"FULL COST ACCOUNTING"
for Decision Making at
ONTARIO HYDRO: A CASE STUDY

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Disclaimer

This case study describes Ontario Hydro's approach to environmental accounting, which Ontario Hydro terms "full cost accounting," and implementation activities through February, 1996. The case study focusses on the use of "full cost accounting" in planning and decision-making; it does not address external financial reporting issues. The case study intentionally uses Ontario Hydro's language and definitions in explaining its activities to incorporate environmental costs and impacts into its planning and decision-making. For example, Ontario Hydro uses the term “monetize” to refer to the process of developing appropriate monetary (i.e. dollar) values for the impacts of emissions/pollutants on the environment. The concepts, terms, and approach presented in this case study represent Ontario Hydro's view and not necessarily the position or views of the U.S. Environmental Protection Agency (EPA). By publication of this case study, the EPA is not specifically endorsing Ontario Hydro's definitions or approach, but is offering this case study as an example of an approach to accounting for environmental costs and impacts. Readers may also want to consult *An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms*, EPA 742-R-95-001 (June 1995) for more general information about environmental accounting.

Acknowledgements

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This case study was prepared for the EPA's Environmental Accounting Project. Through the Environmental Accounting project,[1] EPA has been working with stakeholders for the past three years to encourage and motivate businesses to understand the full spectrum of their environmental costs and integrate these costs into their decision-making.

[1] In December 1993, a national workshop of experts drawn from business, professional groups, government, nonprofits, and academia produced an *Action Agenda* which identifies four overarching issue areas that require attention to advance environmental accounting: (1) better understanding of terms and concepts, (2) creation of internal and external management incentives, (3) education, guidance, and outreach, and (4) development and dissemination of analytical tools, methods, and systems. The purpose of this document is to help address the third recommendation, which includes the preparation and dissemination of case studies. The U.S. Chamber of Commerce, the Business Roundtable, the American Institute of Certified Public Accountants, the Institute of Management Accountants, AACE International (the Society of Total Cost Management), and the U.S. EPA co-sponsored the Workshop. For more information, please see the *Stakeholder's Action Agenda: A Report of the Workshop on Accounting and Capital Budgeting for Environmental Costs, December 5-7, 1993* ; EPA 742-R-94-003 (May 1994).

Acknowledgements (continued)

As a product of this effort, EPA has commissioned case studies documenting companies' efforts to address environmental accounting issues. For more information on EPA's activities in this area or for copies of additional case studies, please contact the EPA's Pollution Prevention Information Clearinghouse at (202) 260-1023. Holly Elwood, Co-Manager of EPA's Environmental Accounting Project, would like to hear about companies beginning to implement environmental accounting. She can be reached at (202) 260-4362.

This case study was prepared by ICF Incorporated under EPA Contract No. 68-W2-0008, Work Assignments 82 and 109. The EPA Work Assignment Managers were Holly Elwood and Marty Spitzer. Carlos Lago served as the EPA Project Officer. The ICF principal author was Paul Bailey.

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TABLE OF ACRONYMS

FCA	Full Cost Accounting
MCA	Multicriteria Analysis
SED	Sustainable Energy Development
DSM	Demand Side Management
ESDD	Energy and Sustainable Development Division
CIRP	Central Integrated Resource Plan
LIRP	Local Integrated Resource Plan
BEI	Business Environmental Integration Department
RET applications	Renewable Energy Technology applications

"FULL COST ACCOUNTING" for Decision-Making at Ontario Hydro: A Case Study

Purpose of Case Study

This case study illustrates how Ontario Hydro, the biggest power utility in North America in terms of installed generating capacity, is developing and implementing what it terms "Full Cost Accounting" (FCA). EPA believes that Ontario Hydro represents an informative case study because the company is well along in the process of incorporating environmental costs into planning and decision-making. The document relies heavily on Ontario Hydro documents (listed in Attachment C) and input from Ontario Hydro staff.

Even with increased competition and deregulation of the energy generation industry in the U.S. and Canada, power companies will find full cost accounting approaches like those described here increasingly relevant. For example, one impetus to the development of full cost accounting at Ontario Hydro was a requirement to document the environmental and health impacts incurred by Canada from electricity generated in Canada and then exported to the United States. These and other potential environmental implications of deregulation of this industry are also matters of concern in the United States. This case study demonstrates that full cost accounting will help power companies respond to these types of concerns, and will also assist in making more informed choices on balancing the use of demand side management, conventional, and alternative supply options. EPA believes this case study should also aid a wide range of companies who are interested in incorporating environmental concerns into planning and decision-making.

Organization of Case Study

The presentation of the case study is largely chronological and is organized as follows:

- **Background**. This section introduces Ontario Hydro and presents a chronology of key events in its development and implementation of FCA.

- **How Does Ontario Hydro Define Full Cost Accounting** ? This section explains how Ontario Hydro defines FCA and key related terms such as internal costs, external impacts, monetized external impacts, and non-monetized external impacts.

- **How Did Ontario Hydro Account for Environmental Costs Before Committing to Full Cost Accounting** ? This section reviews Ontario Hydro's past activities in estimating its environmental expenditures, quantifying external impacts, and monetizing those impacts using the damage function approach.

- **Why Did Ontario Hydro Address Full Cost Accounting** ? This section describes why Ontario Hydro's commitment to sustainable development in 1993 led to a focus on FCA and what benefits Ontario Hydro anticipated from full cost accounting.

- **How Did Ontario Hydro Address Full Cost Accounting** ? This section describes the team Ontario Hydro formed in 1993, and the process used to develop an initial set of FCA recommendations.

- **What Did Ontario Hydro's Full Cost Accounting Team Recommend** ? This section lists the six major FCA recommendations developed in 1993.

- **What Has Ontario Hydro Done To Implement Full Cost Accounting** ? This section discusses what Ontario Hydro has done to develop and implement FCA, including the establishment of an institutional foundation, development and application of decision criteria and multi-criteria analysis in planning and decision-making, and development of monetized external impacts of fossil-fired generation.

- **Lessons Learned** and **Looking Ahead**. These sections illustrate Ontario Hydro's findings to date and its agenda for future FCA activities.

Exhibit 1 lists some of Ontario Hydro's key accomplishments in developing and implementing Full Cost Accounting, all of which are covered in this case study.

Exhibit 1: Key Accomplishments

- Calculated externality data to support exports of electrical power
- Estimated annual environmental spending using guidelines containing over 130 environmental spending categories
- Adopted approach for assessing external impacts and costs
- Established internal team to assess status of full cost accounting and develop recommendations
- Clearly defined the corporate definition of full cost accounting (FCA)
- Reviewed literature on external environmental costs of energy production
- Developed preliminary values for some externalities associated with Ontario Hydro activities
- Prepared corporate guidelines for FCA
- Top management made commitment to FCA
- Developed research program on internal and external environmental costs
- Developed sustainable energy development (SED) criteria for incorporation of environmental considerations in financial evaluation and investment decisions
- Presented seminars and training on FCA
- Conducted outreach activities beyond Ontario Hydro to foster widespread adoption of FCA
- Applied FCA in planning at the corporate and local levels

1. Background

Ontario Hydro is the largest utility in North America in terms of installed generating capacity and employs over 21,000 people.[1] It was created in 1906 by provincial statute and operates today under the power corporation of Ontario. Its customers include 307 municipal electric utilities serving more than 2,800,000 customers, 103 large industrial customers serviced directly by Ontario Hydro, and almost 1 million rural customers serviced by 13 Ontario Hydro wholly owned retail utilities. Its revenue for 1994 was approximately $8.7 billion with a net income of C$587 million.[2] Ontario Hydro's supply system includes five

[1] *Ontario Hydro 1994 Annual Report* [latest available].

[2] As of March 27, 1996, the official exchange rate was one U.S. dollar = .73427 cents of one Canadian Dollar.

nuclear, eight[3] fossil-fueled, and 69 hydroelectric energy stations. Total system capacity is approximately 34,000 megawatts transmitted across 29,000 kilometers of transmission lines and 109,000 kilometers of distribution line. Ontario Hydro is a self-sustaining, government-owned utility without share capital, whose bonds and notes are guaranteed by the Province of Ontario.

Ontario Hydro is in a period of great change. As is true for many utilities, since 1990 Ontario Hydro has faced declining load demand due to economic conditions and has excess generating capacity. With an estimated 92% market share, Ontario Hydro traditionally has not been subject to competitive pressures. However, throughout North America the energy business is being redefined and competition is increasing. Accordingly, Ontario Hydro is preparing itself to face the challenges of open access. A new chairperson, Maurice Strong, was appointed in November 1992 to restructure Ontario Hydro and make it more competitive and customer-oriented. In 1993, Ontario Hydro underwent major restructuring to better meet the competitive challenges of the 1990s and beyond. Much of the restructuring was designed to contain costs, stabilize electricity rates, and gain greater efficiency. The changes also involved dividing the company into separate business units, each with clear accountability for its activities, costs, and environmental performance.

As this case study documents, Ontario Hydro has been considering internal and external environmental costs and impacts for many years. Ontario Hydro was the first Canadian company to publish an annual environmental performance report. This case study focusses on its more recent commitment to FCA and extensive efforts to develop and apply environmental accounting under the FCA framework. Exhibit 2 below illustrates this point.

Exhibit 2: Chronology of FCA at Ontario Hydro

[3] In 1995, 6 of the fossil-fueled stations were operating.

1970s	•	Evaluation of external costs began for export sales
1980s	•	Estimation of environmental expenditures began
1990-1994	•	Continued research on externalities/social cost issues
1992	•	New Chairperson supports sustainable development and FCA
1993	•	Sustainable Energy Development (SED) Task Force appointed and prepares report
	•	Full Cost Accounting Team develops recommendations and issues report
1994-Ongoing	•	Work towards development and use of FCA
1994	•	Development and adoption of SED criteria for use in evaluating investment proposals until FCA is more fully developed
1995	•	Development and adoption of SED Policy and Principles which refer to FCA
	•	Development of FCA Corporate Guidelines
	•	Stakeholdering* of FCA Corporate Guidelines
1995-Ongoing	•	Development and implementation of FCA research program for internal and external costs
		Work on development of Business Partnerships to Promote FCA
		Communication of FCA Beyond Ontario Hydro

* "Stakeholdering" is the term Ontario Hydro uses to describe the process of consulting and seeking input from interested parties in the business, government, and environmental communities.

2. How Does Ontario Hydro Define Full Cost Accounting?

Ontario Hydro calls its approach to integrating environmental considerations into business decisions "full cost accounting" (FCA). Ontario Hydro defines FCA as follows:

> Full Cost Accounting (FCA) is a means by which environmental considerations can be integrated into business decisions. FCA incorporates environmental and other internal costs, with external impacts and costs/benefits of Ontario Hydro's activities on the environment and on human health. In cases where the external impacts cannot be monetized, qualitative evaluations are used.[4]

[4] *Ontario Hydro's Corporate Guidelines for Full Cost Accounting* (September 1995). The Guidelines appear in full in Attachment A of this case study. They have been endorsed by Ontario Hydro's Management Committee and discussed at Ontario Hydro's Board of Directors in October, 1995, by the Sustainable Development Committee. These guidelines were tested with a number of stakeholders, including environmental, financial institutions, customers, and government

Ontario Hydro recognizes that some definitions of full cost accounting include only "internal costs" (also termed "private costs"), which are the costs that affect a firm's bottom line, and exclude "external costs" (also termed "societal costs") which is a term used to describe monetized impacts on human health and the environment that currently are not reflected in a firm's bottom line.[5] Ontario Hydro's approach explicitly encompasses both internal costs and external impacts (both positive and adverse), even if the latter cannot be quantified or expressed as external costs (i.e., fully monetized in dollars). In developing their FCA Corporate Guidelines,[6] Ontario Hydro defined the following key terms:

- ***Internal costs*** can be thought of as the costs Ontario Hydro incurs in doing business. However, in some corporations, including Ontario Hydro, there are often less tangible, hidden, or indirect internal costs, including environmental costs, that often are not identified separately or are misallocated to corporate or business unit overheads (e.g., contingent costs, community relations costs). If a business unit is not considering these costs, then the business may not understand the true costs of its products and services, and may, as a result, be making inappropriate business decisions.

- ***External impacts*** or externalities are effects on the environment and on human health that result from Ontario Hydro's activities, but are not included in the costs of its products and services. These impacts are therefore borne by society.

- ***Monetized external impacts*** are external impacts for which Ontario Hydro has developed monetary values. To date, Ontario Hydro has developed preliminary external cost estimates for the operation of its fossil stations and external cost estimates for fuel extraction through to decommissioning for its nuclear generating stations.

- ***Non-monetized external impacts*** are external impacts which can be described only qualitatively because there are scientific limitations in describing the full range of environmental and human health impacts. In other cases, the impact can be quantified (in physical units) but there are limitations in developing appropriate monetized values.

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representatives.

