Sustainability, Stewardship and Scrap Tyres:

The Role of Product Stewardship and
Extended Producer Responsibility in the Achievement of
Pollution Prevention Opportunities for
the Management of Used Tyres

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April 2008

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A dissertation presented in partial fulfillment of the requirements
of a Postgraduate Diploma in Applied Science
(Natural Resource Management)

at

Massey University, New Zealand

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Abstract

Current literature describes Product Stewardship and Extended Producer Responsibility (EPR) policy approaches as end-of-life management tools that can be more effective than traditional waste management options in reducing waste, and hence more effective in achieving the overall sustainability objective of pollution prevention. The principle objectives of Product Stewardship and EPR policy approaches are to shift the physical and financial responsibilities of waste management away from municipalities and towards the producers and users of the product. Through the use economic instruments to internalise the environmental costs of waste into the price of the product, Product Stewardship and EPR policy approaches provide financial incentives for producers and consumers to consider opportunities for pollution prevention in their decision-making. This reduces the physical, financial and environmental costs of waste management.

The purpose of this report is to identify from the literature the pollution prevention opportunities that can theoretically be achieved through Product Stewardship and EPR approaches to used tyre management. These are compared to the pollution prevention opportunities that have actually been achieved through the successful implementation of a Product Stewardship/ EPR approach to used tyre management overseas. The Province of Manitoba in Canada has successfully operated a scrap tyre diversion plan since 1992, re-mediating over 90 percent of tyres covered by the regulation in the Province (9.5 million passenger tyre equivalents) up to 2006 (Marbek, 2006). The scheme is funded through the payment of a mandatory levy, payable by consumers upon purchase of a new tyre to cover the costs of used tyre collection, transportation and recovery. Having operated as a Product Stewardship scheme for several years, the scheme is currently undergoing a change to an Extended Producer Responsibility approach.

Acknowledgements

"It was the development of Western science that allowed human beings to break free of the technological limits which had constrained earlier civilisations, leading to the emergence of a belief in progress. Science would progressively reveal the laws of nature, and allowed a notion to grow that science would allow humanity to dominate over nature. The concept of sustainable development challenges this notion. Scientific evidence now reveals that humanity is in danger of destroying the basis of our existence, and that it would be prudent to take a more precautionary approach to both progress and development" (Dresner, 2002, p1).

I would first like to deeply acknowledge all those wonderful humans in the world who have looked beyond their own comforts and ambitions in order to make the world a better and fairer place for those less fortunate than themselves, and for future generations.

I would also like to thank my supervisors and University staff, the Manitobans and all those others that have contributed to the completion of this report.

Mostly I would like to thank my two daughters, Lydia and Rosie, who have for a considerable part of their lives been forced to share the poverty and stress of my extramural studies, and despite this, have constantly shown such love, patience and understanding. I would also like to thank my partner, Greg Jackson, who has constantly provided support and a desperately needed distraction, and who also deserves a medal for his love, patience and understanding. Finally, I would like to extend a big thank you to all my friends and neighbours, who remained supportive despite the landing of the stressed out 'whinging pom' in their neighbourhood.

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1 Introduction

1.1 Introduction to the Research

Sustainable development can be defined as "policies that place emphasis on resource management choices that fulfill the needs and desires of today's population without endangering the ability of tomorrow's population to fulfill its own" (OECD, 1996, p19). Sustainability is essentially a question of reconciling the competing demands of increasing and inequitable global economic growth (production and consumption) with the finite physical capacity of Earth to continue providing the necessary resources and to assimilate the resultant polluting wastes (Dresner, 2002). "Over consumption, pollution and resource depletion threaten sustainability" (Nicol & Thompson, 2007a, p227).

The emphasis for waste management to date has been on ‘end-of-pipe’ solutions, minimising the health and environmental impacts of waste disposal (EC Commission, 2006b), including policy options such as recycling (Coggins, 2001). Between 1980 and 1997, municipal waste in OECD countries increased by around 40 percent and is predicted to grow by a further 40 percent by 2020 (OECD, 2001a). Rising levels and toxicity of waste, rising costs, declining landfill capacity and the realisation that waste represents an inefficient use of resources (Hanisch, 2000), (EC Commission, 2005), have forced waste management policy to evolve from a focus on end-of-pipe solutions towards an emphasis on the prevention of wastes at source (EC Commission, 2006b). The issue has become one of resource management rather than waste management (Coggins, 2001).

The Pollution Prevention Act of 1990 (USEPA, 2007a) established a hierarchy of preferred options for dealing with environmental pollution (CSS, 2007). The Act states that pollution should be prevented or reduced at the source whenever feasible. Pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible. Pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible, and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner (USEPA, 2007a). Waste prevention demands consideration of the environmental impacts of products throughout their whole lifecycle, from the extraction of raw resources, through design and manufacturing, distribution and consumption, right through to the end-of-life and disposal stages (EC Commission, 2006b).

The New Zealand Ministry for the Environment considers that waste problems arise because once products are sold, producers, importers and retailers are no longer responsible for a product's impacts. In addition, consumers may not consider the environmental or disposal costs, as these fall on others - usually the local authority (NZ MfE, 2005). Thus there is no link between the problems of product disposal and product design, in order to reduce waste at the end of the products useful life (NZ MfE, 2005). Product Stewardship and Extended Producer Responsibility (EPR) are environmental policy approaches that have been implemented increasingly overseas as a more sustainable waste management option than traditional disposal to landfill (Walls, 2006). Product Stewardship and EPR are 'product focused' environmental policy approaches that shift the physical and financial responsibilities for the environmental impacts of waste disposal that traditionally fall to municipalities, towards the producers and consumers of products (Nicol & Thompson, 2007a).

Product Stewardship and EPR approaches link the once separate policy areas of waste management and product policy (production) by internalising the costs of waste management into the price of products (OECD, 1996). This provides incentives for producers and consumers to reduce wastes, providing opportunities for resource efficiency and pollution prevention, and thus developing more sustainable patterns of production and consumption (Brady et al, 2003). The President's Council on Sustainable Development (PCSD) endorses the principle of Extended Product Responsibility as a means for industry, government and the environmental community to "identify strategic opportunities for pollution prevention and resource conservation" throughout the life cycle of a product (USEPA, 1997, p 38).

The manufacturing stage is the most effective stage of a product's lifecycle to incorporate design changes (Design for the Environment) to prevent the generation of wastes and hence reduce environmental harm (USEPA, 1997). Furthermore, internalisation of the environmental costs of waste through the provision of economic instruments, provides an incentive for producers to design product's to last longer, be more recyclable or reduce the toxicity of the materials used (Gertsakis et al, 2002). Thus the key principles of Product Stewardship and EPR policy approaches to waste management are the incorporation of economic instruments, taking a lifecycle approach, the broadening of responsibilities and Design for the Environment (Nicol & Thompson, 2007a).

Product Stewardship and Extended Produce Responsibility (EPR) policy approaches have been implemented widely overseas as an alternative waste management strategy for 'designated,' 'special' or 'priority' wastes such as tyres, solvents, crankcase oil, batteries, packaging and electronics. 'Special wastes' are defined by the New Zealand Government as wastes that are inappropriate for municipal waste management programmes because of their hazardous nature or because of particular management or disposal problems (NZ MfE, 2002a). Such wastes are also often inappropriate for municipal waste management because they embody valuable resource materials and so offer considerable materials recovery potential (Weaver, 1996). Scrap tyres are typical of many priority wastes in that they are generated by society in increasing numbers, are increasingly costly to manage at the end of their useful life and have significant implications for the environment (Russel, 2002).

The New Zealand Government have stated their commitment to the adoption of a voluntary product stewardship policy approach to scrap tyres (NZ MfE, 2005) as part of their longer-term commitment to zero-waste and sustainability, as outlined in their New Zealand Waste Strategy: Towards Zero-Waste and a Sustainable New Zealand (NZ MfE, 2002a). Scrap tyres are a priority waste that has been highlighted for attention because a high proportion of the estimated three to four million used tyres generated annually in New Zealand are currently diverted to landfill, stockpiled or illegally dumped (NZ MfE, 2002a). Such disposal methods often give rise to public nuisance, pose a significant fire and toxic pollution risk, lead to significant health and environmental impacts, result in major legal and enforcement costs for local authorities and also represent considerable inefficiencies in the use of resources (UNEP, 2007a).

To date there are no government-led Product Stewardship or EPR approaches operating in New Zealand, and only a handful of voluntary industry-led EPR type initiatives, none of which contain more than a few elements of either EPR or product stewardship principles (NZ MfE, 2005), (NZBCSD, 2005). Importantly, many of the submissions received in response to the Ministry for the Environment's Product Stewardship discussion document (NZ MfE, 2005) consider the government's proposed voluntary Product Stewardship approach for priority wastes to be inadequate and unlikely to be effective in achieving New Zealand's waste reduction, environmental or longer-term zero-waste and sustainability objectives (NZ MfE, 2006). Even Bridgestone, one of two New Zealand tyre manufacturers, states in their submission that the current voluntary approach to tyres (Tyre Track) is not efficient or effective and does not adequately address the issue of free-riders, especially those importing low-cost tyres (NZ MfE, 2006).

In their Business Guide to Sustainability, Hitchcock & Willard (2006, p72) state that "at its core, EPR is a fundamental shift in responsibility, one that many in industry have resisted." The inadequacy of New Zealand's proposals for priority wastes might be explained, at least in part, by a quote from a New Zealand Parliamentary Commissioner for the Environment (PCE) report. The report states that "MfE informed us that neither economic instruments nor regulation will be introduced by the Ministry to manage waste unless industry wants these policy tools to be used" (PCE, 2006, p44).

The recent OECD Environmental Performance Review of New Zealand states that there is increasing public concern that New Zealand’s 'clean and green' image is waning (OECD, 2007). The report suggests that New Zealand must increase regulatory support for recovery or recycling (including deposit-refund systems) of priority wastes such as end-of-life vehicles and electronic goods, building on the extended producer responsibility principle (OECD, 2007). Mandatory product stewardship and extended producer responsibility (EPR) policy approaches have been widely adopted overseas for scrap tyre management, achieving a range of sustainability goals (ETRMA, 2006).

The problems associated with end-of-life tyres are projected to increase as scrap tyre numbers increase worldwide along with increasing motor vehicle use and tighter legislation on tyre tread depth (Russel, 2002). It is therefore important that research be undertaken to evaluate whether the implementation of a mandatory product stewardship or an EPR approach to scrap tyre management in New Zealand might further New Zealand's long-term sustainability goals. One means of answering this question is to investigate a case where Product Stewardship or EPR approaches have been implemented successfully overseas.

1.2 Research Aim and Objectives

The aim of the research is to identify opportunities to enhance the sustainability goal of pollution prevention through Product Stewardship and Extended Producer Responsibility

(EPR) policy approaches to used tyre management, and to compare these with the pollution prevention opportunities that have been incorporated into such a stewardship approach overseas.

To achieve this goal, three research objectives have been identified:

1 To identify the opportunities to enhance the sustainability goal of pollution prevention that are theoretically achievable through Product Stewardship and EPR policy approaches to used tyre management.

2 To describe product stewardship and EPR policy approaches to used tyre management implemented overseas.

3 To identify the pollution prevention opportunities actually incorporated into a stewardship approach to used tyre management 'successfully' implemented overseas.

The first and second research objectives are to be achieved through a review of the current literature. The third objective is to be achieved through the selection of a successful product stewardship or EPR policy approach for the management of used tyres overseas as a case study.

1.3 Dissertation Outline

This dissertation reports on the key components of product stewardship and EPR approaches to scrap tyre management that represent opportunities for environmental sustainability, in terms of resource efficiency and pollution prevention.

Chapter Two presents an overview of the current literature within the policy areas of sustainable development, waste management, product policy, product stewardship, extended producer responsibility (EPR) and scrap tyre management. This is undertaken in order to develop a model of the key components of product stewardship and EPR approaches to scrap tyre management that represent opportunities for environmental sustainability, in terms of resource efficiency and pollution prevention.

Chapter Three provides a description of the methodology used in this study, including selection of a case study method and the criteria used for case selection. This chapter also includes a description of the data collection and data analysis procedures used.

Chapter Four presents the case description, case study results and a discussion of the results. In the discussion the results of the empirical study are compared and contrasted with the literature review.

In Chapter Five the main conclusions derived from the study are presented, the implications that flow from these conclusions are discussed, the methodology evaluated in light of the study's objectives and areas for further research are identified.

2 Theory Development

2.1 Introduction

This chapter draws on the literature to describe the key objectives and strategies of sustainable development, product policy and waste management that are relevant to the development of Product Stewardship and Extended Producer Responsibility (EPR) policy approaches to used tyre management. This chapter describes strategies for sustainability that are common to sustainable development, product policy and waste management, and how these common strategies therefore link the traditionally separate 'product based' environmental policy areas of product policy (production) and waste management in the pursuit of the sustainability goal of pollution prevention. The sustainability strategies are:- incorporation of the Pollution Prevention Hierarchy (USEPA, 2007a), an integrated lifecycle principle (UNEP, 2007a), the broadening of physical and/or financial responsibilities (Hanisch, 2000), internalisation of the environmental costs of waste through the provision of economic incentives through the polluter pays theory (Walls, 2006) and Design for the Environment (EC Commission, 2007b).

The chapter then describes how Product Stewardship and EPR policy objectives promote the link between product policy and waste management, plus incorporation of these common sustainability strategies, in order to enhance opportunities for pollution prevention throughout the lifecycle of products. The chapter then describes how Product Stewardship and EPR policy approaches have been applied to used tyre management. The chapter concludes with the construction of a conceptual model of the key components of sustainable development, waste management, Product Stewardship and Extended Producer Responsibility (EPR) policy objectives and strategies that are relevant to used tyre management, including the relationships reported in the literature between them. The conceptual model includes a taxonomy of definitions of each of the key components. Due to the broad nature of the research topics, literature from a wide variety of disciplines has been drawn on for the development of the conceptual framework.

Section 2.2 describes the environmental policy areas, policy goals (objectives), policy strategies and policy instruments that are relevant to used tyre management, and illustrates the relationships between them.

Section 2.3 describes the environmental policy area of sustainable development.
Section 2.4 describes the environmental policy area of product policy.
Section 2.5 describes the environmental policy area of waste management.
Section 2.6 describes Product Stewardship and EPR policy approaches to waste management.
Section 2.7 describes Product Stewardship and EPR policy approaches to used tyre management.
Section 2.8 presents conclusions from the literature review.
Section 2.9 presents a conceptual model of the key environmental goals (objectives) and sustainability strategies of Product Stewardship and EPR environmental policy approaches to used tyre management.

2.2 Environmental Policy Areas - Goals, Strategies, Instruments and Evaluation criteria

Policy can be defined as a broad approach including the specification of objectives, the choice of a strategy and its component instruments (Konsult, 2007). Policies are developed and implemented by governments or other agencies in order to achieve a set of goals (objectives) set by society. Policy is usually specific to one area of decision making, such as waste management, and the direction of policy is likely to comply with a longer-term overall strategy, defined as a broad non-specific statement of an approach to accomplishing desired goals and objectives (Govt. of B.C, 2007). Policy instruments (tools) are employed in order to achieve the desired policy goals (objectives) and further the longer-term strategies set by society. Policy instruments can be categorised generally as regulatory, economic and/or informational, and may be applied voluntarily or on a more mandatory basis. Policy instruments (e.g. a landfill ban) can be defined as the specific components of a strategy (Konsult, 2007). Strategy has also been defined as a combination of instruments to meet a given set of objectives (Konsult, 2007). The purpose of policy instruments is to provide incentives (or disincentives) to affected stakeholders in order to encourage decision-making that is likely to achieve the desired policy objectives.

At the development stage, prior to implementation, the 'potential' success of a combination of policy instruments to achieve the policy's desired goals (objectives or strategies) is measured using evaluation criteria. Policy evaluation criteria can be divided into three main categories, environmental effectiveness and feasibility criteria, economic criteria, and political (and administrative) criteria (Kandelaars, 1999), (OECD, 2001a). Environmental effectiveness determines whether the selected instrument is likely to be effective in reaching the environmental goals (Kandelaars, 1999), (OECD, 2001a). Following implementation, the actual effectiveness of a policy in achieving its objectives is measured on the basis of performance targets or other indicators e.g. the amount of waste diverted from landfill (Kandelaars, 1999), (OECD, 2001a). While the economic and political criteria are clearly essential for policy design, this report focuses principally on environmental effectiveness.

The overall goals of environmental policy are related to issues such as to safeguard human health, to preserve well-functioning ecosystems, and to enable access to sustainable natural resources (Lindhqvist, 2000). Traditionally the three environmental policy areas that drive environmental decision-making are sustainable development, product policy and waste management (OECD, 1996). Sustainable development is the broadest of the major environmental policy areas and encompasses the environmental and economic impacts of both production and consumption (OECD, 1996). Sustainable development therefore fully encompasses both product policy and waste management (OECD, 1996). The nature of environmental policy is such that the effects of policy implementation in any of these areas are rarely limited to one policy area, but are also likely to impact on the other major environmental policy areas (OECD, 1996).

Figure 2.1 illustrates the relationships between each of the environmental policy areas, policy approaches and policy strategies that are included in this chapter, as relevant to the achievement of the sustainability goal of pollution prevention. A sub-set within the environmental policy area of waste management is the management of 'designated' (special or priority) wastes, such as used tyres. Product Stewardship and Extended Producer Responsibility (EPR) are policy approaches that lie within the environmental policy area of waste management that have increasingly been applied to the management of such 'designated' wastes. Integrated Product Policy (IPP) is an alternative policy approach within the product policy environmental policy area that could potentially be applied to the management of used tyres.

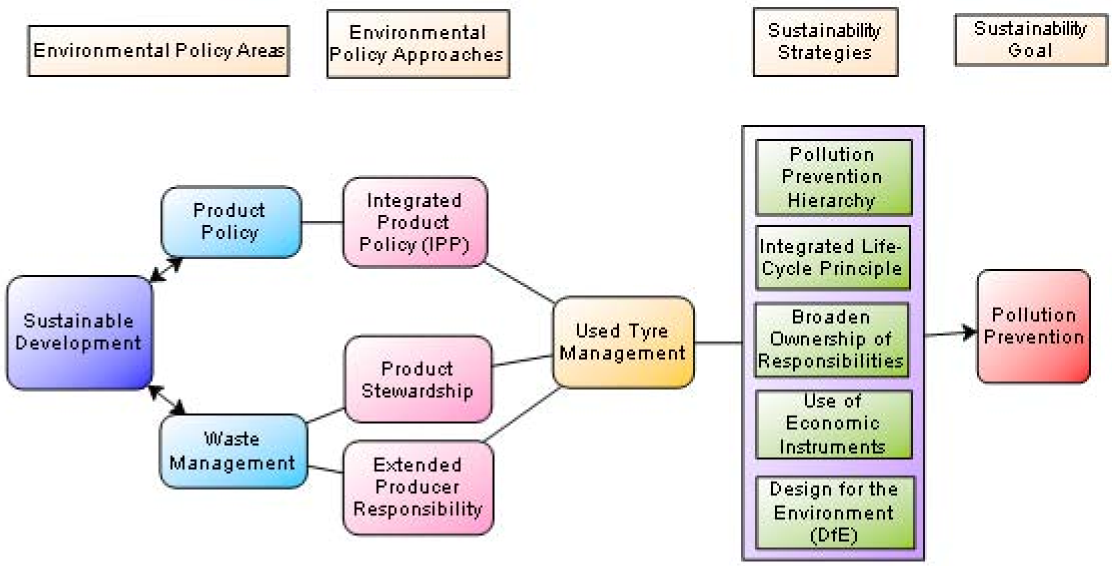


Figure 2.1: Model of the Links between Policy Areas, Policy Approaches, Strategies for Sustainability and the Sustainability Goal of Pollution Prevention.

2.3 Sustainable Development Policy Area

Sustainable development is defined as policies that place emphasis on resource management choices that fulfill the needs and desires of today's population without endangering the ability of tomorrow's population to fulfill its own (OECD, 1996). Sustainable development is now broadly accepted as the desirable and overriding long-term goal of global development (OECD, 1996).

2.3.1 Evolution of the Sustainable Development Concept

The concept of sustainable development solidified following influential reports by Herman Daly, Kenneth Boulding, MIT and others. MIT 's 'The Limits to Growth' in the 1960's provided evidence of the finite ecological limits of the bio-sphere to provide non-renewable resources and to absorb the pollution and wastes of industrial activity, particularly in light of exponential population and economic growth (Dresner, 2002), (Morhardt, 2002). 'Beyond the Limits', a sequel to 'The Limits to Growth, made clear that some important environmental limits had already been passed (Meadows et al, 1992). In 1983 the World Commission on Environment and Development (WCED) was established by the United Nations to examine the connection between economic development and protection of the environment (Perman, 1999). The outcome 'Our Common Future' (The Brundtland Report) in 1987, famously defined sustainable development, and set the agenda for much of the subsequent discussion (WCED, 1987), (Perman, 1999), (Morhardt, 2002).

The 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (Rio Earth Summit) established a comprehensive framework for sustainable development (UNEP, 2007b). The Rio Declaration on Environment and Development comprises 27 statements of principle in regard to global sustainable development, plus Agenda 21 covering 100 specific programmes for the attainment of global sustainable development, which was adopted by more than 178 Governments (Perman, 1999), (UNEP, 2007b). UNCED also agreed on the formation of a Commission for Sustainable Development to oversee the implementation of Agenda 21 (Perman, 1999). Subsequent Earth Summits were held in New York in 1997 (Earth Summit 2), Johannesburg in 2002 (World Summit) and New York in 2005 (World Summit) (UNEP, 2007b).

2.3.2 The Principles of Sustainable Development

The concept of sustainable development highlights the interrelationships and tensions between poverty, high living standards in the West (production and consumption patterns) and the resulting environmental degradation caused by industrial pollution (UNCED, 1992), (Dresner, 2002). Agenda 21 recognises that poverty and environmental degradation are closely interrelated, so that measures undertaken for the protection and enhancement of the environment must take fully into account current imbalances in the global patterns of consumption and production (UNCED, 1992). This is because although consumption patterns are very high in certain parts of the world, the basic consumer needs of a large section of humanity are not being met (UNCED, 1992). Thus through an emphasis on intergenerational equity, the concept of sustainability cleverly merges the competing demands for environmental protection with the desire for both economic development in the South and economic growth in the North, requiring recognition of the mutual interlinkage between the economy and the environment (Dresner, 2002). The underlying goal of sustainable development is to integrate environmental, social and economic considerations by transcending sectoral divisions, dealing with the linkages underlying specific problems and challenging us to make decisions that simultaneously improve each (Dresner, 2002), (Hitchcock & Willard, 2006).

2.3.3 Environmental Sustainability Objectives

Agenda 21 states that while poverty results in certain kinds of environmental stress, the major cause of the continued deterioration of the global environment is unsustainable consumption and production patterns ('living standards'), particularly in industrialized countries (UNCED, 1992). Special attention should be paid to the demand for natural resources generated by unsustainable consumption, and to the efficient use of those resources, consistent with the goals of minimizing depletion and reducing pollution (UNCED, 1992). Over consumption, pollution and resource depletion threaten sustainability (Nicol & Thompson, 2007a). Achieving the goals of environmental quality and sustainable development will require both efficiency in production and changes in consumption patterns in order to emphasize optimization of resource use and minimization of waste (UNCED, 1992).

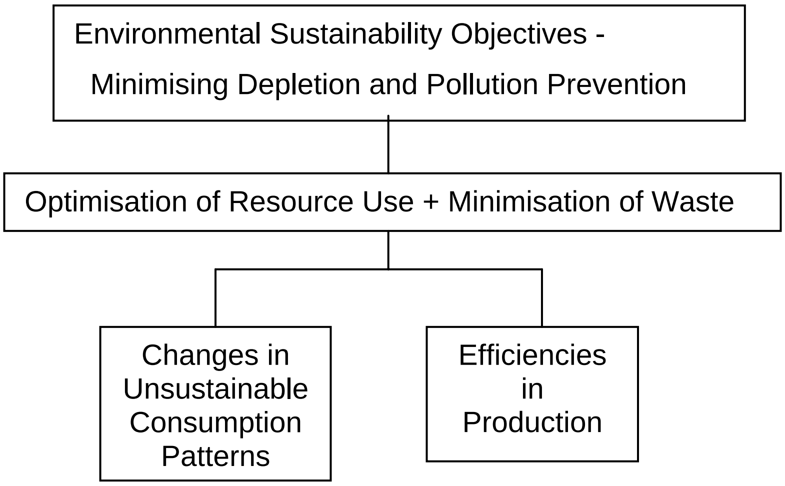


Figure 2.2: Environmental Sustainability Objectives

Agenda 21 states that the improvement of production systems through technologies and processes that utilize resources more efficiently and at the same time produce less wastes - achieving more with less - is an important pathway towards sustainability for business and industry (UNCED, 1992). At the same time, society needs to develop effective ways of dealing with the problem of disposing of mounting levels of waste products and materials (UNCED, 1992). Governments, together with industry, households and the public, should make a concerted effort to reduce the generation of wastes and waste products (UNCED, 1992). Thus there is a clear link between efficiencies in production and efficiencies in waste management, in reducing the overall generation of wastes, in order to promote the environmental sustainability objectives of minimising depletion and pollution prevention.

Clearly while changing unsustainable patterns of production and consumption is a crucial component in the overall sustainability debate, this component is largely beyond the scope of this report. This purpose of this report is to identify opportunities for pollution prevention and resource efficiency (sustainability goals) within the production (product policy), and waste management policy areas through product stewardship and extended producer responsibility (EPR) policy approaches.

2.3.3.1 Pollution Prevention and Resource Efficiency

A huge variety of terms are used both within Agenda 21 and elsewhere to describe the environmental objectives of sustainability. These include optimization of resource use, minimisation of waste, waste prevention, waste reduction, production efficiency, resource efficiency, minimizing depletion, cleaner production, reducing pollution and pollution prevention. Most of these terms are used in reference to production activities.

Agenda 21 states that 'optimization of resource use' is achieved through the efficient use of finite resources in the production process and the minimization of waste (UNCED, 1992). 'Minimisation of waste' is defined as measures or techniques that reduce the amount of waste generated during industrial production processes. It is very similar to waste prevention and in its broader terms can also include waste recycling and other efforts to reduce the volume of wastes going to landfills or incineration plants (OECD, 2002). Waste minimization was one of the first initiatives in the area of pollution prevention, and focused almost exclusively on solid wastes regulated under the Resource Conservation and Recovery Act (RCRA) (CSS, 2007). Agenda 21 defines 'efficiencies in production' as reducing the amount of energy and materials used per unit in the production of goods and services (UNCED, 1992). The European Community describes production efficiency as the efficiency with which inputs (of material, labour and capital) are allocated to produce the desired output (also known as technical efficiency) (EC Commission, 2007b).

Pollution prevention and resource efficiency are among several terms that are often used synonymously and are broadly applicable to the accomplishment of many environmental tasks, but are not used consistently (CSS, 2007), (OhioEPA, 2002). Pollution prevention is the term now used to describe most of these concepts, and incorporates the goal of resource efficiency (CSS, 2007). Pollution is defined as any release of waste to the environment (i.e. any routine or accidental emission, effluent, spill, discharge, or disposal to the air, land or water) that contaminates or degrades the environment (Das, 2005). It was the United States

Environmental Protection Agency (USEPA) that confirmed a change in focus from pollution control to pollution prevention with the enactment of the Pollution Prevention Act of 1990 (USEPA, 2007a). The Act defines Pollution Prevention (P2) as source reduction and other practices that reduce or eliminate the creation of pollutants through increased efficiency in the use of raw materials, energy, water or other resources, or the protection of natural resources by conservation (U.S.EPA, 2007b).

2.3.3.2 The Pollution Prevention Hierarchy

With a central focus on source reduction, the Pollution Prevention Act of 1990 (U.S.EPA, 2007a) established the Pollution Prevention Hierarchy of preferred options for dealing with environmental pollution, and officially places prevention at the top of the list (CSS, 2007). The Act states that pollution should be prevented or reduced at source whenever feasible. Pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible. Pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible, and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner (USEPA, 2007a).

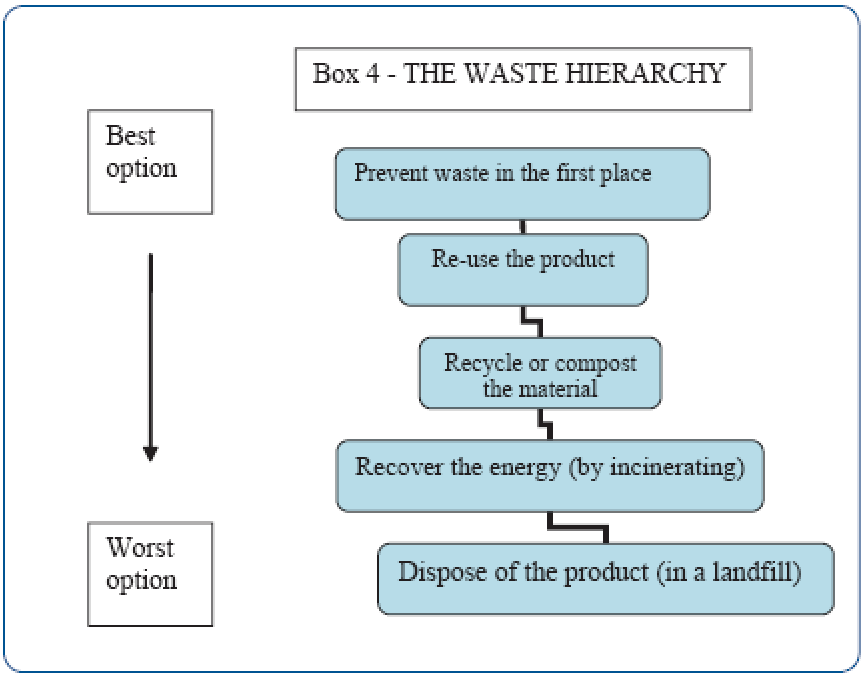


Figure 2.3: The Waste Hierarchy reproduced from EU Waste Policy: The Story Behind the Strategy, 2006.

The Pollution Prevention Hierarchy (or waste hierarchy) is illustrated in Figure 2.3. With it's emphasis on source reduction, a number of activities including recycling, energy recovery, treatment and disposal, incineration, treatment to reduce volume or toxicity etc are technically not included within the definition of pollution prevention under the USEPA Pollution Prevention Act (1990), (USEPA, 2007a), (OhioEPA, 2002). However, many others since have argued that recycling and other reclamation activities, although not strictly 'reduction at source,' also represent progress toward reducing environmental pollution and achieving greater efficiency in resource use (CSS, 2007). Furthermore, the position of recycling as the second highest option within the Act's pollution prevention hierarchy, attests to its desirability as a goal in cases where wastes cannot be feasibly prevented (CSS, 2007). Nicol and Thompson (2007a) state that effective policies exploit all possible avenues for waste reduction (i.e. source reduction, recycling, material substitution, etc).

The hierarchy of integrated resource management options describes the use of materials that involves the highest and best use of materials in the area of energy and resources and has been adopted as a guideline to policy development in many countries (Ludwig et al, 2003). Clearly waste reduction at source (avoided waste) is the cheapest, most effective and most efficient method of preventing environmental damage and saving resources (Ludwig et al, 2003). Control measures further upstream are more efficient and are preferable to reuse which is preferable to recycling which is preferable to disposal (Ludwig et al, 2003).

2.3.3.3 Reuse, Recycling and Recovery

In accordance with the Pollution Prevention hierarchy, Agenda 21 states that the primary objectives of a preventive waste management approach are to focus on changes in lifestyles, and in production and consumption patterns to stabilize or reduce the production of wastes destined for final disposal (UNCED, 1992). Waste management programmes should also take maximum advantage of resource-efficient approaches to the control of wastes to maximise environmentally sound waste reuse and recycling (UNCED, 1992). As the economics of waste disposal services change, waste recycling and resource recovery are becoming increasingly cost-effective (UNCED, 1992). Agenda 21 considers numerous options and incentives to encourage industry, institutions, commercial establishments and individuals to reuse and recycle wastes over disposal (UNCED, 1992). These include the implementation of national waste management plans to give priority to and provide incentives for waste reuse and recycling (UNCED, 1992). The strengthening of national capacity through the provision of information, techniques and appropriate policy instruments (UNCED, 1992). The modification of existing standards or purchase specifications to avoid discrimination against recycled materials, and the development of public education and awareness programmes to promote the use of recycled products (UNCED, 1992).

2.3.4 Economic Implications of Pollution Prevention

Any approach considering the wider sustainability agenda must be rooted in the principles of economics to achieve real environmental progress at least cost to society (NZBCSD, 2005). Even though waste and natural resources may not show up on a business balance sheet, the economy is, after all, embedded in the environment, and companies, and by extension humanity - will not in the long term, prosper if these goods and services are depleted (Hawken et al. 1999). Sustainable development includes consideration of both the environmental and economic impacts of both production and consumption (OECD, 1996), (Hawken et al. 1999).

Environmental law and regulation are important but cannot alone be expected to deal with the problems of environment and development. Prices, markets and governmental fiscal and economic policies also play a complementary role in shaping attitudes and behavior towards the environment (UNCED, 1992). Within a supportive international and national economic context and given the necessary legal and regulatory framework, economic and market-oriented approaches can in many cases enhance capacity to deal with the issues of environment and development (UNCED, 1992).

2.3.4.1 Economic Growth

Economic growth is defined as the market value of all final goods and services produced within a country during a given time period, and is measured in terms of Gross Domestic Product (GDP) (McKerlie et al, 2006). Increased economic growth has been the principal cause of an increase in waste production, as economic growth increases production, which increases consumption and thus increases waste (OECD, 2001b), (NZ MfE, 2002a), (King et al, 2006). Within the OECD, waste levels have been increasing at a similar rate to that of economic growth (Brady et al, 2003). Between 1980 and 1997, municipal waste in OECD countries increased by around 40% (King et al, 2006), and is predicted to grow by a further 40% by 2020 (OECD, 2001a).

The New Zealand Ministry for the Environment (2002a & 2005) states that the long-term challenge is to de-couple environmental pressures from economic growth - to learn how to use resources more efficiently - to produce more with less. Efficient pricing policies that reflect the full costs of waste disposal are a crucial step, in conjunction with high environmental and health standards, in de-coupling environmental pressures, health implications and inefficient resource use from economic growth (NZ MfE, 2005). However the downside of the aim for a consensus between environmental and economic concerns, is that the concept of sustainable development is somewhat vague, with huge disagreement about the sacrifices that must be made regarding economic growth, in order to bring about equity - both within and between generations, in terms of depletion of the world's life supporting services and resources (Dresner, 2002). The Brundland Report (1987) states that "to make growth sustainable, worldwide policies would have to involve reducing, at the global level, the material content of economic activity, economising in the use of resources as the value of output increases, and substituting the services of man-made capital for environmental services" (UNCED, 1992), (Perman et al, 1999, p16).

2.3.4.2 Market Failure and Resource Depletion

Market failures have important implications for resource depletion, pollution prevention and sustainability. Harmful impacts that may arise from market failure include excessive resource extraction leading to a faster depletion of natural resources; emissions of harmful substances (pollution) during resource extraction, production, consumption, collection and disposal of goods; and the visual and odour impact of landfills on local amenity (Australian Government, 2003).

The impact of increasing resource demands, as populations grow, leads to the depletion of many resources, and in some cases extinction (Australian Government, 2003), (Ludwig et al, 2003). In an efficiently functioning market, the economic scarcity of natural resources would be reflected in their price, however there are two key reasons why the prices of natural resources may understate the social costs of their use (OECD, 2005). First, in many countries resource extraction and processing activities are heavily subsidised, and as a result virgin materials are often seriously under-priced. Where sustainable development is the primary concern, heavy emphasis should be placed on resources consumed in the production phase, including questions such as whether they are from renewable resources (OECD, 1996).

The neo-classical economic perspective on the use of resources is based on Optimal Resource Extraction theory (Ruth, 2002). Under optimal resource extraction conditions (Hotelling's Rule), non-renewable resources are extracted at a rate such that the extraction of the resource to exhaustion maximises the present value of utility, profit or welfare gained from the resource (Ruth, 2002). However, uncertainties concerning concepts that play a crucial role in guiding economic decision-making have introduced complexities and identified limitations to current economic models (Ruth, 2002). This is forcing decision-makers to broaden their views, and is likely to influence the future of sustainable resource extraction (Ruth, 2002). Many analysts have concluded that world resource consumption needs to be cut by 50 per cent to be sustainable (Wackernagel & Reese, 1996).

2.3.4.3 Market Failure and the Presence of External Costs

The second reason why the prices of natural resources may understate the social costs of their use is that there may be significant externalities associated with resource extraction and processing that would be ignored in resource-use decisions based on market price alone (OECD, 2005). If virgin resources were properly priced, to reflect the full costs, including the external costs of extraction and processing as well as the scarcity value of exhaustible resources, producers might be encouraged to design products to reduce material input requirements, and to make greater use of recycled materials (OECD, 2005).

Furthermore, environmental economics has traditionally focused on partial analysis of environmental problems, as illustrated by separate branches such as 'resource economics,' dealing with depletion issues, and 'pollution economics' to address pollution externalities (Kandelaars, 1999). As a result, the interdependence of environmental problems related to linkages which occur between the extraction of resources and environmental pollution have been neglected, and the indirect effect of policies may have been overlooked (Kandelaars, 1999).

McKerlie et al (2006) state that until the true environmental and social costs of ‘disposable societies’ are accurately reflected in product pricing, and such principles are more comprehensively integrated into policies and programs, efforts to encourage pollution prevention will continue to be met with limited results (McKerlie et al, 2006). The objective of waste policy should be to overcome failures in the market that leads to harmful impacts to the environment and local community, the cost of which are not borne directly by the producers and consumers of goods (Australian Government, 2003).

