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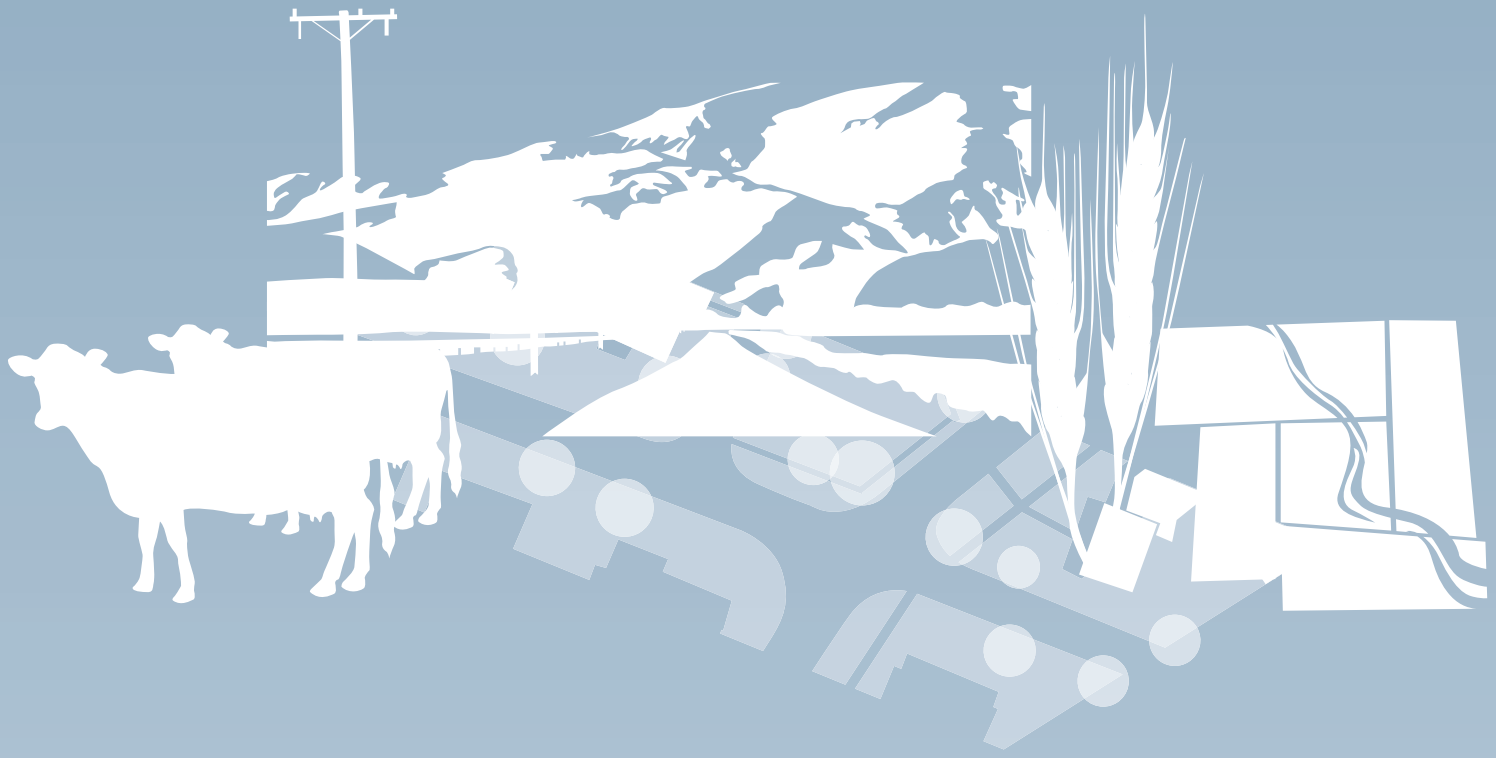

RESOURCE EFFICIENCY IN NEW ZEALAND

LITERATURE REVIEW

December 2009

Boffa Miskell

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Prepared for

Ministry for the Environment

by

Boffa Miskell Limited

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CONTENTS

APPENDICES

1.0 Introduction

The Ministry for the Environment's aim is to work to achieve high environmental standards for New Zealand, while sustaining and enhancing social and economic development. As part of its role the Ministry assists businesses to improve economic performance by using natural resources more sustainably, while reducing their environmental impacts.

The overall aim of the Ministry's resource efficiency policy work is to reduce the negative environmental impacts of the production and consumption of goods and services while fostering improved productivity.

To be able to effectively target policy in this area, the Ministry needs to understand the current state of environmental effects of business, with regard to production and consumption patterns. The Ministry proposes to implement a resource efficiency framework for New Zealand business, based on common, or well-tested, approaches from overseas.

Boffa Miskell Ltd has been appointed to develop, test, and implement a draft resource efficiency framework as part of the Ministry's broader aims. The key outputs from this process are a framework, and a collation and presentation of the results for selected resource efficiency outputs, based on existing data, for the following sectors:

- Agriculture;
- Finance, Insurance, Property and Business services;
- New Zealand-based Manufacturing (excluding Food and Beverage);
- Food and Beverage Manufacturing including Agricultural products;
- Retail;
- Tourism; and
- Building and Construction.

In addition to developing a framework key elements of the work include:

- Identifying a meaningful measure of resource efficiency that can be used within sectors and to compare sectors within New Zealand, and with overseas counterparts; and
- Selecting appropriate economic and environmental indicators that will contribute to the measure of resource efficiency, including the nature of the data or information that is required.

This report represents part of the first phase in the three phase project. This report provides an analysis of international approaches with the aim of developing an approach that is specific and applicable to New Zealand and allows appropriate comparisons with other countries. The draft framework data for New Zealand is developed in a separate document. Phase two of this project will identify existing information / data, data gaps, broad comparisons of sectors and identify opportunities and priorities for future data collection.

2.0 What is Resource Efficiency?

2.1 Defining Resource Efficiency

The terms 'resource efficiency' and 'eco-efficiency' are used interchangeably. Internationally, the term 'eco-efficiency' is more widely used. For the purpose of this report however, the term 'resource efficiency' is used, but draws on the concepts and definitions of 'eco-efficiency'.

All economic activities involve the consumption of energy and raw materials, and generate wastes and emissions. It is widely cited[1] that current production and consumption patterns are unsustainable. A number of tools have been developed to measure, and ultimately manage, unsustainable practices at the business and sector level.

Resource efficiency has emerged as a management response to environmental issues associated with production, and is part of a broader concept of 'sustainable production and consumption' which involves changes in production and consumption patterns that lead to sustainable use of natural resources. Resource efficiency has a myriad of definitions, but is generally accepted to mean the efficiency with which ecological resources are used to meet human needs. The European Environment Agency (EEA) defines it as "more welfare from less nature" and states that the impetus for resource efficiency arises from decoupling resource use and pollutant release from economic development and overall welfare (EEA, 2000).

In its simplest form, "resource efficiency" is a measure; the ratio of environmental inputs (or waste / pollution outputs) to productive output. A resource efficiency ratio expresses how much benefit or welfare is achieved from a unit of 'nature', or natural resources as shown in Figure 1.

Resource efficiency is also a widely used management tool, and comprises the development of goals and measures to bring about innovation in behaviour, technology, and different ways of doing business. The management tools address production processes and behavioural changes to achieve an increase in product or service value, or a reduction in environmental influence, thus improving an entity's resource efficiency.

Figure 1: Resource efficiency ratio (Source: WBCSD)

$$\frac{\text{product or service value}}{\text{environmental influence}}$$

[1] See for example, *Johannesburg Plan of Implementation* (United Nations, 2002) and OECD "Consumption, Production and Environment" at: www.oecd.org www.oecd.org.

Defined as:

- *Produce or service value* = a financial output (exports, profit, GDP), social welfare (e.g. employment), or production unit.
- *Environmental influence* = natural resource use / consumption, ecosystem service, or a non-productive output such as solid waste or pollution.

The resource efficiency ratio can take two forms.

1. It can be calculated by dividing product value by environmental influence or,
2. It can be calculated by dividing environmental influence by product value.

The first approach is considered 'true' resource efficiency, for example, an energy input represents an indication of the resource efficiency of energy use in production. The reverse – energy divided by the process - may be referred to as 'energy intensity.' The difference is mathematically insignificant; essentially they measure the same thing and both provide a good indicator of resource efficiency (Jollands, 2003). For the purposes of this report, the 'true' resource efficiency calculation illustrated by example 1, is used.

Progress in resource efficiency is achieved by providing more value per unit of environmental influence, and is an important element of sustainability.

2.2 Background and Aims of Resource Efficiency as a Management Tool

The 1992 Earth Summit concluded that the major cause for the continued deterioration of the global environment is the unsustainable pattern of consumption and production. The Business Council for Sustainable Development (BCSD[2]) sought a tool that addressed both environment and economic development [hence the term 'eco' efficiency]. Its specific aim was to develop a solution to sustainable development at the company level. The ensuing plan of action included a number of goals relating to cleaner production and resource efficiency. Both remain important subjects in international policies; the 2002 UN World Summit on Sustainable Development, for example, resolved to establish a 10-year framework of regional and national programmes and projects designed to promote sustainable consumption and production patterns.

Degradation of ecosystem services (water, biodiversity, and climate) and consumption of natural resources (renewable and non-renewable) have specific, long term implications for business with regard to the costs and supply of resources (Millennium Ecosystem Assessment, 2005). In addition, there is increasing global emphasis on the need to address climate change impacts, particularly at the business and development level including the need for countries to develop low carbon economies and commercial low carbon technologies for the future (Stern, 2007).

2 The Business Council for Sustainable Development (BCSD) merged with the World Industry Council for the Environment (WICE) to form the World Business Council for Sustainable Development in 1995.

Addressing business consumption and production patterns requires meaningful and useful information to develop an understanding of pressures on resources, and develop appropriate responses. Resource efficiency provides a method for collating that information.

Resource efficiency encourages businesses to search for environmental improvements that yield parallel economic benefits. It focuses on business opportunities and allows companies to become more environmentally responsible and more profitable (WBCSD, 2006).

The most widely quoted definition of resource efficiency being achieved is when:

> *...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*
>
> *(UNEP and WBCSD, 1996)*

The WBCSD identifies seven success factors to achieve an increase in resource efficiency:

1. reduce the material intensity of goods and services
2. reduce the energy intensity of goods and services
3. reduce toxic dispersion
4. enhance material recyclability
5. maximise sustainable use of renewable resources
6. reduce material durability
7. increase the service intensity of goods and services (Verfaillie and Bidwell, 2000).

2.3 Resource Efficiency Measurement Frameworks

Resource efficiency frameworks are applied at the company (micro) and government (macro) policy level as follows in Figure 2:

Figure 2: Micro and macro level resource efficiency

Micro-level:

$$\text{resource efficiency} = \frac{\text{product or service value}}{\text{environmental influence}}$$

Macro-level:

$$\text{resource productivity} = \frac{\text{more welfare}}{\text{less resource use / pollution}}$$

Source: WBCSD, 2006

Micro-level measurement frameworks

Resource efficiency frameworks applied at the company level measure the ratio between natural resource input (or pollution output) and economic or productive outputs. Productive outputs can be units of product manufactured, hours of service delivery, operating surplus, shareholder returns etc. Frameworks are most commonly used to measure and monitor a company's environmental performance.

Companies can use resource efficiency as an environmental management tool within their policy or mission statements. They can also set resource efficiency objectives for environmental or integrated management systems.

Resource efficiency as a measure is considered a useful tool for monitoring and reporting performance, benchmarking against others in the industry sector, and for helping a company communicate with its stakeholders.

Macro-level measurement frameworks

Macro-level approaches are focussed on the economic welfare arising from production through improved use of resources, but are not often called resource efficiency. Rather, these indicator frameworks usually relate to the 'intensity' of resource use for production, such as energy or greenhouse gas intensity.

