GREEN BUTTON COST-BENEFIT ANALYSIS REPORT

Submitted to: **ONTARIO MINISTRY OF ENERGY**
Conservation and Energy Efficiency Branch

Prepared by:

dunsky ENERGY CONSULTING

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INTRODUCTION

Ontario's Ministry of Energy has hired Dunsky Energy Consulting to support its efforts in developing policy recommendations for the potential implementation of Green Button for electricity, natural gas, and water utilities in Ontario. Specifically, our team is conducting a cost-benefit analysis and facilitating stakeholder consultations on behalf of the Ministry. The Ministry is taking on an exciting leadership role in this area, as no jurisdiction has attempted a quantified cost-benefit analysis of the Green Button standard to date.

This report includes the following information:

- The **cost-benefit analysis report,** which outlines how the Green Button cost-benefit analysis was developed including:
  - **Overview of cost-benefit analyses in general:** principles, strengths, and limitations of cost-benefit analyses (not Green-Button-specific);
  - **Green-Button cost-benefit analysis assumptions:** generic assumptions and inputs used in our modelling (not scenario-specific); and
  - **Key scenarios:** assumptions and inputs used in our modelling related to specific scenarios.

- **Appendix A** includes the Cost-Benefit Analysis slide deck, which was presented to stakeholders during the second round of consultations, held July 18th to 27th.

- **Appendix B** includes descriptions of, and sources for, the assumptions built into the cost-benefit analysis model and is designed to provide the Ministry with an understanding of how our research informed the analysis and the inclusions therein.

- **Appendix C** provides an overview of the components of the costs and benefits that are included in the model. To avoid double-counting costs and benefits, many important considerations of a Green Button initiative were required to be rolled up into larger categories. This table is intended to demonstrate that these costs and benefits have not been excluded from the analysis; rather, they have been included at a higher level.

- **Appendix D** explains the methodology, assumptions, and inputs used to estimate the conservation costs and benefits, including greenhouse gas reductions, related to the implementation of Green Button.

- **Appendix E** includes additional scenario analyses using a real societal discount rate of 3.5%, which has been used by the Ministry of Energy in other recent analyses.

COST-BENEFIT ANALYSES

This section explains how cost-benefit analyses in general are structured, as well as alternatives and limitations.

OVERVIEW

The cost-benefit analysis (CBA) developed to assess the potential implementation of Green Button in Ontario follows the general principles of cost-benefit analyses: it provides a common ground to compare the costs incurred by each scenario under consideration to the potential benefits that are expected to materialize as a consequence of that scenario. One of the key strengths of a CBA analysis is that it provides a coherent and consistent view of benefits and costs using a common expression. In most cases the common expression is monetary value, which means that all costs and benefits in the analysis must be expressed as a monetary value. If they cannot be expressed in this way, they cannot be included in the analysis. For example, time can be converted by utilizing assumptions for hourly or daily labour costs.

CBA analyses are based on a set of fundamental parameters and considerations. Some of the key ones are the following:

- Benefits and costs are expressed in constant dollars, taking into consideration the time-value of monetary flows.
- CBA analyses must be balanced (i.e., the analysis should strive to account for all costs and benefits of any specific component).
- Its boundaries must be clearly defined, to capture and express costs and benefits within these boundaries.
- Double counting of costs and benefits must be avoided. This can be challenging when benefits can be expressed in different fashions or accrue to different stakeholders (i.e., if any components are included at a more granular population than the general boundary of the analysis, they should not be included in a broader stakeholder category).
- CBA analyses cannot provide a perfect appraisal of all present and future costs and benefits. Recognizing this, effort should be focused on the evaluation of costs and benefits with a material impact on the expected results.
- CBA outcomes rely on the accuracy and quality of the inputs used. Data quality can be higher when it is possible to draw from similar types of analyses conduct in other jurisdictions or when detailed, market-specific data is available.

BENEFIT-COST RATIOS

Benefit-cost ratios are the result of a cost-benefit analysis. To calculate them, total benefits (in dollars) are divided by total costs in the following way:

$$R \quad = \frac{B}{C}$$

If the ratio is positive, it means that the benefits outweigh the costs, so the initiative being analyzed is cost-effective. If it is negative, the costs exceed the benefits and the initiative is not cost-effective.

Here is an example:

$$B \qquad C \quad R \quad = \frac{\$4,000,000}{\$1,000,000} = 4$$

In this example, the benefits outweigh the costs by 4 to 1, so the initiative being analyzed is cost-effective.

ALTERNATIVES

Alternatives to CBA exist that use a different denominator for the benefits where appropriate. As an example, cost-effectiveness analyses for energy efficiency programs can be expressed in $/unit of energy saved, and similar constructs are used for economic analysis in other spheres ($ per life-year saved, $ per GHG emissions reduction, etc.). When assessing the potential implementation of a Green Button policy, since the vast majority of benefits can be readily expressed in a monetary figure, this is the most appropriate denominator to be used for a CBA analysis.

