Including Economic Externalities in Demand-Side Management Planning

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Introduction

The objective of this paper is to describe how Consumers Gas (the Company) included economic externalities into industry standard screening tests. These tests are for Demand-Side Management (DSM) programs. The Company wanted to expand the tests to make them as comprehensive as the cost-benefit test used by the Company for analyzing supply-side options.

Energy usage imposes a variety of costs on society. Some of these costs, such as the direct costs of facility construction, operation and fuel consumption, or the cost of emission control equipment, are borne directly by the utility and, in turn, by the consumer in the prices that are charged for the delivery and distribution of that energy. However, energy usage also results in costs that are not reflected in the gas prices paid by either the utility or the consumer. Most notable among these "external" costs are those associated with adverse environmental and human health impacts resulting from energy facility construction and the extraction, processing, transportation and combustion of fuels. Some of these impacts can be reflected (or "internalized") in direct costs, to the extent that regulations and engineering practices respond to scientific research and public concern. Others, however, are not captured in the market transaction of the energy provided to the consumer. These impacts are referred to as "externalities."

The inclusion of social externalities is an important component in the analysis of DSM programs.

The inclusion of social externalities is an important component in the analysis of DSM programs. The difficulty lies in determining which externalities to include, how to quantify them, and how to monetize them. Despite the difficulties associated with the treatment of externalities, there is general agreement that they should be considered in energy supply and use decisions.

In its *Energy Board Order Report*, E.B.O. 169-III, the Ontario Energy Board (OEB) indicated that externalities involving significant social benefits and costs should be included in the analysis of DSM programs. The Board also indicated that consideration and inclusion of societal externalities when initiating DSM programs should not be delayed until the methodology for measuring externalities has been further developed or the results of further studies of relevant externalities are available.

Consumers Gas considered two types of social externalities in

its 1995 DSM Plan: environmental and economic. The Tellus Institute was retained by Consumers Gas to develop environmental externality values for its DSM Plan. The Company also considered economic externalities in this DSM Plan, consistent with those it currently uses in its benefit-cost analysis of system expansion projects.

In the next section, an overview of the economic externalities considered by the Company is provided. In the following sections, a description is provided of each of the externality factors analyzed, and results run at three different social discount rates are presented to show the economic externality values. Detail of the economic externalities methodology is documented in the Appendix.

Overview

Consumers Gas has used an analysis of economic externalities as part of its system expansion feasibility procedures since 1987. These externalities were analyzed using a framework suggested by the Company's consultant in this area, Econanalysis and Associates (1988). In preparing its 1995 DSM Plan, Consumers Gas wished to provide an economic externalities analysis which was consistent with what it currently uses for its expansion projects.

Consumers Gas measures economic externalities as flows to the government sector, which represents society.

For expansion projects the analysis is done in two stages. The first stage, which excludes externalities, is done from the corporate point of view. For this analysis, the corporate discount rate – the Company's weighted average cost of capital – is used for discounting. In the second stage, economic externalities are considered from the societal perspective. At the societal level, where economic externalities are introduced, the Societal Discount Rate (SDR) is used. Since the benefits and costs from the corporate analysis are included in the societal analysis, one component of the second stage cost-benefit analysis is a factor which takes into account the difference between the Company's discount rate and the SDR. This factor was not relevant in this analysis because environmental and economic externalities are included in a Societal Cost Test (SCT) which already uses the SDR for discounting.

In this context, externalities refer to impacts associated with energy usage that are not reflected in the price of gas. An example of an economic externality is the extra tax collected and lower unemployment insurance paid by the government as a result of a job being created by a DSM program. Externalities can be positive and can add to the attractiveness of the project, or they can be negative, in which case they detract from the project.

The Company measures economic externalities as flows to the government sector, which represents society. The net returns to government of an expansion project result from net tax, tariff and other net government revenue generated by the project. The Company analyzed four categories of net returns:

1) foreign exchange;
2) tariff, sales, and/or excise taxes;
3) utility income taxes; and
4) labour.

The Company developed factors to quantify these externalities on the basis of various Canadian academic studies done in the 1970s and 1980s. These factors were considered appropriate for the purposes of this DSM analysis, but no new academic work was incorporated. They were applied to the utility and DSM participant cost estimates for the five years of the DSM Plan, and to the energy supply savings over the lifetime of the DSM measures.