National indicator programmes that attempt to quantify natural resource stocks such as forests, fisheries, water, biodiversity and soil fertility regularly provide results as ratios with employment or GDP statistics as part of the reporting. This approach provides the ratio of environmental performance to welfare.

A number of European countries use resource efficiency at the national level to compare business sectors in European countries. More detailed assessments of selected schemes are provided in Section 4.2.

The fundamental approach is the same for the micro and macro level framework. The main difference between these approaches is that national approaches may incorporate a wider set of indicators including natural resource availability, consider more 'socio-economic' outcomes compared with the micro-level, and use national datasets (rather than business data).

National approaches aim to monitor economic, social, and environmental trends, and to assist with implementation of sustainability commitments made by governments, in contrast, business level approaches assist companies with improving individual or sector performance.

Resource Efficiency in New Zealand

As an environmental management tool: Resource efficiency is factored into a range of voluntary initiatives in New Zealand, mostly led by district and city councils or industry groups. Resource efficiency developed from a focus on solid waste reduction and 'zero waste' in the 1990's. Early programmes include Target Zero and BusinessCare. Current drivers include the New Zealand Energy Efficiency and Conservation Strategy which promotes energy use efficiency and Local Government Act 2002 and Waste Minimisation Act 2008 which give local government the role of supporting and implementing solid waste minimisation programmes.

There are a number of programmes available in New Zealand that encompass the resource efficiency approach. Many focus on reducing resource use and pollution, but do not necessarily look at the productivity gains. Examples include:

- **New Zealand Packaging Accord:** An industry led programme (with government support) setting targets and developing programmes for (amongst other things) reducing the material use and energy in manufacturing packaging.
- **Target Sustainability:** A subsidised programme run by the Christchurch City Council, which assists businesses to reduce solid waste to landfill, water use and energy use.
- **Envirostep:** A free, entry-level environmental management tool developed by the Ministry for Economic Development (MED). It includes methods for calculating an environmental performance score and profile, recommendations to reduce operating costs, environmental impacts and risk, action plans and links to other resources.
- **New Zealand Greenhouse Gas (GHG) Footprinting Strategy for the Land-Based Primary Sectors:** An initiative developed in partnership with the primary sector at the end of 2007. It seeks to position New Zealand's land-based primary sectors to respond to significant and increasing pressure by key export markets for information on the GHG-intensity for primary products.
- **Sustainable Tourism Advisers in Regions (STAR)**: This programme, based on improving resource efficiencies, is one of a number of actions contained in the New Zealand Tourism Strategy 2015. STAR provides tourism operators in nine regions in New Zealand with tools for monitoring and improving their resource efficiency.
- **Resource Efficiency in Building and Related Industries**: On-line waste minimisation guidance for the construction and demolition industry.

As a measure of business performance: There is no regional or central approach or policy framework for monitoring or collecting data on the resource efficiency of businesses or business sectors. Resource efficiency frameworks for assisting policy development were studied by Jollands (2003). The research selected fourteen indicators and forty-six sectors of the New Zealand economy using data collected in the 1990s. The base data used in this research was derived from EcoLink database[3]. The approach was generally consistent with core indicators used in international examples.

[3] EcoLink was developed collaboratively by Garry McDonald (Market Economics Ltd), Prof Murray Patterson (Massey University) and representatives of the various participating councils.

3.0 Resource Efficiency and Sustainable Development

Resource efficiency fits within the wider realm of sustainability tools and policy frameworks used internationally to provide an indication of the demands on the environment arising from the production and consumption of goods and services. This section looks briefly at the sustainable development issues and indicator frameworks and its relationship with resource efficiency.

Sustainable development is the ability to meet this generation's needs without compromising future generations. It is also about intra-generational equity, and fair access to resources. The assumption is that the environment (natural resources, ecosystem services etc) provides essential goods and services. To enable future generations to have the benefits of those goods and services, there must be a sustainable rate of consumption of environmental goods and services in each generation.

Increases in resource efficiency may not suffice to further sustainable development, as any gains are still likely to be outpaced by global growth in consumption, particularly where there is an emphasis on economic growth. Resource efficiency is a relative measure, but is not a sufficient condition for achieving sustainability; in most cases, absolute reductions in some environmental pressures are required to achieve sustainability (Moll and Gee, 1999). This limitation is an important consideration when applying resource efficiency frameworks.

Resource efficiency still has its place as one of the primary contributions that industry can make to sustainable development, as promoted by the WBCSD, various national governments, and multi-lateral organisations such as the OECD and the United Nations Environment Programme (UNEP).

There are many different sustainability indicator frameworks which measure environmental and social issues at a national level and compare country performance. They include national programmes such as those undertaken in New Zealand by MfE and Statistics New Zealand, and international programmes for instance, the OECD Global Project on Measuring the Progress of Societies[4]. A comparison of the various indicator framework typologies is provided in Table 1 **Comparison of Indicator Frameworks**.

[4]See: http://www.oecd.org/document/5/0,3343,en_40033426_40037349_40038469_1_1_1_1,00.html

Table 1 Comparison of Indicator Frameworks

Framework	Approach	Benefits for measuring sustainability	Limitations
***Pressure-state-response* (also known as driving force-state-response)** e.g. State of the Environment monitoring Community wellbeing monitoring	3 sets of indicators: - Pressure: processes that have a positive or negative impact - State: indicate the current situation - Response: societal actions aimed at moving towards sustainable development	Can meet all pillars of sustainability	Not well suited to addressing the complex inter-linkages amongst issues. Does not adequately highlight the relationship between indicators and policy issues.
Issue or theme based e.g.: Sustainable Development Indicators for European Union.	- Indicators are grouped into various issues relevant to policy. - Regional based, national based, industry based, issue based.	Link indicators to policy processes and targets. Clear and direct messages to decision makers and stakeholders. Flexible to adjust to priorities and policy targets over time.	Not necessarily comprehensive and may miss links to other issues in the economy / environment.
Capital	- Calculating national wealth as a function of financial, production, natural, human, social and institutional capital, expressed in monetary terms.	Tracks the way that 'capital' is used, enhanced, degraded etc.	Assumes substitutability between capital. Difficult to express all capital in monetary terms. Difficult to integrate intra-generational equity.

Framework	Approach	Benefits for measuring sustainability	Limitations
Accounting e.g. SEEA	- Extends national accounting to include environmental aspects. - Accounts are expressed in monetary terms as well as physical terms.	Allows a common database for common sustainable development indicators. Standardised process, allowing comparability over time and between countries.	Many do not consider the social, cultural, or institutional pillars of sustainability. Requires a commitment to comprehensive data collection for accounts.
Stocks and Flows	- Measures the stocks of environmental resources and the rates of consumption. Changes over time can be monitored. - Can be linked to resource management policy.	Considers the use of resources compared to the availability of resources, which indicates whether use is equal to or exceeding the natural replenishment rates.	Environmental pillar only. Does not necessarily measure causal links, or measure the efficiency of use.
Aggregated e.g. Ecological Footprint	- Aggregation of several indicators and translate into a standard measure or index (productive land, water footprint etc).	Convey simple messages to stakeholders and decision makers. Allows for comparison between sectors / countries.	Many focus on environmental pillar only. Aggregation can be hampered by data availabilities, aggregation methodologies, selection, and weighting of variables.
Resource efficiency **(or intensity)**	- Ratio of environmental performance to productive value	Measures the efficiency of resource use. Can be used at the business, sector, or national scale.	Does not measure the stock of resource, or link the environmental performance to actual effects on the resource / environment. Does not commonly include socio-cultural indicators.

4.0 Approaches to Resource Efficiency Frameworks

This section provides an overview of the key elements and approaches to resource efficiency frameworks from a number of countries. A more detailed summary of examples of international frameworks discussed in this report is attached at Appendix 1.

4.1 Background and Overview

Numerous frameworks have been developed to assess resource efficiency. While frameworks continue to be refined, there are common attributes in the approaches including:

- Establishment of a system boundary which defines the extent of a business or sector being measured;
- Development of indicators for environmental performance and product or service value for the respective side of the resource efficiency ratio;
- Data collection on each of the indicators;
- Calculation of the resource efficiency ratio.

There is a wealth of information on resource efficiency as an environmental management tool at an international level[5]. The following examples and organisations are commonly cited in literature and referred to throughout this report:

- World Business Council for Sustainable Development (WBCSD)
- Canadian National Round Table on the Environment and the Economy (NRTEE)
- Global Reporting Initiative (GRI)
- EU Eco-Management and Audit Scheme (EMAS)
- ISO 14031 - Environmental Performance Evaluation
- German Federal Environmental Agency
- European Environment Agency (EEA) Core Indicators
- World Resources Institute (WRI)
- United Nations
- Wuppertal COMPASS (COMPanies' and Sectors' Path to Sustainability)
- EcoReg Indicators Programme (Finland)

[5] A simple "resource efficiency frameworks" search identified 11,900,000 Google™ results and 76,304 articles on Science Direct electronic serials.

In addition, a number of country-specific approaches provide useful examples of implementation of macro-level resource efficiency frameworks though central government. Country specific initiatives have been undertaken in Canada, and a number of European states including UK, Germany, Austria, Sweden, and Finland.

EMAS, ISO, and the WBCSD and German Federal Environmental Agency approaches are aimed at internally oriented performance management of a business whereas multilateral approaches such as the World Resources Institute (WRI), NRTEE, and EEA focus on external or sectoral performance measurement (Olsthoorn et. al, 2001).

The majority of frameworks cite the WBCSD as the origin of resource efficiency approaches. More recent approaches, particularly in Europe, seek alignment with reporting approaches and endorse tools such as the Global Reporting Initiative and ISO standards for this purpose.

Early examples of measuring resource efficiency are focussed on the design and application of individual resource efficiency frameworks (NRTEE, 1997; Azzone & Noci, 1996). Over time the focus has shifted towards greater collaboration of effort and standardisation of approaches. This increasing push for standardisation is reflected in business focussed tools such as ISO 14031 and ISO 14032 and EMAS. Sets of core indicators have also been developed with the introduction of tools such as the Global Reporting Initiative (GRI, 2000) and OECD.

The focus or aims of these approaches and various frameworks are generally consistent and each represents a variation on the theme of resource efficiency and its measurement.

Resource efficiency frameworks have been developed on the premise that effective environmental policy requires complex environmental systems to be captured using simple figures or indicators, which are understandable to policymakers in a way similar to the Dow Jones index or gross domestic product. The basic principle is that through a limited set of figures, environmental issues relating to production and consumption can be effectively communicated, environmental conditions efficiently monitored, and results of policy and management measured.

Most frameworks have developed as part of an economic accounting approach. The UN approach for example, uses an accounting framework to measure resource-efficiency and states that information about environmental performance vis-à-vis financial performance is useful in determining the ability of an enterprise to adapt to changes in the environment in which it operates (UN, 2003).

A key focus of frameworks is the development of ‘indicators’ which measure ‘production outputs’ and ‘environmental performance’ at the macro and on the micro level (Moll and Gee, 1999). Indicators are commonly used as a tool for obtaining general information on issues such as health, sustainability, and economic welfare. Work on environmental and sustainability indicators commenced during the early 1990s following the Rio Conference with the aim of gaining a better understanding of environmental issues (UNEP and WBCSD, 1996; Helminen, 2000; Berkhout et. al, 2000; Segnestam, 2002; Veleva and Ellenbecker, 2000).

There has been some convergence on approaches to measuring resource efficiency; there are also variations in their emphasis, often due to the origin of the framework (e.g. accounting vs. environmental management based-standards and inclusion or exclusion or socio-cultural aspects).

