Inquiry are:

- Australia requires a total material flow of about 175 tonnes per person per year to support the lifestyle of its population. This is more than twice that of other OECD countries. The rate of growth of the Australian flows is substantially above that of other OECD countries.
- Hidden flows (e.g. mining overburden, soil eroded in farming) represent over 70% of total flows, provide no direct economic benefit, and involve an environmental cost. This proportion is likely to increase as manufacturing declines in relative terms.
- Although there have been significant advances in environmental commitment and performance, these have not been sufficient to outweigh increases in materials flows. Reduction at the source through lower material use is therefore also required.
- Historically the cost of materials compared to labour has been low, which has led to the optimisation of labour use rather than materials and energy use with significant implications for the viability of recycling which is usually labour (and energy) intensive.
- Under current accounting practices and because of the small economy, capital plant for producing materials has a long life, so improvements in technology are slow to affect material producers and flows. This has implications for impact minimisation through cleaner production and waste treatment *versus* waste avoidance through new products and production metabolisms based on industrial ecology.

Box I.2: Materials Flow Analysis in Europe (Moll et al. 2005)

The Wuppertal Institute produced the most recent material flow and intensity study for the European Union. The report includes significant details on resource flows and the environmental impact of those flows, which are of interest to a range of specialist groups.

The main findings of the report are:

- The economy as a whole is expanding at a greater rate than direct material use and total material requirements. This decoupling implies that market forces already favour resource efficient production. Vice versa, it also means that increased resource productivity is relevant to competitiveness.
- There has been no decrease in the aggregate volume of EU's total resource requirements, and therefore the environmental burden related to resource use remains high.
- In individual countries, a decrease in aggregated resource requirements has been due to government policy, indicating that business as usual will not achieve this outcome.
- It is not possible to scientifically determine which environmental impacts of which specific resource flows are of highest importance in the short or long term. Priority setting for policy measures will therefore require political judgement.
- There is a significant shift in resource requirements from domestic sources towards the use of imports and thus a shift in environmental burden to other regions. Resource use is thus increasingly becoming a matter of international burden sharing.
- There is a continually growing risk associated with the physical growth and expansion of the technosphere (additional buildings and infrastructure), which will affect future waste generation and capacity for renewable resource supply and resource regeneration.

Recommendations in the report include:

- *Problem analysis*: in regard to development of criteria for assessment of sustainability; more detailed quantitative data for specific resource use patterns and resource use and productivity by sectors and improvement in information tools, sources and methodologies.
- Start a *multi-stakeholder process* for setting objectives and quantitative targets, potentially including a "target metabolism".
- Develop a *new policy mix* to address the entire industrial metabolism by assessment of existing policies, carrying out a gap analysis; and developing new policies to fit the gaps (an inventory and promotion of resource-efficient technologies and management options is a crucial element of this approach).

Box I.3: The IPAT equation (modified from Chertow (2001))

The IPAT equation mathematically conceptualises the relationship between technological innovation and environmental impact. IPAT is an identity simply stating that environmental impact (I) is the product of population (P), affluence (A) and technology (T).

$$I = P * A * T$$

Generally credited to Ehrlich (Ehrlich *et al.* 1972), IPAT embodies simplicity in the face of a multitude of more complex models, and has therefore served as a starting point for investigating interactions of population, economic growth and technological development (Chertow 2001).

The original IPAT equation can be restated to focus on Resource Efficiency (RE) and Wealth (W).

$$I = (P * W)/RE$$

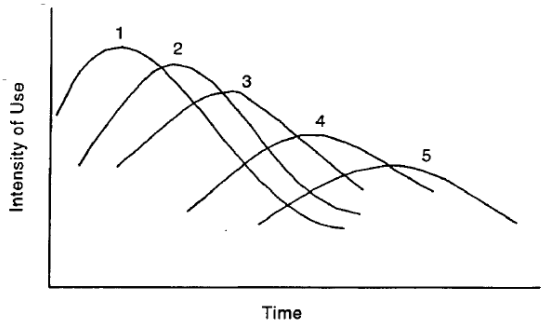
With $W = A/P$ average wealth per person (e.g. per capita GDP)
$RE = A/I$ average resource efficiency of wealth creation (e.g. GDP/tonne resource use)

This revised version of the IPAT equation shows that *resource efficiency initiatives can contribute to management and reduction of environmental pressures, without necessarily compromising on opportunities for wealth creation and population.*

There is broad acceptance for the notion that total materials consumption is a function of the population size, the average wealth and the materials efficiency of wealth generation (or technology). This is a variant of the well-known IPAT equation for environmental pressure (see Box I.3). IPAT formalises the assumption that as wealth and population grow, so will materials consumption (and associated environmental impacts), unless the material resource efficiency improves faster than the combined impact of population growth and affluence.