[5] See *An Introduction to Environmental Accounting As A Business Management Tool: Key Concepts and Terms*, EPA 742-R-95-001 (May 1995) and *Finding Cost-Effective Pollution Prevention Initiatives: Incorporating Environmental Costs into Business Decision-Making* (1994, Global Environmental Management Initiative (GEMI)).

[6] *Ontario Hydro's Corporate Guidelines for Full Cost Accounting* (1995). See Attachment A.

Exhibit 3 illustrates how these concepts relate to each other. Ontario Hydro has explicitly acknowledged that the dividing line between internal and external costs is not static. For example, a cost that Ontario Hydro considers external today may be internalized tomorrow because of new environmental regulations or corporate standards. Ontario Hydro's long-term goal is to better incorporate environmental impacts and costs into planning and decision-making.

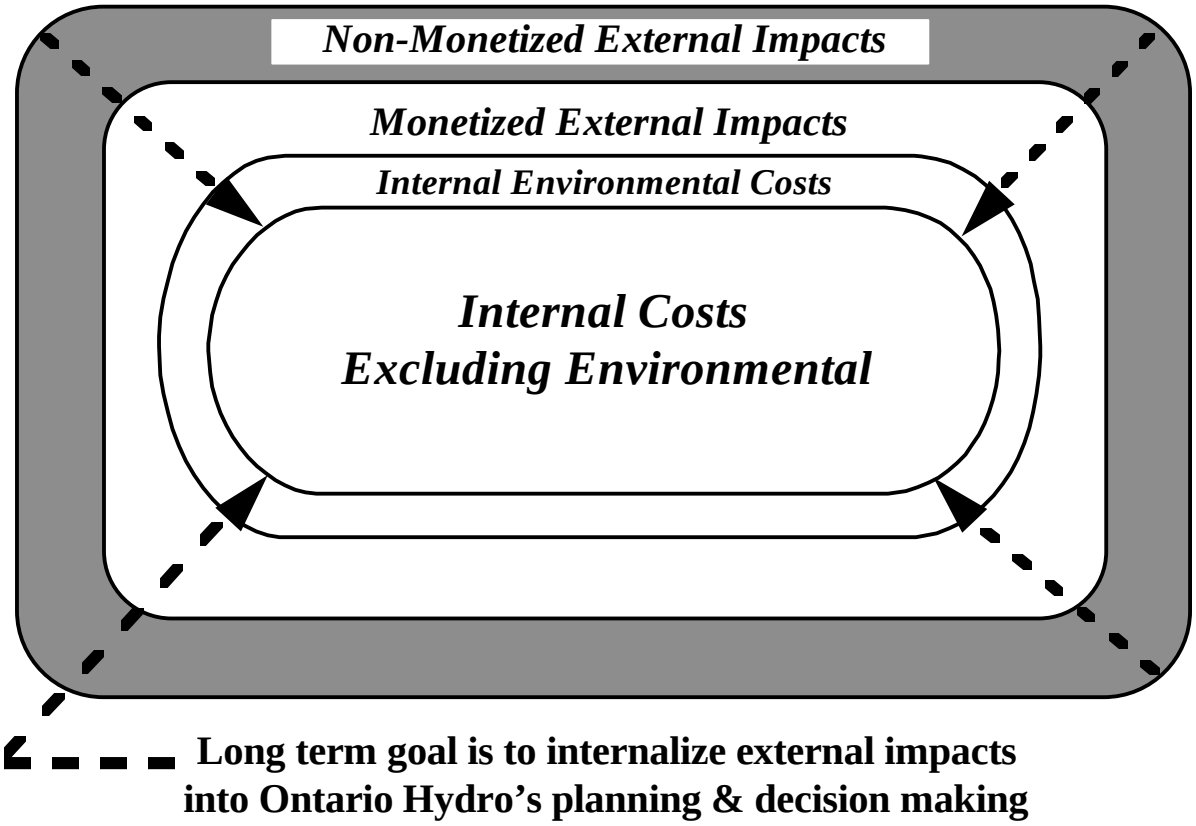
For Ontario Hydro, FCA is

- not THE decision-making process,
- not full cost pricing,
- not an accounting system, and
- does not require absolute or complete monetization of all internal and external impacts.

All four points are important. Ontario Hydro sees FCA as providing information necessary but not sufficient for decision-making. Ontario Hydro uses full cost information as an input to its decision-making, not as the sole basis for making decisions. At this time, Ontario Hydro has no plans to include external costs in

Exhibit 3

ONTARIO'S HYDRO'S APPROACH TO FULL COST ACCOUNTING



electricity prices; FCA does not require the corporation to adopt full cost pricing. Because Ontario Hydro's goal is to use FCA in planning and decision-making, its focus is on changing management behavior, not accounting systems. Ontario Hydro feels that their information systems are only as good as the information put into them. They note that internal and external environmental costs must be calculated *before* they can be put into an accounting system. (For example, an accounting system will not have the capability to quantify and monetize externalities). Finally, while quantification and monetization of externalities is desirable whenever possible, the key for FCA at Ontario Hydro is that environmental impacts be considered in planning and decision-making whether or not the impacts can be quantified or monetized.

3. How Did Ontario Hydro Account for Environmental Costs Before Committing to Full Cost Accounting?

This section describes how Ontario Hydro approached internal and external costs in the years prior to 1993.

3.1 Process for Measuring Internal Environmental Expenditures

> **Environmental Spending** is any monetary expenditure, revenue, or revenue foregone, whether capitalized or charged to current operating expenses, made by Ontario Hydro for the primary reason of sustaining or protecting the environment. This definition includes any cost incurred for control, reduction, prevention, or abatement of discharges or releases to the environment of gaseous, liquid, or solid substances, heat, noise, or unacceptable appearance.
>
> — 1993 Environmental Performance Report

Although most major companies in Canada, including utilities, do not collect and report overall environmental spending data, Ontario Hydro has been estimating its environmental expenditures since 1989. Revised in 1991, the guidelines developed by Ontario Hydro's environmental staff and business managers, entitled "Environmental Cost Concepts, Principles and Accounting Guidelines", serve as the basis for identifying environmental outlays and estimating environmental spending levels that indicate the environmental component of over 130 individual spending categories[7]. For example, outlays associated with monitoring ground water conditions at ash and solid waste disposal sites are considered 100 % environmental, while solid waste disposal site preparation expenses associated with construction activities are considered only 25 % environmental. For some activities, *incremental* expenditures incurred to reduce environmental impacts are treated as environmental spending; for example, the incremental cost of right-of-way maintenance to reduce herbicide use is considered 100 % environmental.[8]

Ontario Hydro's estimates of environmental spending are compiled in a couple of ways:

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[7] The Environmental Spending Guidelines were originally developed in 1982 and were up-dated in 1991. See Attachment B for Ontario Hydro's Environmental Spending Guidelines.

[8] Attachment B offers more examples of environmental expenses identified by Ontario Hydro.

(1) Environmental spending is estimated by each business unit in terms of operations, maintenance, and administration (OM&A); major capital initiatives; and fuel and related;

(2) Environmental spending is categorized by: material and waste management, water management, air management, land use management, environmental approvals, and energy efficiency.

Because Ontario Hydro's environmental expenditures have not routinely been identified through its accounting system, the data have been manually collected and judgement applied to define the percentage of expenditures classified as environmental. As a result, the spending estimates represent a "best judgement" and are considered gross estimates at best. Moreover, Ontario Hydro notes that the figures for capital expenditures include only major project initiatives and may not represent all outlays on capital. Since 1989, the results have been provided to Ontario Hydro's Board of Directors and summarized in the company's *Annual Sustainable Development and Environmental Performance Report*. One of Ontario Hydro's goals is to better define and allocate internal environmental costs to enable it to make better decisions and ensure value from environmental expenditures.

3.2 Externalities Research

This section describes the history and status of externality research at Ontario Hydro prior to 1993 and explains Ontario Hydro's approach to quantifying and monetizing externalities.

Ontario Hydro has been investigating externalities for many years. For the past twenty years, as part of its license application process to export electrical energy to the United States, Ontario Hydro has been required to submit external cost studies to the National Energy Board of Canada to demonstrate that Ontarians are not being adversely affected by incremental generation for such sales. This led Ontario Hydro to the development of a methodology for identifying, quantifying and monetizing external impacts and costs for its fossil and nuclear electricity generation system.

In 1991, Ontario Hydro established a Steering Committee on Environmental Costs (SCEC) with a mandate to coordinate and oversee all of Ontario Hydro's work on external environmental costs and benefits. In 1992, Ontario Hydro adopted a corporate position to adopt the damage function approach for quantification and *monetization*[9] of external environmental impacts.

Ontario Hydro's Approach for Quantifying and Monetizing Externalities. There are two main approaches currently being used by industry and government to place monetary value on externalities: (1) the cost of control approach, and (2) the damage function approach. The cost of control approach uses the cost of installing and operating environmental control technologies as a proxy for the dollar value of actual damages. The damage function approach uses site-specific data and modelling techniques combined with economic methods to estimate external impacts and costs.

Ontario Hydro supports the damage function approach to quantifying and monetizing externalities and has used this approach since 1974. Although the cost of control approach is the simpler of the two approaches to calculate, Ontario Hydro does not support its use because it bears little relationship to environmental impacts and costs. Because the cost of control approach does not account for site-specific environmental factors or impacts, the external cost estimates derived for two similar power stations would be the same even if one station was located close to an urban center while the other station was in a rural area. The cost of control approach also is limited to pollutants for which control technology is available. The damage function approach, on the other hand, attempts to place a dollar value on the actual impacts to human health and the environment by considering site-specific impacts. Ontario Hydro advocates using market prices to estimate monetary values for those impacts (e.g., crop losses) that are traded in the market. For impacts that are not explicitly traded in markets (e.g., human health and mortality), Ontario Hydro believes

[9]Ontario Hydro defines monetization to mean the process of developing appropriate monetary (i.e., dollar) values for the impacts of emissions/pollutants on the environment.

that a number of valuation techniques can be used to derive estimates of willingness to pay (WTP) or willingness to accept (WTA) for changes in environmental quality[10].

Ontario Hydro has acknowledged that even the most accurate externality estimates can be extremely sensitive to site-specific factors. For example, some pollutants create problems only when combined with other pollutants whose presence varies considerably from site to site. As a result, transferring damage cost estimates from one site to another can be very controversial. In addition, because damage estimates are based on scientific evidence regarding the relationship between pollution and human health, crop production, natural resources, materials, visibility, etc., impact estimates are limited by the nature of the scientific data available. Acknowledging these uncertainties, Ontario Hydro believes that the real benefit of the damage function approach is its focus on potential site-specific damages to receptors.

4. Why Did Ontario Hydro Address Full Cost Accounting?

The activities described in the previous section were brought under the FCA framework in 1993 as part of Ontario Hydro's Task Force on Sustainable Energy Development initiative. This section describes the context for FCA as a key component of Ontario Hydro's committment to sustainable development.

4.1 Commitment to Sustainable Development

One of the major catalysts for Ontario Hydro's committment to sustainable development was the appointment of a new Chairman, Maurice Strong, in late 1992, who in addition to his mandate to re-structure the corporation, also had a strong sustainable development focus.

[10] For more information, see Attachment C.

Chairperson Maurice Strong came to Ontario Hydro with a personal commitment to sustainable development[11]; he recognized that movement towards sustainable energy development (SED) would be a key priority for the future. As a result, in 1993, Ontario Hydro incorporated sustainable development into its mission statement as follows:

> Ontario Hydro's mission is "to make Ontario Hydro a leader in energy efficiency and sustainable development, and to provide its customers with safe and reliable energy services at competitive prices."
>
> – Ontario Hydro

Ontario Hydro views sustainable development as a long-term strategy for achieving business success within environmental limits. Ontario Hydro defines sustainable development as "development which meets the needs of present generations without compromising the ability of future generations to meet their own needs[12]". Ontario Hydro believes that moving towards sustainable development will enable it to simultaneously make progress on environmental goals and cost reduction, job creation, and competitiveness. It also believes that business competitiveness cannot be achieved separately from environmental sustainability.

> Sustainable development is a matter of economic survival in a world of finite resources and unlimited desire for growth. For present and future generations to enjoy a good quality of life, government, industry, and individuals need to become ever more efficient in the use of materials and energy, minimize wastes through recycling and reuse, and develop new disposal methods.
>
> — Maurice F. Strong, Chairperson

The SED concept applies the principles of sustainable development to the energy sector. A fundamental tenet of SED is the efficient use of energy, human, financial, and natural resources. In this view, business success, ecological limits, and inter-generational equity are related and should be managed

[11] Prior to coming to Ontario Hydro, Maurice Strong played a major role in the United Nations Conference on Environmental and Sustainable Development in Rio de Janeiro in June 1992.

[12] World Commission on Environment and Development, 1987.

together to drive decisions which are "ecologically efficient" under the framework of SED. To emphasize that SED should not be seen as an add-on, Dr. Al Kupcis, President and CEO of Ontario Hydro, indicated to business unit leaders that he did not expect to see specific SED action plans, but rather, wanted SED to become the business norm throughout business units' planning processes.