A common aspect of all frameworks is that they aim to quantify effects of industry or sectors on resources in relation to economic output. However, as noted earlier in this report, few attempt to determine how environmental stocks and changes in them affect local demands, supply scarcities, and opportunities for substitution. In addition, few attempt to measure overall resource efficiency or sustainability (Olsthoorn et. al, 2001; MEPI, 2000; Wehrmeyer et. al, 2001).

The key outcome is to provide an indicator of resource efficiency that prompts further analysis and/or action. As such, the information provided through these frameworks is indicative and the aim is generally to provide an overview of effects rather than more precise environmental assessment of production and processes that might, for example, be developed through more precise tools such as life cycle assessment. This serves to inform businesses, provide information for stakeholders, and compare industry performance and trigger further action.

Each approach is considered to have strengths and weaknesses with regard to performance measurement or performance management, applicability within an environmental management system or reliability of data collection *(See: Olsthoorn et. al, 2001; MEPI, 2000; Wehrmeyer et. al, 2001 for further discussion)*.

Resource efficiency is typically regarded as the relationship between the economy and the environment. Socio-cultural dimensions of sustainability are not generally included in resource efficiency analyses. There is increasing recognition that social dynamics - or social and cultural welfare are important aspects and preconditions for economic activities and therefore resource efficiency (Melanen et al, 2004; WBCSD, 2006). Some attempts have been made to include a socio-cultural perspective (see for example Melanen et al, 2004) but these tend to be more commonly applied at the national or regional level reporting level.

Summary of key aspects of approaches:

- Resource efficiency is part of larger systems of environmental management (ISO, GRI etc), and is a 'stand alone' framework. Larger systems involve monitoring and managing absolute environmental / resource use, and other qualitative and quantitative data, whereas resource efficiency is only a measure of the 'relative resource use'.
- Indicators are used as proxy for the otherwise large number of environmental and economic parameters of a business or business sector.
- Indicators change depending on the scale (business, sector, national).
- Some core indicators have been identified and are most relevant when compared at the sector and scale.
- Socio-cultural indicators are increasingly recognised as an important element of measuring sustainability and are commonly measured at a national level. The inclusion of socio-cultural indicators in sector-based resource efficiency is less prevalent.

4.2 Central Government Approaches

Overview

Central government approaches to macro-level monitoring generally focus on one or more of the sustainability indicator frameworks listed in

Table **1**, rather than resource efficiency. Common approaches include material or energy intensity of economies, state of the environment monitoring, material stocks and flows, and accounting frameworks. This section looks at multilateral, country and regional initiatives. See Appendix 1 for further information on the following examples.

Multi-lateral Initiatives

Chapter 40 of Agenda 21 called on countries and the international community to develop indicators of sustainable development, to increase focus on sustainable development and assist decision-makers to adopt national sustainable development policies. Both the OECD and UN have developed indicators for use at the macro level (national, international, and global decision making) for this purpose.

The UN Commission on Sustainable Development (CSD) developed indicators of sustainable development ("CSD indicators") between 1994 and 2001. These were revised following the World Summit on Sustainable Development in 2002 (United Nations, 2007). The revised CSD indicators contain a core set of 50 indicators which are part of a larger set of 96 indicators of sustainable development. The core set covers issues grouped under 'themes' and 'sub-themes'. The UN aims to cover issues of relevance to most countries, using data that is either readily available or could be made available within reasonable time and costs.

The OECD set of indicators also aims to standardise international approaches. The OECD has several categories of indicators including 'core environmental indicators' which are used to track environmental performance and progress and cover a broad range of environmental issues. In addition, 'key environmental indicators' are used to inform the public and provide key signals to policymakers. They comprise a reduced set of core indicators, selected from the OECD core set, that serve wider communication purposes (OECD, 2003).

OECD indicators are classified following the "Pressure-State-Response (PSR) model" (see

Table **1**). The original sets of UN indicators also apply a similar model. However, the model was not considered suitable for addressing the complex inter-linkages of sustainability and was replaced in favour of 'themes' and 'sub-themes' in the revised UN indicator set (UN, 2007).

As noted, these indicator frameworks are commonly applied to state of the environment-type reporting; they provide data sets on sustainability issues but do not typically provide ratios of inputs-to-outputs.

Country Approaches

Resource efficiency measurement has filtered down to central government policy through multi-lateral initiatives, described above. These broad frameworks have provided impetus for resource efficiency measurement in many countries.

An additional driver for resource efficiency in European countries is European Union policy. Notably, the 6th EC Environment Action Programme which aims at better resource efficiency and to improve resource and waste management, to help bring about more sustainable patterns of production and consumption (EC, 2002).

- Regional sustainability indicators

Regional sustainability indicators have been developed for Finland via the "Eco-efficiency of Regions Project" (EcoReg) (Melanen et al. 2004). The project developed an indicator framework for measuring regional sustainability using eco-indicators and a complementary monitoring tool. The approach combines life cycle assessment and material flow analysis, statistical data freely available in EU countries, and various indicators in order to create indicators for regional eco-efficiency development.

The ECoReg approach includes socio-cultural indicators to support the measuring of resource efficiency. Twenty-one socio-cultural indicators were selected to support the measurement of the eco-efficiency of the Kymenlaakso region. These have been classified in eight themes (population change, employment, social exclusion, health, safety, education, culture, local identity), which support the topics raised in Kymenlaakso region during the process.

- Inter-country Co-operation

Resource efficiency is a central goal of the *Nordic Sustainable Development – New Bearings for the Nordic Countries 2009-2012* (Nordic Council of Ministers, 2000). The Nordic Co-operation[6] recognises that patterns of consumption need to change if sustainable development is to be achieved. A set of sustainable development indicators was developed to monitor the goals set out in the strategy. The indicators monitor progress of strategy areas relating to sustainable development and are designed to be comparable with national and relevant international indicators such as those of the EU, OECD, and UN (op.cit). The indicators measure the three dimensions of sustainably – environment, economy and social. Joint EU funded studies on sector-based approaches[7] attempt to develop measures for comparing the overall environmental performance of industrial companies.

- Material Flow Measurements

[6] The Nordic Co-operation includes Denmark, Finland, Iceland, Norway, Sweden and the autonomous territories of the Faroe Islands, Greenland and Åland.

[7] The "Measuring Environmental Performance of Industry" (MEPI) project was co-ordinated by the Science and Technology Policy Research at the University of Sussex, UK and funded under the Fourth Framework Programme (Environment and Climate) of DG Research of the European Commission. A standardised approach for quantitative environmental performance indicators in six industrial sectors was developed, and the patterns, dynamics, and drivers of performance in a large sample of European companies were analysed.

Current OECD work focuses on indicators for material flows (OECD, 2008). Material flow indicators provide insight into the economic efficiency and environmental effectiveness of materials used in the production and consumption chain, up to final disposal (op cit.).

Material flow measurements use a range of indicators, including resource efficiency indicators. For example, economic output indicators (such as GDP or value added) are compared to material flow indicators to provide information about the material productivity or intensity of a given sector (op. cit).

The OECD work is in its early stages but is focused on collaborative approaches and development of common sets of indicators and could be revisited in the future to check progress and relevance for New Zealand policy development.

4.3 Sector Specific Approaches

The key difference between national and sector based approaches is that sectors generally obtain data from a sample of plants / businesses, or model plants / businesses, and use it as the performance measure. National approaches use national databases of resource use and productive output to obtain macro-level performance measures.

Sector specific frameworks for measuring resource efficiency are less common. Sector-specific indicators have developed as part of work on general frameworks, or as part of company or sectoral interest in sustainability reporting. Standardisation across the various sector approaches is not commonplace, making cross-sector comparison difficult or impossible.

In general, sector-specific frameworks have developed from multilateral organisation approaches developed in conjunction with business sectors. Both the WBCSD and the NRTEE, include a set of core indicators and industry specific indicators, along with 'supplementary' indicators which can be used for a specific sector with particular concerns or activities. In addition, the onus is often on individual sectors or companies developing their own specific indicators (WBCSD, 2000).

Sector specific frameworks otherwise arise in response to regulatory drivers and more stringent requirements at the business level, for example in the UK. In Germany, the Wuppertal Institute developed specific approaches for the aluminium industry. Resource efficiency was also applied to the pulp and paper industry in a Finnish study (Helminen, 1998). The study evaluates resource [eco-] efficiency using a reference plant as a measure for evaluating performance (op. cit).

There has been some attempt to assess indicator suitability to allow cross-sector comparisons and provide a more robust description of the comparative environmental performance of companies (Berkhout, 2001). However, limited information is available on these approaches.

The infancy of sector approaches is exemplified in part, by the EC which is only now developing sectoral approaches[8]. The EC has committed to developing reference documents and guides with

[8] This contrasts to guidance available for corporate sustainability reporting which generally measures progress against a set of objectives. In this area, sector specific guidance is more commonplace, an example being sector reporting supplements developed as part of the GRI.

the aim of developing sectoral reference documents. These are referred to in the latest amendments to EMAS (See Appendix 1). The EC sectoral guides will include environmental performance indicators for specific sectors and benchmarks of excellence and rating systems identifying performance levels.

The EC intends to take into account existing reference documents and environmental performance indicators developed in accordance with other environmental policies and instruments in the Community or international standards. A working plan is due at the end of 2010, setting out an indicative list of sectors, which will be considered priorities for the adoption of sectoral and cross-sectoral reference documents. It may be beneficial to New Zealand to keep watch on this development.

See Appendix 2 for a selection of sector-specific approaches

5.0 Defining the System Boundary and Indicators

The following section outlines the fundamental elements that are common to resource efficiency measurment frameworks as follows:

- A boundary to the business sectors and their interaction with the environment, as way of defining each sector, and defining the extent of the environmental and economic parameters.
- Indicators that provide a measure for the environmental and economic parameters.

5.1 Defining the System Boundary

System boundaries provide direction as to the nature and scope of the indicators, data, and resource efficiency ratios that can be developed. Typically, boundaries are determined by three factors:

- The character of the business, industry, or sector. A business may be defined by the stage of a product / service life cycle that is measured, or whether subsidiaries are included. Industries may be defined by common products or processes, whereas a sector may be defined by the nature or size of relevant industries within the sector.
- The physical or spatial limit of a business or sector's environmental footprint. For example, what resources does the sector use or what are the waste streams?
- The specific area where environmental performance is analysed e.g. energy, recycling, suppliers, or total performance.

5.2 Indicators

Indicators are used in resource efficiency frameworks to represent resource use, waste produced, and economic productivity. They provide a reliable overview of the efficiency of a business or businesses to produce goods and services from natural resources (and the efficiency of waste produced) and can provide triggers for dialogue and further enquiry (NRTEE, 1999; WBCSD, 2000). As noted in Section 4 of this report, indicators are not expected to measure and communicate all aspects and details of environmental performance, but do allow comparison of performance between companies and across sectors.

The two groups of indicators are:

1. Physical indicators – representing the environmental resource or waste and
2. Economic indicators – representing the unit of productivity or economic value, as such:

$$\text{Resource Efficiency} = \frac{\textbf{Economic indicator}}{\textbf{Physical indicator}}$$

Selection of appropriate indicators for each part of the resource efficiency framework, for a given business or sector, is derived from the system boundary and from consideration of relevant inter-business, inter-sector or international comparisons.

Physical Indicators

Physical indicators generally relate to mass and energy flows through the business process and are measured in units such as kg/year or Mj/year (Azzone, 1996; MEPI, 2000; Olsthoorn et.al, 2001).

There are many potential physical indicators for measuring resource efficiency. Indicator selection is generally based on the relevant environmental issues and the business or sector within the system boundary. International approaches show a trend toward using a manageable number of indicators (between ten and twenty) (Berkhout et. al. 2001; OECD; EMAS). Exceptions arise, including ISO 14031:1999, which divides physical indicators into management and operational streams and lists over 100 indicators.