Foreign Exchange

Four categories of economic externality were quantified: foreign exchange; tariff, sales and/or excise taxes; utility income taxes; and labour.

If the DSM programs save gas that can then be exported and earn foreign exchange, this should be reflected as a credit to the project. The foreign exchange premium has been estimated by Jenkins and Kuo (1985) as 6.5% greater than the market exchange rate in Canada. That is, for every dollar of foreign exchange earned or saved by a project there is an additional $0.065 benefit to Canada.

There have been major changes to trading relationships, tariffs, taxes, subsidies, and energy prices since the Jenkins and Kuo study was completed. This factor was reconsidered by the Company, but not changed, in February 1990. Changes such as the termination of the National Energy Program, modifications in federal and provincial tax rates, GATT, the Free Trade Agreement, and the then-proposed federal goods and services tax (GST) were considered. Updating this factor would require an analysis that took into account more recent taxes and tariffs. It would be a large undertaking to update Jenkins and Kuo's general equilibrium analysis for recent changes. As an interim measure, the Company decided that freer trade would likely lower the premium and suggested that a premium of 5% could be used for the purpose of estimating economic externalities for this DSM Plan.

Tariff, Sales and Excise Taxes

Tariff, sales and excise tax externalities refer to flows to the government sector as a result of a project. To determine these, all commodity inputs to, or outputs from, the project must be classified as tradeable or non-tradeable. With non-tradeable commodities, sales taxes are the main externality; both federal and provincial sales taxes are included in this category. Tradeable commodities can be further sub-divided into importable and exportable commodities. A tariff externality arises on any importable commodity that is subject to tariffs or import duties. The tax paid on the transportation of gas, which is an exportable

commodity, is also included. Most costs considered by the Company are pre-tax, so the tax externality is usually zero. Where tax is included, the provincial sales tax (PST) rate of 8% and the federal GST rate of 7% were used. Tariff rates on commodities, such as natural gas, furnaces and higher-efficiency water heaters, were taken from the 1992 tariff table.

Utility Income Taxes

Utility taxes paid by Consumers Gas represent a transfer from the Company to the government, and not a cost to society as a whole. Also, because the DSM program analysis has been conducted on a before-tax basis, there was no need to include income taxes as an economic externality.

Labour

In any cost-benefit study, a decision has to be made as to the level of detail of the analysis. Consumers Gas attempted to identify all backward linkages, but did not consider second-order environmental effects.

Labour externalities are the net changes in Unemployment Insurance Commission (UIC) payments, personal income taxes, and rents earned by labour as a result of a particular project. If DSM programs create net jobs they may deserve a credit for reducing UIC payments and generating more personal income tax revenue. However, the amount of credit would depend on a number of factors:

- unemployment rate;
- labour productivity;
- job permanency;
- job skill level;
- job locations;
- alternate employment opportunities; and
- worker migration in response to job creation.

The production and installation of equipment and materials should produce incremental labour effects for DSM programs. These have been assessed at 5.1% (of the net present value of the wage bill) for construction jobs using contractor labour, 10% for construction jobs using Company labour, and 15.6% for operating jobs created. These factors are taken from Evans, Schwartz and Glenday (1981) who simulated a general equilibrium model of a regional labour market in Ontario. The general equilibrium analysis takes into account all of the factors listed above.

Other Externalities

In any cost-benefit study, a decision has to be made as to the level of detail of the analysis. There will always be externalities and linkages that are not addressed. For example, there may be second-order environmental externalities that result from the production or consumption of some DSM measure (for example chlorofluorocarbons or CFCs released as a result of making a more efficient water heater). Consumers Gas attempted to iden-

tify all backward linkages, but did not consider second-order environmental effects.

Results

DSM measures are combined into 12 programs, of which 10 were selected to be included in the final portfolio.

The Company's Marketing Department identified DSM measures such as low-flow showerheads, toilet dams, installation of higher efficiency equipment, insulation, and heating equipment tune-ups. They then combined the DSM measures into 12 programs which were screened for the final portfolio. The economic externality analysis broke the programs into commodities that had unique characteristics in terms of its capital/labour split, Canadian content, tax rates, or tariff rates. Ten programs passed the Company's selection criteria, and were included in the final portfolio. The 10 programs that passed were:

1) RP-2 Efficient water heating units;
2) RP-3 Water heating conservation retrofits;
3) RP-4 Efficient space heating units;
4) RP-5 Space heating/conservation retrofits;
5) RP-6 Green communities;
6) CI-1 Commercial new construction;
7) CI-2 Efficient space heating demonstrations (apartment);
8) CI-4 Water heating conservation retrofits;
9) CI-5 Custom efficiency program for large volume customers;
10) CI-6 Boiler analysis and adjustment program.