Ontario Hydro acknowledges SED as a long-term goal. To move towards this goal, Ontario Hydro recognizes that its economic activities must be balanced with the capability of the Earth's ecosystems to respond to the stresses or changes caused by those activities. To do this, Ontario Hydro may need to make investments in the near term that do not meet its normal “payback period” requirement. The evaluation of such investments will need to take into consideration the possibility for longer term benefits for both the environment and business. Ontario Hydro believes that by taking some actions now in order to reduce resource consumption, promote pollution prevention, and minimize wastes, and reduce environmental damage, it can contribute to the long term objective of creating a healthier environment and saving resources available for future use.

4.2 Relationship Between Sustainable Energy Development and Full Cost Accounting

What is the relationship between Ontario Hydro's commitment to SED and its sponsorship of FCA? Ontario Hydro sees FCA as one of the cornerstones of its sustainable development strategy. Of the ten central elements Ontario Hydro identified for SED actions, two were as follows:

- integrate environment and economics in decision-making, and
- adopt full cost accounting (FCA).

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* Energy utilities can meet their mandates to serve the needs of their customers by using a combination of two different strategies: (1) delivering power to meet energy requirements through various conventional and alternative supply options, and (2) helping customers use energy more efficiently, termed "demand side management" or "demand management."

FCA can support sustainable development by helping to ensure that internal and external environmental impacts and costs are factored into business decisions. By better understanding the internal and external environmental costs associated with its activities, including quantifying, and where possible, monetizing externalities, and incorporating this information into planning and decision-making, Ontario Hydro expects to be in a better position to fulfill its sustainable development mission and enhance its competitiveness. Ontario Hydro articulated in 1993 the following expected benefits from introducing FCA:

- provides a powerful incentive to search for the most economic ways of reducing environmental damage
- leads to choices that include explicit consideration of the present and future environmental impacts of alternative options
- should lead to a more efficient and effective use of resources
- should help in "leveling the playing field" when evaluating demand and supply options (e.g., demand side management, alternative power generation technologies, conventional supply options)*

Notably, the FCA framework encompasses Ontario Hydro's ongoing efforts to estimate both internal environmental spending and external environmental impacts and costs.

5. How Did Ontario Hydro Address Full Cost Accounting?

In 1993 two important and related events occurred at Ontario Hydro that catalyzed its commitment to FCA and have served as an impetus for action in 1994 and beyond. These events included:

(1) The formation of the Sustainable Energy Development (SED) Task Force and the completion of its report *A Strategy for Sustainable Energy Development and Use for Ontario Hydro* (October, 1993), and, in conjunction with the SED Task Force,

* Energy utilities can meet their mandates to serve the needs of their customers by using a combination of two different strategies: (1) delivering power to meet energy requirements through various conventional and alternative supply options, and (2) helping customers use energy more efficiently, termed "demand side management" or "demand management."

(2) The establishment of a Full Cost Accounting (FCA) Team (as part of the SED Task Force initiative) and the completion of its report *Full-Cost Accounting for Decision-Making* (December, 1993)

The FCA Team Report served as the background document for the SED Task Force recommendations on FCA discussed below.

5.1 Established SED Task Force

> "The Sustainable Energy Development (SED) Strategy developed in 1993 reinforced and will build on many effective environmental initiatives already in place, but more than this, it provides the strategic vision and direction for further progress and new initiatives."
>
> — Maurice F. Strong, Chairperson

In June 1993, Chairperson Maurice Strong commissioned a special Task Force to develop a strategy for Sustainable Energy Development (SED). In launching the Task Force, Chairperson Strong stated, "We must examine ways and means to incorporate full cost accounting in our financial planning and controls and to monetize externalities and incorporate them in our planning." On June 3, 1993, the 12-member Task Force (assisted by over 150 Ontario Hydro staff members) held its first meeting, organizing itself into ten teams for gathering data, identifying and analyzing issues, and formulating recommendations. In September, the Task Force met to review and finalize its report and recommendations. The *Strategy*, including FCA recommendations, was formally submitted to the Board in October, 1993.

5.2 Established Full Cost Accounting Team

The FCA Team was one of the ten teams formed by the SED Task Force. The team consisted of eight members representing environmental economics, corporate finance, management, financial accounting, environmental, and planning functions. When necessary, other contributors were called on for expertise in environmental science, engineering, and strategic planning. The Team's mandate was to:

- Define full cost accounting and examine how it relates to Ontario Hydro's internal accounting and decision-making systems.

- Based on availability of data, provide estimates of internal and external costs of Ontario Hydro activities where possible. Identify data requirements and propose a research program to expand upon existing estimates of internal and external costs and develop external environmental cost estimates of the full range of Ontario Hydro's activities.

- Determine how internal and external costs can be integrated into a full cost accounting framework for Ontario Hydro.

- Examine the potential applications of full cost accounting and assess the implications of its implementation at Ontario Hydro.

Building on past research, the FCA Team worked on an accelerated schedule established by the SED Task Force to analyze issues and develop recommendations. Team efforts entailed conducting substantial research and discussion to explore internal costs and externality quantification and monetization. The FCA Team held a "Full Cost Accounting Workshop" in June of 1993 and invited other Canadian and U.S. environmental economists and accountants to share their knowledge of FCA, comment on Ontario Hydro's work, and offer guidance on next steps. The FCA Team presented its recommendations to the SED Task Force and later issued a detailed report entitled *Full Cost Accounting for Decision-Making* (December, 1993). The report defined the concept of FCA, discussed the incorporation of full costs into Ontario Hydro's accounting and decision-making frameworks, presented a preliminary and partial assessment of external impacts and costs associated with Ontario Hydro's activities, and documented the FCA Team's recommendations for developing and implementing FCA.

6. What Did Ontario Hydro's Full Cost Accounting Team Recommend?

The following recommendations were created by the FCA Team and represent a detailed set of suggested next steps that were grouped into these umbrella recommendations:

Ontario Hydro 1993 Full Cost Accounting Recommendations

(1) Modify the current accounting system into a full cost accounting system

(2) Augment the current financial evaluation framework

(3) Support a research program on full cost accounting

(4) Initiate a training program on full cost accounting

(5) Take full cost accounting beyond Ontario Hydro

(6) Establish a fund for decommissioning, waste disposal, etc.

More detailed information on the FCA Report, these recommendations, and the reasons the team made these recommendations are available in Attachment D. Section 7 summarizes Ontario Hydro's implementation activities in response to these recommendations.

7. What Has Ontario Hydro Done To Implement Full Cost Accounting?

The 1993 FCA report represented a "wish list" for FCA at Ontario Hydro. In moving ahead, Ontario Hydro has taken a more practical approach, and, in doing so, can report many concrete accomplishments. This section describes the many initiatives undertaken by Ontario Hydro to develop and implement FCA since 1993.

The first step was to establish an institutional foundation responsible for managing the implementation of the *SED Strategy*. To do this, Ontario Hydro created division called the Environment and Sustainable Development Division (ESDD). As part of ESDD, the Business/Environment Integration (BEI) Department was established, which is responsible for FCA. The mandate of this department is to identify and implement means to better integrate environmental considerations into business decisions. Seven full-time staff are involved in these activities; developing and implementing FCA is a significant part of this work.

7.1 Established FCA Corporate Guidelines

In 1995, ESDD developed *Corporate Guidelines* for FCA. The *Guidelines* define key terms, state the goal of FCA at Ontario Hydro, articulate Ontario Hydro's rationale for FCA, describe how Ontario Hydro plans to use FCA, delineate roles and responsibilities, and lays out an implementation plan through 1997[13].

Ontario Hydro's *Corporate Guidelines* articulate several reasons for supporting FCA:

- **Improved environmental cost management** – improve identification, allocation, tracking, and management of environmental costs in each business unit;
- **Cost avoidance** – improve ability of business units to anticipate future environmental liabilities and costs, so that corrective action can be implemented earlier;
- **Revenue enhancement** – improve ability of business units to identify revenue enhancement opportunities either through environmental technology innovations spurred by cost cutting initiatives or by strategic alliances with companies that use waste products as material inputs in their own manufacturing;
- **Improved decision-making** – aid business units to better integrate environment into decision analyses;
- **Environmental quality improvement** – establish an optimal level for reducing emissions/effluents/wastes with consideration for least cost to society;
- **Contribution to environmental policy** – contribute effectively to the development of environmental regulations/standards and emissions trading markets, and
- **Sustainable development** – assist in the transition to a more sustainable energy future.

Ontario Hydro's adoption of FCA guidelines represents a fundamental change in the way it expects to do business.

> Managing resources wisely and minimizing environmental damage will also contribute to Ontario Hydro's competitiveness, particularly in the longer term. By better understanding the environmental impacts of its activities and by making better resource allocation decisions based on this information, Ontario Hydro can save money, become more competitive, and move towards the goal of sustainable development.
>
> – Ontario Hydro Corporate Guidelines for FCA (September 1995)

[13] These *Guidelines* appear in full as Attachment A of this case study.

Ontario Hydro has conducted stakeholdering of its corporate FCA guidelines in order to communicate its approach to interested parties and respond to their questions and comments. As part of this process Ontario Hydro convened a full day, professionally-facilitated workshop in September 1995. Participants included representatives of the energy sector, consumers, environmentalists, university researchers, and government agencies. Stakeholders were encouraged to raise issues and air any concerns. The facilitator sought their perceptions of the merits and constraints of the draft *Corporate Guidelines* and the proposed FCA Research Programme. Overall, the majority of workshop participants supported Ontario Hydro's efforts to develop and implement FCA and viewed the *Corporate Guidelines* as a reasonable step in that process.

7.2 Applied FCA to Decision-Making

Ontario Hydro anticipates that FCA will evolve over time. Incorporating FCA into decision-making will take place on a step-by-step, pragmatic basis. In response to the FCA recommendations, Ontario Hydro has already taken concrete steps such as adding environmental considerations into investment decisions by implementing SED decision criteria in 1994, as described below.

Traditionally, environmental analysis and evaluation at Ontario Hydro have focussed on compliance with environmental regulations. In the past, a generic set of questions was used to ensure consideration of the environmental implications of proposed projects or plans going to the Board of Directors for approval. These questions were:

- What are the environmental implications of this proposal? What environmental approvals are required?
- Does this proposal comply with existing environmental regulations? Is there sufficient flexibility to respond to more stringent, future environmental regulations?

- Is this proposal consistent with existing corporate environmental initiatives?
- Will this proposal contribute to a policy of sustainable development; for example: will waste products be recycled? Has energy efficient equipment been incorporated?
- Will this proposal create a significant public concern – real or perceived? If so, then what measures are being considered to offset this effect?
- What are the environmental alternatives for/to this proposal? What are the relative merits of these alternatives?

Although this checklist of environmental considerations may have been effective in eliciting the general environmental implications of a proposal, this approach was quite limited. It relied mainly on qualitative and often subjective data. Because information on environmental impacts was not explicitly incorporated and monetized into cost information, Ontario Hydro had limited ability to rank investment alternatives using a common denominator.

SED Decision Criteria. Effective September 1994, Ontario Hydro introduced new SED Decision Criteria as part of its Business Case Analysis Guidelines for evaluating investment decisions requiring senior management approval. The SED criteria represent a framework for Ontario Hydro to integrate environmental and economic information into decision making. In addition, the SED criteria, notably the environmental impact subcriterion, reflect an FCA approach. The SED criteria are intended to help Ontario Hydro's business units describe and evaluate the SED implications of expenditure decisions going to senior management or the Board of Directors for approval. Ontario Hydro believes that the SED decision criteria reflect its commitment to sustainable energy development and the movement towards FCA.

Life Cycle Costing and FCA

Ontario Hydro has considered concepts of life cycle costing (LCC) in developing its strategy for FCA. For internal costs, Ontario Hydro considers the full fuel cycle, inventorying energy requirements and generation of wastes/pollution. For external costs, involving the consideration of damages to human health and the environment, Ontario Hydro aims to consider the full life cycle but expects to emphasize at a minimum the stages of the life cycle over which Ontario Hydro has direct control and responsibility: design, construction, operation and maintenance, and decommissioning/disposal.

The SED criteria require that Ontario Hydro consider a project's (1) resource and energy use

efficiencies, (2) environmental impacts, (3) social impacts, (4) employment of renewable energy sources, and (5) financial integrity. The five criteria were chosen because they are the macro SED indicators that Ontario Hydro uses to gauge its SED performance. According to the criteria, the evaluation should consider:

- full life cycle impacts, where possible, but at a minimum, design, construction, operation, maintenance, decommissioning, and disposal;
- *expected* damage to ecosystems, community, and human health (i.e., versus ability to meet existing or proposed environmental regulations);
- *potential* positive and negative environmental impacts, including impacts that may be common to all the project alternatives being compared
- *quantification and monetization* of the potential impacts, where possible; but at a minimum a qualitative description; and
- *trade-offs* made in selecting the preferred alternative.

Ontario Hydro expects that this analysis will uncover relationships between competitiveness and sustainability that might otherwise go unnoticed and, as a result, lead to better investment decisions.