Discussions on materials use efficiency are often grounded on the presumed existence of an environmental Kuznet curve (first hypothesised by the World Bank (1992)). The underlying hypothesis is that resource depletion and pollution increase in the initial stages of development but then tend to fall as incomes rise, producing an inverted U shape function (as shown in Figure I.1) (World Bank 1992; Bernardi *et al.* 1993; Cleveland *et al.* 1999). The argument is that environmental quality is a normal economic good, so that people are willing and able to pay to consume more of it as incomes rise. The implicit assumption is that richer nations have the ability to pay for the investment in new technology that reduces pollution and degradation, and that as economies mature, they produce a less materials- and energy-intensive mix of goods and services. Even though there are some empirical data that show declining intensities of use for certain materials over time in mature economies, the studies generally rely on visual inspection of data trends, and due to a lack of proper statistical analysis (i.e. regression analysis) do not exclude competing hypotheses (Cleveland *et al.* 1999). The environmental Kuznet curve is therefore at best a *tentative* hypothesis on the relation between income and environmental quality.

Figure I.1: Graphical representation of the materials environmental Kuznet curve (source: Cleveland et al (1999))



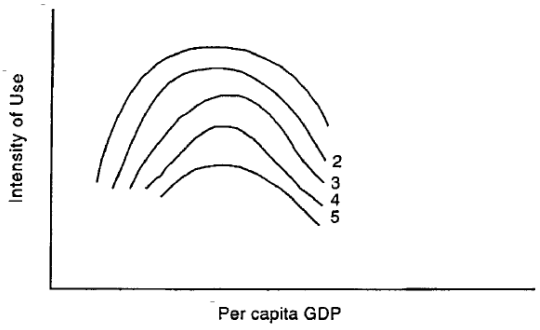


Figure 2 Graphical representation of the materials environmental Kuznet curve as envisioned by Bernardini and Galli (1993). Nations 1–5 complete development in subsequent periods of time at around the same value of per capita GDP. The intensity of use of a given material declines the later in time each nation develops.

Annex II: Sustainability Management

Organisational inertia is a principal business barrier to resource efficiency and innovation. Reinhardt (1999) argued that managers need to go beyond the question "*does it pay to be green*?" and ask instead "*under what circumstances do particular kinds of investments deliver returns to shareholders?*" He outlined five approaches to integrate the environment into business (Reinhardt 1999; Reinhardt 2000). First, some companies can distance themselves by differentiating their products and commanding higher prices for them. Second, other companies may succeed in managing their competitors by helping to shape the rules so that marginal cost increases for competitors are higher. Third, companies may find efficiency opportunities and thereby cut costs of their production. Fourth, almost all firms can improve their risk management, and thereby reduce expenditure associated with accidents, lawsuits and boycotts. And, fifth, companies may be able to make systemic change and redefine competition in their markets.

Reinhardt (2000) convincingly argued that the environment should be approached as a business problem, like other business problems in marketing, competition, and product and business development. This implies that most businesses can turn the environment into an opportunity. Doing so requires a focus on vision and strategy, as well as application of proven business tools.

II.1 Corporate sustainability strategy

Several frameworks have been presented to develop and implement business strategies for corporate sustainability, for example by Pieter Winsemius and his MacKinsey colleagues (former Dutch Minister for the Environment (Winsemius *et al.* 2002)), Professor Dexter Dunphy (University of Technology Sydney (Dunphy *et al.* 2003)) and Bob Doppelt (Doppelt 2003). Dunphy's sustainability phase model is particularly interesting as it outlines a number of distinct performance levels organisations can aim to achieve, from active antagonism, through indifference, to a strong commitment and actively furthering sustainability values, not only within the organisation but within industry and society as a whole (Dunphy *et al.* 2003). These phases are (*ibid*, pg 15-16):

1. *Rejection*: involves an attitude on the part of the corporation's dominant elite that all resources, employees, community, infrastructure and the ecological environment are there to be exploited by the firm for immediate economic gain.

2. *Non-Responsiveness*: usually results from lack of awareness or ignorance rather than from active opposition to a corporate ethic broader than financial gain.

3. *Compliance*: focuses on reducing the risks of sanctions for failing to meet minimum standards as an employer or producer. It is primarily a reactive approach to growing legal requirements and community expectations for more sustainable practices.

4. *Efficiency*: reflects growing awareness on the part of the dominant elite in the corporation that there are real advantages to be gained by proactively instituting sustainable practices.