The relationship between commodities, measures, programs, and the portfolio is shown in Figure 1.

The set of five-year DSM programs that comprise the portfolio were expected, at the time of the study, to reduce the demand for natural gas by approximately 1,900 10^6 m^3 over the 29-year life of these programs. The largest savings, in 1999, represent a 1.5% reduction in demand. Cumulative peak day demand is forecast to be reduced by 14.8 10^6 m^3. The largest savings, in 2000, are 1.3% of peak demand for that year.

The environmental savings of 3.8 million tonnes of CO_2, 3,000 tonnes of NO_X, and 30 tonnes of SO_X, were valued at a net present value (NPV) of $25-285 million discounted back to 1995, using a range of values for these externalities. The economic and environmental benefits were $260-480 million (NPV) and economic externalities added another $10 million (NPV) to this.

The results of the economic externalities analysis using three different SDRs are summarized in Tables 1 to 3. The SDRs, 5%, 7%, and 9% real, or 7.1%, 9.14%, and 11.18% nominal are taken from a literature search done by Parker (1994).

The largest economic externality is the foreign exchange externality, which ranges between $4.0 million and $5.8 million (NPV), depending on the SDR used. This is mostly as a result of the gas saved by DSM, which can then be exported to generate foreign exchange.

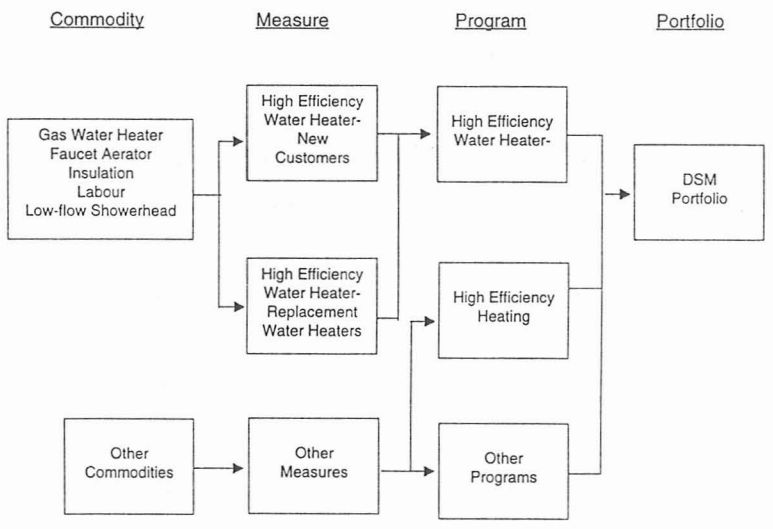

Figure 1: Relationship between Commodities, DSM Measures, Programs, and the Chosen Portfolio of Programs

The economic and environmental benefits of the DSM portfolio were $260-480 million (NPV) and economic externalities added another $10 million (NPV) to this.

The labour externality varies from $2.8 million (NPV) in the 11.18% SDR case to $2.9 million in the 7.1% SDR case. The labour externality is highest for those programs that have the highest labour content, so the DSM administration costs therefore generated the largest labour externality. Also, because administration jobs are more permanent, less cyclical, higher skilled, and higher paid than construction jobs, they are subject to a larger externality per dollar of wage bill. This is because the jobs will generate more income tax and less UIC payments than construction jobs.

The tariff externality arises mostly from DSM program RP-4: the residential heating program. This is because it involves importing high efficiency furnaces into Canada, which have a tariff rate of 7.1%. In several programs the tariff externality is negative because the tariffs generated as a result of importing goods for the DSM program are outweighed by the foregone tariffs on imported plastic pipe for gas distribution. The tariff externality amounts to roughly $1.7 million (NPV) in all three SDR scenarios.

The tax externality is small because the corporate taxes were not deducted in the screening results (which are stated on a before-tax revenue requirement basis) and, for the most part, GST and PST were not built into the costs and benefits. The exception was for the DSM programs that had a water savings component: RP-3, RP-6, and CI-4. In these programs low-flow showerheads had some tax factored into their cost. The calculated tax externality is therefore only $0.3 million (NPV).