President and CEO Al Kupcis has charged Ontario Hydro's ESDD staff with providing senior management with an independent review of the SED component of business case summaries. ESDD staff also are available to work with the business units to advise on SED during the development of business case summaries. Since the SED criteria were implemented in 1994, 19 BCAs have been reviewed. The majority of these BCAs addressed the criteria appropriately and were recommended for senor management approval. In some cases, the SED implications analysis was effective in the development of alternatives that incorporated the principles of sustainable development. The SED analysis also exposed business unit staff outside of the environmental functions (ie., financial staff) to sustainable development issues.

As an example, in one case, a proposed investment decision for a $24 million transmission line refurbishment, the SED implications were:

- 20% reduction in energy loss in transmission lines through the use of energy efficient conductors;
- $.5 million annual increase in revenues through the re-use and recycling of removed line components;
- initiation of a program to improve the biodiversity of rights-of-way by restoring and replacing natural habitats; and
- provision of employment and economic benefits to local communities.

This investment decision was approved.

7.3 Applied FCA to Planning

In addition to major investment decisions, Ontario Hydro has used FCA for such planning activities as the following:

- **Corporate Integrated Resource Plan (CIRP)**[14] is a business-wide, strategic exercise to evaluate different supply generation and demand management plans for the future. One of the criteria used to assess the plans was environmental impact. The assessment was performed on an environmental damage basis (using the damage function approach), consistent with Ontario Hydro's corporate guidelines for FCA. Impacts were either quantified, and monetized where possible, or qualitatively described, depending on the data available. Additional SED considerations were included in the form of "committed impacts," that is, impacts that would have to be managed by future generations (e.g., used nuclear fuel in storage; consumption of non-renewable resources; greenhouse gas emissions). The analysis was performed on a life-cycle basis.
- **Local Integrated Resource Plans (LIRPs)** address tradeoffs in supply and demand management options for specific geographic areas with potential supply shortfalls. Ontario Hydro initiated six LIRP studies in 1993 and carried out nine LIRP studies in 1994. LIRP studies examine a wide range of options, including demand side management (DSM) strategies, to meet customer needs. These studies offer customer participation in decision-making and aim to provide solutions that harmonize with environmental and social objectives. In 1994, Ontario Hydro evaluated environmental and other plan attributes such as cost and reliability within one LIRP Process. Other LIRP studies have shown that DSM programs could defer the need for constructing major new capacity.

[14] "The objective of integrated resource planning is to ensure that all available options are considered in determining how best to meet customer energy needs." Ontario Hydro 1994 Sustainable Development/Environmental Performance Report.

In time, Ontario Hydro also plans to incorporate FCA into procurement decisions; Ontario Hydro procures about $1 billion each year in goods and services.

Use of Multi-Criteria Analysis in Planning . Because Ontario Hydro has not yet developed monetized environmental impact estimates for all available supply, demand side management, and transmission options, an evaluation method is required to facilitate comparison of environmental impact information expressed in different units (qualitative, quantitative, and where available, monetized) and to integrate such data into Ontario Hydro's decision-making and planning processes. A similar evaluation method is also required to compare and make trade-offs between environmental and other plan attributes (cost, reliability, risk, etc.) in the planning process. Ontario Hydro uses Multi-Criteria Analysis (MCA) for these purposes.

MCA has been used in both Ontario Hydro's CIRP and LIRP processes to evaluate and compare these environmental "unlikes," evaluate and compare environmental and other (e.g., cost, reliability) plan attributes, and make trade-offs. In 1995, MCA was used to select the key environmental indicators for evaluating the CIRP plans. In addition, Ontario Hydro is currently using MCA to evaluate plan attributes within its ongoing LIRP processes. Ontario Hydro believes that approaches such as MCA, combined with FCA, are necessary to evaluate trade-offs in decision-making and planning.[15]

7.4 Undertook Full Cost Accounting Research

Ontario Hydro has undertaken recent research on internal environmental cost accounting and external impact and costs issues. The following is a brief description of the results.

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[15]Ontario Hydro's application of MCA is described in: Boone, C., Howes, H. & Reuber, B.. "A Canadian Utility's Experience in Linking Sustainable Development, Full Cost Accounting and Environmental Impact Assessment", Toronto: Ontario Hydro, June 1995.

Internal Environmental Cost Research

Environmental Expenditures and Overhead Accounts. Ontario Hydro believes that to implement full cost accounting, it must be able to isolate (i.e., distinguish from other types of expenditures) environmental expenditures, particularly from overhead accounts. For example, payments pursuant to compensation agreements with aboriginal peoples have traditionally been allocated to corporate overhead rather than to a business unit. Ontario Hydro is minimizing the practice of charging expenses to overhead accounts, and has implemented the following procedures to ensure that each business unit is accountable for its own costs:

- All costs are incurred by or allocated to business units;
- Overhead charges for corporate services are limited only to those costs for which fees cannot be reasonably charged.

Making each business unit responsible for its own expenditures and costs helps Ontario Hydro achieve better internal environmental cost information, thereby minimizing cross business unit subsidization and the amount of money charged to general overhead accounts. Some business units are in the process of evaluating and implementing activity-based costing (ABC) systems, which will further aid Ontario Hydro in identifying and managing environmental costs.

Allocation of Energy Efficiency Expenditures as Internal Environmental Costs. In 1994, Ontario Hydro expanded its definition of environmental expenditures to include costs associated with improving internal and customer energy efficiency. Exhibit 4 presents Ontario Hydro's estimated environmental expenditures for 1994[16]. Ontario Hydro's annual environmental report for 1994 presents the totals shown in the last column.

[16] All sums are in Canadian dollars and may not add due to rounding.

Exhibit 4: Ontario Hydro Estimates of Environmental Spending (1994) ($M)*

Category	OM&A	Capital	Fuel & Related	Total
Material & Waste Management	30	49	20	**100**
Water Management	5	8	0	**13**
Air Management	15	53	16	**83**
Land Use Management	14	0	0	**15**
Environmental Approvals	19	7	0	**25**
Energy Efficiency	26	69	0	**95**
TOTAL	**109**	**186**	**36**	**331**

* As of March 27, 1996, the official exchange rate was one U.S. dollar = .73427 cents of one Canadian dollar.

Ontario Hydro is currently investigating methods to obtain more precise information on its internal environmental expenditures at the project/process level, to track and allocate these expenses on a life-cycle basis, and to accomplish this more explicitly than in the past. As the first step in this process, Ontario Hydro is undertaking a pilot study within one of its Retail Utilities. The pilot project is described below.

Internal Environmental Cost Pilot This pilot project is currently underway at Southwest Hydro, one of the thirteen retail utilities owned and operated by Ontario Hydro, and located in Southwestern Ontario. The Southwest Hydro Utility territory includes approximately 75,000

customers and had a net income of $19 million in 1995. The goal of the pilot project is to identify and collect all internal environmental costs associated with Southwest Hydro's activities, identify and prioritize processes or products having higher environmental costs and liabilities, and develop recommendations leading to cost savings, cost avoidance, revenue generation, waste reduction and improved image in the community for the Utility. Results from the pilot project are expected to benefit other management of the business.

Since environmental expenditures at present are not identified and recorded separately throughout Ontario Hydro's accounting system, the process of collecting environmental costs involved estimation based on physical data available or obtained through interviews with Utility personnel, use of data from other Utilities as proxy, and various other sources of information. A list of all major environmental activities and associated costs was then prepared by manually collecting data by separating environmental costs from other operating and capital costs, using environmental expenditure guidelines and allocation methods based on work practices and employees' experiences. Costs that were incurred and recorded as a one time expenditure were annualized.[17]

Internal environmental costs were defined as expenditures on both external and social environmental initiatives, whether capitalized or charged to operations for equipment, labour, fuel and program to protect and restore the environment. The scope of this project covered costs incurred by the utility and did not include estimation of external costs relating to environmental impacts from its operations.

[17] spread over frequency of occurrence, i.e., incurring every 4 - 5 years.

The total environmental costs were approximately 15% of the Utility's Operating, Maintenance, and Administrative (OM&A) costs and 8% of the total annual expenditures. The top five environmental activities and associated costs were related to fuel consumption, transformer management, Polychlorinated Biphenyls (PCBs), energy efficiency, and forestry work. While PCBs and energy efficiency enhancement related expenditures were classified as being 100% environmental, other like fuel consumption, transformer management, and forestry did not attribute entirely to environmental costs, as they were incurred to meet operating requirements.

It is expected that the analysis of the results will lead to identification of cost drivers, fixed vs variable costs, regulatory vs non-regulatory costs, high risk vs low risk costs and future liabilities. Opportunities for managing these environmental costs and risks will also be identified for further analyses, such as evaluation of low cost wast management/recycling options, green procurement (steel poles and pole extensions), alternate fuels for fleet (ethanol, gas), moving to PCB free operations, adopting natural landscaping, investigating line loss reduction options (shunt capacitators and transformer sizing), possible out-sourcing of fueling to reduce risk from underground tank leakages, optimizing of tree trimming cycles, future partnerships with other service providers (Bell, Cable TV, Parks for RET applications). The results from the pilot study are also expected to help in benchmarking environmental expenditures and in the Utility's business planning and budgeting activities. The pilot project is expected to be completed by 1Q/96.

Externalities Research

As mentioned in the definition of externalities contained at the beginning of this case study, even after existing environmental regulations have been met, there are still residual emissions with associated environmental damage. It is Ontario Hydro's view that by better understanding these "residual" environmental impacts that the corporation will be in a better position to reduce future environmental liabilities and enhance its competitive position in the future. It is for this reason that Ontario Hydro is pursuing research on its external impacts and their associated costs. By understanding the external impacts and costs of its operations, Ontario Hydro can be better positioned to respond to tighter future regulations by developing process changes now to reduce its externalities, as well as better managing future environmental liabilities.

Quantification and Monetization of Externalities. Ontario Hydro has developed monetized externality estimates for the operation of Ontario Hydro's fossil stations located in southern Ontario and for the full life-cycle of its nuclear stations (Attachment E). These are preliminary estimates and certainly in the case of fossil, underestimate the health impacts associated with the operation of the fossil stations. Monetized externality estimates have yet not been developed for Ontario Hydro's hydroelectric stations, transmission or distribution line systems, renewable energy technologies or demand side management initiatives.

> Ontario Hydro supports the Damage Function Approach, rather than the Cost of Control Approach, to identify, quantify, and where possible, monetize, the external impacts of the full life-cycle of its activities. This approach first considers site-specific environmental and health data; then uses environmental modelling techniques which consider how emissions/effluents etc. are transported, dispersed or chemically transformed in the environment; and then considers what receptors (e.g., people, fish) are affected by these emissions. Finally economic valuation techniques are applied to translate physical impacts into monetary terms.
>
> – Ontario Hydro's Corporate Guidelines for FCA (September 1995)

In the summer of 1993, the FCA Working Group expanded upon previous work completed within the Corporation to identify, quantify and monetize external impacts and costs associated with Ontario Hydro's activities. Preliminary estimates were derived for external impacts associated with the operation of Ontario Hydro's fossil stations located in southern Ontario. Estimates were also also developed for the nuclear system on a full life-cycle basis.[18] Monetized estimates of physical impacts (i.e., statistically estimated impacts in terms of human mortality, morbidity, crop losses, and building material damages) were developed based on the use of per unit dollar values it had previously developed. The estimates are provided in Attachment E. As an example, Exhibit 7 presents one of the resulting tables; it summarizes the FCA Team's preliminary estimates of the system's average external costs due to the generation of electricity in Ontario using fossil fuels.[19] As shown, the external costs associated with statistical premature mortality were estimated to be about $21.4 million (in 1992 Canadian dollars) or 0.088 cents per kilowatt. For all the impacts considered, the average monetized estimate was $95.79 million or 0.395 cents per kilowatt.

Exhibit 7: Monetized External Impacts of Fossil Generation in Ontario*

Receptor	Pollutants of Concern	Unit Values	Monetized Impacts	
			$M 1992	¢/kW
Mortality: (Statistical Deaths)	SO_2, SO_4, O_3, NO_3	$4,725,600	21.40	0.088
Morbidity: (Admissions)	SO_2, SO_4, O_3, NO_3, TSP	$44,700	50.83	0.210
Cancer Cases	Trace Metals	$408,397	9.53	0.039

[18] These preliminary externality estimates are contained in the FCA Team's Report (December 1993) and are expected to change as research progresses.

[19] These monetized impacts are based on the use of a specific methodology -- termed the "damage function approach" -- that was described in Section 3 above.

Crops	O_3	N/A	8.32	0.034
Building Materials	SO_2	N/A	5.7	0.024
TOTAL			95.79	0.395

* As of March 27, 1996, the official exchange rate was one U.S. dollar = .73427 cents of one Canadian dollar.

Since December 1993, ESDD has focussed on developing research priorities to improve its externality impact and cost estimates and to broaden the range of environmental impacts for which externality cost estimates are developed. This is being done by working with the business units to better define and understand their external impacts and costs.