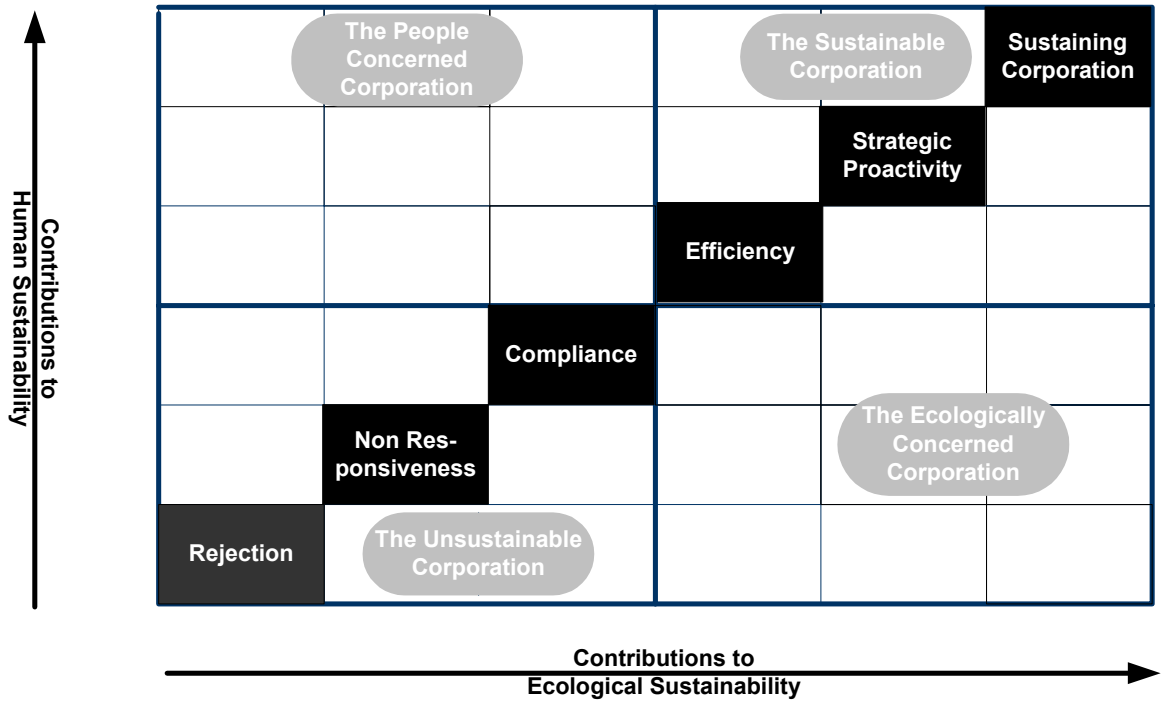
5. *Strategic Proactivity*: moves the firm further along the sustainability path by making sustainability an important part of the firm's business strategy. The commitment to

sustainability is strongly embedded in the quest for maximising longer-term corporate profitability, that is, it is motivated by intelligent corporate self-interest.

6. *Sustaining Corporation*: a strategic elite has strongly internalised the ideology of working for a sustainable world. The firm's fundamental commitment is to facilitate the emergence of a society that supports the ecological viability of the planet and its species, and contributes to just, equitable social practices and human fulfilment.

An organisation can enhance its sustainability performance through a combination of environmental and social initiatives as illustrated in Figure II.1. The organisation thereby becomes both *'sustainable'* (it is able to secure its future, through continuation of its licence to operate, maintaining its resource and skill bases and its access to finances and markets) as well as '*sustaining*' (it is able to enhance society's capability to survive, by investing in natural and human capital for the future (Dunphy *et al.* 2003)). Of particular significance in this context is the fact that resource efficiency has been singled out as a distinct performance level in the organisational transition towards corporate sustainability.

Figure II.1: Phase model for sustainable business development (modified from Dunphy et al (2003)).



II.2 Environmental Management Accounting

> *Environmental Management Accounting =*
> *doing better, more comprehensive management accounting,*
> *while wearing an environmental hat that opens the eyes for the hidden costs*
>
> *United Nations Division for Sustainable Development (UNDSD 2001)*

While strategy and vision are important guiding posts, they should be deployed on the basis of sound analysis and understanding of the business. This has sparked interest in Environmental Management Accounting (EMA) (van Berkel 2003). An EMA system can be

thought of as a management accounting system that has been refined so as to enable users of the system to be provided with information that reflects the environmental performance of the organisation (Schaltegger *et al.* 2001; Deegan 2003).

EMA is being implemented through the vigorous application of accepted management accounting procedures and tools to the environmental aspects and impacts of an organisation (Schaltegger *et al.* 2001; Envirowise 2002; Deegan 2003; van Berkel 2003). In particular, EMA embraces:

- *Expanded inventory of environmental costs and benefits*. environmental costs cover five tiers, respectively: conventional costs; hidden costs; contingent costs; relationship and image costs; and societal costs (USEPA 1995). All organisations need to consider their conventional environmental costs (such as cost of direct raw materials, energy and disposal of waste and emissions), but most often they are only partially recognised as environmental costs. 'Waste costs' are a case in point as these typically only include the costs of collection and recycling or disposal by a third party (the external costs). These are generally only a fraction of the internal costs (i.e. the value of raw materials and intermediate and final product lost with waste, staff time spent on collecting and managing waste within the company's premises, costs of waste management systems). EMA aims at comprehensive accounting for conventional environmental costs, including both external and internal costs, and consideration of hidden, contingent and image costs, to cover all private environmental costs.

