New Directions Group

The Application of Life Cycle Assessment to the Development of Environmental Policy

Summary of the Debate of the Life Cycle Assessment Project Team

March 2007

The New Directions Group

The New Directions Group (NDG) provides an informal and neutral forum for leaders from progressive Canadian businesses and NGOs to debate potentially divisive sustainability issues. In addition to advancing policy, the purpose of the NDG is to enhance capacity building, mutual learning and collaboration on significant sustainability issues.

The NDG is a virtual entity that operates with a core group of sponsors and supporters, including Suncor Energy, Alcan, Falconbridge, Dow Chemical Canada, Pollution Probe, and the Pembina Institute for Appropriate Development. The NDG is administered through Pollution Probe. While these organizations provide the NDG's foundation, specific project teams comprise individuals from the business and NGO communities who are recognized as thought leaders on the issue to be addressed. In recent years, NDG initiatives have benefited from the input of leaders from the agricultural, chemicals, energy, forestry and mining sectors, to name a few, as well as from conservation, environmental, health and academic NGOs.

Over the years, NDG initiatives have had a direct impact on environmental policy in Canada. For example

- its inaugural report, *Reducing and Eliminating Toxic Substance Emissions: An Action Plan for Canada,* became the basis for the Accelerated Reduction/Elimination of Toxics (ARET) partnership administered by Environment Canada;
- the report, *Criteria and Principles for the Use of Voluntary or Non-regulatory Initiatives to Achieve Environmental Policy Objectives,* provided the foundation for Environment Canada's Environmental Performance Agreement Policy Framework and for the Cooperative Agreements of the Ontario Ministry of Environment and influenced the design of numerous voluntary programs in Canada and internationally;
- another report, *Developing Credible and Effective Covenants for the Management of Greenhouse Gas Emissions,* had a clear influence on the Draft Model Covenant proposed by the Large Final Emitters group of Natural Resources Canada; and
- the NDG's latest report, *Applying Precaution in Environmental Decision-Making in Canada,* was highlighted by the External Advisory Committee on Smart Regulations in its report to the Prime Minister.

In addition to dedicated projects, the NDG conducts a variety of experts' workshops and networking initiatives. NDG projects are well received because the resulting reports reflect the current thinking, if not a consensus, of leaders of Canada's business and NGO communities on topical sustainability issues. This provides valuable guidance to other businesses and NGOs, but more specifically to governments, in understanding the range of views on the issues and formulating effective policy and strategic responses.

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Preface

The New Directions Group Life Cycle Assessment (LCA) project began with an experts' workshop held in April 2005 to review a background paper prepared by the Pembina Institute (see Appendix I). The LCA Project Team (LCAPT) was established in the fall of 2005 and met four times over the following year. The first meeting was largely conceptual and shaped the agenda of the next three meetings. The second meeting examined the context within which LCA should be undertaken and the third focused on applying LCA in a public policy setting. The fourth meeting considered the application of information derived from LCA in policy or decision-making using biofuels as a case study.

This report is a summary of the debate of the LCAPT. While there is general agreement among LCAPT members with respect to the content of the report, this does not imply consensus, except where noted.

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1. The New Directions Group and Life Cycle Assessment

Since 1990, the New Directions Group (NDG) has been convening leaders of the business and NGO communities to debate sustainability issues that may be either of common interest or potentially divisive. The aim, in both cases, is to develop greater understanding and certainty in order to avoid future conflicts. While conflicts may arise due to a clash of values, many are caused simply by confusion in applying or defining terms and concepts. That is, businesses, NGOs and government may be using similar words or concepts to mean very different things.

Participants on the NDG Life Cycle Assessment Project Team (LCAPT) believe that continued uncertainty over the definition of "life cycle assessment" (LCA) and the application of this concept in public policy could lead to unnecessary confusion and conflict in the future.

The purpose of this project was thus to identify some commonality of purpose among the business and NGO communities regarding LCA and public policy, which the LCAPT believes to be of strategic importance in ensuring the appropriate, consistent and credible application of this tool, described in more detail in Section 2.

2. Life Cycle Assessment

The term "life cycle assessment" is often used loosely to refer to a spectrum of tools and terms ranging from a life cycle approach to thinking about systems to Life Cycle Assessment studies as prescribed by the ISO 14040 series of standards. The NDG LCAPT uses the term Life Cycle Assessment (LCA) to refer exclusively to the latter. The focus of the project, and thus this report, is on how LCA can best be applied to the development of environmental policy.

According to the ISO 14040 Standard on Life Cycle Assessment, "LCA is a technique for assessing the environmental aspects and potential impacts associated with a product by:

- compiling an inventory of relevant inputs and outputs of a product system;
- evaluating the potential environmental impacts associated with those inputs and outputs; and
- interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives of the study."

LCA studies the environmental aspects and potential impacts associated with a product throughout its entire life (i.e., cradle to grave), from raw material acquisition through production, use and disposal. The general categories of environmental impacts considered include resource use, human health, and ecological consequences.

LCA can be helpful in:

- identifying opportunities to improve the environmental aspects of products at various points in their life cycle;
- making decisions in industry and governments or non-governmental organizations (e.g. strategic planning, priority setting, product or process design or redesign);
- selecting relevant indicators of environmental performance, including measurement techniques;
- marketing (e.g., underpinning an environmental claim, eco-labelling scheme or environmental product declaration); and
- developing and implementing green procurement policies.

Since the development of the ISO standard in 1997, LCA has become broadly accepted as a decision-making tool. Indications of this include:

- the continued development and use of the ISO standards and technical reports;
- ongoing methodological work pertaining to LCA being conducted by academics, research institutes, practitioners and international organizations such as the UNEP/SETAC Life Cycle Initiative;
- reference to LCA in many recent public policy documents at the federal and provincial level;
- increasing application of LCA by government, the research community, companies and industry associations;
- increasing accessibility due to the availability of open data bases and qualified consultants; and
- the adoption of LCA into the curricula of seven Canadian universities.

In the private sector, the role of LCA in decision-making and product development is relatively well understood, particularly among some large multinational firms. This is not the case, however, with either small- and medium-sized enterprises or various levels of government, where there remains a widespread lack of understanding of both LCA and its potential applications. This is especially true at community and regional levels of government where the resources to undertake necessary LCAs may also be lacking. Further, higher-level government commitments to a life cycle approach to decision-making exceed the current capacity to implement such an

approach. For example, the Gouvernement du Québec's recent Bill 118 (2005) mandates that life cycle thinking be a part of both project development and defining sustainability for *all* government programs. Federally, acknowledgement of the importance of the life cycle approach goes back more than a decade to *Pollution Prevention — A Federal Strategy for Action* (1995) and the *Toxic Substances Management Policy* (1995). Despite the history, this thinking has yet to permeate the federal government.

Governments have yet to fully develop either the internal processes or capacity to incorporate the full range of options, from life cycle thinking to formal LCAs, into public policy decision making. Life cycle thinking and LCA are typically used only sporadically, inappropriately or incompletely, and rarely to their full potential. Few processes are in place to educate government policy makers on how and when to implement a life cycle approach or perform an LCA; further, the mechanisms for enshrining accountability for applying a life cycle approach or LCA do not exist. This not only compromises the development of environmental policy but also hinders government's own pursuit of sustainability. Policies at all levels that could benefit from the information provided by LCA are instead often developed and implemented with predetermined outcomes or little structured analysis of their long-term implications, the inherent trade-offs among choices, or an assessment of their potential unintended or hidden consequences.

One example of the benefits of a life cycle approach to environmental policy comes from the development of Canada-wide standards on mercury containing products. In this case, the life cycle approach supported a system perspective on the issue: the major life cycle stages, inputs and emissions for key categories of mercury-containing products were clarified. Key intervention points in the life cycle of these products were then documented, thus revealing the places where government could most effectively apply policy tools and instruments.

Given the current gap in the application of LCA to policy development, the NDG LCAPT set itself the specific task of providing clarity and guidance in the application of LCA to environmental policy. While the initial experts' workshop generated a number of issues as topics for discussion, the LCAPT narrowed the focus of its work to the following:

- clarifying LCA as a concept;
- making a case for the value of applying LCA in shaping environmental policy or regulation; and
- developing a process for determining where and how to apply LCA.

3. The Life Cycle Assessment Hierarchy

A key challenge in employing LCA in policy development is that the term "LCA" is often used loosely. This has led to unrealistic expectations of what LCA can accomplish, how it is applied, and the demands it imposes in terms of data collection and analysis. As indicated in Section 2, the NDG LCAPT uses the term LCA to refer to the tool proscribed by the ISO 14040 series of standards; however, LCA is only one in an overlapping series of tools that differing parties may refer to as "LCA". This series ranges from an initial "systems thinking" concept to increasing degrees of analytical detail and quantification. While any of these tools may be used in the development of environmental policy, specific circumstances will dictate which tool is most appropriate in a given situation. The NDG LCAPT has created an "LCA Hierarchy" (Table 1) which can help decision makers determine the scope and rigour of analysis required on a particular issue. A central principle of the LCA Hierarchy is that the degree of effort expended in the analysis and the tool selected have to be appropriate to the task at hand and the questions to be addressed.

Policy makers faced with a particular problem or issue can use the LCA Hierarchy to determine how best to proceed. A basic approach of systems thinking or life cycle thinking is appropriate at the initial stages in addressing almost any issue. As discussed in more detail in Section 5, decision makers should always approach an issue with Life Cycle Thinking. As a result of having done so, they will be able to determine whether it is necessary to move to the next step in the LCA hierarchy. It wll also help them to identify the level of detail, level of certainty and degree of quantification required for the issue of concern, which is directly related to the time, effort and costs involved in assessing the issue. Finally, it will lead to a clear and justifiable decision as to whether a streamlined LCA, full LCA, or LCA applied in concert with other tools is the most appropriate approach to securing the information needs for the policy development situation.