Working Groups. During the period from 1994-1995, a number of "Externalities Working Groups" were established at the business unit level to address issues relating to the development and implementation of FCA within Ontario Hydro and to define and where possible monetize external impacts. The working groups were initatied by the business units to examine externalities and assess how business case analysis could be undertaken with full cost accounting-based information. Examples of three such working groups include:

(1) Energy Services Working Group. This working group involved examining the implications of FCA for the evaluation of demand side management technologies and programs. The group examined environmental impact issues associated with demand side management (DSM) technologies and programs and provided recommendations on how to incorporate environmental externalities into future decisions.

(2) Ontario Hydro Nuclear Working Group. This working group examined the implications of FCA on business decisions relating to nuclear generation of electricity, focussing on environmental impacts and costs (i.e., external costs). The study revisited several recently approved projects and attempted to include FCA considerations. The study identified many items that should be included for a proper treatment of FCA; only some of these items could be included with information currently available. In some cases, FCA would not change the decision; in others, environmental

impacts could be the deciding factor. The study addressed such issues as how to supply data, data consistency, cost-effectiveness of using FCA, necessary infrastructure, training needs, and required corporate guidelines.

(3) Transmission Working Group. A GRID Externalities Team was established to undertake an examination of potential externalities due to activities associated with the transmission and distribution of electricity. The team consists of members from Grid System Strategies and Plans, Grid Operations, Grid Transmission Projects (Environment), Corporate Health & Safety, Corporate Strategic Planning, Aboriginal and Northern Affairs, and ESDD.

The following are examples of GRID group activities:

- identified the life-cycle phases of Grid facilities and activities and, in general terms, activities in each phase of the life-cycle;
- identified potential human health, natural (including ecosystems), and social environmental effects for activities in each phase and categorized them into impact areas. The impact areas were terrestrial and aquatic ecosystems, socioeconomic, human health, and visibility;
- classified the environmental effects either as potential externalities, internal, or internalized costs;[20]
- assigned the potential externalities a high, medium, or low priority; The most significant potential grid-related externalities were identified to be the human health effects of electric and magnetic fields, the effects on ecosystems of transmission corridors, waste disposal issues, and the impact of transmission facilities on property values, recreation, and tourism.
- identified relevant issues for examination; and
- recommended how efforts should proceed towards quantification and, where possible, monetization of the potential externalities through the use of the damage function approach.

In 1995, ESDD developed its FCA research program in consultation with each of the business units and with review and input from stakeholders. The research program is undergoing

[20] "Internalized costs" was used to distinguish what would have been externalities if mitigation had not been undertaken.

review by Ontario Hydro's Business Planning process, as of February 1996. Currently identified priorities are listed on p.43 below.

Ontario Hydro is also monitoring trends in externality-related research in North America and Europe. For example, ESDD participated in an international conference held in Brussels to review research on the social costs of energy. The objective of the Brussels conference was to discuss the state-of-the-art in calculating externalities/impacts of major fuels and review the results of several new studies. Ontario Hydro concluded that the methodologies used, the issues identified, and the estimates of external costs produced by recent studies supported by The European Commission and the U.S. Department of Energy were consistent with those produced by Ontario Hydro. In developing its research program, Ontario Hydro hopes to address some of the issues raised at the conference by other researchers.

7.5 Executed FCA Communication and Education Programs

In 1994, ESDD gave a number of presentations to its Business Leaders (senior managers), line managers, and key support staff. Topics covered included:

- The concept of FCA
- Uses and implications of FCA
- Its implications for planning processes, and
- Tools and techniques for incorporating FCA into decision-making processes.

In March 1994, ESDD delivered a one-day seminar focussing on the externalities component of FCA to sixty (60) environmental and financial staff with representation from all business units. The objectives of the "Externalities Seminar" were to:

- Explain the concept of FCA, focussing on externalities,
- Introduce the economic theory of externalities and describe approaches for their quantification and monetization,
- Describe externalities research,
- Differentiate between environmental and socio-economic externalities, and
- Discuss issues associated with incorporating externalities into planning and decision-making.

ESDD also has developed and delivered shorter presentations to senior level management covering the concept of FCA, its uses and implications, and the status of its development at Ontario Hydro. ESDD prepared similar presentations tailored to specific business unit needs for line managers and working level staff. In addition, ESDD wrote an *FCA Backgrounder (1995)* for internal use. The *Backgrounder* defines FCA, reviews how FCA builds on prior work at Ontario Hydro to incorporate environmental impacts into decision-making, summarizes the status of quantification and monetization of externalities at Ontario Hydro, and identifies next steps for FCA research.

In addition, in 1995, ESDD conducted training seminars on applying the SED Decision Criteria, at the request of the GRID business unit planning function.

7.6 Conducted Outreach Beyond Ontario Hydro

Ontario Hydro has taken a leadership role in fostering broader use of FCA. For example, since the December 1993 completion of the FCA Team Report, Ontario Hydro:

- Began work towards development of business partnerships to promote education on FCA in Ontario and across Canada, develop a network of academic, research, and

professional organizations active in this area; and co-sponsor and promote FCA research that will produce practical results.

- Participated in an FCA study sponsored by the Canadian Institute of Chartered Accountants (CICA) to examine Full Cost-Accounting issues. The project is examining what FCA means, the usefulness of internal and external environmental cost information, primary users of the information, the practicality of implementing FCA, and potential problems and solutions.

- Provided input to the Business Council on Sustainable Development (BCSD) report *Internalizing Environmental Costs to Promote Eco-Efficiency*.

- Participated and presented materials in a workshop on "Accounting for Capital Budgeting and Environmental Costs" (co-sponsored by the U.S. EPA) and contributed to the workshop's development of a set of Action Agendas.[21]

- Hosted a two-day meeting on FCA with Dupont, U.S.A. to exchange information and share perspectives on FCA. The meeting facilitated discussion about FCA and other efforts underway at each company relating to sustainable development and environmental accounting. Participants also identified potential areas for future collaboration.

- Participated in a review panel for environmental accounting guidelines for management accountants.

- Collaborated with the U.S. EPA on this case study detailing Ontario Hydro's experience with FCA.

- Reviewed the World Resources Institute environmental accounting case studies.[22]

- Participated in Government of Ontario Economists working group to promote awareness of the current status of economic assessment in public policy development and to provide a forum for discussing economic issues, sharing information and expertise, and improving the quantity and quality of economic assessment in Ontario Ministries.

- Conducted FCA stakeholdering as described in this case study.

- Participated in Environmental Accounting Conference in Houston, Texas held by the University of Houston, the World Resources Institute, and the Business Council for Sustainable Development.

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[21] See *Stakeholders' Action Agenda; A Report of the Workshop on Accounting and Capital Budgeting for Environmental Costs (December 5-7, 1993)* , U.S. EPA, Office of Pollution Prevention and Toxics (EPA 742-R-94-003, May 1994).

[22] See *Green Ledgers: Case Studies in Corporate Environmental Accounting* , edited by Daryl Ditz, Janet Ranganathan, and Daryl Banks (World Resources Institute, 1995).

7.7 Addressing FCA Accounting Processes and Issues

FCA and GAAP. Ontario Hydro is currently co-authoring a discussion paper to explore issues relating to FCA and Generally Accepted Accounting Principles (GAAP). Ontario Hydro wanted to clarify its understanding that GAAP does not necessarily pose a barrier to FCA; rather, that accountants and managers need to understand how each group defines terms such as "cost" and "liability" differently.[23]

8. What Has Ontario Hydro Learned About Full Cost Accounting?

Below are some of the lessons learned by Ontario Hydro to date, in its effort to develop and implement FCA[24]. Ontario Hydro hopes that this information can be useful for other companies interested in, or working on FCA issues.

Ontario Hydro has learned that:

- Full Cost Accounting (FCA) must be positioned as an approach which makes "good business sense" in order to promote integration of environment and business issues. Steps must be taken to demonstrate the benefits of understanding the environmental impacts and costs (internal and external) associated with business activities (i.e. the potential for reductions in future environmental costs and liabilities). If this is done, FCA will be considered to make "good business sense"[25].
- Case studies and projects where FCA has been applied and have contributed to a better business decision provide concrete examples that may facilitate change in acceptance.
- FCA, for internal environmental costs and externalities, is not yet mainstream thinking. It is often difficult to get a "foot in the door". A way to overcome this barrier is to highlight the potential to avoid potential future environmental liabilities. In addition, if a company understands the environmental implications of its business activities, it can sometimes influence regulation.

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[23] It is anticipated that this paper will be completed in Q2/96.

[24] Boone, C. and H. Howes. “FCA: Barriers and Opportunities - Ontario Hydro’s Experience”, Toronto: Ontario Hydro, March 1996.

[25] This finding is consistent across a number of corporations as reported in a recent Arthur D. Little survey, and points to the "lack of integration between environmental and business issues in companies...and the failure to convince management that environment is an important business issue"

- FCA needs an executive member of the organization to champion its value and use for business decisions.

- FCA should be developed and implemented as part of a larger context; for Ontario Hydro, sustainable development is that context.

- FCA is only one of the elements that go into making business decisions, **it is not the decision making process**. It is very important to communicate this point. Building on this, it is important to highlight that FCA can contribute to more informed decision-making which highlights a greater variety of the trade-offs involved in all decisions -- Ontario Hydro has found that its approach to FCA, which includes Multi Criteria Assessment, provides an effective tool for this.

- It is important to implement FCA as a central component of a corporation's overall Environmental Management System (EMS). In this regard, it is important to develop some high level FCA Guidelines and link them to the EMS[26].

- Ontario Hydro also stresses that FCA does not mean "full blown monetization" of all internal environmental costs and external impacts and costs. In this regard, Ontario Hydro stresses that it is essential to have a methodology for considering externalities which allows for the consideration of monetized (economic value of environmental damages) and non-monetized (i.e., qualitative description of damages or emission levels) environmental information. Ontario Hydro's use of the damage function approach to consider externalities and its use of Multi Criteria Assessment have facilitated this.

- Developing and implementing FCA is a gradual process (for internal environmental costs and external costs). It will not happen overnight. However, just because it takes time and may be difficult does not mean that it should not be done. It is best to focus on those areas where it is possible to exert the most influence and obtain positive results. There are many environmental, economic and competitiveness benefits that will be realized by those companies that explicitly integrate externality concerns into the way they do business now. Ontario Hydro believes that it will become more competitive by knowing and integrating these considerations into its business practices through methods such as FCA[27].

- The process of changing corporate culture and attitudes are key to fostering support and commitment to FCA; however, this is often a long, slow process. The challenge is to develop an appreciation for the business case for FCA and sustainable development.

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[26] According to Ontario Hydro, an **Environmental Management System (EMS)** is a management system designed to achieve organizational directives and policies regarding environmental impacts of an organization's activities. Key issues include: full cost accounting, sensitivity to issues of due diligence, an ability to monitor and respond to effects of ongoing activities and a commitment to continuous improvement through self evaluation, correction and a capacity for learning and creation of economic incentives and instruments. ISO14000 will provide a framework for EMSs and will be released as guidelines in 1996.

[27] In a recent survey of Ontario electricity customers, environmental performance and environmental leadership were considered to be important by over 90 per cent of respondents, in their potential future selection of supplier. Ontario Hydro believes that it can strengthen its environmental performance and environmental leadership through initiatives such as FCA.

- FCA is multi-disciplinary by its very nature. The successful development and implementation of FCA requires a team approach with input from a wide variety of professionals in the organization such as: scientists and planners, environmental economists, and accounting-based disciplines. Full Cost Accounting is **not solely** an accounting system issue. Rather it is a framework that can be used to consider the broader financial and environmental implications of doing business.

- Terminology causes **many** problems, in part, because of the multi-disciplinary nature of FCA. There is a need to develop an agreed upon set of terminology to address FCA. For example, terminology such as environmental cost accounting, full cost accounting, total cost assessment, true cost accounting, total social costing and full cost pricing, are often used inter-changeably and are sometimes assumed to mean different things. In addition, some practitioners use FCA to describe only internal environmental costs, others refer to it when discussing externalities.

- There is a need to draw the links between internal and external environmental costs. See Exhibit 3. It is important to understand that the boundaries between internal and external environmental costs are not static, but rather are dynamic because both regulations and company policies change over time. For example, a system-wide cap on greenhouse gas emissions, or new regulations on air toxins which may be either certain or possible, would lead to an expansion of the internal environmental cost domain and a reduction of the external cost domain. Whether voluntary or mandatory, it is certain that the external cost domain will contract over time. Corporations with a serious commitment to sustainable development will be at the forefront of this evolution.

- The process of identifying, quantifying and where possible, monetizing environmental impacts and costs (internal environmental costs **and** externalities) and integrating information into decision-making processes is data-intensive. Data must be analyzed consistently if it is to be meaningful in decision-making and the promotion of sustainable development.

- Training and communication on what FCA means, the rationale for, the benefits of and the methods for implementation, should be a priority in order to drive the right behavior of managers and decision-makers. However, it is sometimes difficult to provide broad-based training in and era of corporate "right-sizing" because individuals and departments are usually only interested in training that is "directly" relevant to their job. This is a barrier that must be overcome.