2.3.4.4 Internalisation of External Costs through the Polluter Pays Principle

The presence of external environmental costs are a major obstacle to achieving sustainable development (OECD, 2001b). For sustainable development, heavy emphasis should be placed on ensuring that the environmental costs of resource extraction and use are included in materials and product price (OECD, 1996). Traditionally the financial benefits of production go to industry whereas the external costs (in terms of contamination and resource use) fall on society at large, and private resource users often lack any economic incentive to take account of the social costs of their actions (OECD, 2005). The absence of a link between producer choices and waste management costs arises fundamentally because households do not bear, directly and precisely, the costs of waste management of the products they purchase and discard, as they are generally hidden in their general municipal tax (OECD, 2005). Waste problems arise therefore because once products are sold, producers, importers and retailers are no longer responsible for the product's impacts, in addition, consumers may not consider the environmental or disposal costs as these fall on others (NZ MfE, 2005).

The OECD (2001a) recommends that sustainable and economically efficient management of environmental resources require the internalisation of pollution prevention and control and damage costs. Without the stimulus of prices and market signals that make clear to producers and consumers the environmental costs of the consumption of energy, materials and natural resources and the generation of wastes, significant changes in consumption and production patterns seem unlikely to occur in the near future (UNCED, 1992). Agenda 21 (UNCED, 1992) describes three fundamental objectives to achieve significant progress:

(a) To incorporate environmental costs in the decisions of producers and consumers, in order to reverse the tendency to treat the environment as a 'free good' and pass these costs on to other parts of society, other countries or future generations.

(b) To move more fully towards integration of social and environmental costs into economic activities, so that prices appropriately reflect the relative scarcity and total value of resources and contribute towards the prevention of environmental degradation.

(c) To include wherever appropriate, the use of market principles in the framing of economic instruments and policies to pursue sustainable development.

Governments, business and industry, including transnational corporations, academia and international organizations, should work towards the development and implementation of concepts and methodologies for the internalization of environmental costs into accounting and pricing mechanisms (UNCED, 1992). During the past several years, Governments in industrialized countries, Central and Eastern Europe and in developing countries have been making increasing use of economic approaches, including the polluter-pays principle and the more recent natural-resource-user-pays concept (UNCED, 1992).

2.3.4.5 Polluter Pays Principle (PPP)

Under the Polluter Pays Principle, the polluter should bear the expenses of carrying out pollution prevention and control measures decided by public authorities to ensure that the environment is in an acceptable state. That is, the costs of these measures should be reflected in the costs of goods and services which cause pollution, and to pay for the pollution caused by polluting activity (OECD, 2002). When the environmental costs of treatment and disposal are incorporated into the cost of the product under the 'polluter pays' principle, this creates the setting for a market to emerge that truly reflects the environmental impacts of the product (NZ MfE, 2005), (EC Commission, 2007a). Under the 'polluter pays' principle, industry and consumers pay the full costs of their decisions, including the costs of avoiding and remedying any environmental damage (NZ MfE, 2005). Internalisation of environmental externalities under the 'user-pays' theory shifts the costs of managing wastes from ratepayers and tax payers to producers and consumers, ensuring that the costs of wastes get considered when purchase and production decisions are made (NZ MfE, 2005). Where the costs of wastes are internalised in the costs and prices of products, they will also be factored into product design and whether or not to use the product (NZ MfE, 2005).

2.3.4.6 The Polluter Pays Principle and Use of Economic Instruments

Economic instruments are defined as a policy, tool or action which has the purpose of affecting the behavior of economic agents by changing their financial incentives in order to improve the cost-effectiveness of environmental and natural resource management (UNEP, 2004). Economic instruments are market based policy instruments that internalise previously uncosted environmental effects into a market structure through the Polluter Pays Theory (PCE, 2006). Economic instruments such as free market mechanisms, in which the prices of goods and services reflect the environmental costs of their input, production, use, recycling and disposal, can make a positive contribution to sustainable development (UNCED, 1992). In addition to adopting best environmental practice and triple bottom line reporting (TBLR), governments, business and industry have an essential role in internalising environmental costs into accounting and pricing mechanisms (UNCED, 1992). In support of the principle that generators of wastes pay for their disposal, Agenda 21 advocates formulating waste minimization policies that utilize economic instruments, including tax incentives and deposit/ refund systems, to encourage waste reuse and recycling, and induce beneficial modifications of production and consumption patterns (UNCED, 1992). Some progress has begun in the use of appropriate economic instruments to influence consumer behavior (UNCED, 1992).

2.3.5 Strategies for Sustainable Development

Regulators are seeking more dynamic opportunities to minimise the environmental effects of production and consumption (Goldberg, 2001). As the economics of waste disposal services change, waste recycling and resource recovery are becoming increasingly cost-effective, future waste management programmes should take maximum advantage of resource-efficient approaches to the control of wastes (UNCED, 1992). Agenda 21 advocates the incorporation of a number of strategies in order to promote the environmental sustainability goal of pollution prevention within the policy areas of production and waste management. In addition to the Pollution Prevention Hierarchy and the use of economic instruments, Agenda 21 advocates the incorporation of an integrated lifecycle principle, the broadening of responsibilities, Design for the Environment (DfE) and stewardship policies (UNCED, 1992).

2.3.5.1 Incorporation of an Integrated Lifecycle Principle

The adoption of an integrated lifecycle principle states that substances and products should be managed in such a way that there is minimal environmental impact during their production, use, reuse and disposal (UNEP, 2007a). Walls (2006) defines a life-cycle approach as policies that reflect resource scarcity and efficient resource use, i.e. the incorporation of a 'closing the loop' or cradle to grave approach. Through preventive strategies and cleaner and more efficient production processes throughout the product life cycle, that avoid and minimize wastes, the policies and operations of business and industry, including transnational corporations, can play a major role in reducing impacts on resource use and the environment (UNCED, 1992). Environmentally sound waste management must also go beyond the mere safe disposal or recovery of wastes generated, and seek to change unsustainable patterns of production and consumption through the application of an integrated life cycle management concept (UNCED, 1992). Application of an integrated life cycle management concept presents a unique opportunity to reconcile development with environmental protection (UNCED, 1992).

2.3.5.2 Incorporation of Broaden Ownership of Responsibilities

No formal definition of the broaden ownership of responsibility strategy has been found in the literature, however the concept is widely applied and results directly from the practical application of the integrated lifecycle principle. The broaden ownership of responsibility concept implies a broadening of the physical, financial and/or administrative responsibilities (accountability) for a product's environmental impacts, to all of the stakeholders involved at each stage of a product's lifecycle. Agenda 21 states that to achieve sustainable development in a climate of increasing globalisation, the pursuit of economic development, social justice and environmental quality must be integrated at all levels of society from individuals and governments to supranational corporations (UNCED, 1992). All sectors of society should participate in all the programme areas (UNCED, 1992). To achieve sustained minimization of waste generation requires Government initiated programmes with participation from non-governmental organizations and consumer groups (UNCED, 1992). The broaden ownership of responsibility strategy internalises physical, administrative and financial responsibilities, not unlike the way that the use of economic instruments internalises economic accountability.

2.3.5.3 Incorporation of Design for the Environment (DfE)

Agenda 21 states that the improvement of production systems through technologies and processes that utilize resources more efficiently and at the same time produce less wastes - achieving more with less - is an important pathway towards sustainability for business and industry (UNCED, 1992). Design for the Environment (DfE) can be defined as the incorporation of environmental consideration at the design stage (Walls, 2006), or as re-designing products to maximise sustainability benefits using best available technology (Hitchcock & Willard, 2006). The EC Commission (2007b) defines Design for the Environment (DfE) as the systematic consideration during design of issues associated with environmental health over the entire product life cycle. DfE can be thought of as the migration of traditional pollution prevention concepts upstream into the development phase of products before production and use (EC Commission, 2007b). The objective is to minimize or eliminate, during design, the anticipated waste generation and resource consumption in all subsequent life cycle phases: construction, operation and closure (or production, use, and disposal) (EC

Commission, 2007b). Agenda 21 emphasises the promotion of both public education and a range of regulatory and non-regulatory incentives to encourage industry to change product design and reduce industrial process wastes through cleaner production technologies and good house keeping practices (UNCED, 1992).

2.3.5.4 Adoption of Product Stewardship and EPR Policy Approaches

Agenda 21 encourages the concept of stewardship in the management and utilization of natural resources by entrepreneurs (UNCED, 1992). Some enlightened leaders of enterprises are already implementing 'responsible care' and product stewardship policies and programmes, fostering openness and dialogue with employees and the public and carrying out environmental audits and assessments of compliance (UNCED, 1992). These leaders in business and industry, including transnational corporations, are increasingly taking voluntary initiatives, promoting and implementing self-regulations and greater responsibilities in ensuring their activities have minimal impacts on human health and the environment (UNCED, 1992). The regulatory regimes introduced in many countries and the growing consciousness of consumers and the general public and enlightened leaders of business and industry, including transnational corporations, have all contributed to this (UNCED, 1992).

2.3.6 Tools to Evaluate Sustainability

Agenda 21 (1992) states that indicators of sustainable development need to be developed to provide a solid basis for decision making at all levels and to integrate environmental and development systems (Khan & Islam, 2006). However sustainability has been described as a 'contestable concept,' along with concepts such as liberty, social justice and democracy, which have basic meanings, and almost everyone is in favour of them, but deep conflicts remain about how they should be understood, and what they imply for policy (Jacobs, 1991). While sustainable development is widely accepted as a vision for managing the interaction between the natural environment and social and economic progress with respect to time, the concept lacks clear direction on the 'scale' of needs and experts are still struggling with the practical problem of how to measure it (Khan & Islam, 2006). Khan & Islam (2006) describe a number of models (matrix systems, indices and frameworks) that have been developed to measure sustainability, generally taking the economic, environmental and social contexts into consideration. However most are limited to minimising risk and re-mediating problems of specific processes or technologies, and don't address potential future problems that could arise from the introduction of new technologies (Khan & Islam, 2006). There are no straightforward guidelines to achieve true/inherent sustainability (Khan & Islam, 2006).

Life Cycle Assessment (Life Cycle Analysis) (LCA) is one tool that can help to place the assessment of the environmental costs and benefits of various options, and the development of appropriate and practical waste management policies, on a sound and objective basis (University of Bolton, 2007). LCA is defined as the assessment of the environmental impact of a given product throughout its life span (ISO, 2007). LCA is a systematic technique for identifying and evaluating the potential environmental benefits and impacts (use of resources; human health; ecological consequences) associated with a product or function throughout its entire life from extraction of raw materials to its eventual disposal and assimilation into the environment (University of Bolton, 2007). A standard methodology for LCA is contained within International Standards Organisation ISO 14044:2006 (ISO, 2007). Use of LCA in policymaking can enable the internal market to facilitate recycling and recovery activities (EC Commission, 2005).

2.3.7 New Zealand's Commitment to Sustainable Development

In the Sustainable Development for New Zealand, Programme of Action (2003) report, the then Minister for the Environment, the Honorable Marian Hobbs states that the sustainable development approach will help us find solutions that provide the best outcomes for the environment, the economy and our increasingly diverse society. New Zealand’s success in the modern world depends on this – so too does the wellbeing of future generations (NZ MfE, 2003). New Zealand is also a signatory to the principles and objectives of Agenda 21 (NZ MfE, 2002b).

2.4 Product Policy Environmental Policy Area

Although no formal definition of product policy was found in the literature, product policy is described as including decisions regarding the provision of goods and services (Rebitzer et al, 2004). Traditionally, product policy was largely been driven by concerns related to consumer health and safety (OECD, 1996). Producers were held responsible for the potential of product's to harm the environment during the manufacture and performance of their goods, but until recently, no-one asked who was responsible for managing the disposal of a product at the end of its useful life (Hitchcock & Willard, 2006).

2.4.1 Cleaner Production - Embracing a Lifecycle Approach

During the 1990's, sustainable development focused mainly on cleaner production and eco-efficiency, and was therefore focused at an operations level (Cox, 2003). The concept of cleaner production, formulated under the United Nations Environmental Programme (UNEP) in May 1989, embraces the principles of waste minimisation (CAE, 1992). Cleaner production is defined as the continuous application of an integrated, preventative environmental strategy to products, processes and services to increase eco-efficiency and reduce risks to humans and the environment (OECD, 2002). For production processes, cleaner production includes conserving raw materials and energy, eliminating use of toxic materials and reducing the quantity and toxicity of all emissions and wastes before they leave the process (OECD, 2002).

However, in embracing the principles of waste minimisation, the concept of cleaner production strives for optimal efficiencies at every stage of the product life cycle (UNCED, 1992). Many OECD countries are increasingly addressing product policy to include the full range of potential environmental impacts, with a growing emphasis on a life-cycle approach to environmental management (OECD, 1996), (UNCED, 1992). Increasingly product policy includes resource extraction, the design and development of a product, production (manufacturing and provision), use and consumption, and finally end-of-life activities (collection /sorting, reuse, recycling and waste disposal) (Rebitzer et al, 2004).

2.4.2 Product Policy and Design for the Environment

Agenda 21 identifies the significance of technical innovation and design within production systems to utilize resources more efficiently and at the same time produce less wastes - achieving more with less (UNCED, 1992). Product policy has seen an increasing assimilation of product design to enable greater recycling potential and greater incorporation of recycled materials (OECD, 1996). As stated, Walls (2006) defines Design for the Environment (DfE) as the incorporation of environmental consideration at the design stage. Brady et al (2003) and Hitchcock & Willard (2006) state that DfE is significant because most of the environmental impacts of products are determined by their design, so product design and development is the most effective phase to target environmental protection and resource minimisation. DfE is also derived from the premise that the producer, in holding the most product-related knowledge, has the greatest ability to realize environmental improvements and to influence changes in both the upstream manufacturing and downstream phases of a product’s life

(USEPA, 1997), (Nicol & Thompson, 2007a). DfE also enables designers to eliminate the use of hazardous materials and to optimise opportunities for material recovery at the end of a product's useful life, thereby reducing the environmental and economic costs for end-of-life management (Brady et al, 2003)

2.4.3 Use of Economic Instruments

The Australian Government (2003) describes how only 5% of the total social costs of production and consumption of goods arise from their land filling as waste, therefore focus of policy should be designing economic instruments that focus directly on upstream activities.
Agenda 21 emphasises the promotion of public education and an appropriate mix of economic instruments, regulatory and non-regulatory incentives to encourage industry to change product design and reduce industrial process wastes (UNCED, 1992). Brady et al (2003) confirms the need for more rigorous application of the polluter pays principle (including producer responsibility) and preferential treatment in regards to taxation and state aid for greener products. (Brady et al, 2003). Brady et al (2003) also describes how a key element of the European Union's Integrated Product Policy (IPP) strategy is to incorporate a range of instruments including market forces (taxes and subsidies to internalise external costs), eco-design and information mechanisms such as eco-labels.

2.4.4 Promotion of Product Stewardship and EPR Policy Approaches

Disposable products or planned obsolescence ‘rewards’ producers with high volume sales but translate into increased waste management costs for local governments, therefore effective policies that provide direct incentives for waste prevention must be introduced (McKerlie et al, 2006). In the absence of extended producer responsibility, industry pursues high volume sales without consideration for residual materials management at the product’s end-of-life (McKerlie et al, 2006). Adoption of producer responsibility would impose a take-back of end-of-life products to the producer (ETRMA, 2006).

2.4.5 Integrated Product Policy (IPP)

The European Union's Integrated Product Policy (IPP) strategy is a product focussed environmental policy approach that represents a move away from waste management (relying on 'end-of-pipe' technologies), and focuses on reducing 'front-of-pipe' environmental effects, i.e. at the product development and design stage (Coggins, 2001), (Brady et al, 2003), (CfSD, 2007). IPP and EPR are the two key conceptual approaches to product focussed environmental management in Europe, the distinction between the two policy approaches being the point in the product's life-cycle that is targeted for action (Brady et al, 2003). EPR focuses on end-of-life, whereas IPP focuses on product policy (material selection, product design and consumer choice) (Brady et al, 2003).

IPP is defined in an EC Green Paper as public policy which seeks to reduce the life cycle environmental impact of products from the mining of raw materials to production, distribution, use and waste management (EC Commission, 2000). The objective of IPP is to integrate environmental considerations into key decision points in the product's life cycle stages and assist stakeholders (producers, consumers and policymakers) in making environmentally sound choices (Brady et al, 2003). In taking a more holistic view of the relationship between products and their burden on the environment throughout their life cycle, IPP is a fully integrated approach to resource use and environmental impacts and implies a fundamental change by industry (Coggins, 2001). Such a ‘cradle-to grave’ approach is often associated with Life Cycle Assessment (Coggins, 2001). While still in its infancy in the European Union, IPP is considered essential for sustainable development (Brady et al, 2003).

2.5 Waste Management Environmental Policy Area

Waste is defined as any substance that the holder discards or is required to discard (OECD, 2002), (EC Commission, 2007b). A high proportion of waste in many countries is simply diverted to landfill, where the complex and potentially hazardous nature of waste streams often give rise to air, water and land pollution with implications for human health and environmental integrity, and also create a public nuisance (EC Commission, 2005), (King et al, 2006). Landfilling of waste also represents steeply rising costs, increasing pressure on land for new landfill sites, and the permanent loss of material and energy resources (EC Commission, 2005), (King et al, 2006).

Waste management can be defined as the administration of activities that provide for the collection, source separation, storage, transportation, transfer, processing, treatment and disposal of waste (USEPA, 2007b). Environmentally sound management of wastes concerns the relationship between environmental degradation, production and consumption and waste management (UNCED, 1992). Nicol & Thompson (2007a) describe how waste management policies frequently fail to reduce consumption, prevent pollution, conserve resources or foster sustainable products. Waste management is inextricably linked to the economy and the environment and also has significant social (and cultural) implications so that all three aspects of sustainability (economic, environmental and social) have to be considered in waste management (Ludwig et al, 2003).

2.5.1 Key Waste Management Objectives

Key objectives of waste management are summarised in Figure 2.4: Waste Management Objectives, and are described in the following sections.

Figure 2.4: Waste Management Objectives

2.5.2 Reduction to Landfill - From End-of-Pipe Solutions towards Waste Prevention and the Pollution Prevention Hierarchy

Traditional waste management policy has primarily been concerned with the establishment of protective standards for the final disposal of waste products (OECD, 1996), focusing on 'end of pipe' disposal rather than prevention (NZ MfE, 2002a). However, in the last decade, waste management policy priorities have evolved from simple end-of-life landfill solutions to the promotion of waste prevention and minimisation in accordance with Agenda 21 and the Pollution Prevention Hierarchy (UNCED, 1992), (OECD, 1996). The principle objective of the

United Nations Environment Programme technical guidelines for waste management is source reduction, whereby the generation of wastes should be minimized both in terms of quantity and potential for causing pollution (UNEP, 2007a).

The waste management hierarchy (Pollution Prevention Hierarchy) has now been adopted by most developed nations including Australia (Australian Government, 2003), Japan (Ogushi & Kandlikar, 2007), and the European Community (EC Commission, 2005). European Community (2005) waste policy states that the waste hierarchy remains an excellent rule of thumb as to which management operations are best for the environment, and it can be a useful proxy where scientific analysis is not possible or proportionate. In accordance with the Pollution Prevention Hierarchy, the preferred options for waste prevention are to maximise environmentally sound waste reuse, recycling and recovery (UNCED, 1992), (EC Commission, 2005), along with other efforts to reduce the volume of wastes going to landfills or incineration plants (OECD, 2002).

EC Commission policy (2005) states that unsustainable trends in waste generation can be a symptom of the environmentally inefficient use of resources. The long-term goal is for the EU to become a recycling society that seeks to avoid waste and uses waste as a resource, to reduce the negative environmental impacts of the use of natural resources (EC Commission, 2005). Nicol & Thompson (2007a) state that effective waste management policies exploit all possible avenues for waste reduction (i.e., source reduction, recycling, material substitution, etc). According to Ludwig et al (2003), sustainable waste management (SWM) is the consideration of all possible options for the reduction of the negative impacts of consumption. This means all the options society has to ultimately turn waste into a zero-valued good, i.e. appropriately treated residues which can be safely landfilled for indefinite duration, or recycled by transforming them physically and/or chemically to become valuable again as a raw material for new products.

2.5.3 Separate Collection of Special (Priority) Wastes

Implicit in the ability to recycle is the identification and segregation of reusable or recyclable wastes (Ludwig et al, 2003). Consistent with the principal goal of sustainable waste management i.e. to stabilise or reduce the production of wastes destined for final disposal, Agenda 21 promotes the separate collection of priority wastes (recyclable parts of household wastes) to encourage waste reuse and recycling (UNCED, 1992). The OECD (2005) defines special (or priority) wastes as wastes that are inappropriate for municipal waste management programs. Wastes that may be inappropriate for municipal waste management programs include those with a high residual value (embedded resources) i.e. those that are reusable or recyclable (OECD, 2001b). Wastes may also be inappropriate for municipal waste management programs because they cause particular management or disposal problems (high health or environmental impact e.g. high volume or hazardous components) or those that create a public nuisance (OECD, 2001b), (NZ MfE, 2005). Agenda 21 proposes formulating goals based on waste weight, volume and composition in order to induce separation to facilitate waste recycling and reuse (UNCED, 1992). Australian waste policy sets a national per capita waste reduction target of 50 percent to landfill by the year 2000, plus several State and Territory Governments have announced policies of zero waste to landfill (Australian Government, 2003).

2.5.4 Reduction of Local Authority Burden

Under 'conventional' waste management practices for household wastes, the collection and disposal of end-of-life products is typically the responsibility of local or municipal governments, financed through some form of general taxation or user charges levied on households and/or businesses (OECD, 2005). However the exhaustion of traditional disposal sites, stricter environmental controls governing waste disposal and increasing quantities of more persistent wastes, particularly in industrialized countries, have all contributed to a rapid increase in the cost of waste disposal services (UNCED, 1992). Thus a key objective of sustainable waste management policy is to reduce local authority burden. As no definition for reduction of local authority burden was found in the literature, it can be defined as to reduce the physical, financial and/or administrative burden of waste management (i.e. collection, disposal and recycling of waste products) that falls otherwise to local authorities and society at large.

2.5.5 Incorporation of Sustainability Strategies

More sustainable waste management through greater incorporation of the pollution prevention hierarchy (reuse, recycling, recovery) has been described above. Remaining strategies that may be employed for greater sustainability in the achievement of waste management objectives include an Integrated Lifecycle Principle, Broadening Ownership of Responsibilities, Use of Economic Instruments and Design for the Environment (DfE).

2.5.5.1 Incorporation of an Integrated Lifecycle Principle

Effective waste management policy now emphasises a lifecycle approach, which examines cradle to grave impacts of products and processes (Nicol & Thompson, 2007a). Preventing the production of waste materials has not traditionally been considered a part of waste management in its strict sense (Ludwig et al, 2003). However, in addressing the objective of reducing the volume of wastes to landfill, Australian waste policy now addresses both the downstream post-consumer (end-of-life) environmental impacts associated with waste materials and the upstream lifecycle impacts (Australian Government, 2003). This includes goals such as minimising the environmental impacts associated with resource exploitation (e.g. conserving virgin resources) and production processes (e.g. reducing the toxicity of products) (Australian Government, 2003). UNEP (2007a) technical guidelines on environmentally sound waste management strategies include the adoption of an integrated lifecycle principle, whereby substances and products should be managed in such a way that there is minimal environmental impact during their production, use, reuse and disposal.

2.5.5.2 Use of Economic Instruments through the Polluter pays Principle

OECD (1996) and UNEP (2007a) guidelines endorse the internalisation of the environmental costs and responsibilities associated with waste management under the polluter-pays principle as a major objective of environmentally sound waste management strategies. Waste management used to be the responsibility of the public domain, financed by taxpayers, with little or no incentive for the consumer or the producer to diminish the rate of waste production (Ludwig et al, 2003). Internalisation of environmental externalities under polluter pays principles shifts the costs of managing wastes from ratepayers and tax payers to producers and consumers, so they pay the full costs of their decisions, including the costs of avoiding and remedying any environmental damage (NZ MfE, 2005). Through the provision of appropriate incentives to stakeholders throughout the design, production, use and post use life cycle stages of products, environmental and economic waste management objectives can be maximised to enhance waste reduction and sustainability (Australian Government, 2003), (Ludwig et al, 2003). Many Governments, primarily in industrialized countries but also in Central and Eastern Europe and in developing countries, have been making increasing use of market-oriented economic approaches such as the polluter-pays principle (UNCED, 1992).

2.5.5.3 Incorporation of Design for the Environment (DfE)

Design for the Environment is derived from the premise that the producer is in the best position to assume waste management responsibilities, holding the most product-related knowledge and controlling the production and design process (Nicol & Thompson, 2007a). The term Integrated Waste Management (IWM) has been coined to include front end measures such as design for recycling, exclusion of problematic materials in products etc as an integral part of waste management (Ludwig et al, 2003). The overall objective of IWM is a reduction in the total environmental impact resulting from wastes, reducing the flow of materials to the environment at each level of the life-cycle i.e. prevention, recycling, end-of-pipe treatment and safe disposal (Ludwig et al, 2003). Reducing the input to the waste management system, by increasing the material efficiency of the economy is the preferred option in the long-term (Ludwig et al, 2003).

2.5.5.4 Incorporation of the Broaden Ownership of Responsibility Strategy

Stewardship approaches to waste management policy transfer both waste management costs and responsibilities from the public to the private sector (highest social benefit), reducing the financial burden on municipalities (OECD, 2005). The concept of broadening the ownership of responsibilities is therefore implicit through the incorporation of the other sustainability strategies (i.e. Integrated Lifecycle Principle, the Pollution Prevention Hierarchy, Design for the Environment and Use of Economic Instruments) for the achievement of sustainable waste management.

2.5.6 Moving Towards Zero-Waste Societies

The principles of zero waste first arose over 30 years ago from the realisation that the impact of increasing resource demands, as populations grow, would lead to the depletion of many resources and in some cases extinction (Ludwig et al, 2003). Zero-waste strategies are based on natural systems where nothing is wasted, every waste is another’s feedstock (Ludwig et al, 2003). Zero-waste encourages the elimination of waste by encouraging recognition of the potential economic value of recoverable resources embedded in many waste streams for use in further production (Ludwig et al, 2003), (Hitchcock & Willard, 2006). Disposal to incinerators or landfill would be replaced by systems that capture materials and recycle them in a closed loop system of reuse, repair, recycle and redesign (Ludwig et al, 2003). A zero-waste society would tax virgin or raw material use, give tax breaks for industries that use recycled materials and make dumping illegal or expensive (Ludwig et al, 2003).

When applied to waste management policy, zero-waste generally implies 'zero waste to landfill' and applies only to solid wastes, and is easier to achieve than zero-waste in everything (Hitchcock & Willard, 2006). Organisations that have achieved the goal of zero waste to landfill have eliminated haulage costs, reduced the environmental impact of their products, and also get paid for the 'residual products', formerly known as waste (Hitchcock & Willard, 2006). Two objectives necessary for a move towards a zero-waste society are building markets for recyclable materials through economic development incentives, and implementing product stewardship/EPR legislation for all toxic materials, requiring some form of product take-back, that creates incentives to manufacturers to create more sustainable alternatives (Hitchcock & Willard, 2006). Gertsakis et al (2002) describe the principles of the Industrial Ecology as a similar concept, the need to generate circular processes that keep valuable components and materials out of the waste stream by allowing for the re-use of products, components or materials.

In March 2002 the New Zealand Ministry for the Environment published The New Zealand Waste Strategy: Towards Zero-waste and a Sustainable New Zealand (NZ MfE, 2003). The Strategy describes the long-term challenge as a move towards zero-waste and sustainability, with a need to shift from 'managing waste disposal' to higher environmental standards and more efficient use of resources and resource recovery (NZ MfE, 2002a). The Strategy sets out a long-term vision for reducing waste, recovering resources from the waste stream and managing residual waste more effectively, including the greater use of product stewardship and EPR type schemes for priority wastes, including tyres (NZ MfE, 2002a).

2.6 Product Stewardship and Extended Producer Responsibility (EPR) Policy Approaches to Waste Management

Hitchcock & Willard (2006) describe how, at the core of product stewardship and EPR approaches is a shift in responsibility, one that many in industry have resisted. Traditionally producers were held responsible for the manufacture and performance of their goods, but until recently no-one asked who was responsible for managing the disposal of a product at the end of its useful life (Hitchcock & Willard, 2006). Germany was the first country to introduce an EPR type approach, establishing a comprehensive take-back and recovery system for packaging waste (the Duales System Deutschland Green Dot Scheme). The scheme is now established in 25 countries as a symbol for packaging recycling (Der Grune Punkt, 2007). Product Stewardship and extended producer responsibility (EPR) type policy approaches have since been implemented in Europe, Japan, Korea, Taiwan, USA and Canada for a variety of priority wastes including solvents, crankcase oil, tyres, batteries, beverage containers, packaging, domestic appliances and electrical & electronic equipment (E waste) (Hanisch, 2000), (Gertsakis et al, 2002), (Walls, 2006), (Ogushi & Kandlikar, 2007).

2.6.1 Product Stewardship and EPR Functional Definitions

The term extended producer responsibility was first coined in Sweden by Thomas Lindhqvist, as a product take-back mechanism to provide incentives for producers to make changes that would reduce waste management costs (Walls, 2006). The Organisation for Economic Co-Operation and Development (OECD) have been leaders in advancing the EPR concept (Hanisch, 2000). The OECD's (2001b) widely quoted definition of EPR is an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's lifecycle. However EPR is a dynamic and evolving area of activity in terms of both government policy and business practice, and definitions are in flux (Gertsakis et al, 2002).

The product stewardship concept is closely related to EPR but involves sharing responsibility across the range of affected parties, rather than placing responsibility almost solely with producers (Product Stewardship Council, 2006). Product stewardship is the policy approach most commonly adopted within the European Community, where it is defined as a management system based on industry and consumers taking lifecycle responsibility for the products they produce and use (EC Commission, 2007b). Product Stewardship is basically synonymous with EPR (extended producer responsibility in the EU or extended product responsibility in the US) (Hitchock & Willard, 2006), and the terms are often used interchangeably (McKerlie et al, 2006). The New Zealand government describes Product Stewardship as a very similar tool to EPR, although Product Stewardship extends responsibility for the environmental effects of a product to ALL involved parties whereas EPR has a narrower focus on producer responsibility (NZ MfE, 2005). The Minnesota Office of Environmental Assistance makes no distinction between extended product responsibility, shared responsibility, manufacturer responsibility and EPR (Nicol & Thompson, 2007a). Otherwise Product Stewardship and EPR share similarities in terms of their theoretical and economic foundations, objectives, strategies and mechanisms (policy instruments).

2.6.2 Product Stewardship and EPR - Objectives and Strategies

The key objectives and strategies of EPR and product stewardship policy approaches that are discussed in the following sections are illustrated in Figure 2.5.

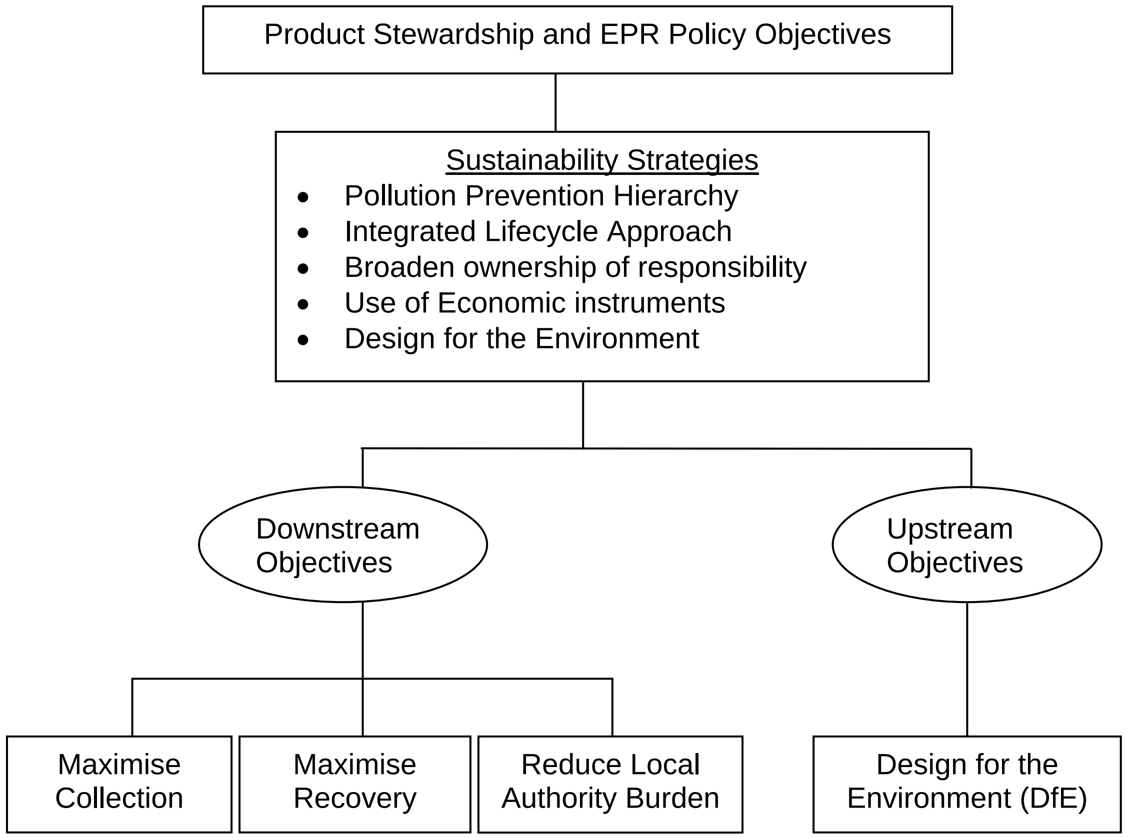


Figure 2.5: Product Stewardship and EPR Policy Objectives

According to Lindhqvist (2000), the three principle objectives of EPR are to guarantee an organised collection of the discarded products, to achieve an increased level of recycling of materials from the discarded products (reuse, recycling or energy recovery), and to provide incentives for design changes of products or product systems that lead to overall improvements of their environmental qualities. Jessen (2005) of Boston's Product Stewardship Institute describes the objectives of product stewardship as more efficient waste collection, product design changes to enable greater recycling and the establishment of recycled resource markets through the internalisation of responsibilities at each stage of the product's lifecycle.

Gertsakis et al (2002) describe the overall goals of product stewardship and EPR as to transfer the costs of municipal waste management from local authorities to those actors (i.e. the producers) most able to influence the characteristics of products which can become problematic at the post-consumer stage: waste volume, toxicity, and recyclability. By transferring these costs, governments hope to provide powerful incentives for producers to prevent waste generation, reduce the use of potentially toxic inputs, design products that are easily recyclable and internalise the costs (Gertsakis et al, 2002). The OECD (2001b) describes the key features of EPR as (i) the shifting of responsibility (physical and/or economically, fully or partially), upstream to the producer and away from municipalities and (ii) to provide incentives to producers to incorporate environmental considerations in the design of their products.

2.6.3 Incorporation of Sustainability Strategies

Each of the sustainability strategies described within the sustainable development, product policy and waste management policy areas, i.e. Broaden Ownership of Responsibility, Integrated Lifecycle Approach, Design for the Environment, Use of Economic Instruments and the Pollution Prevention Hierarchy, are integral to the achievement of Product Stewardship and EPR objectives.

2.6.3.1 Incorporation of the Broaden Ownership of Responsibilities Strategy

At the core of Product Stewardship and EPR is the shifting of responsibility (physical and/or economically, fully or partially), upstream and away from municipalities (OECD, 2001b), (Gertsakis et al, 2002), (Hitchcock & Willard, 2006). EPR shifts responsibility for waste from government to private industry, obliging producers, importers and/or sellers to internalise the waste management costs of products after their useful life in their product prices (Hanisch, 2000). They must either take back spent products and manage them through reuse, recycling or in energy production, or delegate this responsibility to a third party, a so-called producer responsibility organization (PRO), which is paid by the producer for spent-product management (Hanisch, 2000), (Environment Canada, 2006). This relieves municipalities of the financial burden of waste management, and encourages producers to reduce resources, utilize recycled materials, and undertake product design changes to reduce waste (OECD 2001b). Although EPR programs take many forms, they are all characterized by the continued involvement of producers and/or distributors with commercial goods at the post-consumer stage (EC Commission, 2007a).

In contrast, Product Stewardship involves sharing responsibility across the range of affected parties rather than placing responsibility almost solely with producers (Product Stewardship Institute, 2006). Product Stewardship is a multi-stakeholder approach which advocates participation from, and the provision of incentives to all actors along the product chain including corporations, brand owners, producers, manufacturers, importers, distributors, retailers, consumers, waste handlers & recyclers, local and national government agencies (NZBCSD, 2005), (Sheehan & Speigelman, 2005). In New Zealand, Product Stewardship is defined as 'an approach whereby producers, importers, brand owners, retailers, and other parties involved in the lifecycle of a product accept responsibility for the environmental impacts of products throughout their lifecycle (NZ MfE, 2005).

Although EPR and product stewardship policies both share a similar foundation in extending responsibilities for waste management, many of the difficulties encountered with the application of such 'products' based approaches have occurred because of the blurring between the concepts (McKerlie et al, 2006), (Nicol & Thompson, 2007a). The blurring of the lines between each approach has confused policy makers and this confusion has to be removed in order to arrive at truly progressive polices that prevent rising levels of waste and pollution (Nicol & Thompson, 2007a). The level or degree of producer responsibility (full or partial for physical and/or financial activities) for the EPR programme is crucial (OECD, 2001a).

The US Environmental Protection Agency (EPA) describes product stewardship as a system of shared responsibility extending beyond EPR (Hanisch, 2000). However McKerlie et al (2006) consider that this shared approach does not clearly designate responsibility to any one party, diluting the impetus to advance waste prevention. Allocating responsibilities among many stakeholders often leads to confusion over who is primarily responsible for end-of-life management (OECD, 2001b), (Thorp et al. 2004). When you make everybody responsible for everything then nobody is responsible for anything (Fishbein et al, 2000). Responsibilities should be well defined and not be diluted by the existence of multiple actors across in the product chain (OECD, 2001b). Mixing of the two concepts obliterates the important difference between truly progressive EPR programs which aim to prevent rising levels of waste and pollution, versus shared product stewardship initiatives, which primarily mandate that producers cover a portion of waste collection and recycling costs at the end of a product’s useful life (McKerlie et al, 2006), (Nicol & Thompson, 2007a). To achieve high recycling rates, reduce toxic emissions, encourage environmental design and provide adequate funding, EPR is clearly superior. (Nicol & Thompson, 2007a).