LIMITATIONS

BENEFIT-COST RATIOS

The cost-benefit results (in the form of benefit-cost ratios) are presented at the societal level, not for individual sectors or customer groups. This is because there are numerous overlapping and multi-tiered costs and benefits that cannot be broken out. For example, setup costs are incurred at the utility level (therefore all customers), but only a subset of customers see associated process efficiencies. Conversely, some customers will incur costs, but other customers will receive benefits related to that investment.

While we are unable to present balanced cost-benefit ratios at the sector or customer-group level, the results have been built up from inputs at those levels rather than developed from a top-down approach. We are therefore able to present the dollar values used as inputs in key scenarios to provide a sense of scale.

LEVEL OF GRANULARITY

CBA analyses provide a reasonable estimate of the best alternatives to be considered. However, they should be used to inform and guide decisions, not to dictate them. Components and considerations not included in the CBA analysis (including qualitative benefits) should also be accounted for in the decision-making process.

It is also important to note that Green Button is a relatively new opportunity, and little documented and verified data exists at the granularity that exists for other types of CBAs. The information we gathered was largely new and primary-source based, and data for some sectors, costs and benefits is more widely available than others. Where detailed, granular data does not exist, or the project scope did not allow for in-depth research, our team therefore developed assumptions and proxies.

For this reason, the analysis highlights scenarios that are cost-effective and ones that are not. However, the results should not be interpreted as exact; they should be interpreted as indicative. The inputs we gathered and developed are appropriate for a policy-level analysis designed to determine whether the benefits of a Green Button implementation outweigh the potential costs. However, they are not developed at the granularity that an actual implementation plan would require.

Where costs and benefits have been broadly quantified based on limited data availability, we recommend caution in the interpretation of the results. This is especially the case with results for which the benefit-to-cost ratio is close to one, as small deviations from the assumptions used can lead to different conclusions (e.g., the benefit/cost ratio can fall or rise above one if assumptions change).

RESEARCH SOURCES

Our team conducted secondary research and literature reviews that included evaluation and research reports, utility filings and reports, Statistics Canada data, conservation and demand management (CDM) and demand-side management (DSM) programs, and other sources.

We also generated key inputs and assumptions through a series of consultations, surveys and interviews with stakeholders. Information on this source of primary data is provided below, and the assumptions developed from each source is provided in Appendix B.

STAGE ONE CONSULTATIONS

We obtained initial input from stakeholders on general costs and benefits they could experience from a Green Button implementation. This stage was designed to ensure we research the appropriate topics and details. Eighty-nine organizations attended these sessions, with the breakout by stakeholder group provided below.

Figure 1. Breakdown of Stakeholder Groups Attending Stage One Consultations

STAGE ONE WORKBOOKS

We asked a series of questions asking stakeholders to quantify costs and benefits they could see as a result of a Green Button implementation. Questions focused on how and for what purposes utility data is requested or shared, challenges with accessing or providing data, time and effort that could be saved by accessing data via Green Button, and other potential benefits such as access to additional insights in energy or water use, greater potential for taking action to save energy or water, and other outcomes. We received thirty workbooks in total, with the cross-section of stakeholder groups provided in figure 2 below.

Figure 2. Breakdown of Completed Workbooks by Stakeholder Group

INTERVIEWS

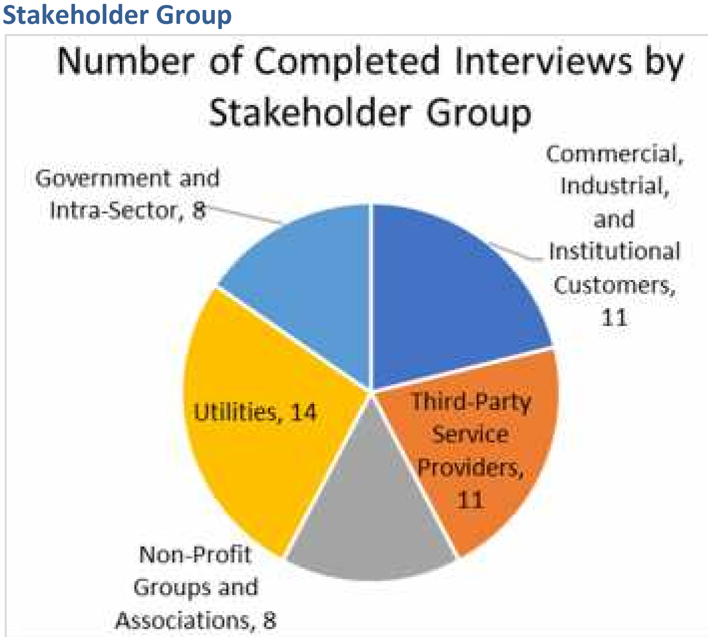
The Stage One Consultations and workbooks were designed to ensure we understood the potential scope of costs and benefits for a Green Button implementation. However, to obtain more granular data and inputs with which to assess the costs and benefits, our team conducted interviews with multiple organizations in each stakeholder group.