Table 1:The LCA Hierarchy

Approach	Benefits	Considerations
Life Cycle Thinking — A way of approaching issues that considers impacts and flows at every stage in the life cycle of a product or process (from raw material to disposal) but with little technical analysis. Life Cycle Thinking is an excellent first step and may be sufficient for issues that are determined to have little environmental impact. Employing this approach could, however, also illustrate that further analysis is needed.	• serves as a quick and inexpensive starting point for discussing and conceptualizing of 'upstream' and 'downstream' impacts (e.g., uses of energy and materials and release of wastes) that is quick and inexpensive • helps to instill a behaviour of employing system-wide analyses for all decisions and broadens the questions to be asked beyond single issues • broadly identifies trade-offs and allows them to be considered • helps identify relevant stakeholders	• offers little rigour as it is not a quantitative analysis

Table 1: The LCA Hierarchy *continued*

Approach	Benefits	Considerations
Streamlined LCA — An abbreviated LCA in which certain components may be truncated or eliminated from the analysis due to known impacts or lack of concern, or in which generic data may be employed at certain stages. Streamlined LCAs can be useful when numerous activities are subject to life cycle considerations (e.g., in the implementation of Québec's Bill 118). In conducting a Streamlined LCA it may become evident that a more detailed approach is necessary.	• offers a more focused assessment than Life Cycle Thinking, targeting specific impact areas of concern • allows life-cycle implications to be considered in a more formal manner. In some cases the results may be sufficiently clear to avoid a full LCA • can be based on readily available information • compared to Life Cycle Thinking, gives a fuller picture of major issues and trade-offs	• it is difficult to ensure the quality and relevance of generic data • costs money to obtain specific data • lack of rigour of analysis compared to a full LCA • requires a methodology for making decisions on what is to be included and excluded in the analysis
LCA as Principal Decision Support Tool — An application of LCA as proscribed through the ISO14040 series of standards with the resulting information being a major input into decision making.	• provides a comprehensive evaluation ensuring a complete picture and a full understanding of life cycle impacts and trade-offs within the boundaries of the analysis • can be adapted and modified to incorporate new information into the analysis, whether arising externally or through the LCA itself • has the ability to look back and forth from flows to boundaries to determine where significant gaps exist, thus allowing an iterative approach and the use of sensitivity analyses	• needs a clear set of questions to establish the boundaries of the analysis • may be difficult to integrate non-environmental issues (such as occupational health and safety) • requires a process for incorporating values into the analysis and/or subsequent decision • only offers a snapshot in time, making it difficult to address frequent changes in suppliers and in the suppliers' suppliers • can be difficult to apply to some issues (e.g., renewable resources, new technologies and product systems) that do not have readily available data) • may be very costly
LCA Applied in Concert with Other Tools — An application of LCA in conjunction with other tools (e.g., environmental assessment) to secure a broad range of inputs into decision making on complex issues.	• the complementary use of LCA and other tools broadens the boundaries of the analysis and can enable a more comprehensive understanding of the LCA data	• necessitates a relative weighting of the output of the LCA in the overall decision-making process

4. Life Cycle Assessment and Environmental Policy

The NDG LCAPT focused its discussions on the interface between LCA and environmental policy, aiming to identify the conditions that would enable LCA to be applied more widely and effectively in this area. This section outlines the benefits of LCA to the development of environmental policy. Section 5 examines these benefits in more detail, using biofuels as a case study. Section 6, looks more specifically at providing the framework and setting for initiating and conducting a successful LCA, while Section 7 addresses some of the challenges involved in implementing LCA in a public policy setting.

LCA is relevant to environmental policy in a number of ways. Government can apply LCA to its own internal operational decisions, incorporate LCA into the development of policies, or mandate when those subject to policy and regulations should apply LCA. The LCAPT investigated where, if done well, LCA could positively inform policy. It also aimed to illustrate where LCA would not be an appropriate tool to use. Consideration was also given to the steps government could take to further integrate LCA into environmental policy (e.g., invest in research, support data bases, set standards, train staff).

The LCAPT believes that, within government, LCA needs to be better integrated into all decision-making processes as it provides sound information to support good decisions and enhances transparency. The following inherent aspects of LCA practice should be recognized.

1. LCA's system-wide view clearly illuminates trade-offs and potentially unforeseen or hidden issues when analyzing the flows of resources from cradle to grave. LCA is a policy tool (not an instrument of policy) that provides a strategic map of a system that can help decision makers identify where to apply
   - other complementary tools to gain needed information (see below), and
   - policy instruments in order to secure the greatest leverage and control with the fewest trade-offs.

   For example, the use of sensitivity analysis within an LCA can suggest where financial resources might best be invested in the short term as well as the long term, particularly with respect to research and development.

2. On complex issues, LCA can be combined with other tools, such as a financial assessment, an implementation assessment, a risk assessment, or "intangibles" (political issues, etc.) to provide a comprehensive framework for decision making. For financial assessments that take a life-cycle approach, such as net present value and life-cycle costing, LCA should be considered a 'sister' tool to be used in conjunction with these to generate a more complete picture.

3. LCA is helpful when comparing different materials, products, and services or policy options. As it is based upon using a "functional unit", it allows an "apples to apples" comparison to be made. The functional unit ensures that calculations are cast for an equivalent comparison based upon the task, service, or function provided (e.g., the transport of a person for 100 kilometres, the cleaning of a standardized load of laundry, the painting of a specific wall area). LCA also takes into account that many operations have more than one product, such as a mine which produces lead as a by-product of copper, refineries that produce a multitude of product streams, and so on. LCA allocates energy, resources, wastes and recycling scenarios to various products to allow for fair comparisons.

Many of these features are unique to LCA, and contribute to its strength as a tool for decision makers. The specific benefits of employing LCA in the development of environmental policy are outlined in Box 1. Above all, LCA is a tool to gather additional information when developing environmental policy. It is important to recognize, though, that LCA is neither a panacea for all issues nor is it the only factor on which a decision should be based. LCA provides a broader range of information than would be available without its application and widens the perspective upon which a decision can be made. Thus, LCA is best viewed as a tool to support rather than make a decision. Broadly, LCA can serve policy development by requiring proponents to formulate a clear question as to the benefit to society that is being sought, and clearly defining early in the process what function or service is to be analyzed. Defining boundaries and the scope of the analysis helps to determine what information must be included in the analysis and subsequent decision and what can be ignored. The process must always remain transparent, however, and the information that is to be included and excluded must be recorded and justified.

In applying LCA, governments need to differentiate between areas in which they have control and areas in which they have influence. LCA is relevant to many governmental responsibilities, but LCA may have the greatest application where governments have significant control, such as infrastructure development, technology and fiscal instruments. Government application of LCA to influence others through information dissemination and education (e.g., consumer information programs, green procurement) is also important. LCA can be a useful tool in a number of these areas, as summarized in Table 2. It is important to note that in the first two policy areas LCA can inform government policy: in the remaining four areas government has a range of specific policy tools available whose application can be influenced by the information provided by the LCA.

Box 1: Benefits of Applying LCA in a Public Policy Setting

LCA conveys a number of benefits to the development of environmental policy. These include the following:

- testing the desired goal to determine if it is achievable or reasonable, or informing the goal-setting process (including assessing the impacts on other goals);
- assessing multiple options and scenarios fairly, consistently and transparently in the analysis;
- raising awareness of associated environmental issues, such as greenhouse gas emissions;
- ensuring that any comparison is equivalent by carefully evaluating and defining the functional unit;
- quantifying and validating the environmental and resource benefits and impacts/consequences;
- identifying places in the life cycle where resources are used, wastes are produced, and where potentially hazardous emissions occur;
- clarifying what is well known and what is poorly known (thus exposing uncertainties);
- providing a dispassionate way of identifying where opportunities and threats exist before commitments are made;
- enabling a good framework for public discussion of the issues;
- identifying potential trade-offs in decision-making (e.g., media resource categories);
- identifying issues at points in the system where other tools may be needed to support a decision;
- using the information provided in various stages of an LCA to determine where to most effectively apply policy levers;
- providing information about the potential unintended consequences of policy;
- adding transparency to a policy decision;
- supporting subsequent decisions (both positive and negative); and
- directing future research and the strategic orientation of technology development.

Table 2: Environmental Policy Areas in Which Governments Can Apply the LCA Hierarchy

Policy Area	Assumptions and Considerations
Infrastructure Development • energy supply • transportation/land use • municipalities, universities, schools and hospitals (MUSH)	• it may be more effective to use LCA on new vs. existing infrastructure • it may be better to state the life cycle information that is required on a new project and leave the proponent to choose the best tools to secure it • LCA could have an immediate impact on policy if applied to the patterns and priorities of infrastructure investments
Technology • investments • regulation and standards	• there is a need to understand energy and material sources and flows and their long-term implications
Fiscal Instruments • full cost pricing • R&D (e.g., bioenergy work) • economic instruments (price of cigarettes, fuel taxes)	• using a life cycle approach can help identify both the type of externalities to be considered and the points in the system or supply chain where they are potentially significant
Procurement • products and services (fleet purchases, criteria)	• LCA can contribute to a sound framework for procurement policies
Performance Standards • regulations • standards (e.g., building codes)	• it may be necessary to distinguish between voluntary and mandatory requirements • distinguishing between consensus-based vs. leadership initiatives may also be required • as different points along the supply chain can influence the impacts associated with the provision and use of a given product or service, the life cycle of that product or service must be considered in the development of regulations (e.g., CFCs) • need to incorporate regional considerations
Information/Outreach • eco-labelling (e.g., Environmental Choice) • consumer information and guidelines (e.g., Energy Star, imported products) • systems thinking education	• LCA allows consumers to make better purchasing decisions. It provides them with more in-depth information about a product than simply its individual features, such as recycled content, bleaching process, etc.