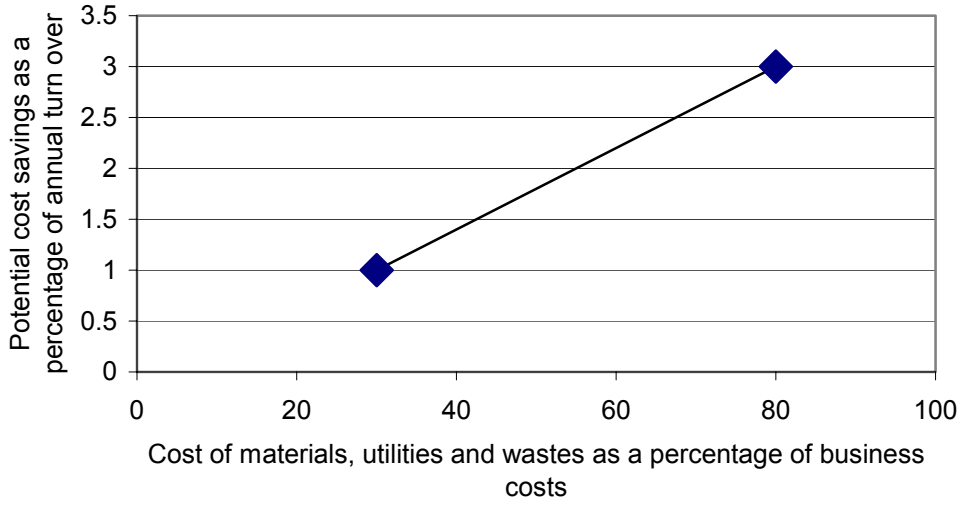
- *Proper allocation of environmental costs and benefits*. Many organisations account for their environmental costs as part of their overhead. Being part of overheads, environmental costs remain hidden to the product and process managers, who can act to reduce environmental aspects and costs. Moreover differentiation between products and processes on the basis of their contribution to environmental aspects (and hence environmental costs) is not possible. The use of overhead accounts thus generally contributes towards an organisation's failure to monitor and control its environmental costs. EMA applies Activity Based Costing to environmental costs, in order to ensure that environmental costs are charged to the products and processes that cause the environmental costs. This will generally require a resource tracking system, to track where and in what quantities energy, water and materials are being used in the organisation, and from which processes and products waste and emissions originate. When applying EMA, many organisations find that their 'clean' products effectively subsidise their 'wasteful' products.

- *Expanded time horizon*. The tendency to use short term financial indicators for investment decisions (e.g. pay back) is not favourable for environmental projects, as in many cases, the benefits and savings from environmental projects will only accrue over time, as a result of further strengthening of environmental policies and rising expectations of consumers and other stakeholders.

As illustrated by a range of case studies (Schaltegger *et al.* 2001; Envirowise 2002; Deegan 2003), EMA has diverse benefits ranging from direct and tangible to indirect and intangible, including: more informed decision making; uncovering opportunities; improved pricing of products; input for internal and external reporting; increased competitive advantage; improved reputation; staff retention and attraction; and generation of societal benefits. A

recent UK study of over 500 businesses that participated in the various waste minimisation initiatives found that EMA is pivotal to structured approaches for resource productivity, which can help companies achieve cost savings of 1-3% of annual turnover, depending on the nature of their business operations (Envirowise 2002). The UK findings enable projections of likely cost savings from resource efficiency on the basis of the share of environmental costs as part of the total business cost. This is illustrated in Figure II.2.

Figure II.2: Typical cost savings as a percentage of annual turnover (Envirowise 2002).



Annex III: Program examples

A range of government-sponsored programs is in place to foster the uptake of resource efficiency programs in Australian businesses. The following summarises some examples from New South Wales, South Australia and Western Australia. No comparative analysis of relative strengths and weaknesses, and overall results has so far taken place, and this in turn has become an impediment to the further advancement of resource efficiency[26].

III.1 New South Wales

The '*Profiting from Cleaner Production Industry Partnership Program*' engaged over 460 organisations in Cleaner Production projects, saved companies almost $10 million and delivered environmental savings that included 9,200 tonnes of raw materials and 8,900 tonnes reduction in waste to landfill (also energy and water savings)[27]. The costs included $2.7 million government contribution, matched by cash and in-kind effort by companies.

Projects were based on product and service life-cycle and sought to:
- Build the business case for environmental improvements;
- Lower resource use, especially toxics;
- Encourage waste avoidance;
- Identify technologies with cleaner production potential;
- Promulgate opportunities and outcomes, with an emphasis on specific industry sectors; and,
- Encourage building on the experience.

The most successful strategies for working with the private sector include efforts to build the business case for environmental action. This business case for sustainability needs to be built on motivators such as the wish to:
- Reduce costs, grow the business and increase profits;
- Comply with the law and manage risk;
- Respond to staff interests, and boost satisfaction and productivity; and,
- Contribute to environmental and social well-being and meet local community expectations.

Large companies turned out to be more likely to understand the deeper benefits of sustainability, including enhancing business reputation and improving access to markets and capital. Small and Medium sized Enterprises are focussed on cost reductions and profit improvements with 1-2 year return on investment. Regulation and its enforcement will therefore always remain necessary to underpin efforts to progressively improve the environmental performance of business.

[26] As a starting point, the Centre of Excellence in Cleaner Production has taken the lead to bring together the highlights of cleaner production and eco-efficiency programs and projects in Australia and New Zealand into a special issue of the international Journal of Cleaner Production. Publication is expected in the second half of 2006.
[27] This section is derived from: Trewin, D. (2005). Cleaner Production: using the profit motive to engage business and deliver environmental results in NSW. 6th Asia Pacific Roundtable on Sustainable Consumption and Production, Melbourne (Vic), Australia, Asia Pacific Roundtable on Sustainable Consumption and Production.

