CCME

Canadian Council of Ministers of the Environment

Le Conseil canadien des ministres de l'environnement

GUIDE FOR IDENTIFYING, EVALUATING AND SELECTING POLICIES FOR INFLUENCING CONSTRUCTION, RENOVATION AND DEMOLITION WASTE MANAGEMENT

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NOTE TO READER

This guide is based on an unpublished report prepared under contract to CCME by Brantwood Consulting Ltd. and has been revised and edited by the Construction, Renovation and Demolition Waste Project Team of CCME's Waste Reduction and Recovery Committee.

EXECUTIVE SUMMARY

Construction, renovation and demolition (CRD) wastes make up one of the largest solid waste streams in Canada. This waste comes at a significant cost: it is expensive to manage, poses risks to human health and the environment, and represents a missed opportunity to recover value from discarded materials. Consequently, there are strong social, economic and ecological imperatives to both reduce the rate of CRD waste generation and increase the quantities diverted from disposal.

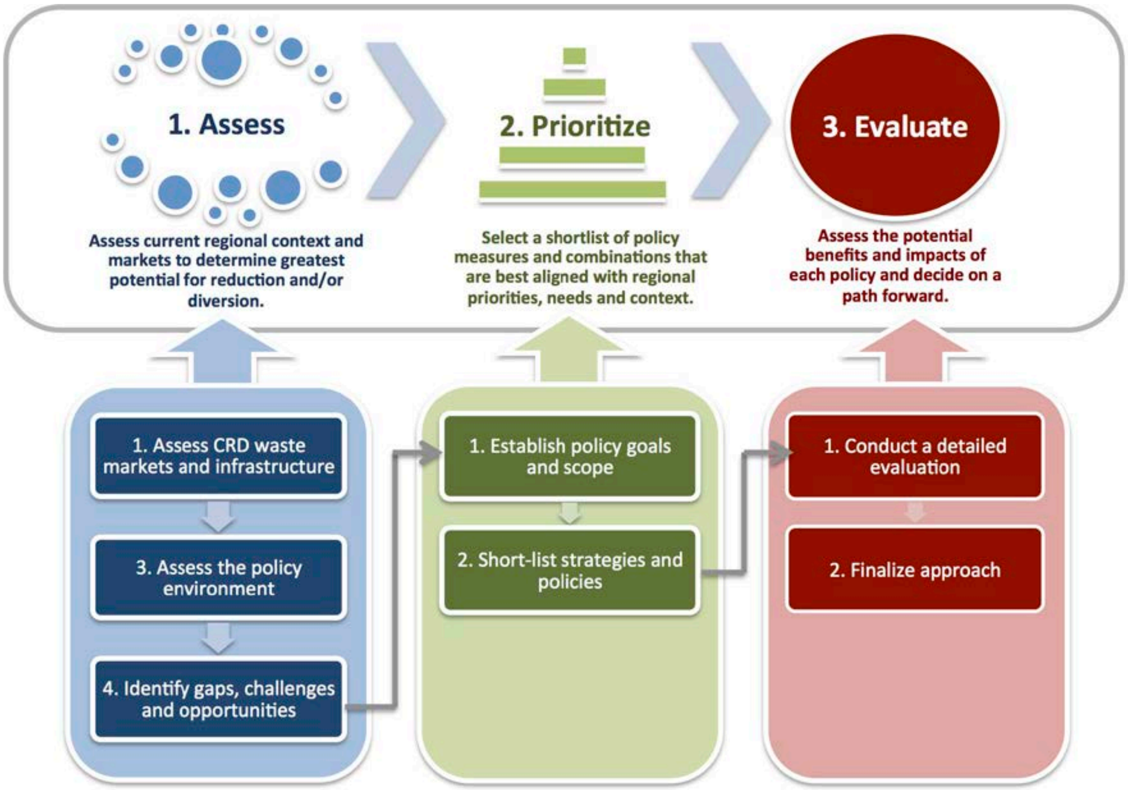
This guide provides decision-makers with high-level guidance for identifying, evaluating and selecting effective policies for influencing CRD waste management. This includes reducing the amount of waste generated by CRD activities, decreasing the amount of CRD waste that is disposed, lessening the environmental impacts of the CRD waste that is disposed, and strengthening the markets for, and value of, diverted CRD materials.

Key Steps in CRD Waste Policy Development

Reducing the amount of CRD waste heading to landfill is a complicated task, and there is no single policy that can address the issue on its own. CRD waste reduction and diversion requires a comprehensive approach. Successful jurisdictions use a combination of policies that are tailored to their unique regional political, economic and market conditions. Policymakers can leverage a three-step process for evaluating CRD waste management policies:

1. **Assess**: The starting point is to assess the regional context to determine the current state of CRD waste management and identify the materials and systems with the greatest potential for reduction or diversion.
2. **Prioritize**: The second step is to establish a set of goals and select a short list of strategies and policy measures that are most closely aligned with the regional priorities, needs and context. This may include setting diversion targets and identifying priority materials, construction life-cycle stages and actors for action.
3. **Evaluate**: The final step is to assess the potential benefits and impacts of each policy and decide on a path forward.

CRD Waste management policy evaluation process



Overview of Construction, Renovation and Demolition Waste in Canada

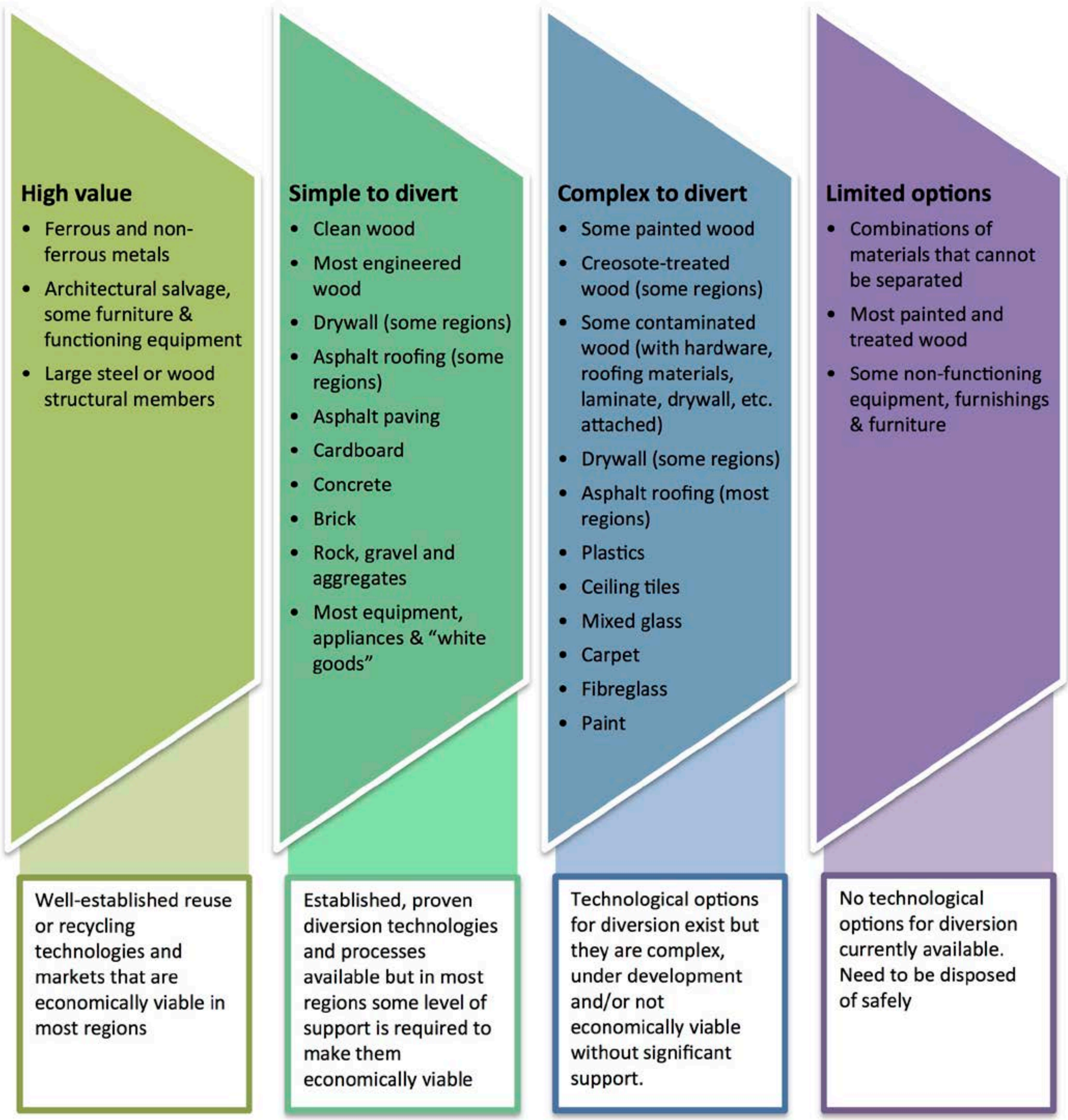
Although CRD wastes may consist of similar materials, the quantities and waste stream composition may vary significantly depending on the region and the time of year, and this has significant implications for waste management. Guy Perry and Associates and Keller Environmental (2015) divide CRD waste into three streams:

- **Construction waste** refers to wastes that are derived from the process of building new structures, excluding large civil and public infrastructure projects (dams, bridges, etc.), marine pilings, telephone, rail, land clearing and so on.
- **Renovation waste** is generally a hybrid of construction waste and demolition waste and is derived from undertaking improvements and repairs to existing structures, excluding large civil and public infrastructure projects (dams, bridges, etc.), marine pilings, telephone, rail, land clearing and so on.
- **Demolition waste** refers to wastes and material debris that are derived from the process of demolishing existing structures. Demolition activities tend to produce mixed waste that is challenging to separate into different materials for reuse or recycling.

CRD waste is made up of many different types of materials and products. The most prevalent materials by weight are wood (clean, engineered, treated and painted), asphalt roofing and drywall. Other materials include metals, plastics, concrete, asphalt paving, bricks, glass, cardboard, and a host of other materials found in relatively small quantities such as ceiling tiles, equipment, furniture and paint.

Waste diversion is the process of diverting waste from landfills or incinerators through various means such as reuse, recycling, composting or gas production through anaerobic digestion. From a diversion perspective, CRD waste materials are categorized by ease of diversion as high value, simple to divert, complex to divert and limited options.

Categories of construction, renovation and demolition waste materials organized by ease of diversion



Policy Options for Construction, Renovation and Demolition Waste Reduction and Diversion

This guide presents six broad strategies and 14 policies that can influence CRD waste management. These strategies and associated policies are not presented in any order of priority, effectiveness or preference.

Strategy	Associated CRD waste management policies
A. **Create accountability for waste diversion**	Make specific actors (e.g., producers, builders, facilities) more accountable for reducing and diverting CRD waste. Policies: 1. Waste management plans and processes for facilities and projects 2. Producer responsibility programs
B. **Limit disposal options**	Limit where, how or what materials can be disposed of. Policies: 3. Waste disposal bans, limits and surcharges 4. Transportation requirements and restrictions
C. **Align financial incentives**	Use levies, fees and charges to encourage waste reduction and diversion. Policies: 5. Disposal fees and levies 6. Virgin material levies
D. **Improve CRD processes**	Increase the resource efficiency of CRD activities. Policies: 7. Building codes and requirements 8. Green building certification 9. Environmental product standards and labels 10. Deconstruction standards
E. **Strengthen diversion markets and infrastructure**	Increase the supply and demand of diverted materials by designing out waste and requiring proper end-of-life management when purchasing products and waste services. Policies: 11. Support infrastructure and market development 12. Public procurement
F. **Build knowledge and establish accountability measures**	Increase the capacity and knowledge of key stakeholders and establish systems whereby progress can be tracked over time. Policies: 13. Industry outreach, education and resources 14. Benchmark and track data

Managing Common Construction, Renovation and Demolition Waste Materials

The most common CRD waste materials in most regions of Canada are wood (clean, engineered, painted, treated), asphalt roofing and drywall. The table below outlines some of the policy approaches that may be evaluated to reduce and divert these materials.

Waste material	Overview	Policies
1. Clean wood waste	Clean wood (also known as white wood) is not treated with chemicals (e.g., for pressure treatment), paint or other coatings. It includes solid wood, lumber, and pallets that are unpainted, unstained, untreated and free of glue. Although there are many uses for clean wood waste, the challenge can sometimes be in creating functional and	• CRD waste bans, limits and surcharges • Deconstruction standards • Strengthened infrastructure and

Waste material	Overview	Policies
	economically sustainable markets given the variability and seasonality of supply. The presence and maturity of markets for clean wood waste varies across the country. Addressing the large amounts of clean wood waste that are generated from new construction, renovation and demolition requires a change in business approach. Currently, large volumes of CRD wood waste cannot be diverted because it is commingled with other materials and contaminants or is in such poor condition that the cost of processing and cleaning limits the economic viability of processing and reusing the material.	markets
2. Engineered wood waste	Engineered (composite) wood refers to manufactured plywood, particleboard, medium-density fibreboard (MDF), oriented strand board (OSB), veneers, glulam beams, and so on, which may include nails, metal plates, glues and other chemicals. Significant quantities are generated from new construction, renovation and demolition. The markets for engineered wood are mostly similar to clean wood. As the diversion process and end-user markets for engineered wood are similar to clean wood, the policy goals and priorities are also similar. Therefore, the policy approaches provided for clean wood waste above may also be applied to engineered wood.	• CRD waste disposal bans and surcharges • Deconstruction standards • Strengthened infrastructure and markets
3. Painted wood waste	Painted wood contains a coating (e.g., paint, varnish, sealer, stain) applied onto or impregnated into clean, engineered or treated wood. It includes trim, doors, cabinets, flooring, some siding, balustrades and baseboards. Market options depend on the coating. Some painted wood may contain hazardous or toxic substances and, because it may be difficult to test the type of paint, it is usually not possible to divert from landfill. Painted wood recycling and reuse markets also depend on the wood substrate (i.e., clean, engineered, treated). Because painted wood is so difficult to divert, alternative upstream solutions may be considered to reduce the volumes of waste generated.	• Transportation requirements and restrictions • Investment in research to develop new processing technologies and infrastructure
4. Treated wood waste	Treated wood refers to wood that is pressure treated or coated with wood preservatives to protect it against decay, mould and insects. It includes fencing and wood for exterior applications, marine pilings, railway ties, and products that have been treated with stains or preservatives. In most regions, although the composition of treated wood is different than for painted wood, the policy goals and	• Disposal fees and levies • Producer responsibility

Waste material	Overview	Policies
	priorities are similar. Paints, coatings and preservatives can all contain chemicals that may need to be handled carefully and disposed of safely. Therefore, similar to painted wood waste, options for diverting treated wood waste from landfill are extremely limited.	
5. Asphalt roofing waste	Roofing shingles and asphalt sheeting are made from fibreglass or organic backing, asphalt cement, sand-like aggregate and mineral fillers (Crushcrete, 2017). Many provinces have an excellent record on reusing asphalt paving in road construction. However, due to processing standards, asphalt from building-related CRD waste typically has a lower recovery rate and is often rejected as unclean because it can be contaminated with other products and some may contain asbestos. Although processing asphalt shingles is more complex than for some other materials, it can be economically viable. Technology exists to recycle 100 per cent of asphalt shingles for sale as an additive for paving or kiln fuel. Processing facilities for asphalt roofing exist in most major urban centres, but recycling can be challenging in other parts of the country due to lack of infrastructure. Given that effective recycling technologies exist, the primary policy goal when dealing with asphalt roofing waste is to limit disposal options (e.g., via transportation requirements and restrictions, waste disposal bans) and enable diversion (by providing access to processing facilities) and then ensuring that facilities are operating state-of-the art equipment.	• Requirements for waste management plans • Investment in infrastructure in combination with differential tipping fees • Transportation requirements and restrictions • CRD waste disposal bans, limits and surcharges
6. Drywall waste	Also called gypsum, plasterboard, sheetrock, Gyproc and wallboard, drywall waste comprises gypsum (94 per cent) and paper backing (6 per cent) and may contain screws and fasteners (metal content of drywall amounts to less than 1 per cent of the total). Where recycling facilities exist, drywall is a straightforward product to deal with. Clean waste drywall that is commonly accepted by processing facilities comprises board material, non-hazardous strip-out plasterboard products, plaster blocks and construction off-cuts. Challenges to drywall recycling are primarily related to the potential for contamination. By far, the largest volumes of drywall come from demolition, but markets for demolition drywall can be very selective. In particular, the challenges of asbestos-containing drywall products are significant because the identification of and recycling of asbestos-containing drywall is not straightforward.	• CRD waste disposal bans, limits and surcharges • Investment in infrastructure in combination with differential tipping fees

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LIST OF ACRONYMS

ASHRAE	American Society of Heating and Refrigeration and Air-Conditioning Engineers
BOMA	Building Owners and Managers Association
CCA	chromated copper arsenate
CRD	construction, renovation and demolition (waste)
CCME	Canadian Council of Ministers of the Environment
CaGBC	Canada Green Building Council
CSA	Canadian Standards Association
CWM	construction waste management
DfE	Design for the Environment
EfW	energy from waste
EPA	(US) Environmental Protection Agency
EPD	Environmental Product Declaration
EPR	extended producer responsibility
GHG	greenhouse gas
HMA	hot mix asphalt
ISO	International Organization for Standardization
LCA	life-cycle assessment
LDPE	low-density polyethylene
LEED	Leadership in Energy and Environmental Design
MRF	material recovery facility
NGO	non-governmental organization
OSB	oriented strand board
PEF	processed engineered fuel
PRO	producer responsibility organization
R&D	research and development
WtE	waste to energy

GLOSSARY

Building deconstruction describes the selective dismantling or removal of materials from buildings prior to (or instead of) conventional demolition. It is an approach to building removal that can convert this waste stream into highest-value resources in a manner that retains their original functionality as much as possible for reuse in future buildings.

Circular economy refers to a closed-loop model of an economy where waste is eliminated and products are sold, consumed, collected and then reused, remade into new products, returned as nutrients to the environment or incorporated into global energy flows (Giroux Environmental Consulting 2014).

Construction waste refers to wastes that are derived from the process of building new structures, excluding large civil and public infrastructure projects (dams, bridges, etc.), marine pilings, telephone, rail, land clearing, and so on.

Cradle to cradle design (also referred to as C2C, cradle 2 cradle or regenerative design) is a biomimetic approach to the design of products and systems. It models human industry on nature's processes, viewing materials as nutrients circulating in healthy, safe metabolisms (McDonough and Braungart 2002).

Demolition waste refers to wastes and material debris that are derived from the process of demolishing existing structures.

Design for disassembly describes how a building is "designed with the end in mind" so that it can be cost-effectively and rapidly taken apart at end of life and its components can be reused or recycled. The design team creates a disassembly plan that sets out the method of disassembly of major systems during renovations and end of life, and the properties of major materials and components (Zizzo *et al.* 2017).

Design for durability considers the implications of the functions and loads on a building on a life-cycle basis. The intention of standards such as Canadian Standards Association (CSA) S478-95, *Guideline on Durability in Buildings* is to protect against premature failure of components and systems and to minimize the impacts of renovation and repair. However, design for durability also contemplates the adaptability of a building as a means to extend its service life and its potential for repurposing and reuse in lieu of demolition.

Design for the Environment (DfE, D4E) is a design approach to reduce the overall human health and environmental impact of a product, process or service, where impacts are considered across its life cycle. (US Environmental Protection Agency [EPA] n.d.-a).

Diversion (waste diversion, landfill diversion) is the process of diverting waste from landfills through various means such as reuse, recycling, composting or gas production through anaerobic digestion. Waste diversion is a key component of effective and sustainable waste management (Federation of Canadian Municipalities 2009). Detailed definitions are found in CSA SPE-890, *A Guideline for Accountable Management of End-of-Life Materials* (CSA Group 2015).

End waste is the waste that results after residual materials have been sorted, processed, and reclaimed and cannot be processed any further under existing technical and economic conditions to extract reclaimable content or reduce its polluting or hazardous character (Government of Québec n.d).

Energy from waste (EfW) or **waste to energy** (WtE) is a process that recovers energy from waste materials. It may include direct combustion, the collections of emissions and by-products from waste such as biogas, and the processing of waste into other fuels that can be used in industrial processes, such as cement kilns.

Extended producer responsibility (EPR) is "a 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. EPR shifts responsibility upstream in the product life cycle to the producer and away from municipalities. As a policy approach, it intends to provide incentives to producers to incorporate environmental considerations in the design of their products. EPR also shifts the historical public sector tax-supported responsibility for some waste to the individual brand owner, manufacturer or first importer" (Giroux Environmental Consulting 2014).

Life-cycle assessment (LCA) is a comprehensive method for assessing a range of environmental impacts across the full life cycle of a product system, from materials acquisition to manufacturing, use, and final disposition (US Environmental Protection Agency [EPA] n.d.-a).

Linear economy is a consumption model of an economy where a product is sold, consumed and discarded (take-make-waste) (Gorgolewski 2017).

Renovation waste is generally a hybrid of construction waste and demolition waste and is derived from undertaking improvements and repairs to existing structures (Public Works and Government Services Canada 2013).

Sustainable consumption and production: As defined by the Oslo Symposium in 1994, sustainable consumption and production (SCP) is about "the use of services and related products, which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardize the needs of further generations" (United Nations n.d.).

Sustainable materials management (SMM) is an approach to promote sustainable materials use, integrating actions targeted at reducing negative environmental impacts and preserving natural capital throughout the life cycle of materials, taking into account economic efficiency and social equity (Organisation for Economic Co-operation and Development [OECD] 2012).

Virgin materials are resources extracted from nature in their raw form, such as gravel, timber or metal ore, that have not been previously used or consumed or subjected to processing other than for its original production.

Zero waste is a policy concept that goes beyond recycling to focus first on reducing waste and reusing products and then recycling and composting/digesting the rest, with the ultimate goal of eliminating all waste and achieving zero waste to landfill (Giroux Environmental Consulting 2014). Achieving zero waste requires new business and economic models. At the level of the economy, it involves a transition from the prevalent "linear economy" to a "circular economy" closed-loop model where a product is sold, consumed, collected and then reused, remade into a new product, returned as a nutrient to the environment or incorporated into global energy flows (Giroux Environmental Consulting 2014).

INTRODUCTION

Construction, renovation and demolition (CRD) wastes make up one of the largest solid waste streams in Canada. It is estimated that as much as 40 per cent of the raw materials consumed in North America — wood, metals, minerals, and so on — are used in construction (State of Massachusetts 2005). When building stock turns over, most of these materials become waste. CRD waste from residential and non-residential buildings accounts for a significant amount of Canada's annual waste production.

This waste comes at a significant cost to governments, businesses and the environment. It is expensive to manage — for example, Canadian municipalities alone spent more than $3.2 billion[1] on waste management in 2012 (Statistics Canada 2014) — and it represents a missed opportunity to recover value from materials in the waste stream (Giroux Environmental Consulting 2014). The production and disposal of waste may also negatively impact human health and the environment through habitat loss, soil contamination and the release of air emissions such as greenhouse gases (GHGs) (Statistics Canada 2005).

Consequently, there are strong social, economic and ecological imperatives to both reduce the rate of CRD waste generation and increase the quantities diverted from disposal. The good news is that most waste materials from construction are reusable or recyclable. Numerous projects across the country have shown that it is possible to divert as much as 95 per cent of all CRD waste materials through reuse and recycling.[2] These diversion efforts also generate significant economic benefits. One study estimated that there are over 4,800 green jobs associated with CRD waste and recycling in Canada (The Delphi Group 2015). Another study concluded that seven jobs are created for every 1,000 tonnes of waste diverted (all types), with an economic benefit four times greater than the net cost (AECOM 2009).

Reducing the amount of CRD waste heading to landfill is a complicated task that requires a sophisticated policy approach. There is no single policy or strategy that can address this issue on its own. Successful jurisdictions — such as the Netherlands, the State of Massachusetts and the Province of Nova Scotia — have been able to achieve high CRD waste reduction and diversion rates using a combination of policies that were tailored to their unique political, economic and market conditions.

Purpose

This guide provides policy-makers seeking to reduce CRD waste with high-level guidance to identify, evaluate and select the most effective mix of policies to:

- reduce the amount of waste generated by CRD activities
- decrease the amount of CRD waste that is disposed
- lessen the environmental impacts of the CRD waste that requires disposal
- strengthen the markets for, and value of, diverted CRD materials.

1 All dollar values are in Canadian currency.

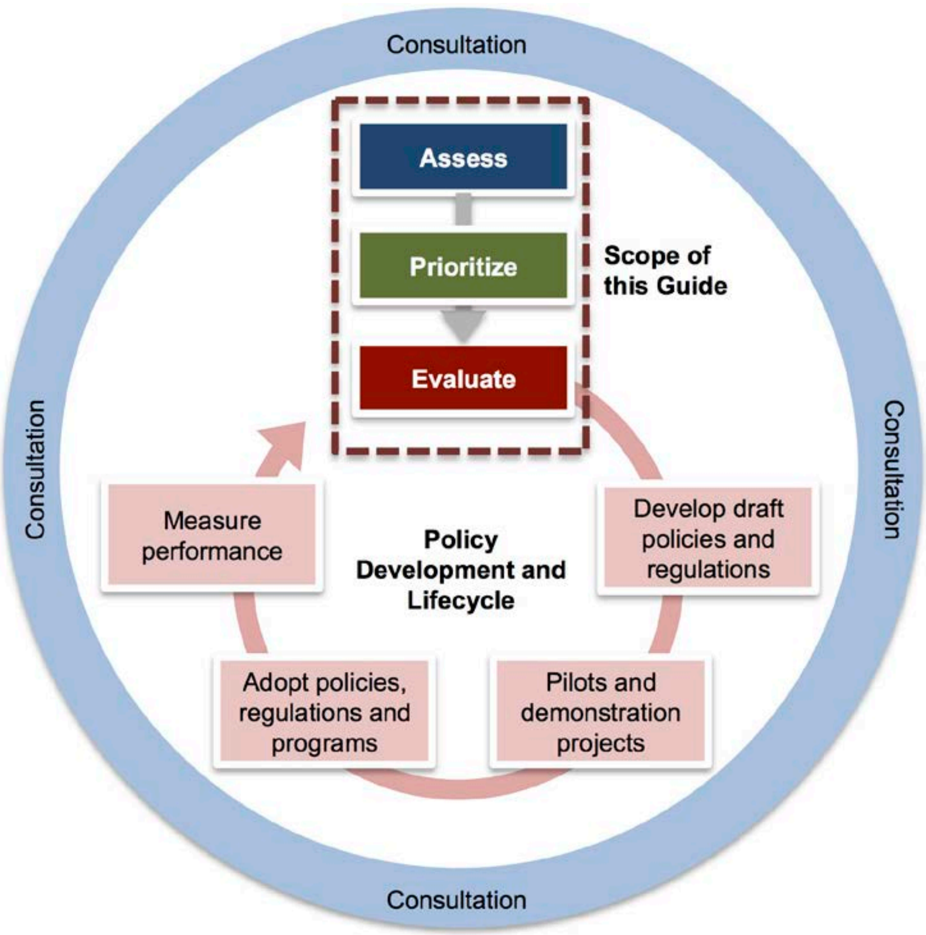
2 Based on case study examples in Sonnevera 2006.

This guide is written primarily for federal, provincial, territorial and municipal government policy-makers responsible for managing and reducing solid waste. However, it may also be of interest to businesses, design professionals, non-governmental organizations (NGOs) and other stakeholders who are involved in the production, diversion and management of CRD waste.

Assumptions, Scope and Limitations of this Guide

This guide does not endorse any particular strategy, policy or combination of them. Rather, it presents decision-makers with high-level guidance for identifying, evaluating and selecting policies for influencing CRD waste management. It does not delve into the process and best practices for developing policies generally. It also does not deal with other aspects of policy development, consultation and implementation, because they are highly variable depending on a jurisdiction's individual circumstances and the stages of development of current CRD policies. The guide assumes that readers are familiar with the policy development process in their jurisdictions, as illustrated in Figure 1. Therefore, the guide instead focuses on identifying the unique considerations and questions for assessing, prioritizing and evaluating policies (see Section 2).

Figure 1: Policy development and life cycle



Source: Brantwood Consulting (2015)

This guide complements other work on CRD waste already under way across the country and assumes that the reader has a basic understanding of the CRD waste management context, concepts and approaches. Section 2 provides a brief overview of these topics for those who are new to the field. For an inventory of what each jurisdiction is currently doing, refer to the reports *State of Waste Management in Canada* (Giroux Environmental Consulting 2014) and *Characterization and Management of Construction, Renovation and Demolition (CRD) Waste in Canada* (Guy Perry and Associates and Kelleher Environmental 2015). This guide takes the approach of describing desired outcomes of the policy development process in the form of a series of questions that policy-makers can answer.

This guide presents an overview of some of the most common policy tools for managing CRD waste drawn from Canada and elsewhere and reviews their applicability to the most common CRD waste materials. However, many other policies can also be used to encourage the reduction and diversion of CRD waste materials, and Appendix A provides a more extensive list of policies.

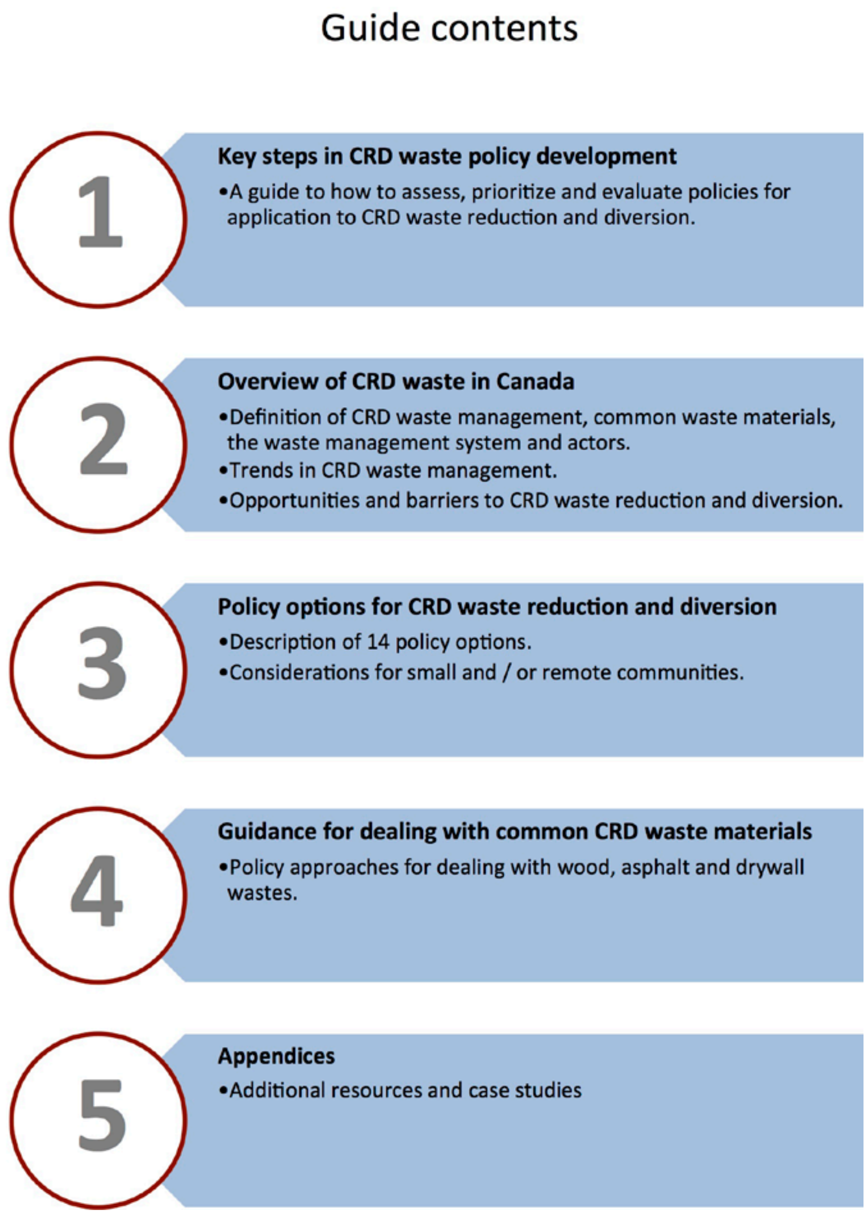
How to Use this Guide

This guide is organized into four distinct sections. It starts with guidance on the process for assessing, prioritizing and evaluating potential CRD waste reduction and diversion policies.

It then offers an overview of CRD waste management, descriptions of 14 policy options for managing CRD waste and a focussed discussion on how to deal with the most prevalent CRD waste materials (wood, asphalt roofing and drywall).

Throughout the guide there are numerous Canadian and international examples and case studies, as well as specific considerations for dealing with CRD waste in remote regions.

The appendices provide a full list of CRD waste management policy options along with a summary of all the key CRD



materials, recycling and reuse markets and considerations for diversion. The appendices also provide a map of CRD waste processing facilities in Canada and an introduction to some of the emerging methods for tracking and reporting CRD waste management. Finally, there are two case studies of CRD waste management policies working together.

The list of references provides material and website links for further reading.

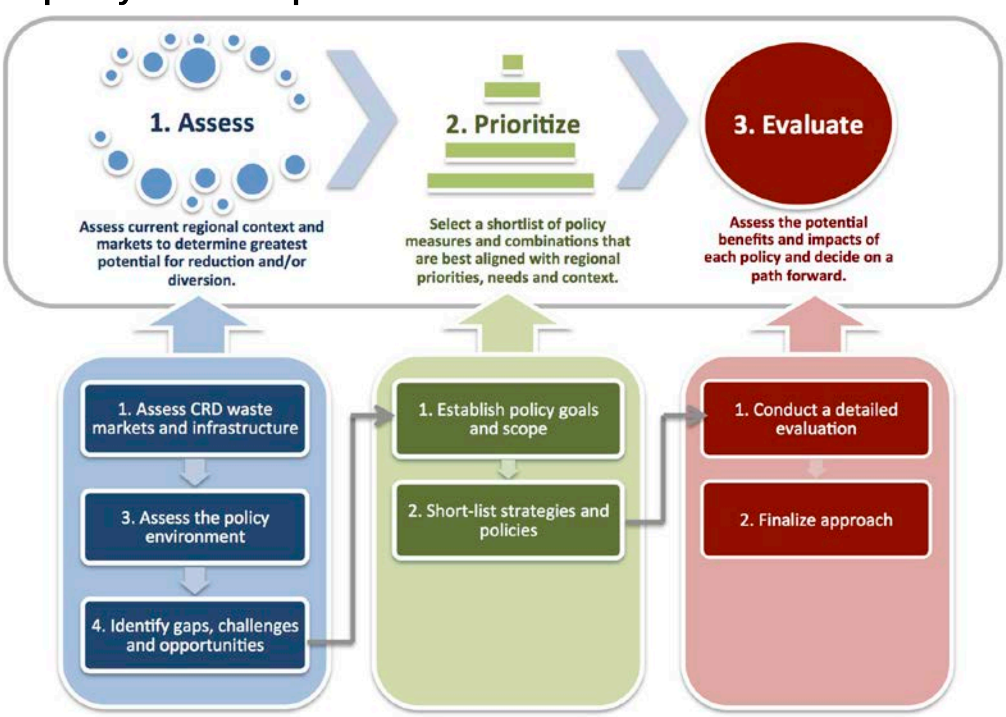
1. KEY STEPS IN CONSTRUCTION, RENOVATION AND DEMOLITION WASTE POLICY DEVELOPMENT

Reducing the amount of CRD waste heading to landfill is a complicated task, and there is no single policy that can address the issue on its own. CRD waste reduction and diversion requires a comprehensive approach. Successful jurisdictions use a combination of policies that are tailored to their unique regional, political, economic and market conditions. This section presents a three-phase process for evaluating CRD waste management policies, with the objective of developing more sustainable CRD waste management action plans:

1. **Assess**: The starting point is to assess the regional context to determine the current state of CRD waste management and identify the materials and systems with the greatest potential for reduction or diversion.
2. **Prioritize**: The second phase is to establish a set of goals and select a short list of strategies and policy measures that are aligned with the regional priorities, needs and context. This may include setting diversion targets and identifying priority materials, construction life-cycle stages and actors for action.
3. **Evaluate**: The final phase is to assess the potential benefits and impacts of each policy and decide on a path forward.

This section provides a high-level overview of each of these phases and highlights the key questions and considerations that are specific to the CRD waste management context. Subsequent sections in this guide then provide additional information that policy-makers can use to help them answer these questions as they move through the policy selection process.