5. Life Cycle Assessment in Practice: Evaluating Biofuels

Decisions made recently with respect to biofuels reveal the ways in which LCA can inform environmental policy and the choices that are made. The LCAPT specifically examined the case of the decision-making tool known as GHGenius (see Box 2).

Based on the experience gained with GHGenius and the debates of the LCAPT, the information in Table 2 was modified to reflect the potential contribution of LCA to the development of environmental policy pertaining to biofuels across a broad range of policy areas. This is illustrated in Figure 1.

As can be seen, the scope and goals of LCA as potentially applied to biofuels can be quite broad. It is assumed in this example that there are economic, social or environmental justifications for proceeding with an LCA. For example, biofuels can be used to support rural economies, drive value-added from existing feedstock, achieve air quality goals or mitigate climate change. The focus of an LCA is on environmental goals (such as understanding greenhouse gas emissions, the type of resources used and the wastes across the systems being compared) but it could certainly be expanded to incorporate social and economic goals and thus address broader sustainability concerns.

LCA proponents need to be clear about the goals and the boundaries of the system. For instance, is the aim of the analysis to examine only the use of the biofuels or also the feedstocks used to produce them? The answer to this question will determine how the functional unit will be formulated and how it might be used for comparisons. In the former case, the scenarios would involve the "best" use for biofuels leading to reductions in both the amount of fossil-fuel based energy used and the release of greenhouse gases for a given unit of biofuels (regardless of source). In the latter, the scenarios would be designed to consider the use of land, materials, energy and pesticides, as well as the waste generated, associated with each feedstock examined.

Box 2: GHGenius

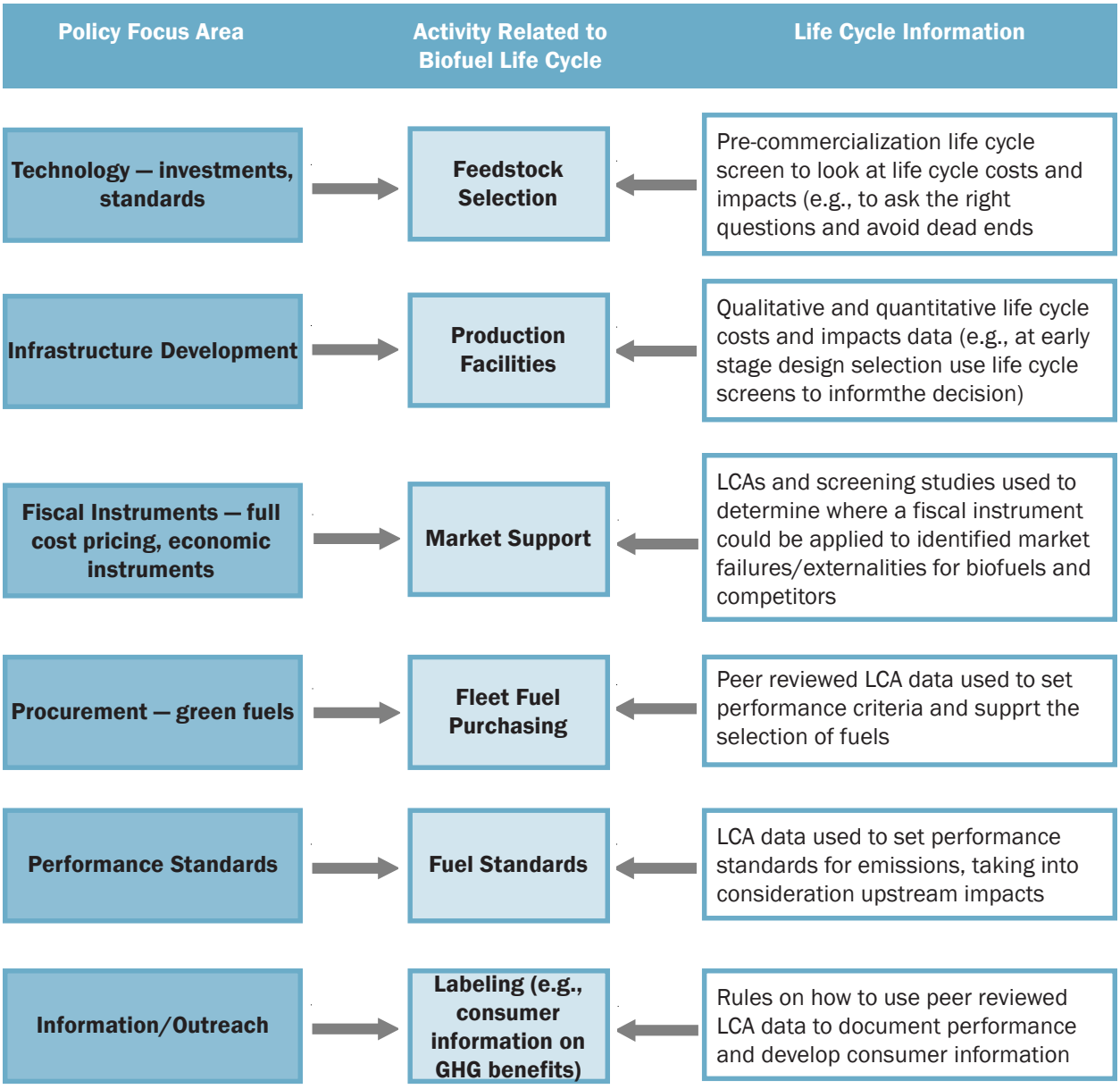
GHGenius (**www.GHGenius.com**) is a decision support tool that played a key role in the Canadian government's establishment of its 5 per cent biofuels target. The model took eight years to build and was initially motivated by the Kyoto Protocol but evolved more broadly as more people became involved. A key lesson from this process is that development can be accelerated if key stakeholders are engaged early and if political support is built for the process (e.g., engaging provincial governments and industry in GHGenius was critical to its success). Much of the development of GHGenius involved educating people, which was an ongoing process due to political and bureaucratic turnover.

Similar LCAs can be completed in a few weeks in the private sector if the appropriate data are available and if the proponent wants the information urgently and is willing to pay for it. Even within government, an eight-year build for a similar model may no longer be necessary in many areas due to the greater availability of data and greater familiarity with the methodologies.

Still, the strengths of GHGenius include a long, iterative leaning curve among parties, a multifaceted approach, and the ability to do and to perform scenarios and options analyses and to respond to changes and future trends. These factors mean that GHGenius is able to dispel myths for decision makers and to provide them with a logical way of wrestling with complexity.

Figure 1: LCA and Environmental Policy — Biofuels Example

The first column highlights a policy area where life cycle information can be used to support policy decisions (drawn from Table 2). Using biofuels as an example, the second and third columns illustrate the type of life cycle information that can be used to help policy makers make the right choices. It is assumed that LCA data would be only one input into the decision-making process and that other types of information (such as socio-economic data) would also be used.



In addition to the LCA system boundaries there are also the policy boundaries of scale to consider — provincial, national, North American or global; these can also have a profound impact on the analysis. For example, Ontario is unable to produce sufficient feedstock provincially to achieve its 10% ethanol goal. Further, there is concern that subsidies for ethanol could have perverse implications on the price of timber and cash crops in Third World countries.

With respect to a biofuels LCA, then, the following questions could be posed:

- What is the best feedstock or product based on environmental factors, such as land use, minimization of fossil fuel inputs, or total greenhouse gases?
- What is the most efficient fuel in terms of energy and material inputs and waste and emission outputs?
- How can the system be optimized (e.g., infrastructure investments)?
- What impacts need to be researched and managed?
- Can the policy goal be served by the domestic market?
- Are there significant regional or provincial variations that should be considered?
- What are the unintended consequences (e.g., impacts on existing agricultural sectors and markets)?
- Where are the hotspots and leverage points for applying other policy instruments?

Some of the policy lessons that the LCAPT drew from this example are as follows:

- The treatment of co-products and wastes is essential, especially from the business perspective.
- The analysis has to be as objective as possible to avoid creating winners and losers, but must show direction (in terms of investment) to demonstrate what is good for Canada (recognizing that regional differentiation is a given).
- The challenge is to identify desired outcomes (e.g., energy efficiency) and let the market sort out how to get there, as opposed to attempting to validate a specific approach (e.g., ethanol from corn).
- Each option in the analysis has specific characteristics (e.g., GHG use in transportation) and LCA illustrates the pros and cons of different options.
- LCA can't account for broader changes outside of the system (available energy options, productivity) that may affect the configuration of a future LCA. However, these may be addressed by undertaking scenario planning in conjunction with the LCA.

6. Providing an Effective Context for Life Cycle Assessment

When using LCA to inform the development of environmental policy, the context, framework and setting of its application are extremely important. Generally, LCA should be undertaken early in the policy development process; the information it provides can feed into many decisions. The need for and the use and time of introduction of an LCA principally depends on the policy questions to be addressed. For example, LCA is not an appropriate method for determining an initial direction or setting priorities.

Governments should begin by determining the issues that need to be addressed when developing sound environmental policy. They can then go on to determine the rigour with which each issue needs to be assessed (by applying life cycle thinking, a streamlined LCA, a full LCA, or LCA in combination with other tools as appropriate) to get confidence in an answer. A clear goal and scope for both the exercise and the questions to be asked will ensure that resources are not wasted.