It is also important to distinguish between physical (e.g. collection, transportation, storage), financial (e.g. the payment or collection of levies, transportation, storage or recycling costs) and organisational (e.g. management, administrative or legal - registration, reporting & compliance) responsibilities within any program. Physical responsibility refers to the direct or indirect handling of a product, including take-back by producer for recycling (Toffel, 2002). Financial responsibilities include payment for end-of-life recycling and disposal costs (OECD 2001b). Decisions on the allocation of responsibility should be made in view of the policy goals, product characteristics, market dynamics, actors in the product chain and resources needed to implement the policy (OECD, 2001a). Producer Responsibility Organisations (PRO's) are third party organisations that may be formed to allow producers to collectively manage the take back of products under product take-back schemes, deposit/refund systems and advance disposal fee programmes (OECD, 2001b).

2.6.3.2 Incorporation of an Integrated Lifecycle Approach

Product Stewardship involves a full life cycle approach by taking responsibility for a product for its entire lifetime, including planning for proper management and handling at the end of its useful life (Hitchock & Willard, 2006). EPR imposes accountability over the entire lifecycle of products and packaging introduced on the market, so that firms which manufacture, import and/or sell products and packaging, are required to be financially or physically responsible for such products after their useful life (Hanisch, 2000). EPR extends the traditional environmental responsibilities that producers and distributors have previously been assigned (i.e. worker safety, prevention and treatment of environmental releases from production, financial and legal responsibility for the sound management of production wastes) to include management at the post-consumer stage (EC Commission, 2007a).

As stewardship (EPR and product stewardship) concepts continue to evolve, the lifecycle principle extends the producer's responsibility to include not only end-of-life management, but also consideration of a product's upstream environmental impacts, i.e within the extraction, production (design), consumption and end-of-life lifecycle components. Producers of products should bear a significant degree of responsibility, (physical and/or financial), not only for the environmental impacts of their products downstream from the treatment and/or disposal of the product, but also for their upstream activities inherent in the selection of materials and in the design of products (EC Commission, 2007a). Walls (2006) states that the whole life-cycle approach objective should reflect resource scarcity and efficient resource use, i.e. the incorporation of a 'closing the loop' or cradle to grave approach. This means modeling market functioning (material, labour, energy costs) and material flows (virgin, recycled) throughout the design, production, consumption and post-consumer (e.g. recycle, landfill) stages (Walls, 2006).

The USEPA (1997) refers to EPR as 'extended product responsibility,' based on the principle that all actors along the product chain share responsibility for the lifecycle environmental impacts (pollution prevention and resource conservation) of the whole product system (Hanisch, 2000), (Schwartz & Gattuso, 2002). This includes upstream impacts inherent in the selection of materials for products, impacts from manufacturers' production processes and downstream impacts from use and disposal of products system (USEPA, 1997), (Hanisch, 2000).

2.6.3.3 Incorporation of The Pollution Prevention Hierarchy and Lifecycle Analysis

When properly undertaken, EPR’s strength lies in its ability to simultaneously operationalise lifecycle thinking, the waste minimisation hierarchy and the Polluter Pays Principle (OECD, 1997). Lindhqvist (2000) states that (for EPR to be effective) maximising of recycling/reuse must give priority to material recycling processes, then energy recovery then landfill incineration as the least desirable option. The challenge of product stewardship is to move beyond disposal to facilitate a paradigm shift toward 'zero-waste and sustainable production' (Zero Waste New Zealand Trust, 2002). Product stewardship principles should reflect resource efficiency by utilising fewer and more sustainable raw materials which are easier to re-use, not just reduction of waste (NZBCSD, 2005).

The New Zealand Business Council (2005) and McKerlie et al (2006) recommend conducting Life Cycle Analysis to assess the overall impact of a product, in order to make informed decisions re environmental harm and to identify the trade-offs required. OECD guiding principles state that EPR policies and programs should take a lifecycle approach to ensure that environmental impacts or improvements (e.g. materials reductions) are not increased or transferred somewhere else in the product chain (e.g. in increased energy use) (OECD, 2005), (EC Commission, 2007a), (McKerlie et al, 2006). Certain products may be best re-designed for deconstruction and re-use rather than being put into the recycling stream (McKerlie et al, 2006).

2.6.3.4 Incorporation of Design for the Environment (DfE)

Waste problems arise because once products are sold, producers, importers and retailers are no longer responsible for the product's impacts. In addition, consumers may not consider the environmental or disposal costs as these fall on others. Thus there is no link between the problems of disposal of the product and product design to reduce waste at the end of the products life (NZ MfE, 2005). The OECD's (2001b) definition of EPR is that the producers' responsibility, physical and financial, for a product is extended to the post-consumer stage of a product's lifecycle, to provide incentives to producers to incorporate environmental considerations in the design of their products. Lindhqvist (2000), Ritchey & Stenstrom (2004), Walls (2006) and the EC Commission (2007a) all agree that a core characteristic of EPR is that in placing some responsibility for a product’s end-of-life environmental impacts on the original producer, EPR provides incentives for fundamental design (DfE) changes in products or product systems that lead to overall improvements in their environmental qualities. These can be in the form of goals for downsizing products, reducing material usage, increased use of recycled material, improving product recyclability and reusability or using fewer environmentally dangerous substances (Lindhqvist, 2000), (Ritchey & Stenstrom, 2004), (Walls, 2006).

As described, product stewardship is a multi-stakeholder approach, involving the provision of incentives to ALL affected parties that share in the responsibility for the lifecycle of a product (design, use and disposal), rather than placing responsibility almost solely with producers (Sheehan & Speigelman, 2005), (NZBCSD, 2005), (Product Stewardship Institute, 2006). Thus for product stewardship, the link between end-of-life product management and product design appears to be more tenuous. Within the European Community, product stewardship is the policy approach most commonly adopted for end-of-life product management, defined as a management system based on industry and consumers taking lifecycle responsibility for the products they produce and use (EC Commission, 2007b). However. product stewardship in the EU has a focus on waste collection and recycling targets, rather than seeking to directly reduce the environmental impacts during the extraction, production and consumption stages (Centre for Sustainable Design, 2007). Thus the EU Environment Directorate is developing a separate Integrated Product Policy (IPP) Approach (as described), in order to reduce the environmental effects at 'front-of-pipe,' i.e. the product development and design stage, rather than relying on 'end-of-pipe' technologies (CfSD, 2007). The New Zealand Business Council (2005) states that DfE objectives should be part of every waste reduction strategy.

2.6.3.5 Incorporation of Economic Instruments

The use of economic instruments to internalise waste management costs, reduce local authority burden, fund program operation and provide incentives for Design for the Environment, is a core characteristic of EPR policy approaches (OECD, 2005), (Walls, 2006), (EC Commission, 2007a). Under EPR strategies, the use and post-consumer phases of a product's lifecycle are important aspects of pollution for which responsibility must be assumed under the Polluter Pays Principle (Ayres, 1996), (OECD, 1996), (Walls, 2006). Through shifting the costs of managing wastes from ratepayers and tax payers to producers and consumers, EPR can be an effective mechanism to promote the integration of the lifecycle costs associated with products into the market price for a product (Gertsakis et al, 2002). According to the EC Commission (2007a) the primary function of EPR is the transfer of the costs and/or physical responsibility of waste management from local government authorities and the general taxpayer to the producer. One of the chief advantages of EPR is that it directly connects producers with the waste management costs of their products (OECD, 2005). If appropriately designed, so that individual producers bear a financial burden under EPR that directly reflects the costs of waste management for their own products, then producers have a clear incentive to modify product design in order to reduce waste management costs (OECD, 2005).

Many waste products have some residual economic value at the end of their lives but usually not enough to ensure recycling of materials or safe disposal (NZ MfE, 2005). Through the internalisation of waste management costs, stewardship mechanisms are able to provide powerful incentives for producers to both minimise environmental externalities and promote the recovery of the economic value of resources (Gertsakis et al, 2002), (NZ MfE, 2005). Wolnik & Fischer (2006) quote lessons learned from European and Canadian stewardship programs which highlight the importance of designing EPR programs with clear legislation that encourages sustainable product design by delivering a full range of signals to producers.

2.6.4 Product Stewardship and EPR Policy Instruments (Mechanisms)

A key objective of both product stewardship and EPR is to provide incentives for the internalisation of responsibilities at each stage of the product's lifecycle (Lindhqvist, 2000), (Jessen, 2005), (EC Commission, 2007a). The three basic categories of policy instruments used to provide incentives are regulatory 'command and control' or voluntary measures (e.g.

take-back requirements and performance standards), economic instruments and persuasive (informational or educational) instruments (Kandelaars, 1999), (OECD, 2001b).

Selection of policy instrument is dependent on the key objectives that drive policy (OECD, 2001b). Where policy objectives are waste management driven, the key focus will be on diversion of wastes from landfill, and on the development of material recycling and recovery activity (OECD, 2001b). Where resource efficiency is the primary objective, there will be more focus on a lifecycle approach, with a greater emphasis on resources consumed in the consumption and production phases (OECD, 2001b). Here policy instruments would be chosen in order to drive design changes in production, particularly if the product poses environmental problems at the end-of-life phase (OECD, 2001b). The New Zealand Parliamentary Commissioner for the Environment (2006) states that for any stewardship program to be cost-effective it must provide incentives, directly or indirectly, for consumers to return products for recycling; and for products where product design is a key determinant of the cost of recycling, it is essential that incentives are provided for DfE. Walls (2006) states that EPR must include 'incentives' to incorporate environmental decision-making in the design stage. Walls (2006) proposes modeling market functioning throughout the design, production, consumption and post-consumer stages, plus all possible side effects and restraints, to determine the socially optimal level of waste, recycling, production and product design in order to then determine what combination of policy instruments might achieve the social optimum, i.e. to provide the right incentives in order to achieve the objectives.

Instrument selection is also influenced by the degree of government intervention that is deemed optimal in the provision of incentives (carrots) and disincentives (sticks), i.e. whether a voluntary or a mandatory approach would be most effective. The role of the market (i.e. through use of economic instruments to internalise environmental externalities) and the role of local and central government are significant factors in the development of cost-effective and environmentally effective stewardship policy approaches to priority waste management. The problem, then, is to develop flexible EPR and product stewardship strategies for a future in which there is a good deal of uncertainty concerning national or international directives, technological developments, shifting political ideology, market forces and ethical concerns (Ritchey & Stenstrom, 2004).

2.6.4.1 Voluntary (Corporate Responsibility or Free Market) Approaches

Voluntary industry led approaches are usually 'Voluntary Product Take-back Schemes,' either with or without recycling rate targets, involving collection and recovery of products through voluntary covenants with producers or importers (Gertsakis et al, 2002). EPR can be an effective mechanism to promote the integration of the lifecycle costs associated with products into the market price for a product, and whether this occurs through imposed regulations or voluntary actions is not an issue (Gertsakis et al, 2002). However, while voluntary industry led approaches provide flexibility and opportunity for industry leadership, scheme development is often slow and piecemeal (NZ MfE, 2005), and where recycling rate targets are established, there are no laws or penalties for not meeting goals (Walls, 2006). While a voluntary approach to product stewardship may be sufficient for many waste products, for products where major adverse impacts have been identified such as cars and their components (including tyres and used oil), legislation is the appropriate method to ensure a level playing field, and to deter free-riders (NZBCSD, 2005). Freeriders are scheme non-participants who seek to benefit while not complying with the mechanisms established, or contributing an appropriate share of the costs (OECD, 2001b), (NZ MfE, 2005). Furthermore, to be employed broadly enough to be effective, even voluntary approaches require a solid legislative framework to ensure both fairness and effectiveness, and the provision of a range of tools from which voluntary schemes can be developed (NZBCSD, 2005).

2.6.4.2 Regulatory (Mandatory) Instruments

Regulatory 'Product Take-back Schemes' require the producer and/or retailer to take back the product after use (Gertsakis et al, 2002). In order to focus responsibility upstream to producers, take back is often combined with 'Minimum Recycled Content' targets (Gertsakis et al, 2002), or 'Tradable Recycling Credit schemes' where credits can be traded to meet overall recycling targets (Walls, 2006). Landfill, incinerator or substance bans are regulatory instruments that are often used in conjunction with economic instruments to fulfill program objectives (Gertsakis et al, 2002). In countries where the public sector plays a large role in the economy, Government Procurement (purchasing) policies, in which government agencies support green products and services, are a regulatory tool that signal clear guidance to the market, influencing corporate decisions and public perceptions (UNCED, 1992), (NZBCSD, 2005). Walls (2006) states however that these instruments cannot be considered to fulfill true product stewardship (or EPR) instrument criteria in that they do not incorporate the use of economic (price-based) instruments and so do not provide incentives upstream to producers for Design for the Environment. Without the employment of economic instruments, producers are not financially responsible for the waste generated by their products (Walls, 2006).

2.6.4.3 Economic Instruments

Walls (2006) considers that economic instruments that send signals through the market (although imperfect) throughout a product's lifecycle, exploit all the different means by which waste can be reduced and are more likely to yield the constrained optimal amount of waste disposal, recycling, consumption and product design. Economic instruments include end-of-life waste management fees such as Deposit Refund Schemes or Advance Disposal or Advance Recycling Fees (ADF/ARF) (Gertsakis et al, 2002). Deposit Refund Schemes involve a refundable levy payable upon purchase, and although most commonly applied to products such as beverage containers, have been applied to tyres in Austria (Gertsakis et al, 2002).

Under ADF or ARF approaches, consumers are charged all or part of the marginal collection and treatment (resource recovery, recycling, reuse or disposal) costs of specific waste products through an “end-of-life” fee (tax or levy) at the point of sale (Gertsakis et al, 2002), (OECD, 2005), (PCE, 2006). This may be a charge per bag or per kilogram of general household refuse ("pay as you throw"), or a specific charge for the collection and treatment of a particular item (OECD, 2005). The levy can be paid to the government, the producer or a Producer Responsibility Organisation (PRO) (OECD, 2005). PRO's are third party organisations that can be formed to allow producers to collectively manage the take back of products under Product Take-back, Deposit Refund, ADF and ARF schemes (OECD, 2001b). PRO's can support both mandatory and voluntary schemes and often have functions beyond product collection such as education and training of both producers and consumers (OECD, 2001b). ADF's have been used widely overseas for a range of products such as beverage containers, car tyres, refrigerators, end-of-life vehicles, batteries and mobile phones (Australian Government, 2003). Other economic instruments that have been incorporated into stewardship policy approaches, usually in combination with ARF's, are Landfill Levies (tipping fees), Recycling Subsidies, Recycling Investment Tax Credits and Material taxes (tax breaks that can be used to reduce the use of virgin materials in favour of recycled or less toxic materials) (OECD, 2001b), (NZBCSD, 2005), (Walls, 2006). However these economic instruments are not considered to be proper EPR instruments in themselves as they provide no incentives upstream to producers for Design for the Environment (Walls, 2006).

In addition, where the costs and responsibilities for waste are shared between the user and producer of the goods, the distribution of these costs needs consideration so that the costs do not fall unfairly on particular groups (PCE, 2006). When using economic instruments, conditions should be established to ensure that a significant degree of the physical and/or financial responsibility is allocated to the producer (OECD, 2001b). For instance if the consumer is required to pay an ADF to cover the additional costs for treating their product at its post-consumer phase, then the physical responsibility should be extended to the producer (OECD, 2001b).

2.6.4.4 Informational and Educational Instruments

Provision of accurate information is essential for decision-makers at all levels, so educational and informational instruments, although rarely used in isolation, are likely to support virtually every other type of policy instrument (Gunningham et al, 1996). Educational and informational instruments can take numerous forms including training workshops, advertising, toll-free help lines, eco-labeling and award schemes. Environmentally inappropriate behavior often arises simply from ignorance of viable alternatives (Gunningham et al, 1996).

2.6.4.5 Multiple Instrument Approaches

Few policy instruments are able in isolation to satisfy all of the EPR or product stewardship policy objectives, such as the internalisation of waste costs AND the provision of incentives upstream to producers to make design change (Walls, 2006). Tinbergen (1967) considers that as many policy instruments are needed as there are policy goals. An optimal strategy may utilize a mix of voluntary, price-based and regulatory instruments to provide dependability, plus a mix of motivational (economic) and informational instruments to close the gap between public and private interests (Gunningham, 1996). Given the diversity of products and their different characteristics, one type of program or measure is not applicable to all products, product categories or waste streams (EC Commission, 2007a). The precise mix of policy mechanisms that is likely to provide overall effectiveness will depend on the nature of the waste problem and the industry concerned, so that each scheme will be unique and tailored to individual products and waste situations (OECD, 2001b), (NZ MfE, 2005).

2.6.5 New Zealand's Approach to Product Stewardship and EPR

New Zealand legislation does not currently provide for the regulation of stewardship schemes, and to date there are no regulated government led product stewardship or EPR approaches operating in New Zealand (NZ MfE, 2005). Government supported used oil recovery and tyre tracking schemes and the 2004 - 2009 New Zealand Packaging Accord incorporate elements of product stewardship such as voluntary product take-back, voluntary recycling targets, voluntary tracking and voluntary design commitments (NZ MfE, 2005). There are also a handful of voluntary industry led EPR type initiatives such as those implemented by Vodaphone and Fisher & Paykel, some of which incorporate elements of product stewardship such as product take-back and voluntary industry levies (NZ MfE, 2005).

However New Zealand is actively seeking a solution to the management of priority wastes and stated their commitment to the adoption of a voluntary product stewardship policy approach in the Ministry for the Environment's 2005 Product Stewardship and Water Efficiency Labeling discussion document (NZ MfE, 2005). Stated objectives for product stewardship include increased resource efficiencies through a reduction in volumes of waste produced and greater recovery of resources (NZ MfE, 2005). This is to be achieved through broadening responsibility for end-of-life waste management, internalisation of the environmental costs of managing products/wastes consistent with the polluter pays principle, and the promotion of design changes to enhance resource efficiencies through greater resource recovery potential (NZ MfE, 2005). The Product Stewardship discussion document (2005) proposes four policy options for proceeding with product stewardship in New Zealand, the status quo, voluntary options, mandatory options, and the government's preferred option - a mix of voluntary and mandatory options (NZ MfE, 2005). According to submissions to the document, voluntary mechanisms are clearly preferred by industry, sector groups and councils (NZ MfE, 2006). However over half of the 130 submissions by stakeholders stated that non-participants to product stewardship schemes should be regulated, sharing the Government's preferred approach of a mix of voluntary and regulatory approaches (NZ MfE, 2006). However many of the submissions considered the government's proposed approach to be inadequate and therefore unlikely to be effective in achieving New Zealand's waste reduction, environmental or longer-term zero waste and sustainability objectives (NZ MfE, 2006).

In addition, the Waste Minimisation (Solids) Bill (2005), submitted by Green Party MP Nandor Tanczos as a private member's bill, is due back from the Local Government and Environment

Select Committee on March 1st 2008 (Tanczos, 2005), (Green Party, 2007). The bill proposes a mandatory approach be taken to specified categories of waste, by creating incentives to reduce the quantity of waste created at source, including the setting of targets and dates, in order to give full effect to principles of the New Zealand Waste Strategy (Tanczos, 2005). The Bill provides for mandatory extended producer responsibility (EPR) programmes for specified products, a landfill levy for all waste disposed of to landfill, phased in bans to landfill for specific materials, public procurement policies and the establishment of a dedicated Waste Minimisation Authority (Green Party, 2007). The Select Committee recently (18th September 2007) agreed upon amendments whereby the principle mechanisms of the Bill remain unchanged; but the methods and detail of their implementation and administration have been improved (Green Party, 2007).

The latest OECD (2007) Environmental Performance Review of New Zealand states that there is increasing public concern that New Zealand’s 'clean and green' image is waning. Also that New Zealand is much less regulated than many other OECD countries, and that economic and fiscal instruments (e.g. taxes, charges, deposit-refund programmes) are little used to internalise the external environmental costs of sectoral activities (OECD, 2007). The report suggests that New Zealand must increase regulatory support for recovery or recycling (including deposit-refund systems) of priority wastes such as end-of-life vehicles and electronic goods, building on the extended producer responsibility principle (OECD, 2007).

Hitchcock & Willard (2006, p72) state that "At its core, EPR is a fundamental shift in responsibility, one that many in industry have resisted." The inadequacy of New Zealand's response to priority wastes may be explained, at least partly, by a quote from a New Zealand Parliamentary Commissioner for the Environment (PCE) report. The report states that "MfE informed us that neither economic instruments nor regulation will be introduced by the Ministry to manage waste unless industry wants these policy tools to be used" (PCE, 2006, p44).

2.7 Product Stewardship and EPR Policy Approaches to Scrap Tyre Management

Approximately 800 million scrap tyres are disposed of around the globe every year (van Beukering & Janssen, 2001), with the number expected to increase by approximately 2 percent each year (UNCTAD, 1996). A high proportion of these tyres are landfilled, stockpiled or illegally dumped, posing a significant fire and toxic pollution risk, with human health implications and contributing to environmental pressures (UNEP, 2007a). See Appendix 1: Health and Environmental Characteristics of Tyres. In addition local authorities face major legal and enforcement costs associated with scrap tyre management (UNEP, 2007a). However end-of-life tyres (EOT's) embody valuable resource materials offering considerable materials recovery potential and considerable quantities of recoverable embodied energy (Weaver, 1996). The New Zealand Commissioner for the Environment (2006) describes used tyres as one example of an end-of-life product that is cheap to import into New Zealand, offers only short-term benefits to the consumer, cannot easily be reused or recycled, and soon creates long-term environmental costs.

2.7.1 Overview of EPR and Product Stewardship Approaches to Scrap Tyre Management Overseas

Countries that are moving, or have already moved towards a more sustainable economic scenario through the establishment of product stewardship or EPR type policy approaches for scrap tyres include the European Union, USA and Canada, Korea, Taiwan and Australia (The World Watch Institute, 2004), (Jessen, 2005). These are described in the following sections. Appendix 2: An Overview of Product Stewardship and EPR Policy Approaches to Used Tyre Management Implemented Overseas, provides additional data including producer responsibility organisations (PRO's) where relevant, the main instruments used, numbers of tyres generated and numbers collected and/or recovered.

2.7.1.1 European Union (EU)

European Union (EU) member states have led the way on producer responsibility legislation due to declining landfill capacity and EU members recognition of the importance of transferring the financial and operational burdens of managing waste systems to producers to stimulate DfE and achieve resource efficiencies (Hanisch, 2000). European environmental policies have also demonstrated a strong commitment to the Precautionary Principle and pollution prevention with the emergence of Integrated Product Policy (Hanisch, 2000). Tyre legislation in each European member country is shaped by European Community Directives, the Community Waste Strategy (COM (96) 339), the EC Thematic Strategy on the Prevention and Recycling of Waste (COM(2005)666), the Landfill Directive (1999/31/EC), the End-of-Life Vehicle (EOV) Directive (2000/53/EC) and the Incineration of Waste Directive (2000/76/EC). The Landfill Directive bans the landfilling of whole tyres from 2003 and shredded tyres by 2006 (Debo, 2005). An additional Directive (2006/12/EC) is a framework for coordinating and limiting the generation of waste within the Community, based on two complementary strategies - avoiding waste by improving product design and increasing the recycling and re-use of waste (EC Commission, 2006b).

Although the legislation sets the objectives to be met, it does not designate responsibilities (ETRMA, 2006). Individual countries have the freedom to implement the appropriate legislation (Shulman, 2000). Policy instruments commonly employed for collection and recovery include product take back schemes with recycling rate targets, advanced recycling fees (ARF) and a deposit refund scheme in Austria (Gertsakis et al, 2002), (Jessen, 2005). European countries follow three basic systems - Free Market, State Tax and Producer Responsibility systems (ETRMA, 2006). Under Free Market Systems, all the operators in the recovery chain contract under free market conditions and act in compliance with legislation, distributors dealing directly with the recycler of his choice on a free market basis (ETRMA, 2006). Free market systems may be backed up by voluntary cooperation between companies to promote best practices and are active in at least 12 countries - Austria, Bulgaria, Estonia, France, Germany, Greece, Ireland, Italy, Lithuania, Spain, Switzerland and the UK (ETRMA, 2006).

Under State Tax Systems recovery & recycling of tyres is financed by a tax levied on tyre (production) and subsequently passed onto the customer (ETRMA, 2006). Producers pay a tax to the government, which is responsible for the overall organization and remunerates operators in the recovery chain including recyclers (ETRMA, 2006). State tax systems are active in Denmark, Latvia, Slovak Republic and Slovenia (ETRMA, 2006). Producer Responsibility/ Product Take Back Systems mandate individual producer responsibility to producers (manufacturers and importers) for organising and funding take back and processing of end-of-life tyres (EOT's) (ETRMA, 2006). Producers contribute to a collective fund that finances a national operating company (recycling organization or PRO) to organise collection, recycling and recovery (ETRMA, 2006). Producer Responsibility/Take back systems are active in Belgium, Czech Republic, Finland, Hungary, Norway, Poland, Portugal, Romania and Sweden (ETRMA, 2006).

The End-of-Life Vehicle (EOV) Directive requires car manufacturers to take back and disassemble all end-of-life vehicles (ELV's), including the removal of tyres to ensure that they do not end up in landfills (Debo, 2005), (Ogushi & Kandlikar, 2007). The ELV Directive also provides incentives for Design for the Environment (DfE) by establishing targets for reuse, recycling and recovery for car and tyre manufacturers to be achieved by 2015 (Debo, 2005), (ETRMA, 2006), (Ogushi & Kandlikar, 2007). EU manufacturers that follow specific DfE guidelines receive a product certification label (Ogushi & Kandlikar, 2007).

2.7.1.2 USA

The approximately 280 million scrap tyres generated across the US in 2001 are managed in a variety of ways (Jessen, 2005). Thirty seven US states have legislation to ban whole tyres from landfills, 28 states require tyres to be quartered or shredded before landfilling and nine of those states have banned shredded tyres from landfills as well (Jessen, 2005). Some states operate a landfill levy (tipping fee), programs to remediate illegal stockpiles and/or provide tyre amnesty days (Jessen, 2005), (MPCA, 2007). Thirty five US states operate a waste tyre fee (ARF/ADF) on new tyres (Gertsakis et al, 2002), (Walls, 2006) and fourteen US states operate recycling subsidies where the state provides incentives for the purchase of tyre-derived products by state government agencies (Jessen, 2005). Most allow a 5 to 10 percent price preference for state purchases of tyre-derived products over virgin material counterparts (Jessen, 2005). The Rubber Manufacturers Association and the Tire Industry Association provide support to state and federal tyre management programs through information, workshops and other educational activities (Jessen, 2005).

2.7.1.3 Canada

Canada operates some of the most advanced tyre recycling schemes in the world (CATRA, 2007a), with every province except Ontario operating a mandatory deposit refund scheme or advanced recycling fee (ARF) for scrap tyres, with regional variations (Jessen, 2005). In each program a fee is payable on new tyres purchased, with the take back component of used tyres often undertaken voluntarily (Jessen, 2005). Five of the Canadian programs are managed by third-party organizations (PRO's), two (including British Columbia) are managed by government, and one program is under development in Ontario (Jessen, 2005). An estimated 195 direct and indirect jobs were created within the province as a result of British Columbia's Financial Incentives for Recycling Scrap Tires (FIRST) Programme (Jessen, 2005).

2.7.1.4 Japan

Tyre programs have been part of end-of-life vehicle (ELV) recycling regulations in Japan since 2003 (Ogushi & Kandlikar, 2007). The twin objectives of Japan's EPR approach are to shift the responsibility for end-of-life products (physically and/or financially) away from municipalities and upstream to the producer, and to provide incentives for producers to incorporate environmental considerations into product design (Ogushi & Kandlikar, 2007). Producer “take-back” legislation is central to the Japanese approach to EPR (Ogushi & Kandlikar, 2007). Design for the Environment (DfE) is encouraged through specific recovery targets, and through the provision of R & D funding for recycling and dismantling technologies and for recycled material applications (Ogushi & Kandlikar, 2007). An electronic manifest system is employed to track end-of-life vehicle (ELV) processing (Ogushi & Kandlikar, 2007).

2.7.1.5 Australia

Some Australian states have adopted voluntary product stewardship approaches for a variety of products (MfE, 2005). However New South Wales (NSW), which accounts for about 30 percent of the approximately 170,000 tonnes of end-of-life tyres (EOT's) generated each year in Australia, about half of which are disposed of to landfill, is the only state to have made any headway towards an EPR approach for tyres (WMAA, 2003).

2.7.1.6 New Zealand

Although New Zealand legislation does not currently provide for the regulation of product stewardship schemes, the Government has stated a commitment to the adoption of a mixed voluntary/regulatory product stewardship approach to tackle the problem of priority wastes (including tyres) in New Zealand (NZ MfE, 2005). Approximately 75 percent of the estimated three to four million end-of-life tyres (EOT's) generated annually in New Zealand are disposed of to landfill, with the remainder stockpiled or illegally dumped (URS, 2006), (NZ MfE, 2006). Since July 2004, the New Zealand tyre industry have operated Tyre Track, a voluntary product take-back scheme supported by the Ministry (provision of a code of practice for participants), the Motor Trade Association (MTA) (administration), the Imported Motor Vehicles Association and others (NZ MfE, 2006). Tyre Track is a national tracking system, linking tyre dealers with registered transporters and registered end-points (recyclers, approved storage and sanitary landfills) and monitoring tyre movements (NZ MfE, 2006). The introduction of Tyre Track was accompanied by a communication campaign to dealers, transporters, recyclers and the public (NZ MfE, 2006). However the scheme contains no more than a few elements of stewardship principles (NZ MfE, 2005). The scheme tracks used tyres and disposal options as a precursor to a proposed future product stewardship scheme such as an industry levy, but does not set recycling rate targets (K. Karavias, 7th November 2006, personal communication). The Ministry acknowledges that although many companies are signing up to Tyre Track, they are still unwilling to charge disposal fees that are out of line with competitors, and that there is still resistance to the cost of shredding (NZ MfE, 2005). Bridgestone, one of only two New Zealand tyre manufacturers, state in their submission to the government's product stewardship proposals that the current voluntary approach to tyres (Tyre Track) is not efficient or effective and does not adequately address the issue of free-riders, especially those importing low-cost tyres (NZ MfE, 2006).

2.7.2 Key Objectives of EPR and Product Stewardship Approaches to Scrap Tyre Management

Used Tyre Management can be defined as the administration of activities that provide for the collection, storage, transportation, transfer, reuse, recycling, re-processing and disposal of scrap tyres (the author). Jessen (2005) describes the goals of managing tyres as to reduce waste through the maximisation of tyre recovery (collection and return to processor), the development of waste tyre markets and the internalisation of responsibilities. According to Weaver (1996) the goals of public policy for end-of-life tyre management are to eliminate the landfilling of tyres, to recover valuable resources, to increase tyre life and to increase tyre recycling. However the key point is to make the manufacturer (or designated agent) responsible for taking back the tyre at the end of its useful life (Weaver, 1996). The European Tyre and Rubber Manufacturing Association describes the ultimate objectives of a producer responsibility approach to EOT management as a 100% recovery rate of annual arisings plus the progressive elimination of historic stockpiles (ETRMA, 2006). The goals of California's product stewardship approach to waste tyre management are to reach an agreement among government officials, manufacturers, retailers, environmental groups, tyre recyclers and other participants that will result in fewer waste tyres, the efficient collection, reuse, and recycling of waste tyres, increased and sustained waste tyre markets, maximum value from waste tyres and fewer waste tyres going to landfill (Jessen, 2005). EPR approaches to used tyre management in Japan and in the EU also include the provision of incentives for producers to pursue Design for the Environment objectives (Ogushi & Kandlikar, 2007). These objectives are summarised in Figure 2.6: Key Objectives of Product Stewardship and EPR Approaches to Used Tyre Management.

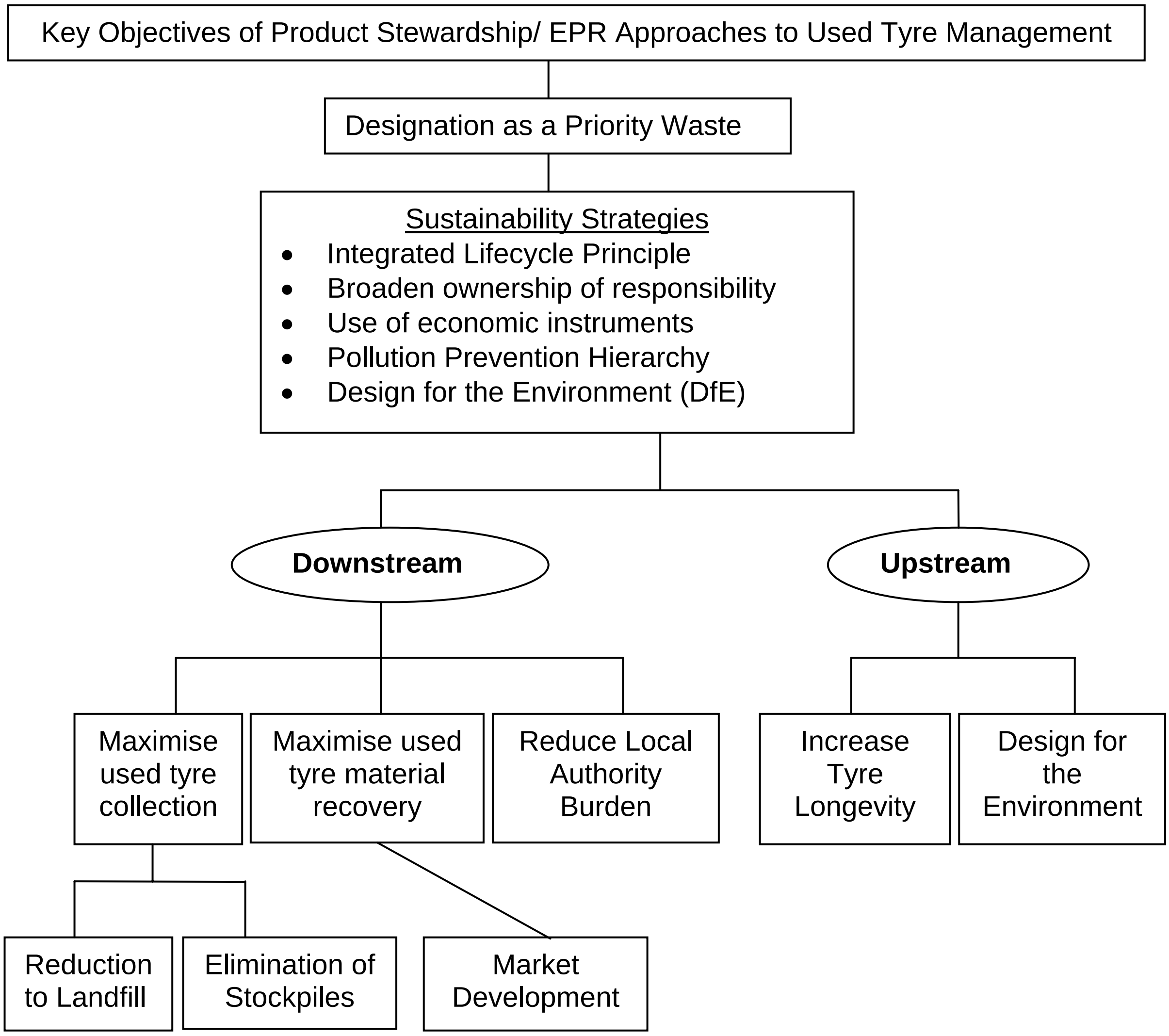


Figure 2.6: Key Objectives of Product Stewardship and EPR Approaches to Used Tyre Management

2.7.2.1 Designation of Used Tyres as Special (or Priority) Wastes

A pre-requisite for the establishment an EPR or product stewardship scrap tyre management program is a formal agreement to segregate the specified designated waste (i.e. tyres) from the waste stream for an alternative and/or more appropriate management strategy. Scrap tyres are typical of many special (or priority) wastes in that they present disposal difficulties, contribute to environmental pressures, have human health implications, add to visual pollution, are an externality problem and represent both an inefficient use of resources and public funds (OECD, 2001b), (NZ MfE, 2005), (URS, 2006).

2.7.3 Incorporation of Sustainability Strategies

The following sections describe how each of the identified sustainability strategies i.e. Integrated Lifecycle Approach, Broaden Ownership of Responsibility, Use of Economic Instruments, Design for the Environment and the Pollution Prevention Hierarchy are incorporated into Product Stewardship and EPR policy approaches to used tyre management.

2.7.3.1 Incorporation of an Integrated Lifecycle Approach

The physical, environmental and economic characteristics of tyres are significant at all lifecycle stages from the mining of resources, production (e.g. energy use or hazardous waste), use (e.g. generation of noise, energy efficiency of vehicles or rubber loss), through to collection, processing and disposal (van Beukering & Janssen, 2001), (URS, 2006). Thus, there are numerous opportunities to ensure that key players accept responsibility for the achievement of specific tyre management objectives at key points throughout the tyre lifecycle (URS, 2006).

The tyre lifecycle traditionally comprises five main stages (Nicoletti and Notarnicola, 1999), including extraction, production, consumption, collection of used tyres and solid waste management (SWM) (van Beukering & Janssen, 2001). Figure 2.7: Product Lifecycle of a Tyre in New Zealand, indicates tyre lifecycle components and the responsibilities of key stakeholders within each component. 'Upstream' components include extraction, production and importation, distribution and use (consumption) (URS, 2006). 'Downstream' components include collection (of used tyres), processing and recycling (material recovery) and final disposal (URS, 2006). A distinction must be made between the components of the tyre lifecycle that occur within the country in question, i.e. those that can be influenced by a country's product stewardship policy approach, and those that occur overseas and are therefore effectively outside the realm of influence of a country's policy (URS, 2006).