For interviews with utilities:

- We interviewed small, medium, and large electricity and water utilities as well as both large natural gas utilities to ensure we captured differences between how each size and type would be impacted by a Green Button implementation.
- We interviewed both utilities involved in Ontario's Green Button Connect My Data Pilot in order to obtain as much detail as possible on the actual implementation experience in Ontario, in particular for the costs of implementing Green Button Connect My Data (including Extract, Transform, and Load (ETL) protocols, integration with customer portals, meter data, external testing and validation, etc.).

These semi-structured interviews went into more detail in terms of quantifying the costs and benefits identified in the earlier consultations and workbooks. Our team completed 52 interviews across the range of stakeholder groups, with a higher percentage completed with groups identified as having the greatest potential benefits and/or costs: Commercial, Industrial and Institutional customers, utilities, and third-party service providers (consultants, energy efficiency services organizations, app developers, and hosted solution providers), as highlighted in figure 3 below.

Figure 3. Breakdown of Completed Interviews by Stakeholder Group



UTILITY INFORMATION TECHNOLOGY SURVEY

An important component of the cost-benefit analysis was understanding the information technology (IT) infrastructure of utilities. Because benefits arising from Green Button change based on the type and frequency of utility metering and meter reads and other utility IT considerations, we sent surveys to electricity, natural gas, and water utilities. The surveys included the following question categories:

Category Type	Information Sought
Consumption Data	Type of metering infrastructure by customer segment
	Number of installed meters and sub-meters by customer segment
	Typical time intervals for meter reads and whether estimates are used, by customer segment
	How meter data is managed for General Service and Large User customers (specifically whether or not it is outsourced or done in-house)
	Availability and frequency of access of online customer portals
	Billing frequency and format
	Billing processes including whether or not it is conducted by a third party
	Customer access to consumption data, including availability, format, process, granularity, frequency, and cost
	Processes for authorized third-party access to customer utility data, including time and effort required to grant approvals
	Percentage of customers requesting access to their consumption data in a machine-readable form, by customer segment, and the cost and effort of fulfilling such requests
Generation Data	Availability of customer generation data (for applicable customers), by customer segment
	Level of granularity and frequency of customer generation data
	Percentage of customers requesting access to their generation data in a machine-readable form, by customer segment, and the cost and effort of fulfilling such requests
Additional Questions	Current investment in smart meters, by customer segment
	Planned meter and IT investment, including smart meters (by customer segment), meter data management infrastructure, billing, customer portals

These surveys were used, in combination with other sources, to develop estimates of the number of water utilities with metering infrastructure, accounts by utility type and customer segment, penetration of submeters in buildings and facilities, percentage of customers currently accessing utility data in electronic format, and annual cost reductions by utility type and size.

Overall, our team received 61 completed surveys, broken down as follows:

- 33 electricity utilities (46 percent of possible utilities);
- 2 natural gas utilities (67 percent of possible utilities); and
- 26 water utilities (5 percent of possible utilities).

SOLUTION PROVIDER SURVEY

Additional data was also required to estimate the costs for developing, hosting, and maintaining the Green Button platforms. Because we required detailed cost information that is difficult to gather via phone interview, we sent surveys to eleven solution providers, from which we received two submissions. The surveys asked for estimates of the following costs for each of two scenarios:

Scenarios:

1. Implementing Green Button Connect My Data as a hosted solution for each utility (e.g. if each utility was responsible for hiring a firm to implement Green Button Connect My Data).
2. Implementing Green Button Connect My Data as a hosted solution for a group of utilities (e.g. if a hosted solution provider were hired to implement it for a group of utilities or for the entire province).

Information Requested:

- Fixed and variable costs for each utility if hired on an individual basis, by utility type, size (small, medium, or large), or group;
- Time required to set up and launch the platform; and
- Assumptions, including whether or not the provider is hosting Connect My Data or is installing Connect My Data software.

This information was used to develop estimates for the costs of developing and hosting a Green Button Platform. Rolled-up, not itemized, costs were requested; they included front-end solutions, cloud services, platform costs, development and testing, and registration.

GREEN BUTTON COST-BENEFIT ANALYSIS

The following sections describe 1) the general assumptions used in the Green Button cost-benefit analysis and 2) inputs and assumptions used in modelling specific scenarios.