When approaching environmental policy issues, as shown in the LCA hierarchy (see Table 1), policy makers should first apply Life Cycle Thinking. They can then decide if a certain application level of LCA or other tools are warranted to address the questions identified in that initial exercise. There is merit in formalizing this Life Cycle Thinking stage into a structured life cycle screening process that would, itself, become a tool in the decision-making process. The result would be a consistent framework for determining whether a streamlined LCA, full LCA or one of these in combination with other tools is appropriate to address identified questions.

While the factors leading to a decision to invest in a full LCA will vary according to circumstances, there are a number of factors that may trigger such an approach (see Box 3).

Box 3:Triggers that May Prompt an LCA in Environmental Policy

In applying the LCA Hierarchy presented in Section 3, decision makers should understand the triggers that may warrant the conduct of a formal LCA. Some of these may include:

- the complexity of the system, or of the product and its life cycle;
- the scale of the issue;
- the extent of knowledge of the upstream/ downstream implications of the decision;
- the level of capital investment;
- the level of disagreement within government and externally;
- the degree of impact of the decision on stakeholders (including taxpayers);
- the extent of agreement needed on the outcome.

These triggers, perhaps put in the form of questions, provide a generic policy framework for the application of LCA. Structured as a decision tree, with some overarching questions and more specific sets of questions at each point in the LCA Hierarchy, they can help decision makers select the appropriate approach to applying life cycle thinking to an issue. With a good checklist and well-informed people, it should be quickly evident whether an LCA is required on an issue as little analysis is required to determine whether the life cycle of a product or process can be assessed or managed.

In exploring the role of LCA in policy development, a few cautions are in order. LCA is just one input into decision-making that can expand system boundaries and enable high level comparisons of options. Using LCA to meet environmental policy objectives should not be used to deliberately confer a competitive advantage on any product or

process. That said, there is a need to link corporate change back to public policy as this would offer industry the incentive and motivation for change. LCA can be of service here by identifying and rewarding those that have truly minimized their environmental impacts. Decision makers should also ensure that political decisions don't abuse or discredit tools, such as LCA and the processes (such as stakeholder consultations, data sources and peer review) that provide the information on which decisions are based.

A peer review panel may be helpful to review the details of the LCA, but in some circumstances, particularly on controversial issues, a higher level, strategic body (such as an advisory committee made up of key stakeholders) may also be beneficial to sanction the process. A more extreme option, perhaps when public opinion is too polarized on an environmental policy issue to permit the above approaches, would be to have an independent agency undertake the LCA on behalf of government, as has been done in the Netherlands. Moreover reviewing the LCA with stakeholders prior to finalizing a policy decision, or at least releasing the results of an LCA simultaneously with a policy decision, may be of benefit. Although critics may disagree with the policy or process it would be clear and transparent why the decision was made.

Finally, protecting the credibility of an LCA is critical to ensure that the tool is an effective component of environmental policy development, particularly in securing public support for the ensuing decision. For that to happen, the process and the technical components of the LCA must be considered as equally important. Foremost, the LCA should not be compromised by the desire to support a particular outcome. This point is especially critical as stakeholders may use their own LCA to undermine or challenge that of the government on environmental policy questions. Even if stakeholders are fully engaged in the implementation of an LCA, those with competing interests may try to unduly influence the process, or in some cases actively delay or undermine it. These risks need to be anticipated and managed. This also highlights the need for using LCA experts, where appropriate, and providing internal training on life cycle approaches to ensure the concepts are properly understood and applied.

7. Implementing a Life Cycle Assessment on Environmental Policy Questions

Clear direction on how to undertake an LCA is provided by the ISO 14040 series of standards. Some considerations specific to applying an LCA within an environmental policy setting are outlined in Box 4.

An LCA needs to have a very clear scope of work and be accompanied by a well defined set of assumptions. Also, in conducting an LCA, the relevant parties should not attempt to anticipate every problem or option that may arise through the process before it starts. LCAs tend to evolve as they proceed and new questions are then asked; the process is thus iterative — new information leads to new questions or a refinement of old questions. The process must revisit and sometimes redefine the scope of the work and change or add particular assumptions. It is therefore extremely important that LCAs with environmental policy implications be transparent and have stakeholder engagement; a tight project management plan is also imperative to keep them on track.

As a first step in implementing an LCA, organizations must clearly understand what they want to achieve and how well they can measure progress. This should be placed in the context of the product, the process, and the overall organization. LCA works best when it is applied to the whole, i.e., when complete automobile composition (weight, etc.) and energy and recycling issues are considered instead of just pieces of the automobile.

An initial qualitative assessment (i.e., the Life Cycle Thinking stage in the LCA Hierarchy described in Section 3) can map out the system with its many issues and possible trade-offs and identify the functional unit, thus enabling impacts of changes to the system to be explored. Should a decision be made to undertake an LCA, its rigour can be scaled to

Box 4: Necessary Conditions for Implementing an LCA Successfully in a Public Policy Setting

For an LCA to be successfully applied, the proponent should

- determine that it is the most appropriate jurisdiction (i.e., it should be clear at what point the responsibility moves from a departmental process to become an interdepartmental, interjurisdictional or a multistakeholder process)
- have clearly articulated goals for applying LCA
- allocate appropriate time and resources
- ensure credibility by generating confidence in the process, data and analysis among external stakeholders
- outline clear policy boundaries for the analysis — whether provincial, regional, national, North American or global
- secure the cooperation of key stakeholders (recognizing that there are likely to be losers and a process is thus needed for dealing with conflicts and conflicts of interest)
- ensure the analysis is transparent and independent
- engage competent people with appropriate skills and knowledge
- secure good quality data that is appropriate to local, regional, national or global circumstances
- ensure a comparison of apples with apples (both in terms of boundaries and functional unit)
- decide if a valuation or scoring system is needed and then develop an appropriate valuation process
- have clear criteria which to base a decision, and a link from the information provided by the LCA to the decision.

the context, complexity, scale and scope of the decision required. As indicated earlier, in some cases an LCA can be "streamlined"; meaning that certain stages in the process may be truncated or omitted from quantification.

The length of time it can take to conduct an LCA can be an issue in policy development. One option, particularly for streamlined LCAs, is to develop publicly available databases. A drawback, however, is that these databases tend to become out of date quickly and are subject to competition among companies or sectors trying to ensure that their products are best positioned; further, they may enable companies to figure out the cost structures of their competitors.

Once organizations are accustomed to performing LCAs appropriately, and the mechanisms necessary for collecting and maintaining data are in place, the speed at which an LCA can be conducted may increase and the costs associated with it may decrease. For example, once LCA is embedded into the product development process or templates and data for similar decisions already exist, experienced companies can screen a new product within a few days to a few weeks.

When implementing an LCA in environmental policy development, a number of factors must be considered that are specific to the issues to be addressed (these are in addition to those general considerations listed in Box 4). These factors include having in place

- appropriate methods for engaging stakeholders and establishing the level of their engagement
- processes for securing peer review or a higher level oversight committee, if warranted
- methodologies for incorporating social factors, which may vary according to cultural differences (e.g., the expected number of diaper changes per day differs from country to country, thus making it difficult to transfer results of an LCA from one country to another)
- a process for considering regional or site-specific differences and possibly incorporating them in the sensitivity analyses of the LCA
- a process for addressing occupational health and safety or CSR issues, which quickly become environmental issues if they are not dealt with
- a methodology for weighing social considerations, which are often short-term, against potentially longer-term environmental impacts in subsequent decision-making; and
- a methodology for placing a valuation on differing issues and outcomes (e.g., weighting according to the ability of the identified problem to be reversed or considering the cost differential of options and the benefits that can be secured from the preferred one for the price).

In positioning LCA within the policy development process, comparisons can be made to risk assessment and risk management, in which risk assessment is an objective, technical exercise followed by risk management where choices are made about how to respond to the information generated. With LCA, there is a need to provide a bridge so that those who are doing the managing understand that the LCA was done correctly and know how they can best use the information to make sound decisions. This bridge means including stakeholders, making the process with its assumptions and data transparent, and using peer review to test the quality and reveal any short-comings of the LCA. However, any such process must also be managed to avoid interference and undue delays.

8. Conclusion

The NDG LCAPT believes that, properly applied, LCA can confer significant benefits to the development of environmental policy at all levels of government. For that to happen, greater awareness and understanding is required of the LCA Hierarchy presented in Section 3. The first stage, Life Cycle Thinking, is the essential starting point in analyzing many problems. Undertaking this initial step will then enable decision makers to determine when a streamlined or full LCA is an appropriate decision support tool. Should a decision be made to proceed with a formal LCA, the boundaries of the analysis must be clearly defined. It should be acknowledged that this decision will be influenced by the questions to be asked and may change as the LCA is implemented. A clear link from the LCA to decision-making is required to enhance transparency and support for the subsequent decision. Further, the time and resources necessary to implement LCA effectively need to be committed to the process, and should remain independent of the perception of predetermined outcomes. As LCA continues to grow in importance in the private sector, it should become equally as important in the public sector as it can contribute to better and more defensible environmental policy decisions than are possible in its absence.

Appendix 1 — Life Cycle Assessment Applications in Public Policy: International Examples and Domestic Opportunities

the PEMBINA institute

DISCUSSION PAPER

April 2005

Life-Cycle Assessment (LCA) Applications in Public Policy: International Examples and Domestic Opportunities

Prepared for:
New Directions Group

Prepared by:
The Pembina Institute

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List of Tables and Figures

1.0 Introduction

This paper provides an overview of how the life-cycle concept has been and could be incorporated into public policy; it illustrates the various applications with case studies. Barriers, challenges, and opportunities for integrating life-cycle concepts into policy are also outlined. The paper is a basis for further discussion by participants at a multi-stakeholder workshop of experts on the role of life-cycle assessment (LCA) in public policy.