Total economic externalities for all programs, including the administration costs, amount to between $8.8 million and $10.8 million (NPV). The largest contributor to this total is program CI-5 because it is the largest in terms of avoided costs, admini-

Table 1: Economic Externalities at a 7.1% SDR ($NPV)

Program	Foreign Exchange	Tariff	Tax	Labour	Total
RP-2	1,418,013	(28,243)	0	222,764	1,612,534
RP-3	112,675	24,766	12,462	68,605	218,508
RP-4	174,336	1,622,984	0	667,978	2,465,298
RP-5	102,907	(5,765)	0	93,926	191,068
RP-6	218,203	31,406	298	128,856	378,763
CI-1	178,581	6,046	0	56,450	241,077
CI-2	39,944	250,129	0	103,094	393,167
CI-4	715,364	82,830	312,763	(8,463)	1,102,494
CI-5	2,814,004	(223,416)	0	747,983	3,338,571
CI-6	56,041	(4,557)	0	23,532	75,016
Admin.[1]	(1,493)	0	0	827,943	826,450
Total	5,828,575	1,756,180	325,523	2,932,668	10,842,946

1/ Administration costs for DSM programs

Table 2: Economic Externalities at a 9.14% SDR ($NPV)

Program	Foreign Exchange	Tariff	Tax	Labour	Total
RP-2	1,252,668	(24,652)	0	198,577	1,426,593
RP-3	96,754	23,793	11,848	65,337	197,732
RP-4	(15,960)	1,583,812	0	652,468	2,220,320
RP-5	82,240	(4,607)	0	90,649	168,282
RP-6	179,111	31,640	284	123,516	334,551
CI-1	144,695	6,671	0	54,718	206,084
CI-2	12,240	241,543	0	99,618	353,401
CI-4	621,745	80,729	299,188	(7,415)	994,247
CI-5	2,396,881	(195,240)	0	730,266	2,931,907
CI-6	53,401	(4,343)	0	22,691	71,749
Admin.	(1,225)	0	0	809,629	808,404
Total	4,822,550	1,739,346	311,320	2,840,054	9,713,270

Table 3: Economic Externalities at a 11.18% SDR ($NPV)

Program	Foreign Exchange	Tariff	Tax	Labour	Total
RP-2	1,113,702	(21,659)	0	178,099	1,270,142
RP-3	83,570	22,857	11,280	62,299	180,006
RP-4	(157,656)	1,544,709	0	636,827	2,023,880
RP-5	67,111	(3,759)	0	87,508	150,860
RP-6	148,938	31,496	271	118,416	299,121
CI-1	118,611	7,082	0	53,032	178,725
CI-2	(8,557)	233,311	0	96,273	321,027
CI-4	543,741	78,577	286,620	(6,539)	902,399
CI-5	2,052,767	(171,686)	0	712,695	2,593,776
CI-6	50,970	(4,145)	0	21,909	68,734
Admin.	(1,037)	0	0	792,613	791,576
Total	4,012,160	1,716,783	298,171	2,753,132	8,780,246

stration, program, and participant costs.

Conclusion

In some cases, economic externalities accounted for almost 30% of the social impact.

The inclusion of economic externalities in DSM planning is as justified as that of other externalities. For Consumers Gas this represents a logical extension of established practices since it is consistent with previous cost-benefit analyses the Company has done on system expansion.

The results of the analysis are that economic externalities are small relative to environmental externalities if we use the high end of the range of values for environmental externalities but can, at the low end of the range, account for almost 30% of the social (environmental and economic) impact. While no decision rested on the value of the economic externalities in this instance, this need not be the case in other jurisdictions or for other DSM plans.

References

Econanalysis & Associates (1988) 'Economic Analysis of the Georgian Bay Expansion Project,' Section 5.0, Appendix 2, of *Ontario Energy Board Leave Order* (E.B.L.O.) 223 (Toronto: Ontario Energy Board).

Evans, John C., Harvey Schwartz and Graham Glenday (1981) 'Estimation of the Regional Employment Benefits and of the Economic Opportunity Cost of Labour for Onakawana and Alternative Generating Stations,' *A Study Commissioned by the Economics Division of Ontario Hydro.*(Toronto: Ontario Hydro).