- There is a need to build bridges between environmental and financial staff in the organization. Many of the capital investment decisions are made within the financial area of the organization. If investment proposals are to be considered on more than just private costs, there must be communication and collaboration between the financial and environmental decision-makers in the organization.

- Hydro clearly distinguishes between Full Cost Accounting for Decision Making and Full Cost Pricing. As stated throughout this document, Ontario Hydro's approach to Full Cost Accounting focusses on planning and decision making, **not pricing.** Full Cost Pricing (FCP) occurs when external costs are incorporated into the price of the product or service (i.e., they are explicitly accounted for in market transactions). It is important to recognize that consideration of internal environmental costs and external environmental impacts and costs in decision-making can facilitate better decisions without being explicitly incorporated into the price of a given product or service. While Ontario Hydro believes that, theoretically, prices should reflect all internal and external costs and benefits associated with production and consumption, the corporation does not intend to pursue Full Cost Pricing at this time due to competitiveness reasons and other issues. However, the development and use of FCA (internal environmental costs **and** externalities) in business decisions can help to move in a direction in which corporations make decisions that are least cost to society.

9. Looking Ahead

In looking ahead, Ontario Hydro has identified several important challenges. For example, Ontario Hydro believes that there should be greater support for its definition of FCA in its business sector. Ontario Hydro has also found that some of their business sector's major customer groups are questioning the need for FCA. While believing that the practice of SED can enhance its competitiveness, Ontario Hydro has recognized a need to demonstrate results. Ontario Hydro plans to address these challenges through better defining its externalities and costs, and through further communication, education, and training. This section lists the major elements of the FCA corporate program which Ontario Hydro is in the process of implementing.

Use of FCA in Operating, Planning, and Decision-Making Processes. Ontario Hydro plans to incorporate FCA into evaluations of:

- Major Local Integrated Resource Plans;
- Operation and dispatch of Ontario Hydro's system;
- Investment decisions;
- Environmental externalities associated with imports and exports of electricity
- Contribute to decisions about retiring or rehabilitating existing stations;
- Procurement decisions.
- Evaluate benefits and costs of additional pollution control equipment
- Monitor environmental performance improvements

Ontario Hydro also believes that FCA will assist the corporation to:

- Provide input to the establishment of reference starting points for emission reduction trading
- Evaluate benefits and costs of new proposed environmental regulations
- Evaluate environmental externalities associated with private generation
- Contribute to decisions about DSM programmes to address societal issues (i.e., greenhouse gas reduction)

Research Program on FCA.

Ontario Hydro has designed its research program to focus on:

Internal Environmental Costs . To better understand its internal environmental costs and to determine if Ontario Hydro is getting value for its environmental dollars, this program element will focus on:

- Continuing to estimate environmental expenditure for reporting in annual Environment and Sustainable Development Reports
- Developing methods to track, allocate, and report on internal environmental costs
- Linking pollution prevention initiatives and internal environmental cost accounting to drive better pollution management decisions
- Completing the GRID and retail pilot studies. Initiate pilot studies in Fossil, Nuclear, and other Business Units.

External Environmental Costs:

- Enhancing evaluation methods to ensure that qualitative, quantitative, and where possible, monetized environmental impact data are appropriately considered and integrated into decisions.
- Developing ecosystem approaches to assess environmental impacts.
- Improving the current externality impact and cost data for the full life-cycle of fossil-fired stations and nuclear stations.
- Developing full life-cycle externality impact and cost data for transmission and distribution systems, hydroelectric stations, renewable energy technologies, and demand management;
- Working with Canadian and Provincial governments, academics, businesses, professional associations, and stakeholders to undertake research on environmental externalities.
- Considering the development of an integrated externality impact and cost computer framework.

Expand FCA Communication/Education Program . In order to develop internal awareness and understanding of FCA, this program element focusses on:

- Developing communication materials on Ontario Hydro's approach to FCA

- Designing and delivering internal training programs/workshops on FCA

Promote FCA Beyond Ontario Hydro . To promote the understanding and application of FCA beyond Ontario Hydro, this program element focusses on:

- Working with the government, academics, businesses, professional associations, and stakeholders to promote a better understanding and application of FCA.
- Establishing Business **Partnerships** for Environmental Costing to identify and establish a network of Canadian and other experts engaged in FCA work, to educate others about FCA, and to identify opportunities to initiate or collaborate on FCA research.
- Seeking opportunities to present papers on FCA.

The development and implementation of FCA at Ontario Hydro is an ongoing process. While much progress has been made and much has been learned, Ontario Hydro looks forward to the next several years as it advances its research and use of this important management tool.

Ontario Hydro is facing some significant changes as the electricity sector moves forward with restructuring, which in turn facilitate movement towards a more competitive electric utility industry. One of the key challenges for Ontario Hydro relates to ensuring that key elements of sustainability are maintained in a more competitive electricity sector. The corporation believes that the electricity sector's move to an increasingly completive market highlights the need for a regulatory framework that will promote sustainability in the energy sector in Ontario. In addition, Ontario Hydro believes that mechanisms/options will be required to ensure that environment/sustainability are addressed in a restructured and competitive electrical utility industry in North America.

Ontario Hydro firmly believes that FCA has a key role in enhancing the corporation's competitive position in a new open electricity market. Ontario Hydro also firmly believes that the energy utilities that prosper in the 21st century competitive marketplace will be those that exhibit strong environmental

leadership and sustainability qualities. Ontario Hydro realizes that most companies already operate in a competitive market place and believes that the future for such companies will be equally linked to environmental leadership and sustainability.

For additional information on Ontario Hydro's implementation of Full Cost Accounting, contact

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Attachment A

Ontario Hydro Full Cost Accounting Guidelines

Attachment B

Ontario Hydro Environmental Spending Guidelines

(Last Revised 1995)

1. **MATERIEL AND WASTE MANAGEMENT**
   - 1.1 Used fuel (nuclear management)
   - 1.2 Radioactive waste management
   - 1.3 Ash management
   - 1.4 Scrubber waste management
   - 1.5 PCB (Polychlorinated biphenyl) management
   - 1.6 Chemicals, oil and toxic substance management
   - 1.7 Research and Development
   - 1.8 Other

2. **WATER MANAGEMENT**
   - 2.1 Chemical emissions management including MISA
   - 2.2 Radioactive emissions management
   - 2.3 Thermal emissions management
   - 2.4 Fish/zebra mussel management
   - 2.5 Water level/flood management
   - 2.6 Research and Development
   - 2.7 Other

3. **AIR MANAGEMENT**
   - 3.1 Acid Gas($S0_2$ and $N0_x$ as N0) management
   - 3.2 Radioactive emissions management
   - 3.3 Particulate emissions management (fugitive & opacity)
   - 3.4 Chemical emissions management (including CFC, $C0_2$)
   - 3.5 Research and Development
   - 3.6 Other

4. **LAND USE MANAGEMENT**
   - 4.1 Right-of-way management
   - 4.2 Soil damage prevention (construction)
   - 4.3 Aesthetics (landscaping etc)
   - 4.4 Secondary land use including heritage resources
   - 4.5 Electric and magnetic effect studies
   - 4.6 Habitat and Wetland Protection
   - 4.7 Community impact management including agreements
   - 4.8 Research and Development
   - 4.9 Other

5. **ENVIRONMENTAL APPROVALS**
   - 5.1 Env Assessments/studies/and approvals
   - 5.2 Social Cost Studies
   - 5.3 Environmental Hearings
   - 5.4 Alternate Technologies
   - 5.5 Audits
   - 5.6 Environmental Communications
   - 5.7 Corporate Environmental initiatives
   - 5.8 Other

6. **ENERGY EFFICIENCY & RENEWABLE ENERGY TECHNOLOGY**

Category/Description	Remarks	Recommended (%)
1. MATERIEL AND WASTE MANAGEMENT		
1.1 **Used Fuel (nuclear) Management**		
. Nuclear Fuel and Fuel Waste	The cost of work on long-term immobilization, storage and disposal of nuclear fuel and fuel waste.	25
1.2 **Radioactive Waste Management**		
. Compactor	Costs associated with the compaction of radioactive waste prior to disposal/retrievable storage.	25
. Incinerators	Costs associated with incineration of radioactive waste materials.	25
. Storage Facilities	Cost of low level storage building, quadricells, tile holes and trenches, except for the cost of the land required for these facilities.	25
. Hydrogeological Data	The cost of work done to collect hydrogeological data and establish the suitability of the site for radioactive waste storage.	100
. Monitoring for Radioactivity	The cost of monitoring radioactivity levels in surface runoff and subsurface drainage from storage facilities, including the cost of water sampling holes.	100
1.3 **Ash Management**		
. Fly Ash Conveying and Storage	25% of the costs of fly ash management. 75% of cost of managing fly ash is good engineering practice.	25
. Monitoring	Costs associated with monitoring ground water conditions at ash and solid waste disposal sites.	100
. Transportation	Ash to disposal.	25

Category/Description	Remarks	Recommended (%)
. Disposal Equipment	For equipment to aid in disposal in environmentally acceptable manner.	25
. Site Preparation	25% of all ash disposal site preparation costs.	25
. Site Reclamation	Entire cost of site reclamation.	100
. Diversion from disposal	Costs associated with marketing ash to divert from disposal.	100
1.4 **Scrubber Waste Management**		
. Land	The cost of land purchased for environmental control processes such as provision for SO_2 scrubber sludge disposal.	100
1.5 **PCB (Polychlorinated biphenyl) Management**	The cost of handling, storing, disposing PCB materials in accordance with regulation.	100
	The cost of retro-filling and replacing equipment for environmental risk reasons (not inside equipment for fire hazard).	100
	Mineral oil decontamination.	100

Category/Description	Remarks	Recommended (%)
1.6 **Chemicals, Oil and Toxic Substance Management**		
Effluent Control		
. Oil and Toxic Chemical Spill Control	The costs associated with equipment used to eliminate spills and to remove from the surface of water or from land.	100
. Oil Spill Containment	The cost of any measures to prevent spilled oil from contaminating ground water.	100
. Toxic Chemical Containment	The cost of containment of toxic chemicals by means of double tube sheet heat exchanger, double wall piping, trenches, dykes, etc.	75
. Coal Pile Drainage	Any costs associated with monitoring, analysing and treating coal pile drainage.	100
. Oil Wastes	The costs associated with equipment required for the treatment of oil contaminated effluent.	100
. Sewage Treatment	The cost associated with sewage treatment facilities, but not including collection and disposal systems.	25
. Wet Ash Disposal	The costs associated with treating liquid effluent from wet ash disposal systems and ponds.	100
. Acid Clean	The costs of treating liquid wastes from boiler acid cleaning processes.	100
. Air Preheater Wash	The costs of treating liquid wastes resulting from air preheated washes.	100
. Water Treatment Plant	The costs of neutralizing sump and clarifier sludge handling systems.	100
. Disposal of Toxic Wastes	All costs associated with any special requirements necessary for the disposal of toxic substances.	100

Category/Description	Remarks	Recommended (%)
. Hydrogen Sulphide Drains Stripper	The costs associated with process drains strippers for the reduction of hydrogen sulphide concentrations in the liquid drained from process units during maintenance work.	75
. Hydrogen Sulphide Recovery System	50% of the costs associated with the system which collects hydrogen sulphide from process drains, relief, dump and vent valves by using a vent header, a compressor system, a di-ethanolamine system and a water scrubber.	50
. Hydrogen Sulphide Lagoon	All costs associated with the lagoon system which is provided to delay the return of heavy water plant process effluent to the lake if high concentrations of hydrogen sulphide occur in the process effluent stream.	100
. Surface Water Treatment	Costs associated with treating surface water to remove/recover oil, iron and carbonate equipment drains.	100
. Alternate Technologies	The cost of work to establish the technical and economic feasibility of alternate effluent control technologies.	100
1.7 **Research and Development**	All costs associated with environmental research for materiel and waste management.	100
1.8 **Other**		
. Solid Waste Disposal	Solid waste disposal site preparation costs.	25
. Solid Waste Site Reclamation	The entire cost of site reclamation.	100
. Construction Solid Waste	Solid waste disposal site preparation costs associated with construction activities.	25
2. **WATER MANAGEMENT**		

Category/Description	Remarks	Recommended (%)
2.1 **Chemical Emissions Management Including MISA**		
. Non-Radioactive Emissions	The cost of monitoring, recording and reporting chemical emissions to effluent streams, including equipment costs to do so. (i.e., MISA program).	100
. Water Quality	The cost of monitoring intake and discharge water for pH and suspended and dissolved solids.	0
2.2 **Radioactive Emissions Management**		
. Radioactive Liquid Decontamination	The cost of systems used specifically for the removal of radioactivity from a batch of liquid prior to discharge to the environment (i.e., filter and ion exchange column on a dispersal tank, evaporator/bituminiser).	100
. Radioactive Liquid Waste Management	The cost of systems used to collect and treat all potentially contaminated waste streams.	100
. Deratings	The cost of deratings imposed on generating stations to meet radioactive effluent regulations.	100
. Radioactive Emissions	The cost of monitoring, recording and reporting radioactivity levels in effluent streams from nuclear facilities including equipment costs.	100
. Heavy Water Leak Detection	The cost of heavy water leak detection systems where they provide the first line of defence against leaks to the environment (i.e., bleed cooler or moderator heat exchanger service water monitors). Prime incentive is to reduce heavy water loss.	25
2.3 **Thermal Emissions Management**		
. Tempering	All costs associated with tempering systems.	100
. Deratings	The cost of deratings imposed on a generating station to meet water temperature regulations.	100