1.1 Structure of paper

Following this introduction, the paper has two main sections.

Section 2 focuses on past and current international and domestic applications of life-cycle concepts; this information was obtained largely through an international literature search and personal communication with selected Canadian experts.

Section 3 outlines important opportunities, challenges and barriers related to LCA application in Canadian public policy, and ends with key conclusions for further discussion at the upcoming workshop.

1.2 Life-cycle concept

The life-cycle concept is a systems approach for analyzing environmental, social, and economic impacts of products, services, or activities (herein referred to as products) from a "cradle-to-grave" perspective (see Figure 1). Various approaches have been used to implement the life-cycle concept and it is being applied through a number of tools (e.g., Design for Environment, full environmental cost accounting, industrial ecology).[1] LCA is a specific method that incorporates the life-cycle concept into an analytical framework designed to comprehensively evaluate the environmental burdens of a product throughout its life cycle.[a] For the purposes of this paper, LCA is broadly defined to include the spectrum of approaches used to minimize the environmental burdens associated with a product over its life cycle.[b]

[a] ISO 14040, Section 3.19 defines LCA as a method for assessing the environmental impacts of a product or service over its entire life cycle, and identifying opportunities for reducing these impacts (CSA 1997 as cited in Thompson 2002.)

[b] In practice, life-cycle thinking, life-cycle management, triple-bottom-line thinking, and other approaches are also used.

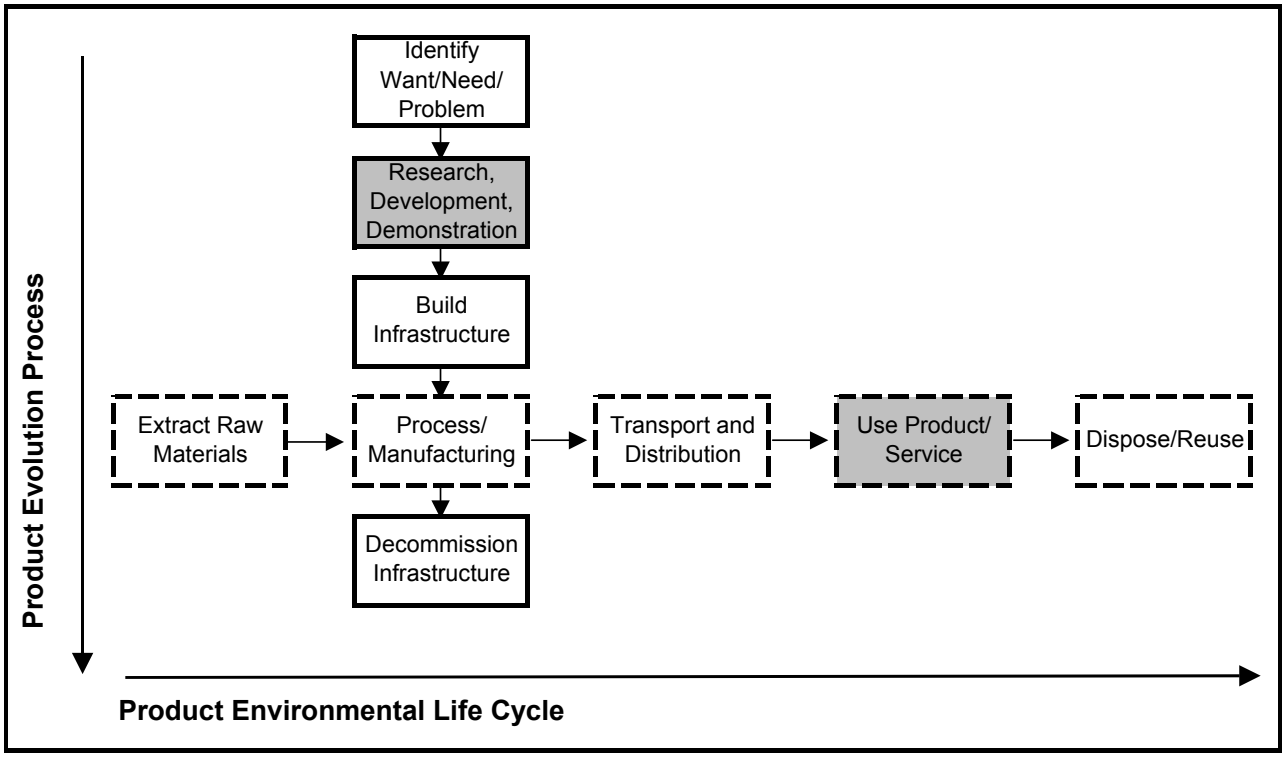

Figure 1: Product Life-Cycle Concept

LCA can be applied at two levels:

1) Conceptually, as a thought process that guides the selection of options for improvement; and
2) Methodologically, building a qualitative or quantitative assessment of alternatives to improve environmental performance.[2]

The application of LCA varies in breadth, depth and rigor depending on at least two factors: 1) the nature and significance of the decision being made; and 2) the number of parameters (i.e., inputs and outputs) being examined. In any application, LCA can help lead to more informed decisions because of its “cradle-to-grave” or “cradle-to-cradle” perspective.

1.2 The role of life-cycle assessment in public policy

To appreciate how LCA could be (and has been) incorporated into policy, it is helpful to review the various public policy options in which LCA could play a role. Public policies are "actions, decisions, statements, mandates, orders, or guidance taken by governmental entities that affect other governmental entities, nongovernmental entities, the public, and private interests."[3] This paper limits discussion to policy options that relate to the environment.

The goal of applying LCA to public policy is to find opportunities to reduce environmental impacts associated with a particular product over its entire life cycle. This requires identifying the environmental impacts, deciding which ones to address, and developing options for reducing them.

Opportunities to use LCA in public policy can be considered in two dimensions:

1) Phases of the product evolution process, and
2) Stages of the product life cycle (see Figure 1).[4]

Within these two dimensions, public policy can be used to facilitate life-cycle thinking and reduce environmental impacts. Policy intervention can significantly influence the "research, development and demonstration" phase as well as the "use product/service" phase of the product life cycle, which is where manufacturer and consumer choices are made (these stages are highlighted in gray in Figure 1).

Four relevant policy categories are:

- Information-based policies
- Research, development and demonstration (RD&D), and procurement policies
- Economic policies
  - Financial incentives and disincentives
  - Market-based regulatory initiatives
- Regulatory policies

The specific policy options in each of these categories are listed in Table 1. In the next section we illustrate how LCA is being applied in each policy category.

Table 1: Public Policy Categories

Policy Category	Examples of Policy Options
Information-based policies	▪ Environmental labeling ▪ Training initiatives ▪ Educational curricula
Research, development and demonstration (RD&D), and procurement policies	▪ Green procurement ▪ Demonstration (pilot) projects
Economic policies 1. Financial incentives and disincentives 2. Market-based regulatory initiatives	▪ Grants ▪ Rebates ▪ Tax credits and exemptions ▪ Low interest loans ▪ Environmental taxes ▪ Market stimulation programs: e.g., green tags, cap and trade program for greenhouse gas emissions, regulated or fixed price policies
Regulatory policies	▪ Direct regulation ▪ Reporting requirements ▪ Take back legislation ▪ Standards ▪ Guidelines

2.0 Past and Current International and Domestic Applications of Life-Cycle Assessment in Public Policy

This section presents an overview of past and current international and domestic applications of LCA in public policy. The discussion is presented in four sections that correspond to the policy categories outlined in Section 1.2. Each section begins with a brief description of how the life cycle is considered in the particular policy category, and what the policies can accomplish. Specific LCA applications in each section are summarized in tables.

Although this paper organizes the LCA applications according to policy categories, LCA applications in policy are not as well defined as this structure suggests. Some policy initiatives can cross over several categories and use a variety of instruments (e.g., voluntary approaches, economic incentives). Policy initiatives that use a combination of instruments will likely be more successful than those that use a single approach.

2.1 Information-based policies

Information-based policies are one method by which government can stimulate the adoption of sustainable practices. Information-based policies encourage the manufacture and use of environmentally preferable products by building knowledge and capacity among consumers and producers.

Product labeling initiatives are commonly used to provide environmental information. Environmental labeling (an "ecolabel") is one of the most obvious areas where life-cycle assessment has been incorporated as a key component of public policy.[5] The European Union (EU) has formally directed that the EU ecolabeling program shall be based on LCA, and requires member countries to conduct LCAs on specific product categories.[6] The EU labeling initiative has worked to establish a common framework for developing criteria.[7] Canada's Environmental Choice™ Program is also based on LCA. Before granting the EcoLogo™ to a product or service, Environment Canada uses life-cycle review to evaluate the environmental impact of the product or service.[c8]

A number of official and private ecolabeling programs are in use throughout the world (see Box 1). The use of life-cycle concepts including life-cycle assessment in eco-labeling programs has been well documented[d] and is not discussed further in this paper.

[c] Terra Choice Environmental Marketing, an environmental program and consulting services firm, has been the Environmental Choice Program's official management and delivery agent since 1995.
[d] See Allen, D.T. et al 1997

Box 1: Examples of Ecolabels

Brazil: Departemento de Certificacao
Canada: Environmental Choice Program
France: Marque NF Environment
Germany: Blue Angel
Israel: Green Label Program
Japan: Eco-mark
New Zealand: Environmental Choice
The Netherlands: Stichting Milieukeur
United States: Green Seal

Nordic Council White Swan Program: Sweden, Norway, Finland, Iceland
European Union Ecolabel ("The Flower"): EU Countries

Source: Allen D.T. et al, 1997; European Environment Agency (EEA), 1997

Potential Discussion Question:
To what extent is LCA being appropriately applied in ecolabeling in Canada?