Key learnings about fundamentals for success included:

- A partnership approach including experienced department staff, local councils, industry groups and consultants is essential for recruitment, project development and delivery.
- Managers and staff know the strengths and weaknesses of their business so teamwork is more successful than relying solely on outside expertise.
- Sector and location clusters are important for finding solutions.
- Commitment to data collection, promulgation and celebration is essential.
- Integrity of the process must be assured by transparent and rigorous accounting.

III.2 South Australia

South Australian Greener Business Alliance (Harris *et al.* 2005) involved an alliance between SA EPA, The Yalumba Wine Company, and ten of its suppliers. It was part of the Greening the Supply Chain Program. The conclusions from the project included:

- The project delivered real eco-efficiencies ($432,500 savings over 5 years);
- A strong alliance was developed among Yalumba, its suppliers and the EPA (based on human factors that are not a prominent feature of traditional business relationships);
- The new network was a good information-sharing mechanism; and,
- The benefits were achieved beyond the formal six-month project and further improvements are being identified through an ongoing process.

III.3 Western Australia

Since 1999, the Centre of Excellence in Cleaner Production (CECP)[28] has delivered cleaner production and eco-efficiency programs to businesses of all sizes, both individually, and in groups based on industry sectors or location or a shared interest in eco-efficiency and sustainability (van Berkel forthcoming-a). Key programs included (see also Table III.1):

- *Small Business Program*: Over a number of trials and iterations during 1999-2002 it evolved into a program with one primary target group ('*entrepreneurs*') and two secondary target groups ('*intermediaries*' and '*practitioners*'). An implementation level was first developed and 20 businesses completed it in 2000-2001. For small businesses, the program was then developed into three 'levels', best characterised as '*awareness*', '*understanding*' and '*implementation*. Each covers the 'why', 'what' and 'how' of cleaner production and has its own delivery format and resources. The delivery is further enhanced with supportive information materials, in particular company case studies and sector specific fact sheets (for example for the dry-cleaning and building sectors).

- *Learning by sharing program* (for the WA Sustainable Industry Group): The WA SIG '*learning-by-sharing'* program promotes and advances best practices in cleaner production, eco-efficiency and sustainability-led innovation. Unlike the small business and other training programs, '*learning-by-sharing'* is not specifically directed at predetermined learning outcomes. Instead it provides for organised and facilitated topical networking among professionals working in the business' environment and sustainability field. A typical activity involves an overall scene-setting presentation with some three to five case study presentations, followed by a panel discussion, for example on benchmarking and

[28] The Centre of Excellence in Cleaner Production has been established with funding support from the WA Waste Management and Recycling Fund and is being hosted by Curtin University of Technology.

reporting of environmental performance, energy efficiency topics and eco-industrial parks. Networking is further enhanced through electronic newsletters and the website.

- *WA Cleaner Production Statement* (van Berkel 2004b): The WA CP Statement presents a vision for the greater application of eco-efficiency for a clean and competitive WA, achieved through collaboration between industry, State and local government, professional and community organisations, and the education sector. It is therefore best seen as a Statement of Intent calling on industry, government, business, community and professional stakeholders to consider eco-efficiency seriously and act accordingly. The WA SIG created a register of signatory organisations, which was launched in May 2001, and has since expanded to include some 90 signatory organisations.

Collectively these programs have been pivotal to putting eco-efficiency and sustainable development profoundly on the business and government agendas. Key learnings include:

- There is a real business case for eco-efficiency.
- There needs to be a capacity within government to regulate for and enforce compliance with an environmental baseline, but to recognise that achievements above that baseline depend on co-operative programs and partnerships.
- Learning-by-sharing is an effective mechanism for improvement but requires significant resources for organisation, facilitation and technical expertise.
- Reporting of successes and review of failures is essential but resource-intensive.
- Clustering is more effective than individual actions, but does not reduce the need for support and expert assistance for almost every business involved, i.e. communication within the group is not automatic.
- Communication outside the group (flow-on effect) is very low, especially for SMEs.
- Programs do not become self-funding.

Table III.1: Examples of WA Cleaner Production / Eco-efficiency programs:

Year	Title of program	Target audience	Link
Ongoing	Protecting Your Profits: An Integrated awareness, training and implementation program	3-level training package for SMEs	29
Ongoing	Improving environmental management for Local Government Authorities and their clients	Local authorities	30
Ongoing	Business and the Environment Manual	All WA businesses	31
2004-5	2005/2004 Eco-Efficient Entrepreneur Series	All WA businesses	32
2004	Centre of Excellence in Cleaner Production Small Business Program	Building, Dry Cleaning, Food Processing, Health Care, Metal Fabrication, Nurseries, Printing	33
2003	Energy Management Seminar Series	All WA businesses	34
2002	Sustainability and Business Seminar	Members and supporters of WA SIG	35
2001	Environmental performance evaluation	Members and supporters of WA SIG	36