Figure 2: The policy selection process



Source: Brantwood Consulting (2015)

Each phase of the process — assess, prioritize, evaluate — presents a number of questions that can be addressed only through research and consultation with industry and other key stakeholders. The questionnaire is designed as a tool to help assess the regional waste management system as a whole and to prioritize among the different steps that may be taken to improve CRD waste management.

1.1 Assess

Each province, territory and region has its own unique context that influences which policies are most effective for managing CRD waste. Consequently, it is important to collect as much information as possible about the CRD waste streams, infrastructure and markets before setting a goal and selecting a set of policies. Ideally, this information should be validated with industry and other key stakeholders.

The key questions that need to be addressed during the assessment phase are presented in three stages: waste markets and infrastructure; policy environment; and gaps, opportunities and challenges (Figure 3).

Figure 3: Assess the market and policy context

1. Assess waste markets and infrastructure

- Have clear definitions of CRD waste been established, and how will CRD waste be measured and tracked?
- How do the current definitions, metrics and tracking procedures for CRD waste compare to other successful practices?
- What are the current disposal and diversion rates (overall and by material)?
- What is the state of the current CRD waste management system (actors, infrastructure, services, markets)?

2. Assess policy environment

- What is the current policy framework for waste reduction and diversion? For CRD waste in particular?
- What are the drivers, and what is the degree of urgency for addressing the issue?

3. Identify gaps, opportunities and challenges

- What are the gaps or barriers that strategic policy intervention can address?
- Where are there opportunities to significantly move the bar on waste management?

Source: Brantwood Consulting (2015)

Assess Waste Markets and Infrastructure

An assessment of CRD waste markets and infrastructure involves looking at the current CRD waste stream and the infrastructure and markets that can support diversion. The options for diversion may vary depending on the type and relative volumes of material (e.g., wood, drywall, asphalt), its source (e.g., residential, non-residential) and the activities from which it is derived (construction, renovation or demolition).

The cost and viability of collecting, processing and diverting materials depend upon the accessibility of regional public and private infrastructure and the state of the markets for reused and recycled materials and feed stocks.

Construction, renovation and demolition waste markets and infrastructure

Questions to consider:

- What is the composition of materials in the CRD waste stream?
- What is the definition of CRD waste (i.e., what waste materials will be included)?
    - Which materials can be diverted and which cannot (e.g., asbestos)?
    - Consider referring to Canadian Standards Association (CSA) SPE-890, "A Guideline for Accountable Management of End-of-Life Materials," as a means to establish definitions, metrics and measurement processes.
- What are the current disposal and diversion rates (overall and by material)?
    - Do you have a methodology to measure and track waste?
- What is the state of the current CRD waste management system?
    - What public or private facilities, services and actors exist for receiving, handling and processing CRD waste materials in the region?
    - What is the estimated remaining capacity and lifespan of key facilities?
    - Where is there potential for leakage (e.g., for circumventing the waste management system, or illegal dumping)?
- What is the state of diversion and disposal markets?
    - What are the options for using diverted materials?
    - What end-users and markets exist for buying and selling these materials?
    - What is the cost or price of different diversion and disposal options?
- Which materials are particularly easy or challenging to divert?
    - Are there products that need to be sent to disposal (such as asbestos)?
    - What are the gaps in coverage?

As part of this assessment, it can be useful to categorize materials based on the ease with which they can be diverted from landfill:

- **High value**: Materials for which well-established reuse or recycling technologies and markets exist that are economically viable in most regions (e.g., metals).

- **Simple to divert**: Materials for which established, proven diversion technologies and processes are available, but in most regions some level of support may be required to make them economically viable (e.g., clean wood, concrete, brick).
- **Complex to divert**: Materials for which technological options for diversion exist but are complex, under development or not economically viable in all regions without significant support (e.g., plastics, carpet, drywall, asphalt roofing).
- **Limited options**: Materials for which no technological options for diversion are currently available (e.g., painted or treated wood).

Assess the Policy Environment

CRD waste management occurs within a broader solid waste management context and regulatory environment. The options available to policy-makers depend on their order of government (municipal, regional, provincial, territorial, federal), departmental mandate, and existing related policies and regulations.

Policy environment

Questions to consider:

- What is the overall policy framework for waste reduction and diversion?
    - What goals, measures and tools are in place to support diversion of solid waste in general?
        - For CRD waste in particular?
        - For specific CRD waste materials?
- Are there pre-existing policies or regulations that may hinder CRD waste diversion?
- What is the current funding model for CRD waste management activities?
    - What support exists for research and infrastructure development?
- What are the experiences of other jurisdictions?
    - What are the relevant leading practices and lessons learned?
- What level of political, public and industry support is there for acting on CRD waste?
    - What is driving interest in the issue, and what is the degree of urgency?
    - Why is action needed now?

Identify Gaps, Challenges and Opportunities

Policy-makers can then use the market, infrastructure and policy context assessments to identify the specific gaps, opportunities and challenges for CRD waste management in their jurisdiction or region. This includes identifying the general and material-specific barriers that can be addressed through a strategic policy intervention. Some of the common challenges that governments may seek to address through CRD waste policies include:

- time and money required for CRD waste diversion activities, particularly given market forces that result in labour and land being expensive, and materials being inexpensive (and therefore disposable)
- lack of established markets and market capacity to effectively serve consumers of secondary materials with the right product in the right place at the right time
- lack of accessible infrastructure for supporting diversion into reuse and recycling
- CRD waste materials often being combined in such a way that they are difficult to separate
- complex life cycle of building products and materials and the diverse number of actors involved
- organizational culture impediments, such as customer/client preferences for new materials, a general lack of awareness of deconstruction options, lack of ability to differentiate between professional recyclers and “fly-by-night” operations, and the firm entrenchment of status-quo construction practices.

1.2 Prioritize

Construction is a slow-moving industry, and it can respond well to long-range market signals that give businesses the confidence to invest in new products, processes and training. All orders of government can set the stage by establishing long-term plans for CRD waste that include clear goals, targets and strategies.

This phase involves establishing a set of goals and selecting a short list of strategies and policy measures that are most closely aligned with the regional priorities, needs and context. This may include setting diversion targets and identifying priority materials, construction life-cycle stages and actors for action.

The policy prioritization phase has two steps, shows in Figure 4.

Figure 4: Prioritize goals and strategies

1. Establish goals and scope
   - What are the goals and targets for CRD waste management as a whole? For specific materials?
2. Short-list strategies and policies
   - Which policies are well aligned with the regional goals, priority needs and context?

Source: Brantwood Consulting (2015)

Establish Policy Goals and Scope

Following the assessment process, governments are well positioned to establish goals and targets for managing CRD waste. Section 2.7 below provides a review of common CRD goals, targets and effective practice examples. At the highest level, these goals address four areas: reducing the amount of waste generated by CRD activities, decreasing the amount of CRD waste that is disposed, lessening the environmental impacts of the CRD waste that is disposed, and strengthening the markets for, and value of, diverted CRD materials.

CRD waste goals can vary considerably in their specificity, targets and ambition. They may be targeted to specific materials (e.g., wood waste) or building types (e.g., homes), or they may be applied to the CRD waste stream as a whole. They may include concrete, time-bound reduction targets or simply establish a general direction (e.g., reducing waste) without specifying a target or timeline.

Drivers of CRD waste diversion are normally time based whereby specified amounts of waste (or percentage of a total waste stream) are to be diverted by a certain date. As a result, policy mechanisms such as waste disposal ban dates can be powerful motivators for CRD waste diversion policies.

The level and time frame of goals and targets depend on the degree of political ambition. They may be intended to foster small, incremental changes and improvements or a significant overhaul and transformation of the waste management system as a whole. Similarly, some decision-makers will set targets based on a rigorous analysis of what is achievable within their current market context, whereas others will choose to set aspirational targets (to “plant a flag in the sand”) and offer an incentive for innovation. For example, the City of Whitehorse has set a goal of achieving zero waste by 2040 (City of Whitehorse 2013). Setting both short-term tangible targets and long-term aspirational goals can offer opportunities to celebrate early success. The Province of Ontario has developed a series of interim targets (e.g., 30 per cent diversion by 2030) as well as a long-term vision for zero waste and zero GHG emissions from the waste sector (Province of Ontario 2016). However, it is worth noting that target setting is unlikely to result in meaningful impact without adequate support and enforcement.

Many aspirational waste diversion targets have their roots in emerging waste management approaches and movements such as Zero Waste, Design for the Environment (DfE), Cradle to Cradle, circular economy and sustainable materials management (SMM). These approaches advocate for the complete elimination of waste to landfill through the design of durable, reusable and recyclable products and materials. These concepts are gaining increasing traction in Canada through the effort of organizations such as regional recycling councils and the National Zero Waste Council (National Zero Waste Council 2017).

In sum, there is not a set process or standard for establishing CRD waste policy goals. Each jurisdiction and leadership team use an approach that fits its unique circumstances.

Short-list Strategies and Policies

This guide presents six distinct strategies and 14 associated policies for achieving CRD waste goals. Each strategy uses different policy tools to influence CRD actors, markets and systems at various stages in the building life cycle.

In general, governments with an ambitious agenda will need to use a combination of strategies to achieve their goals. This is because the effectiveness of each strategy depends in large part on the accessibility of diversion options and markets, and these vary significantly across different materials and regions.

At this step in the process, the purpose is to identify a short list of regionally appropriate strategies. In developing their short list, decision-makers can consider how policies align with:

- **Overall goals**: Some strategies are better suited to reducing the production of waste (e.g., Strategy A: Create accountability and Strategy D: Improve CRD processes), whereas others have more of an impact on increasing diversion rates (e.g., Strategy E: Strengthen diversion markets).
- **Market conditions**: Some policies can be implemented in almost any market (e.g., public procurement), whereas others are better suited to markets and materials with established diversion options (e.g., waste disposal bans). Appendix C shows a map of key processing facilities across Canada.
- **Desired impact**: Some policies have the potential to significantly shift CRD waste diversion rates (e.g., waste disposal bans), while other policies are more effective at sending a market signal (e.g., public procurement) and stimulating innovation at a project level (e.g., green building certification).
- **Appetite for risk and innovation**: Some policies have a long track record of successful implementation in Canada (e.g., differential tipping fees), whereas others represent more emerging practices for CRD waste that are in use elsewhere but have yet to be adopted in Canada (e.g., virgin material levies). Some policies may come with risk of political and legal challenges (e.g., transportation requirements and restrictions).
- **Government mandate**: Some policies can be implemented only by federal, provincial or territorial governments (e.g., building codes), while others are better suited to local government (e.g., differential tipping fees).

Another consideration is the preferred intervention approach of the government. The EPA describes three broad intervention approaches (described in National Center for Environmental Economics 2010):

1. Voluntary approaches (such as education)

2. Prescriptive regulations (such as codes and prohibitions)
3. Market-based (or economic) instruments (such as fees and grants).

Some governments lean towards using a single approach for waste management, while others prefer to use a combination of approaches. Similarly, some of the policies can be implemented only by using a specific approach (e.g., building codes are prescriptive regulations, and differential tipping fees are economic instruments), whereas other policies can be implemented in different ways (e.g., extended producer responsibility [EPR] programs may be voluntary or required).

1.3 Evaluate

Having identified a short list of policies, the last phase is to conduct a detailed evaluation of each policy and then finalize the approach. These policies should ideally be validated and refined through consultation with industry and other key stakeholders, as well as engagement with other jurisdictions that have experience with these policy approaches.

Each jurisdiction will have its own evaluation process based on its priorities, consultation mechanisms and information sources. This section provides some high-level questions to consider as part of the evaluation. There are two steps: conduct detailed evaluation and finalize approach (Figure 5).

Figure 5: Evaluate preferred policies

1. Conduct detailed evaluation

- Are short-listed policies socially, economically and ecologically viable in the market and policy context?
- Can the short-listed policies be properly and practically administered and enforced?

2. Finalize approach

- Select final suite of policies and develop detailed policy approach.

Source: Brantwood Consulting (2015)

Conduct a Detailed Evaluation

The detailed evaluation takes a deeper look at each of the short-listed policies to ensure that they are viable in the regional market and policy context, will be effective at achieving the desired outcomes, and will align with the environmental, economic and social priorities of the government, industry and general public.

This process can also be used to tailor the policies to appropriately address the issues and challenges governments face. For example, one of the most important considerations is how to fund the implementation and administration of each policy. Some common options are:

- **Using revenue from general or waste-specific taxes, fees and charges** such as via disposal fees, differential tipping fees (Section 3.3.2) and virgin material levies (Section 3.3.2). For example, the Québec government charges a levy on solid waste that is used to fund the development and implementation of regional governments' residual materials management plans. Funding levels are tied to waste diversion performance.[3] Another example is the UK's Aggregates Levy Sustainability Fund, which charges a fee on virgin aggregate and uses the fees to fund environmental programs and research to stimulate the market for recycled and secondary materials (BMAPA n.d.).
- **Requiring end-of-life management costs to be paid by generators**. This is commonly done through producer responsibility and product stewardship approaches (Section 3.1.2). For example, under the California Carpet Stewardship Bill (AB 2398), customers are charged a fee for all new carpet purchased, and the revenues fund post-consumer carpet recycling measures (CalRecycle 2017).
- **Using deposit-refund schemes** to both incentivize compliance and generate revenue. For example, the City of Vancouver's *Green Demolition Bylaw* imposes a $15,000 refundable fee paid with the demolition permit of a detached house. If the deconstruction, reuse and recycling targets are achieved, then $14,650 is refunded, with the remainder being used to offset administrative costs (City of Vancouver n.d.-a). The Province of Nova Scotia charges a deposit on beverage containers and provides a 50 per cent refund when the containers are returned for recycling. The balance is used to fund recycling programs throughout the province in a way that is cost neutral to taxpayers (Divert Nova Scotia 2013).

To help inform this process, Section 4 provides a deeper look at the policy options for the most common CRD waste materials: wood (clean, engineered, painted and treated), drywall and asphalt roofing.

There are many questions to ask when undertaking an evaluation of prioritized CRD waste policies. They fall into four broad categories: policy viability and effectiveness, economic and funding considerations, environmental considerations, and social considerations.

[3] Information about the legislation is available at Government of Québec (2017). Feedback from industry suggests that directing investment to municipalities for specified technologies instead of to the private sector may have limited opportunities for the most effective market responses to be brought forward.

Policy viability and effectiveness

- Based on regional circumstances, will the proposed suite of policies be effective at diverting waste?
    - Will the policies offer the right degree of certainty and deliver the desired results within the available time frame?
- How easy will the policy(ies) be to implement and enforce?
    - What are the potential costs (for administration, monitoring, other costs)?
    - Do they have rigour (e.g., what tools will ensure that materials are being properly managed)?
    - Can results be measured?
- Is (are) the proposed policy(ies) compatible with other jurisdictions?
- How flexible or costly will the proposed policy(ies) be for target audience(s)?
    - What is the likely level of public and industry acceptance and capacity?
    - Will there be risk of legal challenge and, if so, what are the potential costs and impacts?
- Is it important for the proposed policy(ies) to be easily adaptable over time?
- Is (are) the proposed policy(ies) technical viable?
    - Are there available markets and infrastructure?
        - If so, how functional are they?
    - If markets and infrastructure are not yet in place, is it possible to provide notice of a potential policy change with enough time to give the market confidence to get ready or to invest?
- Is (are) the proposed policy(ies) fair and equitable in terms of the distribution of costs and benefits, and creating a level playing field?

Economic and funding considerations

- How will the policy(ies) be funded?
    - Is (are) the policy(ies) financially sustainable?
- What are the associated direct economic benefits (e.g., revenues from taxes, fees, deposits)?
- What are the associated ancillary economic benefits?
- Are there any costs to government, producers, recyclers, taxpayers and consumers?
    - If so, how significant are they?
- What are the implications for trade, investment and competitiveness?
    - Does (do) the proposed policy(ies) cause any market distortions?
        - If so, how significant are they?
- To what extent does (do) the proposed policy(ies) foster innovation and investments in research and development (R&D)?

Environmental considerations

- What are the associated direct environmental benefits (e.g., resource efficiency)?
- What are the associated ancillary environmental benefits?
- Are there any environmental costs and risks?
    - If so, how significant are they?
- What is the potential to reduce GHGs?
    - Offset credits may be available for composting (as has been deployed by the City of Edmonton [Yee 2013]). Offsets are reductions in GHG emissions resulting from carrying out voluntary, non-regulated activities that are different from business as usual.

Social considerations

- What are the associated direct social benefits (e.g., jobs, health)?
- What are the associated ancillary social benefits?
- Are there any social costs and risks (e.g., health)?
- What are the current levels of awareness about CRD waste management?
    - How much effort and resources will be needed to ensure that all actors accept and can achieve CRD waste goals?
- What degree of behavioural change will be necessary to achieve the desired policy goals.

Finalize Approach

The last step is to finalize the suite of policy options and move into the detailed policy development process.

Unfortunately, there is not a great deal of practical data on which policy works best given a certain set of specific circumstances and market characteristics. For example, for some regions it has been very important to have recycling infrastructure in place prior to implementing waste disposal bans so that the market can adjust to the ban quickly (see a map of key processing facilities in Appendix C). In contrast, some regions have used a ban to incentivize infrastructure development. For example, when the Province of Nova Scotia imposed a ban on compostable organic material in 1997 (Province of Nova Scotia n.d.-a), there were very few existing composting facilities or established markets. The ban helped to create the conditions for the private sector and municipalities to react and develop the facilities and markets required.

Therefore, an important part of the final stage of the policy development process is to engage with other jurisdictions that have experience with the short-listed policy approaches.

To illustrate how policy making for CRD waste diversion is not a linear process, Appendix E provides two detailed case studies of leading jurisdictions (the State of Massachusetts and the Netherlands) that have implemented a large number of coordinated CRD policies and achieved significant reductions in CRD waste to landfill. These case studies illustrate some international practices in CRD waste management. They show how it may be necessary to assemble a large number of decision-making criteria in order to develop a portfolio of suitable policy tools and levers that will meet the needs of the region’s specific circumstances.

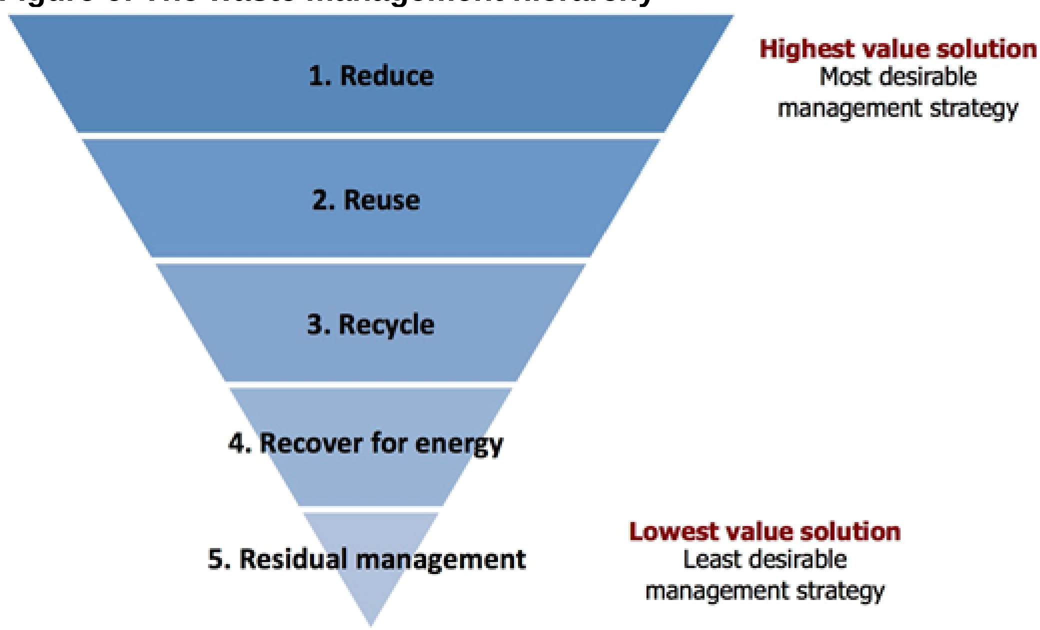
2 OVERVIEW OF CONSTRUCTION, RENOVATION AND DEMOLITION WASTE IN CANADA

This section presents an overview of key concepts and the state of CRD waste management in Canada and introduces some of the conceptual frameworks that underlie the guide. It includes a review of the waste management hierarchy (Section 2.1) as well as an overview of CRD waste definitions, common materials, and key waste management systems and actors (Sections 2.2 to 2.4). It also identifies the building life cycle and key policy intervention opportunities (Section 2.5), presents emerging approaches for waste management (Section 2.6), reviews common CRD waste diversion goals (Section 2.7), and reviews opportunities and barriers for reducing and diverting CRD waste (Section 2.8).

2.1 The Waste Management Hierarchy

At the heart of all solid waste management policy making is a combination of strategies known as the waste management hierarchy or the “5Rs”: 1) Reduce, 2) Reuse, 3) Recycle, 4) Recover for energy and 5) Residual management (waste to landfill). There are many permutations of the waste management hierarchy, but they all aim to extract the maximum practical benefits from materials and to generate the minimum amount of waste (NCTCOG n.d.). Figure 6 illustrates how the 5Rs hierarchy helps to establish policy priorities because the higher levels of the hierarchy (e.g., Reduce) are preferred over lower levels (e.g., Residual management). Polices and market mechanisms are needed to drive recycled materials back up the 5Rs hierarchy via the highest-value markets.

Figure 6: The waste management hierarchy



Source: Brantwood Consulting (2015)

2.2 Defining Construction, Renovation and Demolition Waste

CRD waste is the waste stream derived from construction, renovation and demolition activities. It is composed of many different types of materials, such as wood, asphalt roofing products, drywall, plastic, metals and aggregates.

CRD waste can come from residential sources (e.g., house renovations) or from non-residential sources (e.g., construction or demolition of office buildings). Generally, it excludes large civil and public engineering projects (dams, bridges, etc.), marine pilings, telephone, rail, land clearing, and so on.

"Construction waste" refers to wastes that are derived from the process of building new structures.

"Renovation waste" is generally a hybrid of construction waste and demolition waste and is derived from undertaking improvements and repairs to existing structures.

"Demolition waste" refers to waste and material debris that are derived from the process of demolishing existing structures.

Source: Guy Perry and Associates and Kelleher Environmental (2015).

Although construction, renovation and demolition wastes may consist of similar materials, the composition of each waste stream can vary because the waste materials emerge from very different processes. So, while it is relatively straightforward to separate and divert waste materials from new construction projects from landfill, it is much more challenging with demolition and renovation projects because they involve:

- much larger quantities of waste (often the entire building).
- less certainty about the composition of materials being removed. For example, older buildings may be contaminated with hazardous materials (e.g., asbestos).
- automated demolition equipment like cranes and grapples, which do not lend themselves to the separation of one material from another.
- tight and inflexible schedules and economics. The highest project value is in new construction, while demolition is perceived simply as a cost, with the goal to finish as quickly and cheaply as possible (Ponnada 2015).

CRD waste from residential and non-residential buildings accounts for a significant amount of Canada's annual waste production. Statistics Canada estimates that about 4 million tonnes of CRD waste was generated in Canada in 2010, and this figure could be much more depending on how CRD waste is tracked (Statistics Canada 2013).[4]

[4] Statistics Canada data represent the most consistently gathered and nationally accepted source of information on CRD waste statistics in Canada at this time. However, this data does not include:

- waste managed and recycled or reused on CRD project sites
- waste transported directly from CRD project sites to end markets for reuse or recycling
- waste transported directly from CRD project sites to disposal facilities outside of the country
- CRD waste managed within residential and non-residential waste streams that is not identified and recorded as CRD waste
- CRD waste from large construction projects that is not disposed in municipal solid waste landfills
- CRD waste from civil engineering, marine and large public infrastructure projects.

According to a 2015 study commissioned for Environment Canada, only about 16 per cent of CRD waste was reused or recycled (653,000 tonnes), while the remaining 84 per cent was disposed (3,353,000 tonnes), mostly in landfills (Table 1).

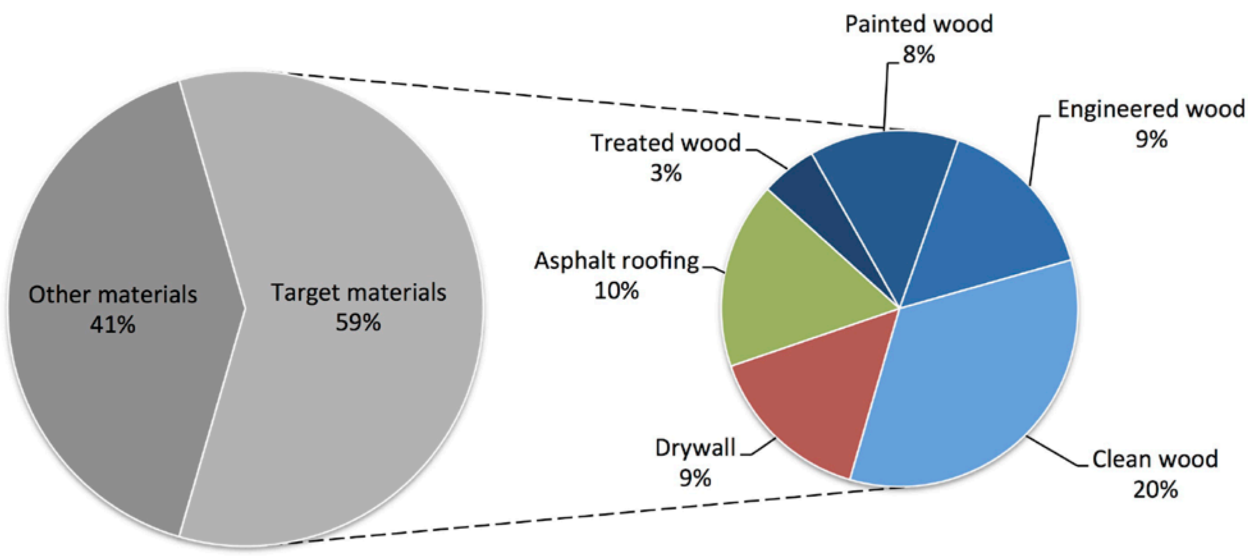
Table 1: Sources of CRD waste

Building stage	Residential	Non-residential	Total CRD waste
Construction	15%	5%	444,700 tonnes (11%)
Renovation	57%	32%	1,873,200 tonnes (47%)
Demolition	28%	63%	1,668,900 tonnes (42%)
Total amount of CRD waste	**2,443,900 tonnes (61%)**	**1,562,800 tonnes (39%)**	**~4 million tonnes (100%)**

Source: Guy Perry and Associates and Kelleher Environmental (2015).

CRD waste is made up of many different types of materials and products. Figure 7 demonstrates that the most prevalent wastes by weight are wood (clean, engineered, treated and painted), asphalt roofing and drywall. Section 4 highlights these wastes for particular attention. Other materials include metals (3 per cent of the total by weight), plastics (4 per cent), concrete and aggregate (4 per cent), cardboard (1 per cent), and a host of other materials that, individually, are found in relatively small quantities, such as glass, asphalt paving, bricks, ceiling tiles, equipment, furniture and paint.

Figure 7: Most prevalent CRD waste streams (percentage by weight) in Canada in 2010



Source: Guy Perry and Associates and Kelleher Environmental (2015).

2.3 Common Waste Materials and Considerations for Reduction and Diversion

From a waste management perspective, it can be helpful to categorize CRD waste materials into the following groups:

- **High value**: Materials for which well-established reuse or recycling technologies and markets exist that are economically viable in most regions (e.g., metals).
- **Simple to divert**: Materials for which established, proven diversion technologies and processes are available, but in most regions some level of support is required to make them economically viable. These materials are mostly environmentally benign but generally require some processing and command less market value (e.g., clean wood, concrete, brick).
- **Complex to divert**: Materials for which technological options for diversion exist but are complex, under development or not economically viable without significant support. These more complex materials are composed of numerous raw materials that require extensive processing infrastructure (equipment, on site space, etc.), so markets are likely to need incentives to accept and process them (e.g., plastics, carpet, asphalt roofing).
- **Limited options**: Materials for which no technological options for diversion are currently available. This includes materials containing hazardous or toxic substances specified under applicable federal, provincial, territorial and municipal legal requirements, which may pose risks to human health and the environment if improperly managed.

Figure 8 presents the current status of common CRD materials using the four diversion categories (high value, simple to divert, complex to divert, limited options). It does not include materials that have to be disposed of safely (e.g., hazardous materials). It should also be noted that some demolition and renovation materials may pose a serious health concern for landfill staff and processing facility sorters and need to be handled correctly.[5]

[5] Best practices for dealing with hazardous materials are well documented by occupational health and safety organizations across Canada, such as WorkSafeBC (www.worksafebc.com) and its website on asbestos: http://www.hiddenkiller.ca.

Figure 8: Categories of common CRD waste materials with associated management and recycling opportunities

Source: Brantwood Consulting (2015)

Given that the largest volumes of waste materials from construction and demolition projects are inert materials (clean wood, concrete, etc.), numerous projects across Canada have demonstrated that high diversion rates are possible. Leadership in Energy and Environmental Design (LEED) offers credits for construction waste management (CWM) in excess of 50 per cent (one credit) and 75 per cent (two credits), which is considered easily achievable, particularly in urban centres (and especially when concrete and rubble are included).[6] Indeed, the new Toronto airport terminal project included demolition specifications for the old Terminal One building, including the requirement to divert a minimum 90 per cent of materials from landfill. Overall, 95 per cent of demolition wastes were diverted, while an estimated $1,845,000 was saved by recycling concrete on site (Sonnevera 2006).

Markets for recycled materials are growing, albeit slowly and in selective areas, and motivations to build green are improving levels of awareness and familiarity with the CRD waste management process. Appendix B illustrates 20 of the most common CRD waste materials, the potential markets and the opportunities for diversion.

Note that the materials above are discussed in the context of clean, uncontaminated waste streams. However, a great deal of CRD waste comprises materials that are not technically or economically feasible to separate and must be disposed of safely (e.g., wood waste contaminated with drywall, hardware, plastic laminate). Currently, most processing facilities can tolerate only a small amount of contamination (10 per cent at most).

2.4 Construction, Renovation and Demolition Waste Management System and Actors

The management of CRD waste involves many different organizations, processes and activities and a waste stream composed of thousands of different types of products and materials. Policy-makers may consider the presence (and absence) of actors, service providers, infrastructure, facilities and markets when developing CRD diversion policies. Table 2 presents the key actors involved in the production and management of CRD waste. Figure 9 provides a simplified view of the generic CRD waste management ecosystem and its complex web of interrelationships.

[6] The LEED rating system and guide is available from the Canada Green Building Council (CaGBC). Credit details and language are available at www.usgbc.org/node/2601031.

Table 2: Actors involved in the production and management of CRD waste

CRD waste generators
Entities that generate waste and therefore have a role in reducing volumes created

- Homeowners
- Designers (architects, engineers, etc.)
- Building owners and developers
- Builders (general contractors, trades)
- Demolition contractors, salvagers

Facilities
Companies and agencies responsible for receiving, sorting and processing CRD waste

- CRD waste processors, also known as material recovery facilities (MRFs)
- Transfer stations
- Waste/material haulers and equipment renters
- Landfill operators

Transporters
Companies that move waste from the point of generation to the facilities and end users

- Hauling companies

End users and markets
Organizations involved in the sale and reuse of CRD materials

- Public procurement agencies
- Product manufacturers and suppliers
- Wholesalers, retailers (with or without deconstruction or installation services)
- Materials exchanges

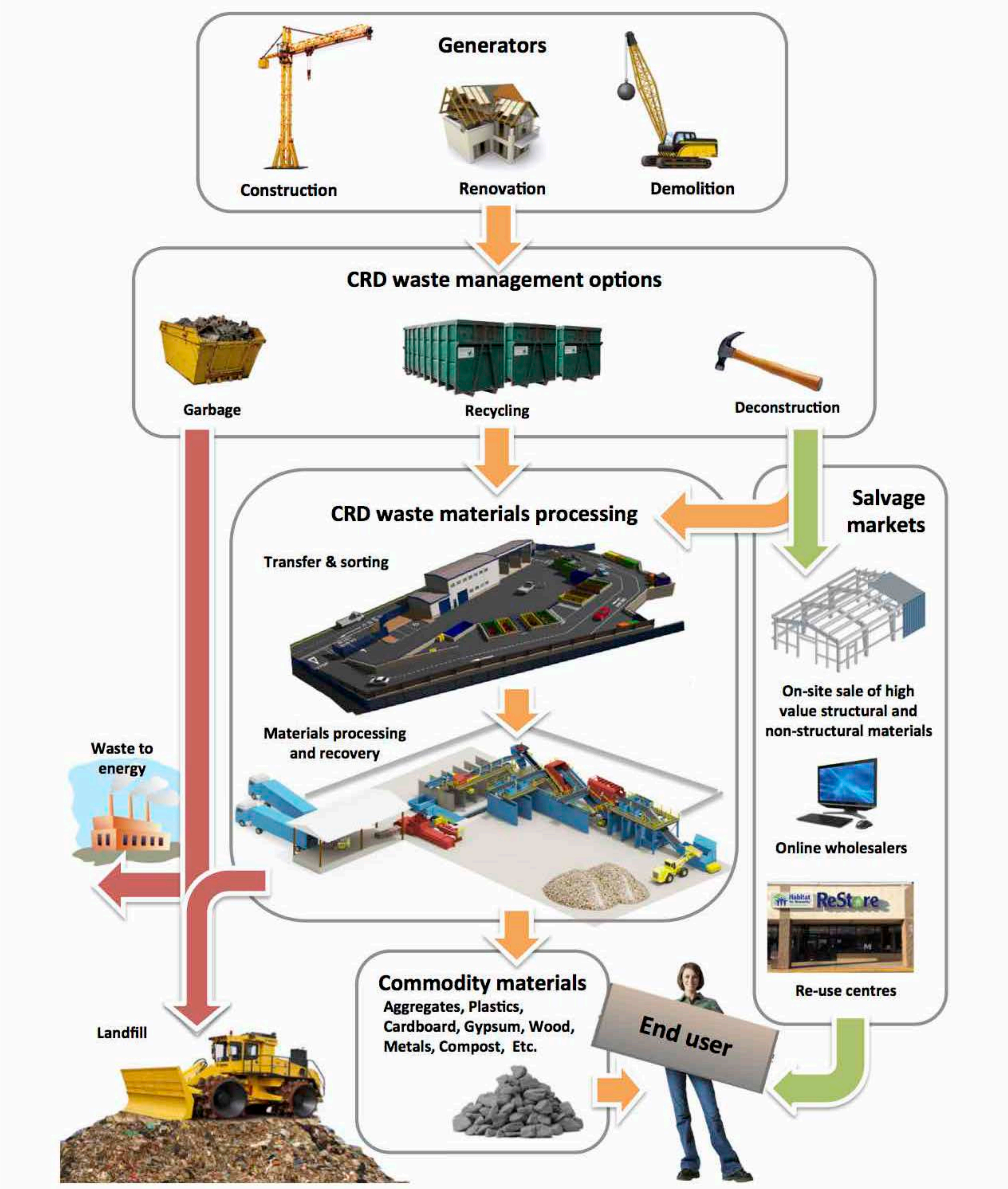
Regulators
Governments, agencies and standards organizations responsible for controlling CRD waste management

- Federal, provincial and municipal governments
- Standards organizations

Other stakeholders
Organizations with interests in CRD waste management

- Industry associations and councils (e.g., trade associations and product councils)
- producer responsibility organizations (PROs)
- NGOs
- R&D centres

Figure 9: Simplified CRD waste management system



Source: Brantwood Consulting (2015)

Energy from Waste

Energy from waste (EfW), also known as waste to energy (WtE), generally refers to any waste treatment process that recovers energy from the waste materials. It may include direct combustion, the collection of emissions and by-products from waste (such as biogas), and the processing of waste into other fuels that can be used in industrial processes (such as cement kilns). EfW excludes anaerobic digestion, which typically processes source-separated organics in the absence of oxygen to produce biogas.

Most of Canada's EfW facilities are owned by local governments that have invested in these facilities to achieve long-term solid waste management solutions. There are a variety of different applications, but more or less any hydrocarbon-based material (plastics, wood, etc.) can be used as a fuel source for EfW. For example, small scrap, painted and damaged wood is often used as fuel source for power generation plants and cement kilns, and wood waste is increasingly being used in biomass boilers for district energy systems.