Physical indicators can be defined as 'core', 'sector specific' or 'supplementary'.

International examples commonly use a set of 'core' physical indicators which provide a representation of the overall resource use / waste production of an organisation or sector over time. There is also a clear trend toward standardising the core physical indicators, so that they are applicable to any organisation or sector. The core indicators allow for general inter-sector or international comparisons. Commonly cited core physical indicators are:

- Energy (Gj)
- Water (m^3)
- Solid waste (tonnes)
- Greenhouse gas emissions (tonnes $CO_{2\,e}$)
- Ozone depleting substances (tonnes CFC II_e)

These five indicators reflect high priority global environmental issues and are common aspects of consumption and production processes.

Core indicator approaches are generally consistent with sustainable indicator approaches that measure overall country performance. Examples of these approaches include the OECD core global indicators and the European Environment Agency (the latter tracks sector performance across Europe). As noted, the OECD Core Set is used to measure environmental progress and is complemented with several sets of sectoral environmental indicators to help integrate environmental concerns in sectoral policies (OECD, 2004).

In addition to listing 'core' indicators, a number of frameworks also list 'supplementary' indicators which tend to be organisation or sector specific. Examples of this approach include the German Federal Environment Ministry, NRTEE, UN, and WBCSD. The result is a list of core indicators that are relevant to any organisation or sector, and supplementary indicators that may only be specific to a small group. Often the supplementary indicators are not well defined in the frameworks and ultimately left to be determined by the framework user.

Sector programmes have well designed sector-specific indicators. For example, sectors which produce air or waste water discharges may have 'core indicators' like chemical oxygen demand (COD) from waste water discharges, or SO_2 from discharges to air. Material use is also commonly used for measuring resource efficiency, and while it would be a core indicator for a particular industry it does not compare well across industries or sectors.

Summary of key aspects of approaches to physical indicators:

- Methodologies for using environmental indicators for measuring environmental performance or impact have converged to a state where there are obvious commonalities in many approaches. Canada for example, is aligned with WBCSD approaches; Germany aligns with EMAS and ISO (see: NRTEE, 1999, 2001; WBCSD, 2000). Both include core indicators and supplementary or sector specific indicators.
- A balance needs to be struck between oversimplifying and overcomplicating indicators within the resource efficiency framework. Having a small number of indicators required to describe resource use / waste outputs assists with simplifying the task of data collection and analysis and can improve the practicability of performance measurement. However, this simplifying step needs to be balanced with retaining a sufficiently broad picture of the different and relevant dimensions of resource efficiency being measured (Berkhout et. al. 2001).

  Table 2 provides an overview of physical indicators used within some of the frameworks included at Appendix 1.

Table 2: Summary of international frameworks and physical indicators

Framework	Reporting level	Core Physical Indicators							Supplementary / business specific
		Energy use	Materials	Water use	GHG emissions Climate change	Solid Waste	Ozone depleting substances	Air emissions	
Global Report Initiative (GRI)	Business	✓	✓	✓	✓	✓	✓		✓
World Business Council for Sustainable Development (WBCSD)	Business	✓	✓	✓	✓		✓		✓
National Round Table on the Environment and the Economy (NRTEE)	Business	✓		✓		✓			- life-cycle energy, transportation energy, water discharges
United Nations Environment Programme	Business	✓		✓	✓	✓	✓		
Department for Environment, Food and Rural Affairs (DEFRA)	Business	✓		✓		✓			
Azzone et al. (1996)	Business	✓			✓				- transport
Organisation for Economic Co-operation and Development (OECD)	National	✓		✓	✓	✓	✓	✓	- forest resources, fish resources, biodiversity
European Environment Agency (EEA)	National	✓		✓	✓	✓	✓	✓	- biodiversity,

Framework	Reporting level	Core Physical Indicators							Supplementary / business specific
		Energy use	Materials	Water use	GHG emissions Climate change	Solid Waste	Ozone depleting substances	Air emissions	
									fisheries, transport
German Federal Environment Ministry	Business	✓	✓	✓	✓	✓		✓	- transport, cleaning agents, packaging
Eco Management and Audit Scheme (EMAS)	Business	✓	✓	✓	✓	✓			- biodiversity
Berkhout et al. 2001 (for EC Environment and Climate Research Programme)	Sector	✓		✓	✓	✓		✓	- emissions to water
The Eco-efficiency of Regions – Case Kymenlaakso (ECOREG)	Regional	✓	✓	✓	✓	✓	✓	✓	- Social-cultural indicators - Degradation of landscapes and cultural environments etc - Eutrophication, acidification, odour, noise, loss of biodiversity etc.

Economic Indicators

Economic indicators represent the productive outputs of a sector or business, the economic well-being of its stakeholders, and the contribution to the economic systems at the local, national, and / or global levels. They can encompass any aspect of economic interaction including traditional measures used in financial accounting such as profit or net value (Krajnc and Glavič , 2005). Economic variable can be expressed either in monetary terms (sales, value added) or in physical terms (quantity of production) (Erkkoa et al. 2005).

A range of economic indicators are used and are generally defined by the unit of output related to the product or service. The literature indicates that a large multiplicity of data and measurement units are available (Berkhout (2001). Most have been developed at a micro-level and are business specific. Commonly cited examples include:

- Functional unit: a standardised unit of production from a given company or sector
- Turnover: total sales for a given company or sector
- Employees: number of personnel employed by the company or sector
- Value added: total value of sales minus cost of materials
- Profit: untaxed total value of sales minus cost of sales (adapted from Olsthoorn et al. 2001).

There is little information on selection of economic indicators at a sector level. Economic indicators need to adequately reflect the size and/or the activity of the production unit for the firm or sector being measured. They should also suit the business being operated, a manufacturer for example, may measure the tonnes of product sold (NRTEE, 2001), whereas for a service firm the hours charged to clients may be more applicable. A large industrial sector may use total gross value added while a smaller organisations may use annual turnover or number of employees.

Turnover or sales are often promoted in studies on the measurement of environmental performance, because they are simple and readily available in most situations. However, when considering production chains, there may be problems of double accounting and therefore a misleading picture may emerge. Looking at environmental performance within a sector, a better measurement may therefore be the something broader like shipment value or exports (Olsthoorn et al. 2001).

Consideration also needs to be given to comparing across countries where the context may vary e.g. taxation, culture, and regulatory frameworks. Economic terminology also varies across countries and resource efficiency frameworks.

As with physical indicators, there are commonly applied economic indicators including gross domestic product (GDP) and number of employees. At the sector or national level the economic indicator tends to be more general, for example, GDP (as the best known measure of macro-economic activity). GDP is commonly selected due to the availability of data and comparability across countries. GDP (in combination with other indicators) provides a “compact set of indicators which review the economic performance at the macro level” and can be used at a sectoral level (UN et al. 2003).

A key limitation of economic indicators is that they do not take into account depreciation, resource depletion, environmental degradation or transfers into and out of a country, which reflect quality change and other aspects of our changing society. No single measure or set of economic indicators has been developed that provides a true measure of sustainability and these matters (Stiglitz et. al, 2008). Work on developing economic indicators that reflect issues such as the environment or social inequalities are in their infancy. For example, the European Commission is currently working on development of a comprehensive environmental index and an improvement of the quality-of-life indicators that effective summarise the three aspects of sustainability (Commission of the European Communities, 2009). Appropriate data sets would be required to use alternative approaches to economic indicators.

Further detail on commonly cited economic indicators is provided in Table 3, including a summary of benefits and flaws.

Table 3: Economic Indicators

Economic Indicator Category	Economic Indicator	Benefits / Flaws
Business activity	• Employees (e.g. numbers, labour hours	- There may be differences in labour across sectors - A good proxy for the manufacturing activity - Readily available data - Does not entail the problems linked with financial quantities
	• Units (e.g. number) sold	- Readily available data at company level – variable at sector level
	• Space (e.g. in building management)	- Limited application
	• Output production (minus input use) - quantity	- Suited to situations characterised by one unique physical production output - Provides for comparisons among factories or companies within the same sector
Monetary	• Net Sales/Turnover	- Simple and readily available in most situations - When considering production chains, there may be problems of double accounting and therefore overrating
	• Shipment value	- May be a better measure for comparing sectors (compared with turnover) - Not a commonly used term in New Zealand
	• Net Income • Earnings	- Not useful for comparison across countries due to different taxation
	• Operating Profit	- Takes into account the depreciation of the capital stock

	• Gross profit	- Not useful for comparing different sectors or countries because of large differences in the labour markets
	• Total Investments and write-offs	- Reflect only a part of the activity - May be taken as a substitute to either turnover or value added - Sensitive to the socio-economic context and may have little relationship with the actual environmental impact
	• GDP	- Use for national indicator approaches - Criticised for not measuring environmental sustainability or social inclusion (common to all economic indicators) - A standard benchmark used by policy-makers, internationally - GDP aggregates the value added of all money-based economic activities - Based on a clear methodology that allows comparisons to be made over time and between countries and regions.
Function	• Product performance • Services delivered • Agricultural yield • Transport capacity	*Function describes the functional value of a product/service to the end-user. As a result, they are highly specific and can only be used for individual products and services.*

Source: WBCSD, 2000:31, Olsthoorn et.al, 2001; and MEPI, 2001

5.3 Indicator Selection

Given the variety of indicators available, selection criteria are an important aspect of developing a sector-based resource efficiency measure framework. Approaches and methods for selecting indicators are widely cited[9] and summarised as follows[10]:

- *Direct relevance* – the indicators selected must be closely linked to environmental issues and economic measures that are relevant to the sector and the national context.

9 See for example: Berkhout; 2001, Gabrielsen et. al, 2003; Melanen et. Al, 2004; Moll et. Al. 1999; Segnestam 1999, 2002; Moll et. Al. 1999; NRTEE, 1999; UN, 2007.

10 These are generally consistent with New Zealand's approach to selecting core national environmental indicators. The Ministry for the Environment applied six criteria used to select its twenty-two core national environmental indicators as follows: nationally significant, relevant, measureable and statistically sound, simple and easily understood, cost effective and internationally comparable (MfE, undated).

  - With regard to physical indicators consideration should be given to key environmental issues, resource availability issues, central government policy direction, and international reporting responsibilities.
  - Economic indicators should be selected from current macro-economic reporting, but also need to be relevant to the business sector. A macro and micro level indicator are suggested to achieve this.

- *Limit the number* – a small set of well chosen indicators is considered effective and adequate for providing an overview of environmental issues arising from sectors.
- *Clarity in design* – indicators should be clearly defined in order to avoid confusion during the development, or misinterpretation of results.
- *Realistic collection or development costs* – the cost of collection and development of indicators in an important consideration. Excessive data collection costs may lead to trade-offs between the information content of various indicators and the cost of collecting them.
- *High quality and reliable data* - indicators, and the information they provide, are only as good as the data from which they are derived. The quality of the data collected and its longevity are fundamental to providing useful measures of environmental issues.
- *Appropriate spatial and temporal scale* - appropriate spatial and temporal scale of indicators require consideration, generally data is collected for annual measurement of performance.

(adapted from Gabrielsen et. al, 2003; Segnestam 1999, 2002; Berkhout; 2001)

6.0 Data Collection

Data is the most basic component of the indicator framework and provides the basis for indicators. This section discusses the two key methodologies for sourcing data sets, these being:

1. From individual businesses, and build up to a sector profile
2. From national data sets, and break down to a sector profile.

It also discusses the nature and quality of data required to ensure reliability with resource efficiency ratios.

Much of the literature discusses the methodologies for identifying data sources and collection at the business level. This includes the voluntary business guides for micro-scale resource efficiency measurement (See: WBCSD, Appendix 1), and macro-scale government initiatives to drive policy and regulations on what and how businesses should provide data (See: DEFRA/UK, Appendix 1).