[29] http://cleanerproduction.curtin.edu.au/cecp/cecptraininghome.htm
[30] http://cleanerproduction.curtin.edu.au/cecp/cecplocalgovernmenthome.htm
[31] http://cleanerproduction.curtin.edu.au/cecp/cecpbusinesshome.htm
[32] http://www.wasig.curtin.edu.au/wasig/wasigpub2005.htm
[33] http://cleanerproduction.curtin.edu.au/cecp/cecpindustrysectorhome.htm
[34] http://www.wasig.curtin.edu.au/wasig/wasigpub2003.htm
[35] http://www.wasig.curtin.edu.au/wasig/wasigpub2002.htm
[36] http://www.wasig.curtin.edu.au/wasig/wasigpub2001.htm

Bibliography

ACCI (2003). Eco-Efficiency Survey 2002-2003. Canberra (ACT), Australia, Australian Chamber of Commerce and Industry: 24.

ANZECC (1998). Towards Sustainability: achieving Cleaner Production in Australia. Canberra (ACT), Australia, Australia and New Zealand Environment and Conservation Council: 80.

Ayres, R. and J. van den Bergh (2005). "A theory of economic growth with material/energy resources and dematerialisation: interaction of three growth mechanisms." Ecological Economics 53: 96-118.

Bernardi, O. and R. Galli (1993). "Dematerialisation: long term trends in intensity of use of materials and energy." Futures: 431-448.

Bringezu, S. and Y. Moriguchi (2002). Material flow analysis. Handbook of Industrial Ecology. R. Ayres and L. Ayres. Cheltenham, UK, Edward Elgar Publications: 79 - 90.

Chambers, N., S. Simmons and M. Wackernagel (2000). Sharing Nature's Interest: ecological footprints as an indicator of sustainability. London, UK, Earthscan Publications.

Chertow, M. (2001). "The IPAT Equation and Its Variants: changing views of technology and environmental impact." Journal of Industrial Ecology 4(4): 13-29.

Clayton, A., G. Spinardi and R. Williams (1999). Policies for Cleaner Technology: a new agenda for government and industry. London, UK, Earthscan Publications.

Cleveland, C. and M. Ruth (1999). "Indicators of Dematerialisation and Intensity of Use." Journal of Industrial Ecology 2(3): 15-50.

DCT/WAMA (1993). State Recycling Blueprint. Perth, WA, Department of Commerce and Trade and Western Australian Municipal Association.

Deegan, C. (2003). Environmental Management Accounting: an introduction and case studies for Australia. Canberra (ACT), Australia, Environment Australia, in collaboration with EPA Victoria, and the Institute of Chartered Accountants in Australia.

DEP/SRAC (2001). Review of the State Recycling Blueprint. Perth, WA, Department of Environmental Protection and the State Recycling Advisory Committee.

DeSimione, L. and F. Popoff, Eds. (1997). Eco-Efficiency: the business link to sustainable development. Cambridge, MA, The MIT Press (for WBCSD).

DETR (1997). Cutting Costs by Reducing Wastes: a self-help guide for growing businesses. Environmental Technology Best Practice Program. London, UK, Department of the Environment, Transport and the Regions and Department of Trade and Industry.

Doering, D., A. Cassara, C. Layke, *et al.* (2002). Tomorrow's Markets: global trends and their implications for business. Washington/Paris/Geneva, World Resources Institute, United Nations Environment Program and World Business Council for Sustainable Development: 61.

Doppelt, B. (2003). Leading Change toward Sustainability: a change management guide for business, government and civil society. Sheffield, UK, Greenleaf Publications.

Dorfman, M., W. Muir and C. Miller (1992). Environmental Dividends: cutting more chemical waste. New York, USA, Inform: 272.

Dudock van Heel, O., J. Elkington, S. Fennell, *et al.* (2001). Buried Treasure: uncovering the business case for corporate sustainability. London, UK, SustainAbility.

Dunphy, D., A. Griffiths and S. Benn (2003). Organisational Change for Corporate Sustainability. London, UK, Routledge.

Ehrlich, P. and J. Holdren (1972). "Impact of Population Growth." Science 171: 1212-1217.

Envirowise (2002). Increase your profits with environmental management accounting. Oxford, UK, Envirowise.

Esty, D., M. Levy, T. Srebotnjak, *et al.* (2005). 2005 Environmental Sustainability Index: benchmarking national environmental stewardship. New Haven, Yale Centre for Environmental Law and Policy: 62.

Foran, B., M. Lenzen and C. Day (2005). Balancing Act: A Triple Bottom Line Analysis of the Australian Economy. Canberra (ACT), Australia, Commonwealth of Australia,: 800pp (4 volumes).

Geiser, K. (2001). Materials Matter: towards a sustainable materials policy. Cambridge (MA), USA, The MIT Press.

GoA (2002). State of the Environment 2001. Canberra (ACT), Australia, Commonwealth Government of Australia,.

GoSA (2005). South Australia Waste Strategy 2005-2010. Adelaide (SA), Australia, Zero Waste South Australia: 60.

GoV (2005). Towards Zero Waste. Sustainability in Action. Melbourne (Vic), Australia, overnment of Victoria: 60.