EfW is controversial in many parts of Canada. Some jurisdictions consider it an effective mechanism for generating energy and reducing waste to landfill, while others see it as a low-priority diversion option and have concerns regarding emissions and the loss of valuable materials through combustion. This debate is complicated by the diversity of technologies and fuel sources used for EfW and the prevailing energy sources that EfW is intended to substitute. For example, CRD wood waste–derived fuel can play a role in replacing high-carbon fuels for industrial processes and can therefore contribute to an industrial GHG reduction strategy. EfW can also deal with hard-to-divert materials. For example, the Enerkem facility in Edmonton is able to tolerate a small proportion of treated wood (Enerkem n.d.-b). However, the benefits offered by wood waste for EfW depends on the environmental impact of fuels the wood waste is being substituted for (e.g., coal, natural gas), the efficiency of landfill methane gas capture and other factors. The UK government's hierarchy for wood waste sees EfW as preferable to recycling lower-grade materials (Department for Environment, Food and Rural Affairs 2011). In contrast, recent life-cycle assessment (LCA) research suggests that it may be good practice to store carbon in landfill rather than incinerate it (Morris 2016).

The solid waste management hierarchy (see Section 2.1) identifies the preferred order for managing waste to minimize its environmental impacts. The most important steps are to reduce, reuse, and recycle or compost. The next step is to recover, which includes recovery of energy. Many jurisdictions are first committed to improving waste diversion rates through reuse, recycling and composting programs, and some jurisdictions do not count EfW towards meeting diversion targets. In some cases, specific material streams recovered from CRD waste may be considered cleaner or safer sources of alternative fuel (e.g., clean wood versus natural gas, oil, coal or mixed plastic).

While jurisdictions have different perspectives on EfW, approved EfW applications for CRD waste are generally based on a combination of environmental and socio-economic factors. With respect to CRD materials, it is important to note that wood and (increasingly) asphalt shingles are often processed for use as (non-waste) alternative fuels at industrial boilers and other facilities that may not necessarily be approved as solid waste facilities.

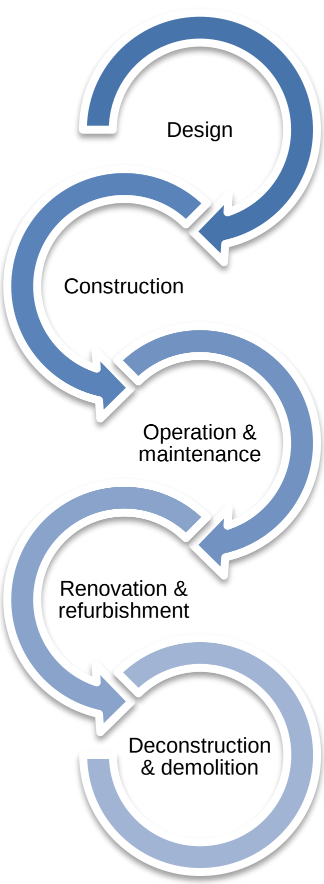
2.5 Building Life Cycle and Policy Intervention Points

To develop effective policies aimed at encouraging strategies to minimize the creation of CRD waste and maximize diversion from landfill, it is important to understand who makes decisions about the deployment of materials and processes, and when those decisions take place in order to determine the most appropriate opportunity to intervene to influence behaviour.

For example, it is said that 90 per cent of the decisions made related to the configuration, composition, process and schedule for a building project are made during the first 10 per cent of the project process. This suggests that the most effective opportunity to inform CRD waste reduction strategies (such as design for disassembly, selection of sustainable materials, etc.) is as early as possible in the building life cycle (Figure 10).

The building industry is highly regulated, offering many opportunities for policy-makers to interact with industry actors at the various regulatory milestones in the building life cycle, although some of these policy "touch points" are typically outside the jurisdiction of provincial or territorial governments. Figure 10 shows the typical milestones.

Figure 10: Typical building life cycle



Source: Brantwood Consulting (2015)

- Enactment of legislation, for example:
  - Provincial legislation
  - Local government plans and bylaws
  - Land use and zoning bylaws
  - Building preservation bylaws
- Issuance and administration of permits and licences, for example:
  - Development permit
  - Building permit (new construction and renovations)
  - Trade permits and periodic inspections
  - Occupancy permit
  - Demolition permit
  - Hauler and facility licences
- Point of payment, for example:
  - Fees at the processing facility or landfill gate
  - Product point of sale
- Other policy tools can be directed towards the manufacturers and sellers of building products and materials, haulers of CRD waste, and the facilities that manage, sort and process the materials. These policies interact with actors at the product point of sale, at the processing or sorting facility, or at the landfill gate.

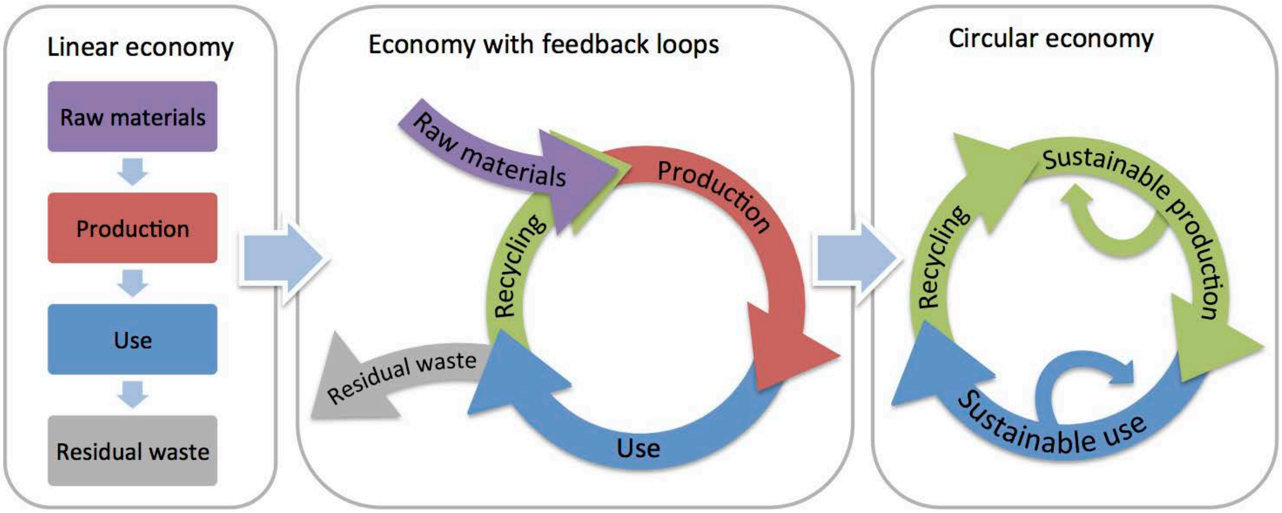
2.6 Emerging Approaches in Construction, Renovation and Demolition Waste Management

The CRD waste management industry is evolving, and policy-makers are increasingly looking for new opportunities to move up the waste management hierarchy and eliminate waste to landfill. Emerging waste management approaches and movements — such as zero waste, DfE, Cradle to Cradle, circular economy and SMM — advocate for eliminating waste to landfill entirely, through the design of durable, reusable and recyclable products and materials. An overview of many of these key concepts is provided below.

Sustainable Materials Management	DfE is underpinned by SMM. SMM is a holistic approach to keeping materials out of the waste stream, influencing upstream behaviours of the various actors in the construction supply chain to reduce waste, and informing the design and manufacture of products and buildings in a way that reduces carbon footprint. SMM involves “integrating actions targeted at reducing negative environmental impacts and preserving natural capital throughout the life cycle of materials, taking into account economic efficiency and social equity” (OECD 2012). SMM policy development is underpinned by the following principles or “framework conditions”: • Preserve natural capital. • Design and manage materials, products and processes for safety and sustainability from a life-cycle perspective. • Use the full diversity of policy instruments to stimulate and reinforce sustainable economic, environmental and social outcomes. • Engage all parts of society to take active, ethically based responsibility for achieving sustainable outcomes. The Dutch chain-oriented waste policy (see Appendix E) is an example of SMM applied to policy making.
Design for the Environment	DfE is a design approach that aims to reduce the overall human health and environmental impact of a product, process or service, where impacts are considered across its life cycle. Carpeting is an example of a product category that has embraced DfE principles. Some carpet companies have shifted their marketing philosophy away from the manufacture of a product to the provision of a “service.” How the product is made is defined by its ability to perform the service required (durable, comfortable, sound absorbent, non-toxic, easy to maintain flooring), be easy to remove and be completely recyclable. DfE is an important mechanism in reducing waste to landfill.
Zero Waste	“Zero waste” is also a commonly used term that supports similar goals as the circular economy (and the terms can sometimes be used interchangeably). The term is defined and deployed in various ways. For example, “zero waste” is defined by Zero Waste Canada as “A goal that is ethical, economical, efficient and visionary, to guide people in changing their

	lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use" (Zero Waste Canada n.d.). This definition may be understood to limit energy recovery, which may be an end market solution for CRD waste for some regions. By comparison, Zero Waste Scotland lays out a softer approach whereby "resource use is minimised, valuable resources are not disposed of in landfills, and most waste is sorted into separate streams for reprocessing, leaving only limited amounts of waste to go to residual waste treatment, including EfW facilities" (Zero Waste Scotland n.d.). Several regions in Canada have adopted policies that establish zero waste goals or are designed to support zero waste (see Section 2.7).
Circular Economy	DfE and SMM are important pillars in making the shift to a "circular economy" whereby waste is eliminated and products are sold, consumed and collected, and then reused, remade into new products, returned as nutrients to the environment or incorporated into global energy flows (Figure 11). Circular economy principles are part of Ontario's recently approved *Waste-Free Ontario Act* (Legislative Assembly of Ontario 2016). Also, the Construction Resource Initiatives Council (CRIC), a national NGO focussed on addressing waste in Canada's construction sector, has set a "Mission 2030" goal of zero waste (CRIC n.d.). From a policy-making perspective, the objective of a circular economy is to keep materials out of the waste stream by influencing the upstream behaviours of the various actors in the construction supply chain. This philosophy also aims to influence the design and manufacture of products and buildings in a way that reduces carbon footprint. Promoting sustainable materials use to achieve a circular economy ultimately implies an integrated approach that reaches beyond the construction industry. These actions should target reducing negative environmental impacts and preserving natural capital throughout the life cycle of materials, taking into account economic efficiency and social equity (OECD 2012). An example of a circular economy project is the Park 20|20 office park (see Case study 2: Dutch Chain-Oriented Waste Policy in Appendix E).

Figure 11: The transition from a linear to a circular economy



Source: Brantwood Consulting (2015).

2.7 Construction, Renovation and Demolition Waste Diversion Goals and Targets

At the highest level, governments can establish goals in four areas:

- Reduce the amount of waste generated by CRD activities (e.g., through improved efficiency in design and construction).
- Decrease the amount of CRD waste that is disposed (e.g., through improved reuse, recycling and composting systems and markets).
- Reduce the environmental impacts of the waste requiring disposal (e.g., through safe disposal and the use of less-toxic materials).
- Create increased value and stronger markets for "waste" materials that can then re-enter the economy and reduce upstream impacts of producing new products.

CRD waste goals vary considerably in their specificity, targets and ambition. They may be targeted to specific materials (e.g., wood waste) or to the waste stream as a whole. They may include concrete, time-bound reduction targets or simply establish a general direction (e.g., reducing waste) without specifying a target or timeline.

Many jurisdictions have set ambitious goals for reducing and diverting CRD waste that are higher than for general waste reduction. These goals are also in line with emerging waste management approaches and movements (e.g., zero waste, DfE, Cradle to Cradle, circular economy, SMM) that advocate for the elimination of waste to landfill entirely through the design of durable, reusable and recyclable products and materials. Table 3 shows examples of a range of goals and targets in effect across Canada and around the world.

Table 3: Examples of CRD waste management goals and targets in Canada and internationally

<table>
<tr><th colspan="2">Provinces and territories</th></tr>
<tr><td>Nova Scotia</td><td>Nova Scotia’s Environment Act and the Environmental Goals and Sustainable Prosperity Act (EGSPA) established the goal of maintaining 50 per cent waste diversion and reaching a target for waste disposal of no more than 300 kilograms per person per year by the year 2015 (Province of Nova Scotia n.d.-b).</td></tr>
<tr><td>Ontario</td><td>The Province of Ontario has developed a long-term vision for zero waste and zero GHG emissions from the waste sector (Legislative Assembly of Ontario 2016).</td></tr>
<tr><td>Québec</td><td>Québec’s residual materials management policy sets the following goals for the end of 2015 (Government of Québec n.d.):
Reduce the quantity of disposed residual materials to 700 kilograms per person (110 kilograms less than in 2008).
Recycle 70 per cent of paper, cardboard, plastic, glass and metal waste.
Process 60 per cent of organic putrescible waste.
Recycle or reclaim 80 per cent of concrete, brick and asphalt waste.
Sort at source or send to a sorting centre 70 per cent of CRD waste from the building sector.</td></tr>
<tr><th colspan="2">Local and regional governments</th></tr>
<tr><td>Halifax Regional Municipality, Nova Scotia</td><td>The Halifax Regional Municipality requires the operators of licensed CRD waste sites to meet recycling targets of 75 per cent diversion.</td></tr>
<tr><td>Metro Vancouver, British Columbia</td><td>Metro Vancouver’s 2010 Integrated Solid Waste and Resource Management Plan set four broad goals:
Minimize waste generation.
Maximize reuse, recycling and material recovery.
Recover energy from the waste stream after material recycling.
Dispose of all remaining waste in landfill, after material recycling and energy recovery.
It also established several associated targets:
Reduce the quantity of waste generated per capita within the region to 90 per cent or less of 2010 volumes by 2020.
Increase the regional diversion rate from an average of 55 per cent to a minimum of 70 per cent by 2015, with an aspirational target of 80 per cent by 2020. This includes an 80 per cent diversion target for demolition, land clearing and construction waste by 2015.</td></tr>
<tr><td>Regional District of Nanaimo, British Columbia</td><td>The Regional District of Nanaimo (RDN) is a regional government located on Vancouver Island serving a population of about 146,000. In 2006, the RDN set a target of diverting 75 per cent of the region’s waste from landfill by 2010. At that time, about 11,000 tonnes of CRD waste was landfilled, including about 8,000 tonnes of wood waste and 3,000 tonnes of asphalt shingles.
Guided by its Construction/Demolition Waste Strategy (RDN n.d.), the majority of the RDN’s CRD waste is now recycled (Maura Walker & Associates 2013):
Wood waste is chipped and used as hog fuel at pulp mills on Vancouver Island and Washington State.
Drywall (gypsum) is recycled.
Metal is recycled.
Concrete and asphalt are recycled.</td></tr>
</table>

	• Asphalt shingles are recycled on a limited basis. Salvage operations and retail stores also achieve significant reuse of building materials and fixtures.
Whitehorse, Yukon	The City of Whitehorse's 2013 Solid Waste Action Plan establishes a goal of 50 per cent solid waste diversion by 2015 and zero waste by 2040 (City of Whitehorse 2013).
Regional Municipality of York, Ontario	York Region has established a goal of more than 90 per cent diversion from landfill by 2016 and eliminating the disposal of unprocessed waste in landfill by 2020 (York Region 2013).
International	
Massachusetts, US	The State of Massachusetts' Solid Waste Master Plan established a state-wide goal of 88 per cent reduction in CRD waste by 2010 (Massachusetts Department of Energy and Environmental Affairs 2000). (See Appendix E for a detailed case study.)
The Netherlands	The Netherlands has achieved recycling and recovery rates for CRD waste of 95 per cent (Dutch Ministry of Housing, Spatial Planning and the Environment 2004). (See Appendix E for a detailed case study.)

2.8 Construction, Renovation and Demolition Waste Diversion Opportunities and Barriers

CRD waste diversion offers many substantial economic and environmental benefits, such as the following:

- CRD waste management is good for local economies. It is estimated that CRD waste management and recycling contributed $460 million to Canada's GDP in 2014 (The Delphi Group 2015). Construction is a predominantly localized endeavour, with waste management occurring within the jurisdiction in which the building activity is also taking place. Detailed assessments of the economic impacts of waste diversion are found in the 2014 Conference Board of Canada report *Opportunities for Ontario's Waste: Economic Impacts of Waste Diversion in North America* (Gill and Knowles 2014).
- Increasing CRD waste diversion presents a multi-billion-dollar opportunity. Canada is projected to generate close to a billion tonnes of municipal solid waste between 2008 and 2033, including approximately $25 billion in recyclable materials (about $1 billion per year) (Canadian Council of Ministers of the Environment [CCME] 2009). Bringing the annual average of waste disposed down to 500 kilograms per person would inject about $10 billion into the Canadian economy and generate more than 50,000 jobs, as an estimated seven jobs are created for every 1,000 tonnes of waste diverted (CCME 2009; Ontario Waste Management Association [OWMA] 2015). This is highly achievable: for example, the Province of Nova Scotia has already achieved 50 per cent overall diversion and lowered its rate of per capita solid waste disposal to less than 400 kilograms per year, on route to its target of 300 kilograms per year (Province of Nova Scotia 2016).
- CRD waste recycling reduces environmental impacts. As one study puts it,

    > On a life-cycle basis, recycling produces usable materials at much lower environmental cost than materials from primary sources. That is, in addition to conserving raw materials, recycling conserves energy and water, and reduces the production of GHG emissions and

other pollutants. On and off the job site, recycling is one of the most significant commitments that the construction industry can make to sustainability. (Lennon 2005)

- CRD waste recycling creates jobs. It is estimated that there are over 4,800 green jobs associated with CRD waste and recycling in Canada (The Delphi Group 2015). Another study concluded that seven jobs are created for every 1,000 tonnes of waste diverted (all types) with an economic benefit four times greater than the net cost (AECOM 2009). In providing materials to local vendors and processors, job site diversion creates employment and economic activity, which help to sustain local economies. For example, implementation of Nova Scotia's Solid Waste–Resource Management Strategy in 1995 was expected to create over 600 jobs through "the expansion of diversion programs, industry stewardship initiatives and the manufacturing of value-added goods from recovered materials" (Province of Nova Scotia 1995).[7]
- Reclaimed construction materials offer choice to Canada's construction industry. The construction industry as a whole (one of Canada's largest employers) is a significant consumer of reclaimed CRD waste materials, some of which can be processed and used on site.

In order to capture these opportunities, governments must address a number of barriers and challenges to CRD waste diversion. These include:[8]

- **Presence of easily accessible, low-cost disposal options.** Most communities provide easy access to landfills, and landfill fees are low compared to the cost of diversion.
- **Large number of actors involved in the decision to divert CRD waste from landfill.** These actors sometimes have different, even potentially conflicting, priorities. For example, deconstruction and disassembly usually takes longer than conventional demolition. This may impact subsequent construction schedules, which, in turn, may add more cost to the project than might be saved from CRD waste recycling.
- **Pre-existing policies that hinder or conflict with CRD waste diversion goals.** Before developing CRD waste management policies, governments must undertake a situational analysis. For example, zoning policies may not allow for the establishment of CRD waste processing facilities.
- **Market forces that create expensive labour but inexpensive materials.** When labour is expensive, builders are less likely to use used materials, at any stage of the building process. Further, used building material stores have a hard time staying in business when land is expensive.
- **Disaggregated supply.** When supply is disaggregated, each supplier of used building materials has a small inventory, a good deal of CRD waste is sold informally, and there is no way to capture the entire offering. Architects can have a hard time finding what is available.
- **Lack of established markets and market capacity to effectively serve consumers of secondary materials with the right product in the right place at the right time.** Fluctuating

[7] Another case study from Nova Scotia reinforces the economic impacts of waste recycling and is available at Community Research Connections (2013).

[8] This list is adapted from Kane Consulting 2012.

commodity markets and the seasonal and cyclical nature of the construction industry add further complications. Very few (if any) used building material stores are able to support large projects. There is also a lack of markets for materials to be recycled back into new products. Indeed, some procurement practices may explicitly or implicitly prefer the use of virgin materials (e.g., inroad building).

- **Lack of producer responsibility for materials.** Currently, most producers are not responsible for their building materials once they reach the end of their useful life. Therefore, life cycle costs are not factored into pricing, and processes for managing products at end of life are not well established.
- **Disconnect between each step in the construction process.** Decisions are made separately at the design, construction, renovation, deconstruction and diversion stages. If the decisions were coordinated, incorporating used materials would be much easier.
- **Time and expense required for CRD waste diversion.** It is often cheaper to demolish a structure and dispose than to deconstruct and/or separate waste materials for recycling. Funding or other incentives may be necessary for the various actors (contractors, facilities, etc.) to undertake deconstruction, disassembly, sorting and cleaning activities that are sufficient to generate materials of a quality that are accepted by the market.
- **Lack of infrastructure for diversion into reuse and recycling.** Many communities do not have many drop-off locations or are missing facilities for certain types of materials. In some cases, pricing structures are aimed at large-scale recycling and are not appropriate for small- and medium-scale recycling. Appendix C shows the location of key CRD processing facilities in Canada.
- **Long and complex life cycle of building products, materials and structures.** Different materials need to be replaced at different times, and some materials are easier to remove and replace than others.
- **Lack of information or knowledge about alternatives to disposal.** Canada's building industry is characterized by a large proportion of small- or medium-sized enterprises, which have little capacity to stay up to date with trends in CRD waste management. They are also unlikely to be members of industry associations or unions and are therefore difficult to reach other than through the regulatory process (e.g., information at permit counters or provided by municipal staff) (Globe Advisors and Brantwood Consulting 2013).
- **Cultural impediments.** In some cases, clients demand new materials. In other cases, builders have trouble differentiating legitimate waste processing facilities from "fly-by-night" operations, or simply do not know about different deconstruction options. The construction industry in general has a strong attachment to traditional practices.

3 POLICY OPTIONS FOR CRD WASTE REDUCTION AND DIVERSION

This section presents six strategies and 14 policy approaches that may be considered for CRD waste management. This guide does not endorse any particular strategy, policy or combination of them.

Table 4: Strategies for reducing and diverting CRD waste

Strategy	Associated CRD waste management policies
A. **Create accountability for waste diversion (Section 3.1)**	Make specific actors (e.g., producers, builders, facilities) more accountable for reducing and diverting CRD waste. Policies: 1. Waste management plans and processes for facilities and projects 2. Producer responsibility programs
B. **Limit disposal options (Section 3.2)**	Limit where, how or what materials can be disposed of. Policies: 3. Waste disposal bans, limits and surcharges 4. Transportation requirements and restrictions
C. **Align financial incentives (Section 3.3)**	Use levies, fees and charges to encourage waste reduction and diversion. Policies: 5. Disposal fees and levies 6. Virgin material levies
D. **Improve CRD processes (Section 3.4)**	Increase the resource efficiency of CRD activities. Policies: 7. Building codes and requirements 8. Green building design certification 9. Environmental product labelling and standards 10. Deconstruction standards
E. **Strengthen diversion markets and infrastructure (Section 3.5)**	Increase the supply and demand of diverted materials by designing out waste and requiring proper end-of-life management when purchasing products and waste services. Policies: 11. Invest in infrastructure and markets 12. Public procurement
F. **Build knowledge and skills (Section 3.6)**	Increase the capacity and knowledge of key stakeholders and establish systems whereby progress can be tracked over time. Policies: 13. Industry outreach, education and resources 14. Benchmark and track data

These policies are not presented in any particular order or priority, as their relative utility to a particular region will be determined as part of the evaluation process. In each case, the description introduces the main characteristics of the policy, its applicability to CRD waste, its advantages and disadvantages, important considerations when developing the policy and, where they exist, some examples of the policy in use.

CRD waste policies work well in combination; it is very difficult for a single policy to be designed to deliver meaningful reduction and diversion on a stand-alone basis. The most suitable combination of policies for a particular region may be determined based on the evaluation process described in Section 1. There are too many possible combinations to discuss them all in this document. However, where appropriate, examples of successful combinations have been provided, including two detailed case studies in Appendix E. In all cases, it is assumed that stakeholder engagement and consultation will be an integral part of any policy development process.

It is important to note that the policies presented are at different stages of adoption in Canada. While some are well understood and accepted (such as disposal fees and levies, and CRD waste disposal bans, limits and surcharges) others are in the early stages of development in Canada (such as deconstruction standards and virgin material levies) though in practice elsewhere (such as the UK and the Netherlands).

3.1 Create Accountability for Waste Diversion

This strategy focusses on making specific actors (e.g., producers, builders, facilities) more accountable for reducing and diverting CRD waste. This strategy includes waste management plans and processes for facilities and projects, and producer responsibility programs.

3.1.1 Construction, Renovation and Demolition Waste Management Plans and Processes for Facilities and Projects

Policies can be implemented that require CRD waste generators and facilities to prepare and implement a waste management plan. These policies may be enacted in a variety of ways, including:

- municipal waste management bylaws tied to the building regulatory process (e.g., as a condition of a demolition or building permit)
- facility operating licences
- building codes and requirements (Section 3.4.1)
- procurement requirements for publicly funded projects (Section 3.5.2)
- green building certification schemes (Section 3.4.2).

When done right, this can be a very effective way to increase waste diversion by requiring these actors to meet certain standards or targets. These policies may require proponents to:

- develop a waste management or diversion plan that outlines the types of materials to be diverted and how they will be separated and processed for reuse and recycling. They may also address managing hazardous materials, deconstruction, salvaging and onsite reuse.
- undertake specific CRD waste management activities, such as the separation of certain materials at source.
- set processing standards or requirements for certain types of waste.
- set targets for the percentage of waste diverted from landfill (e.g., total waste, by material).
- track and report on activities, such as the location, material type, volume/weight and facility.
- send waste to specific facilities that have been approved for processing CRD waste.
- pay a deposit that is refunded when the requirements are met (e.g., submitting the waste management plan, achieving a diversion target).

These policies are effective only when there are appropriate incentives for compliance. Therefore, they are well suited to authorities that have the mandate to impose financial, legal or administrative penalties for non-compliance, such as warnings or notices, consent orders, unilateral orders, licence restrictions, fines or fees. This may be challenging for some local governments that are responsible for issuing construction permits but may not be able to force builders to go beyond what is required through the building code.

In these cases, governments may rely on financial incentives (e.g., rebates on development cost charges or deposit-refund schemes), moral suasion and negotiation (e.g., during rezoning processes).

Applicability to Construction, Renovation and Demolition Waste Materials

Waste management plans can apply to all CRD waste. However, they are most effective at increasing diversion rates for readily recyclable materials with established regional infrastructure and markets (e.g., clean wood, concrete, metals). They can be used to encourage waste reduction (e.g., through efficient processes) as well as reuse and recycling. They are also flexible and can be applied at any stage of the life cycle, from design to construction, renovation and demolition.

Policy advantages

- Waste diversion plans can be very effective at stimulating diversion, particularly through hard diversion targets tied to permit approvals.
- Waste diversion goals can be applied at any stage in the building life cycle but have the greatest impact when applied early in the design stage to inform how buildings are built, thereby reducing the volumes of waste generated.
- Waste diversion goals offer flexibility to stakeholders to develop a plan that suits their businesses.
- Waste management plan requirements are usually simple to manage and administer.
- Waste management plans help industry differentiate between legitimate processing facilities and "fly-by-night" operators.

Policy disadvantages

- Some jurisdictions may have the authority to require reporting but not performance (e.g., building permits). If so, they need to provide sufficient incentive to encourage compliance.
- Affordable alternative facilities need to be in place to prevent illegal dumping.
- Regulated diversion goals require strong and continuous enforcement, which may add cost.
- These policies do not deal with weak end markets.

Considerations when developing the policy

- Requirements for waste management plans can be more effective when they include enforceable targets or outcomes. Plans without targets generally result in low levels of compliance.[9]
- Establishing CRD waste diversion targets for processing facilities is administratively simple and can be an effective way to stimulate a market response. Targets provide facilities with the incentive to charge higher fees for non-recyclable materials, invest in equipment that facilitates processing and find innovative new end uses for materials.
- Creating waste management plans and the subsequent tracking and reporting of CRD waste is a requirement under LEED V4 (Green Building Council n.d.) (see Green Building Certification in Section 3.4.2).
- When supported by disposal bans (Section 3.2.1) and disposal fees and levies (Section 3.3.1), CRD waste management plans can be valuable where wide-ranging changes in behaviour are needed across a large number of production and consumption activities.
- To be effective, these policies should establish sufficient financial or non-financial incentives for compliance. These can be supported by an effective enforcement regime (e.g., inspections, document review) to ensure the plans are implemented and materials end up in the right facility.
- Web-based tools (accessible by the regulator, the project team and the processing facilities) are available to assist with the considerable measurement and tracking required to determine if goals are met, and to take corrective action if they are not (see Appendix D).

Government involvement in policy development and implementation

Waste plan requirements may be implemented by any order of government (federal, provincial/territorial, municipal/regional) with jurisdiction over the target actor.

Examples

City of Vancouver *Green Demolition Bylaw*

Operating under the Vancouver Charter, the City of Vancouver (population 647,000) has imposed a $15,000 refundable fee paid with a demolition permit (City of Vancouver n.d.-a). If the following deconstruction, reuse and recycling targets are achieved, then $14,650 is refunded:[10]

- **Houses built before 1940**: 75 per cent of materials by weight, excluding hazardous waste.
- **Houses built before 1940 and deemed character houses by the city**: 90 per cent of materials by weight, excluding hazardous materials.

[9] Feedback from stakeholders: Ontario’s 3Rs Regulation, which was developed in the early 1990s (O. Reg. 102/94), only requires construction and demolition projects to develop and submit waste reduction workplans. Historically, there has been a low compliance rate with completing these plans, as many CRD operators consider preparing workplans as just an administrative process.

[10] Targets are quoted from City of Vancouver (n.d.-a).

Halifax Regional Municipality licensed facility diversion targets

The Halifax Regional Municipality (HRM) (population 414,000) has established licensed sites to receive CRD materials and requires the operators of those sites to meet recycling targets of 75 per cent diversion. Generators should separate CRD materials (wood, insulation, vinyl siding, asphalt shingles, drywall/plaster, vapour barrier, metals, roofing materials, doors and windows, rugs/ carpeting/vinyl flooring, countertops/cupboards, tiles) to maximize diversion opportunities (Jeffrey, 2011 and personal communication with Bob Kenney, Nova Scotia Environment, June 2014).

Town of East Gwillimbury, Ontario, waste management targets and requirements for CRD waste management plans

The town of East Gwillimbury (population 22,500) has created Thinking Green! Development Standards, which require project owners to undertake the following (Town of East Gwillimbury 2012):

- Submit and implement a CWM plan to demonstrate diversion of approximately 50 per cent or more of construction, demolition and land-clearing waste from landfill.
- Provide at least one recycling or reuse station during construction dedicated to separating, collecting and storing materials for recycling (at a minimum, wood, drywall, paper, corrugated cardboard, glass, plastics and metals).
- Recycle at least 75 per cent of non-hazardous construction and demolition debris.
- An optional goal is to submit and implement a CWM plan that demonstrates diversion of at least 75 per cent of construction, demolition and land-clearing waste from landfill.

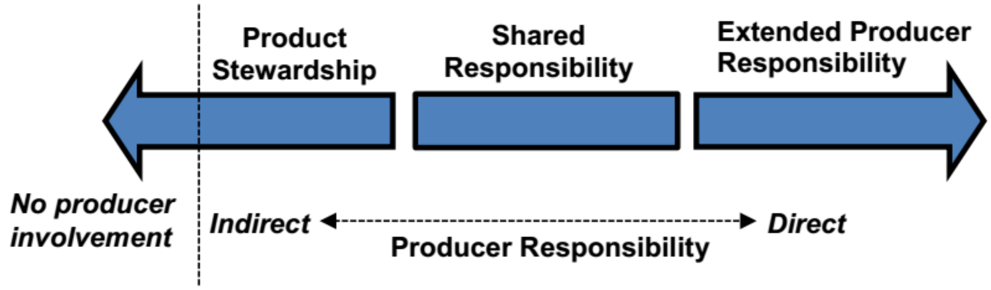
3.1.2 Producer Responsibility Programs

Producer responsibility programs are upstream policy approaches “in which a producer’s responsibility for a product is extended to the postconsumer stage of a product’s lifecycle” (CCME 2014). Also referred to as “product take-back” schemes, the intent is to shift responsibility for end-of-life management to the “producer” of the product or material, where the producer is defined by CCME as the “most responsible entity and may include but is not limited to the brand owner, manufacturer, franchisee, assembler, filler, distributor, retailer or first importer of the product who sells, offers for sale or distributes the product in or into a jurisdiction” (CCME 2014).

For many governments, an important benefit of producer responsibility programs is the ability to engage industry in taking responsibility for the products and materials they produce and creating markets for used and recovered materials. Producer responsibility is also linked with broader philosophies such as DfE that are aimed at reducing the overall human health and environmental impact of a product, process or service, where impacts are considered across its life cycle.

Note that a large number of producer responsibility programs operate in Canada with different requirements; some jurisdictions use the same name (e.g., “product stewardship”) to refer to programs with very different structures. In an effort to standardize nomenclature, CCME distinguishes among three approaches that connect production and consumption activities with the post-consumer stage of a product’s life cycle: product stewardship, shared responsibility and EPR (Figure 12).

Figure 12: Continuum of producer responsibility by approach



Source: CCME (2014).

As defined by CCME, the three types of producer responsibility approaches can look similar. However, they vary in governance structure and in the level of responsibility they place on producers for dealing with their products at end of life. CCME defines the terms as follows (definitions quoted from CCME 2014):

- **Product stewardship:** Programs in which manufacturers, brand owners and/or importers are neither directly responsible for program funding, nor for program operations. These are waste diversion initiatives funded by consumers or general taxpayers and are operated by public agencies or delegated administrative organizations. These programs may be mandated through legislation and regulations or may be voluntary. Producers may play an advisory role.[11]
- **Shared responsibility:** Programs operated by governments (e.g., municipalities or other public agencies) but with varying degrees of producer responsibility, control and/or funding. These are commonly found in the areas of packaging and printed paper, where municipalities provide collection and sorting/processing services with substantial funding provided by producers, notably through a PRO or an industry funding organization.
- **EPR:** Programs or requirements in which manufacturers, brand owners and/or first importers are directly responsible for both the funding and the operation of the programs. Properly done, an EPR program covers the entire cost of managing a product at its end of life. EPR programs may be legislated (i.e., required by government legislation or regulations) or voluntary industry-led programs that have not been regulated or otherwise mandated by the government.

All these approaches involve setting up waste management systems for targeted products (e.g., paint), product categories (e.g., electronic products) or waste streams (e.g., packaging). They all also rely on financial mechanisms to cover the costs of collection, processing and diversion. These can be in the form of industry stewardship fees, consumer eco-fees, deposit-refund systems or some combination of income sources. For example, Nova Scotia's deposit-refund program for beverage containers generates net-revenue, which funds a network of Enviro-Depots, recycling programs and regional waste management systems (Divert Nova Scotia n.d.).

[11] Note that the term "product stewardship" is currently used by some jurisdictions to describe producer responsibility programs that reflect the "shared responsibility" definition. This guide uses CCME definitions.

Producer responsibility programs will generally include the following elements:

- Clear definitions of the products, product categories and/or waste streams covered by the policy and their associated responsible (or designated) producers.
- Clear description of roles and responsibilities for the financing and operation of the program.
- A stewardship plan that outlines how producers will meet their obligations.
- Requirements for performance, documentation, reporting, communication and auditing.
- The consequences of non-compliance, such as financial, administrative, legal or other penalties.
- Compliance with trade agreements and competition requirements.

Some jurisdictions have also explored other variations on producer responsibility that do not fit into the three categories above. For example, the Province of Nova Scotia considered requiring brand owners and manufacturers of drywall, asphalt roofing and composite/engineered wood to disclose additional information on their products (e.g., chemicals of concern) and to work with CRD generators and processors to expand and develop new value-added products at end of life (personal communication with Bob Kenney, Nova Scotia Environment, June 2014).

Applicability to Construction, Renovation and Demolition Waste Materials

A range of EPR, product stewardship and shared responsibility programs are in operation across Canada (and around the world). However, they are primarily focussed on consumer products and to date have not been applied to the construction sector in a comprehensive way. As such, there is a lack of information on the applicability or effectiveness of producer responsibility programs for CRD waste.

In particular, most producer responsibility programs focus on individual materials, whereas most CRD waste is generated at the building level, particularly demolition waste (for which producer responsibility programs are complex to apply due to the lack of clarity around product "ownership" throughout a building's long life cycle). Consequently, CRD waste policies typically focus on influencing waste generators rather than product producers. Therefore, the design of producer responsibility policies for CRD waste should consider the incentive and requirements for both generators and producers.