Discussion in international literature focuses on data collection requirements at the corporate level and recognises that there is variation between companies with regard to what data is collected and how it is managed.

The WBCSD notes that tracking resource efficiency performance should, wherever possible, be based on information that is already available but notes that some information must be estimated because it is not practical to obtain actual measurements (e.g. GHG emissions associated with purchased electricity) (Verfaillie et.al 2000). Mainstream business information sources such as production reports, annual financial reports, material safety data sheets, and environmental reports are considered key sources of information (Berkhout et. al. 2001; WBCSD / Verfaillie et. al, 2000).

The data requirements for assessing environmental performance for the national data sets are potentially very large. This stems from the multiple levels of a sector that may be assessed (e.g. processes, production, firm type) and various dimension of a sector (e.g. energy use, water consumption, emissions) which can be included as indicators. In the UK for example, there is extreme diversity in terms of the information provided for measuring resource efficiency; the Government is now considering whether a standard reporting protocol could be developed for data (Defra, 2007).

Data used for measuring indicators needs to be comprehensive and cross-representative against data availability, data quality, and policy interest, while taking into account the value of the information gained (Jollands, 2003). These considerations are relevant to developing a framework and are common in international examples.

To assist, data collection criteria are generally developed for each indicator which includes:

- Indicator definition – a description of the physical and economic indicators (as discussed above);
- Indicator classification – classification of the basic data, if necessary, reference figures;
- Indicator data sources – list sources of data for ongoing collection;
- Conversion factors - if relevant;

- Frequency of data collection and determining indicators.

Data management is discussed in further detail in the Framework document which complements this literature review.

7.0 Developing a New Zealand Framework

The following section provides a summary of key findings from the literature review that are recommended when developing the sector-based resource efficiency framework for New Zealand. It considers existing methods used for assessing resource efficiency that aim to measure environmental performance and productive value, and the various ways that resource efficiency has been applied at the micro and macro scale.

Overall, the approach to measuring resource efficiency using a 'true' resource efficiency ratio of product or service value against environmental influence is considered appropriate for New Zealand. The ratio aspect is particularly important for comparing inputs and outputs of systems to provide a broad picture of environmental performance arising from the production and consumption of goods.

The following aspects of a framework are recommended:

- a core set of physical indicators identified
- raw materials could be used as a supplementary physical indicator for selected sectors
- economic indicators to include GDP, employee number and export value
- production unit should be used as a supplementary economic indicator for selected sectors
- indicators should be developed using the selection criteria identified in this report
- a data filter should be applied to manage data quality.

Details on each of these elements are provided in Table 4: Summary of Key Findings and Application to New Zealand Framework below which provides a summary of key findings regarding each element of ratio frameworks and discusses how and why this aspect should be applied in the New Zealand context.

A draft framework is provided in a separate report.

Table 4: Summary of Key Findings and Application to New Zealand Framework

MEASURING RESOURCE EFFICIENCY	
Key Findings	*Measuring resource efficiency using an input-output ratio is common across examples. Resource efficiency frameworks commonly include:* • *A boundary to the business sectors and their interaction with the environment.* • *Indicators that provide a measure for the environmental and economic parameters.*
New Zealand Application	It is considered appropriate to use international approaches as a basis for a resource efficiency measuring framework for New Zealand. The resource efficiency ratio approach is well documented and tested across countries. International approaches

	have been in place since the earlier 1990's and New Zealand is likely to benefit from those experiences and current developments in resource efficiency approaches. Boundary selection is less relevant in New Zealand as data collection is determined by sector – essentially the sector defines the boundary.
Key Findings	*Few approaches attempt to measure overall resource efficiency (i.e. full input-throughput-output analysis) and even fewer address overall sustainability. To do so, a full range of social-economic and environmental aspects would need to be assessed required in conjunction with a detailed understanding of material flows and throughputs.*
New Zealand Application	Environmental and economic indicators would be selected (see 'Indicators' below). Socio-cultural indicators may be developed in the future but are considered beyond the scope of the framework, requiring input from relevant ministries. As such, socio-cultural indicators require further consideration before they can be applied as a resource efficiency indicator in New Zealand. Detailed assessment of the sustainability of sectors is beyond the scope of the framework. The key outcome at this stage is to provide an indicator of resource efficiency that prompts further analysis and/or action. As such, a resource efficiency approach that measures an economic-environmental ratio is considered adequate to provide the indication of resource efficient required at this stage. Socio-cultural indicators are considered an important aspect of sustainability and should be given further consideration as the resource efficiency programme develops.
Key Findings	*Information provided through resource efficiency framework (measurement) is indicative and the aim is generally to provide an overview of effects rather than more precise environmental assessment of production and processes that might, for example, be developed through tools such as life cycle assessment and material flows analysis.*
New Zealand Application	As noted above, a more detailed sustainability assessment is beyond the scope and purpose of the framework being developed for New Zealand. The proposed framework should serve, in time, to generally inform businesses, provide information for stakeholders, and compare industry performance.
Key Findings	*Each of the frameworks emphasise the importance of comparability over time and between reporting entities.*
New Zealand	This should be taken into consideration for the development of a draft framework for New Zealand. Data management is considered an important aspect of achieving

Application	comparability over time and between reporting entities and will be factored in to the data filter.
Key Findings	*The terminology used in frameworks varies.*
New Zealand Application	For this project a consistent terminology should be applied to the framework. A more detailed glossary of terminology could be developed in the long-term as part of policy development using national and international terms that are widely understood and comparable across sectors and countries.
INDICATORS	
Key Findings	*The development of physical and economic indicators is a key aspect of resource efficiency frameworks. The purpose of an indicator is for it to indicate the general performance of business, and not necessarily disclose all aspects.* *The selected indicators need to be sufficient to provide an approximate, yet reasonably robust, description of performance of sectors. Key considerations when developing indicator sets are completeness, feasibility, and communicability of indicators. A balance needs to be struck between oversimplifying and overcomplicating indicators within the resource efficiency framework.*
New Zealand Application	The selection criteria summarised from literature (Section 5.3) is consistent with the Ministry's core indicator selection. Given this consistency, it is considered appropriate to apply the selection criteria to the indicators for the resource efficiency framework for New Zealand. Having a small number of indicators required to describe resource use / waste outputs assists with simplifying the task of data collection and analysis and can improve the practicability of performance measurement. However, this simplifying step should be balanced with retaining a sufficiently broad picture of the different and relevant dimensions of resource efficiency being measured.
Key Findings	*International examples demonstrate that it is possible to achieve a relatively robust approach using a minimum set of indicators - these are relatively well-defined across approaches.* *Indicators should also address key global issues, such as climate change and water quantity to allow international comparisons over time.* *Supplementary indicators are appropriate for sectors that use resources or create emissions / waste that do not fit within the core set*

New Zealand Application

A set of core physical indicators is considered appropriate for New Zealand. A list of supplementary indicators based on existing indicator sets could be developed over time to refine the resource efficiency framework. The following are recommended for the draft framework:

Core

- Water use
- Solid waste
- Energy use
- Greenhouse gas emissions
- Wastewater

Supplementary

- Material use (specific to a sector)

These indicators are recommended for the following reasons:

Water use: Water is an important indicator category for New Zealand. It will provide a ratio of water use to productive output and assist with understanding sector demand for freshwater resources.

Freshwater quality is a key environmental issue in New Zealand. Water quality and quantity are also important issues for business, particularly in high demand areas such as agriculture.

The volume of water allocated for irrigation, domestic use and manufacturing increased by approximately 50 per cent between 1999 and 2006. It is anticipated that the demand for freshwater will continue to increase. At 2006, 77% of allocated water was used for irrigation. The remaining 33% is shared among public water supply, manufacturing and industry, and stock water.

Solid waste: Waste minimisation is a key policy area in New Zealand. The Waste Minimisation Act, 2008, was introduced to encourage waste minimisation and a decrease in waste disposal in order to protect the environment and provide environmental, social, economic, and cultural benefits. A solid waste indicator category provides information on the amount of waste produced in each sector.

Energy use: Energy is an important issue affecting all sectors and production. Energy use is constrained by supply of oil and the supply of electricity. Energy from fossil fuels is likely to become more constrained as prices increase and supply is reduced. Therefore, monitoring the efficiency of sectors can indicate how vulnerable sectors are to energy supply changes.

Greenhouse gas emissions: GHG emissions and climate issues are a significant national and international environmental and economic issue. As signatory to the Kyoto Protocol, New Zealand reports its GHG emissions at an international level. This indicator is considered an important aspect of the framework to support climate change

	policy. ***Wastewater:*** Water quality is a key issue in New Zealand, and the discharge of wastewater to water is contentious in many communities, particularly around coastal lagoons, recreation areas, and traditional food gathering areas. Wastewater may also provide an indicator of the waste of freshwater. ***Supplementary indicator - Materials Use:*** Materials use is a fundamental part of the input / output equation in productive industries, and a key measure of the reliance on natural resources. Materials use is sector-specific making cross-sector comparisons difficult. It is considered useful to highlight key materials use in one or two sectors to provide an indication of the production throughput.
Key Findings	***Economic indicators*** *are less consistent in the literature; they are generally determined by the size and type of organisation or sector being measured. Research indicates that economic indicators should adequately reflect the size and / or the activity of the production unit.* *Like physical indicators, economic indicators need to be objective, understandable and allow for meaningful comparisons. They must also be workable insofar as the data required to implement them is accessible and widely available.* *Sector or national approaches commonly cite GDP as the numerator denoting the economic values in resource efficiency indicators for the whole economy.*
New Zealand Application	As the New Zealand framework is aimed at the sectoral level it is considered appropriate to provide some cross-comparison of performance between sectors by using measures that are standardised (such as monetary or financial) rather than by production unit. Based on availability of data in New Zealand, monetary output expressed in GDP is considered an adequate measure of sector outputs at the national level. GDP is considered to meet this requirement and the selection criteria outlined above, if used in conjunction with other economic indicators. GDP removes the value of intermediate consumption and provides a value of production that is free of duplication. While GDP can vary and possibly skew results over time, it remains a useful measurement that is widely used, measured and relatively comparable across countries. As stated above, to ensure the analysis is robust, economic indicators would not be used in isolation. For example, GDP and employee number could provide useful economic indication of resource efficiency when reported together. Exports per commodity and production unit also provide useful economic indicators for New Zealand's export based economy. Production unit is not a viable indicator for each sector as it would be extremely time-

	consuming and costly to collate the data. However, because it provides a meaningful indicator of actual output (without the monetary variables), it is recommended that production unit be applied to a selection of sectors during initial application of the framework to further test its applicability for the long-term use in the framework. **Supplementary indicators** should be developed in collaboration with sectors/industry to ensure they meet the selection criteria. This is not considered feasible for the development phase of the framework although in the long-term it may be reasonable to develop sector specific indicators for targeting specific policy responses as resource efficiency policy develops in New Zealand.
DATA COLLECTION	
Key Findings	*It is essential to maintain a consistent approach to collecting and classifying data for meaningful, long term data collection and interpretation.* *A balance needs to be struck between the complexity of measuring environmental impacts of business and the practicality, particularly in the initial stages.* *Any comparison of indicators must be undertaken with indicators determined and derived using the same methods. Ongoing data collection will also lead to the refinement of this aspect which may limit availability of information required to achieve these aspects.*
New Zealand Application	Sector-based physical and economic indicators based on publicly available regional or national data sets is considered a feasible approach for New Zealand. It is therefore recommended that data should be collected at a national level to provide a sectoral indicator of resource efficiency, rather than using business or sector data to calculate resource efficiency ratios for each sector. There may be exceptions where, for example, industry associations maintain data sets. A data filter will be included as part of the framework to ensure a consistent approach to collecting and classifying the quality of data for meaningful, long term data collection and interpretation. Data on each indicator selected will not be available for all sectors. It is important to identify these gaps as part of the framework which may assist with prioritising any future data collection requirements. The level of detail, and completeness of information obtained from this approach, is dependant on data availability. Gaps in data will be identified during Phase 2 of this project.