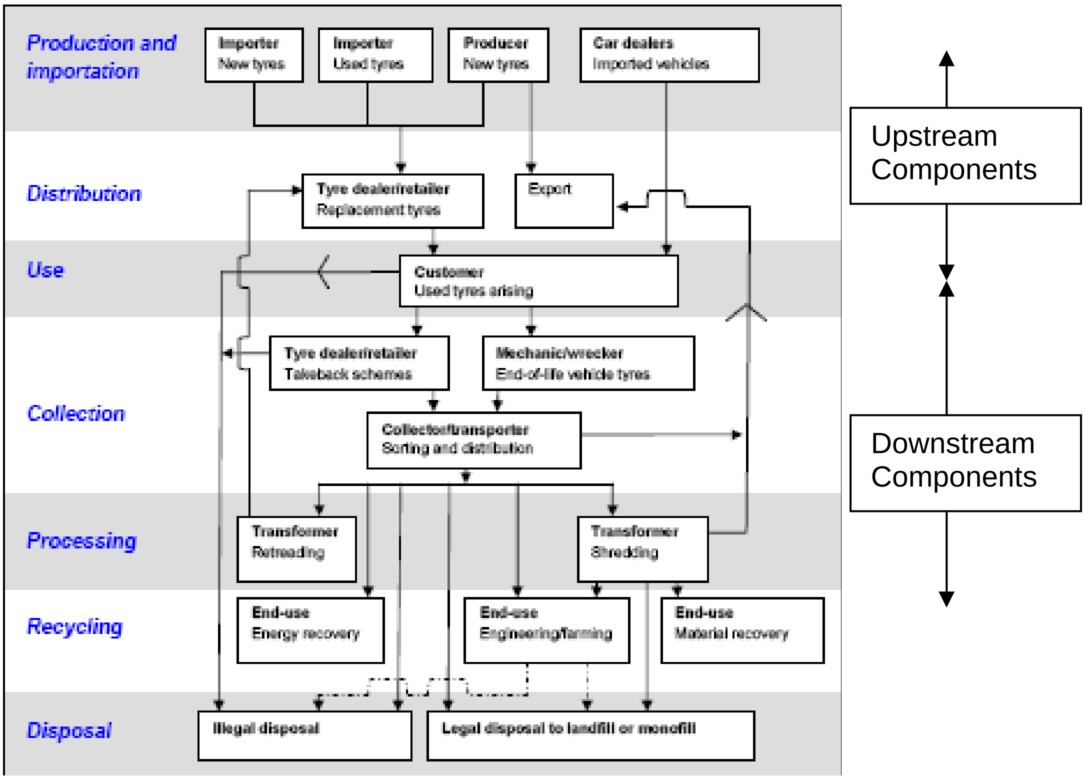


Figure 2.7: Product Life Cycle of a Tyre in New Zealand (URS, 2006).

2.7.3.2 Incorporation of the Broaden Ownership of Responsibility Sustainability Strategy

Hanisch (2000) describes how EPR (stewardship) approaches are based on the principle that all actors along the product chain share responsibility for the lifecycle environmental impacts of the whole product system. This includes upstream impacts inherent in the selection of materials for products, impacts from manufacturers' production processes and downstream impacts from use and disposal of products (Hanisch, 2000). Most products, including tyres, comprise a range of economic players managing the process, each exercising control over a part of the production process, distribution, product use and end-of-life processes (ETRMA, 2006). The tyre industry believes that responsibility for waste management must be shared equally by economic operators and other stakeholders (ETRMA, 2006).

Responsibilities are generally divided into physical responsibility i.e. to manage the waste tyre from generation through its end-of-life management, and financial responsibility, involving who pays the management costs, how they are collected, what they are used to fund and how it is disbursed (Jessen, 2005). There is also program management responsibility which involves setting goals, evaluating performance, planning and providing overall leadership

(Jessen, 2005). The exact nature of this 'shared' aspect of responsibility is at the heart of product stewardship negotiations (Jessen, 2005). Jessen (2005) uses the term 'internalisation of responsibilities', defined as to ensure that key players accept responsibility for the achievement of specific tyre management objectives at key points throughout the tyre's life cycle, in order to describe the Broaden Ownership of Responsibility concept.

2.7.3.3 Incorporation of Economic Instruments

The use of economic instruments to internalise waste management costs, reduce local authority burden, provide incentives for design for the Environment and fund program operation, is a core characteristic of EPR policy approaches (OECD, 2005), (Walls, 2006), (EC Commission, 2007a). Jessen (2005) states that the existence of a financing system that can sustain the management of waste tyres is a critical component of a successful program, fuelling all current efforts to manage waste tyres. The achievement of tyre management objectives, and the development of sustainable markets for end-of-life tyres is likely to require the provision of economic, regulatory and informational incentives to all stakeholders, plus the setting of measurable goals for market development (Jessen, 2005).

The financing systems most commonly used to finance collection, transportation and recycling activities are waste tyre levies (ARF/ADF's) and deposit refund schemes (Houghton et al, 2004), (Jessen, 2005). In waste tyre levy/benefit schemes an advanced disposal fee (ADF) or advanced recycling fee (ARF) ('waste tire fees' in the US), is imposed on manufacturers and importers of tyres to cover recovery costs (Houghton et al, 2004), (Jessen, 2005). The tax or charge may also be levied at the time a product is sold, at a level intended to reflect the end-of-life waste management costs of the product (OECD, 2005). The fees collected are then used to fund programs targeted at end-of-life issues for waste tyres (Houghton et al, 2004). These may include benefits paid to recyclers or re-users of waste tyres and/or those involved in the collection and transportation of waste tyres, or to fund programs such as education, research and development and marketing (Houghton et al, 2004).

Thirty-five US states have enacted waste tyre fees (ARF's) to pay for the costs of tyre management programs. However in recognition of the negative value of tyres, the need for levies to supply industry with incentives to recycle scrap tyres, plus the need to clean up tyre piles, levies have been increased (Gertsakis et al, 2002), (Jessen, 2005), (MTSB, 2007b). A levy benefit scheme can be part of a voluntary industry scheme (Free Market scheme) or part of a mandatory scheme supported by government legislation (ETRMA, 2006). Or alternatively a quasi-mandatory scheme whereby a voluntary industry scheme is backed up by legislation to capture those who choose not to participate in the industry voluntary scheme (freeriders) (OECD, 2005).

2.7.3.4 Incorporation of Design for the Environment (DfE)

Environmental impacts are substantially determined at the point of design, where key choices are made on materials, processing and finishing technology etc, that is with the producer (Gertsakis et al, 2002). A core characteristic of EPR is that in placing some responsibility for a product's end-of-life environmental impacts on the original producer, EPR provides incentives for fundamental design (DfE) changes in products or product systems that lead to overall improvements in their environmental qualities (Lindhqvist, 2000), (OECD, 2001b), (Ritchey & Stenstrom, 2004), (Walls, 2006), (EC Commission, 2007b). DfE targets environmental improvement by eliminating hazardous materials, eliminating the environmental and economic costs for end-of-life management requirements and optimising opportunities for material recovery at the end of a product's useful life (Brady et al, 2003). The intent is to provide incentives for producers to make design changes that would factor tyre longevity and materials recovery/ reuse potential into the choice of materials and product design (Weaver, 1996).

A disadvantage of the use of ADF or ARF's alone in a policy approach is that they may not provide any incentives for DfE for producers (OECD, 2005). Producers may be responsible for collecting the charge and remitting it to the public authorities, but may not otherwise be involved in the collection or disposal of wastes (OECD, 2005). To provide an incentive for innovation in product or process design to facilitate material reduction or greater recycled content, ADFs need to be performance based for example through the inclusion of recycling rate targets (Australian Government, 2003), (Lindhqvist & Lifset, 2003), (Jessen, 2005). Incentives for DfE can also be lost if fees are the same for all products of a particular type, i.e. do not distinguish between products which will be costly to manage as waste and competing products which have been designed so that waste management is less costly (Lindhqvist & Lifset, 2003), (OECD, 2005). Where the ADF is based on per unit sold, and applies equally to all producers/importers (regardless of inherent properties), the individual producer does not benefit directly from product design improvements (Lindhqvist & van Rossem, undated), (Lindhqvist & Lifset, 2003). Thus where benefits are shared by all producers irrespective of individual efforts, there are no incentives for producers to design products to reduce end-of-life (EOL) costs (Lindhqvist & van Rossem, undated), (Lindhqvist & Lifset, 2003). To be effective, charges levied on companies or PRO's must be related to sales volume or market share so that producers are responsible for their own products (Lindhqvist & Lifset, 2003), (Castell et al, 2004), (OECD, 2005). Performance could also be linked to producers' downstream management of products entering the waste stream (e.g. supporting reuse or recycling) (Australian Government, 2003), (Lindhqvist & Lifset, 2003).

Knight et al (2006) and the OECD (2005) state that while product design changes may be driven by the subtle shift of end-of-life responsibility to producers, the blunt instruments of mandated recycling rates and material bans account for much of the attention to product redesign that has resulted from certain EPR programs. EPR regulations within the EU are intended to create incentives for manufacturers to follow specific DfE guidelines so that they engage in increased design for disassembly, reuse and recycling (Ogushi & Kandlikar, 2007). In Japan, explicit DfE guidelines do not exist however manufacturers incorporate DfE as part of their plan to meet specific recovery targets (Ogushi & Kandlikar, 2007). Jessen (2005) describes how under British Columbia's Financial Incentives for Recycling Scrap Tires (FIRST) product stewardship program, there are no incentives provided to tyre manufacturers to make design changes as the tyre industry, manufacturers and importers are completely external to the scheme.

2.7.3.5 Incorporation of the Pollution Prevention Hierarchy

Few direct references were found within the tyre management program literature regarding incorporation of the Pollution Prevention Hierarchy, however Weaver (1996) and Jessen (2005) endorse the waste hierarchy as the key principle for the environmentally sound management of tyres.

2.7.4 Pollution Prevention Opportunities within the Downstream Tyre Lifecycle Components

'Downstream' (end-of-life) lifecycle components include the collection (of used tyres), processing and recycling (material recovery) and final disposal (URS, 2006). Thus the key Product stewardship and EPR objectives for used tyre management within the downstream tyre lifecycle components can be described as to Maximise Collection, Maximise Material

Recovery and Final Disposal. The following sections describe the opportunities for pollution prevention that are potentially achievable through achievement of each of these objectives within the downstream lifecycle components.

2.7.4.1 Maximize Used Tyre Collection Objective

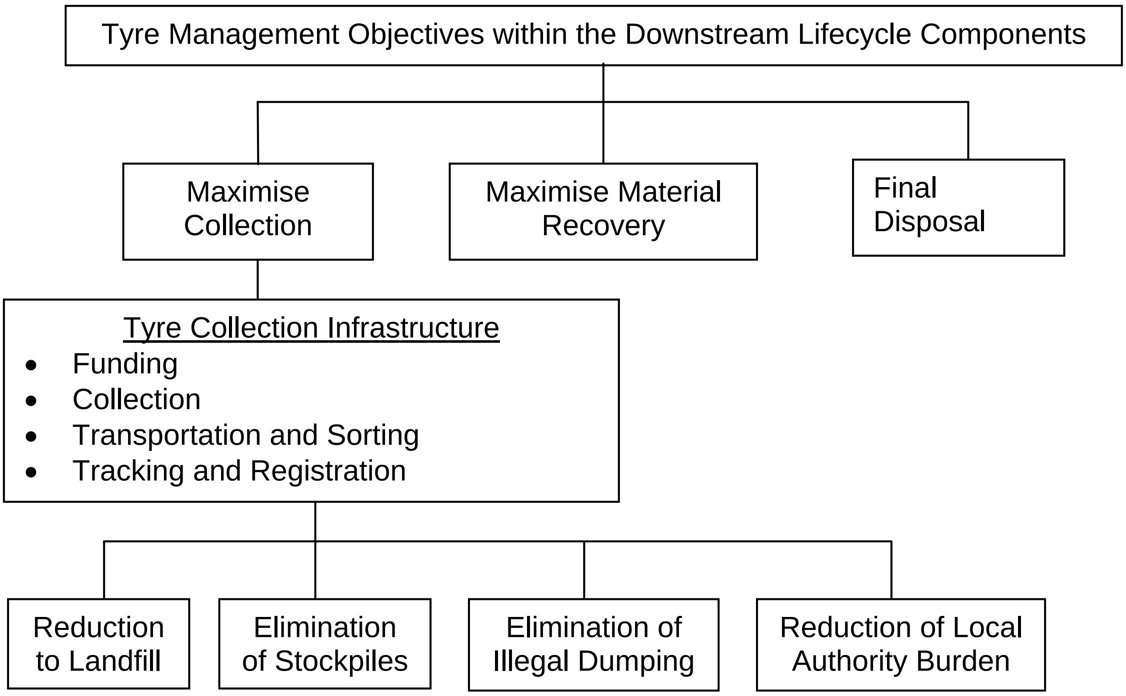


Figure 2.8: Tyre Management Objectives within the 'Collection' downstream Tyre Lifecycle Component

Collection is considered a separate stage within the tyre lifecycle (van Beukering & Janssen, 2001). Within the 'collection' lifecycle component, the 'Maximise Collection' objective can be defined as to maximize the collection of scrap tyres diverted from landfill and other methods of storage and disposal, including illegal dumping, that are likely to result in adverse environmental impacts for return to processor (Jessen, 2005). Figure 2.8 illustrates the tyre management objectives within the 'Collection' downstream tyre lifecycle component. Development of Tyre Collection Infrastructure is a pre-requisite for the achievement of the further tyre management objectives of Reduction to Landfill, Elimination of Stockpiles, Elimination of Illegal Dumping and Reduction of Local Authority Burden.

Tyre Collection Infrastructure

Diversion from landfill is promoted through the development of a convenient used tyre collection infrastructure (BridgestoneAmericas, 2007). To fulfill the maximise collection objective for used tyres a 'collection infrastructure' must be in place for issues such as Funding, Collection, Transportation and Sorting, and for Registration and Tracking.

Funding

The existence of a financing system that can sustain the management of waste tyres is a critical component of a successful program, fuelling all current efforts to manage waste tyres (Jessen, 2005). Funding systems such as Advanced Recycling Fees (ARF) and deposit refund schemes have been described under Use of Economic Instruments.

Collection

For any stewardship program to be cost-effective it needs to provide incentives, directly or indirectly, for consumers to return products for recycling (PCE, 2006). Policy instruments commonly employed to encourage the producer and/or retailer to take back the product from the consumer after use are Product Take Back Schemes, employed voluntarily or on a more mandatory basis through regulation (Gertsakis et al, 2002), (Jessen, 2005). Product Take Back Schemes are often used in combination with recycling rate targets, advanced recycling fees (ARF) and deposit-refund schemes (Jessen, 2005).

Transportation and Sorting

UNEP (2007a) technical guidelines on environmentally sound tyre management state that collecting, transporting and sorting of tyres are important phases in the management process. Tyres require sorting according to their recovery potential. A part-worn tyre is defined as a tyre which is reusable for its original purpose i.e. as a second hand purchase or re-usable for reprocessing (retreading) (ETRMA, 2007). A scrap tyre is defined as a tyre that is no longer suitable for its original intended purpose because of wear, damage or defect (Marbek, 2006). Scrap tyres are potentially retreadable and are therefore distinguishable from an end-of-life tyre (EOT) which is defined as a tyre which has suffered permanent damage to its structure and is no longer suitable for retreading (UNEP, 2007a). An end-of-life tyre is a tyre that is non-reusable in its original form and that enters the waste management stream as based on product/material recycling, energy recovery or final disposal to landfill (ETRMA, 2007).

Transportation of used tyres from the various sources of generation to facilities for sorting requires logistics and planning, and represents an additional burden in terms of costs, taking into account the diversity of points where these tyres are generated and distances between the points of collection and sorting (UNEP, 2007a). Safety during transportation is another factor that needs to be taken into account, requiring rules for storing and packaging (UNEP, 2007a). Sorting (for reuse, recycling or processing) requires the availability of covered facilities and a specialized workforce (UNEP, 2007a).

Registration and Tracking

Registration and tracking systems provide traceability in order to prevent stockpiling and illegal dumping. A key to effectiveness at the collection stage is 'traceability,' which involves the registration of tyre dealers, collectors and transporters and the provision of a Code of Practice to ensure that key players act responsibly (Tyre Track NZ, 2004).

Also central to the function of stewardship programs is the establishment of producer responsibility organisations (PRO's) to handle collection and recycling and to ensure that targets are met (Walls, 2006). Collection infrastructure is essential for achievement of the tyre management objectives within the collection lifecycle component i.e. Reduction to Landfill, Elimination of Stockpiles, Elimination of Illegal Dumping and Reduction of Local Authority Burden.

Reduction to Landfill, Elimination of Stockpiles and Elimination of Illegal Dumping Objectives

Landfill bans are regulatory policy instruments that have been widely employed to both reduce waste to landfill and maximize the used tyre collection objective. In the European Union whole tyres have been banned from landfills since 2003 and shredded tyres are banned from July 2006 (URS, 2006). Thirty-seven US states ban or restrict the disposal of tyres to landfill (NWPSC, 2007). Other landfill regulations include Landfill levies, an economic instrument that in addition to acting as an economic disincentive to landfilling, can also be used as a source of collective funds to finance collection and recycling activities (Jessen, 2005). However, an unintended consequence of bans or charges on waste disposal is that they may encourage illegal dumping (Walls, 2006). Diversion from landfill is also promoted through the development of convenient used tyre collection infrastructure in conjunction with the development of markets for alternative uses (BridgestoneAmericas, 2007). As the markets for recycled tyres grow, fewer and fewer tyres end up in landfills (BridgestoneAmericas, 2007). Many countries, including the European Union, have introduced legislation to deal with historic stockpiles (existing illegally dumped and stockpiled tyres) (ETRMA, 2006). Program targets usually measure 'recovery rate' in terms of the percentage or number of tyres recovered from the waste streams, stockpiles or diverted from landfill (Jessen, 2005). Success within the maximise collection objective contributes to the overall objective of pollution prevention as reductions of used tyres to landfill, and elimination of the stockpiling and illegal dumping of used tyres results in a reduction of their harmful environmental impacts.

Reduction of Local Authority Burden Objective

The Reduction of Local Authority Burden objective can be defined as to reduce the physical, financial and/or administrative burden of waste management (i.e. collection, disposal and recycling of waste products) that fall otherwise to local authorities and society at large. Scrap tyres represent a financial cost to local authorities whether disposed of legally to landfill, stockpiled or illegally dumped (URS, 2006). Agenda 21 describes how the exhaustion of traditional disposal sites, stricter environmental controls governing waste disposal and increasing quantities of more persistent wastes, particularly in industrialized countries, have all contributed to a rapid increase in the cost of waste disposal services (UNCED, 1992). At the core of Product Stewardship and EPR is the shifting of responsibility (physical and/or economically, fully or partially), upstream and away from municipalities (OECD, 2001b), (Gertsakis et al, 2002), (Hitchcock & Willard, 2006). Product stewardship and EPR policy approaches transfer the burden of waste management away from municipalities and towards alternative stakeholders. This is achieved through the incorporation of the Broadening Ownership of Responsibilities sustainability strategy.

2.7.4.2 Maximise Resource Recovery Objective

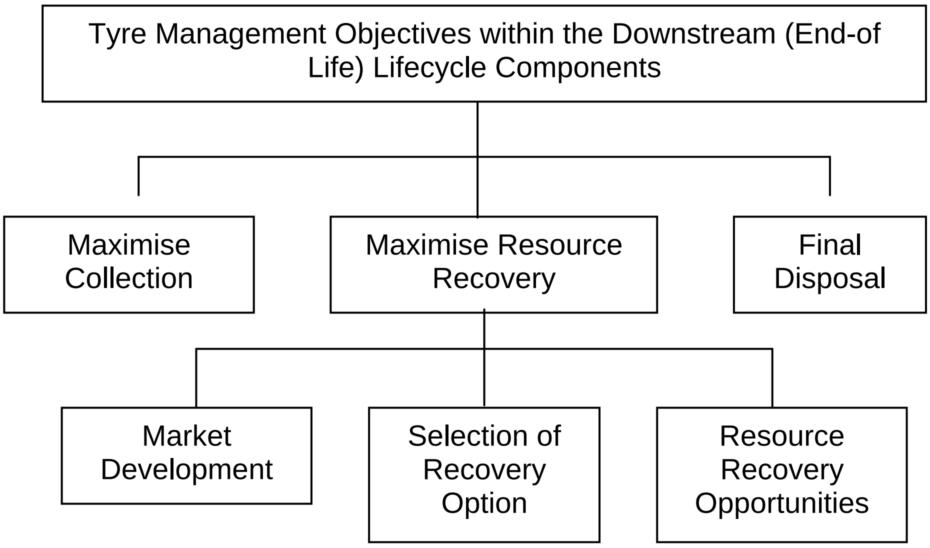


Figure 2.9: Tyre Management Objectives within the 'Recovery' downstream Tyre Lifecycle Component

The second tyre management objective within the downstream tyre lifecycle component, is the Maximise Resource Recovery Objective, defined as to maximise the extraction of useful energy or materials from waste (OECD, 2002). This objective includes the goals of Market Development (development of waste tyre markets), Selection of Recovery Option and Resource Recovery Opportunities, as illustrated in Figure 2.9. Key stakeholders at the recovery stage of the tyre lifecycle include retreaders, reprocessors and recyclers.

Market Development Objective

Jessen (2005) defines the development of waste tyre markets (market development) as to maximise the quantity, value and opportunities for reused, re-cycled and re-processed tyre material to be marketed for further uses. Agenda 21 states that it is important that markets for products from reclaimed materials be identified in the development of reuse and recycling programmes (UNCED, 1992). Governments and industry must seek new processing applications and technologies to provide for the environmental sound disposal of used and scrap tyres (UNEP, 2007a).

End-of-life tyres (EOT's) embody valuable resource materials, offering considerable materials recovery potential in the form of elastomers and oils, metals, carbon black and sulphur compounds that can substitute for virgin materials, in addition to considerable quantities of recoverable embodied energy (Weaver, 1996). However a lack of viable markets, materials recovery operations and good networks of tyre collectors, plus increased regulations at all levels continue to hamper further market development (ETRMA, 2006). The economic viability of many emerging opportunities is also hampered by management and process costs exceeding the inherent value in the waste material, and hence the prices obtained for by-products (Jessen, 2005), (ETRMA, 2006). Thus funding is required to properly manage waste tyres, prime the market for recycled tyre products and conduct demonstration projects and technical research (Jessen, 2005). Market development requires the development of value-added markets for waste tyres so that no extra funds are needed to manage the product (Jessen, 2005). To improve the marketability of technically recyclable waste (tyre reuse and recycling) requires the provision of economic, regulatory and informational incentives to all stakeholders, plus the setting of measurable goals for market development (UNCED, 1992), (Jessen, 2005).

Regulatory incentives to encourage market development include the development of recycling and recovery targets, such as those included under the European Community End-of-Life Vehicle (EOV) Directive (2000/53/EC), which establishes targets for reuse, recycling and recovery for car and tyre manufacturers to be achieved by 2015 (Debo, 2005). Government procurement (purchasing) policies also signal clear guidance to the market, influencing corporate decisions and public perceptions (UNCED, 1992), (NZBCSD, 2005). Informational incentives include investment in Research & Development, plus the establishment of industry standards to increase the credibility of end-of-life tyre (EOT) applications (ETRMA, 2006). Promotion of the development of sustainable and diversified crumb rubber markets is also required, through the provision of financial incentives to increase the demand for recycled rubber (Jessen, 2005). Furthermore, the role and commitment of a national consortium (PRO) to drive the search for new and innovative initiatives and strategies to address EOT management is crucial (ETRMA, 2006). An appropriately designed EPR programme could encourage producers to reduce their use of virgin resources, and to make greater use of recycled materials, where there is a social case for doing so (OECD, 2005).

Selection of Recovery Option Objective

The Selection of Recovery Option objective can be defined as selecting and prioritising, from a range of alternative opportunities, those products and applications that clearly demonstrate that they constitute value-added products, are environmentally sustainable and commercially viable (UNEP, 2007a). From an eco-efficiency perspective, it is critical to seriously consider the alternative uses for EOT's (URS, 2006). Weaver (1996) and Jessen (2005) endorse the waste hierarchy as the key principle for the environmentally sound management of tyres.

Jessen (2005) states that the most efficient tyre management options in terms of energy and material efficiency for the recovery of resources are reduce, reuse, retread, recycling into other products (including civil engineering applications), tyre-derived fuel and chipped-tyre fuel (energy value from combustion) then proper disposal. Weaver (1996) states that materials would be 'cascaded down' a hierarchy of economic uses i.e. re-used several times, each time maximising the materials efficiency of recycling and optimising the materials/application match. At the end of the cascade, there would be a final destructive/re-constructive stage (incineration) for energy and basic materials recovery with minimum environmental disturbance (Weaver, 1996).

The Guide on the Best Available Techniques and Best Environmental Practices (BAT/BEP), describes the pros and cons of the various alternative options for the sound environmental management of scrap tyres (UNEP, 2007a). Any form of disposal will generate impacts so each country should evaluate which alternative is the most viable according their own realities (UNEP, 2007a). It is appropriate to say that, at this time, there is no safe and long lasting solution for the disposal of the large volume of scrap tyres that is being generated worldwide. The management of used tyres is a challenge that still requires considerable research and investment (UNEP, 2007b). Whether diverted resources are returned to the producer for reuse, or recycled into new products, real markets must exist which are both cost-effective and resource efficient (Jessen, 2005). For this reason, Jessen (2005) and the NZBCSD (2005) suggest conducting life cycle assessments (LCA) for different options in order to make a comparison among different market opportunities regarding resource efficiency, environmental impact and cost-effectiveness. Extensive research into the management and monitoring of EOT technologies is required, including Life Cycle Analysis of relative environmental impacts, prior to full commercialisation (ETRMA, 2006). Use of LCA can help increase the acceptance of a programme and lead to a products' environmental optimisation (OECD, 2001a). An LCA performed on behalf of the Swedish Tyre Recycling Association measured the environmental performance of six alternative scenarios for tyre material and/or energy recovery according to a wide range of parameters. The LCA concluded that the utilisation of used tyres was environmentally beneficial compared to the use of 'virgin' raw materials for all scenarios (SDAB, 2004).

Resource Recovery Opportunities

The resource recovery opportunities objective is the identification of all product management options that represent an opportunity for pollution prevention according to the Pollution Prevention Hierarchy, i.e. reduce, reuse, retread, recycling, energy recovery and proper disposal (the author). As an objective within the downstream (end-of-life) tyre lifecycle components, all Resource Recovery objectives reflect opportunities for the recovery of resources from tyres that have already been generated. Thus there are no opportunities to reduce the numbers of tyres generated within this objective and hence there are no opportunities at the 'reduction' level of the Pollution Prevention Hierarchy. Figure 2.10 illustrates some of the tyre resource and energy recovery opportunities that have been identified within the literature.

Reuse of Part Worn Tyres

Reuse opportunities include the re-sale and retreading of part worn tyres. A part-worn tyre is defined as a tyre which is reusable for its original purpose i.e. as a second hand purchase or re-usable for reprocessing (retreading) (ETRMA, 2007). Some countries allow used tyres to be reused as partly worn for their original purpose, however there are risks involved as these tyres could have originated from vehicles involved in accidents, damaged by potholes and obstacles, used without the appropriate pressure calibration or incorrectly repaired (UNEP, 2007a). In Europe 11 percent of used tyres that can be reused for their original purpose are reused locally or exported (ETRMA, 2006). The United Kingdom has enacted legislation to cover the sale and distribution of used tyres as part of its “Motor Vehicle Tyres Safety Regulations” (1994) (UNEP, 2007b). Currently studies are being undertaken to equip tyres with an electronic chip, a Radio Frequency Identification Device (RFID), to record information about their conditions of use. If their efficiency can be proven, RFID may provide a means to identify the appropriate conditions for the re-use of used tyres (UNEP, 2007a).

Part worn tyres may also be suitable for retreading. Retreading is the process of replacing the worn rubber outer layer of a tyre with a new rubber layer, saving up to 80 percent of the material costs, yet lasting just as long (Debo, 2005), (NWPSC, 2007). It takes around twenty-two gallons of crude oil, along with steel and natural rubber to make a new tyre (NWPSC, 2007). Retreading requires only one third the petroleum products of a new tyre (NWPSC, 2007), saving about 400 million gallons of oil each year in North America alone (BridgestoneAmericas, 2007). Manufacturing of new tyres is the most environmentally intensive method of production, energy consumption, for example is fifteen times higher than for retreading (Rosendorfova´ et al., 1998). In America, truck tyres are often retreaded several times, keeping hundreds of thousands of truck and bus tyres on the roads and out of landfills (BridgestoneAmericas, 2007). Current technologies allow quality, dependability & performance comparable with new tyres, and retreads can be sold for 30 to 50 percent less than new tyres (Debo, 2005). Retreading is environmentally & economically beneficial because it increases the useful life of tyres, postponing their disposal as waste (Debo, 2005), (UNEP, 2007a).

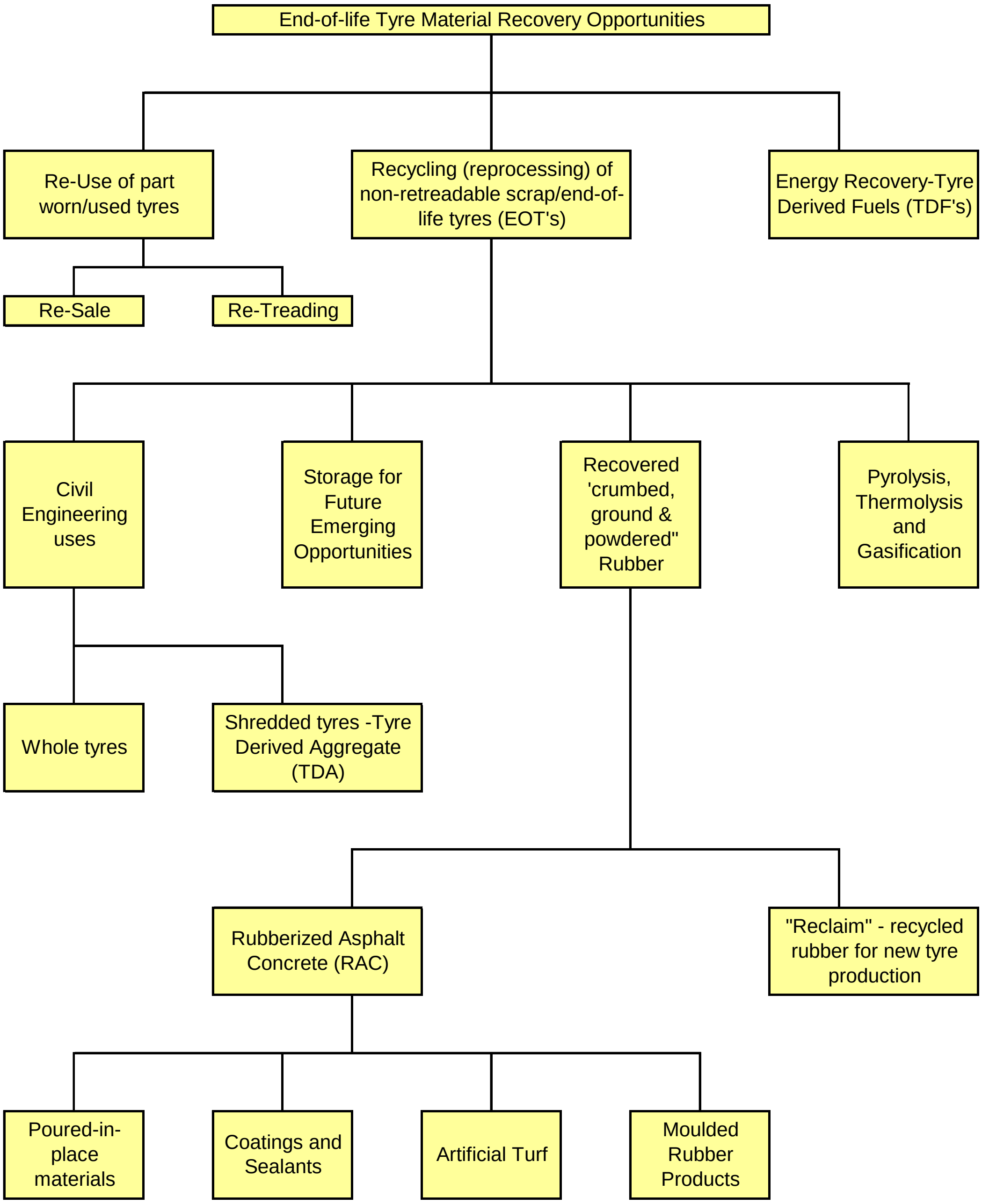


Figure 2.10: Tyre Resource Recovery Opportunities

In spite of the technological capabilities, passenger tyre retread markets are however declining for several reasons (Debo, 2005). One is a 'perceptual' problem in that retreads have a reputation of bad or at least variable quality, encouraging a preference for new tyres despite the lower cost of retreads (Debo, 2005). To overcome this problem, EU member states agreed in 2006 to incorporate United Nations Economic Commission for Europe (UNECE) regulations into EU law so that recycled tyres fulfill similar standards of safety and quality control as new tyres (URS, 2006). The World Business Council have endorsed this decision in providing legal certainty (URS, 2006). In addition, education programmes can be employed to help overcome perceptions related to inferior quality of recycled content and retreaded tyres (Jessen, 2005). There is however less reliability and higher sorting costs associated with the collection of passenger tyres relative to truck tyres for retreading (Debo, 2005). In addition, the labour costs of retreading are high therefore it is harder to compete with cheaper imported "budget" tyres, which also usually have a lower level of retreadability, and therefore further exacerbate retreadable casings supply problems (Debo, 2005). There may also be legislative barriers to the use of retread tyres in some countries (Debo, 2005). The main negative environmental impact of retreading is the health damage to workers resulting from volatile organic compound (VOC) emissions (van Beukering & Janssen, 2001).

Recycling of Non-Retreadable 'End-of-Life' (Scrap) Tyres

A scrap tyre is defined as a tyre that is no longer suitable for its original intended purpose because of wear, damage or defect (Marbek, 2006). A scrap tyre is synonymous with an end-of-life tyre (EOT), which is defined as a tyre which has suffered permanent damage to its structure and is no longer suitable for retreading (UNEP, 2007a). Scrap tyres (EOT's) do not have the technical conditions necessary for retreading, but can be transformed through physical, chemical or biological processes (recycling, reprocessing or energy recovery) into a new product or raw material to be used as input for applications other than their original use (UNEP, 2007a).

Tyre recycling is defined as any process by which post-consumer tyres or materials derived from post-consumer tyres are converted back into the original material (UNEP, 2007a). There are three main markets for scrap tyres - engineering (whole or shredded), rubber recovery and energy recovery (Tyre Derived Fuels) (Debo, 2005). Limited quantities of whole used tyres can be used in a variety of engineering applications including coastal protection, erosion barriers, artificial reefs, breakwaters, docks, avalanche shelters, slope stabilisation, retaining walls, road embankments, landfill construction, course arenas, playgrounds, sound barriers, insulation and farming applications (ETRMA, 2006), (Marbek, 2006). Tyre shredding or mechanical grinding to different grades (from 25 - 300 mm) makes the tyre rubber viable for numerous further applications (UNEP, 2007a). As a lightweight fill material, tyre shred (Tyre Derived Aggregate (TDA)) can be substituted for traditional civil engineering materials such as aggregate, stone, sand or gravel for draining in septic fields and landfill construction, foundation for roads and railways, backfill for walls, embankments and bridges (Jessen, 2005), (ETRMA, 2006). TDA even has advantages over many traditional civil engineering materials in that it is lighter by 30 to 50 percent, drains 10 percent better than well graded soil and provides 8 times better insulation than gravel (ETRMA, 2006). However tyre grinding is highly costly, energy intensive and generates dust and noise, costs that must be considered when calculating the final cost of the application (UNEP, 2007a).

Ground tyre rubber can also be blended with asphalt to make Rubberized Asphalt Concrete (RAC) (ETRMA, 2006). RAC has been used for roading material, sports stadiums, artificial turf for playing fields and running tracks, shock absorbing mats, surfaces for schools & playgrounds, cow mattresses, industrial flooring, paving blocks, tiles for patios and swimming pool surrounds, roofing materials and many other products (Jessen, 2005), (Marbek, 2006), (ETRMA, 2006), (BridgestoneAmericas, 2007). However despite the many advantages of RAC over traditional materials including its elasticity, noise absorbing characteristics, reduced noise pollution, being longer-lasting, increased safety in wet conditions and being less costly, RAC is still relatively under-utilised (ETRMA, 2006). California, Arizona and Florida have taken the lead in promoting the use of RAC in state highway projects, providing a beneficial use for huge quantities of scrap tyres (NWPSC, 2007). RAC can also be used for poured-in-place materials, molded rubber products such as wheels for caddies, dustbins, wheelbarrows and lawnmowers, urban furniture and signposts and for coatings and sealants (Marbek, 2006).

Reclaim is a material recovered from used rubber products that can be used as an alternative component for 'virgin' rubber in new tyres (van Beukering & Janssen, 2001). The manufacture of new tyres from crumb rubber derived from scrap tyres could be a significant market for old tyres (NWPSC, 2007). However because its physical properties are not as good as new rubbers (elasticity and chemical resistance), the proportion of reclaim in tyre applications is generally limited to10 percent (Guelorget et al, 1993).

Energy Recovery

Tyres have excellent combustion properties as a function of their high carbon content, their net calorific value being between 32 and 34 MJ/kg (UNEP, 2007a). Due to this embedded energy, many tyres end up as Tire-Derived Fuel (TDF) which actually burns more efficiently and cleanly than coal, and so is widely used to fuel cement kilns, power plants, co-generation plants, steel, pulp and paper mills and for industrial boilers (Jessen, 2005), (BridgestoneAmericas, 2007). Using local tyres for energy may be more efficient and less environmentally damaging than the mining and transportation of coal or coke as a fuel source, as there is a reduction in air pollutant emissions as compared to the combustion of coal or coke (Jessen, 2005). TDF's comply with 2008 emission standards in the EU and ASTM standards in the U.S. (ETRMA, 2006). New Zealand is currently investigating TDF's for use in cement kilns (K. Karavias, 7th November 2006, personal communication).