Guinnee, J., M. Gorree, R. Heijungs, *et al.* (2002). Handbook on Life Cycle Assessment; operational guide to ISO Standards. Dordrecht, The Netherlands, Kluwer Academic Publishers.

Gunningham, N. and D. Sinclair (1997). Barriers and Motivators to the Adoption of Cleaner Production Practices. Canberra (ACT) Australia, Australian Centre for Environmental Law: 115.

Harris, H., E. Wilczek and K. Best (2005). The Greener Business Alliance: a case study on eco-efficiency. 6th Asia Pacific Roundtable on Sustainable Consumption and Production, Melbourne (Vic), Australia, Asia Pacific Roundtable on Sustainable Consumption and Production.

Harris, S. and C. Pritchard (2004). "Industrial Ecology as a Learning Process in Business Strategy." Progress in Industrial Ecology 1(1): 89-111.

Holliday, C., S. Schmidheiny and P. Watts (2002). Walking the Talk: the business case for sustainable development. Sheffield, UK, Greenleaf Publishing.

IISD (2002). Seven Questions to Sustainabilty: how to assess the contribution of mining and minerals activities. Mining, Minerals and Sustainable Development (North America). Winnipeg (Ma), Canada, International Institute for Sustainable Development: 54.

Imai, M. (1997). Gemba Kaizen: a commonsense, low-cost approach to management. New York, USA, Mc Graw Hill.

ISO (2000). AS/NZS ISO 14031:2000 Environmental Management - environmental performance evaluation - guidelines. Sydney (NSW), Australia, Standards Australia: 32.

Kemp, R. and M. Andersen (2004). Strategies for Eco-Efficiency Innovation (Report for the Dutch presidency of the European Union). The Hague, The Netherlands, Ministry of Environment, Physical Planning, and Housing.

Landis-Gabel, H. and B. Sinclair-Desgagne (1998). The Firm, its Routines and the Environment. The International Yearbook of Environmental and Resource Economics 1998-1999; a survey of current issues. T. Tietenberg and H. Folmer.

Lindhqvist, T. (2001). "Cleaner Production: government policies and strategies." UNEP Industry and Environment Review(January - June 2001): 41-45.

Matthews, E., C. Amann, S. Bringezu, *et al.* (2000). The Weight of Nations: material outflows from industrial economies, ,. Washington DC, World Resources Institute.

McKenzie-Mohr, D. (2003). Community Based Social Marketing, McKenzie-Mohr and Associates. 2004.

Moll, C., S. Bringezu and H. Schutz (2005). Resource Use in European Countries: an estimate ot materials and waste steams in the Community, including imports and exporst using the

instrument of material flow analysis. Wuppertal, Germany, Wuppertal institute for Climate, Environment and Energy.

OECD (2000). Strategic Waste Prevention: OECD Reference Manual. Paris, France, OECD (Working Party on Pollution Prevention and Control).

OECD (2001). Extended Producer Responsibility: a guidance manual for governments. Paris, France, Organisation for Economic Cooperation and Development: 160.

PC (2005). Waste Generation and Resource Efficiency: an issues paper from the Productivity Commission. Canberra (ACT), Australia, Productivity Commission: 33.

Porter, M. (1991). "America's Green Strategy." Scientific American.

Porter, M. and C. van der Linde (1995). "Green and Competitive: ending the stalemate." Harvard Business Review(September - October 1995): 120-134.

Reinhardt, F. (1999). "Bringing the Environment Down to Earth." Harvard Business Review(July-August 1999): 149-157.

Reinhardt, F. (2000). Down to Earth: applying business principles to environmental management. Boston, USA, Harvard Business School Press.

Ritthoff, M., H. Rohn and C. Liedtke (2002). Calculating MIPS: resource productity of products and services. Wuppertal Specials. Wuppertal, Germany, Wuppertal Institute for Climate, Environment and Energy: 53.

Robert, K. (2000). "Tools and Concepts for Sustainable Development: how do they relate to the general framework for sustainable development and to each other?" Journal of Cleaner Production 8: 243 - 254.

Sarokin, D., D. Muir, C. Miller*, et al.* (1985). Cutting Chemical Waste: what 29 organic chemical plants are doing to reduce hazardous waste. New York, USA, Inform.

Schaltegger, S. and R. Burrit (2001). Contemporary Environmental Accounting: issues, concepts and practice. Sheffield, UK, Greenleaf Publishing.

Stone, L. (2005a). "Limitations of cleaner production programmes as organisational change agents I. Achieving commitment and on-going improvement." Journal of Cleaner Production 14(1): 1-14.

Stone, L. (2005b). "Limitations of cleaner production programmes as organisational change agents. II. Leadership, support, communication, involvement and programme design." Journal of Cleaner Production 14(1): 15-30.

Trewin, D. (2005). Cleaner Production: using the profit motive to engage business and deliver environmental results in NSW. 6th Asia Pacific Roundtable on Sustainable Consumption and Production, Melbourne (Vic), Australia, Asia Pacific Roundtable on Sustainable Consumption and Production.

UNDSD (2001). Environmental Management Accounting Procedures and Principles. New York, USA, United Nations Division for Sustainable Development.