8.0 Limitations and Assumptions of Resource Efficiency

The following section provides a summary of key limitations associated with resource efficiency frameworks identified during the literature review. While these are not fundamental flaws in the approach, they do need to be considered when applying resource efficiency frameworks.

- As discussed in Section 3.0 of this report, the resource efficiency concept is only one tool of many used to measure or address aspects of sustainability. Hukkinen (2003) refers the "rebound effect" that can occur with resource efficiency implementation i.e. that improved resource efficiency can be accompanied by increased resource consumption that undermines the original environmental improvements.
- Increases in welfare alone do not suffice to further sustainable development, as gains in resource efficiency are still likely to be outpaced by global growth in consumption.
- Resource efficiency is a relative measure, and is not a sufficient condition on its own for measuring environmental impacts or sustainability; in most cases, absolute reductions in environmental pressures are required to achieve sustainability (Moll and Gee, 1999). Resource efficiency is only intended to give business a businesslike way into approaching or responding to the challenges of sustainable development (WBCSD, 2006).
- Some indicators are commonly applied but do not provide any indication of the consumption of natural resources or the emission of waste. Energy use, for example provides a useful indicator of consumption however, the source of energy (e.g. hydro, gas, coal fired) used in production needs to be identified and aggregated to provide the greenhouse gases indicator and meaningful information.
- Little guidance is available for selecting economic indicators however, aggregated, broad indicators such as GDP, exports, employment, and net value are more commonly applied for national measurement.
- Use of a single economic indicator in isolation can skew the results. To lessen this effect, economic indicators should be used as a compact set of indicators which review the economic performance at the macro level and sectoral level, where possible.
- A common shortcoming of existing indicator frameworks is the lack of clear and detailed guidance on how to implement indicator measurement in practice. For example, the GRI lists ninety-six sustainability indicators (both generally applicable and organisation- specific) but does not provide any guidance on selection and implementation.
- While there has been some convergence on approaches to measuring resource efficiency, there are variations in emphasis, often due to the origin of the framework. As a result a variety of terms are used and a need for standardisation of terminology and approaches would be beneficial.
- Comparability of resource efficiency ratios between sectors is not well developed - it is more commonplace to compare similar businesses within sectors. Sector comparisons require the

use of core indicators, which can sometimes provide oversimplified results that provide no real insight into the performance of the sector.

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Appendix 1: Summary of International Approaches

Multilateral Approaches

World Business Council for Sustainable Development (WBCSD)

The BCSD (now WBCSD) coined the term 'eco-efficiency' in 1992. Its programme applies 'generally applicable indicators' and 'business specific' indicators with the aim that a company's eco-efficiency performance profile will include both types of indicators.

The WBCSD framework includes three levels of organisation for eco-efficiency information which are consistent with the terminology used in the ISO 14000 series and the Global Reporting Initiative (GRI) i.e.: categories, aspects, and indicators. Categories are broad areas of environmental influence or business value. Each has a number of aspects, which are general types of information related to a specific category. Aspects describe what is to be measured; Indicators are the specific measures of an individual aspect that can be used to track and demonstrate performance.

The framework uses an 'eco-efficiency ratio' (value per environmental influence) as WBCSD consider that increasing efficiency ratio reflects a positive performance improvement and is comparable to the way business tracks financial performance. The WBSCD sets out a range of principles for indicators. These are not repeated here but generally relate to how information is collected and used to make it relevant and meaningful over the long term.

While the WBSCD has developed a framework for measuring eco-efficiency, the organisation recommends that the ISO 14031 Environmental Performance Evaluation framework be used as the primary approach for selecting sector or company specific environmental influence indicators.

The WBCSD uses two types of indicators: "generally applicable indicators" for global environmental concerns or business value and cross-sector, and "business specific", for all other indicators. The WBSCD has given some consideration to indicators for the environmental influence of product/service use but has been unable to produce common terms given the variation between companies and countries. As such, the framework provides a list of indicators that cover the broad spectrum of environmental 'aspects' related to the production and use of products and services. The framework also contains options for measuring the "value" of products or services. Combined together, these can be used to describe a company's eco-efficiency.

The WBCSD has developed sector-specific indicators to assist companies to identify their relevant indicators. The descriptions, measurement methods and data sources were derived from information provided by pilot companies.

Indicator	Unit / Overview	Cross Sector
Product / service value:		
1. Quantity of goods / services produced /	This indicator is the physical measure or count of product or services produced, delivered or sold.	✓

Indicator	Unit / Overview	Cross Sector
provided		
2. Net sales	Is the total recorded sales less sales discounts and sales returns and allowances. It is considered the most easily measurable and available value indicator.	✓
Environmental influence in product/service creation		
Energy	Gj - Energy purchased or obtained relates solely to energy consumed and transformed on site. Companies could further elaborate on energy use by identifying separately the renewable energy consumption and a breakdown into different types of energy sources such as natural gas, oil and others.	✓
Materials	Tonnes - The sum of weight of all materials purchased or obtained from other sources such as extraction, including raw materials for conversion, other process materials (such as catalysts, solvents), and pre- or semi-manufactured goods, parts and modules (such as automobile parts, computer parts). Excludes packaging.	✓
Water	m^3 - The sum of all water purchased /use on site	✓
Greenhouse gas (GHG) emissions	Tonnes of CO_2e - GHG includes carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro- and perfluorocarbons (HFCs, PFCs) and sulphur hexafluoride (SF_6) emissions from fuel combustion, process reactions and treatment processes. GHG calculations are undertaken using existing calculation tools The GHG indicator applies to emissions arising from corporate activities, but could be expanded to include full product life-cycle if information is available*.	✓ *Sector specific
Ozone depleting substance emissions	Tonnes of CFC11e - as defined in the Montreal Protocol.	✓
Environmental influence of product/service use		✓
Additional financial value indicators	Currency -The definition and application of this term varies with industries and countries and it has proven difficult to define a common term.	✓
Acidification emissions to air	Tonnes - This indicator includes acid gases and mists from fuel combustion, process reactions and treatment processes	

Indicator	Unit / Overview	Cross Sector
Total waste	Tonnes - The amount of substances or objects destined for disposal. The definition and application of the term 'total waste' varies with industries and countries.	

See: WBCSD (Verfaillie,et. al 2000) *Measuring Eco-efficiency: A Guide to Reporting Company Performance available at:*
http://www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=Mjgy

Environmental Management and Audit Scheme (EMAS)

The EC Environmental Management and Audit Scheme (EMAS) was established in 1993, and revised in 2001 and 2008.

The latest revision (2008) introduces a set of core indicators directing businesses reporting on environmental performance. These indicators are defined for the following environmental areas: energy efficiency, material and resource efficiency, waste, emissions, and biodiversity/land use to measure environmental performance. The core indicators aim to:

- give an accurate appraisal of the organisation's performance;
- be understandable and unambiguous;
- allow for a year on year comparison to assess the development of the environmental performance of the organisation;
- allow for comparison with sector, national or regional benchmarks as appropriate;
- allow for comparison with regulatory requirements as appropriate.

Each core indicator is composed of:

- a figure A indicating the total annual input/impact in the given field;
- a figure B indicating the overall annual output of the organisation; and
- a figure R indicating the ratio A/B.

Organisations are required to report on all three elements for each indicator.

The indication of the total annual input/impact in the given field, figure A, is reported as follows:

- Energy efficiency - total direct energy use indicating the total annual energy consumption, expressed in MWh or Gj; plus total renewable energy use indicating the percentage of total annual energy (electricity and heat) consumption produced by the organisation from renewable energy sources material efficiency; and the annual mass-flow of different materials used (excluding energy carriers and water), expressed in tons.
- Water = the total annual water consumption, expressed in m^3.
- Waste = the total annual generation of waste, broken down by type, expressed in Tons; and the total annual generation of hazardous waste expressed in kilograms or Tons.

- Biodiversity - the use of land, expressed in m² of built-up area
- Emissions - the total annual emission of greenhouse gases, including at least emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6, expressed in tons of CO_2e and total annual air emissions, including at least emissions of SO_2, NO_X and PM, expressed in kilograms or tons.

Where an organisation concludes that a core indicator is not relevant to its significant direct environmental aspects that indicator can be excluded, subject to the organisation justifying its exclusion.

Economic indicators or ("indicator of overall annual output") of the organisation (figure B) is the same for all fields, but is adapted to the different types of organisations, depending on their type of activity, and reported as follows.

1. Organisations working in the production sector (industry) indicate the total annual gross value-added expressed in Million € (Mio€) or total annual physical output expressed in tons or, in the case of small organisations the total annual turnover or number of employees.
2. Organisations in the non-production sectors (administration/services), relate it to the size of the organisation expressed in number of employees.

In addition to the indicators defined above, an organisation may use other indicators to express its overall annual output.

Organisations report annually on performance relating to the more specific environmental aspects as identified in their environmental statement and, where available, take account of, and refer to, sectoral reference documents as referred to in Article 46 of the EMAS Regulation.

[Article 46 relates to the provisions of information exchange and collaboration between Member States and other stakeholders on the best environmental management practice for relevant sectors, in order to develop sectoral reference documents, including best environmental management practice and environmental performance indicators for specific sectors, undertaken by the Commission].

United Nations

The United Nations resource efficiency framework was developed for consistency with accounting frameworks and developed primarily for business organisations to provide information on the eco-efficiency of their enterprises. It describes the method that enterprises may use to provide information on environmental performance in relation to financial performance, in a systematic and consistent manner over periods of time. The framework is similar to the WBCSD approach which calculates the environmental burden using resource / output ratio.

Its manual guides businesses to report their eco-efficiency performance for five generic environmental issues:

1. Water use
2. Energy use
3. Global warming contribution
4. Ozone depleting substances

5. Waste.

The framework states that these indicators represent a basic set upon which an enterprise may report. The indicators were selected on the basis that they address global issues and are cross-sectoral. The UN recommends that these evolve as existing environmental problems are reassessed by new scientific and/or social knowledge.

The list can also be expanded to cover the particular industry sector. They note that it would be more appropriate for industry associations to specify sector-specific indicators because they are best positioned to obtain industry consensus. Companies are encouraged to develop additional indicators (e.g. region, site or company-specific) using the framework and guidance. The Guidance developed by the UN provides lists and information on the aspect to be collected for each environmental variable and indicator. The core indicators are:

- Water consumption per net value added
- Global warming contribution per unit of net value added
- Energy requirement per unit of net value added
- Dependency on ozone-depleting substances per unit of net value added
- Waste generated per unit of net value added.

European Eco-efficiency Alliance

The Resource Efficiency Alliance comprises public and private organisations from various sectors. Its aim is to develop synergies to accelerate the implementation of the EU Objectives 2020 (climate change, renewable energy, and energy and resource efficiency) through markets.

The Alliance focuses on energy, water, food, materials, purchasing – including supply chain guidelines and green public procurement, and responsible financing. Its objective is to explore how innovation might be used to assist the shift towards a less resource-dependent society, while maintaining levels of social and economic prosperity. The Alliance uses workshops and think tanks to implement concepts.

See, for further information,: http://www.epe.be/Default.aspx?p=102&n=112

Country Approaches

Canada

National Round Table on the Environment and the Economy (NRTEE) Indicators Programme

The Canadian National Round Table on the Environment and Economy (NRTEE), in collaboration with the WBCSD, commenced work on standardised indicators for business reporting in 1997. One of aims was to provide dialogue and comparison between business sectors, for the companies themselves and external audiences such as investors, customers, regulators and the public.