An important emerging market application for the recovery of end-of-life tyre (EOT) energy in Europe and the US is in steelworks equipped with electric arc furnaces. France now uses more than 7,000 metric tonnes of EOT's as a substitute for anthracite and scrap metal, a particularly promising application as it uses both the carbon and steel content of tyres (ETRMA, 2006). Further emerging market applications include thermal (high temperature) treatment technologies such as pyrolysis (thermal decomposition into intermediate products such as gas, oil and char), thermolysis and gasification (ETRMA, 2006). TDF's however present many challenges. In terms of the Pollution Prevention Hierarchy, the option of energy recovery from waste in second only to disposal in terms of least preferable options (EC Commission, 2006b). In addition, although spiraling energy costs could have a positive impact on the TDF market, TDF markets might have a detrimental effect on other new market openings by squeezing the supply of EOT's (ETRMA, 2006). The true environmental costs and benefits of different EOT energy recovery options requires subjection to Life Cycle Analysis in order to make decisions regarding waste tyre markets, however TDF's may provide an effective means of using EOT's while other markets are being developed (Jessen, 2005). A further recovery option is the safe storage of scrap tyres for future emerging opportunities. Although a potential source of fire outbreaks, monofills are more desirable than landfills as they facilitate material and energy recovery in the future, and may form a temporary solution in countries where capacities for processing used tyres are limited (van Beukering & Janssen, 2001).

Final Disposal

The remaining downstream component of the tyre lifecycle is final disposal, or the environmentally benign disposal of residual EOT materials, through the development of advanced end-of-pipe technologies (Das, 2005). Waste streams for final disposal should be rendered completely harmless so that they do not adversely affect the environment (Das, 2005). Waste Management Guidelines developed by BUWAL, Switzerland in 1986 state that "Waste disposal systems should generate only two groups of materials from waste, namely those which can be recycled, and those which are suitable for depositing on final disposal sites. These are sites where flows of materials into the environment (air, water and soil) are environmentally compatible both in the short-term and long-term without the need for additional treatment" (Ludwig et al, 2003, pvi).

2.7.5 Pollution Prevention Opportunities within the Upstream Tyre Lifecycle Components

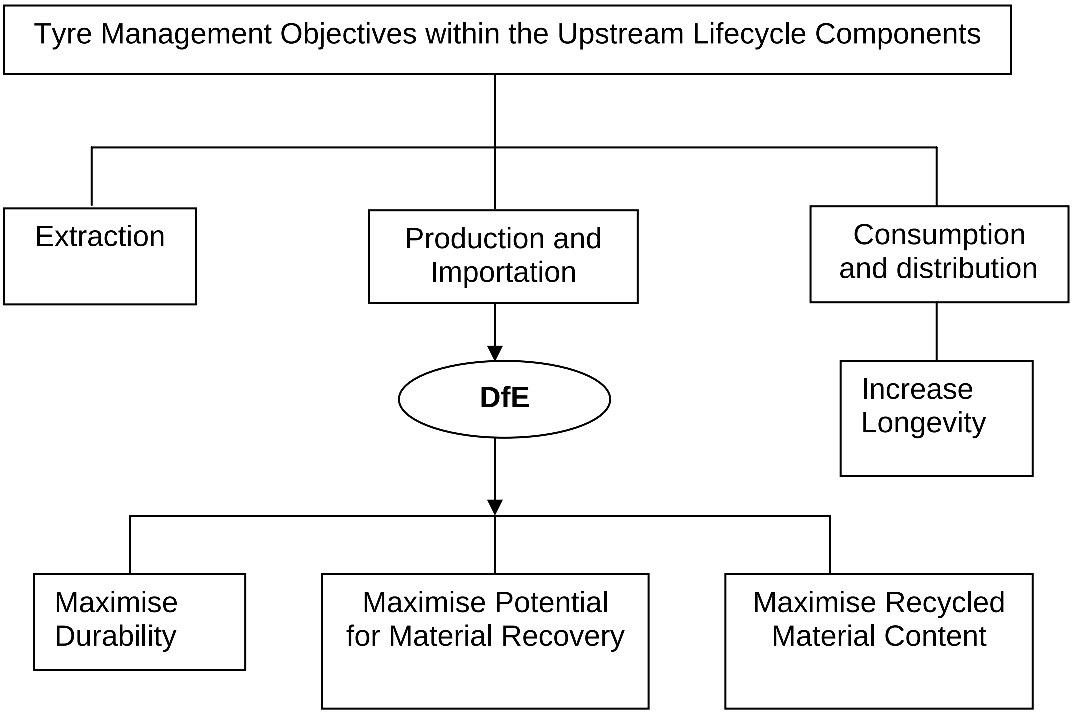


Figure 2.11: Tyre Management Objectives within the Upstream Lifecycle Components

'Upstream' tyre lifecycle components include extraction, production and importation, distribution and use (consumption) (URS, 2006). Figure 2.11 illustrates key tyre management objectives within the upstream lifecycle components.

2.7.5.1 Extraction Lifecycle Component

Generation of the basic raw materials for tyre production, i.e. synthetic and natural rubber, textile, steel and chemical additives, takes place within the extraction component of the tyre lifecycle (van Beukering & Janssen, 2001). Extraction is a lifecycle component that is often largely external to the region in question as natural rubber for example can be produced only in tropical areas (van Beukering & Janssen, 2001). The extraction stage for resources for tyres is none the less significant because the tyre industry is the world's largest consumer of natural and synthetic rubber (van Beukering & Janssen, 2001). It also takes around 22 gallons of crude oil, along with steel and natural rubber to make a new tyre (NWPSC, 2007).

2.7.5.2 Production (and Importation) Lifecycle Components

New tyre production is another lifecycle component that may be largely external to the region in question, limiting opportunities for national policy intervention. Where some or all tyre production occurs externally to the region in question, tyres are imported as new, used or 'fixed,' i.e. tyres that are attached to imported vehicles (URS, 2006). New tyre manufacture is a complicated process requiring a high level of technology, so that high-quality tyres are manufactured in a limited number of industrialised countries (van Beukering & Janssen, 2001). However, the production stage of the tyre lifecycle is significant because environmental impacts are substantially determined at the point of design, where key choices are made on choice of materials, processing and finishing technology etc (Gertsakis et al, 2002), (Brady et al, 2003). Design for the Environment (DfE) at the production stage provides opportunities for pollution prevention and for eliminating the environmental and economic costs of end-of-life management (Weaver, 1996), (Brady et al, 2003). Opportunities include maximising tyre durability (for longevity), increasing recycled material content and eliminating hazardous materials to optimise opportunities for material reuse and recovery at the end of a product's useful life (Weaver, 1996), (Brady et al, 2003).

Maximising Tyre Durability

Advances in tyre design have increased the average life expectancy (durability) of tyres from 32,000 to 96,000 kilometers per tyre (NWPSC, 2007). Economic or regulatory incentives could be directed towards manufacturers to encourage the manufacture of longer-lasting tyres (F. Rotmann, 7th November 2006, personal communication). In addition energy efficient tyres can save up to 6 percent of a vehicle’s fuel (van Beukering & Janssen, 2001). Increasing the durability of new tyres would reduce the number of new tyres required and hence reduce the generation of tyres as waste. Maximising tyre durability is thus a highly desirable option, operating within the highest (reduction) level of the Pollution Prevention Hierarchy.

Maximising Recycled Material Content

According to the 2005 CIWMB report, there is currently between zero and five percent recycled material content in new tyre manufacturing, although it is technically feasible to use as much as ten to fifteen percent (Jessen, 2005). The Ford Motor company has been working with two of its suppliers, Michelin and Continental General, to increase the use of recycled content in new vehicle tyres (NWPSC, 2007). 'Reclaim,' a material recovered from used rubber products is an alternative to virgin rubber, however because the physical properties of reclaim (elasticity and chemical resistance) are not as good as new rubbers, there is debate as to the impact that adding any amount of recycled content has on tyre longevity and performance(van Beukering & Janssen, 2001), (Jessen, 2005). A 2004 report by the Nevada Automotive Test Center (NATC) concluded the necessity to balance inherent tradeoffs between higher recycled content and reduced tyre life (Jessen, 2005).

The development of tyre specifications and education programmes may help to overcome perceptions related to the inferior quality of recycled content tyres (Jessen, 2005). Eco-labeling can also be employed to inform consumers of the environmental benefits of greater recycled rubber content (Jessen, 2005). To achieve greater recycled content in tyres it may also be necessary to develop recycled-content tyre procurement specifications (Jessen, 2005). Design changes to enable a greater percentage of recycled rubber in new tyres could reduce the quantity of virgin material required for new tyres, thus also operating within the highest (reduction) level of the Pollution Prevention Hierarchy.

Maximising Recyclability

In addition to tyre longevity, design changes can factor materials recovery/ reuse potential into the choice of materials and product design (Weaver, 1996). Eliminating hazardous materials reduces the environmental and economic costs for end-of-life management requirements and optimises opportunities for material recovery at the end of a product's useful life (Brady et al, 2003). Economic or regulatory incentives could be directed towards manufacturers to encourage a reduction in toxicity of tyre material through design changes in order to enable greater recycling and re-treading opportunities (F. Rotmann, 7th November 2006, personal communication). EPR regulations within the EU are intended to create incentives for manufacturers to follow specific Design for the Environment guidelines, so that they engage in increased design for disassembly, reuse and recycling (Ogushi & Kandlikar, 2007). In Japan manufacturers incorporate DfE as part of their plan to meet specific recovery targets (Ogushi & Kandlikar, 2007). Maximising resource recovery potential is highly desirable as it enhances pollution prevention opportunities at the end of the tyres useful life i.e. within the reuse and recycling levels of the Pollution Prevention Hierarchy.

2.7.5.3 Consumption (and Distribution) Lifecycle Components

The greater part of the overall environmental impact during the life of a tyre occurs before disposal, with the consumption stage by far the main contributor to environmental damage (Nicoletti and Notarnicola, 1999), (van Beukering & Janssen, 2001). This implies that emphasis in domestic environmental policies related to tyres should shift from the waste stage, and that the consumption stage should be the primary focus of interventions (van Beukering & Janssen, 2001).

Maximising tyre longevity

Tyre maintenance and driving behaviour are the main factors influencing environmental performance in the consumption stage of tyres (Nicoletti and Notarnicola, 1999), (van Beukering & Janssen, 2001). Improvements in tyre manufacturing over the past forty years have more than doubled the mileage of tyres, yet this technical limit is rarely met as driver behavior and neglecting tyre pressures cause the original tread to dwindle at a greater rate, in addition to having a major impact on energy consumption (van Beukering & Janssen, 2001). The biggest cause of tyre wear is over or under-inflation (Debo, 2005). Currently steel belted radial passenger tyres last approximately 65,000 kilometers. If these tyres are properly inflated, rotated, and otherwise cared for, a lifetime of 95,000 to 128,000 kilometers may be achieved (van Beukering & Janssen, 2001). 'Smart tyres' have temperature and inflation sensors (Gertsakis et al, 2002), (Debo, 2005), and filling tyres with nitrogen also helps to maintain tyre pressures and therefore promote longevity (Firestone NZ, 2007). All key players, including manufacturers and tyre distributors can educate consumers on the extension of tyre life through maintenance (optimal tyre pressures and wheel alignment) and promote the availability of tyre repair services, in order to reduce generation rates (Gertsakis et al, 2002), (Jessen, 2005). Maximising tyre longevity would reduce the number of new tyres required and hence reduce the generation of tyres as waste. Maximising tyre longevity at the consumption lifecycle stage is thus a highly desirable option, also operating within the highest (reduction) level of the Pollution Prevention Hierarchy.

2.8 Conclusions from Literature Review

The literature review describes each of key components (objectives and strategies) within the environmental policy areas of sustainable development, waste management, product policy, EPR and product stewardship that are relevant to maximising opportunities for pollution prevention within the policy area of used tyre management. A key feature of the literature review is the identification of five 'sustainability strategies.' The literature review demonstrates how each of these sustainability strategies are now incorporated within both of the product-focussed environmental policy areas of product policy and waste management, to guide the achievement of the overall sustainability goal of pollution prevention. These sustainability strategies are - application of the pollution prevention hierarchy, an integrated lifecycle principle, broadening ownership of responsibilities, the internalisation of externalities through the use of economic instruments and Design for the Environment. The significant features of each of the sustainabilty strategies are that:-

- An integrated lifecycle principle approach enables the identification of pollution prevention opportunities within each lifecycle component of a product i.e. within the extraction, production, consumption and end-of-life stages.

- Incorporation of the Pollution Prevention Hierarchy provides the principle through which to prioritise the overall effectiveness of each pollution prevention opportunity.

- Economic policy instruments are used (in combination with regulatory and informational instruments) to internalise pollution externalities and so provide incentives to stakeholders to pursue pollution prevention opportunities.

- Broadening ownership of responsibilities, through internalisation of the physical, financial and/or administrative responsibilities of stakeholders, encourages the implementation of pollution prevention opportunities by stakeholders within each lifecycle component.

- Design for the Environment (DfE) is important because production is the most significant lifecycle stage in terms of influencing opportunities for pollution prevention at all lifecycle stages.

The literature review then describes the overall objectives of product stewardship and EPR policy approaches, which are principally to reduce waste to landfill and reduce local authority burden. This is achieved by maximising collection and resource recovery and encouraging Design for the Environment. The literature review describes how product stewardship and EPR incorporate each of the sustainability strategies within each objective, in order to identify and maximise opportunities for pollution prevention throughout the product system. Thus through the incorporation of these strategies, Product stewardship and EPR link the once separate product focussed policy areas of product policy and waste management.

The literature review also highlights key differences between product stewardship and EPR policy approaches. Although both product stewardship and EPR policy approaches share similar objectives, they differ in terms of the broadening of responsibilities. While EPR places responsibility almost solely with the producers, as the actors most able to influence the characteristics of the products that give rise to pollution at the end-of-life stage, product stewardship involves sharing responsibility with the range of affected parties (Product Stewardship Institute, 2006). Thus McKerlie et al (2006) and Nicol & Thompson (2007a) distinguish between truly progressive EPR programs which aim to prevent rising levels of waste and pollution, versus shared product stewardship initiatives, which primarily mandate that producers cover a portion of waste collection and recycling costs at the end of a product's useful life.

The literature review also revealed the significant fact that, despite being a core characteristic of stewardship approaches, incentives for Design for the Environment do not feature strongly in overseas tyre management approaches beyond Japan and the European Community. There are a number of possible reasons why so few references were found within the tyre management literature regarding Design for the Environment. Stewardship type policy approaches to scrap tyre management are relatively new, also tyre production is a lifecycle component that is external to many regions. In addition, the most visible health and environmental impacts of tyres occur at the end-of-life (post-consumption) stage. Finally, tyres are a waste product that can relatively easily be recycled or recovered for a wide variety of tyre derived products.

As stated, through incorporation of the sustainability strategies, Product stewardship and EPR policy approaches link the once separate product focussed policy areas of product policy and waste management. A consequence of this link, i.e. the breaking down of the current divide between the two policy areas, reinforces a move towards a zero-waste philosophy. In a zero-waste philosophy, resources embedded in waste streams are not buried and lost, further exacerbating both resource depletion and pollution, but are instead recovered and valued as feedstocks for further production. This conservation philosophy is a logical foundation for sustainability, and should be the long-term goal of product stewardship type and EPR type policy approaches. In the European Community, where the zero waste philosophy has been practiced more seriously, a realisation has dawned that having evolved from a waste management perspective, stewardship type approaches tend to work back-to-front. There are limits as to how far a waste management policy approach can influence changes within upstream lifecycle components such as extraction, production and consumption, i.e. there are limits as to how much the 'tail can wag the dog.' Thus in the European Community, stewardship approaches are being superseded by Integrated Product Policies (IPP), which focus on an integrated systems approach to resource management. IPP policies recognise that sustainable solutions to waste lie essentially at the production stage, i.e. within the product policy environmental area.

2.9 Conceptual Framework

The aim of the research is to identify opportunities to enhance the sustainability goal of pollution prevention through Product Stewardship and Extended Producer Responsibility (EPR) policy approaches to used tyre management, and to compare these with the pollution prevention opportunities that have been incorporated into a stewardship approach overseas.
A case study method (Yin, 1989) was adopted for this research as it was considered to be the most appropriate method for an in depth study of the complex concepts that are involved in environmental policy. A key aspect of the research is the development of a conceptual model or framework of the area of interest from the literature. The conceptual framework illustrates the key objectives and strategies from each of the environmental policy areas that are relevant to the achievement of the sustainability goal of pollution prevention for EPR and product stewardship policy approaches to used tyre management. The conceptual framework, presented in Figure 2.12, also illustrates the important links between each of these concepts. The conceptual framework also includes a taxonomy (definitions and context) of each of the key concepts, and is presented in Appendix 3. Construction of the conceptual model enabled the development of the data collection protocol and selection of the case study.

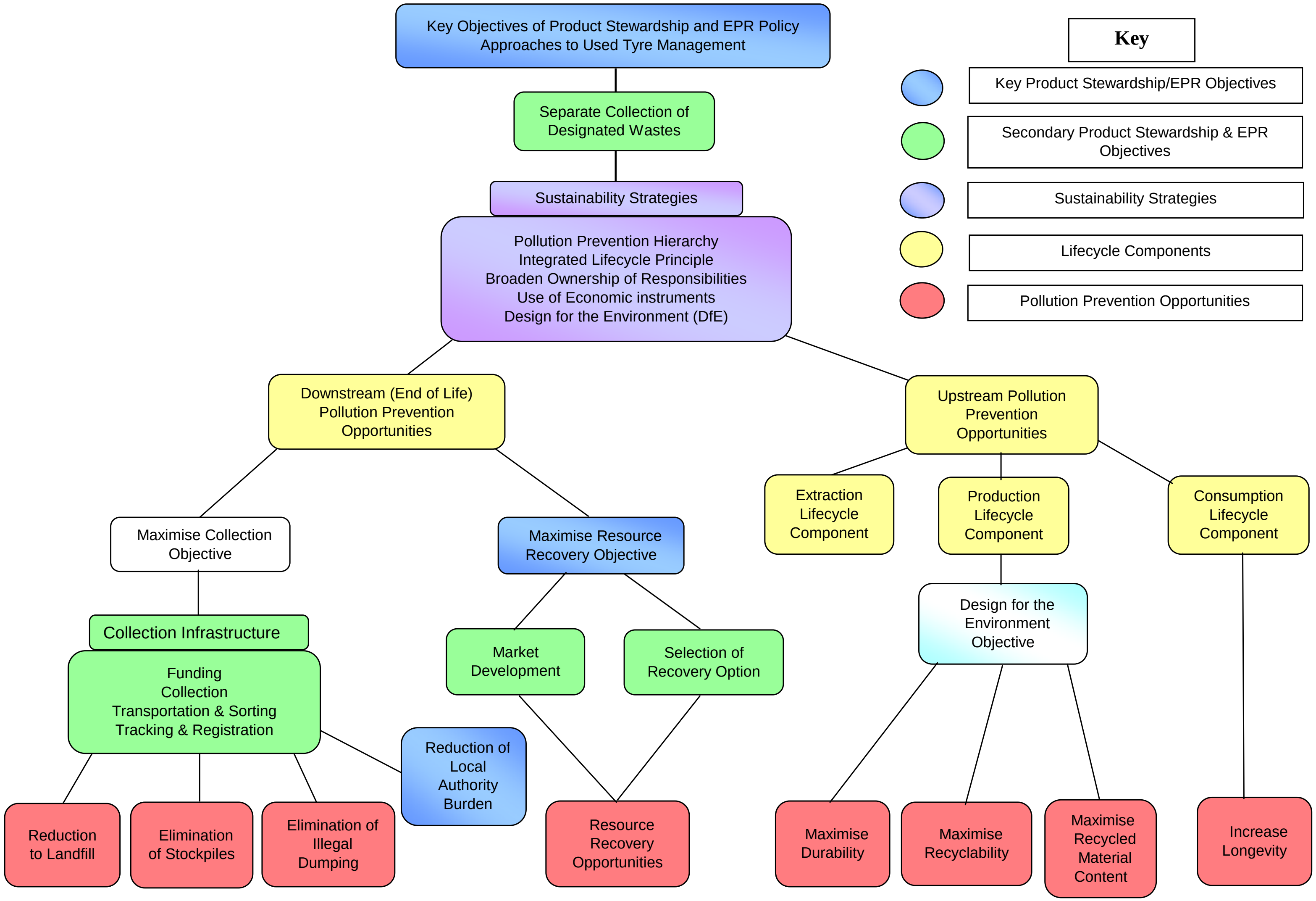


Figure 2.12: Product Stewardship and EPR Policy Approaches to Used Tyre Management – Key Objectives and Opportunities for Pollution Prevention

3 Research Method

3.1 Introduction

The purpose of this research is to establish whether environmental sustainability objectives that have been identified through the literature review, as theoretically achievable through product stewardship or EPR policy approaches to used tyre management, are actually achievable. The nature of this research, being socially driven, demands a fundamentally qualitative methodology in order to promote understanding (Blaikie, 1993). The following sections describe and explain the chosen research method including case selection, data collection and data analysis.

3.2 Selection of Research Method

The variables involved in this topic are too numerous, too subjective and too diverse to comprehensively define or measure, thus precluding the ability to conduct experiments to find evidence of a relationship between the variables through the adoption of a hypothesis testing approach (Bouma, 2000). The topic therefore lends itself more to the exploration of a number of research questions to both guide the research activity and also to define the scope of the research (Blaikie, 2000). Furthermore, the relative infancy and limited applications of wide-scale integrated approaches to product stewardship and EPR approaches, dictates that the study design lends itself more to the use of case studies as the main research methodology. The case study method is ideal for evaluation research, enabling a more in-depth and detailed examination of a wide range of variables within the phenomena of interest, than could be gathered from a survey approach (Philber et al, 1980).

3.2.1 Sample Size

Unlike the 'statistical sampling' associated with more quantitative research methods, where a large number of samples are randomly selected, the case study research method employs a single-case, or a multiple-case study design, in which cases are 'purposely' selected in order to demonstrate theoretically important characteristics (Yin, 1989), (Patton, 1990). Case study design allows an investigation of the phenomena in question at greater depth, although multiple-case studies are more powerful than single-case studies for theory generation, increasing the generalisability or external validity of the results, and hence widening the applicability of the research (Yin, 1989), (Eisenhardt, 1991). Yin (2003) describes how although the results from a multiple -case study approach may be more compelling, the extensive resources and time required may be beyond the means of a single student. Given the time constraints of a 30-point dissertation, and due to the complexity of the research topic, a single case study method was chosen.

3.2.2 Overview of Single Case Study Approach

The steps that comprise a single case-study method are described by Yin (1989) as commencing with the development of theory from the literature. Upon completion of the literature review, the case study is selected, followed by development of the data collection protocol. These three steps constitute what Yin (1989) refers to as the "define and design" stage. The data collection protocol is then used to collect data about the case. The data is then analysed and the results summarised in a case report. The results are then compared to the theory developed from the literature and appropriate conclusions are drawn from the analysis. The final phase in the case study method is the completion of a written report (Yin, 1989).

The chosen research methodology is typical of a qualitative research approach, falling part way along the continuum between an inductive (theory building) and a deductive (theory testing) approach (Gray, 2007). Such a research methodology incorporates an iterative process of data collection, data analysis, comparison to theory and theory modification in the development of the conceptual framework (Yin, 1989).

3.2.3 Development of Theory

An extensive literature review was undertaken to identify the key variables or concepts (strategies and objectives) within the environmental policy areas of sustainable development, waste management and product policy that are relevant to the implementation of product stewardship and EPR policy approaches to used tyre management. The literature review was also undertaken to determine the relationships between each of these concepts and the achievement of the overall sustainability objective of pollution prevention within the policy area of used tyre management. In addition the literature review was undertaken to describe how each of these concepts has been incorporated within product stewardship and EPR policy approaches to used tyre management overseas. A process of logical analysis, as described by Dey (1993), was then used to develop the variables (i.e. the key concepts that had been identified within each of the relevant policy areas from the literature review) into a conceptual framework. The conceptual framework comprises a hierarchy of categories and sub-categories and the relationships between them. The conceptual framework includes a separate taxonomy of definitions of each of the key concepts. The qualitative analysis software program NVivo (QSR International, 2008) was used to aid the development of the hierarchy of categories and sub-categories and to identify the links between the categories, and hence aid development of the conceptual framework.

3.3 Case Selection

The objective of the research was to investigate how effectively opportunities for the achievement of the sustainability goal of pollution prevention, as identified in the literature, have been successfully incorporated into a stewardship type policy approach to used tyre management implemented overseas. Following the literature review, construction of the conceptual framework and selection of the research method, one overseas Product Stewardship/ EPR type policy approach to used tyre management was purposely selected for the study. Yin (2003) describes five rationales for the selection of single case study samples. Of these alternatives, a 'representative or typical case' best represents the method of sample selection for this dissertation. Purposeful selection required the identification of a case that best illustrates specific concepts, 'cause and effect relationships' or process models that were identified through the construction of the conceptual framework (Dey, 1993). To this end, the case was selected according to the following criteria:

- Incorporation of identified sustainability goals and strategies within the used tyre management program objectives and targets.
- Availability of data, particularly data in the English language, as for many of the overseas schemes, the official language used is other than English.
- Evidence of ongoing developments to improve the efficiency of the program.
- Comparable context to New Zealand in terms of demographics (population and land area), GDP, numbers of new and end-off-life tyres produced /generated per year, tyre sources i.e. manufactured domestically or imported.
- Willingness of key stakeholders to be involved in the study.

Following the identification of Manitoba's tyre management program as a potentially suitable case, key stakeholders associated with the Manitoba program were identified through the Manitoba Tyre Stewardship Board (MTSB, 2007b) and Tyre Stewardship Manitoba (TSM, 2007c) websites. Three key stakeholders associated with the program (Brett Eckstein of the Manitoba Government and acting General Manager of the Manitoba Tire Stewardship Board; Glenn Maidment, Chairman of the Tyre Stewardship Manitoba Board and representing the Rubber Association of Canada; and Joe Casciano, Director of Tyre Stewardship Manitoba and representing the Retail Council of Canada) were each contacted by email. This initial contact outlined the objectives of the study, their potential role, likely time commitment and requested permission for their participation. The receipt of positive responses regarding participation in the research from two of these key stakeholders (Brett Eckstein and Joe Casciano) enabled confirmation of the selection of the Manitoba scheme for the case study.

3.4 Design of Data Collection Protocol

Following case selection, the data collection protocol included identification of data sources within the selected case and selection of data collection methods. The data collection protocol was based on the research questions and on the conceptual framework of key concepts developed from the literature. The research questions define the purpose for the data collection, and the conceptual framework identifies the concepts that are relevant to the collection of data (Gray, 2007). The two principal methods chosen for data collection were personal interviews and document analysis. The data collection protocol included the collation of records regarding every data source in order to minimise errors and bias in the study, and hence to increase the reliability or repeatability of the research (Yin, 1989).

3.4.1 Personal Interviews

The conceptual framework of key concepts developed from the literature was used to develop a list of questions (Appendix 3) which were forwarded to the stakeholders that had agreed to participate (Brett Eckstein and Joe Casciano) and also to Glenn Maidment, despite no initial response, for completion. After several weeks there had been no response to the questions. It was concluded that there may have been too many questions, so that it would have been too time consuming for the recipients to respond. The original intention had been to follow up the questions with brief recorded interviews as part of the data collection protocol, however lack of response to the questions, plus the cost of overseas telephone calls to Canada, precluded further pursuit of this method.

Further stakeholders associated both with Manitoba's tyre management program and others with a more general interest in stewardship within Canada had also been identified through Manitoba Tyre Stewardship Board (MTSB), Tyre Stewardship Manitoba (TSM) and government websites and reports. Along with the original participants, further identified stakeholders were contacted by email and asked one or two of the questions from the list of questions presented in Appendix 3. Stakeholders contacted included: -

- Duncan Bury of Environment Canada
- Bill Harper, General Manager of Tyre Stewardship Manitoba (TSM)
- David Lamb, TSM Board Director representing the Rubber Association of Canada
- Moe Tresoor, TSM Board Director representing the Western Canada Tyre Dealers Association
- Gerald Penner, Manitoba representative for the Western Canada Tyre Dealers Association
- Shirley Canty, TSM Board Secretary/Treasurer representing the Manitoba Motor Dealers Association
- Rachel Kagan of the Retail Council of Canada
- Ginette Bureau, Program Director of the Canadian Association of Tire Recycling Agencies (CATRA).
- Dr John A. Sinclair, Professor and Associate Head, Natural Resources Institute, University of Manitoba, also Resource Conservation Manitoba (RCM) Board Director.
- Kenton Lobe, Resource Conservation Manitoba (RCM)
- Scott Nicol - Natural Resources Institute, University of Manitoba and White Goods Program Coordinator for the Manitoba Ozone Protection Industry Association (MOPIA).
- Kate McKerlie - Canadian EPR researcher
- Rosemary Sutton - Program Administrator, British Columbia's 'Financial Incentives for Recycling Scrap Tires' (FRST) Program

Every stakeholder contacted was provided with a description of the research, the purpose for asking the question and their role in the research, enabling the responses to be cited in the research results. Responses were received from Brett Eckstein, Joe Casciano, Glenn Maidment, Duncan Bury and Scott Nicol, and these are included within the relevant sections of the case study results. The overall response from the personal interview method of data collection was however very disappointing, so that the principle method of data collection was from document analysis.

3.4.2 Document Analysis

The primary method of data collection was from the analysis of documents (reports, legislation and websites) produced or operated by key stakeholders within Manitoba's tyre management program, national and provincial government and other organisations associated with or interested in the program. All document data was sourced and accessed entirely through the internet. The documents were then either printed or saved to disc.

3.5 Data Analysis

The data collected from personal interviews and the far more extensive data collected from document analysis was summarised, guided by the questions in Appendix 3, the research questions and the concepts that had been identified through construction of the conceptual framework developed from the literature review. The key points were entered into the NVivo data analysis program (QSR International, 2008), and were analysed according to the iterative process of 'describing, classifying and connecting' as described by Dey (1993). The results were then summarised in an individual case report. The resulting categories and relationships were then compared with the hierarchy of categories of the conceptual framework that had been constructed following the literature review.

3.6 Summary

Due to the complexity of the topic, and also due to the time constraints of a 30-point report, a single case study method was chosen to answer the research questions. The case study sample, which was selected using the criteria of 'a representative or typical case' (Yin, 2003), was also influenced by the 'evidence of ongoing developments to improve the efficiency of the program' criteria. The data was collected through personal interviews (by email) with stakeholders and through document analysis (reports, relevant legislation and websites). Data was analysed with the aid of NVivo data analysis software (QSR International, 2008) and the results summarised in an individual case report. The results of the case study were then compared and contrasted with the conceptual framework derived from the literature, and the conclusions presented.

4 Results and Discussion

4.1 Introduction

In this chapter, the results of the case study are presented and discussed. Section 4.2, the case description, describes the development of used tyre management programs in the Province of Manitoba. The case study results and analysis are presented in Sections 4.3 to 4.6. Section 4.3 describes Product Stewardship and EPR principles and objectives within Manitoba's used tyre management plan. Section 4.4 discusses the incorporation of sustainability strategies within Manitoba's used tyre management plan. Section 4.5 describes opportunities for pollution prevention that have been incorporated within the downstream (end-of-life) tyre lifecycle components. Section 4.6 describes opportunities for pollution prevention that have been incorporated within the upstream tyre lifecycle components. Section 4.7 presents a discussion of the results and compares the empirical study with the literature review. Section 4.8 presents a summary of the results and analysis according to the Pollution Prevention Hierarchy.

4.2 Case Description

This section provides the background to Manitoba's product stewardship/ EPR policy approach to tyre management including a description of the geographical, demographic, economic and other contextual information relevant to the research.

4.2.1 The Province of Manitoba

Manitoba is a province of Canada which, with a total area of 25,823,780 square kilometers divided into 10 provinces and 3 territories, is the world's second largest country (Jessen, 2005). Canada’s consumer culture generates one of the highest per capita volumes of solid waste and has the third largest ecological footprint in the world (McKerlie et al, 2006). The total land area of Manitoba is two and a half times the land area of New Zealand, so with less than a third of the population of New Zealand, the population density of Manitoba is approximately a seventh that of New Zealand (Investment NZ, 2007), (Statistics NZ, 2007), (Wikipedia, 2007), (Government Manitoba, 2007). See Table 4.1: Comparison of Key Demographic and Contextual Data of Manitoba with New Zealand. Real GDP figures cannot easily be compared as the figures presented in the table are in different currencies and are for different years. With respect to tyres, approximately 75 percent of New Zealand's tyres are imported, with 25 percent produced domestically by two manufacturers. In contrast Manitoba has no domestic production and imports 100 percent of its tyres (URS, 2006), (Eckstein, 2007). Another significant difference between the two regions with respect to tyres is that in New Zealand, 85 - 90 percent of used tyres are currently landfilled, whereas in Manitoba, 100 percent of tyres are diverted from landfill for alternative uses (URS, 2006), (TSM, 2007a).

Table 4.1: Comparison of Key Demographic and Contextual Data of Manitoba with New Zealand (Compiled by author).

	New Zealand	Province of Manitoba
Demographics		
Total population (2006)	4,143,279 (Statistics NZ, 2007)	1,148,401 (Government Manitoba, 2007)
Largest city	Auckland	Winnipeg
Population of largest city	1,241,600 (Investment NZ, 2007)	633, 451 (Wikipedia, 2007)
Total land area (km^2)	268, 680 (Wikipedia, 2007)	647,797 (Wikipedia, 2007)
Population density (per km^2)	15 (Wikipedia, 2007).	2.1 (Government Manitoba, 2007)
Official Languages	English / Te Reo	English and French (Wikipedia, 2007).
Economic		
Real GDP ($ billion in 2007)	NZ$ 128 as at Mar 07 (Investment NZ, 2007)	CAN$ 38 as at June 2007 (Government Manitoba, 2007)
GDP per capita	US$ 24,943 in 2006 (Wikipedia, 2007).	CAN$ 35,609 in June 2007 (Government Manitoba, 2007)
Primary export industries	Agriculture, horticulture, fishing and forestry (Wikipedia, 2007)	Mining, agriculture and construction. (Government Manitoba. 2007)
Tyres		
Number of used tyres generated annually	Estimated 3 - 4 million (URS, 2006)	835,000 (TSM, 2007a)
Number of domestic tyre manufacturers	2 (URS, 2006)	zero (Eckstein, 2007)
New tyres manufactured domestically (%)	Approx. 25% (URS, 2006)	0% (Eckstein, 2007)
Tyres imported (%)	Approx. 75% (URS, 2006)	100% (Eckstein, 2007)
Number of tyre retailers	Between 600 and 900 (URS, 2006)	Approx. 900 (TSM, 2007a)
Number of tyres landfilled	85 - 90% (URS, 2006)	zero (TSM, 2007a)

4.2.2 Stewardship Programmes in Canada

There are over fifty mandatory extended producer responsibility (EPR) or product stewardship programs operating, with regional variations, at provincial, regional and/or national levels within Canada. These address more than a dozen separate products and materials including scrap tyres, used motor oil and used containers (CDL) (Zero Waste New Zealand Trust, 2002), (Jessen, 2005), (Green Manitoba, 2006). Programmes are implemented in line with Environment Canada's Sustainable Development Strategy 2007 - 2009 (Environment Canada, 2007a) and are subject to legislation under the Waste Reduction and Prevention (WRAP) Act (1994), which provides the legislative framework for introducing expanded producer responsibilities (Government Manitoba, 1994), (Green Manitoba, 2006).

Tyre stewardship programs are also subject to the Tyre Stewardship Regulation (1995), which was amended in November 2006 (Government Manitoba, 2006a). In each tyre stewardship program a fee is payable on new tyres purchased of between $2 and $35 per tyre (Jessen, 2005). Five of the programs (including Manitoba) are managed by third-party organizations (PRO's), two are managed by government and one program is under development in Ontario (Jessen, 2005).

4.2.3 Background to Manitoba's Scrap Tyre Diversion Program

Manitoba's priority waste streams include tyres, blue box materials, e-waste, paint and Household Hazardous Wastes (HHW) (Green Manitoba, 2007), though of all the waste diversion initiatives, tyre recycling has been described as the clear success story (RCM, 2005). Operating successfully since 1992, Manitoba's scrap tyre diversion program has undergone a number of changes (MTSB, 2007b). In 1992 the Manitoba Government instituted a $2.80 levy on all tyres sold in Manitoba for use on licensed vehicles and trailers (TSM, 2007a). The levy was collected from tyre retailers, distributors and new vehicle dealers by the Department of Finance, with funds fully allocated to the recycling of scrap tyres under the Used Tire Management Program (UTMP) (MTSB, 2007b).

In 1995 a revised product stewardship program was developed under the new Tire Stewardship Regulation (1995) and the WRAP Act (1994) (Marbek, 2006). The regulation established the Manitoba Tire Stewardship Board (MTSB) as an arm’s-length-from-government statutory corporation (PRO) to take over the UTM Program and manage the used tyre-recycling program in Manitoba (Marbek, 2006), (TSM, 2007a). The goals of the new product stewardship program were to remove used tyres from the waste stream, process the material within the province of Manitoba, find markets for the recycled material and encourage the creation of tyre recycling related jobs in Manitoba (Marbek, 2006), (MTSB, 2007b). The Program revenue, derived from the levy on consumer purchases of tyres at the retail level, was used to support industry-delivered solutions upon proof of sale of approved recycled products (TSM, 2007b). The main elements of policy were a landfill ban, an Advanced Recycling Fee (ARF) to fund tranportation and processing credits, and the operation of a tyre tracking system (Marbek, 2006). The program operated successfully, re-mediating over 90 percent of tyres covered by the regulation (9.5 million passenger tyre equivalents) up to 2006 (Marbek, 2006).