Education and training initiatives are another way in which LCA is applied through information-based policies. See Table 2 for examples.

Table 2: LCA Application in Education and Training Initiatives
Denmark ▪ The Danish Environmental Protection Agency (EPA) makes LCA-related reports and other materials available for education. In 2000 and 2001 the EPA published and communicated the results from a range of projects. See Appendix A for more information.
Australia ▪ Australia has produced an information kit drawing on the processes and products of the EcoReDesign™ Program, which is a national demonstration initiative based on life-cycle concepts. The EcoReDesign™ Kit includes a video of the product redesign exercise, case study materials, a step-by-step guide to ecodesign, and a resource directory.[9]
United Kingdom ▪ The Centre for Sustainable Design[e] developed a two-year training program focusing on the implementation of environmental considerations in product development and design in the electronics sector. The ETMUEL program (Eco-design training for manufacturing, use, and "end-of-life" for small and medium-sized enterprises) was designed to provide: increased awareness of strategic environmental issues, training of key personnel, increased business competence, best practice benchmarking, and new business opportunities.[10]

Potential Discussion Question:
To what extent should LCA be incorporated into formal education and training programs in Canada?

[e] Established in 1995 in the Faculty of Design at The Surrey Institute of Art & Design, University College, UK, the Centre for Sustainable Design facilitates discussion and research on eco-design and triple bottom line considerations in product and service development and design.

2.2 Procurement and research, development, and demonstration (RD&D) policies

Procurement and RD&D policies demonstrate the use of and increase confidence in particular products, services, and technologies. These policies are also used to demonstrate leadership in supporting technologies and to ensure that a minimum amount of market penetration takes place to drive down the cost of new and innovative technologies over time.

2.2.1 Procurement

Incorporating life-cycle concepts in the procurement process can help to:

1. Identify points in the product development cycle where environmentally significant decisions can be made;
2. Integrate environmental information into those decisions;
3. Identify alternatives that provide decreased environmental burdens; and
4. Establish criteria for identifying environmentally preferable products (in those cases where an official ecolabel does not exist).[11]

Table 3 provides examples of international and federal procurement initiatives. For further context on selected examples see Appendix A.

Table 3: International and Federal Procurement Programs and Policies
The United States Environmental Protection Agency (USEPA) ▪ Environmentally Preferable Purchasing (EPP) is a federal program that encourages and assists Executive agencies in the purchase of environmentally preferable products. All federal procurement officials are required to access and give preference to environmentally preferable products. Life-cycle perspective is one of the EPA's five guiding principles on EPP. [12]
NHS Purchasing and Supply Agency (United Kingdom) ▪ This public sector agency prepares guidelines and defines procedures for companies to introduce criteria on environmental procurement in their contracts. The green risk methodology[f] is used to prioritize environmental purchasing activity and identify the interventions appropriate for managing the green risks associated with contracts. It also collects information from suppliers to be used in the development of environmental supply chain programs, which seek to improve the environmental performance of supply chains.[13]
Environment Canada ▪ Ministerial approval of the *Environment Canada Green Procurement Policy* (updated in 1999) directs employees to consider the "cradle-to-grave" impact of goods and services, use EcoLogo certified products where feasible, adopt greener criteria in purchasing decisions, and include environmental terms and conditions within the selection criteria of Environment Canada contracts.[14]
United Nations Economic Commission for Europe ▪ Examined and pilot tested the concept of an *environmental product profile* that would facilitate the exchange of information on environmental issues among suppliers, producers, and users of the product. Under this system, a supplier or manufacturer that is adding value to the process or product would document environmental information relevant at that stage and transfer that information to the next, thereby building an overall product profile.[15]

[f] The green risk methodology was developed for prioritizing environmental purchasing activity and for systematically identifying the interventions appropriate for managing the green risks associated with each contract.

Potential Discussion Question:
To what extent should LCA be a requirement in the design of government procurement policies?

2.2.2 Research, development and demonstration

Research, development and demonstration (RD&D) policies "direct public-sector financial, intellectual, and laboratory resources toward the pursuit of strategic public goals (e.g., national security, public health, energy independence, industrial competitiveness, environmental protection)."[16] The intent is to leverage or stimulate product (or technology) design and development by academic institutions and private companies.

RD&D policy examples can be placed into at least two categories:

1) Product-oriented policies (Table 4); and
2) Technology-oriented policies (Table 5).

Table 4: LCA Application in Product Design and Development Policies
Environment Canada ▪ In 1997, Nortel, a telecommunications company, and Environment Canada entered into a partnership to explore environmentally preferable design technologies. Environment Canada sponsored an LCA to identify and verify potential environmental improvements. The final report, detailing the work, was used to promote the business and environmental value of such an approach to product design.[17]
Denmark ▪ The Environmental Design of Industrial Products (EDIP) method describes how to incorporate environmental, health, and resource assessments into product development. The objective of the life-cycle assessment in the EDIP program has been to create a basis of knowledge to use in developing new products. Five of Denmark's largest companies, all in the electromechanical sector, were involved in the program.[18] For more information on Denmark's product-oriented initiatives see Appendix A.
The Netherlands ▪ The PROMISE (a Dutch acronym for Product Development with the Environment as an Innovative Strategy) program was part of the implementation strategy for the Dutch policy on Products and the Environment. The main results of the program were a manual for environmental product development and a report outlining how to stimulate environmental product development and improvement.[19] ▪ Through the ECODESIGN project, a team of product designers and environmental experts work together with ten companies. The main objective is to help companies improve the environmental performance of their products and demonstrate their success to other companies. In the PRISMA project, environmental experts work together with retailers to improve the environmental performance of their product ranges.[20]
Australia ▪ The EcoReDesign™ Program, a national demonstration initiative, helps companies improve the environmental performance of manufactured products. Based on the life-cycle approach, EcoReDesign brings together the skills and expertise of industry and research institutions. Interdisciplinary teams work with companies to integrate environmental considerations into companies' conventional design process.[21]

Table 5: LCA Application in Technology-Oriented Policies
Denmark ▪ The Danish Environmental Protection Act cites cleaner technology as a principal element in the technology strategy. In the Act, the definition of cleaner technology deals with products and production processes, as well as the entire life cycle of a product, from cradle-to-grave. The Danish cleaner technology policy has been implemented through various action plans and programs administered by the Environmental Protection Agency. For more information see Appendix A.
Canada ▪ The Federation of Canadian Municipalities developed a project assessment technology that uses a life-cycle approach. See Appendix A for more information. ▪ Technology Early Action Measures developed a project evaluation methodology called System of Measurement and Reporting for Technologies (SMART). SMART uses a life-cycle approach that tracks greenhouse gas sources and sinks over the life cycle. See Appendix A for more information.

With respect to product- and technology-oriented policy, government can also play a role in collecting and managing data. To conduct sound product analyses and improve product design, data is required on the materials and energy used in the product or consumed during the product life cycle.[22] Government can collect, house, and provide information on environmental materials and energy flows associated with a particular product or system to help companies manufacture environmentally preferable products. Past and current efforts by government and non-government entities to establish life-cycle inventory databases are listed in Table 6.

Table 6: Life-cycle Database Initiatives
Denmark ▪ The Danish EPA developed a cleaner technology database, which includes datasheets on processes, materials, and products in the following sectors: iron and metals (including electroplating), plastics, fish-processing, and wood and furniture industries.[23] ▪ Danish energy producing companies have launched a large joint project to do a life-cycle assessment of production, transmission, and distribution of electrical and district heating energy. The project will result in public LCA data for the different technologies (wind power, coal power, etc.) and for an average kWh of electricity.[24]
Korea ▪ A database for commonly used materials to track their environmental impact was released in March 2005 for the first time in Korea.[25]
Canada ▪ In the 1990s, Environment Canada, Canadian Standards Association, industry and academia developed the Canadian Raw Materials Database (CRMD)— a voluntary project to provide data to small and medium sized companies to encourage them to consider the broader life-cycle implications of their products.[26] The CRMD is currently closed partly because of a lack of funding.

Potential Discussion Question:
To what extent should LCA be used in product- and/or technology-oriented policies?

2.3 Economic policy

Economic policies are characterized as interventions by government in the marketplace through mechanisms such as taxes, fees, grants, rebates, and regulated prices. The intent is to provide producers and consumers with information about the manufacture and use of particular products with the goal of influencing their decisions. For instance, financial subsidies in the form of low-interest loans, direct grants, or preferential tax treatment, can be targeted to specific industries to stimulate environmentally preferable product or technology development. Economic policies fall into two categories:

1) Financial incentives (and disincentives); and
2) Market-based regulatory initiatives. See Appendix B for more information on these policy options.

LCA can be used to inform the application of economic policies that stimulate environmental improvements associated with a product, service, or activity over its life cycle. For example, by giving manufacturers an incentive to consider the environmental impacts of their choices, policymakers can address environmental problems that arise throughout the life cycle of a particular product.[27] Table 7 summarizes worldwide examples of LCA applications used to inform economic-based policies.

Table 7: Examples of LCA Applications in Economic Policies
Denmark ▪ Fee imposed on waste delivered to landfills and incinerators as an incentive to recycling and to support clean technology. ▪ Duty imposed on raw materials such as sand and gravel to minimize their use. ▪ Duties on electricity, gas, coal, some oil products, and petroleum. As a supplement to these duties, another duty on carbon dioxide from certain energy products has recently been introduced. ▪ Ministry of the Environment grants financial support for activities including technological development, implementation and demonstration projects, environmental assessment (including LCAs), and public procurement.
The Netherlands ▪ Taxes on raw materials such as ground water, fossil fuels, and mineral oils. ▪ Taxes on the disposal of solid waste and waste water. ▪ Initiated pilot projects with tariff differentiation. Households pay duties according to the weight or volume of the waste disposed.
Germany ▪ Mandatory deposit refund on plastic beverage containers.
Norway ▪ Tax on non-returnable beverage containers. ▪ Deposit refund on old car bodies.
Sweden ▪ Voluntary deposit refunds for glass and aluminum beverage containers.