Environmental indicators for business were developed through a programme that used 12 volunteer companies, was coordinated by the National Round Table, and funded by Environment Canada. The work built on the principles and framework for eco-efficiency indicators developed by the WBCSD and on previous work by the NRTEE with eight volunteer companies.

The conclusion that energy and water intensity indicators can be widely applied across all business sectors is in line with findings from a WBCSD study. The WBCSD study focused on general principles and a framework for corporate eco-efficiency. The NRTEE program built on this work by translating the principles and framework into specific definitions and rules.

The WBCSD study found that a material-intensity indicator was widely applicable when specific definitions and decision rules were applied, in contrast, the NRTEE program concluded that a material-intensity indicator was not particularly useful in tracking material productivity. As in the WBCSD study, waste production was found to be business-specific.

NRTEE developed a set of three core indicators (energy, waste, and water) to help companies evaluate their performance over time. Companies that participated in the NRTEE indicator program suggested that waste intensity indicators are less amenable to external reporting than the energy and water indicators. Energy, material, and water use is normalised to adjust for facility size or changes in production over time.

Indicators are measured as a ratio of the environmental burden (i.e. use of resources) of a company at the level of its project boundary to the amount of product or service value produced by that section of the company. A denominator for the ratio e.g. tonnes of product; units of product produced or shipped; dollars of sales; megawatt hours; or square metres of floor space. The project boundary (e.g. whole office; entire plant) and timescale is also selected.

Indicator	Overview	Applicability
Energy / Mj	The NRTEE framework uses a core energy intensity indicator which measures all the direct and indirect fuels used to produce the product(s) or deliver the service(s) per unit of production or service delivery. All energy sources are included but sources are not differentiated in the ratio. Conversion factors are provided for each energy source.	Cross Sector

Indicator	Overview	Applicability
	Complementary energy intensity indicators to provide a perspective on additional stages in a product or service lifecycle were also developed (e.g. life-cycle energy, excess energy, transportation energy of materials, and transportation energy of personnel)	
Complementary energy indicators (Mj)	**Transportation energy intensity indicator of materials** Addresses the energy needed to transport materials and/or energy between life-cycle steps per unit of services. Considered a significant indicator for sectors which rely on transport as part of service delivery e.g. forestry **Transportation energy (personnel)** Energy required transport personnel to and from the project boundary as normal business practice; includes the travel of personnel to and from the project boundary on a daily basis and business travel.	Sector Specific Sector Specific
Water (m^3)	The core water intensity indicator represents the amount of water taken into the project boundary per unit of product or service delivery	Cross Sector
Waste (tonnes)	Core waste intensity indicator can be calculated as: - *the mass balance approach* e.g. for companies whose manufacturing or processes are based largely on chemical reactions or, - *the waste output approach* - for companies with a relatively large number of input materials. The core waste intensity indicator measures the total material entering the product boundary minus material that ends up in the product and co-product per unit of production or service delivery. It includes raw materials, packaging and all products and releases to the environment (excluding water) and may be solid, liquid, or gaseous form. Waste indicators measure quantities of wastes but are not weighted for environmental impact due to the considerable variation in measurement and reporting across business sectors.	Cross Sector

System of Natural Accounts

Canada's natural resource stock accounts measure quantities of natural resource stocks (oil, natural gas, minerals, timber and land) and the annual changes in these stocks due to natural processes and human activity. These accounts, are recorded using both physical and monetary units and form the basis of the estimates of Canada's natural resource wealth that are included in the Canadian national balance sheet accounts. The accounts also show supplementary, point-in-time estimates for

Canada's total resource base (in physical terms only). The total resource base provides a means of assessing the resources that might become available in a more distant future.

These statistics are employed to monitor the contribution of natural resources to our national wealth as well as to portray the actual quantities of natural resources that Canada has at its disposal in the short term.

Canada intends to expand its System of Natural Accounts to include Natural Capital Assets. Material and Energy Flow Accounts will be developed to record the flows of materials both between the Canadian economy and the "rest of the world", and between the economy and the environment. These flows will include natural resources, recycled materials, wastes, and hazardous substances. The NRTEE anticipates that this will produce detailed estimates of the resource and waste intensity of various types of economic activities to measure the physical quantities of resources (or wastes) used (or produced) per unit of economic activity (a measure of eco-efficiency).

Germany

Central Government Approach

The German Federal Ministry for the Environment (BMU) and the German Federal Environment Agency (UBA) compiled a guide to environmental performance indicators (EPI's) for businesses which conforms to the ISO 14031:1999.

The Guide aims to transfer the concept of performance indicators from management accounting to "eco-controlling" (environmental management). It provides a variety of environmental performance indicators in the three ISO 14031 categories and applies them for demonstration purposes to four types of businesses. The three main groups of environmental indicators are divided into three groups, depending on whether they describe a company's environmental impact (environmental performance), the management's environmental activities or the company-external condition of the environment, the following groups can be differentiated:

- Environmental performance indicators – these indicators concentrate on planning, controlling and monitoring the company's environmental impact
- Environmental management indicators – present the organisational actions the management is taking to minimize the company's environmental impact
- Environmental condition indicators – describe the quality of the environment surrounding the company

The guide also suggests an eco-balance or input-output analysis as a possible approach to record basic data for environmental performance. The main aim of the guide is to assist internal environmental management, especially of SMEs, and therefore has a focus on developing EPIs tailored to a specific company. The Guidelines are aimed at developing and measuring indicators at the business level.

See: Federal Environment Ministry and Federal Environment Agency (1997)

COMPASS

The Wuppertal Institute for Climate, Environment, and Energy (Wuppertal) developed "COMPASS" (COMPAnies' and Sectors' path to Sustainability) in 1999 to assist with business reporting purposes.

COMPASS addresses life cycle impacts of sectors in different performance issues according to a "Plan-do-check-act" management cycle. COMPASS comprises five elements for setting targets, measuring, analysing, and managing environmental performance. It includes a set of indicators linked to target setting and basis its reporting structure on ISO and GRI.

Sector specific indicators have been developed for the aluminium industry. In order to develop sector specific indicators, current issues, trends and life cycle issues of the European aluminium industry were taken into account. Qualitative and quantitative indicators for economic, ecological, and social sustainability were developed.

See: Wuppertal Institute for Climate, Environment, Energy (2002)

Great Britain

The UK Government has provided funding and policy direction on resource efficiency since 1994. The Department of Environment Food and Rural Affairs (DEFRA) and the Environment Agency both play a part in resource efficiency:

- Environment Agency Resource Efficiency: http://www.environment-agency.gov.uk/business/topics/performance/110996.aspx
- DEFRA: http://www.defra.gov.uk/environment/business/support/index.htm

(DEFRA) works in partnership with a network of delivery partners to implement resource efficiency programmes. The key delivery bodies are summarised as follows:

Organisation	Focus	Outcome measured
WRAP (Waste and Resource Action Programme) www.wrap.org.uk	Creating markets for re-cycled resources	- Material diverted from landfill - Virgin raw materials saved - Carbon reductions - Water savings - Hazardous waste reductions - Cost savings - New business sales
NISP	Cross-industry resource efficiency	- Material diverted from landfill - Virgin raw materials saved - Carbon reductions - Water savings - Hazardous waste reductions - Cost savings - New business sales
Envirowise www.envirowise.co.uk	Resource efficiency	- Material diverted from landfill - Virgin raw materials saved - Water savings - Carbon reductions
Centre for Remanufacturing & Reuse	Product reuse/remanufacturing and associated product service systems	*not stated*

www.remanufacturing.org.uk		
Construction Resources & Waste Platform	Waste recycling	*not stated*
Action Sustainability	Sustainable use of resources through better procurement	*not stated*
BREW Centre for Local Authorities	Support for LA's in their efforts to improve business use of resources and management of waste	*not stated*
Carbon Trust[11] http://www.carbontrust.co.uk	Accelerate the move to a low carbon economy	- Carbon reductions

Delivery of resource efficiency programmes recently been amended to form part of the 'Business Support Simplification Programme' announced in the 2006 UK Budget. The programme aim is to streamline information on support schemes. Its key aims are to ensure that publicly-funded business support is easier for businesses to understand and access, provides better value for public money, and has a substantial and measurable impact in achieving economic and other public policy goals

BSSP superseded the Business Resource Efficiency and Waste Programme (BREW), which ran from 2005 – 2008. The BREW programme was established to ensure that the Landfill Tax escalator incentivise businesses to reduce the amount of waste they send to landfill and assist them in developing ways to achieve this. £284m was awarded to business resource efficiency activities by a range of DEFRA's delivery bodies and other organisations. The current direction in resource efficiency has been developed to align it with carbon programmes and to respond to the economic slow-down, as well as taking heed of lessons learnt since 1994.

Resource efficiency programmes provided by DEFRA (through delivery bodies and from Regional Development Agencies) have been integrated with wider Business Link programmes. This change was based on the belief that the business community increasingly should understand the case for integrating environmental and business objectives.

Refer: ***Business Link: Environment and Efficiency***
http://www.businesslink.gov.uk/bdotg/action/layer?r.s=m&r.l1=1073858799&r.lc=en&topicId=1079068363

A number of delivery bodies continue to provide programmes to help businesses in their drive towards a lower carbon, more resource efficient economy. Funding is focused on providing the necessary evidence to encourage businesses to change behaviour, rather than supporting individual businesses for projects where the benefits came quickly through to the company bottom line. This forms part of DEFRA's wider strategy towards catalysing behaviour change for a low carbon Britain.

[11] Now the responsibility of the newly created Department of Energy and Climate Change (DECC),

The Business Link programme is the primary access channel for business support and Regional Development Agencies are responsible for working with national and regional partners in developing Regional Transitional Management Plans to drive delivery of BSSP at the regional level. Resource efficiency products are part of this resource and Business Link provide business with access to resource efficiency product providers.

The Envirowise Programme was set up in 1994 to increase profitability and reduce the environmental impact of UK businesses by providing advice and support on resource efficiency. The programme provides advice or resource efficiency and works in partnerships with other business support service providers to simplify access for business to support services.

Its current focus is on streamlining the access by Business Links to specialist input on resource efficiency and ensuring that resource efficiency is maintained as a priority in Business Link support services. A key strategic direction of note it to ensure that:

> *…resource efficiency advice to business does not remain at the lowest common denominator level of waste management and recycling but drives better practice in business in order to meet national goals for sustainable consumption and production.(p55)*

Environmental Indicators

A number of resource efficiency delivery partners provide indicator tools for business via the Business Link website. Carbon Trust and Envirowise provide indicator tools on carbon emissions and resource consumption, respectively. The Envirowise website provides an indicator tool for six business sectors. A screen shot is provided below.

Envirowise Indicator Tool

UK Environment Agency (EA)

The EA's role in resource efficiency has stemmed from a compliance role for more polluting industries

regulated by the department. The Resource Efficiency Appraisal and Development (READ) toolkit is to be implemented in 2010, comprising two elements:

- REMI – the Resource Efficiency Management Index - a confidential and voluntary tool which assesses a company's management approach to resource use. There are two versions depending on company size (over or under 50 staff). Using an interactive questionnaire REMI generates a profile of a business. It gives feedback and guidance on priority areas to improve approaches and save money. For small businesses the EA includes an estimate of potential financial savings.
- Resource Efficiency Physical Index - this tool is specifically for regulated businesses which hold an EPR (Environmental Permitting Regulations) A1 permit. It measures physical (or quantitative) performance. From January 2010 the EA will request EPR A1-permitted businesses to use this tool to complete part of their annual Pollution Inventory returns. Its aim is to allow businesses to benchmark themselves against other businesses and sectors. It will also provide year-on-year trend analysis and a review of efficiencies to be achieved. The Government proposes to use the collective data to analyse trends and help industry improve resource efficiency throughout England and Wales and publish annual reports on its website from 2010.