However for several years, the funds raised through the levy were less than the credits paid to processors, depleting the Board's financial reserves (TSM, 2007b). This was largely due to the inclusion for processing of non-levied off-the road tyres (OTR's) plus the funding of OTR stockpile cleanup (TSM, 2007a). For this reason, and in response to the new Tire Stewardship Regulation (2006), a new Manitoba Scrap Tire Program Plan was developed in April 2007 (Manitoba Conservation, 2007). The new plan was opened for public consultation on 20th June 2007 with submissions to the Manitoba Ministry of Conservation closing on August 7th 2007 (Manitoba Conservation, 2007). However to date, neither the submissions nor the results of the consultation process have been made publicly available.

The goals of the new program remain largely unchanged (Marbek, 2006). Tire Stewardship Manitoba (TSM) is committed to removing used tyres from the waste stream, processing the material and finding markets for the recycled material within Manitoba, encouraging the creation of tyre recycling related jobs in Manitoba and respecting the 4R hierarchy (TSM, 2007a), (Marbek, 2006). An additional goal, and the main change, is from a product stewardship model to an extended producer responsibility (EPR) model, with overall financial responsibility for scheme management shifting from government to the tyre industry (producers and consumers) (Manitoba Conservation, 2007), (Marbek, 2006). Responsibility for scheme management shifted to Tire Stewardship Manitoba (TSM), a new not-for-profit organisation (PRO) representing the tyre industry (Manitoba Conservation, 2007). The new program builds on current program policies and procedures as much as practical in order to minimise disruption (TSM, 2007a). In recognition of the critical need for performance reporting to maximize program efficiency and effectiveness, TSM is also committed to working with Green Manitoba, Manitoba Conservation and other stakeholders to define key indicators relevant to four broad program categories:- diversion operations, recycled products mix, core stewardship programs and administration, within its first year of operations (TSM, 2007a).

4.3 Case Study Results - Incorporation of Product Stewardship and EPR Principles within Manitoba's Used Tyre Management Program

The Manitoba Government defines EPR as "an environmental policy approach that extends a producer's material and/or financial responsibility to the post-consumer stage of a product's lifecycle" (Green Manitoba, 2007, p6). The Manitoba Government describe the basic aims of EPR as to minimize waste, to encourage recycling and to reinforce the link between product design and the environment (Green Manitoba, 2007). Resource Conservation Manitoba states that properly designed and implemented, stewardship programs put responsibility for waste in the hands of those best able to reduce or eliminate it, that is the producer and the consumer (RCM, 2007). When that responsibility is appropriately shared, the result can be less waste, more durable goods, lower energy consumption and greenhouse gas emissions at the production end, reduced dependency on primary materials, increased recycling rates, and the creation of new businesses and job opportunities (RCM, 2007). However RCM sees a number of major flaws with Manitoba's new tyre regulations, and so doubt whether the described benefits will be fully realized (RCM, 2007). These flaws are discussed where relevant within the case study results.

Establishment of an EPR or product stewardship program for scrap tyre management requires a formal agreement to segregate the specified designated waste (i.e. tyres) from the waste stream for an alternative and/or more appropriate management strategy.

4.3.1 Designation of Tyres as a Priority Waste

Scrap tyres in Manitoba are a 'designated material' (priority or special waste) subject to the Waste Reduction and Prevention (WRAP) Act (1994) and the Tyre Stewardship Regulation (1995) (Marbek, 2006). This allowed the Board to license all tyre and vehicle retailers, directly collect a tyre levy on the sale of new tyres and to establish a fund and management program (Marbek, 2006). Under the original MTSB program, only licensed highway vehicles were included, with mining and agricultural tyres exempt from the program (Marbek, 2006). Under the new Tire Stewardship Regulation (2006), the definition of designated tyres was expanded to include all pneumatic tyres and tubes, including off road tyres (OTR's), agricultural, mining, construction and aircraft tyres. The only exceptions are tyres for motorized mobility aids (wheelchairs) or vehicles that are powered exclusively or partly by human muscular power (cycles and wheelbarrows), which may be addressed by TSM at some future point (Marbek, 2006), (TSM, 2007a). The cost of recycling unlevied scrap tyres had impacted significantly on the original Tire Stewardship Board recycling program (MTSB, 2007a). Furthermore, a key objective of establishing an EPR program for used tyres is to reduce the physical and financial burden of used tyre management that traditionally falls to local authorities.

4.3.2 Reduction of Local Authority Burden

Government Manitoba's Tyre Stewardship Guideline specifies that the cost of managing designated waste materials be borne by the stewards and users of the product or packaging material rather than by the taxpayer (Government Manitoba, 2006b). Since the establishment of the MTSB in 1995, municipalities have no longer had any physical or financial responsibilities regarding recycling or safe disposal of used tyres (Marbek, 2006). The role of municipalities became limited to the financial and informative responsibilities of accepting and stockpiling tyres to be picked up by processors, for which municipalities were paid $0.50 per tyre (approximately $60,000 a year) by the Board (Marbek, 2006), (Green Manitoba, 2006), (MTSB, 2007a). These payments are reinstated under the new plan (TSM, 2007a). Tyres are a difficult and costly material to manage at landfill and the removal of these tyres from the waste stream represents both a monetary saving to municipalities and extends the life of the landfill (MTSB, 2007a).

4.4 Case Study Results - Incorporation of Sustainability Strategies within Manitoba's Used Tyre Management Program

Sustainability strategies that are employed within product stewardship and EPR policy approaches for the achievement of the key waste management objectives include the Pollution Prevention Hierarchy, an Integrated Lifecycle Principle, Broadening Ownership of Responsibilities, Use of Economic Instruments and Design for the Environment (DfE). The following sections describe how these strategies are incorporated within Manitoba's used tyre management program.

4.4.1 Incorporation of the Pollution Prevention Hierarchy

The principles of sustainability and waste minimization are encouraged under the WRAP Act (2007) through the promotion of reducing, recycling, reuse and recovery (Government Manitoba, 1994). Manitoba’s principles of sustainable development state that Tyre Stewardship Manitoba's (TSM) stewardship program is required to demonstrate consistency with the principles of Pollution Prevention and the 4R's Hierarchy (Government Manitoba, 2006b). Manitoba's program also incorporates the use of economic incentives.

4.4.2 Incorporation of Economic Incentives

A guiding principle of the proposed new EPR scheme under the TSM Board is to encourage, by way of financial incentives, environmentally efficient and economically viable industries to collect, process and manufacture value-added products from scrap tyres discarded in Manitoba (TSM, 2007a). Funds raised for the management of a material or product will relate to the costs of managing that designated material or product (Government Manitoba, 2006b). Under the new TSM plan, the system remains a retail-based funding model, with a retail Ecofee (mandatory Advanced Recycling Fee or ARF) payable on consumer purchases of tyres at the retail level sufficient to cover the entire costs of the program (TSM, 2007a). Changes include a proposed 'rate setting process' to apply to three major areas - the retail Ecofee, transportation credits and processor incentive credits, to ensure that the funding burden is borne more equitably by industry and users of the product (TSM, 2007a).

Changes to the retail Ecofee include increased levies to ensure financial viability, the inclusion of all types of tyres and tubes including off-the-road (OTR) tyres and the application of variable levies by types of tyre to reduce cross-subsidization (TSM, 2007a). Cross-subsidization can occur where users of small tyres are subsidizing large tyre users, because large scrap tyres are more costly to recycle (TSM, 2007a). In one year, medium truck tyres represented 43 percent of levied tyres sold (by weight), but only contributed 13 percent of the total levy collected for recycling (MTSB, 2007a). The application of variable levies by tyre type ($4 per auto tyre to $70 for large OTR's) reduces cross-subsidization, i.e. ensures equitable funding by industry and users of the product (TSM, 2007a).

Changes to the 'rate setting process' also included the separation of transportation credits and recycling (processing) incentives to more accurately capture and reflect the true costs of collection, transportation and processing from all points of origin in the province (TSM, 2007a). Ecofees are to be set at a rate sufficient to cover the entire costs of the program including the transportation and processor credits, plus the administration, enforcement and other regulatory obligations (TSM, 2007a). TSM will be fiscally responsible and will work with Manitoba Conservation and Green Manitoba to dynamically adjust levies and incentive payments to better achieve program goals (TSM, 2007a).

McKerlie et al (2006) consider however, that under Canada's shared stewardship approach, user pays and polluter pays principles are not well enforced. The shared responsibility model does not deliver full market signals, or a clear feedback loop to the producers regarding the true costs of managing their products throughout the whole lifecycle (McKerlie et al, 2006). In order to uphold the polluter pays and user pays principles, producers must be given full responsibility for product throughout their entire lifecycle (McKerlie et al, 2006). This includes full costs for operation of the PRO, collection, recycling, disposal and consumer education (McKerlie et al, 2006). The following section describes the Manitoba programs' incorporation of the Integrated Lifecycle Principle sustainability strategy.

4.4.3 Incorporation of an Integrated Lifecycle Principle

The Manitoba Government's Tire Stewardship Guidelines state that it is important to identify efforts to reduce the environmental impacts of designated material throughout the product lifecycle including increased reusability and recyclability (Government Manitoba, 2006b). There is also a requirement under the Tyre Stewardship Regulation (2006) for TSM to describe efforts taken to reduce environmental impacts throughout the product lifecycle to increase reuse and end-of-life recycling in their Annual Report (TSM, 2007a). The following section describes the Manitoba programs' incorporation of the Broaden Ownership of Responsibilities sustainability strategy.

4.4.4 Incorporation of Broaden Ownership of Responsibilities strategy

Under the original (product stewardship) scheme, federal government had no roles or responsibilities for the program (Marbek, 2006). Provincial government had responsibility for compliance and enforcement, and municipalities had financial and informative responsibilities in that they were paid $0.50 per tyre to stockpile tyres prior to collection by registered tyre processors (Marbek, 2006). Accountable to the provincial government, MTSB worked with stakeholders and had administrative, economic and informative responsibilities in managing the scrap tyre recycling program (Marbek, 2006), (TSM, 2007a). The Board was also required to contract research, share information with other Boards and promote awareness and education (Marbek, 2006).

Government Manitoba's new Tire Stewardship Regulation (2006a) represents a shift from a product stewardship to an EPR approach, with overall responsibility for scheme management shifting from provincial government to the tyre industry (producers and consumers) (Marbek, 2006), (Manitoba Conservation, 2007). A key objective of the proposed Tire Stewardship Manitoba (TSM) Plan is to reduce government involvement in program management, and increase 'industry steward' responsibility for program design and performance (TSM, 2007a). The Tire Stewardship Regulation (2006) requires tyre stewards to develop an industry funding organisation, stewardship plans and a business plan to fund the management of all scrap tyres in the province (Marbek, 2006).

Under the TSM Plan, membership of the new Tire Stewardship Manitoba (TSM) Board (industry funding organisation/PRO) comprises the Rubber Association of Canada, the Retail Council of Canada, Western Canada Tire Dealers Association and the Manitoba Motor Dealers Association (Manitoba Conservation, 2007). Collectively these four major organisations represent the major stakeholders within the tyre industry - international tyre manufacturers, major suppliers and the majority of tyre retailers in Manitoba (TSM, 2007a). The proposed EPR model requires working partnerships with the consumer, industry, the Manitoba Government and local government (Green Manitoba, 2007), with regulatory obligations for individual stakeholders laid out in the legislation (TSM, 2007a). TSM is to address the question of whether other organizations should be represented (TSM, 2007a).

The Tire Stewardship Regulation (2006) defines a steward of tyres as:- (a) the first person who, in the course of business in Manitoba, supplies a new tyre to another person or (b) a person who in the course of business in Manitoba, uses a tyre obtained new in a supply transaction outside of Manitoba (Government Manitoba, 2006a). Government Manitoba Guidelines define stewards as the “first seller” or “first importer” of the product - and may include a variety of participants in the distribution chain, including a brand owner, producer, manufacturer, distributor, retailer or a business that imports tyres for its own use (Government Manitoba, 2006b), (TSM, 2007a). For the purpose of this Plan, the steward will be deemed to be the tyre retailer, which continues the practice in place in Manitoba since the original tyre plan was promulgated in 1992 (TSM, 2007a).

Under the retail based funding model, while the consumer assumed financial responsibility for payment of the retail Ecofee, tyre manufacturers had no financial, physical or organisational responsibilities under the original scheme and this remains unchanged under the proposed new model (Marbek, 2006), (TSM, 2007a). Brett Eckstein (10th February 2007, personal communication) of Green Manitoba, an agency of the Manitoba Government, confirms that as there are no tyre manufacturers in the province, and tyre stewards are the first sellers or importers of tyres, the regulation is limited in Manitoba in its reach to impose any further requirements on manufacturers. The final sustainability strategy that should be incorporated within an EPR type policy approach is Design for the Environment.

4.4.5 Incorporation of Design for the Environment (DfE)

According to Environment Canada (2007b), the core objective of EPR is product design that minimises or eliminates resource consumption and hazardous/non-hazardous waste generation associated with the product. Green Manitoba (2007) describes the basic aims of EPR as to minimize waste, encourage recycling and reinforce the link between product design and the environment. Producer responsibility under EPR programmes is a tangible factor that promotes upstream changes leading to the total life cycle environmental improvement of product systems (McKerlie et al, 2006). Shifting Manitoba's product stewardship approach to a regulated steward responsibility model, in which the companies (stewards) that produce or distribute these products in Manitoba are responsible for developing programs to manage designated wastes, will reinforce the linkage between product design and the environment (Green Manitoba, 2006). One of the primary values of an industry stewardship plan is that there tends to be a much closer relationship and better communication between those who produce the product for its intended purpose, through to its end-of-life management (TSM, 2007a).

Tyre Stewardship Manitoba's Scrap Tyre Program Plan however, contains no references to Design for the Environment. Several stakeholders, including members of the TSM Board, were contacted by email to identify whether, through the transition to the proposed industry based EPR model, any specific regulatory, informational or financial incentives were to be included in the TSM plan to encourage design changes at the manufacturing stage. The sole response was from Brett Eckstein (10^{th} February 2007, personal communication) who stated that "designing for the environment is a long-term goal of EPR, which subscribes to the 4 R's of reduce, reuse, recycle and recover. Given the relative size of Manitoba and the fact that there are no tyre manufacturers in the province, the regulation is limited in its reach to impose any further requirements on manufacturers."

4.5 Case Study Results - Pollution Prevention Opportunities Within the Downstream (End-of-Life) Tyre Lifecycle Components

This section describes the opportunities for pollution prevention that have been incorporated into Manitoba's used tyre management program through the achievement of specific tyre management objectives within the downstream (end-of-life) tyre lifecycle components. The primary objectives within the downstream (end-of-life) tyre lifecycle components are to Maximise Collection and to Maximise Resource Recovery.

4.5.1 Maximise Collection Objective

The Province of Manitoba generates approximately 835,000 used tyres annually (TSM, 2007a), 86 percent of which are passenger tyres, although these represent only 53 percent of the total as a function of weight (MTSB, 2007a). Passenger Tyre Equivalents (PTE's) are based on 20 pounds per passenger tyre so that scrap tyres can be compared by equivalent weights (MTSB, 2007a). Figure 4.1 illustrates scrap tyres generated in Manitoba by tyre type and by weight.

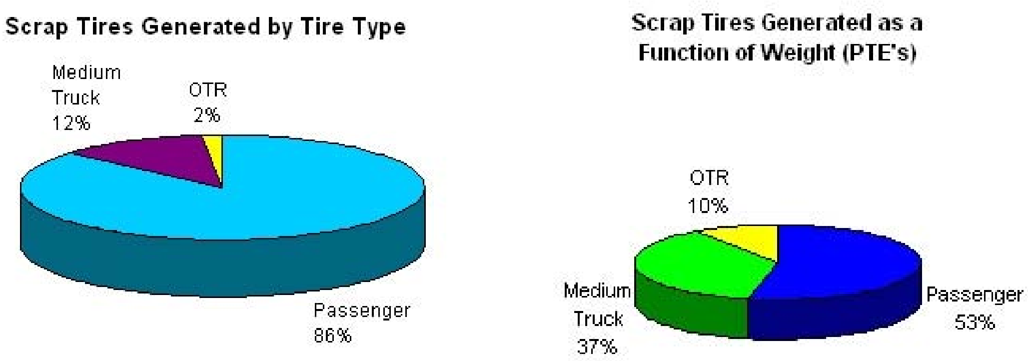


Figure 4.1: Scrap tyres generated in Manitoba. Reproduced from the Manitoba Tire Stewardship Board (MTSB) Three - Year Business Plan (2007a).

Tyre Stewardship Manitoba (TSM) is committed to providing a province-wide, convenient and readily accessible collection system for scrap tyres without collection fees (Marbek, 2006), (TSM, 2007a). Table 4.2: Used Tyre Collection Rates in the Province of Manitoba indicates that although 100 percent of used tyres are already collected under Manitoba's existing product stewardship program, the projected number of tyres collected under the new program is expected to increase due to the inclusion of all types of used tyres in the province i.e. off-the-road tyres (OTR's)) (TSM, 2007a).

Table 4.2: Used Tyre Collection Rates in the Province of Manitoba (compiled by author).

		Original Product Stewardship scheme under Manitoba Tyre Stewardship Board (MTSB) 1995 - 2007	Proposed Extended Producer Responsibility (EPR) Scheme under Tyre Stewardship Manitoba (TSM) from 2007 (projected figures)
Number of scrap tyres generated annually	**Number of tyres**	700,000 (Marbek, 2006) 835,000 (TSM, 2007a)	900,000 (TSM, 2007a)
	Passenger Tyre Equivalents (PTE's)	1.3 million (TSM, 2007a)	1.8 million (TSM, 2007a)
Number of levied tyres sold		786, 676 in 2003 (MTSB, 2007a). 831,731 in 2005/06 (CATRA, 2007). 841,907 in 2005 + 55,654 non-levied OTR's (Green Manitoba, 2006).	900,000 (TSM, 2007a)
Number of scrap tyres collected	**Number of tyres**	835,000 (TSM, 2007a)	900,000 (TSM, 2007a)
	'Passenger Tyre Equivalents' (PTE's)	To date over 9.5 million PTE's collected (Marbek, 2006)	1.8 million (TSM, 2007a)
Elimination of Stockpiles and Illegal Dumping		No used tyre stockpiles left in Manitoba (Marbek, 2006)	Prohibition on stockpiling & illegal dumping. Tire Clean-up program to remediate remaining stockpiles (TSM 2007a)
Elimination to landfill		100% diverted from landfill (RCM, 2005). 1,390,886 PTE diverted from landfill in 2005 (Marbek, 2006)	Prohibition on landfilling (TSM, 2007a).

4.5.1.1 Reduction to Landfill, Elimination of Stockpiles and Elimination of Illegal Dumping

The TSM Plan includes a prohibition on the improper storage, illegal dumping, landfilling, unlicensed burning and non-compliant geotechnical uses of tyres, under the Tyre Stewardship Regulation (2006), including higher penalties (Government Manitoba, 2006b), (Manitoba Conservation, 2007), (Green Manitoba, 2007). See Table 4.2. To prevent illegal dumping, the TSM program also includes a formal tracking system of scrap tyres from the generator's site through to final disposition (TSM, 2007a). The TSM Plan (2007) considers that through the collection and effective diversion of scrap tyres under the program, any environmental concerns arising from the amassing or improper storage of scrap tyres will be either avoided or eliminated.

According to a number of sources, Manitoba is the only program in Canada that has cleaned up all scrap tyre stockpiles, with no major stockpiles remaining other than tyres in processors' inventories and at landfills awaiting collection by processors (Marbek, 2006), (MTSB, 2007b), (Green Manitoba, 2007), (CATRA, 2007a). However, the new TSM Board states that although very successful in cleaning up scrap tyre stockpiles in the province, there is no accounting or documentation of the extent of existing stockpiles in the province (TSM, 2007a). It seems therefore that although no new stockpiles have been created, there are an unspecified number of stockpiles remaining in the Province. A Tire Clean-up program specifically for remediating remaining stockpiles is budgeted for under the new plan (TSM, 2007a). As it is very difficult to ascertain clean-up costs, TSM (2007a) does not accept responsibility or liability for stockpiles created prior to the introduction of its program. The TSM Plan (2007a) states that the existing Board, or the government, must survey the size and scope of existing stockpiles and set aside sufficient abatement funding.

In addition to measures to prevent disposal of used tyres to landfill, stockpiling and illegal dumping, achievement of the Maximise Collection objective requires the development of a Tyre Collection Infrastructure to manage the collection and transportation of used tyres for re-processing.

4.5.1.2 Tyre Collection Infrastructure

For achievement of the Maximise Collection objective, a tyre management program requires a Tyre Collection Infrastructure for funding, collection, transportation and sorting, registration and tracking.

Funding

Under the TSM plan (2007a) the system remains a retail-based funding model, with a mandatory retail Ecofee (ARF levy) payable on consumer purchases of new tyres to cover the entire costs of the program. Under the original scheme retailers were required to remit the funds to the Department of Finance (who forwarded the funds to MTSB) (Marbek, 2006). Under the proposed EPR scheme, funds and details of tyres sold are instead remitted to Tyre Stewardship Manitoba (TSM), the new industry board (TSM, 2007a).

Collection

Scrap tyre collection is well established in the tyre industry as motorists and consumers typically leave their old tyres at the retailer when purchasing new tyres (TSM, 2007a). Under the TSM plan, consumers are required to pay a levy upon the purchase of new tyres and to return used tyres to the retailer (Marbek, 2006).

Transportation and Sorting

The no-charge pick-up, collection and transportation from retail sites will continue under the new plan, but with additional strategic arrangements to encourage the efficient collection and transportation of tyres from rural and underserviced areas to processing sites (TSM, 2007a). Farm equipment dealers, heavy construction and mining equipment dealers, leasing companies etc, will also become collection sites across the province (TSM, 2007a). Payments to municipalities for aggregating and temporarily storing scrap tyres at landfill sites in readiness for hauling to processors will also be reinstated under the new plan (TSM, 2007a). To establish a fair and equitable rate system, a transportation incentive system will take into account the distance from the collection point to the nearest processing point (TSM, 2007a). Transportation credits are to be calculated through national surveys of operating costs e.g. truck types, operating conditions, salaries, fuel, insurance costs etc, in order to more accurately reflect the true costs of collection and transportation from all points of origin in the province (TSM, 2007a). To provide some certainty in their operations, given that transportation credits are prone to more volatility than other program costs, transporters will be given at least six months notice if credit rates are to be reduced due to lower operating costs (TSM, 2007a).

Registration and Tracking Systems

Under both schemes, the approximately 900 registered tyre retailers in Manitoba have physical, economic and informative responsibilities (Marbek, 2006), (CATRA, 2007a). Since 1995 there has been a requirement for tyre retailers in Manitoba to be licensed to sell tyres, to accept used tyres back from consumers, to collect new tyre levies from consumers and to report to the Board on the number of regulated tyres sold (Marbek, 2006), (TSM, 2007a). TSM (2007a) acknowledges that while most retailers, haulers and processors strive to be environmentally responsible, without a structured regime for scrap tyre management, illegal dumping can and does occur. To address this issue the TSM (2007a) program will operate a formal manifest system to track the transportation of scrap tyres from the generator's site (registered retailers) through to final disposition (registered processors) to ensure compliance.

4.5.2 The Maximise Resource Recovery Objective

In addition to the Maximise Collection objective, the other primary objective within the downstream (end-of-life) tyre lifecycle components is the Maximise Resource Recovery objective, defined as to maximise the extraction of useful energy or materials from waste (OECD, 2002). Achievement of the Maximise Resource Recovery Objective requires achievement of the further goals of Market Development, Selection of Recovery Option and Resource Recovery Opportunities.

4.5.2.1 Market Development Objective

The long-term goal of the new TSM program is to encourage the development of an innovative, sustainable and vibrant tyre rubber recycling industry in Manitoba (MTSB, 2007a), (TSM, 2007a). TSM's primary role in addressing market development is to create a demand for scrap tyres, give them value and develop sustainable markets for environmentally efficient products derived from scrap tyres (MTSB, 2007a), (TSM, 2007a). Under the original MTSB scheme, registered processors were required to collect tyres from municipal landfills, retailers and stockpiles (Marbek, 2006). Registered processors were then paid by the Board, upon auditable proof of sale of new product from recycled tyres, a credit of up to $2.50 per 20 lb PTE, based on projected costs and value added to Manitoba (Marbek, 2006). However to date, markets for value-added processing have been relatively volatile, as the supply of scrap tyres and the demand (crumb rubber pricing) are not always aligned (TSM, 2007a). Processors have also expressed a concern that current processing credits/payments were inadequate (TSM, 2007a). Furthermore, when waste has an intrinsic high value (like metals) subsidies may not be required, however, in the case of scrap tyres, which have a negative value, subsidizing of some diversion (processing) is required (TSM, 2007a).

Under the new TSM plan (2007a), part of the program revenue derived from the Ecofee will be used to subsidize some diversion through Processor Incentive Payments (processing credits) upon proof of sale of approved recycled products, and to support industry-delivered solutions. Processing credits will more accurately reflect the true costs of processing by tyre type from all points of origin in the province including historically under-serviced areas (TSM, 2007a). TSM (2007a) will establish rates that are fair and competitive for all affected stakeholders by consulting with processors to apply the findings of up-to-date consultants' reports on tyre programs across Canada. Processor credits are dependant on a variety of factors, some within the control of the processor e.g. labour costs, productivity, product mix etc. Others such as market pricing and competitive pressures being external, are outside the immediate control of the processor (TSM, 2007a). TSM (2007a) will ensure availability of feedstock and scrap tyre product at a predictable price to enable processors to invest in new technology and new capital equipment. The TSM (2007a) program will also secure funding for new technologies and innovation by having an agreement in place with each processor in the form of a Processing Incentive Hierarchy, as illustrated in Figure 4.2, indicating the credit rates TSM will provide for product sold into the market. The Board's goal is to assist processors with credits to develop viable industries at which time the Program can be sunsetted and turned over to industry (CATRA, 2007b). In time, markets will become more self-sustaining while providing measurable environmental and economic benefits through increasing the value and range of recycled products and uses (TSM, 2007a).

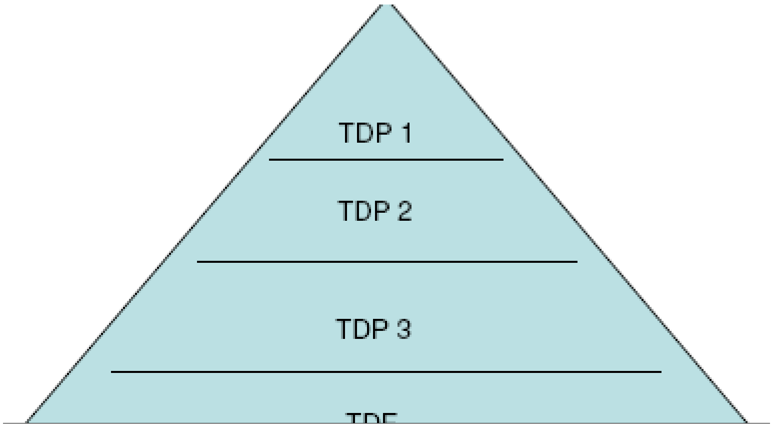
The TSM plan (2007a) will also allocate a proportion of the Ecofee to an R & D program focussed on market development, to ensure environmentally efficient and economically viable new applications, technologies and end markets for products from scrap tyres. To facilitate the exchange of information, expertise and resources between scrap tyre program Boards and processors in the efficient operation of their programs, MTSB was instrumental in the establishment of a scrap tyre information exchange, the Canadian Association of Tire Recycling Agencies (CATRA) (MTSB, 2007b), (CATRA, 2007b). A further market development goal within the TSM Plan is the creation of tyre recycling related jobs in Manitoba (MTSB, 2007a). In addition to the Market Development objective, achievement of the Maximise Resource Recovery Objective also includes the Selection of Recovery Option objective.

4.5.2.2 Selection of Recovery Option Objective

The Selection of Recovery Option is defined as selecting and prioritising, from a range of alternative opportunities, those products and applications that clearly demonstrate that they constitute value-added products, are environmentally sustainable and commercially viable (UNEP, 2007a). The TSM Plan is required to demonstrate consistency with the principles of Pollution Prevention, whereby Performance Measures by stewards, especially producers of consumable products, are required to describe the proportion of product to be managed at each level of the 4R hierarchy (Government Manitoba, 2006b). TSM (2007a) is committed to providing an exemplary tyre-recycling program that respects the 4R hierarchy of reduce, reuse, recycle (TDP), recovery of energy (TDF) and results in a scrap tyre-free environment. In addition, in accordance with Manitoba's principles of sustainable development, stewardship programs shall adhere to the Economic Development and Acceptable Use Framework for economic development and environmentally acceptable uses and end products, as presented in Appendix 5 (Government Manitoba, 2006b). The framework favours where possible, local processing, manufacturing and use of products from scrap tyres over the export of scrap tyres for the same purpose or use (Government Manitoba, 2006b).

The TSM program's recovery objective is to achieve a higher level of self-sufficiency by processing greater volumes of higher-value recycled products locally in Manitoba (TSM, 2007a). To support this, part of the program revenue derived from Ecofee will be used to support Processor Incentive Payments, payable to the processor upon proof of sale of approved recycled products (TSM, 2007a). Processor Incentive Payments will reflect the true cost of recycling by tyre type, plus the additional processing costs associated with higher value added products (TSM, 2007a). A 'Processing Incentives Hierarchy,' illustrated in Figure 4.2, will be applied to indicate the credit rates (Processor Incentive Payments) that TSM will provide for product sold into the market (TSM, 2007a). The 'Processing Credit Hierarchy' of incentive payments encourages value-added processes and products, whereby a higher credit is paid for a higher value-added product requiring greater processing of scrap tyres (TSM, 2007a).

Specific payment rates within the hierarchy are to be established, based on a combination of environmental, economic and market considerations (TSM, 2007a). The processing incentive scheme reflects the Economic Development and Acceptable Use Framework established by Manitoba (Appendix 5) to promote the diversion of waste tyres to the highest and best use, while encouraging maximum economic benefit to Manitoba (TSM, 2007a). TSM (2007a) will continuously strive for cost effectiveness and efficiency, while at the same time offering higher end-use credits for the processors and end users that recycle tyres versus using them for energy recovery.



- **TDP 1 -** Includes operations that reduce the scrap tyre to a highly processed form, typically to a crumb rubber or powder form for use in producing new products with recycled rubber content (particle size up to 5/16" to 40 mesh and lower).
- **TDP 2 -** Fabricated products that are made at least 75% from scrap tyre (e.g. blasting mats, traffic cone bases, etc.).
- **TDP 3 -** Tyre shred with particle size of nominally 2-4 inches produced as an alternative to granular material.
- **TDF** – Whole tyres used as tyre derived fuel (TDF) to supplement other fuels in industrial applications.

Note: Manitoba also pays additional processing credits for finished goods production and sale.

Figure 4.2: Tyre Stewardship Manitoba - Processing Credit Hierarchy (TSM, 2007a)

Regarding the origins of the Processing Credit Hierarchy, Glenn Maidment, Chairman of the new TSM Board states that "The hierarchy of incentives has been thought about for years and is incorporated in just about every tyre stewardship plan across the country. I'm not sure when or where the idea first took hold, but tyre stewardship has been going on since the early nineties in Canada" (G. Maidment, 8th September 2007, personal communication). Brett Eckstein (10th February 2007, personal communication) states that "the processing credit hierarchy reflects the original practice of the Tyre Board, reviewing applications from processors for financial credits on a case by case basis to determine their acceptability and the level of credit per PTE, to a maximum of $2.50 per PTE. The companies with the highest and best use were given the highest credit of $2.50 to reflect the value added through processing the tyre. Less value added products received a lower credit." Influenced by the Market Development and the Selection of Recovery Option objectives described above, the following section describes the resource recovery opportunities that have actually been incorporated under Manitoba's plan.

4.5.2.3 Resource Recovery Opportunities

This section describes the Resource Recovery Opportunities (options) for the promotion of pollution prevention that have actually been incorporated into the TSM Plan, and are presented according to the levels of the Pollution Prevention Hierarchy, i.e. reduce, reuse, recycling, energy recovery and proper disposal. As stated, within the recovery stage of used tyres there are no opportunities for a 'reduction' in the number of used tyres generated, so that opportunities for pollution prevention lie in the options selected for reuse, recycling and recovery.

Re-use Opportunities for Part-Worn Tyres

As described, a part-worn tyre is defined as a tyre which is reusable for its original purpose i.e. as a second-hand purchase or re-usable for reprocessing (retreading) (ETRMA, 2007). The tyre industry is presently engaged in a number of reuse initiatives that give new life to used tyres, the two principal methods of reuse being retreading and the export of used tyres (TSM, 2007a). Due to more harsh winter driving conditions, Manitoba motorists often discard used tyres sooner than they might if the driving conditions were more favourable, therefore the TSM plan (2007a) allows collectors to cull these used tyres for export use.

In addition, a tyre casing can also be retreaded up to three times, greatly extending the life of the product and diverting it from the waste stream (TSM, 2007a). TSM’s approach will encourage retreading of commercial truck tyres by placing the Ecofee on new truck tyres only, thereby contributing to the cost advantage associated with retreads (TSM, 2007a). Regarding the retreading of passenger tyres, Glenn Maidment (8^{th} September 2007, personal communication), states that "Commercial truck tyres are made to be retreaded and there is a well established retreading industry. Passenger tyres on the other hand are not made to be retreaded. Therefore we do not wish to encourage the process by giving any preferential treatment to retreaded passenger tyres. You may ask, why aren’t passenger tyres made to be retreaded? In theory of course anything is possible, but economically and for other reasons, it just isn’t practical. For example, commercial truck casings (the tyre under the tread) are made with steel body plies, while passenger tyre casings are generally made of polyester or nylon fabric, which promotes a better ride and handling. You could make a steel casing, but the ride and handling would be very harsh and it would cost more. Hardly a winning combination for any motorist."

Recycling Opportunities for Non Re-Usable Tyres

Tyres considered unsuitable for reuse are channelled into the recycling stream (CATRA, 2007a). According to the November 1996 WRAP Strategy Report, less than one per cent of used tyres were being recycled in 1991, however by 1995, the number of recycled tyres had risen from 6,000 to 904,000, representing all used tyres generated that year (RCM, 2005). The scrap tyre recycling industry within Manitoba has existing capacity to process the scrap tyres generated in Manitoba into shred, crumb rubber and metal for recycling (TSM, 2007a). While end-use markets for crumb rubber are still developing, crumb is currently being used in a variety of tyre derived products (TDP's), including manufactured products with rubber content, rubberized asphalt, civil engineering and landscaping applications that provide effective alternatives to other materials (TSM, 2007a). Appendix 6 provides a description of the primary reprocessors and markets for recovered tyre material within the Province of Manitoba. Table 4.3 Scrap Tyre Recovery Rates in the Province of Manitoba, illustrates the quantities of specific tyre derived products currently produced in Manitoba by type, and also indicates projected changes under the new TSM plan.

Energy Recovery Opportunities for Non Re-Usable Tyres - Tyre Derived Fuels (TDF's)

Scrap tyres are used extensively around the world as a fuel substitute because of their high BTU value and chemical consistency (TSM, 2007a). Some observers question why, if scrap tyres are such a good option for energy recovery, TSM should devote so much energy and effort to recycle them when the simplest and least costly alternative is to burn them (TSM, 2007a). From a philosophical point of view, TSM (2007a) accepts the premise of the 4R Hierarchy, which is why the long-term diversion of tyres to energy is not promoted in the plan as a highly desirable use. TSM (2007a) will continuously strive for cost effectiveness and efficiency while, at the same time, offering higher end-use credits for the processors and end users that recycle tyres versus using them for energy recovery. By 1995, although all of the used tyres generated were being recycled, less than half of the recovered tyres were being recycled into new products, with most being burned for fuel (TDF) (RCM, 2005). By 2003, 1.475 million tyres were being recycled and only 12 per cent were being used for TDF (RCM, 2005). Figure 4.3: Products Made from Scrap Tyres in Manitoba, indicates the general trend between 1998 and 2003 away from the use of scrap tyres as Tyre Derived Fuel and towards the development of alternative tyre material derived products.

Table 4.3 Scrap Tyre Recovery Rates in the Province of Manitoba.