UNEP (1994). Government Strategies and Policies for Cleaner Production. Paris, France, United Nations Environment Programme: 32.

USEPA (1995). An introduction to Environmental Accounting as a Business Management Tool; key concepts and terms. Washington DC, USA, United States Environmental Protection Agency.

van Berkel, R. (2000). "Cleaner Production in Australia: revolutionary strategy or incremental tool?" Australian Journal of Environmental Management 7(3): 132-146.

van Berkel, R. (2002a). Application of Cleaner Production Principles and Tools for Eco-Efficient Minerals Processing. Proceedings Green Processing 2002: International Conference on Sustainable Processing of Minerals, Cairns (Qld), Australia, Australian Institute of Mining and Metallurgy.

van Berkel, R. (2002b). The Application of Life Cycle Assessment for Improving the Eco-Efficiency of Supply Chains. From Farm to Fork: linking producers to consumers through value chains (Proceedings of the Muresk 75th anniversary conference), Perth (WA), Australia, Muresk Institute.

van Berkel, R. (2003). Managing for Sustainable Development: Using environmental management accounting and sustainable development reporting. CPA 2003 Congress, Perth (WA), Australia, CPA Australia.

van Berkel, R. (2004a). Biting the Dust: making Cleaner Production work for small businesses. Waste and Recycle 2004 Conference, Fremantle (WA), Australia, Keynote Conferences.

van Berkel, R. (2004b). Promotion and Implementation of Cleaner Production and Eco-Efficiency through Voluntary Partnerships: the case of the Western Australian Cleaner Production Statement. 5th Asia Pacific Roundtable on Cleaner Production, Kuala Lumpur, Malaysia, Asia Pacific Roundtable on Cleaner Production.

van Berkel, R. (2005a). Industrial Symbiosis for Sustainable Resource Processing: the Cases of Kwinana and Gladstone (Australia). 6th Asia Pacific Roundtable on Sustainable Consumption and Production, Melbourne (Vic), Australia, Asia Pacific Roundtable for Sustainable Consumption and Production.

van Berkel, R. (2005b). Innovation and Technology for a Sustainable Materials Future. Materials and Testing Conference 2005, Fremantle (WA), Australia.

van Berkel, R. (2005c). The Role of Eco-Efficiency in Industrial Ecology. Industrial Ecology for a Sustainable Future (3rd International Conference of the International Society for Industrial Ecology), Stockholm, Sweden, Royal Institute of Technology.

van Berkel, R. (2005d). Waste Prevention through Business Innovation. (Re)-defining Roles and Responsibilities Achieve Viable Outcomes (2005 Waste and Recycle Conference), Fremantle (WA), Australia, Keynote Conferences (for WA Local Government Association and Department of Environment).

van Berkel, R. (forthcoming-a). "Cleaner Production and Eco-Efficiency Initiatives in Western Australia 1996 - 2004." Journal of Cleaner Production.

van Berkel, R. (forthcoming-b). Industrial Ecology. Handbook of Environmental Technology Management. D. Marinova. Cheltenham, UK, Edward Elgar Publications: na.

van Berkel, R., T. Clark and S. Brereton (2001). Update and Review of Eco-Efficiency and Cleaner Production Case Studies. Perth (WA), Curtin University of Technology (for Environment Australia): 143.

van Berkel, R. and V. Narayanaswamy (2004). Sustainability as a Framework for Innovation in Minerals Processing. Green Processing 2004 (2nd International Conference on the Sustainable Processing of Minerals), Fremantle (WA), Australia, Australasian Institute of Mining and Metallurgy.

VicEPA (1998). Zeroing in on Waste: pathways to Cleaner Production in Victorian Industries. Melbourne (Vic) Australia, Victoria Environmental Protection Authority.

WAste2020 (2001). Towards Zero Waste: WAste 2020 Taskforce Report and Recommendations. Perth, WA, WAste 2020 Taskforce.

WBCSD (2000a). Eco-Efficiency: creating more value with less impact. Geneva, Switzerland, World Business Council for Sustainable Development: 32.

WBCSD (2000b). Measuring Eco-Efficiency: a guide to reporting company performance. Geneva, Switzerland, World Business Council for Sustainable Development: 36.

WBCSD (2001). Sustainability through the Market: seven keys to success. Geneva, Switzerland, World Business Council for Sustainable Development: 56.

Winsemius, P. and U. Guntram (2002). A Thousand Shades of Green: Sustainable Strategies for Competitive Advantage. London, UK, Earthscan Publications.

WMB (2004). Strategic Directions for Waste Management. Perth, WA, Waste Management Board.

World Bank (1992). World Development Report 1992. Washington DC, USA, The World Bank.

YCELP/CIESIN/WEF (2005). 2005 Environmental Sustainability Index: summary for policy makers. New Haven/Palisades/Geneva, Yale Centre for Environmental Law and Policy, Centre for International Earth Science Information Network and World Economic Forum: 8.

Zero Waste SA (2005). Background Paper to South Australia Waste Strategy 2005-2010. Adelaide (SA), Australia, Zero Waste SA: 36.