Source: <http://www.emcentre.com/unepweb/policy.htm> and Curran, 1996.

Potential Discussion Question:
When designing economic policies, how can LCA be effectively applied to ensure the policy is providing an incentive for environmentally sound behaviour?

2.4 Regulatory policies

Policies in this category range from direct regulation to voluntary measures. They specify minimum standards that must be met, investments that must be undertaken, or behavior that must occur. Introducing LCA concepts in the regulatory process,

> "extends the regulatory analysis upstream and downstream within and across all affected media to account for direct and indirect effects of a proposed standard which may otherwise escape a traditional regulatory impact analysis."[28]

LCA is commonly used to inform the following regulatory policy initiatives: 1) Extended producer responsibility 2) Solid waste management and 3) Integrated product policy.

Table 8 summarizes worldwide examples of LCA applications used to inform regulatory policies.

Table 8: LCA Applications in Regulatory Policy
European Community ▪ Waste from Electrical and Electronic Equipment Directive and national electronics 'producer responsibility' laws are designed to reduce the waste arising from electrical and electronic equipment and improve the environmental performance of all actors (producers, suppliers, etc.) involved in the life cycle of electrical and electronic products.[29] ▪ EuP (Eco-design Requirements for Energy Using Products) Directive provides eco-design requirements for energy-using products. The eco-design requirements expect manufacturers to consider the entire life cycle of product groups. See Appendix A for more information.
Germany ▪ Ordinance on the Avoidance of Packaging Waste (Verpackungsverordung) was introduced in 1991. The purpose of this Ordinance is to avoid or reduce the environmental impacts of packaging waste. The law mandates companies to take back and recycle used packaging. [30]
Sweden ▪ Swedens Eco-cycle Bill requires all decisions to be directed toward efficient management and to promote an "ecocycle" society with closed-circuit material flows. Ordinances require producers to take responsibility after use for packaging, newspapers, and tires.[31]
Denmark ▪ Ban on domestically produced non-refillable bottles and aluminum cans.[32] ▪ Polluting companies in Denmark must apply for pollution permits when establishing or extending their production activities. The application must include statements and documentation of the use of cleaner technology and information about the best available installations to protect the environment.[33]
Canada ▪ In 1990, the Canadian Council of Ministers of the Environment (CCME) endorsed the National Packaging Protocol (NAPP), which is a voluntary program with packaging reduction targets and dates. Acknowledging that the environmental impact of packaging extends beyond disposal problems, the CCME prepared LCA guidelines to help industry meet the goals of the NAPP.[34]
Australia ▪ Eco-Efficiency Agreements. See Appendix A for more information.
Japan ▪ Recycling law set target recycling rates of about 60 percent for most discarded materials by the mid-1990s.[35]

Potential Discussion Question:
When designing regulatory policies, how can LCA be effectively applied to ensure the policy is effectively addressing environmental impacts?

For the policy categories and examples above, Table 9 summarizes how LCA was considered and why it was important.

Table 9: Summary of the Application of LCA in Public Policy

Policy Category	Examples	How is LCA used in this policy context?	Why is LCA important in this policy context?
Information-based policy	Environmental labeling	LCA is used for two primary purposes: 1) to identify the stages of the life cycle in which the most significant environmental burdens take place; and 2) to develop labeling criteria to address those environmental burdens.[36]	LCA provides more complete environmental performance information to the consumer.
	Education and training	Life-cycle concepts are incorporated into education and training materials.	Incorporating life-cycle concepts in education and training materials can build competence for integrating environmental considerations into product development and design decisions. It also builds skills in systems thinking.
Research, Development, Demonstration, and Procurement	Procurement	Life-cycle concepts are used to: 1) identify points in the product development cycle where environmentally significant decisions can be made; 2) integrate environmental information into those decisions; 3) identify alternatives that lessen the environmental burden; and, 4) establish criteria for identifying environmentally preferable products.[37]	Incorporating life-cycle concepts in procurement policies provides additional input to decision makers, helping them more completely assess environmental considerations in procurement decisions.
	Product-oriented policy (e.g., new product development, design improvements)	Life-cycle concepts are used to identify points in the product development cycle where design improvements could be made.	Considering environmental aspects throughout the system (i.e., the life cycle) as early as possible in product development helps improve overall environmental performance of the product or service.
	Technology-oriented policy (e.g., technology assessment)	Life-cycle concepts are used to: 1) achieve a more complete accounting of the environmental impacts of projects; and 2) identify and verify potential environmental improvements.	
Economic policy	Tax credits, deposit-refund schemes, low-interest loans	LCA is used to determine what products qualify for financial incentives (or disincentives).	Using LCA helps ensure the environmental performance of the full system is accounted for in designing economic policies.
Regulatory policy	Extended producer responsibility (EPR)	LCA is used to extend the regulatory analysis upstream and downstream to inform the development of EPR laws aimed at reducing environmental impacts associated with the design, manufacture, use, and disposal of products over the life cycle.	LCA reduces the likelihood of environmental burden shifting to a different place, different time, and/or different issue. LCA helps ensure all system environmental impacts are considered in regulatory policy design and implementation.
	Integrated Product Policy (IPP)	LCA is used to extend the regulatory analysis upstream and downstream to inform the development and application of IPP.	

Table 9: Summary of the Application of LCA in Public Policy			
Policy Category	**Examples**	**How is LCA used in this policy context?**	**Why is LCA important in this policy context?**
	Building standards (e.g., LEED™[g])	LCA can be integrated into the LEED™ building assessment system to identify building designs that truly result in reduced environmental impacts.	
	Solid waste management	LCA is used to evaluate the upstream and downstream environmental impacts of solid waste management options.	

[g] LEED™ (Leadership in Energy and Environmental Design) is a registered trademark of the U.S. Green Building Council.

3.0 Opportunities, Challenges, and Barriers of Life-Cycle Applications in Canadian Public Policy

This section provides an initial list of the opportunities, challenges, and barriers involved with integrating LCA into public policy, as identified in the literature and through personal communication with selected Canadian experts. The section ends with a set of conclusions that outline the key questions to discuss at the workshop.

3.1 Opportunities

Canadian policy areas with opportunities for LCA application include:

1. Extended producer responsibility (EPR); e.g., Natural Resources Canada and Environment Canada are working with producers of electronic goods.
2. Technology Assessment; e.g., System of Measurement and Reporting for Technologies (SMART), environmental technology assessment for agriculture (ETAA), Project Performance Reporting System (PPRS) (See Appendix A)
3. Environmental Impact Assessment; e.g., regulatory decisions on capital projects
4. Building standards; e.g., LEED™
5. Green procurement
6. Climate change

3.2 Barriers

Barriers or challenges to integrating LCA applications into public policy include:

1. Lack of awareness and knowledge by academia, government, industry and consumers of LCA concepts and procedures.
2. Reputation. The misconceptions of LCA generated by a few highly publicized studies have diverted attention from many of the other applications of LCA and life-cycle concepts.
3. Quantitative LCAs can be prohibitively expensive.

3.3 Key factors for success

Key factors for successfully integrating LCA applications in public policy include:

1. Education (e.g., introduce the concept into schools and universities)
2. Marketing
   - Conduct LCA under the banner of a new name or approach; e.g., brand it a "systems thinking" method
3. Life-cycle data

3.4 Discussion questions for workshop

Key questions to discuss at the workshop:

1. What key Canadian policy decisions could benefit from systems thinking?

2. What could LCA contribute to those decisions? How could LCA improve a particular policy?

The questions posed throughout this paper are restated below:

1. To what extent is LCA being appropriately applied in ecolabeling in Canada?

2. To what extent should LCA be incorporated into formal education and training programs in Canada?

3. To what extent should LCA be a requirement in the design of government procurement policies?

4. To what extent should LCA be used in product- and/or technology-oriented policies?

5. When designing economic policies, how can LCA be effectively applied to ensure the policy is providing an incentive for environmentally sound behavior?

6. When designing regulatory policies, how can LCA be effectively applied to ensure the policy is effectively addressing environmental impacts?

Appendix A Further Context on Selected Examples

Information-based policy examples

Denmark

Between 2000 and 2001 the Danish Environmental Protection Agency (EPA) published and communicated the results from a range of projects including:

- A handbook on orientating companies' environmental activities to products, focusing on how companies can improve products' environmental conditions at multiple levels;
- A handbook on a simple environment assessment method for basing products on the LCA concept;
- A project under the auspices of TIC, the Technological Information Centre, on life cycle reviews, i.e. assistance to companies on the environmental aspects of their products.
- Guidelines for a simplified approach to environmental considerations relating to products and incentives for companies to launch a product-orientated environmental initiative.[38]

Research, development, and demonstration policy examples

Denmark

Life-cycle perspectives play parts in a wide range of initiatives under Denmark's product-orientated environmental initiative. The Danish EPA has formulated the following objective for LCA application in product-oriented policy:

> *The life-cycle perspective is the basic foundation for the intensified product-orientated environmental initiative. Refining basic life-cycle assessment methods is […] assigned high priority. In addition, a series of simplified and user-adapted tools must be developed. […] The credibility of life-cycle assessments is […] dependent on the underlying data being as qualified as possible and on the simplified tools used being based on an accepted foundation.*[39]

The Danish EPA's efforts to include LCA and environmental considerations in product development include: development of LCA tools to help integrate environmental considerations into product development work; spreading awareness and use of LCA methodologies and tools, and long-term existence of a publicly accessible LCA database and a PC toolbox.