British Columbia (BC), Manitoba and Prince Edward Island have some of the most extensive producer responsibility programs in Canada and cover products such as packaging (e.g., beverage containers), printed materials, electronics and electrical equipment (e.g., computers), and household hazardous wastes (e.g., paints, pesticides, batteries). Ontario passed new legislation in 2016 (the *Waste-Free Ontario Act*) that will overhaul the existing system and significantly expand the role of producer responsibility in the province.[12]

Currently, there are only a few EPR programs related to CRD waste products in Canada, which include thermostats, fluorescent lamps, paint products, solvents and flammable liquids. However, the application of producer responsibility to CRD materials is expected to expand in the coming years. Notably, CRD materials are identified under CCME's *Canada-wide Action Plan for Extended Producer Responsibility* for incorporation into operational producer responsibility programs (CCME

[12] The *Waste-Free Ontario Act* was passed on June 1, 2016. See Legislative Assembly of Ontario (2016).

2009). For example, major manufacturers of both commercial carpet and ceiling tiles already operate voluntary "take-back" and producer responsibility programs in the US (see example below). Some provinces are also considering producer responsibility programs for other CRD materials such as flooring, drywall (wallboard), window glass, brick, asphalt roofing, engineered wood and treated wood (such as creosote timbers).

Policy advantages

- Producer responsibility programs have been very effective at diverting non-CRD waste, supporting recycling infrastructure growth, and encouraging waste material recovery and recycling.
- Producer responsibility may work for some new construction materials (but is unlikely to be effective for all demolition waste).
- Producer responsibility can stimulate innovation in product design (e.g., DfE) and supports the transition to a circular economy.
- Producer responsibility can be a powerful tool for financing the creation and growth of new markets and driving demand for recovered materials.
- Producer responsibility programs can be designed to be revenue neutral for governments or even revenue generating to fund waste diversion. They may raise the cost to consumers, which produces an additional incentive to reduce or divert waste.

Policy disadvantages

- Producer responsibility programs are complicated to design and implement and could be particularly challenging for CRD waste because of the fragmented nature of the industry and the number of different actors.
- To date, producer responsibility programs have not been developed for most forms of CRD waste, which creating uncertainty around efficacy and cost.
- Producers may pass on costs for diversion programs to consumers rather than investing in innovation to reduce the costs of compliance. This can create resistance to the policy, particularly if these are applied as visible eco-fees at point of sale.
- Producer responsibility requires comprehensive and sustained industry education to ensure the responsibilities of all parties are clearly understood.
- For construction and demolition projects, many different materials pass through many hands, making it difficult to pinpoint the responsible parties.

Considerations when developing the policy

- There is a lack of consistency in key definitions, reporting criteria and enforcement across Canada. As noted above, some terms (such as "product stewardship") are used to refer to programs with different structures and requirements. This lack of consistency can make compliance and reporting across jurisdictions a challenge.
- Producer responsibility programs for CRD waste are in the early stages of development and are focussed on a small range of specific materials rather than the sector as a whole. Several provinces are exploring producer responsibility programs for application to CRD waste

materials in response to commitments made under CCME's *Canada-wide Action Plan for Extended Producer Responsibility* (Personal communication with Bob Kenney, Nova Scotia Environment, June 2014).

- Detailed background information is necessary in order to design a producer responsibility program and ensure proper oversight and enforcement. Knowledge of what markets already exist, what other regulations may already apply, what competing interests exist and how the producer responsibility policy will help to achieve objectives is also important (OWMA 2013-b). Producer responsibility programs may be more effective when combined with complementary policies that increase diversion and support the development of markets for recovered materials (e.g., disposal bans and recycled material standards).
- The design of producer responsibility programs should consider the costs of conforming with the program relative to the size of the regulated market, the price and life-cycle cost of the product, and the cost or technical viability of reusing or recycling the product. The design should also consider the need for accurate and transparent reporting, particularly if the program will be managed by a third party such as an industry group.
- Consultation with industry is critical prior to and during the development of any producer responsibility program. Clarifying the roles and obligations of suppliers, general contractors, subcontractors, waste haulers and processors, and the design community is critical to drive adoption.
- Future producer responsibility schemes can incorporate tradable packaging recovery notes, which are gaining traction in Europe. These are a form of credit that producers can trade in markets to reduce the cost of compliance.[13]

Government involvement in policy development and implementation

Producer responsibility programs are generally developed by federal, provincial and territorial governments. However, their design and implementation requires extensive collaboration with local governments, producers and PROs.

Examples

Recycle BC

BC's Recycling Regulation is an example of full EPR that shifts responsibility for end-of-life management of packaging and printed paper from governments and taxpayers to the businesses that produce these materials. Recycle BC is the non-profit organization formed to develop and implement the stewardship plan for residential packaging and printed paper. Businesses that supply printed paper and packaging materials are considered industry stewards and pay annual fees to fund the program. Collection is handled by local governments, First Nations, private companies and non-profits that have partnered with Recycle BC (Recycle BC n.d.).

[13] See Clarity (n.d.) for an example of a packaging recovery note trading centre.

Divert Nova Scotia

Divert Nova Scotia is a not-for-profit organization that operates two core product stewardship programs, the Beverage Container Deposit-Refund Program and the Used Tire Recycling Program. The organization also manages a network of Enviro-Depots throughout the province. The organization is completely self-sustaining and is funded by the environmental fees on new tires, beverage container deposits and the sale of recyclable materials (Divert Nova Scotia n.d.-a).

The California Carpet Stewardship Bill (AB 2398)

This state ordinance is an example of a shared responsibility program that requires carpet retailers to help divert used carpet from landfills. Retailers are now required to create and implement a carpet-recycling plan to increase the percentage of post-consumer carpet diverted from landfill. Customers are charged a fee for all new carpet purchased. The revenues fund post-consumer carpet recycling measures (CalRecycle 2017).

Strengthening markets for producer responsibility materials through procurement and green building certification

Procurement requirements, material standards and certification programs can be used to increase demand for materials managed under producer responsibility schemes. For example, version 4 of the LEED green building certification system provides credit for the use of products managed under producer responsibility programs if they total at least 25 per cent of the value of installed products[14] (See Section 3.4.2).

3.2 Limit Disposal Options

This strategy focusses on limiting where, how or what materials can be disposed, such as through waste disposal bans or transportation restrictions. This strategy includes waste disposal bans and transportation requirements and restrictions.

3.2.1 Construction, Renovation and Demolition Waste Disposal Bans, Limits and Surcharges

A disposal ban prevents or restricts the disposal, transfer for disposal and contracting for disposal of target (or designated) wastes, hazardous items and recyclable materials. Disposal bans encourage the reuse or recycling of materials, conserve disposal capacity, and reduce adverse environmental impacts. They can be imposed on landfills and also applied to other types of waste management operations, such as EfW facilities and recycling facilities.

Disposal bans are an important mechanism in the implementation of a waste diversion plan and targets. When supported by differential tipping fees (Section 3.3.1) and waste diversion targets (Section 3.1.1),

[14] The extract from LEED V4 is available at https://new.usgbc.org/leed-v4

they can be valuable where wide-ranging changes in behaviour are needed across a large number of production and consumption activities.

Bans can be implemented in various ways:

- **Outright bans**: Zero tolerance for the disposal of some materials at the facility (e.g., hazardous materials, batteries). Facilities may reject loads that contain banned materials, resulting in increased costs to separate the materials and transport them elsewhere. The non-compliant organization may be subject to warnings or notices, consent orders, unilateral orders, administrative penalties, licence restrictions, fines or other penalties.
- **Disposal limits**: Maximum permissible amounts of waste materials that may be disposed at the facility. Higher thresholds or more flexible requirements may be allowed for small loads or facilities in remote or rural locations. Disposal of some materials (e.g., clean wood) may be acceptable up to a certain amount. Other considerations may include the quality or physical condition of the banned material, the ease with which it can be separated from the waste stream and worker safety.
- **Disposal surcharges**: A "banned" material may be allowed at the facility, but there are requirements for pre-sorting or pre-treatment, and a surcharge is imposed, usually at the gate. For example, Metro Vancouver imposes a $50 minimum surcharge, plus the potential cost of removal, cleanup or remediation, on loads containing banned hazardous and operational impact materials or product stewardship materials. A surcharge of 50 per cent of the tipping fee on the entire load is applied to loads containing banned recyclable materials (e.g., clean wood and drywall) (Metro Vancouver n.d.-a).

The elements of an effective disposal ban include:[15]

- knowledge of the jurisdiction's unique market context (e.g., waste management policies, available technologies and capacities, diversion rates) based upon good data collection and tracking and monitoring of the CRD waste stream (Section 3.6.2).
- measures in place that will mitigate the potential for unintended consequences such as illegal dumping, transportation of waste to another (less stringent) jurisdiction or the contamination of recyclable waste streams. Pilot programs, industry engagement and beneficial practices research can help alleviate these issues.
- clear requirements for documenting and reporting the transportation and handling of designated materials may be applicable (Section 3.2.2).
- sufficient penalties to incentivize diversion and strong enforcement to ensure compliance.

Disposal bans may be imposed on generators, haulers or facility operators, with different expectations for each of these actors:

- **Generators**: May be required to develop a waste management plan (Section 3.1.1), separate wastes at source to remove and recycle any banned materials and ensure they do not contract for the disposal of banned items.

[15] This section draws significantly on OWMA (2013-a).

- **Haulers:** May be responsible for inspecting loads before transporting them, refusing to transport designated materials, and delivering banned materials only to authorized facilities.
- **Facility operators**: May be required to implement measures (waste management plan, inspections) to ensure that unallowable quantities of banned materials are not disposed or transferred for disposal from their facilities. This would prevent the operator from accepting banned materials.

Applicability to Construction, Renovation and Demolition Waste Materials

Disposal of cardboard, clean wood, drywall and many hazardous materials is banned in several jurisdictions in Canada. For example, the Capital Regional District in BC has banned the following CRD materials: aggregate, asphalt, clean soil, concrete, corrugated cardboard, drywall, rubble and scrap metal.[16] Large loads of inert materials — such as soil, sod, gravel, concrete and asphalt — may also be banned, as they can readily be reused or recycled.

Policy advantages

- Disposal bans can send a clear signal to the market that designated materials must be diverted from landfill through reduction, reuse or recycling.
- Bans can generate revenue via fees and fines that can be allocated to economically sustainable systems for:
  - Processing banned materials
  - Reducing and diverting CRD waste
  - Activities that stimulate the development of reuse and recycling businesses and markets.
- Bans can increase economic activity, including job creation, business development and innovation, and can help stimulate the development of lower-cost products (e.g., animal bedding in Nova Scotia).

Policy disadvantages

- Bans can be “blunt instruments” (i.e., they can be inflexible and take an all-or-nothing approach) that can be costly to implement and enforce.
- Bans focus on end-of-life solutions that do not necessarily affect the volumes of waste being generated (i.e., they do not inform upstream decisions that may have an impact on how much waste is produced).
- Bans are not generally effective on their own. They work well in combination with secondary policies such as differential tipping fees (Section 3.3.1) and established infrastructure (Section 3.5.1) and markets.
- Bans may require significant lead time (e.g., at least one year) to ensure adequate alternatives are in place, allow for communication, education and training, and to set up enforcement mechanisms.
- Strong end markets must be in place for bans to be effective.
- Detecting banned materials in mixed waste can be challenging, and removal may not be feasible due to technical, financial or safety reasons.

[16] CRD Waste Management Plan section 2.1.6 deals with banned materials (see Watkins 1995).

Considerations when developing the policy

- Bans should ideally establish sufficient financial or non-financial penalties to incentivize compliance. They can be supported by an effective enforcement regime to ensure that the banned materials end up in the right facility and are not dumped illegally.
- To be effective, bans rely on comprehensive and sustained outreach and education (Section 3.6.1) in combination with detailed documentation, tracking and reporting (Section 3.6.2).
- Sufficient resources are needed for oversight, education and enforcement. Financial and staff support may also be required to establish or scale up markets and alternatives for banned materials.
- Revenues generated from disposal fees can be allocated to economically sustainable systems for reducing and diverting CRD waste as opposed to going to general revenue. This prevents people from interpreting the fees as a tax.
- Bans can be introduced gradually by starting with differential tipping fees and/or disposal limits (Section 3.3.1.).
- Bans are generally most effective if there are established markets and facilities to collect, process and use the reused, recycled or recovered materials. If this is not the case, policy-makers may wish to provide advance notice of the ban to allow time for these markets to develop.

Government involvement in policy development and implementation

Disposal bans may be implemented by provincial, regional or municipal governments and applied to a variety of facility types. Bans that are developed by provinces or territories are generally managed and enforced by local governments, adding a layer of administrative complexity.

Where the public sector operates the available waste transfer and disposal sites, waste disposal bans are an effective tool. However, in some cases, local governments may have only limited legal ability to apply disposal bans and enforce them at privately owned/operated transfer and disposal facilities. Further, some local governments may not have the legal authority to apply or enforce bans (and other tools) against publicly run waste management facilities based on exemptions or other wording found within the applicable legislation.

Examples

Nova Scotia disposal ban for compostable organic material

Nova Scotia imposed a ban on compostable organic material in 1997, when there were very few existing composting facilities or established markets. The ban created the conditions for the private sector and municipalities to react and create the facilities and markets. Nova Scotia's experience shows that it is not essential to have established facilities and markets in place before instituting a ban, as long as sufficient advanced notice is provided. Other considerations include the presence (or lack) of transportation requirements, market size and scale of demand for recycling facilities. This approach may not be practical for all jurisdictions (Province of Nova Scotia n.d.-a).

Nova Scotia reports that the net benefits of the ban (e.g., diversion, jobs, innovation) outweigh the costs of compliance and enforcement. Nova Scotia has banned almost 20 materials and end-of-life products from disposal and now has a disposal rate almost 50 per cent lower than the Canadian average (Province of Nova Scotia n.d.-a).

Massachusetts waste ban

According to Jeffrey (2011):

> Massachusetts has employed landfill bans for specific CRD waste materials in order to reduce the total amount of waste landfilled in the state. The Massachusetts Department of Environmental Protection (DEP) banned the disposal of asphalt pavement, metal, brick, concrete and wood in 2006 and clean gypsum board in 2011. Through a Solid Waste Master Plan entitled Beyond 2000, the Massachusetts DEP committed the state to an 88 per cent reduction in landfilled non-municipal solid waste by 2010, and the waste bans were designed to assist this process. The master plan was updated in 2006. (For more details see the case study in Appendix E.)

3.2.2. Transportation Requirements and Restrictions

Federal, provincial, regional and local governments may have the authority to use legislation to support the appropriate landscape for CRD recycling in their jurisdiction. Legislative tools may include requirements (e.g., licensing schemes) and restrictions. While transportation requirements and restrictions may be an effective tool in certain situations for select waste streams, the use of this policy tool should be carefully assessed.

Transportation requirements and restrictions should not be implemented as stand-alone policies or in the absence of well-established end markets. For example, in the Netherlands, one of the most progressive countries in the EU when it comes to CRD waste management, the government brought in transportation requirements and restrictions only after it had successfully implemented a suite of other policies to directly address the root causes of CRD waste, including a ban on CRD waste at landfill and one of the highest tipping fees in the world (see Case Study 2: Dutch Chain-Oriented Waste Policy in Appendix E).

Transportation requirements and restrictions can be controversial among stakeholders, so it is important to have clear, enforceable legislation and robust, defensible consultation processes along with well-defined roles and responsibilities (see *Considerations when developing the policy* section below).

Some common reasons for considering transportation requirements and restrictions include:

- Improving diversion rates: Ensuring CRD wastes are taken only to authorized facilities that can sort and process the waste for reuse and recycling.
- Compliance with disposal bans and other policy tools: Preventing CRD wastes from being transported to other jurisdictions may undermine the effectiveness of the local waste management policy (e.g., hinder the development of local end markets). For example, some local authorities are using disposal bans (see Section 3.2.1) to encourage the diversion of CRD wastes (e.g., wood, drywall).
- Financial and market considerations: Keeping valuable CRD wastes within a municipal or regional boundary protects local revenue streams (e.g., tipping fees) and markets (e.g., supply

of diverted materials). Haulers that ship waste out of the municipality or region may not be contributing to the cost of managing the regional disposal system and recycling initiatives.

- Market development for CRD processing facilities: One purpose of implementing transportation requirements and restrictions for solid waste is to ensure that projected amounts of waste (and revenues) will be received at designated waste management facilities, which may even have been supported by public investment (see Section 3.5.1). However, "guaranteeing" feedstock to select facilities comes with significant challenges that should be assessed carefully before proceeding, as it requires an ongoing supply of materials that may be difficult to sustain.

Transportation requirements and restrictions can be enacted through a combination of hauler licences, facility licences and supporting legislation (e.g., waste management plans and bylaws) that control who can transport the waste, where it can be transported, and which facilities can accept it. Non-compliance with licensing schemes usually results in fines. In some cases, a government may have the power to suspend a business's activities or close a business altogether. The requirements for different actors may include:

- Hauler requirements: Many regions operate some form of licensing scheme for haulers, but the standards and forms of compliance vary. A requirement for hauler companies to secure a licence to operate places the onus on the licence applicant to understand fully the types of waste being handled and ensure that the materials are taken to the correct facility. Usually, the entire hauler company is certified (as opposed to a specific vehicle or driver), and loads are subject to inspection at regional facilities to track program effectiveness. In some programs, a hauler may be eligible for incentives (or may avoid a disincentive) for having a portion of their customers meet certain waste diversion criteria (Section 3.2.1).
- Generator requirements: Policies (e.g., municipal bylaws, building/demolition permits, establishment of a site-specific waste management plan or conditions imposed in a business licence) may be used to direct waste to approved facilities within a geographic region and may also discourage or prohibit generators from contracting with unlicensed haulers for the disposal of CRD waste (see the Metro Vancouver example in Section 3.4.1, the City of Port Moody example in Section 4.5, and Case study 2: Dutch Chain-Oriented Waste Policy in Appendix E).
- Facility requirements: Policies (e.g., municipal bylaws, facility licences) may be used to control the types of waste that a facility can accept and to place requirements on how that waste is processed or disposed (see Section 3.1.1 for additional information).

Hauler and facility licence schemes enable strong data collection processes to track and report on CRD waste materials and their diversion. They can also help ensure compliance with other regulations, such as the federal *Environmental Protection Act* or the *Transportation of Dangerous Goods Act*, and their relation to either federal or provincial regulators. However, it should be noted that transportation requirements and restrictions do not necessarily imply that waste cannot be exported to another jurisdiction.

Transportation requirements and restrictions may therefore be considered in combination with municipal bylaws to direct waste to the appropriate facility within a geographic region, complemented by any material disposal bans and prohibitions and considering implications with current or future producer responsibility programs. Other incentives, such as variable tipping fees, may also encourage waste to be directed to appropriate facilities.

Considerations when developing the policy

- Transportation requirements and restrictions policies have been contentious both in Canada and in the US, particularly with municipalities where it is not always clear if the government has the legal authority to implement these restrictions. The provincial/territorial municipal act may need to be amended to provide this authority. Some jurisdictions use waste bans and facility licensing instead of transportation requirements and restrictions to control where CRD waste can be delivered.
- Much of the contention around transportation requirements and restrictions stems from concerns that these policies may limit competition, create inefficient local monopolies, increase costs, or interfere with the free flow of inter- and intraprovincial commerce (McCarthy 1995) There have been numerous cases of litigation related to these policies, particularly in the US.[17] Consequently, local governments should assess the risk of potential legal challenges when considering these types of policies.
- Once complex transportation requirements and restrictions are enacted, they may be difficult to change.
- Jurisdictions may want to have transboundary movement of waste to maximize the economies of scale for processing facilities.
- International and interprovincial trade policies and agreements may impact and can add significant complexity to the development of policies related to transportation requirements and restrictions.
- It is important to understand the CRD waste management market to determine the relative costs and benefits of such policies to the local authority, waste generators, haulers and processors. For example, local processing facilities may rely on hauler licensing and other mechanisms to ensure they receive adequate flow of waste materials to be economically viable.
- Effective enforcement mechanisms need to be determined, such as regular inspections and the application of appropriate legal, administrative and financial penalties.
- Strong data collection, with enforcement, is essential to ensure compliance (e.g., avoid illegal export or dumping).
- Consistent regulations across boundaries, such as disposal restrictions, could also effectively encourage CRD waste to go to compliant facilities. Other incentives, such as variable tipping fees, may also encourage waste to be directed to appropriate facilities.

[17] See, for example, Kim (1993), United Haulers Association v. Oneida-Herkimer Solid Waste Management Authority (2007), and Waste360 (2007).

Applicability to Construction, Renovation and Demolition Waste Materials

Depending on the authorities involved and the local situation, transportation requirements and restrictions may be applied to all CRD waste materials or to a subset of target materials.

Policy advantages

- Transportation requirements provide greater control over the flow of wastes and compliance with local waste management goals and priorities.
- Transportation requirements ensure wastes are transported appropriately and delivered to compliant facilities. The costs of compliance with licensing requirements are borne by the market.
- Transportation requirements reduce waste shipped to other jurisdictions. Applied early in the design process, they may help to reduce the volumes of waste generated.
- Transportation requirements keep valuable CRD wastes within a municipal or regional boundary, which can protect local revenue streams (e.g., tipping fees) and markets (e.g., supply of diverted materials).
- Transportation requirements can be used to increase the cost of disposal and encourage waste reduction and diversion. They can also enable the use of long-term, full-cost accounting to set prices.

Policy disadvantages

- Transportation requirements may reduce competition by creating virtual monopolies for authorized operators, particularly if there are few options available. It some cases they may also be a technical or legal barrier to trade.
- Transportation requirements may create real or perceived competitive disadvantages for waste generators if their choice of hauler or facility is restricted.
- Transportation requirements may increase costs to taxpayers in jurisdictions where waste management services are subsidized (e.g., by increasing wastes processed by subsidized facilities).
- There are costs to governments for administering, monitoring and enforcing the program and potential for conflict with existing or future producer responsibility programs.
- Transportation requirements and restrictions can create real or perceived economic distortions in the marketplace.
- Once complex transportation requirements and restrictions are enacted, they may be difficult to change.
- There is a lack of consistency in how CRD waste is regulated across different jurisdictions, which may make it difficult for hauler licenses to be successful.
- Hauler licenses may not be administered by the government department responsible for solid waste, which may add a layer of complexity to the process.

Government involvement in policy development and implementation

- The government departments responsible for solid waste often are responsible for CRD waste facility licensing (noting that these facilities may be run by private sector operators). Sometimes the same department is also responsible for CRD hauler licences. In some cases, ministries of transportation or highways administer hauler licences.

Examples

Halifax Regional Municipality, Nova Scotia

In 2002, Halifax Regional Municipality (HRM) (population 414,000) passed an amendment to bylaw S-600, *Solid Waste Resource Collection and Disposal By-Law*, prohibiting the export of municipal solid waste generated in the region and requiring its disposal at facilities within its boundaries — essentially using transportation requirements and restrictions as a form of "flow control." As defined by the EPA, flow controls are "legal provisions that allow governments to designate the places where municipal solid waste is taken for processing, treatment, or disposal" (US Environmental Protection Agency [EPA] n.d.-b). The use of flow control in the US and Canada is the subject of much debate among governments, industry and environmental groups in part because of concerns that designated facilities may hold monopolies on local solid waste and recoverable materials.

HRM's policy was disputed in court, with the Nova Scotia Court of Appeal overturning a lower court decision in 2007 and ruling that HRM could lawfully enact and enforce a bylaw requiring locally generated solid waste to be disposed of within the municipal boundaries and thus preventing its disposal outside the municipal boundaries (Waste360 2007).

In 2015, HRM passed Amendment 609 to remove the "export ban," partly in order to extend the life of the municipal landfill (Otter Lake Landfill) but also because it reasoned that the removal of flow control legislation would (Halifax Regional Municipality 2015):

- reduce costs for taxpayers and businesses
- increase competition for waste disposal
- extend the life of existing capital investments
- defer the need to build new landfill cells.

As of 2017, commercial/industrial and municipal solid waste can now be exported, and much of it is ending up at landfills in adjacent municipalities (Personal communication with Bob Kenney, Nova Scotia Environment, June 2017). HRM still has some transportation restrictions and requirements in place for CRD waste. CRD debris is not permitted for export and only accepted at authorized CRD facilities as a result of the 2002 bylaw L-200, *Respecting Licensing of Construction and Demolition Materials Recycling and Disposal Operations.* This bylaw licenses sites to receive these CRD materials and requires the operators of those sites to meet recycling targets of 75 per cent diversion from disposal (Halifax Regional Municipality 2012).

San Francisco, California

CRD waste reduction and diversion is a priority for numerous communities in California, particularly those in and around the San Francisco Bay Area (population 864,000). The City of San Francisco enacted the CRD Debris Recovery Ordinance on July 1, 2006, which applies to all new construction, renovation and demolition projects that generate more than one cubic yard of CRD waste (City of San Francisco 2006).

The city's objective was to increase the amount of CRD debris recycled by 80 per cent. The city also made amendments to its building code, health code and the police code in support of this goal. Under this ordinance, no CRD waste materials can be taken to landfill: all debris material removed from a project must be recycled or reused. Materials must be separated by type at the job site and then transported off site by a registered transporter and taken to a registered facility. For demolition waste, generators must also submit a demolition debris recovery plan that provides for a minimum of 65 per cent diversion from landfill for CRD waste. The plan must be submitted and approved before the city will issue a full demolition permit (SF Environment n.d.).

Berkeley, California

Communities of all sizes have been able to leverage the development of cheap, easy-to-use online CRD waste management tools (see Appendix D) to impose their waste management goals without the need for explicit transportation requirements or restrictions. For example, the City of Berkeley (population 118,000) has been able to steer CRD waste generators towards registered haulers and facilities because both haulers and facilities have to be listed in the online system (City of Berkeley n.d.).

Using the online system, a CRD waste management report can be submitted to the city, summarizing all the different CRD materials, how much is generated and how much is diverted from landfill measured either by volume (cubic metres or cubic yards) or weight (tonnes). The system allows administrators to:

- Track industry performance against CRD waste management goals and show quantitative improvement over time
- Receive alerts related to the functioning of the CRD waste management system such as potential overburdening of processing facilities
- Encourage contractors to submit data voluntarily (as part of green building rating system checklist submissions) so governments can benchmark local industry capacity prior to establishing a waste diversion policy and targets.

3.3 Align Financial Incentives

This strategy focusses on using fees and charges to encourage waste reduction and diversion, such as through disposal fees and levies or virgin material levies. This strategy includes disposal fees and levies, and virgin material levies.

3.6.1 Disposal Levies and Fees

Pricing mechanisms can provide powerful incentives for waste generators and haulers to increase their diversion rates. A tipping fee is the charge levied on a given quantity of waste received (usually based on weight) at the gate of a transfer station, sorting facility or landfill. Fees are also charged at the gate of waste processing facilities. They can be set up as incentives (e.g., discounted fees for source-separated loads of recyclable materials), disincentives (e.g., surcharges for unsorted mixed loads) or a combination of both. They may also be used to encourage waste generators and haulers to bring their materials to specialized facilities (e.g., offering lower rates at CRD waste facilities than at landfills).

Historically, landfill fees have been designed to address the full cost of managing waste, including site development, permitting, labour, equipment, materials, and other items such as capital expenditures, accruals and depreciation. However, to encourage diversion, differential tipping fees (i.e., fee reductions or surcharges) can be set so that the economics of diversion become more favourable than those of disposal. Ideally, the full suite of fees (transporting, handling, recycling, landfill, etc.) will reflect the full cost of management and recovery.

When supported by disposal bans (Section 3.2.1) and waste diversion plans and targets (Section 2.6), differential tipping fees can have considerable environmental and economic impact. Targets help to ensure that CRD waste management decisions take into account the environmental consequences of different disposal options (landfill, incineration, recycling, etc.), and they encourage producers and consumers to substitute their usual products with ones that involve less waste and more efficient recycling (Fullerton *et al.* 2008).

Applicability to Construction, Renovation and Demolition Waste Materials

Differential tipping fees can apply to the entire CRD waste stream.

Policy advantages

- Disposal fees and levies discourage landfilling by making it more expensive and can be used to selectively target specific materials or support end markets.
- Disposal fees and levies can be structured to cover the full cost of recovery and generate funding for infrastructure investment (Section 3.5.1) or education programs to encourage diversion (Section 3.6.1).

Policy disadvantages

- Tipping fees are end-of-life solutions and do not address the volumes of waste generated. They simply seek to divert materials from landfill.
- High tipping fees may generate unintended consequences, such as illegal dumping or transporting waste to lower-cost jurisdictions.
- Generators may simply pass costs on to customers, instead of adopting changes in behaviour (see County of Simcoe's experience in Section 4.3 examples).
- Because fees and levies can be structured to funding for infrastructure investment, "free infrastructure funds" can lead to an unlevel playing field for early investors.

Considerations when developing the policy

- Disposal fees and levies are most effective when applied comprehensively (i.e., to all landfills, both private and government owned/operated), as is done by the Columbia Shuswap Regional District in

BC (Columbia Shuswap Regional District n.d.). However, it should be noted that local governments usually do not have jurisdiction over private landfills, so this would have to happen at the provincial level.

- Disposal fees and levies need to be developed hand in hand with policies that stimulate and grow markets for reclaimed materials and, where applicable, they must meet transportation requirements and restrictions (Section 3.2.2).
- Disposal fees and levies are very price sensitive. If the fee is set too low, there is little incentive to divert waste, and the costs will simply be passed on to customers. If the fee is set too high, it promotes trans-shipment of waste out of the jurisdiction or other avoidance behaviours such as illegal dumping.
- Disposal fees and levies increase the cost of a product or service (such as landfill) and can be particularly valuable where wide-ranging changes in behaviour are needed across a large number of production and consumption activities. Frequently, tipping fees are used to fund improved infrastructure and programs.

Government involvement in policy development and implementation

Several jurisdictions have used disposal levies to support their diversion efforts, including Manitoba, Québec, California, Ohio, Pennsylvania, Wisconsin, and several other US states and European jurisdictions. Experience suggests that the policy will work only if levies are set at an appropriate level to encourage diversion. Indeed, most start low and have a schedule to ramp up over time. Fees and levies work effectively when supported by diligent enforcement and related transportation requirements (OWMA 2014). Provincial, territorial and regional governments that own, operate and/or license landfills and sorting and waste processing facilities are able to impose disposal fees and levies.

Examples

County of Simcoe, Ontario

County of Simcoe, Ontario (population 480,000) CRD waste sites collectively divert 71 per cent of all materials received from landfill through over 20 waste diversion programs. CRD-type wastes are diverted through the application of a range of incoming fees. $310/tonne is the standard rate for mixed waste and is also charged to any load not properly sorted into diversion bunkers.

The following examples illustrate the fee and the amount of materials diverted:

- No cost for drop-off: scrap metal (2,500 tonnes/year), rubble (4,000 tonnes/year), clean brush (3,750 tonnes/year).
- $75/tonne to drop off: wood painted or glued (9,000 tonnes/year), asphalt shingles (6,000 tonnes/year), drywall (2,200 tonnes/year) (see more details as an example in Section 4.3).
- $155/tonne to drop off: window pane glass (350 tonnes/year). (County of Simcoe n.d.)

Bow Valley Waste Management Commission, Alberta

The Francis Cooke Regional Class III Landfill and Resource Recovery Centre services a population of approximately 25,000 permanent residents and a seasonal population approaching 50,000. This site has achieved annual landfill diversion rates as high as 78 per cent, with a 12-year average diversion rate of

63 per cent. The facility offers a 46 per cent reduction in the tipping fee for sorted construction and demolition loads. Acceptable recyclable materials, for which established recycling markets exist, can receive tipping fee reductions as high 87 per cent. A levy is charged on the sale of virgin materials such as rock, sand and gravel (Bow Valley Waste Management Commission n.d.).

Province of Québec

Québec has imposed a levy of $21.95/tonne of waste going to landfill. This has helped CRD recyclers to compete with landfill disposal fees (tipping fee plus landfill tax), since the recyclers can include the levy in their tipping fee without having to reimburse the levy to the government (Government of Québec 2017).

Regional Municipality of Waterloo, Ontario

Waterloo (population 500,000) applies differential tipping fees at their landfill and transfer stations whereby segregated loads of brick, concrete, rubble and yard waste receive a 43 per cent reduction per tonne when compared to general refuse rates. There is no charge for the first 50 kilograms on all loads under 500 kilograms (Region of Waterloo 2011).

Regional District of Okanagan-Similkameen, British Columbia

The Regional District of Okanagan-Similkameen (RDOS) (population 80,700) contracts out a CRD sort line at its Okanagan Falls Landfill. Because demolition and renovation waste is liable to contain materials that may be hazardous to human health, RDOS requires all waste to go through an assessment process meeting WorkSafeBC’s occupational health and safety requirements. To encourage diversion, RDOS has imposed differential tipping fees to encourage assessments and source separation of materials. Also, separated and clean lumber, metal, gypsum, concrete, asphalt and masonry brought source separated to any RDOS landfill will not require hazard assessments if it is clean of contaminants (RDOS n.d.).

3.3.2 Virgin Material Levies

Virgin material levies are taxes that are imposed on the extraction and use of raw (or virgin) natural resources. They are intended to encourage the use of recycled materials in construction projects by increasing the relative cost of virgin materials. These levies can reduce the rate of resource depletion and associated environmental externalities, reduce the production of CRD waste, and encourage the substitution of secondary and recycled materials for virgin materials (United Nations Economic Commission for Europe, 2016). This can also provide indirect benefits, as the opening of new quarries can be challenging politically and financially.[18]

Virgin material levies are generally applied at the extraction phase on a fee-per-tonne basis. The fee applied varies by jurisdiction and is typically between 5 per cent and 20 per cent of the base price of the

[18] An example is the Ontario “gravel wars,” which were much discussed in the media during 2011 and 2012 and which came to a head with the proposal to blast the 2,300-acre, 200-foot-deep Melancthon Quarry on prime farmland in Dufferin County in 2011. See, for example, Shuff (2011).

material. Where subsidies to encourage the extraction of virgin materials exist, these can be lowered or removed to help encourage the use of secondary materials before a virgin material fee is put in place.

Virgin material levies have been imposed in several countries, including Sweden, Denmark and the UK, for aggregates — specifically gravel, rock, stone, etc.— but have yet to be implemented in Canada (Söderholm 2011). The levy may be applied on raw materials that are commercially extracted and consumed within the government's jurisdiction as well as materials that are commercially imported and those that are exported. Some levies include exemptions for specific activities, such as the use of raw materials for industrial processes.

Applicability to Construction, Renovation and Demolition Waste Materials

These levies are most applicable to low-cost materials where large volumes of commensurate-quality recycled alternatives exist, such as gravel, rock, stone, topsoil, sand, sawdust and gypsum.

Policy advantages

- Virgin material levies can reduce the rate of resource depletion and associated environmental externalities (e.g., the impacts of creating new quarries).
- Virgin material levies can reduce the production of CRD waste and encourage the substitution of secondary and recycled materials for virgin materials by making the cost of new materials more expensive.
- Virgin material levies are easy for stakeholders to understand.
- Virgin material levies can generate revenue to fund environmental programs.

Policy disadvantages

- Virgin material levies may have only a modest impact as a stand-alone measure but can be very effective as part of a suite of complementary policies such as disposal bans (Section 3.2.1).
- Virgin material levies may be less effective when the revenues generated are incorporated into a general budget and not allocated to environmental programs.
- To date, no virgin material levies have been implemented in Canada.

Considerations when developing the policy

- Research suggests that a 15 per cent virgin material levy on plastic, wood pulp, cardboard and paper virgin materials would produce an 11 per cent reduction in waste while providing a source of sustained funding for environmental programs (Bruvol 2014; Söderholm 2011).
- In the UK and most European countries, virgin material levies are often accompanied by very high disposal levies. Further, extensive investment in infrastructure and new market creation, including public procurement practices that allow for the use of recycled aggregate, are necessary to drive the market (Section 3.3.2).
- How waste is categorized and how diversion rates are measured varies across the country. Usually, civil infrastructure reconstruction materials (e.g., reclaimed concrete and reclaimed asphalt pavement) are included within the scope of CRD materials and hence report much higher volumes and greater recycling rates. Often, construction contracts with public agencies require the contractor to handle concrete and asphalt materials, which are frequently returned to a central processing

facility operated by the aggregate industry or road-building contractors. Excluding these materials from policy considerations (because they are already largely “diverted”) is missing an opportunity to drive greater uptake.