Category/Description	Remarks	Recommended (%)
. Structures	The costs associated with any structures which are constructed for the purpose of modifying thermal plume profiles.	100
. Alternative Technologies	The cost of work to establish the technical and economic feasibility of alternative temperature control technologies.	100
. Thermal Plume Behaviour	The costs associated with determining thermal plume behaviour, including hydraulic modelling.	75
. Monitoring	The costs associated with monitoring cooling water intake and discharge temperatures and flows.	100
2.4 **Fish/Zebra Mussel Management**		
Fish Control		
. Intake Structures	The costs of any features built into intake structures to prevent fish in the intake.	50
. Fish Control Devices	The costs associated with equipment to return fish in a healthy condition to the water body (i.e., some fish pumps ladders, etc.). (Note - fish includes ichthyoplankton).	100
. Level Control	The cost of water spilled from hydraulic generating stations or units run "out of merit" to maintain forebay levels or river flows for environmental or scenic reasons.	100
. Alternate Technologies	The cost of work to establish the technical and economic feasibility of alternate fish handling technologies, to recover and return fish to the water body in a healthy condition.	100

Category/Description	Remarks	Recommended (%)
. Fish Impingement	The costs associated with programs to determine fish impingement at generating stations and heavy water plants and reporting fish impingement data to regulatory bodies.	100
. Zebra Mussels	The incremental costs associated with eliminating zebra mussels in an environmentally acceptable manner.	100
2.5 **Water Level/Flood Management**		
. Hydraulic Generation	The cost of monitoring privately owned shorelines in erosion prone areas. Review and analysis of water level complaints and flows.	100
. Debris Removal	The costs of cleaning debris accumulated along the shoreline of existing headponds.	25
2.6 **Research and Development**	All costs associated with research for the environmental aspects of water management.	100
2.7 **Other**		
. Dispersion	The cost of work done to determine the movement of pollutants into the environment via water.	100
. Dredging and Spoil Disposal	The costs of measures taken to dredge and dispose of spoils in an environmentally acceptable fashion.	100
3. **AIR MANAGEMENT**		
3.1 **Acid Gas (SO_2 and NO_x as NO) Management**		
. Modifications for NO_x	Costs associated with modified equipment or operating procedures intended to reduce the emissions of NO_x.	100

Category/Description	Remarks	Recommended (%)
. Low Sulphur Fuel	The incremental cost of premium low sulphur fuel purchased for SO_2 purposes. The cost of W. Canadian coal to Nanticoke is not included.	100
. Scrubbers (FGD)	All costs associated with studies, approvals, purchase, construction, operation, and maintenance.	100
. Deratings	The cost of deratings imposed on a generating station to meet SO_2 regulations.	100
. Forecasting	The entire cost of meteorological forecasting and dispersion modelling for intermittent control systems.	100
. Purchases of Power	The cost of power purchased to displace Ontario Hydro fossil to meet the acid gas regulation.	0
. Emission Measurement & Reporting	The cost of measuring and reporting emissions of acid gases.	100

Category/Description	Remarks	Recommended (%)
3.2 **Radioactive Emissions Management**		
. Ventilation System	Costs associated with ducting necessary to segregate contaminated and uncontaminated exhaust air to allow for treatment.	10
. Air Filters	All costs associated with roughing, HEPA and charcoal filters which are used in the station contaminated exhaust to reduce radioactive emissions.	100
. Annulus Gas System	Costs associated with a "closed" annulus gas system (i.e., gas compressors, gas charge, instrumentation, operation, etc.).	5
. Box-Up	All costs associated with dampers and fan controls used to stop a reactor's airborne radioactivity exhausting to the atmosphere. (Not to be confused with equipment used to ensure directional flow within the station).	100
. Building Over-Pressure Containment	100% of the cost of <u>additional</u> provisions made to prevent radioactive emissions to the atmosphere in the course of reactor building pressurization, during a design basis accident. Additional concrete costs to satisfy pressure requirements are included.	100
. Deratings	The cost of deratings imposed on a generating station to meet airborne radioactive emission regulations and/or targets.	100
. Meteorological Instruments	The cost of instruments to provide the necessary data to help in the evaluation of off-site monitoring data and to predict plume travel in the event of accidental releases of radioactivity.	100
. Negative Pressure Containment	All costs associated with negative pressure containment, (i.e., pressure relief valves, pressure relief ducts, vacuum building, water sprays, etc.).	50

Category/Description	Remarks	Recommended (%)
. Off Gas Management System	The cost associated with the off-gas management system.	50
. Monitoring	The cost of monitoring airborne radioactive emissions from stations and radioactive waste incinerators.	100
. Tritium Removal Facility	The cost of any system to contain or monitor discharge to the environment.	50
3.3 **Particulate Emissions Management**		
. Precipitators, Capital	Incremental cost of obtaining plume opacity less than 20%	100
. Precipitators, Operating	Cost of operation maintenance and performance testing of precipitators.	50
. Flue Gas Conditioning	All costs associated with studies approvals, purchase, construction, operation and maintenance.	100
. Coal Dust Suppression in Transit	The portion of the cost of coal which is attributable to the application of dust suppression coatings to the surface of the coal in the rail cars and to dust control at the terminals.	100
. Coal Dust Suppression at the Generating Station	The cost associated with equipment applied to coal handling facilities or modifications to coal handling facilities or to the coal pile, aimed at reducing dust emissions beyond the generating station boundaries.	100
. Stack Opacity Monitoring	The cost of monitoring and reporting stack emission opacity.	100
3.4 **Chemical Emissions Management (incl CFC, CO_2)**		

Category/Description	Remarks	Recommended (%)
. H_2S Propane Burner System	The cost of the propane burner system used to provide both flame stability and plume buoyancy at the H_2S flare stack.	50 (100)
. H_2S Stack	Costs associated with that portion of the stack which exceeds the height of surrounding buildings by 2 times.	0
. H_2S Forecasting	The entire cost of meteorological forecasting and dispersion modelling for intermittent control systems.	100
. Hydrogen Sulphide Monitoring	The cost of monitoring airborne hydrogen sulphide concentrations at heavy water plant to detect unusual releases (mostly for occupational safety). This system is distinct from the environmental monitoring system.	0
. Non-Radioactive Incinerator	The cost of monitoring airborne emissions from non-radioactive waste incinerators.	100
. Emission Measurement	The cost of any measurements to determine the emission rates.	100
. CFC	The cost of CFC studies and phaseout.	100
. CO_2 and radiative gases	The cost of all studies into global warming.	100

Category/Description	Remarks	Recommended (%)
3.5 **Research and Development**	All costs associated with environmental research for air management and emission control.	100
3.6 **Other**		
General		
. Alternate and New Technologies	The cost of work to establish the technical and economic feasibility of alternate air emission control technologies.	100
. Dispersion	The cost work done to determine (or model) the movement of emissions into the environment via air and their environmental fate.	100
. Ambient Monitoring	The costs associated with routine monitoring of the ambient concentrations or effects of active and inactive airborne pollutants (including telemetering of data).	100
4. **LAND USE MANAGEMENT**		
4.1 **Right-Of-Way Management**		
. Selective Clearing	The incremental cost of selective clearing over clear cutting on transmission and distribution line rights-of-way.	100
. Ground Clearances	The incremental costs of increased ground clearances on transmission lines due to public concern for health and safety.	100
. All Herbicide Reduction	The incremental cost of right-of-way maintenance due to herbicide reductions.	100

Category/Description	Remarks	Recommended (%)
4.2 **Soil Damage Prevention (Construction)**		
. Topsoil	The cost of removing and replacing topsoil along access routes and at sites of structures, towers, etc.	100
. Site Grading, Cleaning and Construction	Site preparation costs to cover the cost of such items as dust control, borrow pit drainage, siltation control, seeding, accidental spill control, noise control, restricted construction periods, water level control, protection of trees, stream protection etc.	25
4.3 **Aesthetics (Landscaping, etc.)**		
. Landscaping	Costs associated with landscaping or horticultural endeavour aimed at improving the appearance of the facility (i.e., lawn watering, including the cost of additional land required for landscaping).	50
. Architecture & Lighting	The costs associated with special architectural and lighting features which are provided to improve the general appearance of the facility, such as special finishes on building cladding. Also, the incremental costs associated with low profile transformer and distribution stations and special entrance structures where high profile structures could be used. It may be that estimates of incremental costs have to be made in many cases.	50
. Underground Transmission & Distribution	The incremental costs associated with the use of underground transmission or distribution lines, where these are provided for aesthetic or environmental reasons.	100
. Overhead Transmission & Distribution	The incremental costs associated with the use of aesthetic structures in areas where lattice towers or other less costly structures could be used.	100

Category/Description	Remarks	Recommended (%)
4.4 **Secondary Land Use Including Heritage Resources**		
. Recreation - Water	The cost of any special facilities provided for public use such as beaches, boat launching ramps, fishing piers, etc.	100
. Recreation - Land	The cost of providing special facilities for public use such as parks, trails, etc.	100
. Heritage Resources	All costs associated with identifying, maintaining records and preserving.	100
4.6 **Electric and Magnetic Effect Studies**		
. Electrical Interference	The cost of correcting problems created by electrical fields due to Hydro facilities (e.g., transmission lines).	100
. High Frequency Noise	The cost of monitoring the pre- and post-operational conditions for transmission lines.	100
. EMF	All studies into the health effect implications of electric and magnetic effects, field studies, measurement and demonstrations.	100

Category/Description	Remarks	Recommended (%)
4.7 **Habitat and Wetland Protection**		
. Studies	All studies done to protect or restore habitat and wetlands.	100
. Land	The cost of land and the cost of extra transmission line required for the protection of environmentally sensitive areas.	100
. Fencing	The cost of fencing and protection of environmentally sensitive areas.	100
4.8 **Community Impact Management**		
. Exclusion Zone	The cost of land within the exclusion zone which would fall outside the area that would have to be acquired to accommodate the nuclear facilities.	100
. Disbursements	Grants or special payments and funds made to offset socioeconomic impacts on the community or individuals.	100
4.9 **Research and Development**	All costs associated with environmental research for land use management.	100
4.10 **Other**		
. Attenuation and Control	The incremental costs of equipment and the construction of berms or other shielding facilities intended to reduce noise levels beyond station boundaries.	100
. Noise Surveys	The cost of noise surveys made at the boundary of Ontario Hydro sites.	100

Category/Description	Remarks	Recommended (%)
5.0 **ENVIRONMENTAL APPROVALS AND PLANNING**		
5.1 **Env Assessments/ Studies/ and Approvals**		
. Site Investigations	All costs associated with determining the natural conditions at an approved site or along an approved transmission route, and the impact on the environment of the purchased facility, prior to construction, during construction and during a post construction period; including both radiological and non-radiological pollutants; including routine on-site inspections.	50 (100)
. Route and Site Environmental Assessment Studies and Documentation	Costs of environmental studies conducted. Some of the work (approximately 50%) is done to determine technical and economic feasibility.	50
. Generation Project Environmental Assessment Studies and Documentation	Cost of studies conducted where Environmental Assessment Approval is required. Some of the work is done to determine technical and economic feasibility.	50
. Demonstration Centres	All the costs associated with demonstration centres and other information programs specifically designed to illustrate environmental protection.	100
. Effects	The cost of work done to determine the effect of Hydro activities on plant, animal and human life.	100
5.2 **Social Cost Studies**	NEB Social Cost Study.	100
5.3 **Environmental Hearings**	All community studies and public hearings.	100
5.4 **Alternate Technologies**	Cost of determining the environmental implications of demand management, non-utility generation and advanced technologies.	100

Category/Description	Remarks	Recommended (%)
5.5 **Audits**	Environmental audits and performance reporting (e.g., State-of-the-Environment, fines and legal defense costs)	100
5.6 **Environmental Communications**	All costs of environmental communication programs.	100
5.7 **Corporate Environment Initiatives**	Environment Division, other environment groups.	100
5.8 **Other**		
. Regulatory Bodies	The costs of communicating with the Ministry of Environment, the Ministry of Natural Resources, the Atomic Energy Control Board, the Ministry of Health, etc., on environmental matters.	100
. Contingency Plans	The cost of formulating and implementing plans to protect populations in the event of design basis accidents.	100
6. **ENERGY EFFICIENCY & RENEWABLE ENERGY TECHNOLOGY**	All costs of energy efficiency programs.	100
	All costs associated with development and installation of Renewable Energy Technology (RET) applications, e.g. solar, wind, bio-mass, etc.	100

Attachment C

Ontario Hydro Full Cost Accounting Bibliography

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Attachment D

Details on FCA Team Recommendations

Recommendation #1 Modify the Current Accounting System Into A Full Cost Accounting System

> The FCA Team also recommended that the management accounting system be modified to track other related environmental data. As an example, the Team pointed to Ontario Hydro's accounting practices related to coal purchasing and consumption. Currently, coal purchase and use are distinguished in the corporate accounting system only according to whether the coal is U.S. or Canadian in origin. However, individual power stations maintain records of the sulfur content of the coal they use. Because low-sulfur coal is environmentally advantageous, the FCA Team believed that Ontario Hydro should keep track of this aspect of its physical inventories in its accounting system.