Finland

Finland's programme to promote sustainable consumption was implemented in 2005 in response to the UN Sustainable Development Summit (2002) ten-year framework programme to promote sustainable forms of production and consumption. The programme includes the objective that eco-efficiency should be increased throughout production chains to make Finland one of the world's most eco-efficient societies (see: www.sitra.fi/naturalresources).

Finland uses the term *natural resource efficienc*y to capture resource and material efficiency. Natural resource efficiency equates to the overall use of natural resources in relation to the unit value of a product group or function (Hoffrén et al. 2004). Natural resource efficiency is measured by natural resource intensity concerning the quantity of natural resources consumed by a product or functional unit. It is measured using material and energy efficiency. Eco-efficiency on the other hand, is defined as the environmental load caused by a product or function measured in a different way; natural resource use may be just one factor of environmental load (op.cit).

Lilja (2009) states that waste prevention and resource efficiency have "evaded an effective policy approach in Finland despite ample repetition of this goal in strategic documents" (p.863). Despite this, there has been ongoing work in the area of 'material efficiency' and waste prevention culminating in the development of the Finnish Material Efficiency Unit in February 2008 and publication of a Natural Resource Strategy in 2009.

Finland's Natural Resource Strategy overall vision for 2030 is: "by using natural resources intelligently, Finland thrives and leads the way". The Strategy examines natural resources and their use from a wide perspective extending across all sectors of society. Its goals are linked to natural

resource use, including targets in climate and energy policies, efforts to safeguard biodiversity, and the reshaping of Finland's forest sector.

Material efficiency is a fundamental concept which permeates Finland's environmental policy framework. Finland measures eco-efficiency via national indicator data sets but this forms only part of a wider approach to address resource consumption and production.

The Finnish Material Efficiency Unit is currently developing a "material efficiency audit tool", a consultancy service for public environmental technology procurement. The auditing tool is being developed as a uniform methodology for all business sectors and based on applying life cycle approaches to address resource analysis and apply at the sector and regional level (Österlund, 2009).

Current Finnish project and programmes on resource efficiency include:

- ENVIMAT, Environmental impacts of material flows caused by the Finnish economy (SYKE, Thule-institute, MTT, VTT);
- TMRFIN, Statistical compilation system of the Finnish natural resource use (Thule-institute, Oulu University);
- VALTSU The National Waste plan to the 2016;
- $MASCO_2$, New business models for material efficiency (HSE and others);
- KeHa, Sustainable purchasing – working group;
- Functional Materials – programme 2007-2013 (TEKES);
- KETJU, Sustainable production and products research program 2006-2010 (Academy of Finland);
- UUMA, New material technologies in infrastructure (Thule-Institute).

Regional sustainability indicators in Finland

Regional sustainability indicators have been developed for Finland via the "Eco-efficiency of Regions project" (Melanen et al. 2004). The project developed an indicator framework for measuring regional sustainability using eco-indicators and a complementary monitoring tool.

The Finnish Environment Institute (SYKE), the Southeast Finland Regional Environment Centre, the Regional Council of Kymenlaakso and the Thule-Institute at the University of Oulu undertook the "Eco-efficiency of Regions – Case Kymenlaakso (ECOREG)" project from 1 September 2002 - 31 December 2004 (Melanen et al. 2004). It demonstrated the concept of eco-efficiency and the evaluation of eco-efficiency on a regional scale, using the region of Kymenlaakso in Southeast Finland.

The approach combines life cycle assessment and material flow analysis, statistical data freely available in the EU countries and various indicators in order to create indicators for regional eco-efficiency development.

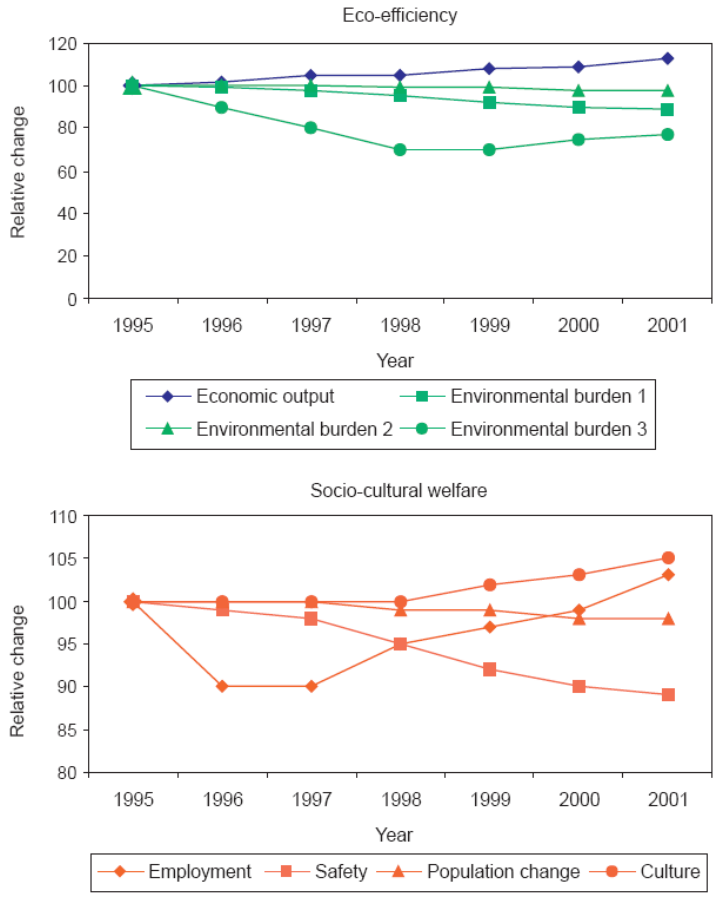
The study defines eco-efficiency as the relationship between the value of a region's economic activities, or "economic well-being", and environmental impacts. As this lacks the social and cultural dimensions, the study also included simultaneous monitoring of socio-cultural factors.

Twenty-one socio-cultural indicators were selected to support the measurement of the eco-efficiency of the Kymenlaakso region. They have been classified in eight themes (population change, employment, social exclusion, health, safety, education, culture, local identity), which support the topics raised in Kymenlaakso during the process.

The value of the goods and services produced in the region are measured using three variables: value added, gross domestic product (GDP) and output.

Twenty-six environmental indicators relating to issues such at atmospheric emissions, water quality, transport, environmental accidents, biodiversity, consumption of natural resources and energy have been developed.

The indicators describing environmental change and interventions were based on a regional environmental analysis made for Kymenlaakso of key issues, and importation of materials. Most of the indicators selected link to environmental conditions or environmental loads, they also include a few environmental measures targeted at the biodiversity preservation. Presentation of the results are provided in the following illustration.



See: http://www.environment.fi/default.asp?contentid=208564&lan=EN

Nordic Co-operation

Eco-efficiency is a general target set by the Nordic countries[12].

The Nordic Council of Ministers undertook research on "Factors 4 and 10 in the Nordic Countries" in the late 1990's to indentify opportunities and obstacles in the implementation of factor 4 and 10 targets at the sectoral level in four Nordic Countries. The report used case studies on the transport sector in Denmark, the forestry sector in Finland, the real estate and building sector in Norway, and the food supply chain in Sweden. For each sector, the report analysed the extent to which it is possible to implement eco-efficiency targets of factor 4 and 10. It also examined the role governments could play in promoting achievement of these targets, and how business and industry, academics, NGOs, and consumers could participate.

It concluded that it would be difficult to reach the factor 4 target in two to three decades (i.e. 2030) and the factor 10 target in the long run (i.e. 2050) without considerable changes in individual and social values as well as regulatory regimes.

The report states that governments have an important role to play in implementing eco-efficiency strategies and factor 4 and 10 targets. The measures suggested in the case studies include a mix of economic, legal, and social instruments, and additional measures aimed at enhancing research and development. It also stressed the importance of participation of all partners, including business, industry and trade, academics, NGOs, authorities at all levels, and consumers (Nordic Council, 1999).

Sustainable production and consumption remains an overall goal for Nordic countries set out in the *Sustainable Development – New Bearings for the Nordic Countries 2009-2012* (Nordic Council of Ministers, 2009). The Nordic co-operation recognises that patterns of consumption need to change if sustainable development is to be achieved.

A set of sustainable development indicators was developed to monitor progress with achieving goals set out in the strategy. Results are published every three years. The indicators are designed to be comparable with national and relevant international indicators such as those of the EU, OECD and UN (p.cit) as follows:

Issue	*Indicator*
Climate and renewable energy	• Decoupling environmental impact from economic growth • Gross energy consumption • Renewables' share of gross energy consumption • Emissions of greenhouse gases • Temperature trends
Sustainable production and consumption	• Cod-spawning biomass in Nordic waters

[12] The Nordic co-operation includes Denmark, Finland, Iceland, Norway, Sweden and the autonomous territories of the Faroe Islands, Greenland and Åland.

Issue	*Indicator*
The Nordic Welfare State / Sustainable Development	• Organic farming • Forest trees damaged by defoliation • Number of licences to manufacture eco-labelled products • Use of chemicals in production in the Nordic countries • Economic growth • Life expectancy at birth • Unemployment • Gini-coefficient (distribution of income) • Families with children living in relative poverty
Education and research, participation and local sustainability.	• Voter turnout • Research and Development • Schools with the Eco Schools Green Flag Proportion of the population with secondary education

Appendix 2: Sector Specific Frameworks

Table 5: Sector Specific Resource Efficiency Frameworks

Sector	Origin	Aspects	Reference
Mining and Minerals Industry	UK	Based on GRI indicator framework and aimed at companies and sector implementation	**Azapagic (2004)**
Aluminium Industry	Germany	Based on sustainability COMPASS (COMPAnies' and Sectors' path to Sustainability) a management tool designed to assist companies and sectors.	**Wuppertal Institute for Climate, Environment and Energy**
Construction and Housing	Germany	Based on sustainability COMPASS.	**Wuppertal Institute for Climate, Environment and Energy**
Agriculture	Australia	Based on Bayesian decision theory, particularly its use to calculate the value of information under conditions of uncertainty. Aimed at use at the business level.	**Pannell D.J., and N.A. Glenn (1999)**
	Canada	The framework uses a series of indicators related to soil quality, water quality, air quality and biodiversity. Outputs are reported on a regional basis (includes agri food and beverage).	**Lefebvre, A., W. Eilers, et B. Chunn (eds.), (2005)**
Pulp and Paper Industry	Finland	An eco-efficiency index was formulated, based on an input / output ratio. Measures efficiencies against a reference plans.	**Helminen (2000)**
	Europe	EPIs were developed for manufacturing firms in six industrial sectors, including pulp and paper, in six EU countries. Core indicators were developed for all six sectors.	**Berkhout (2001)**
Fisheries	Canada	Applies the concept of eco-efficiency to the impacts of primary resource	**Willison J.H. M. and R. P Côte´ (2009)**

		extraction (i.e. Fisheries) industries on indigenous biodiversity.	
Tourism	Europe	Provides a tool for assessing carbon dioxide-equivalent emissions as a measure of eco-efficiency of tourism. Eco-efficiency is thus the ratio of CO2e (kg) to turnover (€).	**Gossling, Peetersb, Ceron, Dubois, Patterson and Richardson (2005)**
	New Zealand	Suggests indicators for monitoring oil consumption within the tourism sector, in particular, destinations indicators.	**Becken (2008)**
Food and Beverage	**Canada**	**Agriculture and Agri-Food Canada (AAFC) developing environmental indicators for the agricultural production sector. This is linked to Canada's Agricultural Policy Framework of which one of the key principles of which is the sustainable development of the food value chain**	**Maxime, Marcotte, and. Arcan (2006),** **Lefebvre, A., W. Eilers, and B. Chunn (eds.) (2005)**