STAKEHOLDER GROUPS

There are five key stakeholder groups involved in the analysis, with further categorization within the groups, as outlined below[1]:

Stakeholder Group	Stakeholder Sub-Group	Additional Considerations (if applicable)		
Customers	Commercial	Large	Owners/Managers; Tenants	Existing users of utility data; New users of utility data
		Small	Owners/Managers; Tenants	Existing users of utility data; New users of utility data
	Large Industrial		Owners/Managers; Tenants	Existing users of utility data; New users of utility data
	Institutional		Owners/Managers; Tenants	Existing users of utility data; New users of utility data
	Residential		Owners/Managers; Tenants	Existing users of utility data; New users of utility data
Third-Party Service Providers	Energy Efficiency Services			
	Hosted Solution Providers			
	Application Developers			
	Consultants			
	Renewables			
Non-Profit Groups and Associations	Associations			
	Non-Profit Organizations			
Utilities	Electricity Utilities	Large; Medium, Small		
	Natural Gas Utilities	Large; Medium, Small		
	Water Utilities	Large; Medium, Small		
Government and Intra-Sector				

[1] Note that stakeholder groups do not necessarily align with higher-level groups used for stakeholder consultations and workshops – these sub-groups align with how research for the cost-benefit analysis was conducted.

QUANTITATIVE AND QUALITATIVE BENEFITS

We considered multiple costs and benefits in our analysis, some of which are direct results of a Green Button implementation, others that are prompted by (but not automatically resulting from) Green Button, and others that are important but cannot be quantified. For this reason, we group them in the following way:

Table 1. Grouping of Costs and Benefits

QUANTITATIVE		QUALITATIVE
Direct (Layer 1A)	**Indirect (Layer 2A)**	**(Layer 2B)**
Benefits and costs are a direct result of Green Button implementation Monetary value can be estimated based on available information	Indirect consequence of Green Button implementation Require an additional external influence or decision point in order to materialize Monetary value can be estimated based on available information	Not included in Cost-Benefit Model Reported as "additional costs/ benefits" Used in overall analysis and policy recommendations

SCENARIOS

Two core considerations in the Green Button Cost-Benefit Analysis were the potential implementation of either Green Button Download my Data (DMD) or the implementation of both Download my Data and Connect my Data (CMD). For clarity, these are the definitions we used, per the Ministry's definition:

Table 2. Green Button Option Definitions

Option	Details
Green Button Download My Data (DMD)	• Provides customers with the ability to download their utility data directly, through their utilities' websites • Data is downloaded in XML and is provided in a consistent format
Green Button Connect My Data (CMD)	• Provides customers with the ability to share their data with solution providers/app developers and compatible databases in an automated way, based on consumer authorization • Process follows Privacy By Design principles

For each of these options, we then layered additional dimensions:

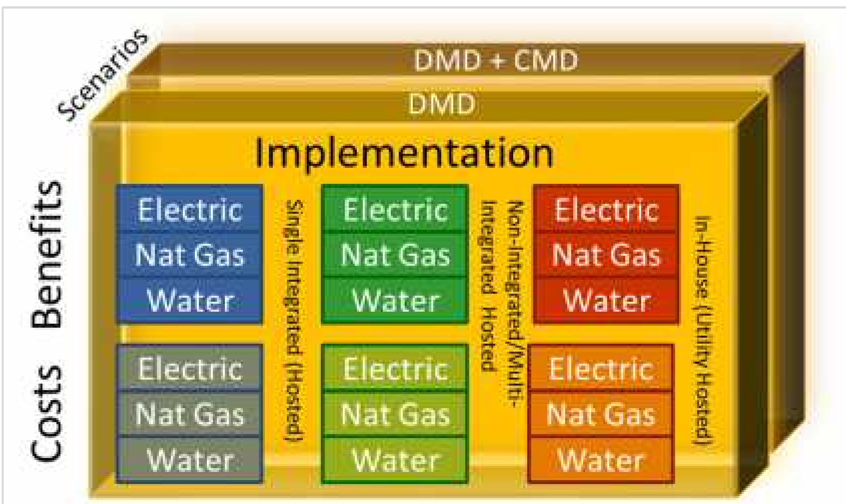
- **Utility Type:** Electricity, Natural Gas, Water
- **Implementation Type:** Single Integrated (Hosted), Multi-Integrated (Hosted), Non-Integrated (Hosted), In-House

For the implementation types, we used the following definitions:

- **Single Integrated (Hosted):** One Hosted Software as a Service (SaaS) provider implements Green Button for all utilities, incorporating one platform for each utility type (three platforms in total).
- **Multi-Integrated (Hosted):** A limited number of Green Button hosted SaaS platforms are used by all utilities.[2] This implementation assumed five implementation platforms for electricity and water utilities and two for natural gas utilities.
- **Non-Integrated (Hosted):** Each utility has the option to develop/procure its own Green Button SaaS hosted platform. One platform per utility was assumed, for 591 platforms in total.
- **In-House:** Each utility develops its own platform on its own IT systems. One platform per utility was assumed, for 591 platforms in total.