- When considering a virgin material levy, it is important to:
  - clearly identify the relevant market failure that the tax is intended to address
  - assess the impacts of the tax on environmental quality and economic efficiency
  - compare these impacts with those resulting from the use of other regulatory approaches.
- The design and use of virgin material levies includes:
  - **Monitoring:** These types of levies tend to be applicable to situations where monitoring environmental impacts (such as non-point source emissions) or property rights regimes are hard to implement.
  - **Market conditions:** For such systems to work, there needs to be sufficient price elasticity for the market to substitute recycled materials. Relative to overall construction costs, the cost of aggregate materials is quite low. So, even significant levies (e.g., 10 to 20 per cent) may only have a modest impact on the market.
  - **Recycling incentives:** A virgin material levy does not provide any incentive for waste generators to increase sorting and processing activities. Consequently, additional policies may be needed to increase the supply, quality and accessibility of recycled materials.

Government involvement in policy development and implementation

Virgin material levies can be applied by federal or provincial/territorial governments. The most well-known examples of virgin material levies come from the UK, Sweden and Denmark, but they have not yet been deployed in Canada.

Virgin material levies are contingent upon the presence of others that drive greater use of recycled aggregates and require that the contractor transport materials to a central processing facility that can produce the quality and volume of reclaimed products suitable for use in new projects. For example, some aggregate industry and road-building contractors receive reclaimed materials for processing and reuse in future projects.

Virgin material levies go hand in hand with procurement practices (see Section 3.5.2) that allow for the use of reclaimed materials. Some jurisdictions impose performance standards on public projects (e.g., in road building) that effectively preclude the use of reclaimed materials.

Examples

UK Aggregates Levy

Effective since 2002, the Aggregates Levy has been charged on all extraction and imports to the UK of sand, gravel and crushed rock used for construction purposes (except for recycled aggregates) and excludes exports (Söderholm 2011). Companies pay a levy of about $4/tonne, which corresponds to about 20 per cent of the total price. With roughly 200 million tonnes of virgin aggregate extracted each year, the levy brings in more than $700 million in annual revenue. Most of the revenue is returned to companies through a reduction in employer taxes, while a portion is directed to the Aggregates Levy

Sustainability Fund. The fund supports environmental programs and research and helps to stimulate the market for recycled and secondary materials. The levy, along with a suite of complementary measures such as a landfill tax, has been successful at delinking aggregates production and construction output, significantly increasing the use of recycled aggregate (to about 25 per cent of the market), and reducing virgin aggregates production (UK Government n.d.).

Swedish tax on natural gravel

Introduced in 1996, the intention was to set the tax rate at a level high enough to close the price gap between gravel and its closest substitute, crushed rock (Söderholm 2011). The Swedish government initially set the tax level at SEK 5 ($0.78) per ton, which corresponded roughly to a 10 per cent price increase on natural gravel. By 2006 the tax had risen to SEK 13 ($2.02) per ton. All the revenues from the tax are incorporated into the central state budget. In 1984 the natural gravel share out of total aggregates production in Sweden was 82 per cent, but in 2008 it had fallen to only 19 per cent. During the same time period, the share of crushed rock and other materials experienced a corresponding increase. This implies that the 30/70 goal set by the government has been fulfilled (Söderholm 2011).

3.4 Improve Construction, Renovation and Demolition Processes

This strategy focusses on increasing the resource efficiency of CRD activities, such as through building certification and deconstruction standards. This strategy includes building codes and requirements, green building certification, environmental product labelling and standards, and deconstruction standards.

3.4.1. Building Codes and Requirements

Building codes and other requirements (such as industry standards) establish technical specifications and provisions that influence the design and construction of new structures as well as the alteration, change of use and demolition of existing ones. Building codes provide specific powers for inspectors and rules for the inspection of buildings and may allow municipalities to establish bylaws related to the use, function and performance of buildings. However, the degree of control over building regulations varies by jurisdiction. Other requirements may be mandatory or voluntary and may be created by government or industry.

The transition to objective- and performance-based building regulations that is happening in Canada is allowing for a wider selection of compliance options. These “functional-based” policies encourage advances in building technology by allowing flexibility of design approach and can lead to innovative, efficient solutions using sustainable materials. In several US examples, building codes include requirements for construction waste diversion, prohibit the use of certain materials and establish minimum environmental performance criteria. In Canada, the 2014 City of Vancouver bylaw 10908 requires that for all work of a value of $50,000 or more, “All waste material on a construction site shall be sorted, diverted and disposed of in a manner satisfactory to the Chief Building Official” (City of Vancouver n.d.-b).

Other ways in which building codes and requirements can support CRD waste reduction, reuse and recycling include:

- **Alternative solutions:** Progressive policy approaches include allowing design teams to create "alternative solutions" with supporting test data that meet or exceed standard requirements.
- **Mandatory standards:** These may be established for CRD waste diversion or for the use or prohibition of certain materials.
- **Mandatory upgrades to ensure that the existing building stock complies with certain regulatory criteria:** For example, the City of Vancouver operates an "existing building upgrade mechanism model" (Part 10 of bylaw 10908, City of Vancouver n.d.-b). The model requires certain additional energy efficiency measures to be undertaken based on the scope of the proposed amendment to an existing building. Such a mechanism could be extended to establish CRD waste diversion targets, durability standards, or the use or restriction of certain materials.

Building codes should not be confused with other building requirements, such as standards. Building standards establish specific "pass-fail" performance criteria (e.g., for energy efficiency, indoor air quality) and may be voluntary. Sometimes, standards are imposed by governments in the form of a "stretch code" as a condition of development (thereby becoming mandatory).

Governments, industries and building owners can create their own standards. For example, the American Collaborative for High Performance Schools established a deconstruction standard for school buildings (see Section 3.4.4), and the University of British Columbia created the Residential Environmental Assessment Program (REAP) standard for residential buildings that included measures for CRD waste diversion (UBC Sustainability n.d.). Green building rating systems (LEED, Built Green, etc.), also a form of building standard, include performance criteria for building reuse, sustainable building materials and CRD waste diversion. They are discussed in Section 3.4.2.

Environmental product standards that similarly demonstrate certain performance achievements also exist (ENERGY STAR for energy-efficient appliances, Forest Stewardship Council [FSC] for sustainable wood products, etc.). See Section 3.4.3.

Applicability to Construction, Renovation and Demolition Waste Materials

Building codes address the performance of a structure as a whole and can be used to address the entire CRD waste stream. They can also be oriented towards the use (or prohibition) of specific materials such as hazardous materials.

Building codes across Canada have recently been updated to allow for mid-rise wood frame construction (up to six storeys), which will, in the long run, reduce the amount of concrete and steel entering the waste stream.

Some local governments have established regulations for moving entire buildings, which is an excellent way to retain the value of the construction materials and reduce CRD waste. For example, the Saskatchewan government has a useful policy for moving buildings (Government of Saskatchewan n.d.) that does not set any limits on the length of the building but rather imposes a weight limit. With the increasing uptake of prefabricated and modular construction, more and more volumetric building components will need to be shipped by road and by rail.

Policy advantages

- Prescriptive regulations create a level playing field and enforce compliance.
- The costs of compliance with the code are borne by the market.
- Building codes are very effective at limiting illegal activity.
- Applied early in the design process, building codes that include CRD waste management criteria can help to reduce the volumes of CRD waste generated.

Policy disadvantages

- Building codes may be developed provincially, but they are managed and enforced locally, adding a layer of administrative complexity.
- Stakeholders may have to bear a cost for compliance with the code, which may adversely affect important markets. There may also be costs to the regulator in the form of administration and enforcement.
- Codes establish minimum levels of permissible performance. It is difficult to use codes to encourage exemplary behaviour.

Considerations when developing the policy

- While building codes may offer many opportunities to encourage the use of recycled materials and establish CRD waste diversion goals, they can also present barriers to creating a truly circular economy. For example, increasingly stringent energy-efficiency codes can make it difficult to reuse old windows, doors, and heating and cooling equipment. To address this challenge, a science-based analysis of the costs and benefits of using old materials and equipment can be made on a life-cycle basis. Life-cycle assessment (LCA) tools can help designers and policy-makers understand whether the operating-energy savings foregone by using an old product are greater or less than the costs and environmental impacts of disposing of the old product, making a new one, transporting to the site and disposing it at the end of its life.
- The following context is necessary for building codes to function effectively:
    - a well-functioning market with knowledgeable and accountable professionals (designers, builders, manufacturers, contractors, etc.) who understand building and stand behind their product, and knowledgeable consumers who know their obligations and

have access to the information they require to make informed decisions and choices
  - a legal framework for the conduct of business so all parties can be held accountable for their actions
  - reliable standards, testing and design guides so that professionals and owners can have confidence in the materials used in construction and trust that these will be installed properly
  - warranties and insurance to provide a measure of assurance to building owners that any practical, technical or performance defects in the ultimate product or process will be rectified
  - education and training to enhance the skills of those involved in the building process. Sustained and comprehensive consultation, outreach and education for all CRD waste management stakeholders are important for success (Section 3.6.1).
- It is important to note that existing municipal zoning does not limit the installation of waste management operations.
- Industry tends to favour outcome-based building codes because they provide freedom to the contractor to seek innovative solutions. Governments can support this by establishing a list of specific CRD materials in municipal bylaws that are considered recyclable materials, establishing waste diversion goals, and so on.

Government involvement in policy development and implementation

Building codes are enacted by provinces or territories and administered primarily by local municipalities.

The National Building Code applies to property under federal jurisdiction. Provinces and territories can also adopt or amend the Code for their own jurisdiction. Some governments adopt the Code and adjust it to suit local conditions. Others develop their own codes, keeping a close eye on federal directives. A few municipalities (e.g., Vancouver) have the right to enact their own building codes and bylaws.

Transportation and highways departments usually handle regulations related to moving entire buildings.

Examples

Metro Vancouver model bylaw

Metro Vancouver (population 2.4 million) has developed a model bylaw for municipalities that requires generators to develop and report on a Waste Disposal and Recycling Services Plan as part of the construction and demolition permit process. Generators pay a fee and receive a refund after submitting their final report (Metro Vancouver n.d.-b). For example, the City of Port Moody (one of Metro Vancouver's 22 member municipalities) has implemented a version of the bylaw and established a target of 70 per cent diversion (see example in Section 3.6.2).

International Green Construction Code

The International Green Construction Code (IgCC) acts as an overlay to an existing set of "opt-in" international building codes and incorporates the American Society of Heating and Refrigeration and Air-Conditioning Engineers (ASHRAE) Standard 189.1 as an alternate path to compliance (see below). The IgCC includes measures to conserve materials, including a requirement for at least 55 per cent of materials to contain recycled content or be recyclable, bio-based or indigenous. It also requires at least 50 per cent of CRD waste to be diverted from landfill. It has been adopted as a mandatory regulation by five US states (and being reviewed by 10 more). It is also referenced in Canada (e.g., by the Bow Valley Waste Management Commission).

American Society of Heating and Refrigeration and Air-Conditioning Engineers (ASHRAE) 189.1

ASHRAE 189.1[19] is a model standard designed for adoption similar to the ASHRAE standards now referenced by building codes across Canada for energy efficiency (see Section 9.3, *Mandatory Provisions*). The relevant sections of 9.3.1, *Construction Waste Management*, reads as follows:

> 9.3.1.1 Diversion. A minimum of 50% of non-hazardous construction and demolition waste material shall be diverted from disposal in landfills and incinerators by recycling and/or reuse. Reuse includes donation of materials to charitable organizations and salvage of existing materials on-site. Excavated soil and land-clearing debris shall not be included in the calculation. Calculations are allowed to be done by either weight or volume but shall be consistent throughout. Specific area(s) on the construction site shall be designated for collection of recyclable and reusable materials. Diversion efforts shall be tracked throughout the construction process. (ASHRAE 2014)

California Green Building Standards Code

Under the California Green Building Standards Code, the State of California requires a minimum of 50 per cent of the nonhazardous construction waste to be recycled and/or salvaged for reuse (State of California 2013).

3.4.2. Green Building Certification

Green building rating systems evaluate, verify and certify the environmental performance of the design, construction, operation and maintenance of buildings. Programs usually benchmark performance against a set of requirements or optional criteria, and several include measures for CRD waste diversion. Systems to certify both new construction and existing buildings, including fit-up, operations and renovations, have operated in Canada for about 20 years. They are usually voluntary and administered by third-party NGOs as leadership-level aspirational goals. However, some (such as the American Collaborative for High Performance Schools deconstruction standard [see Section 3.4.4] and the UBC REAP program [UBC Sustainability n.d.]) have been developed by institutional owners or governments as enforceable standards for specific building types and priorities, functioning more like a building code (see also Section 3.4.1).

[19] ASHRAE 189.1 version 2014 is applicable to all building types except single-family homes and low-rise structures. It is available for purchase at ASHRAE 2014.

Common systems that reference CRD waste management are Building Owners and Managers Association (BOMA) BEST, Built Green and LEED. These certification systems have the following common elements:

- Categories: Common performance categories are energy, water, materials and resources, indoor environmental quality, and site selection.
- Criteria: Most systems have a combination of mandatory (pass-fail) and points-based criteria in each performance category.
- Certification levels: Most systems have multiple levels (e.g., bronze, silver, gold) based on the building's total score across all categories.
- Assessment: Most systems are certified by an independent third party.

CRD waste management credits typically require the submission of a CRD waste management plan that demonstrates how the proposed diversion rate will be achieved. Compliance with the credits is achieved by tracking waste diversion via weigh bills and other documentation (photos, receipts, etc.) and submitting a final total once the project is complete.

Green building rating systems are important mechanisms for introducing new approaches and "stretch" goals for progressive builders to adopt on a voluntary basis. As the industry becomes familiar with the techniques, policy-makers can expand the application of the policies to a broader range of building types and, eventually, incorporate elements of the rating system into legislation.

Applicability to Construction, Renovation and Demolition Waste Materials

Rating systems address the entire CRD waste stream via the following strategies:

- Reuse existing structures (whole or in part) and components
- Incorporate salvaged and reclaimed products
- Source sustainable, reusable and recyclable materials
- Use materials with recycled content
- Implement a comprehensive waste management plan with minimum diversion targets
- Create a building durability plan.

Policy advantages

- Rating systems offer the potential for very high rates of diversion. Numerous projects have achieved diversion rates greater than 90 per cent.
- Rating systems offer clear green targets and flexibility to designers for how they are achieved.
- There are consistent approaches to documentation that are transferable from project to project and across different jurisdictions.
- Industry is familiar with how rating systems work.
- The costs of many green products are competitive with traditional alternatives.
- There are excellent opportunities to educate industry on the principles of green building.
- Third-party validation processes tend to fit well with government priorities.

Policy disadvantages

- Many rating systems include CRD waste management only as optional credits as opposed to mandatory requirements
- Rating systems normally apply only to the top 25 per cent[20] of leadership-level buildings. So CRD diversion from LEED projects represents less than 1 per cent of annual CRD waste generated in Canada.[21]
- Generally, rating systems do not address demolition.
- Certification is not issued until after project completion, making it difficult to enforce.
- Rating systems may not adequately consider the local characteristics of a particular project.
- The checklist approach means it is not always possible to be sure that a project has scored well in CRD waste management.
- Protocols for verification are weak and need to be strengthened.

Considerations when developing the policy

- Green building rating systems are effective at driving improvements in environmental design that lead to generally improved performance, including reducing construction waste, increasing durability and facilitating deconstruction. According to the Canada Green Building Council (CaGBC), LEED projects in Canada have recycled over 3 million tonnes of CRD waste since 2005 (CaGBC 2014).
- Rating systems are useful tools for building owners to use when procuring building projects. Indeed, many governments reference LEED performance for their capital projects (see Section 3.4.2).
- In most rating systems, activities related to CRD waste management make up only a small portion of the overall score. In LEED Canada 2009, CRD waste management accounts for up to two optional credits out of a total of 110 points, and materials credits make up only 13 per cent of the total.
- Most green building rating systems are administered by industry associations or other not-for-profit organizations and may not have the legal authority to hold builders accountable.

[20] For example, as stated in LEED (2016).

[21] Calculated from data in CaGBC (2014).

- Although numerous municipal governments leverage certification systems during rezoning negotiations with developers, it is difficult to mandate builders to exceed the standards outlined in the provincial building code. Some municipalities use incentives (e.g., a rebate on development cost charges) to encourage higher performance.

Government involvement in policy development and implementation

Governments of all orders can demonstrate leadership in advancing CRD waste diversion by adopting green building rating systems in their public procurement policies (Section 3.5.2) (Environment and Climate Change Canada 2012). It is important to not establish regulations that may adversely affect the development of construction and demolition management processes and facilities (e.g., zoning regulations that prohibit materials processing facilities).

Green building rating systems offer governments an opportunity to create or expand the market for a particular product (e.g., requiring the use of wood-waste chips used in public landscaping projects).

Examples

Canada Green Building Council LEED project database

There are over 5,000 LEED-certified buildings in Canada (representing a market penetration rate of about 10 per cent in 2014) (The Delphi Group 2015). The CaGBC operates an online database that is searchable by region (city, province, etc.) (CaGBC n.d.).

Toronto Green Standard

The City of Toronto (population 2.8 million) has developed its own certification scheme, the Toronto Green Standard, which is inspired by LEED. It has two levels: Tier 1 (mandatory) and Tier 2 (voluntary). Tier 2 includes a requirement to recycle at least 75 per cent of construction and demolition waste. As an incentive, developers who achieve Tier 2 may be eligible for a partial development charge refund (City of Toronto n.d.-a).

The Living Building Challenge

The Living Building Challenge is a US-based system that stipulates that builders achieve “net positive waste.” Proponents are expected to create a Material Conservation Management Plan that covers design, construction, operation and end of life. During construction, the project team is required to divert more than 90 per cent of materials. The system also includes requirements for the use of salvaged materials and the adaptive reuse of existing structures. Only three projects in Canada have been certified by this system, all in BC: a house in Victoria, the SFU UniverCity childcare centre in Burnaby and the VanDusen Botanical Garden visitors’ centre in Vancouver (Living Future n.d.).

3.4.3. Environmental Product Standards and Labels

Environmental product standards and labels are documents that provide “requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose” (International Organization for Standardization [ISO] n.d.). They communicate verifiable and accurate information on the environmental aspects of a product from manufacture through to recycling and disposal in order to:

- ensure that products and services are safe, reliable and of good quality
- provide comparable, standardized information to assist consumers with making informed choices
- stimulate the demand for and supply of environmentally friendly products and services.

A very large number of product standards and labelling schemes are in operation, and some are much better organized and more rigorous than others. Ideally, these schemes will define the technical and environmental requirements that materials should fulfil and describe the means of evaluation and compliance.

For end users to accept and adopt materials recovered from CRD waste, they need information on the method to use, functionality and performance (including quality, variability and contamination levels). Further, the requirements to comply with standards and labels can influence the generation, reuse and recycling of CRD waste by providing information on the product at different stages of the product life cycle. This includes:

- product content, such as amount of recycled versus virgin material, biodegradability, and so on
- production process, such as amount of energy used and waste generated and emissions to air, soil and water
- product performance and durability, such as expected lifespan, tolerances, efficiency (e.g., energy, water), emissions and engineering specifications
- product reusability and recyclability, such as design for disassembly, percentage of the product that can be recycled, and so on.

Applicability to Construction, Renovation and Demolition Waste Materials

Environmental product labels can apply to all materials and products. Common multi-attribute certification and labelling schemes related to construction include ECOLOGO (UL n.d.), Green Seal (Green Seal n.d.) and Cradle to Cradle (Cradle to Cradle n.d.). Common product- or material-specific schemes include Forest Stewardship Council (FSC) for forestry products (FSC n.d.) and GREENGUARD for chemicals (GREENGUARD Certification n.d.). Industry-led product category–specific certifications include the US Carpet and Rug Institute’s Green Label Plus program (The Carpet and Rug Institute n.d.).

Policy advantages

- Product labelling provides important support to the markets for secondary materials recovered through waste diversion programs by providing consistent definitions and performance information.
- Product standards support regulations that mandate how much secondary material should be used in products via "recycled content" labels.
- Product standards can help governments to determine the economic value of processed materials along the value chain.

Policy disadvantages

- Not all product standards and labels comply with ISO standards[22] (some are "self-regulated" by the industries they represent), which can make it difficult for governments to determine whether the label or standard has value.
- There are no standard definitions of waste and secondary materials in common use in Canada.
- Producers and users of secondary materials processed from CRD waste tend to restrict themselves to local markets to avoid administrative and judicial costs or risks of an unclear waste status of materials.
- End-of-waste criteria (defined in the examples below) are not in common use or consistent across regional and national boundaries. Comprehensive investment by government and stakeholders is needed to define and verify CRD wastes as secondary materials.

Considerations when developing the policy

- Product labelling will not reduce CRD waste directly. Rather, it will provide the information necessary to establish markets for products made from secondary materials and is an important element when working towards a circular economy.
- End-of-waste criteria are starting to be integrated into standards and labels. However, with CRD waste it is often challenging to determine when a waste ceases to be a waste and becomes a recovered material that can be freely traded in the market (European Commission 2011, 2012, 2013). This is a significant issue because once a material is classified as waste, there may be restrictions on how it can be used and transported (Section 3.2.2). Conversely, when a waste is no longer classified as such, then waste regulations may no longer apply.
- A growing number of manufacturers and scientists are developing a relatively new type of label called an Environmental Product Declaration (EPD) or life-cycle declaration. The purpose of an EPD is to provide standardized, quantified information on a product's environmental performance in order to enable objective comparisons between products fulfilling the same function. EPDs are produced following specific ISO-compliant rules, requirements and guidelines for calculating and

[22] International standards for product labelling practices are provided within the ISO 14020 to 14025 series, which deals with environmental labels and declarations.

reporting environmental impacts across the full life cycle of a product. A qualified third party verifies both the parameters and the process. EPDs are one of the few internationally recognized tools that enable this type of accurate comparison and are starting to be integrated into green building certification programs. While they are referenced in green building rating systems such as LEED Version 4 (Section 3.4.2), they are not part of the Canadian policy context yet.

Government involvement in policy development and implementation

Product certifications and labels are typically administered by industry associations, not-for-profit organizations or federal government agencies. Many labelling schemes are currently in operation, so governments do not have to develop their own.

In developing these policies, it is important to consider the potential burden of additional waste regulations for industries that could use recycled material (e.g., asphalt plants, cement plants).

Examples

ECOLOGO

Almost 7,000 products, services and packaging, including 79 building construction materials, are ECOLOGO certified for reduced environmental impact. According to UL, "ECOLOGO certifications are voluntary, life cycle–based environmental certifications that indicate a product has undergone rigorous scientific testing, exhaustive auditing, or both, to prove its compliance with stringent, third-party environmental performance standards" (UL n.d.). ECOLOGO certification is classified as an ISO Type 1 ecolabel.

European Commission Waste Framework Directive end-of-waste criteria

The European Commission Waste Framework Directive sets out how certain specified waste ceases to be "waste" when it has undergone a recovery operation and complies with specific criteria developed in accordance with the following conditions (Delgado et al. 2009):

- The substance or object is commonly used for specific purposes.
- A market or demand exists for such a substance or object.
- The substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products.
- The use of the substance or object will not lead to adverse environmental or human health impacts.
- Limiting values for pollutants where necessary and shall consider any possible adverse environmental effects of the substance or object.

Consistent definitions of secondary products create legal certainty for waste management decisions and for the different actors dealing with specific waste streams, including producers and users of the recycled material. Investment decisions on new treatment capacities for the management of waste require legal certainty (Grosz 2011). Definitions would also improve compatibility of regulatory frameworks for the recovery and reuse of secondary materials.

In the EU, criteria have, so far, been laid down for iron, steel and aluminum scrap. The next waste streams to be addressed include copper scrap, recovered paper, glass cullet, plastics and biodegradable waste/compost. Technical proposals have been submitted for the end-of-waste criteria on copper scrap metal, recovered paper and glass cullet, and further studies are being conducted on biodegradable waste/compost and plastic. Once established, these criteria will provide a reference for Canada.

3.4.4. Deconstruction Standards

Deconstruction standards describe the selective dismantling or removal of materials from buildings prior to or instead of conventional demolition (National Association of Home Builders (NAHB) Research Centre 2011). Deconstruction is an approach to building removal that can convert the CRD waste stream from demolition into highest-value resources in a manner that retains their original functionality as much as possible for reuse in future buildings. Demolition waste accounts for over 40 per cent of the CRD waste stream in Canada (see Table 1 in Section 2.2). Waste materials removed from buildings also makes up a large part of renovation waste.

Building deconstruction can be handled in several ways and are defined by Re-Use Consulting (n.d.) as:

- Manual building deconstruction is the systematic disassembly of a structure (whole or in part) to maximize reuse and recycling.
- Hybrid deconstruction describes the use of people and machines to efficiently deconstruct buildings, with the goal of maximising reuse and recycling. It refers to the hybrid of demolition and manual deconstruction.
- Partial deconstruction is the removal of part of a structure without harming the remaining section(s) while still focussing on maximizing reuse and recycling.
- Building kits are collections of materials that have been labelled, diagrammed and then carefully disassembled in order to be reassembled at another job site.

The extent to which buildings are designed for deconstruction using recyclable materials is an important indicator of the potential for future economic feasibility of achieving a “zero-waste” building sector.

Applicability to Construction, Renovation and Demolition Waste Materials

Deconstruction can reduce the use of a wide range of new materials, extend the life of existing materials, reduce the amount of materials entering recycling/reprocessing centres, and minimize/eliminate the amount of all materials entering the CRD waste stream. Characteristics of buildings that are likely to be good deconstruction candidates include:

- wood-framed with heavy timbers and beams, or with unique or “old growth” woods
- contains a large proportion of prefabricated components where documentation exists that illustrates the location of fixings (such as bolts, plates, brackets, ties)

- constructed with high-value specialty materials such as hardwood flooring, multi-paned windows, architectural moulding, and unique doors or plumbing/electrical fixtures
- constructed with high-quality brick laid with low-quality mortar (for easy break-up and cleaning)
- structurally sound (i.e., generally weather-tight to minimize rotted and decayed materials).

Buildings constructed mainly of concrete and/or steel may be good candidates for partial deconstruction, or the "stripping" of salvageable materials. Stripping out these materials may make it easier to recycle the concrete and steel as well (NAHB Research Centre 2011).

Policy advantages

- Deconstruction promotes the principle of "closed-loop" construction whereby materials can be reused many times with minimal reprocessing.
- Deconstruction can cost less than demolition overall because of the value of the salvaged materials and the avoided disposal costs (NAHB Research Centre 2011).
- Deconstruction results in significantly greater protection to the local site (e.g., soil and vegetation).
- Deconstruction can divert up to 90 per cent of a building into reuse or recycling while creating much less dust and noise than conventional demolition.
- Manual disassembly of buildings offers excellent job-creation opportunities.

Policy disadvantages

- There is a potential for safety hazards when manually taking down large elements, and some materials may contain toxins such as lead and asbestos.
- It is usually quicker (and therefore less expensive) to landfill a building than it is to deconstruct it.
- The skills required to deconstruct a building may not be readily available.
- Depending on the type of building and the size of the crew, deconstruction can take two to 10 times longer than conventional demolition because most existing buildings have not been designed with disassembly in mind so are not easy to deconstruct.
- Deconstruction requires extensive and easily accessible processing infrastructure to support it.
- There is a lack of sufficiently detailed standards for recovered materials so that they can be accepted by secondary markets.

Considerations when developing the policy

- Deconstruction requires a fundamental rethink of the entire design and construction process to maximize opportunities for building deconstruction in the future. Innovative construction solutions allow for not only easy non-invasive maintenance and repair but also spatial reorganization, adaptability and even reuse of the whole building.
- Deconstruction adds about 25 per cent to the cost of the average demolition. For example, typical demolition for a house in Vancouver costs $16,000, so the added cost for deconstruction is $4,000 (interview with City of Vancouver staff). However, revenues from the recovered materials and the savings from tipping fees may reduce or eliminate this cost differential. The challenge is ensuring

that the costs and benefits are fairly allocated among the stakeholders.

- Effective deconstruction policies commonly include the following elements:
    - guidelines for deconstruction process, including management of hazardous materials
    - requirements for designers to develop a comprehensive disassembly plan that incorporates design for disassembly, durability and adaptability principles
    - the availability of clear deconstruction standards and a qualified workforce that can implement deconstruction safely and efficiently. This includes clear regulations related to the management and disposal of hazardous materials.
    - training or certification for the workforce. Clear deconstruction standards and a qualified workforce that can implement deconstruction safely and efficiently should also be available.
    - requirements or incentives for deconstruction (regulation, economic incentive, etc.)
    - design guidelines and standards to enable deconstruction.
- Builders contemplating a deconstruction project may need help in the form of training, information resources and tool kits.

Government involvement in policy development and implementation

Regulating deconstruction standards is currently occurring at the regional or local scale. Currently, few jurisdictions have established policies promoting building deconstruction and design for disassembly, although there are numerous programs in development and pilot projects.

Examples

King County, Washington, deconstruction guide

King County in the state of Washington (population 2.1 million), which includes the city of Seattle, provides a free downloadable design guide for building disassembly, *Master Specifications for Construction Waste Management and Building Deconstruction and Salvage*. Deconstruction is also encouraged by the County's disposal ban on readily recyclable construction materials, including clean wood, cardboard, metal, gypsum scrap, asphalt paving, bricks and concrete (King County n.d.-a).

Collaborative for High Performance Schools destruction standard

The Collaborative for High Performance Schools (CHPS) is one of the few rating systems in operation that includes standards for building disassembly or deconstruction (CHPS n.d.). Although it addresses only educational facilities, the intent of CHPS requirement *LE3.2: Design for Adaptability, Durability and Disassembly* is to:

- reduce building material waste and promote local building material reuse during construction, renovation, repurposing of space and disassembly

- provide spaces that are adaptable, durable and flexible
- drive innovation in designing schools to support disassembly and reuse.[23]

CHPS describes how the design team should provide the owner, builder and records management systems with a disassembly plan that sets out the method of disassembly of major systems during renovations and end of life, and the properties of major materials and components. The designer is also encouraged to design major systems with differing functions and lifespans to promote disentanglement, for example:[24]

- separation of envelope from structure
- dedicated service voids (chases, raceways)
- separation of interior spatial plan from structure
- separation of finishes from substrate associated with spatial plan, structure or weather envelope.
- For major systems such as roof or HVAC, and so on, access to and types of connections that allow disassembly:
    - visible and ergonomic connections
    - human-scale components and use of industry standard connectors and tools that are trade-friendly
    - minimal number and different types of connectors over whole building
    - use of reversible connections (screws, bolts, nails, clips).

Brummen Town Hall design for disassembly project, the Netherlands

The Brummen Town Hall is an example of a development designed with end of life in mind (see Dutch Chain-Oriented Waste Policy case study in Appendix E).

3.5 Strengthen Diversion Markets and Infrastructure

This strategy focusses on increasing the supply of and demand for diverted materials, such as through public procurement and investment in infrastructure and markets.

3.5.1. Support Infrastructure and Market Development

Technologies, education and capital help to create and grow the infrastructure and markets required to manage, process and then consume CRD waste materials. For example, convenient materials exchanges, reuse centres and retailers are required to purchase, process, refurbish and sell the materials. End markets, the consumers of the reclaimed materials, need to be encouraged to create sufficient demand to meet supply. This usually means some form of financial incentive to the consumer (often in the form of subsidies, tax credits or receipts, etc.).

[23] This list is quoted from Lifecycle Building Challenge (n.d.).

[24] This list is quoted from Lifecycle Building Challenge (n.d.).

Markets do exist for many types of CRD waste materials in Canada and elsewhere. Nevertheless, establishing readily accessible and valuable markets for CRD waste is challenging. From the outset, it is important to identify end-user processes that are capable of incorporating recycled material in existing plants, such as particle board manufacturers for recycled wood (e.g., Tafisa 100 per cent recycled particleboard in Québec [Tafisa Canada n.d.]), asphalt plants for asphalt shingle, gypsum board plants and cement plants for recycled gypsum, and cement plants for CRD wood not suitable for remanufacturing. Also, improving the efficiency with which facilities can process CRD wastes will reduce costs and improve the quality of the recovered and processed materials.

The definition of waste — what it includes and when waste materials are no longer waste — is still not sufficiently resolved in some jurisdictions. This may lead to liability issues depending on whether regulations covering waste (in terms of handling, transportation, etc.) apply. Definitions would improve compatibility of regulatory frameworks for the recovery and reuse of secondary materials.

The economic feasibility of moving materials to available markets is often identified as a key constraint in some jurisdictions. However, careful selection of policies may also serve to improve local recycling infrastructures and stimulate local market development.

There is generally an inverse relationship between a product's place in the 5Rs hierarchy and the potential volume of waste that could be used in making that product. For example, in the context of wood waste, the reuse of heritage items occupies an elevated position in the 5Rs hierarchy (and commands a high dollar value per unit of wood) but is able to consume only a very small portion of the waste generated (Kane Consulting 2012). At the other extreme, chipping wood is able to consume the majority of the wood waste generated but occupies a low level in the 5Rs hierarchy (and commands a low dollar value per unit of wood).

Some of the ways that governments can support and enable infrastructure and market development are:

- **Investment in R&D.** Innovation is essential for industry competitiveness, survival and growth. A healthy innovation ecosystem is critical to the uptake of new technologies and solutions, such as those necessary to introduce and adopt sustainable construction materials. Therefore, grants and funding for research and pilot projects are critical for exploring new opportunities for CRD waste diversion, testing new technologies or equipment, and for addressing the many economic, educational or technical barriers to CRD waste management.
- **Investment in infrastructure either directly (e.g., building and operating facilities) or indirectly (e.g., funding of infrastructure development) or some combination.** The most suitable approach will be determined based on local circumstances. For example, while infrastructure funding may allow the market to determine technical solutions (see the Edmonton Waste Management Centre example, below), it can also hurt local CRD waste management economies that have already developed some infrastructure.
- **Enabling recycling and reuse through end-of-waste criteria.** Clarifying how certain specified waste ceases to be "waste" when it has undergone a recovery operation and complies with specific criteria enables end markets to use the reclaimed materials more effectively (see the European Commission Waste Framework Directive End of Waste Criteria example in Section 3.4.3). Consistent definitions of "secondary products" create legal certainty for waste management decisions and for the different actors dealing with specific waste streams,

including producers and users of the recycled material. Investment decisions on new treatment capacities for the management of waste require legal certainty.

Governments can deliver additional support to establish infrastructure and grow markets in several ways:

- facilitate private, public or some form of partnership funding for new facilities and capital upgrades
- provide grants and funding for pilot projects, studies and other R&D activities
- provide direct investment, subsidies or service agreements in infrastructure for sorting, transportation and processing. For example, offer tax receipts for donated used materials, and eliminate sales tax on used materials.
- encourage non-financial market incentives such as reduced permit fees, density bonuses and set-back leniencies when used building materials are used (Kane Consulting 2012)
- support entrepreneurs and manufacturers, including those involved with both recycling and value-added product manufacturing. Technical assistance to entrepreneurs, partnership programs, financing support, the provision of low-cost land, and the use of other economic development tools will help establish a market pull.
- enable innovative approaches through a supportive policy environment (e.g., zoning/community planning to remove barriers to and encourage private sector investment)
- remove regulatory barriers to pilot or test new markets and to consume reclaimed materials
- collaborate across different orders of government and with the private sector.

Applicability to Construction, Renovation and Demolition Waste Materials

Public investment in CRD waste management infrastructure is applicable to all CRD waste materials. However, while it is difficult to recognize which impacts can be attributed directly to investments on specific CRD waste material streams, all of these types of investment have an important role to play in advancing a more sustainable system of waste diversion and recycling in all regions.

Policy advantages

- Investment in infrastructure fills an important market gap for processing CRD materials and providing them to the market for reuse.
- Investment in upgrades can help to improve the efficiency of processing facilities, which will help to bring down the cost and improve the quality of the processed materials.
- Investment opportunities in the growing waste diversion market may present a compelling economic opportunity for local NGOs and businesses.

Policy disadvantages

- Investment in infrastructure is unlikely to be successful in isolation. Ensuring the economic viability of new facilities and generating a return on investment in infrastructure requires the presence of strong disincentives to landfill target materials.
- Materials reuse and resale centres require significant and sustained (multi-year) investment and a supportive policy environment to get started.
- These policies are likely to cause competition-related issues.

Considerations when developing the policy

- Funding for investment can be sourced from landfill and recycling fees (Section 3.3.1), virgin material levies (Section 3.3.2) or deposit fees (see example in Section 3.1.1).
- There is a high level of industry fragmentation and limited collaboration in the construction industry generally, and within the CRD waste management sector specifically. Further, the levels of investment in R&D and innovation in Canada are low compared to other developed countries both in terms of private sector funding and government spending (Brantwood Consulting 2015).
- Other potential barriers to innovation to advance CRD waste management efficiency and effectiveness, close market gaps, and find new uses for secondary materials include:
  - procurement impacting on the level of collaboration
  - suboptimal knowledge transfer and lost sector-wide learning opportunities
  - issues around market uptake and awareness of benefits from innovation
  - lack of access to finance
  - a risk-averse attitude to innovation (BIS 2013).