In Denmark, the activities targeted at products primarily aim at the development and marketing of cleaner products[h] with a view to reducing the total environmental load from production, use and disposal of products. This objective corresponds with the business-

[h] According to the Danish EPA, "A cleaner product is a product that causes less environmental pressure during its life cycle than corresponding products with the same function and use."

policy objective—"to reinforce Danish trade and industry's competitive edge in a future market that will increasing put the environment on the agenda and demand cleaner products."[40]

Denmark has a clear policy and strategy for cleaner technology. The Danish Environmental Protection Act cites cleaner technology as a principal element in that strategy. In the Act, the definition of cleaner technology deals with products and production processes, as well as the entire life cycle of a product, from cradle to grave. The Danish cleaner technology policy has been implemented through a variety of actions plans and programs administered by the EPA. For instance, the Development Program for Cleaner Technology (1986-89) had the main purpose of reducing environmental impact through a preventive strategy including creating the necessary conditions for encouraging the use of cleaner technology in industry. The activities initiated under the development program included: basic development of cleaner processes; transfer and adaptation of know technologies from one sector to another; establishing demonstration projects; and, development of a sector-oriented computerized information system.

Under the Cleaner Technology Action Plan (1993-1997), the Danish government initiated sector survey projects in several industrial sectors (e.g., iron and metal, wood and furniture, dairy, textiles, paper, concrete). These projects were carried out to gain an overview of the technological situation in each sector and the extent of environmental problems, as well as to identify solutions for these problems in terms of cleaner technology. The results were used to identify technological development and demonstration projects.[41]

Canada

Agriculture and Agri-Food Canada (AAFC) is in the process of developing an environmental technology assessment for agriculture (ETAA). As part of the ETAA, research will be conducted throughout Canada to better understand and manage the impact of agricultural practices on the environment and to develop new technological solutions to key problems for stakeholders in the agriculture sector. AAFC scientists will identify and assess technologies in cooperation with the private sector to minimize environmental impacts and increase efficiency in the agriculture industry.[42]

The Federation of Canadian Municipalities (FCM) developed a system to identify the environmental impacts associated with projects funded through the Green Municipal Fund.[i] The Project Performance Reporting System (PPRS) specifies the methodology that must be used to quantify a project's environmental impacts and benefits. The PPRS uses a life-cycle approach to achieve a more complete accounting of the environmental impacts of projects.[43]

[i] The Government of Canada endowed the Federation of Canadian Municipalities (FCM) with $250-million to establish the Green Municipal Fund (GMF). The GMF is designed to remove investment barriers to green municipal infrastructure. The Funds' priorities are to cut greenhouse gas emissions, to improve local air, water and soil quality, and to promote renewable energy. For more information visit <www.fcm.ca>

Technology Early Action Measures (TEAM), a program operating under the leadership of National Resources Canada, Environment Canada, and Industry Canada, developed a project evaluation scheme similar to that of the FCM. TEAM supports late-stage development projects and first-time demonstration projects designed to reduce greenhouse gas (GHG) emissions nationally and internationally, at the same time sustaining economic and social development. TEAM brings together partners from all levels of government, industry, and communities to encourage investment in innovative technology to reduce GHG emissions.[44] The ability of TEAM-funded projects to mitigate GHG emissions are measured using a method known as the System of Measurement and Reporting for Technologies (SMART). The SMART was designed as a practical and cost-effective approach to provide a clear and accurate evaluation of the technical performance and impacts of projects. The SMART uses a life-cycle approach, whereby GHG sources and sinks are tracked during the life cycle from "cradle-to-grave". GHGs or their precursors are then tracked through the system of various activities (e.g. production, transportation, installation, operation, utilization, decommissioning) to their final destination (e.g. release again to the atmosphere or sequestration). Sustainable Development Technology Canada (SDTC)[j] adopted the SMART to evaluate GHG reductions and the technical performance of SDTC projects.

Economic-based policies

Deposit refund schemes are one of the main governmental applications of LCA in public policy.[45] Deposit refund systems can encourage reuse by providing a monetary incentive to the consumer to return the product or package. For example, some states in the U.S., most Canadian provinces and many European nations have enacted beverage container deposit laws.[46]

Economic instruments are also a mechanism to encourage producer responsibility. Extended Producer Responsibility (EPR) aims at making environmental improvements throughout the life cycle of a product by making the manufacturer responsible for various aspects of the product's life cycle.[47] In Denmark for example, energy and environmental duties on specific emissions and products have been charged for several years.[48] The purpose of duties on packaging such as bottles and cardboard boxes is to promote the use of packaging that can be recycled. Denmark also has duties for raw materials, water, chemical substances, and other waste materials.

The Netherlands also has a tax on the use of raw materials such as water, fossil fuels, and on the disposal of solid waste and waste water.

In other policy initiatives, financial assistance (e.g., grants) is provided for technology and innovation. For instance, through the Green Municipal Fund, the Federation of Canadian Municipalities provide grants and low- interest loans as an incentive for municipalities to generate environmental benefits through innovative environmental infrastructure projects. In Denmark, the Ministry of the Environment grants financial support for activities including technological development, implementation and

[j] Sustainable Development Technology Canada (SDTC) is a not-for-profit foundation that finances and supports the development of clean technologies which provide solutions to issues of climate change and air quality,

demonstration projects, environmental assessment (including LCAs), and public procurement.[49]

Regulatory policy

EuP (Eco-design Requirements For Energy Using Products) Directive

The new framework directive aims to provide eco-design requirements for energy using products except for means of transport and to:

- Ensure the free movement of energy using products within the European Union;
- Improve the overall environmental performance of these products and thereby protect the environment;
- Contribute to the security of energy supply and enhance the competitiveness of the EU economy; and, preserve the interests of both industry and consumers.

The eco-design requirements expect manufacturers to consider the entire life cycle of product groups as well as making an ecological assessment.

Australia—Eco-Efficiency Agreements

Through Eco-Efficiency Agreements—voluntary 3-year agreements—industry associations work with the Department of the Environment and Heritage to help their members improve business efficiency while reducing their impact on the environment. The Department has signed 25 agreements with various industry associations. Under the Agreement, the Association undertakes to publicly commit to eco-efficiency, and develop an action plan for eco-efficiency for three years. The action plan may contain a range of elements, including: the promotion of eco-efficiency to members, and reporting on the eco-efficiency performance of their member companies—including the development and monitoring of appropriate eco-efficiency indicators.[50]

Appendix B More Information on Policy Options

Information-based policies

Examples of information-based strategies that use LCA concepts include:

- Initiating and/or supporting measures that address consumption, such as eco-labeling schemes and environmental product declarations;
- Promoting the adoption of targeted, high profile demonstration projects, to demonstrate the techniques and cost-saving opportunities associated with the manufacture of environmentally preferable products;
- Encouraging educational institutions to incorporate LCA within their curricula; and,
- Promoting the adoption of effective training initiatives.

Procurement, and research, development, demonstration policies

Procurement
Procurement policies secure support for systems, products and supplies, services, technologies, facilities, and other commercially acquired items and activities (collectively referred to as products) in the form of guaranteed purchases of those products. Government entities will secure the particular products for their own use or consumption, often at a premium price. In doing so, government increases commercialization of new and innovative goods and technologies, and prices decline over time.

Taking environmental aspects into consideration in public and institutional procurement is becoming common practice in many countries. For example, the Danish EPA has formulated the following objective for public procurement in Denmark (Miljøstyrelsen, 1996 as cited in European Environment Agency (EEA), 1997):

> To decrease the environmental impacts, including energy related impacts, from public production and consumption, and
>
> To urge all other parts of the society also to use resource and environmentally friendly products and production methods.

In a recent set of recommendations, the OECD Council is encouraging countries to introduce appropriate green procurement polices including "concrete steps to ensure the incorporation of environmental criteria into public procurement of products including, where appropriate, environmental impacts throughout the lifecycle."[51]

Over the past two decades, requirements for greening government procurement practices have evolved significantly in North America.[52] In 1993, US President Bill

Clinton signed Executive Order 12873 requiring all federal facilities to purchase Energy Star™-certified computer, monitors, and printers. Since then, other executive orders have been established including Executive Order 13101, "Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition", which requires Environmentally Preferable Purchasing at federal facilities in the US.[k]

Research, Development and Demonstration

Examples of RD&D and procurement strategies that use LCA concepts include:

- Initiating and/or supporting measures that integrate environmental information into environmentally significant decisions;
- Initiating and/or supporting the establishment of criteria for identifying environmentally preferable products; and,
- Supporting and promoting product- and systems-design improvements through research, development and demonstration projects.

Economic policy

Financial incentives (and disincentives)

Financial incentives are characterized by providing a direct financial incentive (or disincentive) to producers, consumers and other actors such as suppliers to encourage environmentally responsible behaviour. LCA can be applied to things like waste management to identify areas that may produce the biggest improvements and where financial incentives could be applied to stimulate those improvements (e.g., deposit-refund systems). LCA could also help determine what technologies may contribute to improved environmental performance, and which technology investments qualify for grants and low-interest loans.

Market-based regulatory initiatives

Broadly speaking, market-based regulatory initiatives seek to address the market failure of "environmental externalities" either by incorporating the external cost of environmental impacts into a product cost (e.g., through taxation), or by facilitating the establishment of a market (e.g., cap and trade program for greenhouse gas emissions).

[k] Among other things, EO 13101 required the EPA to develop guidance to address Environmentally Preferable Purchasing. The guidance could "also address the issues of use of the technical expertise of non-governmental entities and tools such as life cycle assessment in decisions on environmentally preferable purchasing."

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