Overall, the layering (and resulting combinations of scenarios) can be conceptualized in the following way:

Figure 4. Cost-Benefit Analysis Scenarios



GENERAL INPUTS AND ASSUMPTIONS

UTILITY TYPE

The inputs for each utility type (electricity, natural gas, and water) are critical because Green Button would be implemented by utilities. Our general assumptions are:

[2] This was a hypothetical scenario to demonstration potential synergies in limiting the number of providers; the same assumptions were used for this scenario as for the non-integrated, with the difference being the number of platforms developed and integrated.

Table 3. Utility Input Assumptions

Utility Type	Key Factors in Analysis	Details	Source (if applicable)
Electricity	Utility Population/Sizes	• 7 Large, 21 Medium, 44 Small	• OEB 2014 Yearbook of Electricity Distributors
	Metering Infrastructure	• All are metered • Most have completed smart meter implementation for Residential and Small Commercial • Sub meters exist for many buildings (but unknown to what extent by utilities)	• Utility IT survey • Interviews with stakeholders
	Total Number of Accounts	• 5,162,768 accounts	• OEB 2014 Yearbook of Electricity Distributors • Utility IT survey
Natural Gas	Utility Population and Sizes	• 2 Large, 1 Small	• OEB 2014 Yearbook of Natural Gas Distributors
	Metering Infrastructure	• All are metered • Combination of Automatic Meter Reading (AMR) and analog meters	• Consultations with utilities
	Total Number of Accounts	• 3,423,622 accounts	• Utility scorecards – Ontario Energy Board • Union Gas and Enbridge Gas filings
Water	Utility Population and Sizes	• 39 Large, 91 Medium, 385 Small (only metered utilities were included in the analysis)	• Watertap Ontario
	Metering infrastructure	• All large and medium utilities metered • 70% of Ontario's 550 small water utilities assumed to be metered (resulting in the 385 indicated above) • Analog meters	• Utility IT Survey
	Total Number of Metered Accounts	• 4,955,366 metered accounts	• Residential: based on population in each municipality and average number of individuals per household in Ontario (Statistics Canada) • Commercial: based on proportion of electricity to water accounts

ADDITIONAL INPUTS

Separate from the utility types, our team had to make decisions as to the information and inputs to include in the analysis based on the data available or accessible through research and interviews, as well as the requirements of the analysis. These types of inclusions (and exclusions, as applicable) are provided in Table 4: General Inputs.

A NOTE ABOUT NET-PRESENT VALUE CALCULATIONS AND SOCIETAL DISCOUNT RATE

The economic analysis of Green Button was conducted based on the net present value of the benefits and costs streams generated by the program. All benefits and costs monetary streams were assessed in real values to isolate them from the impacts of inflation and to account for the uncertain timing of the Green Button implementation. Conducting cost-effectiveness analysis using real values is a leading industry practice and recommended in the IESO Conservation & Demand Management Energy Efficiency Cost Effectiveness Guide of June 2015.

The monetary streams were then discounted to the first year of implementation, using a real social discount rate of 2%. The proposed discount rate was informed by the long-term Ontario Global bonds maturing in December 2046 (Series no. DMTN228) with an interest rate of 2.9%, the inflation rate in June 2016 of 1.7%, and the IESO real social discount rate of 4% applied for utilities' CDM initiatives. Monetary values are expressed in 2016 dollars.

Although there are no set criteria to define an appropriate discount rate for government-led energy efficiency initiatives, the public benefit perspective of Green Button advocates for the use of a long-term, risk-free discount rate attuned to the provincial government's long-term interest rates. However, considering that this would translate into a real discount rate of 1.2%, and considering the discount rates used for CDM initiatives of 4%, a more conservative real discount rate of 2% was applied to the Green Button economic analysis.

Relevant sources are as follows:

- Province of Ontario Bond Issues Details: http://www.ofina.on.ca/pdf/bond_issue_details_DMTN228_to_R19.pdf
- 2016 Consumer Price Index and Inflation Rates for Ontario: http://inflationcalculator.ca/2016-cpi-and-inflation-rates-for-ontario/
- Conservation and Demand Management Energy Efficiency Cost Effectiveness Guide: http://www.ieso.ca/-/media/files/ieso/document-library/conservation/ldc-toolkit/cdm-ee-cost-effectiveness-test-guide-v2-20150326.pdf?la=en