Government involvement in policy development and implementation

All orders of government can invest in CRD waste management infrastructure directly or in partnership with industry or NGOs or focus on facilitating private sector investment. Governments can develop clear performance metrics against which to monitor innovation vitality and that reflect the unique characteristics of the building industry.

There is a lot of development in waste management technologies. Establishing performance goals and specifying the expected end results offer the market the most suitable framework in which to respond. Government or corporate investment in sector-specific R&D can extend beyond facilitating access to capital to include the provision of testing facilities and expertise, gathering and sharing information on markets and R&D activities, creating demonstration projects, and connecting researchers to the industry applications.

Examples

Edmonton Waste Management Centre

The City of Edmonton, Alberta (population 928,000), owns and operates the Edmonton Waste Management Centre, a unique collection of advanced waste processing and research facilities. The centre includes (City of Edmonton n.d.-a):

- **Construction and Demolition Facility**. The facility accepts both mixed and segregated loads of CRD waste at a lower tipping fee than the landfill ($0/tonne–$70/tonne depending on the material). This advanced facility diverts more than 90 per cent of segregated loads (wood, drywall, asphalt shingles, concrete, metals and bush/trees) and between about 40 and 60 per cent of mixed loads.
- **Waste to Biofuels and Chemicals Facility.** The City of Edmonton has entered into a service agreement with Enerkem to increase its residential waste diversion from 50 per cent to 90 per cent (City of Edmonton n.d.-b). Municipal waste will be used as the feedstock for producing biofuels at the facility (see WtE in Section 2.3).

Redistribution to municipalities of charges paid for the disposal of residual materials, Québec

The Québec residual materials management policy (part of the *Environment Quality Act*) provides financial support to regional municipalities to develop residual materials management plans that should include all residual materials, including household, industrial, commercial, institutional and other types of waste. Further, approximately 85 per cent of the revenue from landfill fees ($29.93/tonne) is redistributed to municipalities based on their population and their waste management performance (including CRD waste). This is an incentive to improve performance and competition against other municipalities. To date, each municipality has received an average subsidy of $2.58 for each dollar spent on the management of its residential residual materials. However, there is debate about the relative merits of a public solution such as this (where government selects the technologies) over empowering the market whereby the private sector is offered sufficient latitude to respond (Government of Québec 2017).

Continuous Improvement Fund

The Continuous Improvement Fund (CIF) is a partnership between the Association of Municipalities of Ontario, the City of Toronto, Stewardship Ontario, and the Resource Productivity and Recovery Authority (CIF n.d.). According to the organization, “The CIF’s mandate is to improve the effectiveness and efficiency of Ontario’s municipal blue box programs. This mandate is fulfilled through the provision of funding, technical support and training to aid municipalities and program stakeholders in the identification and development of effective practices and technological and market based solutions that lead to program improvements” (CIF n.d.).

Environmental Research and Education Foundation

The Environmental Research and Education Foundation (EREF) is “a US-based private grant-making institution with a national and international scope whose sole mission is to support solid waste research and education initiatives” (EREF n.d.).

Divert Nova Scotia

Divert Nova Scotia is a Nova Scotia–based NGO that administers several waste diversion programs and a network of Enviro-Depots. Its programs generate surplus revenue, which is used to support waste diversion. Divert Nova Scotia provides (Divert Nova Scotia n.d.-b):

- **Funding support** for companies to conduct research into new and more efficient ways to divert CRD and other solid waste from disposal. Research projects can be related to materials or products that incorporate solid waste resources, technologies for separating and recovering solid waste resources, and market opportunities for solid waste resources and recycled materials.
- **Interest-free loans** to Enviro-Depot owners to make improvements to operations and facilities that are used for Divert Nova Scotia programs and activities.
- **Annual funding for solid waste management regions.** Each year, Divert Nova Scotia disperses almost 70 per cent of its net revenues to municipal partners to help fund waste diversion programs, municipal-approved programs, education and awareness contracts, and other programs. Credits are based on the amount of waste diverted from landfill.

National Industrial Symbiosis Program, UK and Canada pilot

According to its website, the National Industrial Symbiosis Program (NISP) "is a business-to-business network that identifies opportunities for resource collaboration, thereby creating economic, environmental and social benefits to businesses and surrounding communities (NISP n.d.). The principle behind industrial symbiosis is quite simple; instead of being thrown away or destroyed, surplus resources generated by an industrial process are captured, then redirected for use as a "new" input into another process by one or more other companies, providing a mutual benefit or symbiosis. These mutually profitable links are not restricted to materials; they include resources such as energy, waste water, transportation, asset utilization and even expertise" (NISP n.d.).

NISP was established in the UK, and it "has a tried-and-true method of creating industrial symbiosis opportunities. Through independent verification and studies NISP has been found to be the most cost-effective, efficient program for delivering economic, social and environmental benefits. NISP-Canada is currently seeking funding to enter in the pilot stage. The NISP-Canada Pilot expects to demonstrate that comparable benefits can be achieved in Canada and will inform the model for a long-term and fully national program" (NISP-Canada n.d.).

3.5.2. Public Procurement

Sustainable public procurement and purchasing policies take into account not only the economic value (price, quality, availability and functionality) but also the related environmental and social impacts of goods and services.

Governments can harness their sizeable purchasing power to reduce consumption of materials, resources and energy (see the Toronto airport example of 90 per cent waste diversion in Section 2.3). They can demonstrate that green procurement requirements are achievable, which can encourage potential vendors to alter their business practices in order to compete in an advantageous way for government business. Sustainable procurement and purchasing can therefore have substantial "trickle-down" effects on the construction materials supply chain (United Nations Economic Commission for Europe 2016).

A sustainable procurement/purchasing policy or program focussed on reducing the impacts of construction materials can include a range of objectives such as waste prevention and reduction, resource reduction, pollution and toxin reduction, GHG emissions reduction, and so on. When a demolition or construction contract is tendered, the bid documents can be designed to reflect "triple bottom line" goals, which encompass environmental, social and economic criteria (United Nations Economic Commission for Europe 2016). Green building certification (Section 3.4.2) and environmental product labelling programs (Section 3.4.3) can provide standards that are simple to incorporate into procurement policies or requirements.

"Social procurement" is also starting to make its way into government procurement policies, for example The City of Toronto's Social Procurement Program (City of Toronto n.d.-b). This is an innovative market-based opportunity to create social impact through existing purchasing whereby projects are evaluated based on quality, price, environmental impact and social value.

Applicability to Construction, Renovation and Demolition Waste Materials

Green public procurement can address the environmental performance of a structure as a whole and can be used to influence upstream impacts of materials as well as the entire CRD waste stream (demolition and construction) via the adoption of tools such as green building rating systems.

Purchasing requirements can also be oriented towards the use (or prohibition) of specific materials (e.g., BC's *Wood First Act*, which promotes wood as a "first choice" material for public projects) (Province of British Columbia n.d.-d).

Policy advantages

- Governments can use public procurement as an effective instrument for forcing behaviour change by demonstrating that desired practices are achievable.
- Public procurement can be a powerful tool to drive market innovation.
- Procurement policies can hold the builder financially liable if the performance criteria (such as CRD waste diversion goals) are not met.
- Green building rating systems and environmental product standards have been in effect for a long time and can be easily referenced in public procurement policies as a means for establishing desired performance.
- Public procurement can help to build industry capacity and acceptance of new business practices.

Policy disadvantages

- Public procurement processes may have to be modernized for the benefits of novel products, processes or solutions to be fully realized.
- Many public procurement policies favour the lowest bid (ignoring the life-cycle impacts or non-financial benefits such as environmental or social impact). This approach can hinder innovation, especially in construction projects.
- There may be a lack of awareness and lack of resources available to purchasing officers for translating desired environmental/social goals into the most appropriate solutions for construction projects.
- Applying too many criteria to the public procurement process may disadvantage small businesses in the bidding process.

Considerations when developing the policy

- Public procurement policies can be applied to both the CRD of public infrastructure and ensuring CRD wastes are diverted as much as possible.
- Governments can "seed the market" by requiring public projects to meet certain CRD waste diversion goals or guaranteeing to supply or purchase certain quantities or types of sustainable materials or reclaimed/reprocessed products. For example, some public agencies are leaders in the use of recycled asphalt and aggregates.
- By favouring the purchase of products with better environmental performance, green procurement strategies can reinforce similar signals given through policies (e.g., producer responsibility programs).
- Frequently, construction contracts with public agencies require the contractor to handle concrete and asphalt materials. These materials frequently return to a central processing facility operated by aggregate industry/road building contractors. Excluding these materials from policy considerations

(because they are already largely “diverted”) may miss an opportunity to drive greater uptake.

- Some public organizations have developed their own green procurement specifications, while others refer to green building certification (Section 3.4.2).
- Procurement of innovative or unfamiliar construction products and processes requires early engagement with the project team and flexible, performance-based agreements.
- Quality-based proponent selection is critical to ensuring a project is developed with its entire life-cycle impacts in mind. Frequently, public procurement is driven by first cost, which results in a building that requires higher levels of maintenance or premature repair/replacement.
- Governments can develop demonstration projects that display outstanding performance in building design and waste reduction.
- Feedback loops are essential to ensure that lessons learned are transferred from project to project and back into the organization as a whole.

Government involvement in policy development and implementation

All orders of government, crown agencies and public sector organizations have an opportunity to lead by example and inject environmental measures into their procurement decisions.

Examples

The Government of Canada green building assessment initiative

The federal government has set a target of assessing 80 per cent of existing buildings to identify environmental opportunities. Consequently, all new construction, build-to-lease projects and major renovation projects should achieve an industry-recognized level of high environmental performance. Similarly, existing Crown buildings and new lease or lease renewal projects over 1,000 square metres should be assessed for environmental performance using an industry-recognized assessment tool (Environment and Climate Change Canada 2012).

British Research Establishment Global Framework Standard for the Responsible Sourcing of Construction Products (BES6001)

BES6001 is a model standard that provides “a holistic approach to managing a product from the point at which component materials are mined or harvested, through manufacture and processing” (BRE n.d.-b). Responsible sourcing “is demonstrated through an ethos of supply chain management and product stewardship and encompasses social, economic and environmental dimensions” (BRE n.d.-b). It has been adopted by large public infrastructure in the UK such as the £15 billion trans-London Crossrail project (BRE n.d.-a).

UK Forward Commitment Procurement tool

The British Columbia Construction Association (2017) describes Forward Commitment Procurement (FCP):

> Forward Commitment Procurement (FCP) has been developed in the UK specifically for local government procurers and wider public sector procurers as an early-market engagement tool.

> FCP creates the conditions needed to deliver innovative, cost-effective products and services. (BIS 2011) The FCP approach was developed to be consistent with value-for-money policy and the legal framework that governs public sector procurement.
>
> FCP brings together progressive thinking and successful practices from the private sector and the innovation and procurement communities, together with understanding of the demand-side barriers to the commercialization of innovative goods and services to bring new cost-effective goods and services into the market. FCP has been used to establish secondary aggregate specifications for road building, compost use in residential sub-divisions or roadsides, etc. In brief, FCP provides the supply chain with information of specific unmet needs and, critically, with the incentive of a Forward Commitment: a commitment to purchase a product or service that currently may not exist, at a specified future date, providing it can be delivered to agreed performance levels and costs. FCP provides the incentive, confidence and momentum for suppliers to invest and deliver innovative solutions. (BIS 2011)

The Village of Cumberland's social procurement framework, British Columbia

Social public procurement leverages existing purchasing to achieve social value. According to the British Columbia Construction Association (2017):

> The Village of Cumberland's [population 3,750] social procurement framework for road building is a form of "two-stage open book." Qualitative requirements are evaluated first on a pass-fail basis and then those that pass will be reviewed for the price. In this format, the owner develops a detailed design brief and from a list of pre-qualified contractors, selects a proponent to prepare an initial project budget based on the brief. Once the owner has accepted the design brief and the initial project budget, it works collaboratively with the contractor to deliver the project for the stated budget in an open book format. The Village of Cumberland on Vancouver Island was recognized as the first certified Buy Social municipality in Canada in 2015.

WRAP Halving Waste to Landfill Commitment

WRAP is a UK-based NGO with a focus on maximizing the value of waste by increasing the quantity and quality of materials collected for reuse and recycling. In October 2008, WRAP created the Halving Waste to Landfill Commitment "to provide a supportive framework to encourage the construction industry to work together to reduce waste and deliver the target. The Commitment's clear supply chain approach to measurement and common metrics helps signatories to achieve year-on-year improvement and generate significant cost savings" (WRAP 2011).

WRAP (2011) further describes the Commitment:

> Signatories to the Commitment need to take a number of steps to translate their statement of intent into action. By engaging key players in their own organization and supply chain, signatories set a target for waste reduction, set a baseline to measure against and embed the target within corporate policy. WRAP provides the following tools and guidance to support implementation:

- Model procurement wording for use within contractual documents to ensure waste reduction is a priority from the beginning of the project.

- "Designing out waste" process and online tools to identify and quantify waste reduction opportunities.
- The "Site Specific Waste Analysis Tool" is intended for use by waste management contractors to capture waste recovery data.
- All stakeholders in a project input into WRAP's Site Waste Management Plan Template to track waste created and recovered.
- Signatories are encouraged to register their baseline and targets within WRAP's Waste to Landfill Reporting Portal. The Portal integrates with WRAP's other tools to collect waste data from projects and allows signatories to monitor their corporate progress.

3.6 Build Knowledge and Skills

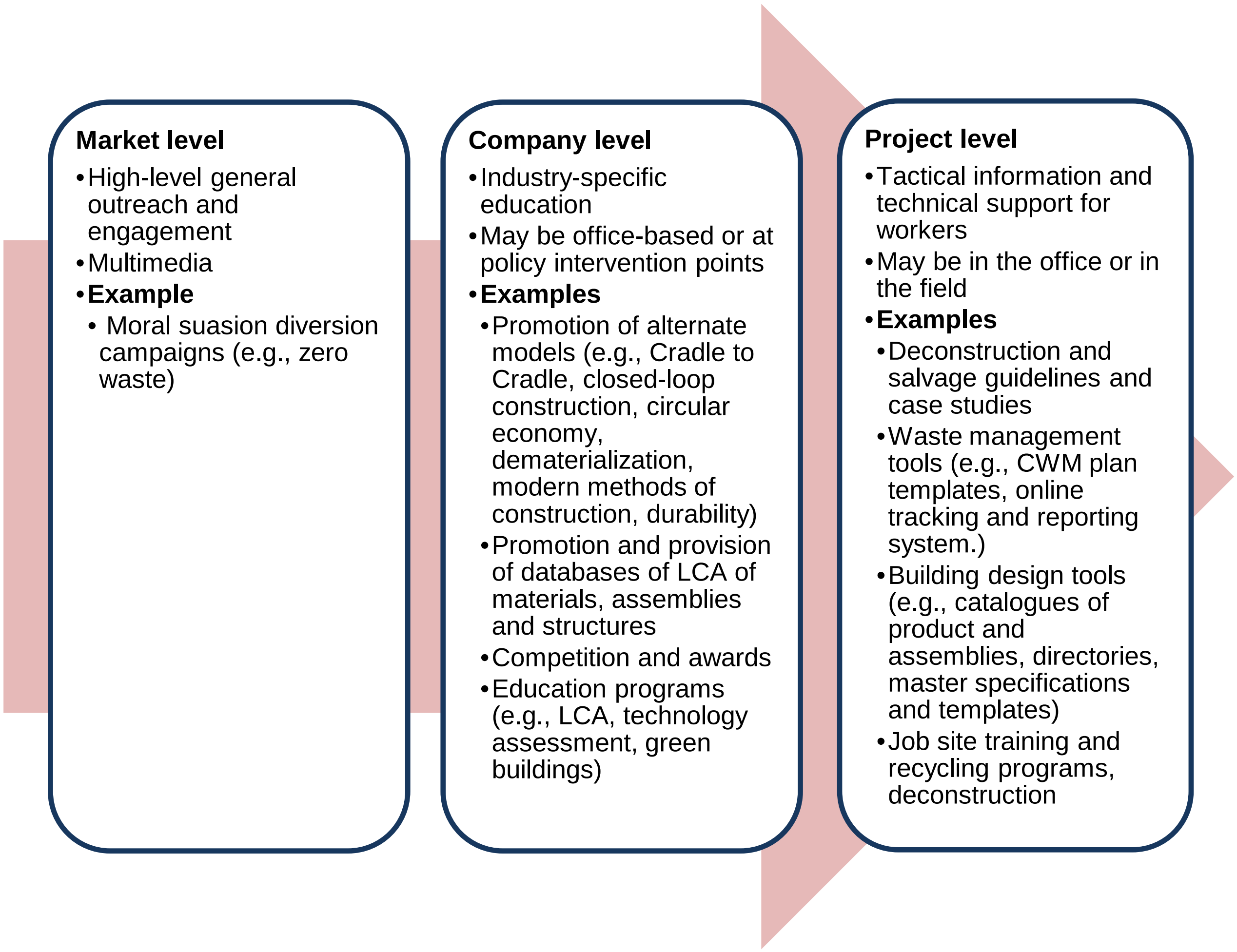
This strategy focusses on increasing the capacity and knowledge of the sector, and includes industry outreach, education and resources, and benchmark and track data. These activities are essential enablers of all of the other policies and are quite broad and cross-cutting and apply to all building materials. Consequently, this guide does not include an analysis of their applicability to CRD materials, advantages, disadvantages or considerations.

3.6.1 Industry Outreach, Education and Resources

An educated market may be more likely to be receptive to changes in the way business gets done. Consultation, supported by easily accessible practical information, will aid the adoption of CRD policies and can take place after fact finding and data collection and prior to policy development and implementation.

There are many methods of providing information to market actors, the key consideration being how to effectively deliver the correct information to the appropriate decision-maker at a strategic time. Given the large number of stakeholders involved in CRD waste management and all the different ways they prefer to receive information, a multi-tier approach to developing and disseminating information, outreach and education can build awareness, stimulate demand and improve documents over time (Figure 13).

Figure 13: A typical multi-tier education model



Source: Brantwood Consulting (2015).

Hands-on technical assistance programs can be provided as free or discounted services to designers, contractors and trades to help them set up their CRD waste management plans, establish diversion goals, find haulers and recyclers, and then document progress.

Other technical support services may include training, mentorship or other advice. For example, master specifications can be developed to assist designers and builders to accurately describe desired processes and outcomes, such as the use of reclaimed or salvaged materials. Or, technical experts can be made available to come into the office or onto the construction site to provide hands-on advice.

Because there are so many nuances to waste streams and opportunities for management, research into new ways to structure and position education and training continues to be important and requires sustained support. For example, how behavioural economics can be used to inform all the different decisions about waste management and diversion is still an evolving science. Given that the CRD waste management industry continues to evolve, it would be helpful for local and regional government advocates to be able to target information gaps for each of the various actors in the system. Research will help them know how to develop the most appropriate form and content of education material, what rationale and business case is most compelling, and the most effective promotional tactics to deliver the information to the various actors in the system.

Education and training programs can be developed, delivered and administered by local governments, training institutions, trade associations, solid waste management companies and NGOs. Adequate and sustained funding may be necessary given the length of construction processes and the long time frames between projects.

Examples

Metro Vancouver multi-tier education

Since the early 2000s, Metro Vancouver (population 2.4 million) has been creating and implementing an integrated outreach and education program designed to support market transformation to a "diversion first" mindset. A range of multimedia programming (including the Sustainable Region TV show [Metro Vancouver n.d.-c]) aims to raise market awareness of the benefits of CRD waste diversion. A range of industry-specific guides for designers, builders and trades includes the "Guide for Builders" (Metro Vancouver 2011) and the "DLC Waste Management Toolkit," (Metro Vancouver 2008), which includes a directory of haulers and facilities.

King County, Washington, master specifications

King County in Washington State (population 2.1 million) has specific language to address expectations for waste reduction, reuse and recycling during construction and demolition for architects to include in their design specifications. The following examples are available (King County n.d-b.):

- Section 01505 - Construction Waste Management
- Section 01736 - Building Deconstruction (and Salvage).

3.6.2 Benchmarking and Tracking Construction, Demolition and Renovation Waste Data

CRD waste management strategies, targets and goals work well when they are based on accurate data.

A robust understanding of the CRD waste materials that are being generated helps policy-makers pinpoint gaps and challenges, report on progress, and monitor performance. This starts with establishing a clear and consistent definition of what is included in CRD waste, what is considered "diversion" (e.g., is alternative daily cover considered recycling?) and what is meant by terms such as "end of waste." The CSA document *SPE-890-15 - A Guideline for Accountable Management of End-of-Life Materials* offers a range of definitions and metrics for managing waste materials (CSA Group 2015).

CRD waste management metrics can include diversion as a proportion of total waste generated, or weight per capita (in kilograms). Metrics also need to be consistent across jurisdictions. For example, some jurisdictions include materials reclaimed from civil infrastructure projects (particularly concrete and asphalt pavement) within the scope of CRD materials, and hence report much higher volumes and greater recycling rates.

As methodologies such as LCA become mainstream, a far greater quantity and quality of data will become available in order to keep track of construction material manufacture and production. This will include data such as embodied energy, GHG emissions and industrial energy efficiency. Also, as environmental performance criteria are incorporated into building codes, the need to establish benchmarks and targets will become increasingly important. Benchmarks and targets are already in place for “in-use” energy and GHG emissions performance in many European countries. The City of Vancouver recently adopted these benchmarks and targets as part of its Zero Emissions Building Plan (City of Vancouver 2016).

Provincial and territorial governments may establish the requirement for benchmarking and tracking of CRD waste management performance. However, local governments and waste management and processing facilities will be primarily responsible for gathering data, evaluating the information and tracking progress. Other tracking that may be useful for informing CRD waste management polices includes an inventory of locally available materials and what they contain and building stock characteristics (such as condition and pace of likely replacement, and number of historical buildings that may be worth preserving).

Governments can use various performance measurements to monitor, measure and report key solid waste management information, both internal and external, for use in decision making and communications. CRD waste management performance measures may include:

- waste composition studies
- recycling participation rates
- waste and recycling tonnages
- diversion rates and costs.

Industry capacity benchmarks are also useful to measure progress in the degree to which industry is well informed and trained to manage waste reduction. Indeed, broader environmental, economic and social indicators can also be developed to complement other regional priorities (such as economic development key performance indicators, GHG emissions and job creation). Appendix D discusses emerging methods for CRD waste tracking and reporting.

As governments start to consider broader impacts, the metrics become more complex. Environmental impact is measured on a life-cycle basis (tonnes of end-of-life waste, volume of CO_2 emissions, pollution and land use). LCA analysis is required to determine if (and to what extent) the policy is having a positive effect in one area (e.g., designing products that can be recycled more easily) but a negative effect in another (e.g., products being made from materials with more energy-intensive extraction methods). This approach raises questions about how and where trade-offs are to be made. Working within a life-cycle policy environment is challenging. It requires large amounts of data and specialists to manipulate it correctly. Although LCA is starting to appear in green building rating systems, for most regions this approach to policy making is still some years away.

Examples

Tracking and reporting on performance in Port Moody, British Columbia

Port Moody is a suburban municipality within Metro Vancouver (population 35,000). Port Moody’s *Solid Waste Bylaw* requires that a waste management plan be part of building permit and demolition permit applications (City of Port Moody 2009). The bylaw requires permit holders to submit proof that 70 per cent of recyclable CRD waste material has been diverted to licensed processing facilities prior to project completion. According to a BC government case study, city staff found that with the bylaw in place, almost 100 per cent of the potentially recyclable materials are being diverted. On the strength of this finding, the City of Port Moody may now consider amending the bylaw to require 100 per cent diversion of recyclable CRD waste materials (Province of British Columbia n.d.-c).

Ontario Waste Management Association online tracking system

The Ontario Waste Management Association has invested in an online data system to track the activity of waste management facilities. This initiative started with landfills and organics facilities with a view to expanding to other sorting facilities. A number of reports and publications are available, and the association believes this system could easily be replicated in other jurisdictions (OWMA 2014).

3.7 Considerations for Rural and Remote Communities

While CRD waste management solutions are becoming increasingly common in urban areas, remote regions encounter many additional challenges aside from those described in Section 2.8. For example, they may have limited (sometimes no) road access, and recycling facilities may be far away. They may also face the high costs of reverse logistics and limited local markets. As a result, many rural and remote communities have low diversion rates and very few options for recycling conventional waste streams, let alone CRD waste.

Consequently, while materials such as clean wood waste and aggregates may be relatively easy to divert in large urban centres, many smaller rural and remote communities may be forced to landfill these materials because of the relatively small scale of demolition and construction activities and the economics of MRFs and infrastructure.

These challenges can be especially acute in the north, where climate can further limit access and transportation options. Examples in this section therefore focus on accomplishments by northern communities, but these experiences may be relevant to many rural and remote locations. To date, CRD waste has not been singled out for specific attention in most rural and remote communities, in large part because of other priorities in the waste stream. This situation is changing, however, as more communities invest in engineered disposal facilities and turn their attention to waste management policies. For example, the City of Whitehorse has set an initial target of 50 per cent overall waste diversion by 2015 (including CRD waste) and a goal of zero waste by 2040. In addition, Whitehorse hosted the first pan-northern zero waste conference in March 2016 (City of Whitehorse 2013).

Partnering is important for remote communities. Collaborating with more populous neighbours can open additional opportunities for remote areas. For example, the Northwest Territories partners with Alberta on its Electronics Recycling Program (Alberta Recycling Management Authority n.d.-b.).

There is a good deal of resourcefulness in many small communities. Where there is no processor within a hauling distance that is economically feasible, waste generators might benefit from some networking to learn if combining loads of CRD waste would make it feasible for an outside processor to haul away the wood. The California Department of Resources Recycling and Recovery suggests another more ambitious option: for generators to research possible end markets for CRD waste products they could make themselves (CalRecycle 2011). This might require some capital investment, such as purchase of a mobile processor or grinder.

Table 5 provides a selection of examples of policies and programs in effect using northern communities as examples.

Table 5: CRD waste management policies that may apply to rural and remote communities

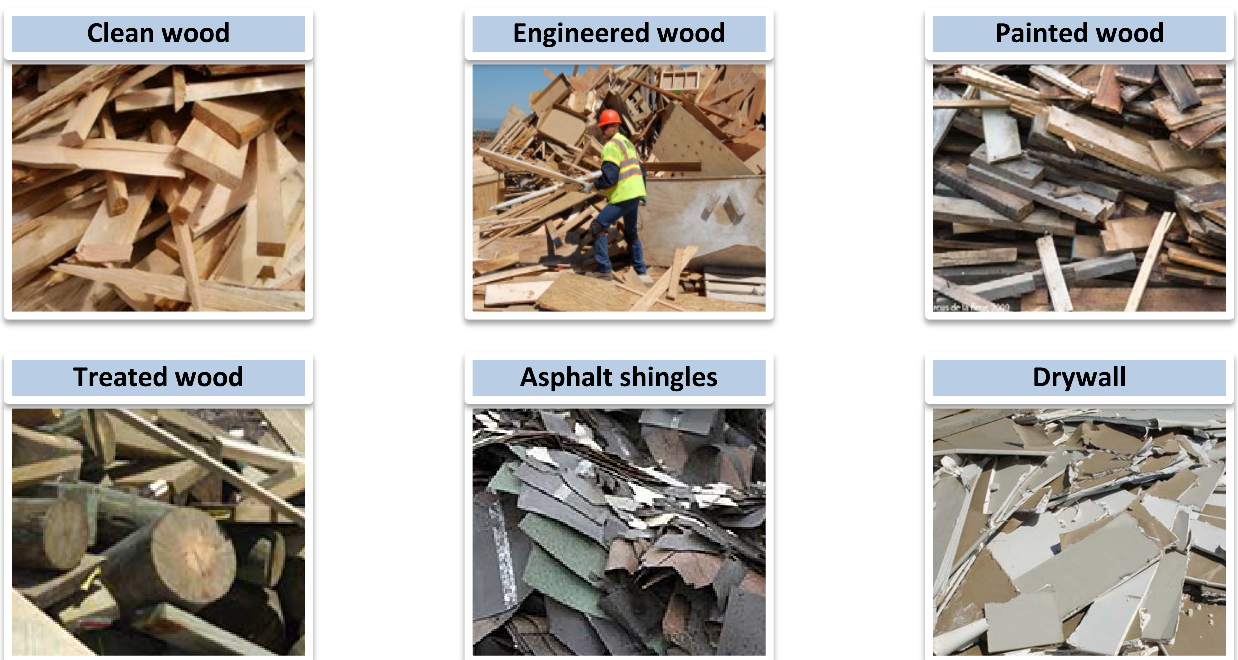
Strategy	Associated CRD waste management policies	Examples
A. **Create accountability for waste diversion**	EPR	The Northwest Territories Electronics Recycling Program is an EPR program that requires companies that supply new electronics to register with the Northwest Territories program, collect environmental handling fees on designated electronics sold/distributed, and then report and remit fees, where applicable (Alberta Recycling Management Authority n.d.-b.).
	Waste management plans for facilities and projects	The Mackenzie Valley Land and Water Board in the Northwest Territories has developed a waste management planning guide describing how project proponents requiring land use permits or water licences should prepare a waste management plan. The guide provides a template for proponents to write a plan and a benchmark for reviewers to evaluate a proponent's plan, thus ensuring that waste management plans are submitted and reviewed in a consistent way (Mackenzie Valley Land and Water Board 2011). Also see Yukon's *Waste Management Cost Recovery Bylaw* below.
B. **Limit disposal options**	Transportation requirements and restrictions	Yukon's *Waste Management Cost Recovery Bylaw* dictates that all waste management activity costs are fully recovered via tipping fees and utility charges, and waste transfer bans are in effect in all communities across the territory. Also, the Yukon government provides a direct subsidy to haulers and processors based on the volumes they process (Government of Yukon 2015). Up to $573,000 is expected to be committed to local recycling processors, based on the type and tonnage of recyclable material they process in 2015–2016. This is 2.5 times more than what was provided the previous year. Another $68,000 will be given to the processors to ship 400 tonnes of stockpiled mixed plastics out of the territory for recycling. Much of this additional cost will come from an increasing recycling deposits on refundable beverage containers and establishing environmental fees on items such as electronics. (Government of Yukon 2015)
C. **Align financial incentives**	Differential tipping fees	The Whitehorse landfill operates differential tipping fees. It accepts recyclables such as beverage containers, bottle glass, plastics, aluminum and paper without a tipping fee (City of Whitehorse n.d.).

Strategy	Associated CRD waste management policies	Examples
D. **Improve CRD processes**	Green building design certification	There are four LEED-certified buildings in Yukon. The LEED Silver Whitehorse Hospital staff residence (complete in 2013) achieved over 50 per cent CRD waste diversion (CaGBC n.d.).
E. **Strengthen diversion markets and infrastructure**	Support infrastructure and market development	Habitat for Humanity opened a ReStore in Yellowknife in June 2016. ReStores are non-profit home improvement stores and donation centres that sell new and gently used furniture, home accessories, building materials, and appliances to the public at a fraction of the retail price (Habitat for Humanity n.d.-b).
	Public procurement	See green building certification above.
F. **Build knowledge and skills**	Industry outreach, education and resources	Zero Waste Yukon regularly celebrates individual and organizational “heroes” (Zero Waste Yukon n.d.).
	Benchmark and track data	The City of Whitehorse has been tracking its solid waste for many years. With a combination of programs, the City has seen overall waste diversion increase. In 2012, the business community landfilled 81 per cent of the total waste generated. In 2015, that number dropped to 65 per cent (City of Whitehorse 2016).

4. SELECTING POLICY APPROACHES FOR MOST-PREVALENT CRD WASTE MATERIALS

In most regions, wood (clean, engineered, painted and treated), asphalt roofing and drywall are generated in particularly large volumes. While other materials such as brick, concrete and metal are also part of most CRD waste streams, there are reuse and recycling options for these materials in place in most, if not all, jurisdictions (see the complete list of common CRD materials in Appendix B). Therefore, this section focusses on policies that are well suited to reducing and diverting wood, asphalt roofing and drywall. Each of the materials is described in detail in Appendix B and summarized in Figure 14. In all situations, it is assumed that that stakeholder engagement will be integrated into the policy-development process.

Figure 14: Common CRD waste materials and the respective ease of diversion in most regions



Source: Brantwood Consulting (2015).

Most of the CRD waste management policies described in Section 3 can be applied to almost any target material — or to all CRD waste at once. Therefore, while this section focusses on a few specific materials, it is possible that the approaches described may work for other materials with similar waste management characteristics (ease of diversion, presence of functioning markets, etc.).

For each material, this section provides:

- a description of the waste material and a discussion about available recycling capacity/infrastructure and markets for end products
- an overview of the policy considerations

- a description of relevant goals, levers and approaches, which may or may not be used in combination
- a few examples of relevant policies (where possible) as illustrations.

4.1 Policy Approaches for Clean Wood Waste

Clean wood (also known as white wood) is not treated with chemicals (e.g., for pressure treatment), paint or other coatings. It includes solid wood, lumber, and pallets that are unpainted, unstained, untreated and free of glue (Metro Vancouver 2017). CRD waste is mostly composed of off-cuts, scraps, wood chips and sawdust from new construction and renovation as well as whole and part boards from renovation and demolition. The wood may be pierced with nails or other metal fasteners, such as screws and staples. Some processing facilities delineate between different grades of clean wood waste, for example (Harvest Urban Wood Recyclers n.d.):

- Grade #1 (80-100% Recyclable)
- Grade #2 (40-75% Recyclable)
- Grade #3 (<40% Recyclable)
- Tree Stumps – 2 feet (over 2 feet in diameter at cut; breakage fee)
- Tree Stumps – 3 feet (over 3 feet in diameter at cut; breakage fee)
- Logs (over 6 inches in diameter and 6 feet in length; breakage fee)

The value of clean wood waste varies by location, market conditions and the available supply. In most regions, there are markets for:

- framing wood
- re-milled wood beams
- chips for panel products (e.g., particle board)
- landscape mulch and compost amender
- erosion control on construction sites
- livestock bedding
- land-clearing and green waste compost.

Although there are many uses for clean wood waste, the challenge can sometimes be in creating functional and economically sustainable markets given the variability and seasonality of supply. The presence and maturity of markets for clean wood waste vary across the country. Most large urban centres are well equipped with a range of market options. In this case, policy approaches are most effective if they focus on improving the quality, consistency and value of the wood waste stream (for example, establishing higher-value markets than for hog fuel) (Kane Consulting *et al.* 2012). Indeed, the production of low-value products, such as alternative daily landfill cover, is able to consume a large percentage of the wood waste stream but is energy/GHG intensive, commands a low dollar value and is ecologically only marginally preferable to landfilling. Indeed, some jurisdictions (such as Metro Vancouver) maintain that alternative daily landfill cover is the “lowest” use of clean wood because (unlike fuel) it does not recover energy, offset fossil fuels or divert recyclable material from the landfill. In other words, it is not appropriate to place wood waste in or on a landfill and simultaneously count it as having been diverted from landfill disposal.

Given the quantities of CRD wood waste generated, end market opportunities exist in most jurisdictions for wood-derived fuel sources in industrial processes such as cement kilns. This may play a role in replacing high-carbon fuels for industrial processes, which can contribute to an industrial GHG reduction strategy. However, after use for alternative daily cover, energy recovery is a low-level solution on the waste management hierarchy (see Section 2.3) and is considered a “last resort” for CRD waste that might otherwise command a higher value as a feedstock for industrial, agricultural or other markets. It is important to consider this approach carefully because policies that promote WtE as an end market to drive CRD wood waste diversion may inadvertently capture materials being recycled for beneficial use and undermine the waste management hierarchy. Ideally, WtE is used in regions that have deployed all other efforts to reduce, reuse and recycle and have achieved high rates of diversion (greater than 50 per cent[25]).

There are also many markets that may need financial support to develop sufficient capacity to process the volumes of waste generated. Small or remote communities may have to first invest in wood waste processing infrastructure and in establishing markets (see Section 3.5.1).

Currently, large volumes of CRD wood waste cannot be diverted because it is commingled with other materials and contaminants or is in such poor condition that the cost of processing and cleaning limits the economic viability of processing and reusing the material. This can be addressed through policy approaches that focus on improving the quality and consistency of clean wood waste, ensuring that sorting, handling and processing facilities are accessible and adequate. Where markets exist for clean wood waste, the policy approach can concentrate on limiting disposal options and enabling diversion for clean wood waste.