Although Ontario Hydro has used its environmental spending guidelines to generate estimates of environmental spending, the FCA Team noted that in some instances Ontario Hydro's accounting system[28] does not itself identify environmental expenditures or assign them to responsible corporate entities (e.g., Ontario Hydro traditionally treated many internal environmental expenses as overhead). Ontario Hydro's accounting system similarly does not include external costs. The FCA Team also recognized that an accounting system that focusses on cash expenditures alone can mask or distort true economic costs.[29] For example, Ontario Hydro's internal use of electricity was considered a free good; under FCA, this would be explicitly recognized as a cost. Similarly, under conventional accounting, a research grant to study nuclear waste management technologies would appear to reduce nuclear waste management costs by reducing total waste management outlays; under a full cost accounting framework, a corresponding adjustment would be made in the accounting system to show full costs. Ontario Hydro's SED Task Force and the FCA Team recommended that Ontario Hydro modify its current accounting system into a full cost accounting system. To do this, they recommended that Ontario Hydro:

- Modify the current accounting system to record, classify, and allocate the external costs and benefits and the internal environmental expenditures and costs associated with each business unit, generating station, and the transmission system.

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[28] At Ontario Hydro, the major accounting information system is known as the Financial Management System (FMS), which serves both management and financial accounting purposes. Although the FMS has the capability to record budgeted future costs, its primary use is the recording of transactions as they occur. As such, it is the heart of the information used in financial accounting reports. Although the FCA Team looked at the connection between financial reporting issues and FCA, the focus of this case study is on the use of FCA in management accounting and related internal decision-making.

[29] In accounting terms, expenditures and costs are different concepts. The former refers to cash outlays during an accounting period, while the latter makes appropriate adjustments (e.g., through depreciation or amortization) to cash flows to provide a picture of the consumption (or commitment) of economic resources during an accounting period. Identifying and tracking environmental expenditures is a necessary step for determining environmental costs.

- Improve accounting guidelines, policies, and procedures for reporting the internal as well as the external costs of Ontario Hydro's activities.

- Prepare budgets, business plans, financial plans, annual reports, and financial statements on the basis of both internal and external costs.

- Develop financial and environmental performance indicators for use in measuring Ontario Hydro's performance in the future.

- Modify monthly variance reports to show how actual internal and external costs and environmental performance indicators compared to plans.

- Ensure compliance with FCA guidelines, policies, and procedures.

Implementing all of these recommendations would require extensive data, much of which is not currently available. As a result, rather than move forward on all of these recommendations, Ontario Hydro has focussed on selected FCA accounting issues, as described in Section 7.5.

Recommendation #2 Augment the Current Financial Evaluation Framework

The second major issue identified by the SED Task Force and the FCA Team was the need to augment Ontario Hydro's approach to financial evaluations and decision-making in order to make environmental considerations more explicit. Ontario Hydro performs financial evaluations and makes many types of decisions for different purposes (e.g., planning, budgeting, expenditures, investments), at different levels of scale (e.g., relating to specific customer locations, to specific power production and transmission facilities, or the company as a whole), and for varying time frames. Management's job is to ensure that these decisions and resulting actions are reasonably consistent over time and reflect strategic objectives.

The FCA Team documented Ontario Hydro's then current approach and found that Ontario Hydro weighed a variety of considerations, some qualitative, when making investment decisions about capital projects.[30] Before decisions were made about a project, Ontario Hydro gathered and analyzed data on the following key factors:

- Cash flows resulting from the decision;
- Impact on Ontario Hydro's financial situation (for projects over $100 million);
- Technical capability, performance and reliability;
- Impact on customer electricity rates;
- Economy-wide impact including economic development, job creation, and extra-provincial sourcing; and

[30] These projects are of two types: (1) projects driven by regulation or statute (e.g., new customer hookup, reliability maintenance, safety standards, environmental requirements), and (2) discretionary cost reduction or revenue producing projects. Subject to meeting other constraints or strategic objectives, projects of the first type tended to be chosen on the basis of least (internal) cost and projects of the latter type tended to be chosen on the basis of greatest net present value.

- Information on environmental and social implications of proposed projects.

Net present value (NPV)[31] of future cash flows generally was the main financial test (i.e., metric) for measuring and ranking alternative investments. Other factors such as social and environmental impacts on local communities and impacts on air, land, and water resources usually were secondary. In limited instances, capital expenditures were justified by noneconomic criteria such as environmental leadership and program momentum.

The FCA Team concluded that making decisions based on full costs would require modifications to Ontario Hydro's decision-making process. Established financial evaluation processes usually weighed only the internal financial implications of a particular investment alternative, and often incompletely. In other words, internal environmental costs could be totally overlooked, and externalities were not usually considered explicitly. The FCA Team's proposed full cost approach, however, would attempt to include both internal costs and, where available, monetized values for externalities to capture the positive and negative environmental and social impacts of an investment option. It recognized that it is possible for Ontario Hydro to make investment decisions which include consideration of externalities that are not explicitly valued. The Team emphasized that explicit consideration and consistent inclusion of environmental and social impacts and costs is essential for minimizing arbitrariness in investment decisions.

The FCA Team recommended the following actions for modifying Ontario Hydro's existing process and criteria for financial evaluations and capital budgeting:

- Augment the current financial evaluation framework used in all types of expenditure decisions. In evaluating competing projects, the new framework should incorporate internal environmental and other private costs, including liability, taxes, subsidies, and other contingent costs, as well as social external costs and benefits.

- Modify the corporate capital allocation process to introduce strategic criteria to reflect sustainable development objectives and externalities.

- Launch pilots to conduct full cost financial evaluations based on interim guidelines for major capital expenditures, including major rehabilitations, demand side management, and non-utility generation expenditures.

- Define roles and accountabilities for conducting and supporting the process for financial evaluations and capital budgeting based on full cost accounting.

- Develop tools and guidelines to support financial evaluations based on full cost accounting principles, including guidelines for incorporating uncertainty associated with external cost estimates.

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[31] Calculating NPV involves the application of a discount rate (often the firm's cost of capital) to future cash flows, thus adjusting for the time value of money and producing a number that can easily be compared to the NPV of other projects with different cash flows.

Section 7.1 of this case study describes relevant Ontario Hydro implementation activities since the FCA Team developed the recommendations presented above and concluded its report.

Recommendation #3 Support A Research Program on External Environmental Impacts and Costs

Ontario Hydro is one of a small, but growing, number of companies actively engaged in assessing the externalities associated with their activities and considering that information in decision-making. Shortly after forming, the Ontario Hydro FCA Team invited U.S. and Canadian experts to discuss research methods for external costs at a June 1993 workshop, at which the invited experts proclaimed Ontario Hydro's externality research efforts state-of-the-art. As part of the FCA Team work program, Ontario Hydro also expanded its review of the literature on the environmental impacts of electricity generation technologies including fossil-fired, nuclear, hydroelectric, and alternative technologies[32]. Attachment C contains the full cost accounting bibliography that resulted from the Team's literature review. The Team determined that the available literature usually did not cover the full fuel cycle and provided limited information about the dollar value of impacts of non-conventional air pollutants, water pollutants, and solid waste. The FCA Team discovered that far fewer studies were available on the environmental impacts of nuclear power, and even less data existed on environmental costs and benefits associated with alternative energy technologies, such as geothermal or solar power. The FCA Team engaged consultants to conduct a literature review and to work with Ontario Hydro staff to develop estimates for externalities associated with Ontario Hydro's nuclear system.

The SED Task Force and the FCA Team recommended that Ontario Hydro continue and expand its research program for (1) identifying, (2) quantifying, and (3) monetizing external impacts and costs. The FCA Team recommended that additional work be undertaken to refine the existing models and to assess impacts associated with Ontario Hydro's facilities.[33] The FCA Team's general recommendations to Ontario Hydro for externalities research associated with electricity generation were the following:

- Research and develop Ontario-specific databases and models that will include site and route-specific external impacts and cost/benefit estimates for all demand and supply options available.

- Estimate environmental characteristics and resource use, air emissions, and waste/effluent for fossil fuels, nuclear plants, hydraulic energy, demand side management, alternative technologies, and transmission.

- Develop new, and improve existing, computer programs to model dispersion of emissions and wastes/effluent for all fossil, nuclear, and hydro-electric stations.

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[32] Attachment C contains the full cost accounting bibiography that resulted from the Team’s literature review.

[33] The FCA Team also identified the following issues that Ontario Hydro should consider as part of its analysis when assessing externalities: external benefits, resource depletion, discounting, equity, competitiveness, scope, risk, and potential liability. These issues are described in the FCA Team's 1993 report.

- Develop Ontario-specific dose-response functions to assess the impacts of all demand side management and supply options on human health, water quality, forests, fisheries and wildlife, visibility, structural materials, and other receptors.

- Where possible, use the damage function approach to monetize external environmental costs of alternative demand side management and supply options.

- Develop a workgroup with representatives of Ontario government, other power generators, and other parties that generate significant externalities (e.g., chemical manufacturers, petroleum refineries) to develop a common framework for estimating external costs and incorporating them into decision-making processes and accounting systems.

- Assess the potential cost and rate impacts of incorporating external costs in decision-making.

Section 7.2 of this case study describes Ontario Hydro's implementation activities since the FCA Team developed the recommendations presented above and concluded its report.

Recommendation #4 Initiate A Communication and Training Program on Full Cost Accounting

The Ontario Hydro SED Task Force and FCA Team recognized the importance of training and communication on full cost accounting. Some Ontario Hydro employees had expressed their concerns that FCA could have a negative impact on the company's bottom line and on employment. Ontario Hydro believes that the success of its sustainable development strategy depends on the awareness, understanding, participation, and commitment of all company employees. It identified several key audiences for internal education and training. To make FCA work, Ontario Hydro concluded that FCA must be understood by all managers and staff. Initially, FCA must be understood by those staff members who have some responsibility for implementing it. The FCA Team made the following recommendations for internal education and communication:

- Communicate the concept, uses, and implications of full cost accounting to all decision-makers and ensure formal training is provided for the implementation of all recommendations.

- Develop and implement communication and training programs for business leaders, line managers, and key support staff. The training programs should deal with decision, planning, and control processes, tools and techniques for incorporating internal environmental costs as well as external impacts and costs in the decision-making process.

Section 7.3 of this case study describes relevant Ontario Hydro implementation activities since the FCA Team developed the recommendations presented above and concluded its report.

Recommendation #5 Take Full Cost Accounting Beyond Ontario Hydro

The SED Task Force recommended that FCA be taken beyond Ontario Hydro and encouraged a joint effort to develop a common system for Ontario energy producers. Section 7.4 of the case study describes Ontario Hydro's activities to promote and take FCA beyond Ontario.

Recommendation #6 Establish a Fund for Decommissioning, Waste Disposal, etc.

The SED Task Force recommended that Ontario Hydro:

- Establish a "liability fund" for all the monies collected [past and future] from customers (including interest) for asset removal, decommissioning, irradiated fuel disposal, and low and intermediate radioactive waste disposal.

- Deposit in the liability fund an amount equal to revenues collected for decommissioning in prior years, including interest, either immediately or within a reasonable timeframe.

- Consider establishing funds for other accrued liabilities of a similar nature.

- Cover the costs of siting and developing facilities for the permanent storage of dismantled plants, used fuel, and other high level wastes under environmentally safe conditions.

Attachment E

Draft External Cost Estimates
For Ontario Hydro's Fossil Stations

Fossil Stations (Site Location & Unit)	Externality Costs* (1992 cents/kWh)
Lakeview (1,2,5,6)	1.66
Lambton (1,2)	0.31
Lambton (3,4)	0.13
Lennox	0.06
Nanticoke	0.46
System Average	0.40

* Cost estimates include externalities associated only with the operation stage of the fuel cycle.
* Potential impacts due to CO_2 emissions are not included in the above estimates.

NUCLEAR STATION EXTERNAL ENVIRONMENTAL COSTS
(1992 cents/kWh)

Station	Low	Nominal	High
Pickering A	0.005545	0.010001	0.119012
Pickering B	0.004298	0.007232	0.096800
Bruce A	0.001826	0.002198	0.006393
Bruce B	0.001549	0.001863	0.005503
Darlington	0.004604	0.006135	0.040101