Table 4. General Inputs

Category	Assumption/Consideration	Status	Rationale	Source (if applicable)
General Inputs	Metered utility types beyond electricity, natural gas, and water	Excluded	Lack of data	
	Societal discount rate	Included	The final policy will provide benefits and costs for Ontario as a whole.	Adjustment to IESO real discount rate (CDM EE Cost-Effectiveness Test Guide) to reflect conservative view of 30-year Ontario real bond rates of 1.2%)[3]
	Participation in Green Button based on Rogers' Diffusion of Innovation (varies by cost/benefit category)	Included	Used in Energy Efficiency Forecasting. Parameters fitted to observed and expected behaviours	Rogers' Diffusion of Innovation
Green Button Standard	Updates to Ontario Green Button architecture	Excluded	Out of scope	
	Single version of the standard for deployment	Included	Ensures consistency among utility implementations	
	Green Button certification costs (utility or solution provider/app developer)	Excluded	Lack of data, certification approach and costs under development at time of analysis	
	Application registration platform costs	Excluded	Not a fundamental requirement and lack of data	
Metering Infrastructure	Infrastructure upgrades (i.e., upgrading to smart meters or installing meters)	Excluded	Out of scope	
	Existing sub-meters: benefits	Included	Small, but quantifiable	Interviews with stakeholders
	Existing sub-meters: costs	Excluded	Initial research indicates lack of additional costs to implement Green Button for existing sub-meters	Interviews with stakeholders

[3] For additional analyses using a real societal discount rate of 3.5%, which has been used by the Ministry of Energy in other recent analyses, please see Appendix E.

Category	Assumption/Consideration	Status	Rationale	Source (if applicable)
Energy Inputs	Duration limited to analysis periods of 5 and 10 years (no end effects)	Included	Conservative assessment and unknown lifetime for retrofit measures	
	Energy retrofit costs ($/kWh or $/annual m^3 saved) accrued at the same time as benefits materialize	Included	Aligns benefits and costs for a more consistent reporting of results	Ontario gas utility's DSM Plan; Canadian Jurisdictions' Electricity DSM Plans (e.g. New Brunswick, Nova Scotia)/Potential Studies

COSTS OF A GREEN BUTTON IMPLEMENTATION

Quantitative costs of implementing and managing a Green Button Connect My Data solution, whether direct or indirect, can be categorized into three main components:

1. **Set-up**: Costs required to develop the Green Button platform (setup can be administered either by utilities or third parties).
    - Setup costs are largely related to developing the Green Button platform, so the costs are incurred for each platform developed. This means they vary based on the implementation model selected (single-integrated hosted, multi-integrated hosted, non-integrated hosted, and in-house), but not by utility size, type, or other consideration.

2. **Integration**: Costs incurred to integrate Green Button with utilities' data systems and processes.
    - These costs vary based on the utility size, reflecting the complexity of systems required to integrate with the Software as a Service (SaaS) hosted implementation platform. As part of the analysis, we also assumed the integration costs would vary based on the implementation scenario being assessed, with increased costs if utilities are required to develop and test all solutions without guidance from a SaaS hosted implementation provider.

3. **Ongoing annual costs**: Costs, expressed as a unit cost (cost per participating account) required to maintain the system and manage third-party solution provider application registration.
    - Similar to integration costs, the analysis assumes that annual costs vary based on the type of implementation model selected (single-integrated hosted, multi-integrated hosted, non-integrated hosted, and in-house). This reflects the range of values reported by third-party hosted solutions providers, with a lower unit cost (cost per participating account) for fewer SaaS platforms and a higher unit cost for individual in-house implementations. Details are provided in the Costs table below.
    - Retrofit costs are also included in this category as an indirect cost, since increased access to utility data is expected to drive interest in energy efficiency. The analysis is agnostic as to whether the retrofits occur outside of or through utility CDM programs, as total costs (whether incurred by the utility or the participant) are included, regardless of the source of funds.

These costs are incurred regardless of specific implementation scenario, although their magnitude changes based on the particular scenario being analyzed. In this section, we provide individual cost inputs to the analysis. Costs associated with specific implementation scenarios (combinations of inputs) are provided in the following section.

COST CATEGORIES, DEFINITIONS AND APPLICABILITY

Table 5 provides an overview and clarifying information regarding the various categories of costs, including definitions and the groups to which the costs apply.