Addressing the large amounts of clean wood waste that are generated from new construction, renovation and demolition requires a change in business approach. In the future, policies could be considered that align building design requirements to reuse wood products more efficiently and use products containing processed waste wood (e.g., DfE described in Section 3.4.4). These approaches should encourage designers to design their projects to suit standard lumber dimensions or to prefabricate building elements off site to prevent waste volumes being generated at all.

Selected Policies for Dealing with Clean Wood Waste

1. CRD waste bans and surcharges

Clean wood waste bans are in effect in several Canadian regions and are generally working well. Waste bans send a strong signal to the market that there will be a certain volume of supply for processing and volume of processed material available to end users, thereby stimulating investment in processing infrastructure and supporting viable end markets.

[25] The diversion rate of 50 per cent is supplied by the Enerkem website (Enerkem n.d.-a). While these rates may be applicable for Alberta, the definition of “high” levels of CRD diversion required to be in place before residual solutions such as EfW are considered is debated and may vary across the country; some believe that 50 per cent is too low and should be in the range of 80–90 per cent.

2. Deconstruction standards

Deconstruction standards can help to improve the quality of the waste stream and reduce the potential for contamination. This improves the marketability of the recovered materials as well as the processing efficiency and effectiveness of the recovered materials. For example, although there are many de-nailing technologies available, some facilities currently refuse to accept nails and screws. This can be a major barrier to clean wood end user markets. Financial assistance or public investment may be necessary to bridge the gap.

3. Support for infrastructure and market development

A variety of markets for clean wood waste exist (although many, such as hog fuel, are low value). Therefore, a multi-pronged approach to market support may be appropriate. This approach should ensure the availability of adequate processing capacity and market support (e.g., the creation of online trading centres and materials exchanges) that will direct clean wood waste to highest use. However, procurement programs that commit to using end-use materials are essential to build the strength of these markets.

Examples

Clean Wood Waste Ban: Regional District of Nanaimo

In January 2008, in accordance with the RDN's Zero Waste Plan (2004) and the Construction/Demolition Waste Diversion Strategy (2007), the RDN (population 138,000) introduced a landfill ban on the disposal of clean wood waste:

> This ban was developed and implemented in collaboration with waste haulers, wood waste generators and licensed private processing facilities (Province of British Columbia n.d.-b). This collaborative approach ensured that all stakeholders had advance notice of this important zero waste initiative. Enforcement consisted of load inspections and surcharges at disposal facilities by landfill staff as well as on-site education and compliance checks by the RDN staff.
>
> The wood waste ban provided a cost-effective way for the Region to divert clean wood waste. As a regulator, the Region did not provide any capital investment for the processing of clean wood waste, as these costs were borne by the private sector. [However, it is important to emphasize Nanaimo does not have a lot of disposal options, which may allow this to be more easily implemented.]
>
> In 2008, as a result of the ban, landfill disposal of wood waste was reduced by 87 per cent. Licensed facilities in the region also reported receiving and processing 23,500 tonnes of clean wood waste or 161 kg per capita. Although this amount was reduced in following years due to the economic slow-down, in 2012, licensed facilities still processed 14,898 tonnes or 98 kg per capita (Province of British Columbia n.d.-b).

City of Vancouver voluntary advanced deconstruction permit

The City of Vancouver is working towards becoming the greenest city in the world, and CRD waste management is an important part of this process:

> About 900 homes are demolished in Vancouver each year (Province of British Columbia n.d.-a).

The City estimates that one and two-family home demolitions are the single largest source of wood waste generated and have lower diversion rates than larger buildings. Prior to the establishments of the voluntary advanced deconstruction permit, the Development Permit process for one and two-family homes included no incentive for contractors to take the time necessary to remove the home through deconstruction.

Now, a building permit for deconstruction can be obtained prior to issuance of a development permit, providing the applicant demonstrates intent to undertake deconstruction. The applicant must commit to completing a compliance report detailing diversion rates, provide copies of receipts from receiving facilities and apply for a Development Permit. The City defines deconstruction as: “Systematic disassembly of a building resulting in the reuse, recycling or recovery of not less than 75 per cent of all building materials, excluding materials which are hazardous or banned from landfill.” (July 2011 Environment Policy Report to City Council). Within the first two years of implementing the advanced permit process, 12 Deconstruction Permits were issued, with reported diversion rates ranging from 86 per cent to 91 per cent per deconstruction project. (Province of British Columbia n.d.-a).

Building Product Reuse Centres

There are more than 95 ReStore building supply stores run by Habitat for Humanity affiliates in Canada. ReStores accept and resell quality new and used building materials, such as windows, doors, paint, hardware, lumber, tools, lighting fixtures, furniture and appliances. Some ReStores also offer pick-up and deconstruction services for property owners, who may receive a tax receipt for the value of salvaged items (Habitat for Humanity n.d.-a).

The ReBuilding Center was set up in Portland, Oregon (population 600,000) in 1998 to offer deconstruction services, which, on average, salvage 85 per cent of a typical wood-frame house. The centre sells building and remodelling materials, both wholesale and retail. The centre also offers workshops and classes on how to work with used building materials. The centre was founded on government grants, private donations and volunteer support but is now a successful financially self-sustaining social enterprise (ReBuilding Center n.d.).

Success for these stores is highly dependent on location. Research shows[26] that locating material drop-off locations at the entrance to waste disposal, transfer or major recycling facilities drives the drop-off rate dramatically higher. For example, there are two building material reuse stores in Metro Vancouver that generate $1.2 million in annual revenues (or about $600,000 each) and serve a population of almost 2 million people. Neither of these stores is located at a disposal, transfer or recycling centre. By comparison, the small town of Whistler has situated its reuse store right at the recycling depot and that store’s revenues are over $1 million for a permanent population of 10,000 people (plus an additional 15,000 seasonal residents and capacity for 30,000 overnight visitors) (Tourism Whistler n.d.).

The reuse store revenue per capita in Whistler is over 100 times greater than in Vancouver because it is so easy for people to drop off their reusable materials. This is despite the fact that the Whistler reuse

[26] Information provided by David Van Seters, Sustainability Ventures, Vancouver, BC, http://sustainabilityventures.ca/.

store has less than one-tenth of the selling space of the Vancouver ReStores. Other contributing factors to Whistler's success are that the town has no curbside collection, so there is a lot more traffic through the drop-off spots.

4.2 Policy Approaches for Engineered Wood Waste

Engineered (composite) wood refers to manufactured plywood, particleboard, medium-density fibreboard, oriented strand board (OSB), veneers, glulam beams, and so on, which may include nails, metal plates, glues and other chemicals. Significant quantities are generated from new construction, renovation and demolition.

The markets for engineered wood are mostly similar to clean wood. In most regions:

- there is some reuse value through deconstruction
- most engineered wood is generally accepted by CRD facilities where it can be de-nailed and processed into chips
- some markets accept composite wood mixed with clean wood for animal bedding
- plywood, particleboard and OSB can be composted
- some plastic-wood composites may be recycled.

Selected Policies for Dealing with Engineered Wood Waste

Because diversion process and end-user markets for engineered wood are similar to clean wood, the policy goals and priorities are also similar. Therefore, the policy approaches and examples provided for clean wood waste in Section 4.1 may also be applied to engineered wood.

4.3 Policy Approaches for Painted Wood Waste

Painted wood contains a coating (e.g., paint, varnish, sealer, stain) applied onto or impregnated into clean, engineered or treated wood. It includes trim, doors, cabinets, flooring, some siding, balustrades and baseboards. The largest quantities of painted wood come from demolition and renovation, although some off-cuts, ends and scrap are generated from new construction and renovation.

Market options depend on the coating. Some painted wood may contain hazardous or toxic substances and, because it may be difficult to test the type of paint, it is usually not possible to divert from landfill. Painted wood recycling and reuse markets also depend on the wood substrate (i.e., clean, engineered, treated). Nevertheless, some markets can tolerate a small amount of painted wood (an unavoidable contaminant) to be incorporated into clean wood waste processing (e.g., WtE facilities, animal bedding). Also, stripping out high-value painted wood items (trim, mouldings, etc.) prior to demolition for reuse makes up a very small portion of the waste stream.

With growing awareness of the importance of indoor environmental quality in buildings, more low- or non-toxic paint is being used, which may make it easier for facilities to accept painted wood waste over time. Governments can take a leadership approach in the use of new healthy paints and coatings via public procurement policies.

In the future, policies that address building design could also be considered so that wood elements in buildings can be protected without the need for difficult-to-dispose-of paints and coatings.

Because painted wood is so difficult to divert, alternative upstream solutions may be considered to reduce the volumes of waste generated. For example, prefabrication (e.g., trusses and panelized walls) and modular construction can greatly reduce waste quantities of all types of wood. If planned for, prefabrication can also allow for easy disassembly and reuse of large components, even entire buildings. As codes shift to increasingly energy-efficient and airtight buildings, prefabrication will become increasingly common. “Lean construction” techniques are also emerging; they focus on construction process efficiency and highlight how waste (materials, labour) eats into the contractor’s profit margin (see Lean Construction Institute of Canada n.d.).

Selected Policies for Dealing with Painted Wood Waste

1. Transportation requirements and restrictions

In most regions, opportunities for diverting painted wood waste from landfill are extremely limited. The most important policy goal is therefore to ensure that painted wood waste is taken to the appropriate facility and disposed of safely. Hauler licensing creates a fair operating environment for haulage companies, ensures minimum collection safety requirements, and attains basic solid waste disposal and recycling data for the authority having jurisdiction (City and County of Denver 2018). Hauler licensing helps to ensure that materials are handled and transported properly to the correct location. Many regions in Canada operate some form of licensing scheme for haulers; however, the standards and forms of compliance vary.

2. Investment in research to develop new processing technologies and infrastructure

There are very few markets for painted wood waste. These are primarily focussed on high-value “architectural salvage” for which functioning markets exist. There are also a few WtE plants that can take a small amount of painted wood waste. Research into new processing technologies and potential markets is also necessary to develop markets for the materials that can be recovered from painted wood waste. At the same time, efforts may need to be applied to finding new ways to reduce the volumes of painted wood waste being generated and encourage the use of alternative environmentally benign paints and coatings.

Examples

Halifax Regional Municipality, Nova Scotia transportation requirements and restrictions

See the description in Section 3.2.2.

Divert Nova Scotia research and development funding

Divert Nova Scotia offers R&D funding support for companies to conduct research into new and more efficient ways to divert CRD and other solid waste from disposal. Research projects can be related to materials or products that incorporate solid waste resources, technologies that will facilitate the separation and recovery of solid waste resources, and market opportunities for solid waste resources and recycled materials (more details provided in Section 3.5.1).

County of Simcoe differential tipping fees for drywall, asphalt shingles and wood

The County of Simcoe in Ontario (population 480,000) has both accessible private transfer stations and public processing facilities. The County has found that the rates charged for residential and commercial drop-off really only influence residential materials and only if the County's options are cheaper than private operators (County of Simcoe n.d.).

For example, the County has established a preferential rate for drywall, asphalt shingles and non-pressure-treated dimensional lumber (including painted, glued and stained) at $75/tonne. The drywall is recycled and the shingles are received and processed by the County itself. The County receives significant commercial quantities of this material because the rate has been set at about $15/tonne cheaper than private transfer costs. However, because the waste wood needs to be quite clean of contaminants (e.g., drywall, siding) the County has found that it gets nearly no materials from commercial users, as they consider the cost to separate this material unreasonable. Other materials, such as window glass, are received at the same rate as regular waste, at $155/tonne and, as a consequence, the County received almost no material from commercial users. By comparison, the County offers rubble diversion for free, and this service is well used by the commercial users.

The County has also found that the (mostly) small commercial renovation firms are generally passing the costs for managing renovation waste on to the owner. Because the renovation firms are not financially impacted by their waste management actions, they simply pay the mixed waste charge of $310/tonne and drop all unseparated materials together for the County to separate (County of Simcoe n.d.).

4.4 Policy Approaches for Treated Wood Waste

Treated wood refers to wood that is pressure treated or coated with wood preservatives to protect it against decay, mould and insects. It includes fencing and wood for exterior applications, marine pilings, railway ties, and products that have been treated with stains or preservatives. The largest quantities are generated from demolition and renovation, although some off-cuts, ends and scrap may be generated from new construction and renovation.

Wood treated with "safer" modern preservatives or, sometimes, with creosote (in small amounts) may be accepted by recycling facilities. However, some wood preservatives may contain hazardous or toxic substances, such as arsenic and chromium, and it is typically not easy to distinguish safer types of treated wood from the older types of treated wood that contained toxic chemicals.

In most regions, although the composition of treated wood is different than for painted wood, the policy goals and priorities are similar. Paints, coatings and preservatives can all contain chemicals that may need to be handled carefully and disposed of safely. Therefore, similar to painted wood waste described in Section 4.3, options for diverting treated wood waste from landfill are extremely limited. It is important to build awareness and capacity to deal with treated wood correctly. However, there are a few solutions for a very small amount of the total volume generated. Any recycling facilities that may accept treated wood will require it to be tested for toxic substances prior to acceptance. Depending on quality, some materials may be deemed worthy of removal for sale. Also, a few landfills accept treated wood as daily cover. Treated wood that does not contain chromated copper arsenate (CCA) or creosote may be tolerated (in small amounts) by EfW facilities, but recent research suggests that it is both safer and better for the environment to landfill this waste (Morris 2016).

Selected Policies for Dealing with Treated Wood Waste

1. Disposal fees and levies

Similar to painted wood, opportunities for diverting treated wood waste from landfill are extremely limited. The most important policy goal is therefore to ensure that painted wood waste is taken to the appropriate facility and disposed of safely. However, where solutions exist (e.g., for high-value reusable elements such as structural timbers), differential tipping fees could be used to encourage generators to take treated wood waste to the appropriate facility. Note that there are very few facilities that accept treated wood waste in Canada, and those that do generally take only a very small amount (e.g., some EfW facilities may tolerate a small amount).

2. Producer responsibility

Disposing of painted or treated wood waste can be expensive. Eco-fees on the sale of clearly labelled products or a producer responsibility program for products that are difficult to dispose of can help cover the entire cost of managing a product at its end of life. A few governments require producers to be responsible for paint products, and the application of EPR to CRD materials is expected to expand. CRD materials are identified under CCME's *Canada-Wide Action Plan for Extended Producer Responsibility* (CCME 2009) for incorporation into operational producer responsibility programs. Although there appear to be no specific examples of EPR for treated wood in Canada, there are programs in place in other countries (such as Australia).

Examples

New South Wales EPR for treated wood

In New South Wales, Australia, CCA-treated timber is a priority waste on its EPR list. A protocol has been developed that describes assessing, handling, transporting, processing, and dealing with processing residues and so on for utility poles and wooden bridges (the protocol is available at Office of Environment and Heritage NSW 2011).

Enerkem Westbury Energy from Waste plant, Alberta

Enerkem Westbury is a demonstration plant "located in a rural area in Alberta, near a sawmill that recycles used electricity and telephone poles and railway ties. Enerkem converts the non-usable portion of these poles, as well as other waste materials, into clean fuels (syngas, methanol, ethanol) and green chemicals." Its annual capacity is 5 million litres per year (methanol) (Enerkem n.d.-b).

Québec treated wood recycling

Serving Québec, Ontario and Manitoba, Les Industries JPB collects treated wood products from railways, electric power plants, road transportation, construction and telecommunications installation and processes them into posts for framing, electricity pylons and other dimensional products. End products can be used in retaining walls, temporary bridge decks, crash barriers for roads and highways, and bearing pads for excavation equipment (JPB Industries n.d.).

4.5 Policy Approaches for Asphalt Roofing Waste

Roofing shingles and asphalt sheeting are made from fibreglass or organic backing, asphalt cement, sand-like aggregate and mineral fillers. Large quantities are generated from demolition and renovation, and, frequently, there is significant scrap from new construction. However, once installed, asphalt shingles cannot be removed from a building and reused in construction.

Many provinces have an excellent record on reusing asphalt paving in road construction. For example, in Ontario, it is almost 100 per cent reused (Recycling Council of Ontario 2006). However, due to processing standards, asphalt from building-related CRD waste typically has a lower recovery rate and is often rejected as unclean because it can be contaminated with other products and some may contain asbestos.[27] Nevertheless, technology exists to recycle 100 per cent of asphalt shingles for sale as additive for paving or kiln fuel (Figure 15). (Recycling Council of Ontario 2006)

Although processing asphalt shingles is more complex than for some other materials, it can be economically viable. Processing facilities for asphalt roofing exist in most major urban centres, but recycling can be challenging in other parts of the country due to lack of infrastructure. Where markets do exist, they may need support to develop sufficient capacity to process the volumes of waste generated. In small markets without processing facilities, hauling waste materials long distances may be hard to justify economically (see Section 3.7). A survey of the state of asphalt roofing recycling in Canada was completed by the Athena Sustainable Materials Institute for Natural Resources Canada in 2007 (Athena Sustainable Materials Institute 2007).

Given that effective recycling technologies exist, the primary policy goal when dealing with asphalt roofing waste is to limit disposal options (e.g., via transportation requirements and restrictions, waste disposal bans) and enable diversion (by providing access to processing facilities) and then ensuring that facilities are operating state-of-the-art equipment.

End-user markets may need to be established and functional so they can absorb the processed materials. This means that for some regions, the most effective policies may focus on creating new facilities and infrastructure with support from a combination of financial strategies (such as differential tipping fees). These policies should ensure the materials go to the right place and are processed to the quality expected by end-user markets and that those markets are economically viable.

[27] According to Asbestos Network, "Many homes built before 1980 contain asbestos in old floor tiles, ceiling tiles, roof shingles, and flashing, siding, insulation (around boilers, ducts, pipes, sheeting, fireplaces), pipe cement, and joint compound used on seams between pieces of sheetrock." Some homes may also contain vermiculite in their attic (Asbestos Network n.d.).

To address the large volume of asphalt roofing waste, policies that incentivize waste generators early in the project to consider downstream impacts (e.g., by using alternate products or approaches, incurring an up-front fee) may be important in combination with policies that could help to develop more processing facilities. So, although there are no EPR programs or waste disposal bans in operation in Canada for asphalt roofing, both of these policy approaches are being considered by several governments.

Figure 15: The asphalt shingle recycling process

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</tr>
<tr>
<td>State-of-the-art shingle-processing equipment can recycle 100 per cent of residential asphalt shingles, either roof tear-off shingles or manufacturer remnants.

Nails are removed automatically with a magnetized separator, collected and recycled.</td>
<td>The final products manufactured are then delivered for end uses:

• Manufactured shingle additive is a homogeneous product composed of asphalt cement and shingle grit. It is used in paving materials such as hot mix asphalt (HMA), cold patch mix asphalt, aggregate substitute, base course, mineral filler and granular base stabilizer. It can be used to pave roadways, parking lots, bike paths and driveways. It is more durable and costs less than pavement containing only virgin asphalt cement. However, the use of shingles in hot mix asphalt may be limited due to pavement/engineering standards.

• Shingles are often used in processed engineered fuel (PEF), which is a homogeneous, oil-saturated fibrous flake for industrial burners such as cement kilns (grit removed). This solution requires less sorting than for HMA.

• Granular grit portion of shingles can be used for landfill site pads and roads, pavement, and trails project</td>
</tr>
</table>

Source: Gemaco, Delta, British Columbia.

Selected Policies for Dealing with Asphalt Roofing Waste

1. Requirements for waste management plans

Waste management plans can be required of generators that specify target materials to be diverted. Governments can stipulate minimum diversion rates for target materials such as asphalt roofing. Data gathered from the administration of waste management plans can be used for benchmarking, monitoring and reporting.

2. Investment in infrastructure in combination with differential tipping fees

Complex-to-divert materials such as shingles (and drywall) require incentives and support to establish and sustain the infrastructure needed to process the materials and to establish viable end markets. Establishing differential tipping fees and charges in combination with new investments in infrastructure is an important policy approach that can help to drive target materials to the facility and therefore help the facility be economically viable. Revenues from the fees and charges can also contribute to capital investment costs as well as education programs to build market awareness. However, it is important to consider whether the processing facilities are private or publicly owned and operated. While local governments may license CRD facilities, they do not usually have the legal power to set the tipping fees charged by privately owned/operated facilities — in this case the province or territory may need to be involved.

3. Transportation requirements and restrictions

Where effective recycling technologies exist (see map of processing facilities in Appendix C), transportation requirements and restrictions can work in conjunction with waste disposal bans, limits and surcharges to ensure the materials are taken to facilities for processing and end markets function effectively. Processing waste asphalt shingles is at an early stage of development, and facilities need sufficient volumes to be economically viable. Transportation requirements and restrictions can be used (in conjunction with differential tipping fees, bans, limits and surcharges) to direct materials to the appropriate facilities and even, potentially, support the business case for further investment in recycling and processing infrastructure.

4. Construction, renovation and demolition waste disposal bans, limits and surcharges

As noted above, effective asphalt shingle recycling technologies exist in some locations but, in order to stimulate further investment in infrastructure, increased use of the facilities is needed to encourage further investment in infrastructure and the creation of end markets. Therefore, a primary policy may be to limit disposal options in order to encourage diversion and the use of appropriate recycling facilities.

Examples

City of Port Moody, British Columbia, waste management plan requirement

The City of Port Moody requires the completion of a waste management plan that lists all potential materials (including asphalt shingles, which are recyclable in the region) as part of both building permit applications and demolition permit applications (City of Port Moody n.d.-b). Within 90 days of project completion, a compliance report should be submitted demonstrating that at least 70 per cent of recyclable material is diverted to licensed processing facilities (City of Port Moody n.d.-a). See the Port Moody case study at Province of British Columbia (n.d.-c).

City of Edmonton's new CRD recycling facility with associated differential fees and charges

The City of Edmonton opened a voluntary CRD recycling facility (Edmonton 2018 in 2012 that accepts and segregates wood, drywall, asphalt shingles, flooring material, asphalt and concrete below 80 centimetres for $60/tonne. Pre-sorted loads of asphalt shingles are charged at the reduced rate of $40/tonne (as are pre-sorted wood and drywall loads).

Divert Nova Scotia Asphalt Shingles Aggregate Pilot Project

Divert Nova Scotia sponsored the 2006 Asphalt Shingles Aggregate Pilot Project conducted by the District of Lunenburg, which investigated the use of a product created from discarded asphalt shingles mixed with aggregate as a potential trail resurfacing material (Municipality of District of Lunenburg 2012).

City of Calgary designated materials program

Designated materials are readily recyclable materials that should be kept out of the landfill. The City of Calgary has imposed a differential tipping fee program enforced by city landfill staff inspections of commercial vehicle loads of garbage for undeclared designated materials. Those containing these items are subject to a higher rate ($175/tonne in 2017) to encourage recycling instead (City of Calgary n.d.). Designated materials include:

- **Concrete**: whole or crushed, up to 1 metre, which may contain asphalt, metal reinforcement or aggregate
- **Brick and masonry block**: structural or decorative, with or without mortar, crushed or whole.
- **Asphalt**: road asphalt or asphalt shingles
- **Scrap metals**: construction, demolition and renovation related scrap metals up to 1.2 metres
- **Recyclable wood**: dimensional lumber, pallets, and other items that are made of raw and un-processed wood
- **Drywall**: gypsum wallboard

4.6 Policy Approaches for Drywall Waste

Also called gypsum, plasterboard, sheetrock, Gyproc and wallboard, drywall waste comprises gypsum (94 per cent) and paper backing (6 per cent) and may contain screws and fasteners (metal content of drywall amounts to less than 1 per cent of the total). Clean waste drywall that is commonly accepted by processing facilities comprises board material, non-hazardous strip-out plasterboard products, plaster blocks and construction off-cuts.

Clean drywall scrap is generated primarily from renovation and new construction. Processing facilities for clean drywall exist in most major urban centres and will usually take scrap from new installation that is free of paint, wallpaper, tape, nails, screws, corner beads, and so on. Clean drywall waste can be made into new drywall products easily, and most manufacturers have now established systems for reprocessing. The gypsum and paper together can also be used as a soil amendment in the agricultural sector to make animal bedding and as an additive at composting facilities. The backing paper can be made into low-grade paper products. In fact, it is possible to recycle 100 per cent of drywall waste into useful products.

Challenges to drywall recycling are primarily related to the potential for contamination. By far, the largest volumes of drywall come from demolition, but markets for demolition drywall can be very selective. This is because it may be mixed with (or attached to) other materials. Common contaminants include wood, paint, wallpaper, ceramic tile, and electrical outlets and wiring. Also, prior to the 1980s, the tape and joint compound (“mud”) used to seal the seams and fill gaps between drywall boards sometimes contained asbestos. Drywall from renovation and demolition projects should be tested in accordance with applicable legal requirements prior to determining the appropriate course of action.

Where recycling facilities exist, drywall is a straightforward product to deal with. Modern, efficient facilities exist in most urban locations in Canada (e.g., Oakville, Ontario; New Westminster, British Columbia; Calgary, Alberta). However, drywall recycling can be challenging in many parts of the country due to lack of infrastructure. Where markets do exist, support is often necessary to develop sufficient capacity to process the volumes of waste generated. Although there are no examples of EPR programs being used for drywall yet, several governments are considering it for the future, as it can help to develop more processing facilities. In fact, some recycling facilities have already established agreements with drywall manufacturers in order to secure a strong supply and demand for the gypsum material (New West Gypsum Recycling 2017).

Co-location of recycling facilities with manufacturing plants can significantly boost the business case for recycling. Also, although virgin material levies are not used in Canada yet, they may be anther financial tool to shift the market into reusing gypsum in new drywall products.

Drywall installation can be wasteful because drywall is a very cheap building material compared with the labour required to install it. In the future, policies that encourage modern and efficient methods of construction (e.g., prefabrication) may help to reduce the volume of drywall waste.

The challenges of asbestos-containing drywall products are significant because identifying and recycling asbestos-containing drywall is not straightforward. In Metro Vancouver, where there is a disposal ban on drywall and a major privately-operated gypsum recycling facility, the cost and time required to test for asbestos has resulted in closures of receiving sites and considerable illegal dumping of gypsum (Daly 2015).

Selected Policies for Dealing with Drywall Waste

1. Waste disposal bans, surcharges and limits

It is important to keep drywall out of landfills. Landfill disposal of drywall (including use as daily landfill cover) is undesirable because it releases hydrogen sulfide gas under wet anaerobic conditions, which could pose hazards to human health and the environment. Therefore, the primary policy goal for drywall waste is to limit disposal options (e.g., via hauler licences, waste disposal bans), enable diversion (by providing access to processing facilities) and then ensure that facilities are operating state-of-the-art equipment. This means that for some regions, the most effective policies are those focussed on creating new facilities and infrastructure (Section 3.5.1) and, if applicable, those that receive support from transportation requirements and restrictions (Section 3.2.2) to ensure the materials go to the right place.

2. Investment in infrastructure in combination with differential tipping fees

For those regions that are growing their materials reprocessing capacity, establishing differential fees and charges in combination with new investments in infrastructure is an important policy approach that can help drive target materials to the facility and therefore help the facility be economically viable. Where infrastructure is in place, disposal fees and levies, supported by transportation requirements and restrictions, are important to ensure that materials are being properly and markets for reclaimed materials are supported.

Examples

Metro Vancouver drywall disposal ban and differential tipping fees

Most regional districts in BC have banned drywall from landfills. Metro Vancouver applies a $65 surcharge, plus the potential cost of remediation and cleanup on loads containing banned hazardous and operational impact materials (including gypsum) (Metro Vancouver n.d.-a).

County of Simcoe differential tipping fees for drywall, asphalt shingles and wood

Described in Section 4.3.

5. APPENDICES

Appendix A: Full List of Construction, Renovation and Demolition Waste Management Policy Options

In order to develop the short list of 14 policies for this guide (presented in Section 3), a long list of examples was created that draws on practices around the world, some of which are in the earliest stage of development. It is a summary of what is possible, not what is currently in practice in Canada, because many fall outside most governments' mandates today.

POLICY TYPE	POLICY TOOLS
Regulations	
1. Performance-based standards	• Mandatory waste diversion performance (overall or for specific materials) to be demonstrated prior to issuance of building permit for demolition or occupancy permit for new construction. • Zero-waste goals and policies designed to minimize the volumes of CRD waste generated. • Landfill bans for CRD waste (overall or for specific materials with highest diversion potential or where alternatives exist). • On-site disposal (fill) limits. • "Outcome-based" building codes with mandatory sustainability and CRD waste diversion standards (e.g., green building certification, durability, climate-appropriateness, minimum requirements for the use of materials with reused/recycled content in new projects, minimum CRD waste diversion). • Legislation that promotes renovation and adaptability (e.g., mandatory preservation/renovation of high-value/heritage buildings). • Land use policy and policies describing desired building form, function and character that can encourage certain building types and uses (e.g., to locate an industrial consumer of wood waste close to an MRF) or prohibit certain building types and designs in high-risk locations to minimize premature repair/replacement. • Permits and licences for haulers, landfill operators and processing facilities. • Limitations on transport (avoid taking to lower-cost jurisdiction). • Regulations that prohibit, restrict or require the use of certain materials. • Mandatory EPR or product "take-back" programs.
2. Design, process or technology standards	• Mandatory plans/narratives describing strategies for CRD waste management, diversion, deconstruction, zero waste and disassembly. • "Prescriptive" building codes (functional-based building codes, form-based codes) that stipulate desired practices and processes. • Mandatory recycling and source separation (including the use of specified demolition/deconstruction processes. • Requirements to use specific facilities or service providers.

POLICY TYPE	POLICY TOOLS
	• Required compliance with durability plans and standards (e.g., CSA S478-95 (R2007) Guidelines on Durability in Buildings). • Compliance with technical standards for reused/recycled materials (establishment of “end-of-waste” criteria).
Market approaches	
3. Taxes, fees and charges	• Tipping fees, levies or landfill taxes (can be used to fund programs). • Fines. • Front-end levies or fees (virgin materials, priority CRD materials, eco-fees on materials that are difficult to divert).
4. Subsidies and incentives	• Reduced fee benefits (e.g., building permit fees, development cost charges). • Process/approval benefits (e.g., density bonus, expedited plan review, expedited permitting, demolition prohibited until building permit for new building approved). • Tax credits/receipts (as deconstruction incentives for donating used materials). • Government-backed insurance. • Grants, subsidies, financing or preferential loans for owners to maintain/upgrade existing buildings (rather than demolition), for companies and facilities providing diversion services (e.g., training, capital cost, R&D), and so on.
5. Combinations	• Deposit-refund on building permits (e.g., based on waste reduction or diversion target). • Standard-price combinations (e.g., targets backed by fees or deposits).
6. Direct public sector investment	• Investment in infrastructure and service provision (e.g., public-private sector processing facility, reuse centres, expanded drop-offs, WtE options, right-sized recycling receptacles, pick up services). • R&D (e.g., developing new uses for recycled CRD wastes, LCA). • Pilot and demonstration projects.
7. Tradable assets	• Tradable supplier obligations and responsibilities notes.
8. Information disclosure	• Waste diversion performance reports (project, business, landfill, MRF). • Notification and registration of waste transports.
Voluntary approaches	
9. Information, guidance and recognition (including outreach)	• Moral suasion diversion campaigns (e.g., zero waste). • Public outreach and education. • Promotion of alternate models (e.g., Cradle to Cradle, closed-loop construction, circular economy, dematerialization, modern methods of construction, durability). • Promotion and provision of databases of LCA of materials, assemblies and structures. • Competition and awards.

POLICY TYPE	POLICY TOOLS
	• Deconstruction and salvage guidelines and case studies. • Waste management tools (CWM plan templates, online tracking and reporting systems). • Building design tools (catalogues of product and assemblies, directories of service providers, master specifications and templates). • Guidelines for preserving heritage and culturally important buildings. • Benchmarking, data gathering and reporting frameworks.
10. Assistance, training and other business supports	• Training and capacity building for industry (e.g., job-site training and recycling programs, deconstruction). • Technical assistance (e.g., LCA, technology assessment, green building). • Enabling reuse (e.g., waste exchange program, free CW collection at builders' supplies stores, free/subsidized pick-up from sites).
11. Voluntary plans, goals	• Industry-government memoranda of understanding. • Industry leadership and self-managed programs (stretch goals). • Waste management, diversion, salvage or disassembly plans (non-binding).
12. Labelling and certification	• Product certification and labelling schemes (e.g., environmental choice label, EPDs). • LCA of building materials, assemblies and structures. • Green building rating systems.
13. Government leadership	• Waste policies. • Emergency and natural disaster planning. • Sustainable procurement policies and regulations that promote the use of recycled building materials and require high diversion on public projects (e.g., through green procurement specifications such as building certifications [LEED, BOMA BEST, etc.], green building codes and other standards).
Cross-cutting	
14. Zero waste goals	• Zero waste goals address environmental impacts acting across the whole material chain and therefore can be brought to bear on the building design process as well as construction and end of life.
15. Product responsibility approaches	• Depending on the approach, producer responsibility and chain-of-custody strategies can use all four policy categories noted above. They may be voluntary or mandatory.

Appendix B: Key Construction, Renovation and Demolition Materials, Recycling and Reuse Markets, and Considerations for Diversion

High value | Simple to divert | Complex to divert | Limited options

Description and sources	Recycling and reuse markets	Considerations for diversion
1. Architectural salvage, high-value items		**High value**
Architectural salvage (e.g., balustrades, doors, mantels, plumbing fixtures, decorative features), wood or steel beams and columns, equipment and appliances, furniture, etc. **Sources**: • High-value items come from renovation or demolition, especially of "character" buildings	There is high demand for good-quality antique or vintage architectural salvage. Many demolition contractors will remove these items prior to demolition and for sale through established channels. There are numerous online markets for architectural salvage. Reuse centres (such as Habitat for Humanity's ReStores) are present in many urban centres and will take a wide range of salvaged products. Equipment and appliances that are in good working order (and safe to use) can be resold.	Established markets exist across the country in the form of antiques stores, reuse centres and online stores. Collection points at transfer stations or CRD waste facilities can help to divert saleable items to reuse centres. Where they exist, some reuse centres offer "house-stripping" services whereby high-value items are carefully removed prior to demolition.