Recovery Option	Original Product Stewardship scheme under Manitoba Tyre Stewardship Board (MTSB) 1995 - 2007	Extended Producer Responsibility (EPR) Scheme under Tyre Stewardship Manitoba (TSM) from 2007 (projected figures)
Reused	RTR of Winnipeg sorts an estimated 100,000 PTE's for salvage and reuse (MTSB, 2007a).	Not available
Culled for Export	Not available	Not available
Retreaded	Not available	Not available
Recycled	1.3 to 1.4 million PTE's annually. TRC of Winkler - up to 400,000 PTE's annually. RTR of Winnipeg - 6 to 800,000 PTE's annually (CATRA, 2007b), (MTSB, 2007a).	85.4% (2007), 94% 2008), 100% for years 2009 - 11) (TSM, 2007a).
Molded products	193,945 tyres in 2005 (Green Manitoba, 2006).	(in 000's PTE's) 2007 - 194, 2008 - 288, 2009 - 350, 2010 - 375, 2011 - 400 (TSM, 2007a).
Shred for Civil Engineering	543,603 tyres in 2005 (Green Manitoba, 2006).	(in 000's PTE's) 2007 to 09 - 500, 2010 - 459, 2011 - 367 (TSM, 2007a).
Mats & Cut Products (in 000's PTE's)	96 in 2005 (Green Manitoba, 2006).	2007 - 160, 2008 - 190, 2009 - 220, 2010 - 250, 2011 - 280 (TSM, 2007a).
Crumb Rubber (in 000's PTE's)	2005 - zero, 2006 - 5 (TSM, 2007a).	2007 - 5, 2008 - 50, 2009 - 100, 2010 - 150, 2011 - 200 (TSM, 2007a).
New Products (in 000's PTE's)	zero (TSM, 2007a).	2007 - zero, 2008 - 56, 2009 - 86, 2010 - 125, 2011 - 150 (TSM, 2007a).
Recovered		
Tyre Derived Fuel (TDF) (in 000's PTE's)	557 in 2005 (Green Manitoba, 2006). Phoenix Industries of Regina - 158 annually (MTSB, 2007a).	2007 to 09 - 250, 2010 - 150, 2011 - 125 (TSM, 2007a).
Creation of tyre recycling related jobs within Manitoba	Since 1995, two major and six smaller tyre recycling businesses developed (MTSB, 2007a) Approx. 70 new, full-time jobs + casual jobs created (Green Manitoba, 2006).	Not available

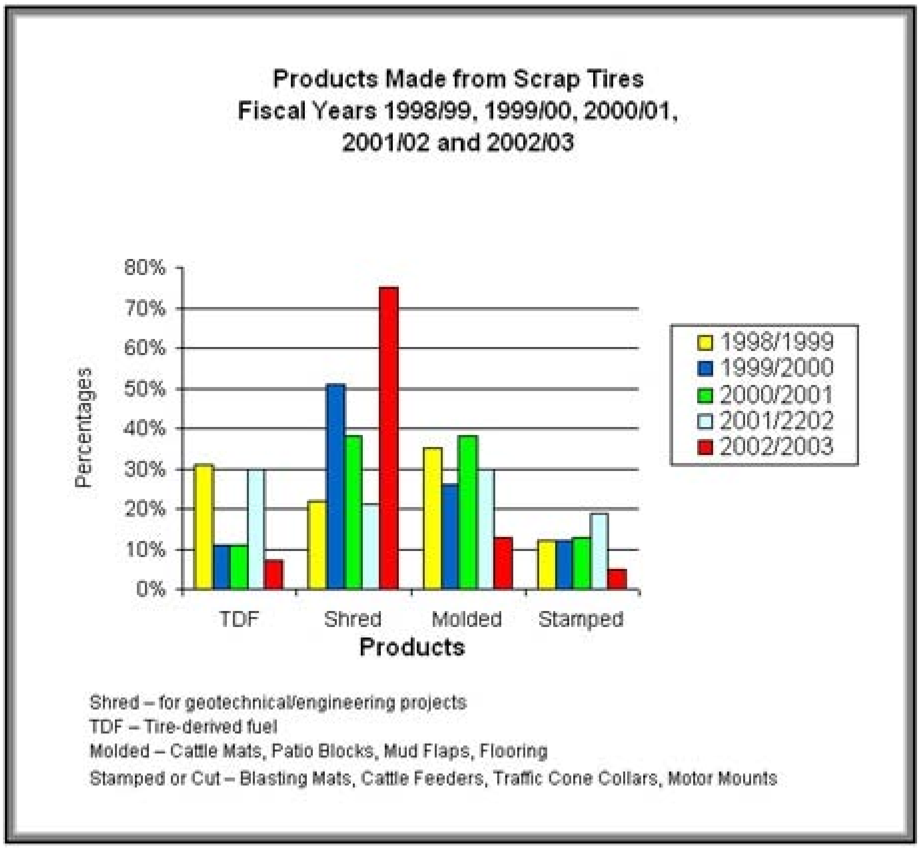


Figure 4.3: Products Made From Scrap Tyres in Manitoba. Reproduced from the Manitoba Tire Stewardship Board (MTSB) Three-Year Business Plan (2007a).

Final Disposal

Incentives will also be in place to ensure that very little, if any, residuals result from the processing of tyres (TSM, 2007a). The fibre (5 percent of the used tyre) component that is recovered after crumbing has limited markets and is usually landfilled (Marbek, 2006). The section above described the pollution prevention opportunities for used tyres under Manitoba's program within the downstream (end-of-life collection and recovery) tyre lifecycle components. Section 4.6 describes opportunities for pollution prevention, incorporated under Manitoba's program, within the upstream (production and consumption) lifecycle components of tyres.

4.6 Case Study Results - Pollution Prevention Opportunities Within the Upstream Tyre Lifecycle Components

This section describes the pollution prevention opportunities that have been incorporated into the TSM plan within the upstream lifecycle components of tyres. The upstream lifecycle components include extraction, production (including importation) and consumption (including distribution).

4.6.1 Production Lifecycle Component

Due to the fact that there are no tyre manufacturers within Manitoba, the TSM plan (2007a) contains no references to the intended use of any economic, regulatory or informational incentives for pollution prevention within the production lifecycle component. The TSM Plan (2007a) simply describes how, in following the principle of continuous improvement in environmental stewardship, the tyre manufacturing industry has achieved considerable success in recent years in extending original tyre life, reducing the number of new tyres required for a given mileage, while improving performance and reliability. In 1981, the expected lifespan of an average highway tyre was approximately 47,000 km. Due to extensive research and innovation on the part of industry, this life-span has been extended to approximately 72,000 km, an over 50 percent improvement (TSM, 2007a).

4.6.2 Consumption and Distribution Lifecycle Components

The TSM plan (2007a) describes how through tyre care, such as maintaining proper air pressure and tyre rotation, consumers can expect to extend the life of their tyres by 20 percent or more, avoiding up to 20 percent of annual scrap tyre generation. By optimizing fuel consumption, tyre maintenance also directly mitigates the contribution of greenhouse gases to the atmosphere (TSM, 2007a). The TSM plan (2007a) includes an integrated public education program to promote the benefits of waste minimization, and to encourage responsible behaviour by consumers and other stakeholders through tyre reduction, re-use and recycling. This includes consumer educational material regarding specific tyre-related benefits associated with improved vehicle and tyre maintenance (TSM, 2007a). The TSM plan (2007a) also supports tyre industry-led consumer education initiatives such as the “Be Tire Smart – Play Your PART” campaign, designed to encourage motorists to check their tyre pressures monthly (TSM, 2007a).

During the operational set-up phase, TSM (2007a) will also undertake an education program to familiarize tyre retailers and consumers in the province with the new procedures. A TSM website will be developed to provide consumers, local governments, existing and potential transporters and processors with detailed and current information on the program, including a feedback mechanism for stakeholder input (TSM, 2007a). The opportunity to implement a consumer information line (telephone) will be explored with a view to handling general calls from the public and advising them, through the most convenient means possible, where they can take their used tyres and how tyres are recycled (TSM, 2007a).

4.7 Discussion of Results

This section compares and contrasts the results from the case study with the conceptual framework developed from the literature. The case study results are discussed in terms of each of the key components identified and defined from the literature as important for the achievement of pollution prevention opportunities through an EPR policy approach to used tyre management.

4.7.1 Key Objectives of Manitoba's EPR Approach to Used Tyre Management

Scrap tyre diversion programs have operated in Manitoba since 1992, with operation changing to a product stewardship model under the Manitoba Tyre Stewardship Board (MTSB) in 1995. In 2007, the new Tire Stewardship Manitoba Board (TSM) Plan began operation under an extended producer responsibility (EPR) model (Manitoba Conservation, 2007), (Marbek, 2006). Under the Tyre Stewardship Regulation (2006), the new TSM Plan shares the European Community's definition of EPR as an environmental policy approach that extends a producer’s material and/or financial responsibility to the post-consumer stage of a product’s lifecycle (EC Commission, 2007b), (Green Manitoba, 2007).

The key objectives of the new EPR program under the TSM Plan are:- designation of tyres as a priority waste, to reduce local authority burden, maximise used tyre collection (reduce the number of tyres going to landfill plus eliminate stockpiling and illegal dumping), maximise used tyre recovery, develop markets for recycled materials, respect the 4R hierarchy and to broaden the responsibilities for end-of-life tyre management to producers and consumers (increasing tyre life). These objectives are broadly consistent with the multiple objectives of

Product Stewardship and EPR policy approaches to used tyre management as described in the literature (Weaver, 1996), (Jessen, 2005), (ETRMA, 2006). Further objectives under the TSM Plan that are not specified in the literature are the goals of processing the material within the region, and encouraging the creation of tyre recycling related jobs within the region (TSM, 2007a), (Marbek, 2006). However the key EPR objective of Design for the Environment as described in the literature by Ogushi & Kandlikar (2007) and others is not included in the TSM Plan.

4.7.2 Separate collection of Designated Wastes

Under the new TSM plan, all types of tyre within the province of Manitoba became designated (priority) wastes and therefore subject to the WRAP Act (1994) and the new Tyre Stewardship Regulation (2006) (Government Manitoba, 2006a).

4.7.3 Incorporation of Sustainability Strategies Within the Tyre Stewardship Plan

It was established from the review of the literature that the effectiveness of Product Stewardship and EPR policy approaches to end-of-life products requires incorporation of each of the five identified sustainability strategies.

4.7.3.1 Incorporation of the Pollution Prevention Hierarchy

Under the legislation, TSM's stewardship program is required to demonstrate consistency with the principles of Pollution Prevention and the 4Rs Hierarchy (Government Manitoba, 2006b). This is broadly consistent with Weaver (1996) and Jessen (2005) who endorse the waste hierarchy as the key principle for the environmentally sound management of tyres.

4.7.3.2 Incorporation of the Integrated Lifecycle Principle

The TSM Plan acknowledges the necessity to reduce environmental impacts throughout the product lifecycle, as described in the literature by Hanisch (2000), (URS, 2006) and the EC Commission (2007a).

4.7.3.3 To Broaden Ownership of Responsibilities

The TSM program is based on the principle that all actors along the product chain accept responsibility for the achievement of specific tyre management objectives at key points throughout the tyre's life cycle as described by Hanisch (2000), Jessen (2005) and ETRMA (2006). Weaver (1996) describes how the key point of EPR approaches to end-of-life tyre management is to make the manufacturer (or designated agent) responsible for taking back the tyre at the end of its useful life. Consistent with this, a key objective under the TSM Plan is to reduce government involvement by shifting overall responsibility for tyre management to producers (industry stewards) and consumers (Marbek, 2006), (TSM, 2007a). However, as there are no tyre manufacturers within Manitoba, the TSM Plan, under the WRAP Act (1994) and the Tyre Stewardship Regulation (2006), substitutes the term 'producers' with the term 'industry stewards,' which for the purposes of the Plan is deemed to be the retailer (Government Manitoba, 2006a), (TSM, 2007a). Thus producers have no financial, physical or administrative responsibilities under the scheme, and as used tyres are returned to the retailer, the retailer becomes the 'designated agent' as described by Weaver (1996).

4.7.3.4 Use of Economic Instruments

Under the TSM Plan an Advanced Disposal Fee (ADF) is employed in the form of an Ecofee, payable by the consumer on the purchase of new tyres to fund all program costs (collection, transportation and recovery plus education, research and development and marketing). This is consistent with Houghton et al (2004), the OECD (2005) and Jessen (2005), who state an ADF (or ARF) may be imposed on manufacturers and importers of tyres, or on the consumer, to fund program management, internalise waste management costs and reduce local authority burden.

Gertsakis et al (2002), the OECD (2005), Walls (2006) and the EC Commission (2007a) describe however, that the primary purpose of the use of economic instruments within an EPR policy approach is to provide an incentive to the manufacturer to incorporate Design for the Environment (DfE) changes. A disadvantage of the use of ADF's alone in a policy approach, is that where costs are passed onto consumers, and producers have no responsibility for the collection or disposal of wastes, there may be no incentives for DfE (Environment Canada, 2002), (OECD, 2005). Thus under the TSM Plan, where all program costs are funded by the consumer, and where producers have no targets or responsibilities for the collection or disposal of wastes, it is doubtful whether the program could be considered equitable, or even whether it should truly be considered an EPR approach. Under Manitoba's plan, the consumer bears full financial responsibility through payment of the tyre levy (Ecofee), yet has little opportunity to influence pollution prevention opportunities beyond tyre longevity during consumption, and has little direct representation on the Board. As described by McKerlie et al (2006), if these issues are not well defined, the 'EPR solution' (e.g. the transfer of waste management costs to the producer) may be an answer to a very different problem i.e. a budget deficit within the municipality. The fact that there are no tyre producers in the Province, and that under the TSM plan all program costs are passed on to the consumer, also has implications for the provision of incentives for manufacturers to implement Design for the Environment changes.

4.7.3.5 Incorporation of Design for the Environment (DfE)

As described by Weaver (1996), Brady et al (2003), Walls (2006) and others, Design for the Environment (DfE) is a core characteristic of EPR. However, there are no tyre producers in Manitoba, hence the substitution of the term 'producers' with the term 'industry stewards' (i.e. retailers) under the relevant regulation. Tyre producers therefore have no physical or financial targets or responsibilities regarding the collection or disposal of wastes under the program, with all program costs passed on to the consumer, hence producers have no incentives to make Design for the Environment changes. Environment Canada (2002) states that many EPR program designs result in costs that are easily passed onto consumers, reducing the incentive for producers to undertake DfE. The Australian Government (2003), the OECD (2005), Jessen (2005) and (Lindhqvist & van Rossem, undated) each present opportunities for providing incentives to producers for DfE within an EPR program, however no references were found in the literature regarding possible solutions for when the manufacturer is external to the region. The lack of manufacturers clearly has implications regarding Manitoba's achievement of pollution prevention opportunities within the production tyre lifecycle component, and for the adoption of an EPR approach. There are tyre manufacturers within Canada however, which may present opportunities at a national level.

Although presenting no solutions for when manufacturers are external to the region, Environment Canada (2002) cites a number of additional barriers that prevent Canadian EPR programs from leading to significant Design for the Environment improvements. In addition to costs being passed onto consumers these include the relatively small size of Canadian markets, relatively low levels of product development and R&D, and comparatively low costs of end-of-life management relative to other product related costs incurred by producers

(Environment Canada, 2002). Resource Conservation Manitoba, a non-profit organisation in Manitoba, also states that to strengthen stewardship in Manitoba, the Province needs to prohibit stewards from passing program costs directly on to consumers through eco-fees, and make manufacturers directly responsible for the waste created by the products they sell (RCM, 2007). This would ensure a financial incentive for producers to reduce waste management costs by designing products that are more durable and more easily recyclable (RCM, 2007).

Scott Nicol (18th December 2007b, personal communication) states that "currently there are no producers involved in the management of any designated products within Manitoba, so responsibilities are placed on the importers, distributors and sellers, which to my knowledge has not driven any environmental redesign changes." Nicol (18th December 2007b, personal communication) states also that "in Canada/Manitoba there is currently no mechanism to mandate a producer to take back a product for waste management." For product innovation to be realized, the goals of sustainable product design, reduced resource use and enhanced recycling must be clearly defined as the purpose of the legislation (McKerlie et al, 2006). In Canada there is a lack of emphasis in the legislation for waste prevention through product redesign, hazardous material restrictions or recycled content requirements and too few incentives to encourage the development of innovative product service systems (McKerlie et al, 2006). Unless producers MUST internalise the full costs of their products throughout its entire life cycle, they are unlikely to re-think business-as-usual or come up with innovative product service systems (McKerlie et al, 2006). It is important that legislation is designed to stimulate pollution prevention and phase out hazardous material use in products, rather than simply transferring the responsibility for end-of-life material’s management to producers (McKerlie et al, 2006). RCM (2006) confirms that encouragement in the design of a more environmentally compatible product distinguishes mere collection and recycling programs from true EPR models which provide producers with clear incentives to design their products and packaging to be more environmentally friendly.

In the following sections, Manitoba's used tyre management approach is compared to the literature in terms of opportunities for pollution prevention that have been incorporated within the upstream and downstream lifecycle components.

4.7.4 Pollution Prevention Opportunities within the Downstream (End-of-Life) Lifecycle Components

This section presents a comparison of the opportunities for pollution prevention that have actually been incorporated within the downstream (end-of-life) tyre lifecycle component under Manitoba's Tyre Stewardship Plan, with the opportunities described in the literature. Primary objectives within the downstream (end-of-life) tyre lifecycle component are to Maximise Collection and to Maximise Resource Recovery.

4.7.4.1 Maximise Collection Objective

Goals within the Maximise Collection objective that enhance opportunities for pollution prevention include the development of Collection Infrastructure, Reduction to Landfill, Elimination of Stockpiles, Elimination of Illegal Dumping and Reduction of Local Authority Burden.

Collection Infrastructure

The TSM Plan establishes an efficient and cost-effective collection infrastructure incorporating all of the features identified in the literature. These include the establishment of a Producer Responsibility Organisation (PRO) (i.e. Tyre Stewardship Manitoba) for overall program management (Walls, 2006) and a tracking and registration system to ensure compliance (Tyre Track NZ, 2004). Also in accordance with the literature (Gertsakis et al, 2002) and (Jessen, 2005), consumers are required, through mandatory Product Take Back regulation, to return used tyres to the retailer (Marbek, 2006). The funding of the program (including collection, transportation and processing costs) is through a mandatory advanced disposal fee (ADF) or EcoFee, payable by the consumer upon purchase of new tyres in accordance with Houghton et al (2004) and Jessen (2005).

Reduction to Landfill, Elimination of Stockpiles and Illegal Dumping

The TSM Plan is committed to the collection and transportation for processing (reuse, recycling or recovery) of all used tyres in the Province, in order to achieve the goals of reduction to landfill and the elimination of stockpiling and illegal dumping (Weaver, 1996), (Jessen, 2005). TSM expects to maintain existing MTSB targets of 100 percent diversion from landfill (Marbek, 2006), (TSM, 2007a). Additional measures in the TSM Plan to maximise these objectives include a landfill ban (including all inappropriate forms of disposal), a formal tyre tracking system, higher penalties to prevent illegal dumping, plus additional funding and programs to target remaining stockpiles, as described by URS (2006) and Walls (2006). In achieving reductions to landfill, plus the elimination of stockpiles and illegal dumping, the health and environmental impacts (pollution) associated with these methods of disposal are effectively prevented.

Reduction of Local Authority Burden

Manitoba's tyre stewardship guideline specifies that the cost of managing designated wastes be borne by the stewards and users of the product, rather than by the taxpayer, consistent with the literature UNCED (1992), Gertsakis et al (2002) and URS (2006). The cost is in fact borne entirely by the users of the product (consumer) under the TSM plan.

4.7.4.2 Maximise Resource Recovery Objective

Following Maximise Collection, the second objective within the downstream lifecycle components that presents opportunities for pollution prevention is the Maximise Resource Recovery objective. This objective includes the goals of Market Development, Selection of Recovery Option and Resource Recovery Opportunities.

Market Development

The market development objective can be defined as to maximise the quantity, value and opportunities for reused, recycled and re-processed tyre material to be marketed for further uses (Jessen, 2005). The TSM Plan incorporates some of the measures identified in the literature for market development such as investment in research and development and financial incentives to increase the processing of recycled and re-processed tyre material (UNCED, 1992), (Jessen, 2005). Under the TSM Plan, a portion the Ecofee revenue will be used to fund Processor Incentive Payments (Processing Credits), a financial incentive payable upon proof of sale of approved recycled products. The TSM Plan does not however provide funding to prime recycled material markets (Jessen, 2005), or set measurable recycling and recovery targets for market development as prescribed by UNCED (1992), Jessen (2005) and Debo (2005). The TSM Plan also does not provide for a Government Procurement policy for recycled materials (UNCED, 1992), or for the establishment of industry standards for recycled materials (ETRMA, 2006), or for financial incentives to increase the demand for recycled rubber (Jessen, 2005) as described in the literature. Although some of these initiatives are likely to be beyond the jurisdiction of TSM, the TSM Board should be in a position to promote such initiatives by Government.

Selection of Recovery Option

Under the TSM Plan, recovery options are consistent with UNEP (2007a) guidelines, being based on a combination of environmental, economic and market considerations. The TSM Plan is required to demonstrate consistency with the Pollution Prevention Hierarchy as described by Weaver (1996) and Jessen (2005). Under the TSM Plan, Processor Incentive Payments (Processing Credits) encourage value-added processes and products in accordance with a Processing Credit Hierarchy, whereby a higher credit is paid for a higher value-added product requiring greater processing of the scrap tyres (TSM, 2007a). However the Processing Credit Hierarchy applies only to processed (recycled) products and energy recovery, thus there are no financial incentives provided under the TSM Plan to encourage pollution prevention opportunities within the reduction or reuse levels of the Pollution Prevention Hierarchy. TSM accepts the premise of the 4R hierarchy however in so far as long-term diversion of tyres to energy is not promoted under the Plan as a highly desirable use, with the Processing Credit Hierarchy offering higher credits for recycling than for energy recovery (TSM, 2007a).

The TSM Plan is also required to follow Manitoba's Economic Development and Acceptable Use Framework, which favours local processing, manufacturing and use of products from scrap tyres over the export of scrap tyres for the same purpose (Government Manitoba, 2006b), (TSM, 2007a). This is consistent with Jessen (2005) and UNEP (2007a) who state that for tyre material recovery to be viable, cost-effective markets must exist and that each country should evaluate alternatives according to their own realities. Finally the TSM Plan contains no references to the employment of Life Cycle Analysis (LCA) techniques in order to compare recovery options and optimise program performance as recommended by the OECD (2001a), Jessen (2005), ETRMA (2006) and others. The following section compares the resource recovery opportunities that are currently incorporated under Manitoba's recovery program with those presented in the literature.

4.7.4.3 Resource Recovery Opportunities

Resource Recovery Opportunities can be defined as all management options that present an opportunity for pollution prevention according to the Pollution Prevention Hierarchy, i.e. reduce, reuse, retread, recycling, energy recovery and proper disposal. As stated, there are no opportunities for 'reduction' within the recovery lifecycle component, as the purpose of the objective is to maximise recovery opportunities for used tyres already generated.

Reuse Option

Reuse options for part worn (used) tyres include second-hand purchase for further use and retreading (ETRMA, 2007). The TSM Plan allows collectors to cull used tyres for export use, and encourages the retreading of commercial truck tyres by placing the Ecofee on new truck tyres only, thereby contributing to the cost advantage associated with retreads. The TSM Plan contains no reference however to the retreading of passenger tyres option. The Chairman of the TSM Board stated that "passenger tyres are not made to be retreaded, and therefore we do not wish to encourage the process by giving any preferential treatment to retreaded passenger tyres" (G. Maidment, 8th September 2007, personal communication). The omission of the passenger tyre retreading option appears to be partly driven by a need to maintain certainty of supply for alternative processing options and partly as a result of technological difficulties. However there are solutions to these constraints, particularly with recourse to European Community strategies as described by Debo (2005) and URS (2006).

Recycling Option

The literature describes a wide variety of recycling options from a wide range of sources, from the use of whole tyres for engineering projects through to shredding and grinding for multiple end uses. The Manitoba program recycles tyres into a wide variety of products, as described within the case study results, so that the capacity to process scrap tyres generated within the Province has increased from less than 1 percent in 1991 to a predicted 100 percent by 2009 - 11(RCM, 2005). Through further market development as described in the TSM plan, options are expected to diversify further. However market development potential may be reduced due to the limited range of market development options included under the plan. In addition, opportunities selected may not be optimised for sustainability, in terms of pollution prevention, due to limitations in the selection of recovery option criteria employed under the plan as described.

Energy Recovery

Jessen (2005), ETRMA (2006) and Brigestone Americas (2007) describe some of the short-term advantages and longer-term disadvantages of recovery of the embedded energy of tyres as Tyre Derived Fuels (TDF). In terms of the Pollution Prevention Hierarchy, the energy recovery option is second only to disposal in terms of least preferable options (EC Commission, 2006b). In 1995, most of the scrap tyres generated within the Province were diverted for energy recovery. Commendably by 2003 only 12 percent were diverted for energy recovery, with numbers expected to continue falling to a predicted 125,000 PTE's by 2011 (RCM, 2005), (TSM, 2007a). Van Beukering & Janssen (2001) also consider the option of storage of tyres in monofill pending future emerging opportunities for processing or energy recovery, an option not considered under the TSM Plan.

4.7.5 Pollution Prevention Opportunities within the Upstream Tyre Lifecycle Components

This section presents a comparison of the opportunities for pollution prevention that have been incorporated within the upstream tyre lifecycle components (i.e. production and consumption) under Manitoba's Tyre Stewardship Plan, with the opportunities described in the literature.

4.7.5.1 The Production Lifecycle Component

The production stage of the tyre lifecycle is significant because it is the most effective phase to incorporate Design for the Environment (DfE) objectives for environmental improvement (Brady et al, 2003). Design for the Environment opportunities within the production lifecycle component of tyres are described in the literature by Weaver (1996), Jessen (2005), Rotmann (personal communication, 7th November 2006) and others, and include the goals of - Maximise Durability, Maximise Recyclability and Maximise Recycled Material Content. These authors describe how economic, regulatory and informational policy instruments are employed within stewardship type tyre management programs to provide incentives to encourage Design for the Environment (DfE) opportunities by tyre manufacturers. However, as there are no tyre manufacturers within Manitoba, the TSM plan includes no policy instruments to provide any incentives to tyre manufacturers to encourage DfE and thus achievement of these goals. The TSM plan simply describes how the tyre manufacturing industry has achieved considerable success in extending tyre life, reducing the number of tyres required for a given mileage.

4.7.5.2 The Consumption Lifecycle Component

Van Beukering & Janssen (2001), Gertsakis et al (2002) and Jessen (2005) describe in the literature how increasing tyre longevity should be the primary objective for pollution prevention within the consumption lifecycle component of tyres. Van Beukering & Janssen (2001) describe how tyre maintenance and driving behaviour are the main factors influencing longevity and hence environmental performance in the consumption stage of tyres, with the biggest cause of tyre wear being over or under-inflation (Debo, 2005). The TSM plan includes an integrated public information and education program to all key players to promote the benefits of improved vehicle and tyre maintenance (optimal tyre pressures and wheel alignment) by consumers, in order to minimise waste, consistent with strategies described by Gertsakis et al (2002) and Jessen (2005). The TSM public information and education program includes brochures, a website, a consumer information line and ongoing support of the industry-led “Be Tire Smart – Play Your PART” campaign.

4.8 Summary of Results - Achievement of Pollution Prevention Opportunities under Manitoba's Tyre Stewardship Plan according to the Pollution Prevention Hierarchy

With its central focus on source reduction, the Pollution Prevention Act of 1990 (USEPA, 2007) established the Pollution Prevention Hierarchy of preferred options for dealing with environmental pollution, and officially places prevention at the top of the list (CSS, 2007). The Act states that pollution should be prevented or reduced at source whenever feasible. Pollution that cannot be prevented should be recycled in an environmentally safe manner. Pollution that cannot be prevented or recycled should be treated in an environmentally safe manner, and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner (USEPA, 2007b).

As described, within the downstream (end-of-life) tyre lifecycle components, i.e. achievement of the Maximise Collection and the Maximise Resource Recovery objectives, opportunities for pollution prevention are limited to reuse, recycling and energy recovery of used tyres already generated. Within the Maximise Collection objective, opportunities for pollution prevention depend on achievement of the three goals of Reduction to Landfill, Elimination of Stockpiles and Elimination of Illegal Dumping. Through 100 percent diversion from landfill, plus the near elimination of illegal dumping and remaining stockpiles, the health, social and environmental impacts associated with these methods of disposal are effectively eliminated. Therefore Manitoba's Scrap Tyre Program can be considered effective in maximising opportunities for pollution prevention within the collection lifecycle component.

Manitoba's Scrap Tyre Program can also be considered effective overall in terms of the Maximise Resource Recovery objective, with a projected figure of 100 percent diversion for reuse, recycling or recovery. In terms of pollution prevention according to the Pollution Prevention Hierarchy, the reuse of used tyres is preferable to recycling. However the retreading of passenger tyres appears to be actively discouraged under Manitoba's program, partly to maintain certainty of supply for alternative processing options and partly as a result of technological difficulties. In terms of recovery options, this represents a missed opportunity at the high 'reuse' level of the pollution Prevention Hierarchy. Also in terms of the Pollution Prevention Hierarchy, recycling of tyre material is preferable to energy recovery. In this respect, Manitoba's program is effective, offering higher processing credits for recycling than for energy recovery. In addition, as a proportion of total recovery options, the number of tyres used for TDF is expected to continue to decline.

Within the upstream tyre lifecycle components, i.e. production and consumption, there are opportunities for pollution prevention within the highest 'reduction' or 'prevention' level of the Pollution Prevention Hierarchy. Within the production component, opportunities for pollution prevention include Design for the Environment objectives in order to Maximise Durability, Maximise Recycled Material Content and Maximise Recyclability. Maximising the durability (average life expectancy) of new tyres would reduce the number of new tyres required and hence reduce the generation of tyres as waste. Maximising tyre durability is thus a highly desirable option, operating within the highest 'prevention' level of the Pollution Prevention Hierarchy. Design changes to enable a greater percentage of recycled rubber in new tyre production would also operate within the highest 'prevention' level of the Pollution Prevention Hierarchy, as it would reduce the quantity of virgin material required for new tyres. Maximising resource recovery potential is also desirable as it would enable the enhancement of pollution prevention opportunities within the end-of-life reuse and recycling levels of the pollution prevention hierarchy. Unfortunately, as the tyre manufacturers are external to Manitoba, they are not required to assume any responsibility for the end-of-life impacts of their products, so none of the Design for the Environment opportunities for pollution prevention are likely to be implemented under the TSM Plan.

Within the consumption lifecycle component, the primary opportunity for pollution prevention is to increase tyre longevity (average life expectancy). Maximising tyre longevity reduces the number of new tyres required and hence reduces the generation of tyres as waste, thus also operating within the highest 'prevention' level of the Pollution Prevention Hierarchy. Tyre maintenance and driving behaviour are the main factors influencing environmental performance at the consumption stage (Nicoletti and Notarnicola, 1999), (van Beukering & Janssen, 2001). TSM's intended provision of an integrated public education and information program to promote tyre longevity through tyre maintenance means that Manitoba's Program is likely to be at least partly effective at promoting pollution prevention opportunities within the consumption component of the tyre lifecycle.

5 Conclusions

5.1 Introduction

The aim of the research has been to identify opportunities to enhance the sustainability goal of pollution prevention through product stewardship and EPR policy approaches to used tyre management, and to compare these with the pollution prevention opportunities that have been incorporated into such a stewardship type policy approach overseas. The research succeeds in identifying numerous opportunities to enhance the sustainability goal of pollution prevention throughout a tyre's lifecycle, and furthermore, the case study demonstrates that many of these opportunities are actually achievable. The report describes key mechanisms (strategies and policy instruments) employed within stewardship type approaches overseas to achieve these opportunities, and also identifies some of the difficulties encountered in enhancing pollution prevention opportunities through stewardship type approaches. It is beyond the scope of this report to provide detailed reasoning for the achievement or non-achievement of all of these opportunities, however such reasonings have been requested, particularly regarding implications for New Zealand. Thus these are included as far as possible without losing sight too far of the research aims and objectives.

5.2 Key Findings From the Case Study

The key conclusion from the findings of the case study is that, of the pollution prevention opportunities within each tyre lifecycle component identified in the literature, many are actually achievable through the implementation of a product stewardship/EPR type policy approach to used tyre management. Through the development of an effective collection system, along with tyre disposal restrictions, Manitoba's program diverts 100 percent of used tyres generated within the Province to alternative uses, i.e. reuse, recycling and/or energy recovery. This effectively eliminates all of the downstream pollution impacts associated with the disposal of used tyres to landfill, stockpiles and illegal dumping, and also promotes greater efficiency in the use of resources, reducing the pollution and scarcity impacts associated with virgin material use. In addition, and central to stewardship principles, Manitoba's program also achieves the objective of reducing local authority burden for the management of 'end-of-life' tyres.

The literature review also reveals opportunities for pollution prevention within the upstream (i.e. production and consumption) tyre lifecycle components. Improvements within the upstream lifecycle stages can reduce the number of new tyres required, and hence reduce the overall number of waste tyres generated. These changes operate therefore within the highest 'prevention' level of the pollution prevention hierarchy. Manitoba's program enhances opportunities for pollution prevention at the 'prevention' (or reduction) level, within the consumption lifecycle component, through the encouragement of vehicle and tyre maintenance for tyre longevity. However, as there are no tyre manufacturers within the Province of Manitoba, none of the opportunities for pollution prevention that are theoretically achievable through Design for the Environment changes within the production component are achieved.

The case study findings also highlight a number of constraints to the achievement of pollution prevention objectives within different lifecycle components, with the lack of tyre manufacturers in the Province likely to be the most significant. As described in the literature, a key goal of EPR policy approaches is to provide incentives for producers to incorporate Design for the Environment (DfE) changes. Opportunities for pollution prevention through DfE changes within the production lifecycle component include Maximising Durability and Maximising the Recycled Material Content of tyres, both operating within the highest 'prevention' level of the pollution prevention hierarchy. Maximising Recyclability is also highly desirable as it enhances pollution prevention opportunities at the end-of-life reuse and recycling levels of the pollution prevention hierarchy. However, as there are no tyre manufacturers in Manitoba, none of these higher-level pollution prevention opportunities have been incorporated under Manitoba's program.

A further constraint regarding opportunities for pollution prevention concerns the recovery of used tyre resources under Manitoba's program. Although the program recovers 100 percent of used tyre material generated within the Province, limitations were identified within both the Selection of Recovery Option and the Market Development objectives, when compared to the literature. Firstly, under Manitoba's program, funding (processing incentives) for recovery options are selected (prioritised) according to a Processing Credit Hierarchy. This favours 'value added' options, i.e. more highly processed options that provide the greatest economic benefit to Manitoba. Recovery options selected under Manitoba's Processing Credit Hierarchy are not necessarily consistent therefore with those considered most desirable for resource recovery according to the Pollution Prevention Hierarchy. Most significantly, 'reuse' options, which operate at the highest 'reuse' level of the pollution prevention hierarchy for recovery opportunities, are not included in Manitoba's Processing Credit (incentive) Hierarchy. Under Manitoba's program some 'part worn tyres' are exported for further use, and the retreading of commercial truck tyres is encouraged, however the retreading of passenger tyres is actively discouraged. This omission appears to be partly driven by a need to maintain certainty of supply for alternative processing options and partly as a result of technological difficulties. Manitoba's Processing Credit Hierarchy does however favour recycling (re-processing) over energy recovery, consistent with the pollution prevention hierarchy. Manitoba's recovery selection criteria also fail to incorporate Life Cycle Analysis techniques, in order to identify trade-offs and optimise environmental performance. This further hinders Manitoba's resource recovery program regarding prioritising and enhancing opportunities for pollution prevention.

In terms of market development, Manitoba's program fails to incorporate measures such as funding to prime recycled material markets, Government Procurement for recycled materials and industry standards for recycled materials, in order to further develop recovered material markets, thus hampering further opportunities for pollution prevention. A yet further constraint to the achievement of pollution prevention objectives concerns the fact that targets for recycling and/or recovery are still to be developed under Manitoba's EPR program.

Conclusions can also be drawn regarding the change from a product stewardship to an EPR approach in Manitoba. From the case study, there appear to be few advantages gained from the change, in terms of enhancing opportunities for pollution prevention. Improvements to the program such as the inclusion of all types of tyre, and transportation and processor credits that more accurately reflect true costs and provide extra processing incentives, could have been achieved under the existing product stewardship approach. Manitoba's approach is consistent with the 'blurring', as described in the literature by Nicol & Thompson (2007a), of the differences between product stewardship and EPR concepts, particularly regarding the broadening of responsibilities towards the producer. Manitoba's EPR approach is inconsistent with the key principle of EPR, that the producer's responsibility for a product is extended to the post-consumer stage of a product's lifecycle (OECD, 2001b). Despite representing international tyre manufacturers, none of the 'tyre stewards' on the new Tyre Stewardship Manitoba board are tyre manufacturers. Therefore the change to an EPR approach does not alter the fact that tyre producers still have no physical, financial or organisational responsibilities for their end-of-life products under Manitoba's scheme. From the case study, it can be concluded therefore that Manitoba's proposed EPR program still more closely resembles the original 'shared responsibility' product stewardship approach, whereby responsibilities are broadened towards other tyre stakeholders, but without necessarily including producers.

It can also be concluded, through comparison with the literature, that Manitoba's use of economic instruments in the form of an Ecofee (advanced disposal fee (ADF)), may be inconsistent with polluter pays principles and could therefore be considered inequitable in terms of policy evaluation criteria. Under Manitoba's use of an ADF, the consumer funds the entire program, yet the consumer is not in a position to be able to influence the overall lifecycle pollution impacts of tyres beyond tyre maintenance to increase tyre longevity at the consumption stage. In addition, individual consumers have no direct representation on the Tyre Stewardship Board. The New Zealand Parliamentary Commissioner for the Environment (2006) states that where the costs and responsibilities for waste are shared between the user and producer of the goods, the distribution of these costs needs consideration so that the costs do not fall unfairly on particular groups. The OECD (2001b) states that if the consumer is required to pay an ADF to cover the additional costs for treating their product at its post-consumer phase, then the physical responsibility should be extended to the producer. Under Manitoba's program, where the consumer funds the entire program operation and producers have no responsibilities, the equity of the program is therefore questionable. In addition, as described, where the ADF is payable only by the consumer, no incentives are provided to producers for Design for the Environment.

5.3 Implications of the Research

The conclusions from the case study have numerous implications for the development of product stewardship and EPR policy approaches for tyres, including the development of such an approach in New Zealand. The most important implication from the analysis is that there are significant opportunities for pollution prevention within both the downstream (end-of-life), and upstream (consumption and production) tyre lifecycle components, all of which are theoretically achievable in New Zealand. However conclusions derived from the case study also illustrate a number of constraints to the overall effectiveness of product stewardship and/or EPR policy approaches to used tyre management, regarding the achievement of pollution prevention and sustainability objectives.

The most significant constraint to the achievement of pollution prevention opportunities, with implications for New Zealand, is that only components of a product's lifecycle that occur within the region in question can be influenced by a country's stewardship policy. Components that occur overseas, (e.g. extraction and/or production), are effectively outside the realm of influence of a country's stewardship policy (URS, 2006). In New Zealand approximately 75 percent of tyres are manufactured externally. Two companies, Bridgestone and South Pacific Tyres (URS, 2006), manufacture the remaining approximately 25 percent within New Zealand. However both are subsidiaries of the global U.S. owned Bridgestone (BridgestoneAmericas, 2007) and Goodyear Tire and Rubber Corporation (Goodyear, 2008) organisations. Thus EPR, with its emphasis on producer responsibility, may not be a realistic solution to used tyre management in New Zealand. There may be limitations in the degree to which New Zealand domestic policy could influence product design through the provision of financial or regulatory incentives to overseas owned manufacturers.