Jenkins, G. and Kuo (1985) 'On Measuring the Social Opportunity Cost of Foreign Exchange,' *Canadian Journal of Economics* XVIII:2:400-15.

Parker, John C. (1994) 'Estimation of the Social Discount Rate' Appendix VII.A of Exhibit D2, Tab 6, Schedule 1 of *Ontario Energy Board Rate Order* (E.B.R.O.) 487 (Toronto: Ontario Energy Board).

Appendix: Economic Externalities Documentation

Below, a commodity is defined as part of a measure that is unique in that it has a different capital/labour split, Canadian content, tax rates, or different tariff rates. For example, program RP-2 is made up of eight measures: R-2, R-2A, R-3, R-3A, R-4, R-4A, R-5, and R-5A. Each measure is made up of two commodities: a high-efficiency residential water heater including heat trap, commodity 1, and extra insulation, commodity 2. The incremental cost of a higher efficiency water heater over a traditional water heater is then allocated to commodity 1 and commodity 2.

The commodities considered are: gas; residential water heaters; residential furnaces; residential insulation; residential water savings products such as low-flow showerheads and toilet dams; commercial boilers; commercial water savings products; commercial insulation; commercial boiler inspections; plastic pipe; steel pipe; computers; and meters.

BENEFITS

Labour Externality Benefits – A positive labour externality arises as a result of job creation:

(Utility Program Costs + Participant Cost) * Commodity 1's Weight in Program * Commodity 1's Labour Component * Labour Externality for Contractor Construction Jobs
+ (Utility Program Costs + Participant Cost) * Commodity 2's Weight in Program * Commodity 2's Labour Component * Labour Externality for Contractor Construction Jobs
+ Utility Administration Costs * Labour Externality for Operating Jobs * Commodity 1's Weight in Program
+ Utility Administration Costs * Labour Externality for Operating Jobs * Commodity 2's Weight in Program

Note: The administration costs are assumed to be 100% labour.

Foreign Exchange Externality Benefits – In the case of DSM, the chief economic benefit is the reduction of natural gas consumption. Since natural gas is primarily an exportable commodity, this reduction in domestic consumption permits increased gas exports. To the extent that natural gas would otherwise have been imported, DSM also reduces imports. The primary foreign exchange externality therefore arises from the additional foreign exchange earned (or saved) as a result of these incremental exports (or reduced imports):

Avoided Costs * Foreign Exchange Premium * (1–Transportation as a Proportion of Price) * {[1 – (Pipe as a Proportion of

Avoided Costs for Commodity 1 * Commodity 1's Weight in Program + Pipe as a Proportion of Avoided Costs for Commodity 2 * Commodity 2's Weight in Program)]}

+ Avoided Costs * Foreign Exchange Premium * Pipe as a Proportion of Avoided Costs for Commodity 1 * Commodity 1's Weight in Program * (1 – Canadian Content of Plastic Pipe) * [1 / (1 + Tariff Rate on Plastic Pipe)] * Plastic Pipe Proportion Avoided Costs for Commodity 1 * Commodity 1's Weight in Program * (1 – Canadian Content of Steel Pipe) * [1 / (1 + Tariff Rate on Steel Pipe)] * Steel Pipe Proportion
+ Avoided Costs * Foreign Exchange Premium * Pipe as a Proportion of Avoided Costs for Commodity 2 * Commodity 2's Weight in Program * (1 – Canadian Content of Plastic Pipe) * [1 / (1 + Tariff Rate on Plastic Pipe)] * Plastic Pipe Proportion
+ Avoided Costs * Foreign Exchange Premium * Pipe as a Proportion of Avoided Costs for Commodity 2 * Commodity 2's Weight in Program * (1–Canadian Content of Steel Pipe) * [1 / (1 + Tariff Rate on Steel Pipe)] * Steel Pipe Proportion

Tariff Externality Benefits – A positive tariff externality arises from capital equipment purchases which we have assumed to be partly importable and partly domestically produced goods. When calculating the tariff externality benefits on importable goods purchases, the tariff is computed on the net-of-tax-and-tariff value of an imported item:

(Utility Program Costs + Participant Cost) * Commodity 1's Weight in Program * Commodity 1's Capital Component * (1 – Canadian Content of Commodity 1) * [Tariff Rate on Commodity 1 / (1 + Tariff Rate on Commodity 1)]
+ (Utility Program Costs + Participant Cost) * Commodity 2's Weight in Program * Commodity 2's Capital Component * (1 – Canadian Content of Commodity 2) * [Tariff Rate on Commodity 2 / (1 + Tariff Rate on Commodity 2)]