<table>
<tr><td colspan="3">2. Wood (40% total CRD waste stream by weight)</td></tr>
<tr><td colspan="2">a. Clean wood (49% of total wood waste)</td><td>Simple to divert</td></tr>
<tr>
<td>Clean wood (also known as white wood) is not treated with chemicals (e.g., for pressure treatment), paint or other coatings. It includes solid wood, lumber, and pallets that are unpainted, unstained, untreated and free of glue. The wood may be pierced with nails or other metal fasteners, such as screws and staples.
Some facilities delineate between different grades of clean wood waste, for example (Harvest Urban Wood Recyclers n.d):
• Grade #1 (80-100% Recyclable)
• Grade #2 (40-75% Recyclable)
• Grade #3 (<40% Recyclable)
• Tree Stumps – 2 feet (over 2 feet in diameter at cut; breakage fee)
• Tree Stumps – 3 feet (over 3 feet in diameter at cut; breakage fee)
• Logs (over 6 inches in diameter and 6 feet in length; breakage fee)
Sources:
• Clean wood waste includes off-cuts, scraps, wood chips and sawdust from new construction and renovation.
• It also includes whole and part boards from renovation and demolition. Prefabricated walls and trusses greatly reduce waste.</td>
<td>The value of clean wood varies by location, market conditions and the available supply. In most regions, there are markets for:
• Framing wood, and structural members that can be recovered for resale
• Re-milled wood beams that can be used in structural and aesthetic applications
• Chips for panel products (e.g., particle board)
• Landscape mulch and compost amender
• Erosion control on construction sites
• Livestock bedding
• Land-clearing and green waste that can be composted.</td>
<td>There are many uses for clean wood waste; however, the challenge can sometimes be in creating functional and economically sustainable markets. Markets that do exist may need support to develop sufficient capacity to process the volumes of waste generated.
The end uses for CRD waste wood are sometimes limited because the wood is commingled with other materials and contaminants or is in such poor condition that the cost of processing and cleaning limits the economic viability of processing and reusing the material.
Clean wood waste is often contaminated with other materials (e.g., tile, drywall).
Notes:
• Some facilities refuse nails and screws.
• Some facilities refuse large land-clearing waste such as stumps, large branches and root balls.
• The production of low-value products, such as alternative daily landfill cover, is able to consume a large percentage of the wood waste stream, but is energy and GHG intensive, commands a low dollar value, and is ecologically only marginally preferable to landfilling.
• Formwork rental can reduce plywood waste significantly.
• Acceptable contamination levels vary by facility but are generally less than 10%.</td>
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b. Engineered (composite) wood (23% of total wood waste)		Simple to divert
Engineered (composite) wood refers to manufactured plywood, particleboard, medium-density fibreboard, OSB, veneers, glulam beams, etc., which may include nails, metal plates, glues and other chemicals. **Sources:** • Significant quantities are generated from new construction, renovation and demolition.	The markets for engineered wood are mostly similar to clean wood. In most regions: • There is some reuse value through deconstruction. • Most engineered wood is generally accepted by CRD facilities where it can be de-nailed and processed into chips. • Some markets accept composite wood with clean wood in animal bedding. • Plywood, particleboard and OSB can be composted. • Some plastic-wood composites may be recycled.	See clean wood waste.
c. Painted wood (20% of total wood waste)		**Limited options**
Painted wood contains a coating (e.g., paint, varnish, sealer, stain) applied onto or impregnated into clean, engineered or treated wood. It includes: Trim, doors, cabinets, flooring, some siding, balustrades and baseboards. **Sources:** • The largest quantities come from demolition and renovation. • Off-cuts, ends and scrap are generated from new construction and renovation.	Market options depend on the coating. Some painted wood may contain hazardous or toxic substances and, because it may be difficult to test the type of paint, it is usually not possible to divert from landfill. • Painted wood recycling and reuse markets also depend on the wood substrate (i.e., clean, engineered, treated). • Some markets may allow a small amount of painted wood to be incorporated into clean wood waste processing. • Some hardwood and softwood flooring and some trim and moulding can be removed and sold prior to demolition.	Stripping out high-value painted wood items (trim, mouldings, etc.) prior to demolition for reuse makes up a very small portion of the waste stream. Mostly, it is not possible to divert painted wood waste from landfill. **Notes:** • With growing awareness of the importance of indoor environmental quality in buildings, more low- or non-toxic paint is being used, which may make it easier for facilities to accept painted wood waste over time.

d. Treated wood (8% of total wood waste)		Limited options
Treated wood refers to wood that is pressure treated or coated with wood preservatives to protect it against decay, mould and insects. It includes fencing and wood for exterior applications, marine pilings, railway ties and products that have been treated with stains or preservatives. **Sources:** • The largest quantities are generated from demolition and renovation. • Off-cuts, ends and scrap are generated from new construction and renovation.	Wood treated with "safer" modern preservatives or, sometimes, with creosote (in small amounts) may be accepted by recycling facilities. However, some wood preservatives may contain hazardous or toxic substances, such as arsenic and chromium. • Depending on quality, some materials may be deemed worthy of removal for sale. • A few landfills accept treated wood as daily cover. • Treated wood that does not contain CCA or creosote may be accepted by WtE facilities.	In most regions, there are very few (if any) markets for treated wood. **Notes:** • It is typically not easy distinguish safer types of treated wood from the older types of treated wood that contain toxic chemicals. • Those recycling facilities that may accept treated wood will usually require it to be tested for toxic substances prior to acceptance. • Wood treated with chrome, copper, arsenic and lead, and CCA-treated or lead-painted wood is not suitable for WtE or for composting. • Regulatory approaches can be used to ensure correct disposal.
3. Asphalt roofing (10 per cent total CRD waste stream)		**Complex to divert**
Roofing shingles and asphalt sheeting are made from fibreglass or organic backing, asphalt cement, sand-like aggregate and mineral fillers. **Sources:** • Large quantities are generated from demolition and renovation. • Frequently, there is significant scrap from new construction.	While recycling of asphalt paving is well accepted, recycling rates for asphalt shingles are much lower because they can be contaminated with other products and some may contain asbestos. Asphalt shingles, remnants and scrap are ground up with 100 per cent of the constituents reused in: • Manufactured shingle additive in paving materials such as HMA, cold patch mix asphalt, aggregate substitute, base course, mineral filler and granular base stabilizer. • Shingles are often used in PEF for industrial burners such as cement kilns (grit removed), as this solution requires less sorting than for HMA. • Granular grit portion of shingles for landfill site pads and roads, pavement and trails project.	Processing facilities for asphalt roofing exist in most major urban centres, but recycling can be challenging in other parts of the country due to lack of infrastructure. Where markets do exist, they may need support to develop sufficient capacity to process the volumes of waste generated. Hauling waste materials long distances may be hard to justify economically. **Notes:** • No materials containing asbestos are allowed in processing facilities. • Metal (nails, flashing, etc.) is usually accepted. • The use of shingles in HMA may be limited due to pavement/engineering standards.

4. Drywall (9% total CRD waste stream)		Complex to divert
Also called gypsum, plasterboard, sheetrock, Gyproc and wallboard. **Sources:** • Clean scrap is generated from renovation and new construction. • Large volumes are generated from demolition.	Drywall is easy to recycle into new drywall products, and most manufacturers have now established systems for reprocessing. 100 per cent of clean drywall waste can be reused in new products. • Gypsum can be used as a soil amendment in the agricultural sector and as an additive at composting facilities. • The backing paper can be made into low-grade paper products • Gypsum and paper together are used to make animal bedding. • Markets for demolition drywall are more selective based on potential for contamination. • Gypsum board may decompose to hydrogen sulphide gas under wet anaerobic conditions, such as in landfill sites. Hydrogen sulphide gas can pose risks to human health and the environment. • The gypsum and paper, not just the gypsum, can be accepted at composting facilities.	Processing facilities for drywall exist in most major urban centres and will usually take scrap from new installation that is free of paint, tape, nails, screws, corner bead, and so on. Markets that do exist may need support to develop sufficient capacity to process the volumes of waste generated. Drywall recycling can be challenging in other parts of the country due to lack of infrastructure. Hauling waste materials long distances may be hard to justify economically. Until about 1990, the tape and joint compound ("mud") used to seal the seams and fill gaps between drywall boards sometimes contained asbestos. **Notes:** • No drywall containing asbestos is allowed in processing facilities. • Drywall attached to other materials (wood, wiring, outlets, etc.) is usually not accepted. • Painted or wallpapered drywall is usually not acceptable. • Some facilities do not accept wet drywall.

5. Concrete (4%total CRD waste stream)		Simple to divert
Poured in place, pre-cast components and “cinder” blocks. **Sources:** • Large volumes are generated from demolition and renovation. • There is very limited waste from new construction.	Fresh (uncured) concrete can be returned to the batch plant. Some plants will use leftover concrete to make blocks and pre-cast modules. Specialist concrete recycling facilities crush cured (dry) concrete (retrieving any reinforcing steel) to make clean fill and aggregate products of various diameters. In some cases, the facilities wash, screen and sort the crushed concrete in order to use it as input material for new concrete blocks that can be used for retaining walls and other new construction applications.	There are few limitations to recycling fresh or cured concrete. Recycling infrastructure exists in urban centres but may need support to grow and develop, especially in smaller markets, to develop sufficient capacity to process the volumes of waste generated. A key consideration is providing sufficient space for crushing and grinding equipment. Some types of crushing and grinding equipment are mobile and can be taken to locations likely to generate large quantities of material to create aggregate on site for use as clean fill. **Notes:** • Concrete containing steel rebar typically should be separated from brick, block and concrete without rebar. • The cost of crushing concrete increases with large rebar components.

<table>
<tr><th colspan="3">6. Plastics (4% total CRD waste stream)</th></tr>
<tr><th colspan="2">a. Rigid insulation</th><th>Complex to divert</th></tr>
<tr><td>Polyurethane (PU), polyisocyanurate (PIR, polyiso or ISO), polystyrene (PS) insulation boards.
Sources:
• Often, there is significant scrap generated from renovation and new construction.</td><td>Markets for foam boards exist but are largely low value:
• Large clean rigid insulation boards of any type can be removed and resold. However, only a few niche markets for salvaged foam boards currently exist.
• There are a few green builders who seek out reused rigid insulation for roofing and so on.
• Demolition firms that have worked with the movie industry report potential for reusing a large volume of hard Styrofoam in set construction.
• Styrofoam can be pressed into dense blocks and up-cycled into new items such as picture frames, crown mouldings and base boards.
• Foam insulation can be used as part of the light or heavy fractions and processed as engineered fuels.</td><td>Recycling facilities and markets are available in a limited number of locations. Reuse centres (where they exist) may accept whole insulation boards. Insulation board is relatively cheap, and reuse may be constrained by limited applicability in building envelope applications, where energy performance is increasingly demanding.
Notes:
• Materials that are mouldy or contain asbestos are not accepted by recyclers.
• Spray foam insulation is difficult to separate from its substrate. It is often not feasible to separate into pieces that are large enough for reuse. Some WtE facilities may take a certain amount of wood/foam mixed materials.
• Some processing facilities will not accept large amounts of adhesive.</td></tr>
<tr><th colspan="2">b. Carpet</th><th>Complex to divert</th></tr>
<tr><td>Most carpet contains one of six pile fibres: nylon, polypropylene (olefin), acrylic, polyester, wool or cotton. Synthetic fibres make up more than 99% of the fibre used by the North American carpet industry.
Sources:
• Large quantities from replacement, demolition and renovation.
• Significant scrap from new installation.
Carpet is the most significant portion, by weight, of the plastics listed.</td><td>Canada has nationwide access to at least one independent carpet recycler.
Several manufacturers (particularly in the commercial office sector) accept their own or other carpet for recycling into new carpet.
• Carpet is taken apart into multiple materials, which are then recycled separately.
• Carpet can also be used in building materials, plastic lumber, cushion stuffing, new carpet pad and auto parts.</td><td>Recycling facilities and markets are available in a limited number of locations. Support may be needed to grow and develop carpet-recycling infrastructure capacity (particularly to include the residential sector and rural locations).
Notes:
• Carpet is usually accepted only if it is dry and mould-free.
• Recycling costs for carpet are typically very high. Recycling is most often economically feasible for manufacturers when coordinated with replacement installation.</td></tr>
</table>

c. Plastics #1–5		Complex to divert
#1. High-density polyethylene (HDPE): piping. #2. Polyethylene terephthalate (PET): bottles and packaging. #3. Polyvinyl chloride (PVC): vinyl doors, windows, piping, flooring. #4. Low-density polyethylene (LDPE): packaging. #5. Polypropylene (PP): piping, furniture. **Sources:** • Small to large quantities are generated from demolition and renovation. • Small to large quantities come from new construction, depending on feasibility of source separation.	Solutions for plastics exist in most regions, but prices for plastic scrap may vary: • All plastics #1–5 can be recycled into new products. • Plastic scrap should be carefully sorted to ensure that different types of plastics are not mixed in order to attract the highest market value. • #2 PET scrap is usually in particular demand because of its ability to be converted into other consumer products. • When sold as mixed scrap, plastics generally have either no value (the plastic end markets will accept them but not pay for them, but this is still a benefit to the CRD recycler), or a small value (around $20/tonne). Alternatively, a tipping fee may have to be paid to deliver the scrap to the end market. • Many plastics (including difficult-to-recycle products such as laminates) can be converted into engineered fuel for EfW.	Markets are in an early stage of development and not available everywhere. They may need support to address the cost differential between landfilling and disassembly, sorting and transportation, as well as ensuring facilities are conveniently located and with sufficient capacity to process the volumes of waste generated. **Notes:** • Most plastics are not recovered from CRD wastes and are disposed as residue. • A major challenge is separation of the different types of plastic and preventing contamination. • Where specific plastics are recovered from CRD waste, they generally do not have a high value, as they are usually not consistent, clean, high-quality streams of one resin.
7. Metals (3% total CRD waste stream)		
a. Ferrous metals		**High value**
Architectural metalwork, sheet metal, and structural and framing steel. **Sources** • Framing scrap comes from new construction and renovation. • Rebar may be extracted from concrete if crushing occurs on site. • Typically, there is very little structural steel waste from new construction or renovation.	Metals are valuable and purchased by recycling facilities and scrap markets to be remade into new products. • Steel is generally worth in the range of $250/tonne,[28] but the value varies depending on general economic conditions, the demand for steel and the available supply. • Because of its value, metal is frequently collected and sold off the job site to recyclers.	Markets for metals are well established across the country.

[28] All market estimates in dollars/tonne sourced from Guy Perry and Associates and Kelleher Environmental (2015).

b. Non-ferrous Metals		High value
Aluminum, copper, brass and alloys from electric, plumbing and HVAC. **Sources** • Often, there is significant scrap in demolition, renovation and new construction.	Metals are valuable and purchased by recycling facilities and scrap markets to be remade into new products. • Highest value if separated by metal at point of generation. • Non-ferrous metals can be mixed and marketed with ferrous metals. • Aluminium and copper are the most valuable metals, with values in the range of $1,500/tonne to $1,800/tonne for aluminium and up to $6,000/tonne for copper, depending on the quantity (larger loads or a reliable supply each month fetch a better price) and processor location.	See ferrous metals.
8. Cardboard (1% total CRD waste stream)		**Simple to divert**
Packaging. **Sources:** • None generated from demolition. • Small to large quantities from renovation and new construction.	Cardboard can be sold to the paper industry for fibre recycling. Other markets exist for: • Feedstock for roofing materials • Cardboard shred for compost amendments. It is a valuable commodity if clean and volumes are large enough; revenues of $150/tonne to $250/tonne are possible depending on location, demand, etc.	Markets for cardboard are well established across the country. **Notes:** • Cardboard can easily become contaminated, making it difficult to sell. It is frequently not generated in sufficient quantities to be of interest to recyclers.

<table>
<tr><td colspan="3">9. Other (29% total CRD waste stream)</td></tr>
<tr><td colspan="2">a. Rock, gravel and aggregates</td><td>Simple to divert</td></tr>
<tr><td>Rock, gravel and crushed ceramics (e.g., plumbing fixtures such as sinks, toilets).
Sources
• Waste materials are generated from demolition and renovation only.
• Usually, there is no waste material from new construction.</td><td>These products are relatively easy to process. Rock, gravel and crushed ceramics (plumbing fixtures, tiles, etc.) can be crushed and used as clean fill similar to concrete or decorative chip.
• There are sometimes challenges with grading and quality control sufficient for the end product to be reused in situations such as road base.</td><td>Some jurisdictions include reclaimed concrete from civil infrastructure within the scope of CRD materials and hence report much higher volumes and greater recycling rates.
Markets for aggregates are well established across the country. In some regions, support may be needed to address the cost differential between landfilling and crushing, grading and transportation, as well as ensuring facilities are conveniently located.
Notes:
• Plumbing fixtures are usually only accepted by recyclers after removal of seats and plastic/metal fixtures.</td></tr>
<tr><td colspan="2">b. Asphalt paving</td><td>Simple to divert</td></tr>
<tr><td>Asphalt paving, waterproofing, etc.
Sources
• Almost exclusively from parking areas.
• Limited waste from new construction.</td><td>It is routine in urban areas for many road builders and paving companies to remove and recycle old road materials into new pavement. This is less so in rural areas.
• Typically asphalt recycled separately from other materials.
• Asphalt paving can also be used for HMA, cold patch mix asphalt, base course, mineral filler and granular base stabilizer.</td><td>Some jurisdictions include reclaimed asphalt from civil infrastructure within the scope of CRD materials and hence report much higher volumes and greater recycling rates.
Markets and processing facilities are well established across the country.</td></tr>
</table>

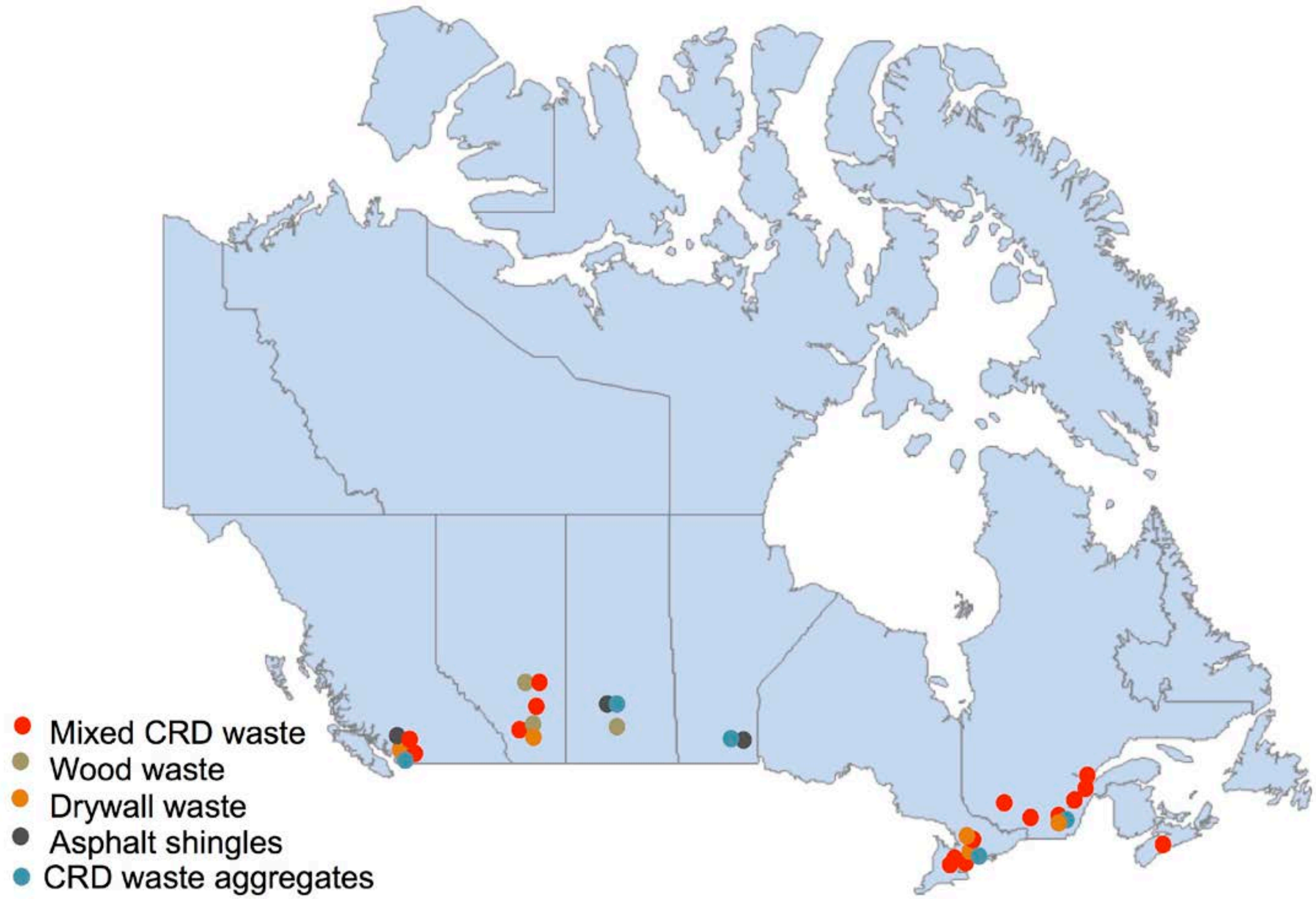
c. Bricks		Simple to divert
Bricks and clay-based masonry, including terracotta and roof tiles. **Sources:** • Largely from demolition and renovation. • Limited waste from new construction.	Most clay-based masonry can be crushed and used as fill like concrete, but there are high-value reuse markets for some brick in most regions. • Clay-based masonry units can also be crushed and used as clean fill similar to concrete. They are often placed in mixed aggregate markets, with concrete and block. • Used in aggregate production. • Good-quality reclaimed bricks and terracotta tiles have value in the market place and may be sold directly from the demolition site. • There are costs associated with taking down and cleaning the mortar from used bricks. It can be a time-consuming manual process.	Markets for reclaimed and crushed bricks are well established across the country. However, support may be needed to address the cost differential between landfilling and disassembly, cleaning and transportation.
d. Ceiling tiles		**Complex to divert**
Metal, plastic or cement fibre modular tiles with metal suspension system. **Sources:** • Largely from demolition and renovation. • Generally limited waste from new construction.	Manufacturers will generally accept and recycle most ceiling tiles, when consolidated to truckload volumes. • Most manufacturers will take tiles for testing prior to recycling. Some will even pick up tiles so long as the shipment meets certain criteria.[29]	Ceiling tile recycling is heavily dependent on programs operated by manufacturers. **Notes:** • Materials that are mouldy or contain asbestos are not allowed. • Materials that are contaminated are usually not accepted (e.g., with vinyl, fabric, foil facing, cardboard-like face or visible wood pulp).

[29] Information provided by Armstrong Ceiling Solutions 2016.

e. Equipment and “white goods”		Simple to divert
Fridges, washing machines, ovens, air conditioners and elevators. **Sources** • Demolition and renovation only. • Usually none from new construction.	In most cases, old equipment is inefficient or no longer functional and should be broken down with the components recycled. • Scrap markets may accept equipment with high metal content. • Good-quality or nearly new items may be taken back by the supplier or resold. • Some utilities offer a free pick-up and take-back program for inefficient appliances such as fridges.	Building reuse centres and scrap metal markets exist in most regions. However, market acceptance is highly dependent on the age and condition of the used equipment and “white goods.” **Notes:** • Some appliances should be disposed of carefully because they contain hazardous constituents (e.g., lead, cadmium, mercury) or ozone depleting refrigerants.
f. Mixed glass		**Complex to divert**
Curtainwall, windows, mirrors and picture frames. **Sources** • Significant window glass comes from demolition. • Some mixed glass scrap is generated from renovation and new construction.	Uses for recycled glass are primarily related to ground glass cullet, which can be used in similar applications as other aggregates (road based, drainage backfill, etc.). Other uses include: • Some glass can be melted and remanufactured into fibreglass. • Incorporating ground glass into a glass and asphalt blend, or stirring it into the reflective yellow and white paint used on roads. • Broken glass can be combined with concrete to create terrazzo flooring and countertops or tumbled into smooth “pebbles” for landscape, floral and decorative applications. • Old windows can be reused, although they are unlikely to be energy efficient.	There are significant limitations on the recycling potential for window glass due to lack of available infrastructure and because of the different types and treatments of glass (e.g., tinting, tempering, coatings), which cannot be combined to create a new product. Window glass has a different chemical composition and melting temperature than the container glass that is accepted for curbside recycling, meaning the two products cannot be recycled together. Disassembling window glass from metal or wooden frames is labour intensive. Because of the poor benefits of recycling (because of distance from markets) and the high cost to recycle (because of processing costs and distance to market), glass could be considered equivalent to brick, rubble, concrete, ceramic, and so on and treated as such from a regulatory standpoint.

g. **Fibreglass**		**Complex to divert**
Batt insulation, window frames and doors. **Sources:** • The majority of fibreglass comes from demolition. • Some fibreglass scrap (mostly from batt insulation) is generated from renovation and new construction.	Fibreglass additionally contains polyester and can be used as a PEF in cement kilns (e.g., asphalt shingle backing). • Commercial uses for surplus fibreglass in Europe include as a substitute constituent for cement, but this is not available in Canada.	A few markets exist in Canada for fibreglass as PEF. **Notes:** • Technology to recycle fibreglass is available but in an early stage of development. It is not focussed on construction products (more on the auto sector). • Insulation from demolition is often mouldy or unfit for recycling.
h. **Paint**		**Complex to divert**
Water-based (latex, emulsions, etc.), oil-based in containers and in spray form. **Sources:** • Generally, there is limited waste from renovation and new construction.	Paint recyclers are present in most provinces and territories, although they may set limits on how much paint they will accept at once. Programs may include: • Paint, varnish and stain (wet and dry) • All paint sold in aerosol containers • Empty paint containers. Latex paint can be recycled into new paint. Oil and spray paints must be disposed of separately and mostly end up as a fuel blend. The metal or plastic containers can be recycled. The highest-value solution is recycling fresh paint into new paint. However, this involves getting paint back to the recycler as quickly as possible.	Recycling facilities and markets are available in many locations as a result of regional EPR programs. Some regions (such as Alberta) are striving to ensure that all areas of their jurisdiction have equitable access to the program (Alberta Recycling Management Authority n.d.-a.). However, diversion rates on construction sites may be low. It is challenging for waste generators to justify a special trip to a recycler. Given their small size, paint cans easily find their way into regular household waste. To recoup the costs of dealing with paint containers correctly, some jurisdictions apply surcharges on paint to the paint industry on product they supply to the region.

Appendix C: Key Construction, Renovation and Demolition Waste Processing Facilities in Canada



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Source: Guy Perry and Associates and Kelleher Environmental (2015).

Appendix D: Emerging Methods for Tracking and Reporting Construction, Renovation and Demolition Waste Management

CRD waste minimization is an important parameter when describing the overall environmental performance of a building project. The construction industry is becoming familiar with tracking and reporting the performance of projects for green building rating systems (such as LEED) as well as regulatory compliance. In fact, some amount of recycling is already ingrained in the industry. Demolition contractors in particular have been segregating wastes for many years, either to capture revenue (e.g., wiring, structural steel) or to reduce disposal costs (e.g., concrete, brick).

To help contractors demonstrate compliance with waste diversion targets, many governments across North America (including over 500 in the US) have adopted online tracking software systems that are designed to help contractors first plan, then track and report CRD waste generated and what happens to it once it leaves the project site. CRD waste that is reused on site can also be tracked. The systems impose consistency in terms of the documentation required (such as photos and weigh bills issued by the receiving facility).

A typical CRD waste management report can be submitted to the local government, summarizing all the CRD materials, how much is generated, and how much is diverted from landfill measured either by volume (cubic metres or cubic yards) or weight (tonnes). The system allows administrators to:

- track industry performance against CRD waste management goals and show quantitative improvement over time
- receive alerts related to the functioning of the CRD waste management system, such as potential overburdening of processing facilities
- encourage contractors to submit data voluntarily (as part of green building rating system checklist submissions) so governments can benchmark local industry capacity before establishing a waste diversion policy and targets.

For the data to be useful on a Canada-wide basis, the definitions of materials, what is to be tracked and the metrics should all be consistent. Currently, there is still no standard definition in Canada for what constitutes CRD waste when it comes to tracking and reporting. For example, some jurisdictions count the waste that is generated then reused on site, while others do not.

Waste diversion goals and the requirements for data gathering are increasingly common in the US. To make the introduction of the CRD waste management policy go as smoothly as possible, many jurisdictions have adopted web-based software tools that are designed to easily and cost-effectively facilitate the real-time tracking of CRD waste for municipalities. Specifically, these tools can:

- allow for the easy evaluation of waste management performance and compliance with bylaw requirements
- track submission of documentation
- make it easier for permit applicants, recyclers and other entities to comply with regional and municipal recycling regulations

- enable governments to review, analyze and monitor waste diversion activities in their communities on a real-time basis
- apply to all types of demolition projects and preferably all construction project types
- apply to municipalities of all sizes and sufficiently flexible to work within a range of regulatory environments
- allow permit applicants to manage many projects in many different municipalities.

There are over 500 jurisdictions in North America, most notably in California and Wisconsin, where web-based tracking software has been adopted. In some locations, these tools have been in use for more than five years. In the UK, CRD waste tracking software was used to manage and report on waste diversion during the construction of the 2012 London Olympic Games venues (Carris and Epstein 2011).

Appendix E: Case Studies of Construction, Renovation and Demolition Waste Management Policies Working Together

The jurisdictions that have had the most success with reducing and diverting CRD waste have implemented a combination of complementary foundational, primary and secondary policies. These case studies provide a sample of some of these approaches.

Case Study 1: State of Massachusetts

Relevant policy tools deployed:

- EPR
- CRD waste management plans and targets for projects
- CRD waste disposal bans (all materials)
- transportation requirements and restrictions
- differential tipping fees
- building codes and requirements
- green building certification
- environmental product standards and labelling
- deconstruction standards
- support infrastructure and market development
- public procurement
- industry outreach, education and resources
- benchmarking and tracking CRD waste data.

The State of Massachusetts has focussed on reducing CRD waste for over 10 years. In that time, it has developed a holistic suite of policies that work to mutually reinforce each other and the overall CRD waste diversion goals.

The Massachusetts Solid Waste Master Plan established a state-wide goal of 88 per cent reduction in CRD waste by 2010 (Massachusetts Department of Energy and Environmental Affairs 2000). As of 2012, the state had achieved a CRD diversion rate of 73 per cent (Massachusetts Department of Energy and Environmental Affairs 2015).

To achieve this goal, the state banned a wide range of CRD waste materials from disposal, incineration or transfer for disposal at a solid waste facility. Materials included asphalt pavement, brick, clean drywall, white goods, concrete, and ferrous and non-ferrous metal. Additionally, treated and untreated wood was banned from disposal or transfer for disposal at landfills. The state also operates EPR regulations for packaging and paint.

The waste ban regulation imposes requirements on facilities operators, stating that “no landfill, transfer facility or combustion facility shall accept the restricted material except to handle, recycle or compost the material” in accordance with a detailed waste ban plan that they should submit to the governing body (Massachusetts Department of Energy and Environmental Affairs 2000). The plan should demonstrate in detail:

- how the facility operator will not dispose, or transfer for disposal, banned materials
- how the facility will, to the greatest extent possible, separate out from waste loads banned materials for subsequent reuse or recycling.

Once approved, a waste ban plan becomes a part of the facility’s permit, and the facility should implement it.

For building owners and contractors, the state has developed a wide range of resources, including sample specifications for construction and demolition recycling. These specifications can be included in requests for proposals and contract language to ensure that recycling will be part of the project. They allow the specification writer to identify what materials are to be recycled, and include planning, reporting and recordkeeping requirements. The specifications are:

- "A comprehensive and detailed specification that lays out very specific procedures for preparation of the Waste Management Plan, material tracking, recordkeeping, and reporting" (Lennon 2005).
- "A simpler specification that includes requirements for recycling, recordkeeping, and reporting, but is less prescriptive in providing detailed instructions and requirements on the contractor" (Lennon 2005).
- A "fixed asset recovery" specification stipulates the reuse or recycling of fixed assets (doors and windows, millwork, flooring, sinks and toilets, bathroom partitions, etc.) before demolition contractors begin wrecking a structure and render usable goods worthless. In almost all instances, recovering fixed assets is a good financial move, even as it provides social and environmental benefits.

Case Study 2: Dutch Chain-Oriented Waste Policy

Relevant policy tools deployed:

- EPR
- CRD waste management plans and targets for projects
- CRD waste disposal bans (all materials)
- transportation requirements and restrictions
- differential tipping fees
- building codes and requirements
- green building certification
- environmental product standards and labelling
- deconstruction standards
- support infrastructure and market development
- industry outreach, education and resources
- benchmarking and tracking CRD waste data.

The Netherlands has a strong history of waste management and has developed an effective, integrated policy-driven life-cycle approach that is predicated upon a landfill ban on CRD waste. Annually, the Netherlands generates about 60 million tonnes of waste, of which 40 per cent (25 million tonnes) is CRD waste (Dutch Waste Management Association 2013).

CRD waste is such a large proportion of the total waste stream compared to Canada (which is about 16 per cent) because the Netherlands sends a great deal of municipal solid waste to WtE facilities and does not count it as disposed.

By 2012, recycling and recovery rates for CRD waste had reached 95 per cent (Dutch Ministry of Housing 2004), which in part has been attributed to the "command and control" approach adopted by the government in 2001, following the centralization of waste management (OECD 2012). At about $162/tonne, the Dutch also impose some of the highest landfill taxes and levies in the world (Bio Intelligence Service 2012). Landfill taxes, which are levied on solid waste by volume, weight or material type, have also been useful tools in stimulating waste diversion strategies.

Now, Dutch policy-makers are looking beyond what they believe to be isolated policy instruments (e.g., landfill fees, landfill bans) because, despite the Dutch system imposing some of the highest taxes and levies on waste, on their own these policies are no longer sufficiently effective to further reduce environmental pressure on a larger scale. The Netherlands' national waste management plan for 2009–2021, *Towards a Material Chain Society*,[30] describes the government's ambitions to minimize environmental pressures over the whole supply chain and to harmonize policy in different areas (e.g., natural resources, products/design, waste management, and concepts such as Cradle to Cradle) by means of a chain-oriented waste policy. Fundamentally, a chain approach considers the entire material chain, including all the stages in the life cycle of a product or material from raw material mining, production and use, to waste and possible recycling, as opposed to concentrating on "end-of-pipe" solutions.

The chain approach identifies the stages in the material chain where the greatest environmental benefit can be obtained efficiently and the necessary actions for realizing this benefit. The overarching aim is to reduce the environmental impact of material chains throughout the life cycle in the most cost-effective manner and establish a single integrated policy framework for the whole material chain. It is most important that the environmental benefit in one stage does not cause a higher environmental impact for another stage or another chain. The Dutch are actively moving towards creating a circular economy for all waste materials. (OECD 2012).

As well as setting out various targets relating to waste prevention, recovery and diversion from landfill, the plan sets out an indicative objective to reduce by 20 per cent the environmental impact for each of the seven priority streams, which will be targeted in the context of chain-oriented waste policy. The seven priority streams, of which CRD waste is one, were selected from the list of all 110 waste streams for which the Netherlands has a waste policy, on the basis of an LCA over the whole chain.

A critical element to this approach is the establishment of partnerships between stakeholders from different links in the chain, facilitated by government. Each material stream will submit an action plan detailing measures by which to reduce the environmental impact of the material chain by 20 per cent. The 20 per cent reduction in environmental pressure will be calculated in terms of end-of-life waste tonnages, volume of CO_2 emissions, pollution and land use. The ultimate aim is to establish more concrete and measurable goals, relating to specific impacts such as percentages of separate collection and waste prevention. The elements of the Dutch waste policy are:

- **Commitment to the 5Rs waste management hierarchy**: reduction and prevention, reuse, material recycling, energy-recovery, incineration and land filling.
- **Stringent standards** for CRD disposal and recycling: decrees on landfill and incineration, standards for building materials, organic fertilizers (such as soil amenders, compost, etc.),

[30] See European Environment Agency (2013) for an English summary. For the Dutch Waste Management Plan, see Dutch Ministry of Infrastructure and the Environment (2009).

and ban on landfill. Commingled wastes are separated at government-certified material-sorting plants, and landfills accept waste only from certified operators, who sort and certify loads.

- **Economic instruments** to reduce waste volumes and to steer the waste to the preferred treatment, which include a municipal waste tax paid by citizens and one of the highest landfill taxes in the EU.
- **National planning,** starting with concessions for collection and treatment, a pro-market approach and integral national waste planning.
- **Co-operation among orders of government** (municipal, regional and federal).
- **Education and communication** to create awareness and enhance participation with separate collection schemes. The CRD focus is on source separation of recyclables with the provision of collection bins on the construction site.
- **EPR programs** that are paid for by consumers, producers or importers (such as recycling fees) for car tires, batteries, paper and cardboard, and packaging (more materials to be added soon).
- **Notification and registration of waste transports:** from separate to one integral system of registration and notification of waste transports.
- **Control and enforcement, which includes a total landfill ban on CRD waste and closed borders to the transportation of waste out of the country**. CRD waste is highly mobile, so controls are in place to prevent haulers from shipping waste from locations with high disposal costs and stringent regulations to neighbouring locations that may be more lax.

The Netherlands' 12 provinces regulate disposal of CRD waste. They gather information about waste streams and monitor disposal and processing by requiring quarterly reports from waste collection and processing companies. Used building material reuse and recycling is estimated to be as high as 90 per cent. Asphalt, concrete and mixed granulates are used in road building. Almost all fly ash produced in the country is currently used in concrete (Kane Consulting *et al.* 2012). There are limits to the amount of materials that can be left on site and mixed with soil after demolition, and also regulations stipulating what materials can be reused (e.g., recycled aggregate in place of gravel in concrete). These measures have been effective at encouraging industry's acceptance of CRD waste diversion.

The new 20 per cent reduction target provides a goal to which industry can work towards and is intended to drive innovation throughout the chain, targeting flows that can be dealt with most cost-effectively. However, it is not a binding target, and there are no penalties tied to non-compliance. Instead, operational targets for specific projects are formulated through co-operation among stakeholders and are made binding by various forms of agreement. Therefore, the success of this policy relies on the presence of viable markets for the recycled materials. Significant research into waste minimization solutions and alternative uses for materials destined for disposal is under way. Dutch buildings are starting to be designed with waste management strategies in mind, such as dematerialization (using less material in the building project) and disassembly. For example, Park 20|20 is a world-class circular economy example and disruptive business model office park outside Amsterdam that espouses circular economy principles (Park 20|20 n.d.).

A case study of a building project that was built following the Dutch CRD waste management policy and designed "with the end in mind" is the Brummen Town Hall, which was designed to have a service life of 20 years, due to concerns over frequently shifting municipality borders. Rather than being constructed with cheap materials, which would likely end up in landfill, the building incorporates a variety of high-quality reusable materials, mostly prefabricated timber components, that will be dismantled and returned to their manufacturers at the end of the building's life (Ellen MacArthur Foundation n.d.).

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