Furthermore, any stewardship scheme that includes imported tyres would also have to be compatible with international standards and regulations such as the WTO Agreement on Technical Barriers to Trade (TBT) (NZ MfE, 2005). This states that use of economic instruments that include certain fees/levies must apply to all imported and domestic products (NZ MfE, 2005). TBT regulations are designed to ensure that standards, testing and certification procedures do not create unnecessary obstacles to trade and are not more trade restrictive than necessary to fulfill a legitimate objective (NZ MfE, 2005).

A further implication from the study, regarding the development of a tyre policy in New Zealand, is the importance of distinguishing between EPR approaches which place responsibility almost solely with producers, and product stewardship which involves sharing responsibility across a range of affected parties (Product Stewardship Council, 2006). Where producers are largely external to the region in question, a product stewardship 'shared responsibility' approach is likely to be more suitable. This may be particularly true for 'consumable' type products such as tyres, packaging (paper, glass, plastic), batteries, oil, printer cartridges etc, which are constructed from resources that can be more easily separated and reused, or recycled domestically into new products. For such products, a product stewardship approach might effectively internalise the environmental costs of disposal, in order to fund collection and provide incentives for reuse and recycling. In addition to reducing the pollution impacts of disposal and virgin material use, such a product stewardship approach might overcome the necessity for producer involvement.

Conclusions from the case study also have implications regarding the use of Advanced Disposal or Recycling Fees (ADF/ARF) to fund stewardship programs. Fistly, it is important where economic instruments such as ADF are utilised within a policy approach under the Polluter Pays Principle, to consider whether the allocation of financial responsibilities is equitable, i.e. whether their use would satisfy standard equity policy evaluation criteria. Secondly, the use of ADF or ARF's alone in a policy approach may not provide any incentives for Design for the Environment (DfE) for producers. It would be necessary also to mandate recycling or recovery rate targets or material bans, or to ensure direct producers' downstream management of products entering the waste stream (OECD, 2005), (Knight et al, 2006), (Walls, 2006). Even where an ADF is payable by the producer, in practice such cost signals may be muted by the producer’s ability to pass on the cost to the consumer (OECD, 2005).

A further implication from the study is that for any type of stewardship approach, it would be beneficial to evaluate the environmental impacts and cost-effectiveness of alternative pollution prevention opportunities through the incorporation of Life cycle Assessment (LCA) techniques (OECD, 2001a), (NZBCSD, 2005), (ETRMA, 2006). While for short-term policy development it is clearly necessary to balance sustainability with cost-effectiveness, i.e. to first develop markets and give tyre material a positive value, the longer-term aim should be for recovery options to shift up the Pollution Prevention Hierarchy towards greater pollution prevention and resource efficiency.

A general implication from the study is that in order to promote longer-term zero-waste objectives, it is clearly more difficult to modify production behaviour (Design for the Environment) from a waste management perspective than it would be from a product policy perspective. It is therefore important to consider the implications of Integrated Product Policy (IPP) approaches in Europe, which focus on 'front-of-pipe' opportunities at the production stage rather than relying on 'end-of-pipe' waste management solutions, i.e. 'the tail wagging the dog!' Through the incorporation of the identified sustainability strategies at the design and production stage, the problem of whether or not the producer is within the region in question, would be largely solved.

There are also wider economic implications that result from the research. To achieve more sustainable patterns of production and consumption overall, it is necessary to deal with market failures that prevent markets from functioning properly. This includes moving towards true resource pricing, i.e. prices that include scarcity, environmental and social costs, at a global economic level. This includes, for example, the removal of perverse incentives that currently mean that virgin materials have a competitive price advantage over recycled resources.

5.4 Assessment of the Method

The case study method was found to be appropriate for meeting the research objectives, as the details and context gained regarding Manitoba's tyre stewardship approach could not have been obtained through a survey method. In addition there would have been considerable time and language constraints associated with a survey method. Clearly a multiple (or comparative) case study approach would have yielded more data and been more robust in terms of replication and increasing external generalisability (Yin, 2003). However, selection of a single rather than a multiple case study approach was appropriate given the time constraints and the complexity of the research topic (Yin, 2003).

The broad diversity and complexity of policy areas and concepts integral to the research question meant that the literature reviewed was drawn from a wide range of disciplines, and that there was limited existing data linking many of the concepts. This presented difficulties in the development of the conceptual framework, which was very time consuming. Time constraints also limited the ability to thoroughly review the diversity of overseas programs, and placed some restraints on both data collection and analysis of the case study data.

A further constraint relating to the literature review, the significance of which was only revealed in hindsight, was that of all the extensive literature reviewed pertaining to product stewardship and EPR policy approaches, each appeared to make the assumption that products were manufactured within the region in question. Yet globally, a high proportion of goods are manufactured elsewhere and then imported for use. In consideration of this fact, it seems an extraordinary omission that this significant operational constraint to the effective functioning of stewardship type approaches was not even considered within the extensive body of literature reviewed. The only related reference found was in the New Zealand government commissioned report which stated that components that occur overseas (e.g. extraction and/or production), are effectively outside the realm of influence of a country's stewardship policy (URS, 2006). The significance of this statement became increasingly obvious during the analysis of the case study data. To clarify this issue, four EPR experts were emailed the question "Is the requirement for the producer to be within the region in question a pre-requisite for the successful implementation of a 'full' EPR approach?" The sole reply was from Thomas Lindhqvist, the Swedish 'inventor' of EPR who replied that "I don't think anyone has addressed in any detail what you focus on in your email. Your analysis and thoughts on these issues should be a good fundament for a research report" (T. Lindhqvist, 1st December 2007, personal communication).

This omission had implications regarding case selection for the case study. An important criterion for case selection was comparable context to New Zealand. Manitoba is relatively comparable to New Zealand in many important respects such as population, GDP and primary production. However the two regions differ in that Manitoba has no tyre manufacturing within the region, whereas in New Zealand, approximately 25 percent of tyres are manufactured domestically. Unfortunately the significance of this important difference had not been apparent at the time of case selection, due in part to the fact the concept had not been revealed throughout the literature review and subequent development of the conceptual framework. Furthermore, even though initial set of questions for data collection included the question of whether tyres were manufactured within the region, unfortunately, as described, no responses to these questions were received.

A further major criterion for case selection was evidence of ongoing developments to improve the efficiency of the program. In addition to early innovation, having operated a tyre program since 1992, the Manitoba program had recently undergone a further transition from a product stewardship to an EPR approach. The new program plan published on April 19th 2007 referred to "a seamless transition period, when the existing Tyre Stewardship Program will be phased out and replaced by the activities of Tyre Stewardship Manitoba" (TSM, 2007, p3). Under the plan, the original product stewardship board (the Manitoba Tyre Stewardship Board) had already been dissolved, and membership of new tyre Board established. In addition a new Tire Stewardship Manitoba website had been established on 2nd October 2006. However with hindsight it became apparent that the new Tyre Stewardship Manitoba program was far from operational. Although submissions to the government on the new plan closed on August 7th 2007, to date (April 2008), the results of the submissions have still not been published. Furthermore the new Tire Stewardship Manitoba website has remained static since its launch in 2006.

Another important criterion for case selection was accessibility of data. In comparison with other schemes investigated through the literature review, there appeared to be a broad diversity of data sources for Manitoba, along with an encouraging sense of pride and enthusiasm, particularly from the Canadian/Manitoban government websites. In addition I had received enthusiastic offers of cooperation from two key stakeholders prior to case selection. However, this initial encouragement did not translate into great success in terms of data collection. As described, response to the initial set of questions and personal interviews was very poor. Out of approximately forty questions emailed to stakeholders, as identified in the research methods chapter, only five responses were received. Following completion of the research report it can be surmised that the lack of response was probably due, in addition to time restraints on the part of the respondents, to the fact that the answers to some of the questions were already available within published documents. Also, since the new Tyre Stewardship Board is still undergoing consultation with government, and the new program is still not operational, it is likely that individual stakeholders contacted were either unable or unwilling to divulge more specific or more leading program details that might be subject to criticism or change. From past experience of data collection, the most constructive method of holding personal interviews at a distance has been through telephone conversations. Financial constraints meant that the cost of telephone calls to Canada, along with the time differences, prohibited this option.

Data collection was therefore almost entirely from document analysis. With hindsight, and with fewer time and funding constraints, both case selection and data collection might have benefitted from more comprehensive and extensive interviews. Even a small number of personal telephone calls might have provided additional data, established relationships and relieved some of the frustration encountered with the limited responses during data collection.

The qualitative analysis software program NVivo (QSR International, 2008) was a useful aid, both for development of the conceptual framework and for data analysis. Due the broad nature and complexity of the topics included in the analysis, the NVivo program proved invaluable in developing the hierarchy of categories and sub-categories, and the links between them. However considerable operational difficulties were experienced with the NVivo data analysis software. Despite numerous communications with the suppliers, reloading the program and adjusting program parameters, an error that frequently and without warning closed the program without saving changes persisted. This was very frustrating and contributed to time delays in the development of the conceptual framework and subsequent analysis of data. However, in light of the release of a new version of NVivo for 2008, I would use NVivo or an alternative data analysis program for subsequent research.

5.5 Future Research

In order to further the development of a stewardship type policy approach to tyres in New Zealand, it would be beneficial to subject further used tyre management schemes to analysis according to concepts now developed within the framework of this research. This might include both a survey method and multiple case studies. Case selection would include cases that have successfully incorporated Design for the Environment objectives, and also those where tyres are manufactured both within and externally to the region. This might provide additional data relevant to enhancing pollution prevention opportunities at all lifecycle stages, and also potential solutions to some of the constraints encountered within the production and extraction lifecycle components. A multiple case study approach would also greatly increase the degree of generalisation that could be attributed to the study results.

Finally, all manner of products are increasingly manufactured externally to the region where they are consumed, a critical issue that is not addressed sufficiently with respect to product stewardship and EPR policy approaches in the literature. Therefore it would be useful to explore alternative strategies for internalising the responsibilities for pollution prevention to producers who are external to the region in question. As confirmed by Lindhqvist (1st December 2007, personal communication), "I don't think anyone has addressed in any detail what you focus in your mail. Your analysis and thoughts on these issues should be a good fundament for a research report. Good luck!"

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Appendices

Appendix 1: Health and Environmental Characteristics of Tyres

The UNEP Basel Convention 2007 - Tyre Guidelines (2007a) provides a comprehensive description of the structural, health and environmental characteristics of tyres. In terms of structure & components, 75-80 percent of the weight of car and truck tyres is synthetic or natural rubber (UNEP, 2007a). A further 15 percent by weight is made up of chemicals including compounds of copper, zinc, cadmium and lead, acidic solutions and organohalogens (URS, 2006). The remainder consists of carbon black, steel wire or textile (URS, 2006). Tyres are difficult to recycle because the steel or fabric belts and metal beads must be separated (CAE, 1992). Also because the carbon black and other compounds are combined into the rubber during the manufacturing process, they are difficult to separate for reuse (URS, 2006). Tyres are designed and constructed to be durable in order to maximise their life (URS, 2006) and are not biodegradable, given that the time they take to decompose is indeterminate (UNEP, 2007a).

In terms of land-use, used tires are high volume and not easily compactable, so even when shredded, contribute significantly to landfill volumes (Debo, 2005), (UNEP, 2007a). Tyres also trap gases in their toroidal structure which surge to the surface and break the landfill structure (Debo, 2005) causing instability and hindering future reclamation (URS, 2006). When illegally dumped or stockpiled, in addition to the visual impact, scrap tyres can block water channels, creeks and storm water drains. Resulting changes in flow patterns can lead to erosion and the silting up of water flows due to the retention of solid wastes contributes to flooding (UNEP, 2007a). Stockpiled and illegally dumped tyres also cause visual pollution and are aesthetically unpleasant (Debo, 2005), (DEC, 2006).

When disposed of inappropriately, whether to landfill, stockpiled or illegally dumped, the hazardous nature of their constituents means that tyres are a threat to health and the environment (UNEP, 2007a). Tyre leachate can cause contamination (eco-toxicity of groundwater and soil (URS, 2006), (UNEP, 2007a). Data on the toxicity of tyre leachate is limited, but preliminary studies indicate that leachate from tyres in aquatic environments may be toxic to aquatic organisms (DEC, 2006). The round shape of tyres coupled with their impermeability enables them to hold water and other debris (e.g. decaying leaves) for long periods of time. This turns them into ideal breeding sites for weeds, rodents and insects such as mosquitoes that can transmit diseases such as dengue and yellow fever (UNEP, 2007a), (Debo, 2005). The shipment of used tyres not only spreads mosquitoes that have a limited reach, but also contributes to the introduction of non-native species, which are often more difficult to control and so increasing the risk of disease (UNEP, 2007a).

Used tyres contain a significant amount of embodied energy and are therefore flammable and a fire risk with significant health and environmental implications, although they do not combust spontaneously (UNEP, 2007a), (Weaver, 1996). Prone to heat retention and owing to their own open structure, stockpiled tyres facilitate the occurrence of fires by arson, or due to accidental causes such as lightning (UNEP, 2007a). Once ignited, tyre fires are difficult and expensive to extinguish and can burn for months (Debo, 2005), (UNEP, 2007a). Tyre fires generate heavy black smoke, toxic oil contaminants, dioxins and furans as well as oxides of nitrogen and sulphur (DEC, 2006), causing a severe pollution risk to air, soil, waterways & groundwater (Debo, 2005), (UNEP, 2007a).

Appendix 2: An Overview of Product Stewardship and EPR Policy Approaches to Used Tyre Management Implemented Overseas

Country	State	Name and Type of Scheme plus Date Implemented	Main Instrument	PRO/Operator	Used tyres generated annually (tyres, tonnes or PTE's)	Collection and/or Recovery Rate (tyres, tonnes or passeger tyre equivalents (PTE's))
Australia	New South Wales	Voluntary product stewardship scheme under development in 2004 (DEC, 2006)	Tyre levy currently charged to consumers at point of sale (DEC, 2006)		5 million tyres (50,000 tonnes) (DEC, 2006)	
Canada	Alberta	Tire Recycling Management Programme. Product Stewardship scheme implemented in 1992 (Marbek, 2006)	Mandatory Advanced Recycling Fee (ARF) (Marbek, 2006)	Alberta Recycling Management Authority (ARMA) (Marbek, 2006)		From 2.83 million PTE's in 2000-2001 to 4.16 million PTEs in 2004-05 (Marbek, 2006)
	British Colombia	Financial Incentives for Recycling Scrap Tires (FIRST) Programme. Product Stewardship implemented in 1991, changing to EPR in 2006 (NWPSC, 2007), (Marbek, 2006).	Mandatory Advanced Recycling Fee (ARF) (Marbek, 2006).	Tyre Stewardship British Columbia (TSBC) (NWPSC, 2007)	2.5 to 3 million PTE's (Marbek, 2006).	38 million PTEs as of March 2004. Annual recovery rate approx. 100% (Jessen, 2005), (EC, 2007a).
	Manitoba current program	Used Tire Management Program . Voluntary from 1992. Mandatory Product Stewardship program from 1995, under change to EPR program 2007 (Marbek, 2006), (MTSB, 2007b)	Mandatory Advanced Recycling Fee (ARF) paid by consumers (Marbek, 2006)	Manitoba Tire Stewardship Board, changed to Tyre Stewardship Manitoba in 2007(TSM) (Marbek, 2006), (TSM, 2007a), (MTSB, 2007a)	835,000 tyres or 1.3 million PTE's (Marbek, 2006), (TSM, 2007a).	1,390,886 PTE's diverted from landfill (Marbek, 2006) Over 9.5 million PTE's to date (Marbek, 2006)
	Ontario	Financial Incentives for Recycling Scrap Tires (FIRST) Programme	Deposit Refund Scheme under development (Marbek, 2006)			
Japan		EPR approach. Part of end-of-life vehicle (ELV) recycling regulations since 2003 (Ogushi & Kandlikar, 2007)	Product Take-back legislation (Ogushi & Kandlikar, 2007)	Japan Automobile Recycling Promotion Center (JARC) (Ogushi & Kandlikar, 2007)		
Korea		Implemented January 1992 (Lease, 2002)	Deposit Refund Scheme, payable by producers/ importers, reimbursed according to recovery rate achieved plus environmental labeling program (Lease, 2002).	The Korea Resources Recovery and Reutilisation Corporation (Lease, 2002)		
Taiwan		Recycling Fund Management Committees (RMF's) est. 1998 under Waste Disposal Act. EPR approach implemented with amendments pending (Lee, 2003), (Lease, 2004).	Mandatory product take-back + ARF paid by producers /importers to state recycling fund. Compulsory product/ collection point labeling + voluntary Green Mark scheme (Lee, 2003)	Recycling Fund Management Committees (RMFC's) under Taiwanese EPA (Lee, 2003)		
USA	California	California Integrated Waste Management Board Tyre Project under California Tire Recycling Act. Product Stewardship approach implemented 2004. Under re-development (Jessen, 2005), (PSI, 2006)	Mandatory Advanced Recycling Fee (ARF) + 5% price preference for tyre-derived products (Jessen, 2005)	State run PSO - Product Stewardship Institute to integrate key stakeholders (PSI, 2006)	33.5 million tyres in 2002 (Jessen, 2005)	75% in 2005, Program to remediate illegal tyre piles + amnesty days (Jessen, 2005)
	Minnesota	Established 1984 (MPCA, 2007)	Voluntary tyre disposal fee charged by retailers, $20,000 a day fine for dumping by retailers/ transporters (MPCA, 2007)	Minnesota Pollution Control Agency (MPCA, 2007)		
EU	Austria	Free market scheme (ETRMA, 2007)	Deposit refund system (ETRMA, 2007)		55,000 t in 2004 (ETRMA, 2006)	100% in 2004 (ETRMA, 2006)
	Belgium	Producer responsibility approach since 2004 (ETRMA, 2007)	Statutary Product take-back (ETRMA, 2007)	RecyTyre (ETRMA, 2007)	82,000 t in 2004 (ETRMA, 2006)	83% in 2004 (ETRMA, 2006)
	Bulgaria	Free market scheme (ETRMA, 2007)			10,000 t in 2004 (ETRMA, 2006)	zero in 2004 (ETRMA, 2006)
	Czech Republic	Producer responsibility/ take back approach (ETRMA, 2007)	Product take back/ fund scheme (ETRMA, 2007)		80,000 t in 2004 (ETRMA, 2006)	15% in 2004 (ETRMA, 2006)

Appendix 2 continued…

Country	State	Name and Type of Scheme plus Date Implemented	Main Instrument	PRO/operator	Used tyres generated annually (tyres, tonnes or PTE's)	Collection and/or Recovery Rate (tyres, tonnes or passeger tyre equivalents (PTE's))
	Denmark	State Tax system since 1995 (ETRMA, 2007)	Product take back/ fund scheme/ tax system (ETRMA, 2007). Fee & subsidy scheme with state procurement initiatives (DEPA, 2007)	Joint - Danish Tyre Trade Environmental Foundation, Environment & Energy Ministry, Danish Motor Trade Association, Association of Danish Recycling Industries (DEPA, 2007)	45,000 t in 2004. Stockpiles eliminated (ETRMA, 2006)	100% in 2004. Retreading prioritised (ETRMA, 2006), (DEPA, 2007)
	Estonia	Free market scheme (ETRMA, 2007)			11,000 t in 2004 (ETRMA, 2006)	36% in 2004 (ETRMA, 2006)
	Finland	Producer responsibility approach implemented 1996 (ETRMA, 2007)	Statutary product take-back/funding system (ETRMA, 2007)	Suemen Rengaskierratys Oy (ETRMA, 2007)	45,000t in 2004: 44,698t in 2006 (FTR, 2007)	100% in 2004 (ETRMA, 2006). 16,600t retreaded, 303,077 tyres utilised as material, 8,732 tyres to TDF to 2007 (FTR, 2007)
	France	Free market/ producer responsibility approach since 2004 (ETRMA, 2007)	Statutary 'take-back' system (ETRMA, 2007)	Aliapur (ETRMA, 2007)	398,000 t in 2004 (ETRMA, 2006)	90% in 2004 (ETRMA, 2006)
	Germany	Free market scheme (ETRMA, 2007)			585,000 t in 2004 (ETRMA, 2006)	94% in 2004 (ETRMA, 2006)
	Greece	Free market / Producer Responsibility approach since 2005 - new legislation pending (ETRMA, 2007)	Statutary product take-back system (ETRMA, 2007)	eco-elastiko (ETRMA, 2007)	48,000 t in 2004 (ETRMA, 2006)	33% in 2004 (ETRMA, 2006)
	Hungary	Producer responsibility approach since 2004 (ETRMA, 2007)	Statutary product take-back/ Tax system (ETRMA, 2007)	HUREC (Tyre Recycling Public Benefit Company) (ETRMA, 2007)	46,000 t in 2004 (ETRMA, 2006)	85% in 2004 (ETRMA, 2006)
	Ireland	Free market system (ETRMA, 2007)			40,000 t in 2004 (ETRMA, 2006)	15% in 2004 (ETRMA, 2006)
	Italy	Free market system changing to Producer Responsibility (ETRMA, 2007)		Eco.Pne.US (ETRMA, 2007)	380,000 t in 2004 (ETRMA, 2006)	95% in 2004 (ETRMA, 2006)
	Latvia	State/Tax system (ETRMA, 2007)			9,000 t in 2004 (ETRMA, 2006)	22% in 2004 (ETRMA, 2006)
	Lithuania	Free market scheme (ETRMA, 2007)			9,000 t in 2004 (ETRMA, 2006)	25% in 2004 (ETRMA, 2006)
	Netherlands	Product Stewardship approach since 2003 (ETRMA, 2007)	Statutary 'take-back' system (ETRMA, 2007)	RecyGEM B.V (ETRMA, 2007)	4,000 t in 2004 (ETRMA, 2006)	100% in 2004 (ETRMA, 2006)
	Norway	Producer Responsibility approach since 1995 (ETRMA, 2007)	Statutary product 'take-back'/ fund scheme (ETRMA, 2007)	Norsk Bekkbetter AS (ETRMA, 2007)	47,000 t in 2004 (ETRMA, 2006)	100% in 2004, Stockpiles eliminated (ETRMA, 2006)
	Poland	Producer Responsibility approach since 2002 (ETRMA, 2007)	Statutary product 'take-back'/ fund scheme (ETRMA, 2007)	OPON Centrum Utylizacji (ETRMA, 2007)	146,000 t in 2004 (ETRMA, 2006)	94% in 2004 (ETRMA, 2006)
	Portugal	Producer Responsibility approach since 2002 (ETRMA, 2007)	Statutary product 'take-back'/ fund scheme (ETRMA, 2007)	ValorPneu (ETRMA, 2007)	92,000 t in 2004 (ETRMA, 2006)	100% in 2004 (ETRMA, 2006)
	Romania	Producer Responsibility approach since 2005 (ETRMA, 2007)	Statutary 'take-back' system (ETRMA, 2007)	ECO Anvelope (ETRMA, 2007)	50,000 t in 2004 (ETRMA, 2006)	50% in 2004 (ETRMA, 2006)
	Slovak Republic	State/Tax system (ETRMA, 2007)			20,000 t in 2004 (ETRMA, 2006)	35% in 2004 (ETRMA, 2006)
	Slovenia	State/Tax system (ETRMA, 2007)			23,000 t in 2004 (ETRMA, 2006)	17% in 2004 (ETRMA, 2006)
	Spain	Free market / Producer Responsibility approach since 1995 (ETRMA, 2007)	Statutary 'take-back' system (ETRMA, 2007)	SIGNUS (ETRMA, 2007)	305,000 t in 2004 (ETRMA, 2006)	53% in 2004 (ETRMA, 2006)
	Sweden	Ordinance on Producer Responsibility for Tyres since 1994 (Lindqvist, 2000), (ETRMA, 2007)	Statutary 'take-back' system (ETRMA, 2007) ADF paid by manufacturers/ importers/consumers (Lindqvist, 2000).	Swedish Tyre Recycling Association - Svens Däckåtervinning AB (SDAB) (ETRMA, 2007)	90,000 t in 2004.Stockpiles eliminated (ETRMA, 2006)	99% by end of 1995, 100% in 2004 (Lindqvist, 2000), (ETRMA, 2006)
	Switzerland	Free market scheme (ETRMA, 2007)			54,000 t in 2004 (ETRMA, 2006)	85% in 2004 (ETRMA, 2006)
	UK	Free market Producer Responsibility Initiative (Gertsakis et al, 2002), (ETRMA, 2007)			475,000 t in 2004 (ETRMA, 2006)	85% in 2004 (ETRMA, 2006)

Appendix 3: Taxonomy of Key Components of Environmental Policy Relevant to the Achievement of Pollution Prevention Opportunities for Used Tyre Management

Key Components	Definitions from Current Literature (where available)
Policy Areas	
Sustainable Development (Sustainability)	Sustainable development policies place emphasis on resource management choices that fulfil the needs and desires of today's population without endangering the ability of tomorrow's population to fulfil its own (OECD, 1996).
Product Policy	Product policy includes decisions regarding the provision of goods and services. This includes the design and development of a product, followed by resource extraction, production (production of materials, as well as manufacturing/provision of the product), use/consumption, and finally end-of-life activities (collection/sorting, reuse, recycling, waste disposal) (Rebitzer G et al, 2004).
Waste Management	Waste management can be defined as the administration of activities that provide for the collection, source separation, storage, transportation, transfer, processing, treatment and disposal of waste (U.S. EPA, 2007b).
Product Stewardship	A management system based on industry and consumers taking lifecycle responsibility for the products they produce and use (EC, 2007b).
Extended Producer Responsibility (EPR)	An environmental policy approach in which a producer's responsibility, physical and/or financial, for a product is extended to the post-consumer stage of a product's life cycle. There are two key features of EPR policy (1) the shifting of responsibility (physically and/or economically, fully or partially) upstream to the producer and away from municipalities and (2) to provide incentives to producers to take environmental considerations into the design of the product (EC, 2007b)
Used Tyre Management	Used Tyre Management can be defined as the administration of activities that provide for the collection, storage, transportation, transfer, reuse, recycling, re-processing and disposal of scrap tyres (the author).
Pollution Prevention	The US Pollution Prevention Act (1990) defines Pollution Prevention (P2) as source reduction and other practices that reduce or eliminate the creation of pollutants through increased efficiency in the use of raw materials, energy, water or other resources, or the protection of natural resources by conservation (U.S. EPA, 2007b).
Priority (or special) wastes	Wastes that may be inappropriate for municipal waste management programmes because they cause particular management or disposal problems (OECD, 2005).
Separate Collection of Designated (Priority) Wastes	The identification and segregation of designated reusable or recyclable wastes from the waste stream for an alternative and/or more appropriate management strategy (the author).

Appendix 3 continued…

Sustainability Strategies	
Pollution Prevention Hierarchy	The Pollution Prevention Hierarchy, established under the US Pollution Prevention Act (1990), is a hierarchy of preferred options for dealing with environmental pollution .The Act states that pollution should be prevented or reduced at the source whenever feasible. Pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible. Pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible, and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner (U.S. EPA, 2007b).
Waste Reduction (Prevention)	The primary objective of a preventive waste management approach is to focus on changes in lifestyles and in production and consumption patterns to stabilize or reduces the production of wastes destined for final disposal (UNCED, 1992, 21.7 & 21.8).
Reuse	Waste reuse refers to the repeated use of a 'waste' material in a process (often after some treatment or make-up). Reuse is effected by simple on-site or at-home operations to collect materials and put them back into the production and consumption process, (as distinct from recycling), instead of disposing of them (OECD, 2002).
Recycling, Reprocessing or Energy Recovery	The transformation through physical, chemical or biological processes (recycling, reprocessing or energy recovery) into a new product or raw material to be used as input for applications other than their original use (UNEP, 2007a). Waste recycling refers to the use by one producer of a waste generated by another (OECD, 2002).Energy recovery refers to any waste treatment that creates energy in the form of electricity and/or heat from a waste source (the author).
Final Disposal	Waste streams for final disposal should be rendered completely harmless so that they do not adversely affect the environment (Das, 2005).
Integrated Lifecycle Principle	The adoption of an integrated lifecycle principle means that substances and products should be managed in such a way that there is minimal environmental impact during their production, use, reuse and disposal (UNEP, 2007a).
Broaden Ownership of Responsibility	A broadening of the physical, financial and/or administrative responsibilities (accountability) for a product's environmental impacts, to all of the stakeholders involved at each stage of a product's lifecycle (the author).
Use of Economic Instruments	An economic instrument is a policy, tool or action which has the purpose of affecting the behaviour of economic agents by changing their financial incentives in order to improve the cost-effectiveness of environmental and natural resource management (UNEP, 2004).
Design for the Environment (DfE)	Design for the Environment is the systematic consideration during design of issues associated with environmental health over the entire product life cycle. DfE can be thought of as the migration of traditional pollution prevention concepts upstream into the development phase of products before production and use. The objective is to minimize or eliminate, during design, the anticipated waste generation and resource consumption in all subsequent lif cycle phases: construction, operation, and closure (or production, use and disposal (EC, 2007b).

Appendix 3 continued…

Downstream Objectives	
Maximise Collection	To maximize the collection of scrap tyres diverted from landfill and other methods of storage and disposal, including illegal dumping that are likely to result in adverse environmental impacts, for return to processor (Jessen, 2005)
Collection Infrastructure	Collection infrastructure is the funding, collection, transportation and sorting, registration and tracking infrastructure required for achievement of the Maximise Collection objective (the author).
Reduction to Landfill	To reduce the number of scrap tyres disposed of to landfill (the author).
Elimination of stockpiles	To both remediate existing tyre stockpiles and prevent the creation of new stockpiles (the author)
Elimination of illegal dumping	To eliminate the illegal dumping of used tyres (the author).
Reduction of Local Authority burden	To reduce the physical, financial and/or administrative burden of waste management (i.e. collection, disposal and recycling of waste products) that falls otherwise to local authorities and society at large (the author).
Maximise Resource Recovery	To maximise the extraction of useful energy or materials from waste. Resource recovery forms an integral part of waste minimisation schemes, and is also employed in pollution prevention (OECD, 2002).
Market Development	Market development is defined as the development of markets to maximise the quantity, value and opportunities for reused, recycled and reprocessed material to be marketed for further uses (Jessen, 2005).
Selection of Recovery option	Selecting and prioritising, from a range of alternative opportunities, those products and applications that clearly demonstrate that they constitute value-added products, are environmentally sustainable and commercially viable (UNEP, 2007a).
Resource Recovery Opportunities	Any product management option that represents an opportunity for pollution prevention according to the Pollution Prevention Hierarchy, i.e. reduce, reuse, retread, recycling, energy recovery or proper disposal (the author).
Upstream Objectives	
Maximise Durability	Advances in tyre design to increase average tyre life expectancy (the author)
Maximise Recyclability	Design changes to enhance end-of-life reuse, recycling, reprocessing, resource recovery and safe disposal opportunities (the author).
Maximise Recycled Material Content	Design changes to maximise the proportion of recycled tyre material in the production of new tyres (the author).
Increase Longevity	Extension of tyre life at the consumption stage through actions such as tyre maintenance (optimal tyre pressures and wheel alignment), tyre repair and driver behavior (the author).

Appendix 4: Data Collection Questionnaire

Goals and Objectives

1. To what extent do the Goals and Objectives of Tire Stewardship Manitoba (TSM) reflect or address the broader sustainability objectives of pollution prevention and resource efficiency?
2. To what extent do the Goals and Objectives of Waste Management in Manitoba reflect the objectives of the "waste management hierarchy" whereby waste prevention (reducing consumption) is preferable to waste reuse and recycling, which is in turn preferable to waste disposal?

Tyre Manufacturers

3. Are there any tyre manufacturers or producers within Canada or Manitoba?

Life-Cycle approach and Broadening of Responsibilities

4. Under the new EPR scheme, what are the roles of:

(i) the tyre stewards (i.e. 1st seller or importer of product including brand owner, producer, manufacturer, distributor, retailer or a business that imports tires for its own use)?
(ii) the consumer?
(iii) the government?
(iv) collectors/transporters?
(v) processors?

Policy Instruments

5. Is there currently a landfill ban or a landfill levy applied to end-of-life tyres in Manitoba?
6. Are any other regulatory instruments employed beyond those described under the WRAP regulations and the New Draft Tire Stewardship Regulation?
7. Are there proposals to employ any other economic instruments beyond the tire levy (Advanced Disposal Fee)?
8. Are any other policy instruments (e.g educational/informational) employed?

Resource Recovery

9. To what extent are the Goals and Objectives of TSM prioritised to reflect the resource recovery hierarchy i.e. reuse (e.g. retreading) being preferable to recycling (e.g. rubber powder production) being preferable to energy recovery (e.g. incineration)?
10. To what extent have Life-Cycle Analysis (LCA) or other methods of impact assessment been applied to resource recovery in order to measure or compare the alternative resource recovery options in terms of true sustainability?
11. Does the TSM actively promote the procurement of recovered products through economic or any other incentives either to the public or to government agencies?

ReTreading

12. Are there any used tyre re-treading facilities within Manitoba?
13. What measures (e.g. financial incentives, R&D, informational e.g. labeling) are being taken by TSM to further promote (i) the tyre re-treading industry in Manitoba? or (ii) greater acceptability and use of retreaded tyres by consumers in Manitoba?

Targets

14. Do the goals and objectives of the TSM include clear and quantifiable targets regarding recovery rates, reuse rates and recycling rates?
15. To what extent have these targets been met?
16. Are these targets and results publicly available?

Design for the Environment

17. To what extent does the TSM program provide incentives upstream to tyre manufacturers/producers to incorporate changes in the design phase to be more environmentally sound for example greater recycled rubber content in tyres? Increased tyre durability?

Appendix 5: Manitoba's Economic Development and Acceptable Use Framework (Government Manitoba, 2006b).

ECONOMIC DEVELOPMENT AND ACCEPTABLE USE FRAMEWORK		
Economic Development Hierarchy	**Acceptable Uses and End Products**	**Prohibited Uses**
1. Locally processed tires for acceptable uses and/or locally manufactured end products 2. Export of locally processed tires for acceptable uses or end product manufacture 3. Export of whole tires for processing and/or acceptable uses or end product manufacture	• Culled tires for safe re-use, retread • Moulded/manufactured product, such as: - mats - traffic cone weights - mud flaps - truck box liners - feeders - crumb - blast mats - sidewall rings - die cut - livestock application • Shred for: - civil engineering - landfill cover/drainage - tire derived fuel	• Improper storage • Illegal dumping • Unlicensed burning • Non-compliant geotechnical projects • Landfilling

Appendix 6: Recovered Tyre Material Markets Within the Province of Manitoba

Approximately seven main processors within Manitoba process approximately 700,000 million scrap tyres annually (MTSB, 2007a). One produces tyre-derived fuel (for industrial use as a replacement for bunker C oil), one shreds the material; one moulds the material into other products and three die-cut the material (Marbek, 2006). All have legal contractual agreements with MTSB (MTSB, 2007a). Of the seven, two are major operations, the remainder use small amounts of tyres for the manufacture of die-cut products and cattle feeders (MTSB, 2007a). Moulded and stamped products and tyre shred represent approximately 80 percent of the destination for used tyres (Marbek, 2006). Transportation derived fuel (TDF's) represent the remaining 20 percent of all tyres recycled (Marbek, 2006).

The major processors within Manitoba are - The Tire Recycling Corporation of North America (TRC) of Winkler, Reliable Tire Recycling (RTR) of Winnipeg, Magnum Industries of Regina and OTR Recycling (TSM, 2007a).

The Tire Recycling Corporation of North America (TRC)

Main products produced include molded mats, mud flaps, truck box liners, playground crumb rubber and other items such as paving blocks depending on product demand (CATRA, 2007b). The majority of mats were sold to the oil industry in Alberta as road cover on the tar sands to support up to 300-ton trucks (Marbek, 2006). TRC processes up to 400,000 PTE's annually, and produces up to 3 million kilograms of product per year (CATRA, 2007b). In May 2001, the plant was destroyed by fire but a new plant has since been constructed. Product markets are slowly being regained and it will take some time before recycling volumes reach their maximum (MTSB, 2007b). In addition to tyre recycling, TRC purchased an equipment manufacturing plant in Winkler to manufacture passenger tyre debeaders. They have the patent for this machine which removes bead wire from tyres which is then sold to a scrap yard (MTSB, 2007a). Shredding or crumbing beadless tyres greatly reduces equipment maintenance costs (MTSB, 2007a).

Reliable Tire Recycling (RTR)

Reliable Tire Recycling (RTR) produces 3 million kilograms of recovered product per year and processes 6-800,000 PTE's of Tyre Derived Fuel annually (CATRA, 2007b). In 1995, RTR set up a large operation in Winnipeg employing up to 14 full-time employees plus casual staff throughout the year. Initially RTR culled tyres for repair or reuse and shipped the remainder to the US for tyre-derived fuel (TDF). RTR now manufactures large blasting mats, traffic cone collars and rubber tyre shred for geotechnical (civil engineering) works such as leachate collection in modern landfills and for drainage in feedlots and roads (MTSB, 2007a). RTR has the capability to produce crumb rubber and playground crumb, however they have not pursued these avenues (MTSB, 2007a).

Magnum Industries

Magnum Industries had a small operation in Winnipeg from where they collect approximately 125,000 PTE's of tyres annually from specific retailers for shipment to the US for tyre-derived fuel (MTSB, 2007a). In 2001, Magnum Industries was replaced by Phoenix Industries of Regina, Saskatchewan, collecting 158,000 PTE's annually for tyre derived fuel (TDF), primarily in south-west Manitoba (MTSB, 2007a).

OTR Recycling

MTSB assisted OTR Recycling in obtaining large mining tyres from Ruttan Lake mine for conversion into water cisterns for cattle. The Board also assisted in the removal of mining tyre scrap from their site for shipment to the US to be shredded for fuel (MTSB, 2007a).