Tax Externality Benefits – The positive tax externalities must be consistent with the preceding calculation. That calculation, however, examined only importable commodities, and part of the capital costs might be supplied from domestic sources. In this latter case, we need to make some assumptions about domestic industry conditions. In the following formula, we assume that the domestic industry has constant costs and excess capacity (i.e., that it can supply all the capital items required without raising the domestic price). In this case, there is incremental tax revenue earned on the increased domestic production:

(Utility Program Costs + Participant Cost) * Commodity 1's Weight in Program * (PST Rate + GST Rate) * Commodity 1's Capital Component

+ (Utility Program Costs + Participant Cost) * Commodity 2's Weight in Program * (PST Rate + GST Rate) * Commodity 1's Capital Component

Note: The PST & GST externality is charged only if GST and PST is included in the costs.

COSTS

Labour Externality Costs – A negative labour externality arises when jobs are lost:

Avoided Costs * Commodity 1's Pipe Portion of Avoided Costs * Labour Portion of Pipe Installations * Labour Externality for Contractor Construction Jobs
+ Avoided Costs * Commodity 2's Pipe Portion of Avoided Costs * Labour Portion of Pipe Installations * Labour Externality for Contractor Construction Jobs

Foreign Exchange Externality Costs A negative foreign exchange externality occurs when importable goods are purchased for a DSM program:

(Utility Program Costs + Participant Cost) * Foreign Exchange Premium * Commodity 1's Weight in Program * Commodity 1's Capital Component * (1 – Canadian Content of Commodity 1) * [1 / (1 + Tariff Rate on Commodity 1)]
+ (Utility Program Costs + Participant Cost) * Foreign Exchange Premium * Commodity 2's Weight in Program * Commodity 2's Capital Component * (1 – Canadian Content of Commodity 2) * [1 / (1 + Tariff Rate on Commodity 2)]

Tariff Externality Costs – There is a negative tariff externality when a DSM program displaces capital expenditures that would otherwise have generated tariff revenue. Once again, when calculating the tariff externality costs, the tariff is computed on the net-of-tax-and-tariff value of an imported item:

Avoided Costs * Commodity 1's Pipe Portion of Avoided Costs * (1 – Canadian Content of Commodity 1) * Plastic Pipe Proportion * [Tariff Rate for Plastic Pipe/ (1 + Tariff Rate for Plastic Pipe)]
+ Avoided Costs * Commodity 2's Pipe Portion of Avoided Costs * (1 – Canadian Content of Commodity 2) * Plastic Pipe Proportion * [Tariff Rate for Plastic Pipe/ (1 + Tariff Rate for Plastic Pipe)]
+ Avoided Costs * Commodity 1's Pipe Portion of Avoided Costs * (1 – Canadian Content of Commodity 1) * Steel Pipe Proportion * [Tariff Rate for Steel Pipe/ (1 + Tariff Rate for Steel Pipe)]

+ Avoided Costs * Commodity 2's Pipe Portion of Avoided Costs * (1 – Canadian Content of Commodity 2) * Steel Pipe Proportion * [Tariff Rate for Steel Pipe/ (1 + Tariff Rate for Steel Pipe)]

Tax Externality Costs – There is a negative tax externality when a DSM program displaces activities that would otherwise have generated tax revenue. One of these activities is foregone capital expenditures on pipe, both imported and domestically produced:

Avoided Costs * Commodity 1's Weight in Program * Pipe as a proportion of Avoided Cost for Commodity 1 * (PST Rate on Steel and Plastic Pipe + GST Rate on Steel and Plastic Pipe)
+ Avoided Costs * Commodity 2's Weight in Program * Pipe as a proportion of Avoided Cost for Commodity 2 * (PST Rate on Steel and Plastic Pipe + GST Rate on Steel and Plastic Pipe)

Note: This assumes that there is no GST in the avoided gas costs.

TOTAL ECONOMIC EXTERNALITIES

(Labour Externality Benefit + Foreign Exchange Premium Benefit + Tariff Externality Benefit + Tax Externality Benefit)
– (Labour Externality Cost + Foreign Exchange Premium Cost + Tariff Externality Cost + Tax Externality Cost)