Table 5. Cost Categories, Definitions and Applicability

Category	Cost	Definition	Impacted Groups[4]	Grouping
Platform Setup Costs	Front-end solutions	Interfaces and applications that users interact with directly	Utilities (can be via Software as a Service Green Button Implementation Providers)	Direct, Quantified
	Cloud services	Computing resources and services that support the deployment of Green Button and provide access to its applications, resources and services	Utilities (can be via Software as a Service Green Button Implementation Providers)	Direct, Quantified
	Green Button platform	The technical foundation that allows multiple products (such as Green Button applications) to be built within the same framework and execute successfully	Utilities (can be via Software as a Service Green Button Implementation Providers)	Direct, Quantified
	Development and testing of the services to manage third-party (solution provider) applications	Management of integration, registration, risk assessment, issues, etc.	Utilities (can be via Software as a Service Green Button Implementation Providers)	Direct, Quantified
	Testing of required security and privacy mechanisms and protocols	Required for ensuring mechanisms and protocols are acceptable	Utilities (can be via Software as a Service Green Button Implementation Providers)	Direct, Quantified

[4] Party incurring the costs

Category	Cost	Definition	Impacted Groups[4]	Grouping
Utility Integration Costs	Customer information system extract, transform and load (ETL) protocols	Protocols for the functions required to pull data from a utility's database into another database	Utilities (can be via SaaS Green Button Implementation Provide	Direct, Quantified
	Other integration costs such as integration with customer portals, meter data, external testing and validation, etc.	Testing and resolving issues with the connections between utility data systems and external systems via Green Button	Utilities	Direct, Quantified
Annual Variable Costs by Participating Customer	Maintenance and ongoing operations	Ongoing modification to address issues, improve performance, or incorporate changes to the standard	Utilities	Direct, Quantified
Retrofit Costs	Unit Costs of Retrofit Activity ($/conservation benefit)	Unit costs are the costs of an activity (e.g. retrofits) divided by the energy saved. Increased energy efficiency retrofits are expected to occur with a Green Button implementation, so related costs must be included to provide a balanced analysis.	Customers	Indirect, Quantified

COST INPUTS, SOURCES AND ASSUMPTIONS

Table 6 includes key inputs for each cost component, including sources and assumptions our team used to develop them.

Costs associated with solution provider/app developer registration with utilities were excluded because they were outside of cost-effectiveness testing parameters (they are built into the solution providers' costs).

Table 6. Cost Inputs, Sources and Assumptions

Cost Component	Unit Cost	Assumption/Considerations	Sources [5]
Platform Setup Costs – Green Button Platform	$50,000/ platform	• Assumes fixed cost per CMD implementation platform for setup (number of platforms drives costs). • Significant differences in values were quoted by different providers (from $0 to $50,000), but the value selected is a reasonable representation because it includes all services, including third-party registration.	• Based on discussions with hosted Software as a Service (SaaS) providers and solution provider survey.
Utility Integration Costs – Hosted Solution Implementation Scenarios (Multi-Integrated, Single Integrated, and Non-Integrated)	Large Utilities: $225,000/utility Medium Utilities: 72,000$/utility Small Utilities: 22,500$/utility	• Costs vary based on utility size, which reflects complexity of utilities' IT infrastructure. • Utility type does not alter the assumptions as it is IT, not energy, factors that impact the costs.	• Based on stakeholder interviews (specifically on Ontario's CMD pilot project experience).
Utility Integration Costs – Impact of in-house Implementation Model	Integration costs increase by 33% in comparison to the Single Integrated Hosted Solution implementation scenario	• Costs vary based on utility size, which reflects complexity of utilities' IT infrastructure. • Cost inefficiencies occur because software hosting is not part of utilities' core business.	• Based on stakeholder interviews (specifically on Ontario's CMD pilot project experience).

[5] When interviewees provided a range of responses our team used the mid-range unless, based on our experience and knowledge, it appeared overly optimistic, in which case we selected a higher end of the range.

Cost Component	Unit Cost	Assumption/Considerations	Sources [5]
Annual Variable Costs by Participating Customers	**SaaS Multi- and Non-Integrated Hosted Implementations:** $1/participating customer	• Fixed costs per participant vary by implementation scenario: assumes economies of scale between implementation scenarios (the fewer the number of platforms, the greater the cost efficiencies related to management of the platform and system). • Assumes mid-range of information provided by Software as-a-Service providers. • Includes general operational costs and costs to support solution provider/app developer registration.	• Professional judgment based on information provided by SaaS providers during stakeholder interviews.
	SaaS Single Integrated Hosted Implementation: $0.80/participating customer	• Fixed costs per participant vary by implementation scenario: assumes economies of scale between implementation scenarios (the fewer the number of platforms, the greater the cost efficiencies related to management of the platform and system). • Includes general operational costs and costs to support solution provider/app developer registration. • The input selected reflects operational maintenance efficiencies compared with the multi- and non-integrated implementations.	• Representative of information provided by SaaS providers during stakeholder interviews.

Cost Component	Unit Cost	Assumption/Considerations	Sources [5]
	In-House Utility Implementations: $1.20/participating customer	• Fixed costs per participant vary by implementation scenario: assumes economies of scale between implementation scenarios (the fewer the number of platforms, the greater the cost efficiencies related to management of the platform and system). • Analysis assumes high range of information provided by Software as-a-Service providers in order to be conservative and based on professional judgment.	• High range of information provided by SaaS providers during stakeholder interviews.

Retrofit Costs – Customers' energy efficiency upgrades resulting from access to data	**Residential Electricity Customers:** $0.65/$ value of benefits
	Residential Natural Gas and Customers: $0.69/$ value of benefits
	Non-Residential Customers (all utility types): $0.50/$ value of benefits
		• Annual levelized costs.
		• Costs are in relation to level and extent of retrofit activity.
		  • Full retrofit costs are included regardless of whether customers participate in a CDM/DSM program or not (i.e. if costs are partially paid by the utility or fully by the customer).
		  • Behavioural and operational savings are assumed to be implemented by the customer at no cost because they result from a change in procedures or behaviour rather than a solution that requires a capital outlay.[6]
			• Ontario utility and other Canadian CDM/DSM Plans (e.g. New Brunswick, Nova Scotia); Potential Studies

[6] Some process efficiencies could require additional resources or labour, but this is expected to be minimal and has therefore been excluded from the analysis.

BENEFITS OF A GREEN BUTTON IMPLEMENTATION

Quantified benefits from a Green Button implementation can be categorized into **two main categories:**

- **Operational Efficiencies**
  - Process efficiencies in accessing consumption, billing and generation utility data;
  - Reduced customer care effort; and
  - CDM/DSM program efficiencies and innovations.

- **Conservation / Energy Efficiency**.
  - Energy and water savings from behavioural changes resulting from additional access to utility data; and
  - Energy efficiency retrofit improvements resulting from additional access to utility data.

These benefits are incurred regardless of specific implementation scenarios, although their magnitude will change based on the particular scenario being analyzed. Benefits associated with specific implementation scenarios (combination of inputs) are provided in the following section.

BENEFIT CATEGORIES, DEFINITIONS AND APPLICABILITY

Table 7 on the following page provides an overview and clarifying information regarding the various categories of benefits included in the analysis, including definitions and the groups to which they apply.

Table 7. Benefit Categories, Definitions and Applicability

Category	Benefit	Definition	Impacted Groups[7]	Grouping
Operational Efficiencies	Utility consumption, billing and generation data process efficiencies and Ongoing utility consumption monitoring and benchmarking	• Process efficiencies for customers and consultants/service providers include efficiencies in energy audits; reduced effort/cost for energy tracking, reporting, and benchmarking; reduced effort to consolidate/ standardize data across facilities; reduced effort to "clean" and quality-check data; reduced effort to authorize data sharing; and access to increased frequency and granularity of utility data. • The benefits relate to customers who require data for their own internal use (e.g. for internal benchmarking or operational requirements) or who will need to comply with the Ministry of Energy's Large Building Energy and Water Reporting and Benchmarking initiative under *Ontario Regulation 20/17, Ontario Reporting of Energy Consumption and Water Use*. • Benefits to utilities include increased operational efficiencies from improvements to IT systems resulting from preparing systems to meet Green Button requirements.	Customers, Consultants/Service Providers, Utilities	Direct, Quantified
	Reduced customer care effort	• The benefit results from a reduction in the time required to provide consumption information to utility customers.	Utilities	Indirect, Quantified
	CDM/DSM program efficiencies and innovations	• Efficiencies resulting from streamlined CDM/DSM program implementation (e.g., easier access to data to conduct audits) and program evaluation (e.g. less resource time to gain access to billing data). • Innovations to existing programs based on increased customer access to utility data.	Utilities	Indirect, Quantified

[7] Who receives the benefits

Category	Benefit	Definition	Impacted Groups[7]	Grouping
Energy Efficiency and Conservation	Energy savings from behavioural and retrofit improvements resulting from additional access to utility data	Behavioural benefits include conservation behaviours resulting from increased access to utility data, greater operational savings in commercial/industrial buildings, and increased participation in CDM/DSM programs. Examples of behavioural/ operational efficiencies include turning lights off or optimizing equipment schedules to minimize energy use. • Energy Efficiency retrofit benefits include increased implementation of energy efficiency measures (e.g. purchasing and installing energy efficient measures, conducting building audits and implementing recommendations, etc.). Measures could be implemented through participation in existing CDM/DSM programs or outside of utility programs.	Customers[8]	Indirect, Quantified

[8] Energy efficiency benefits were not applied to utilities to avoid double-counting the benefits

BENEFIT INPUTS, SOURCES AND ASSUMPTIONS

Table 8 includes key inputs for each benefit, including sources and assumptions our team used to develop them.

Benefits of increased real estate value were excluded from the analysis because the impact is diffuse and not material in the analysis: only a certain percentage of homes would be sold during the study period, of which only a certain percentage would access GB data, of which only a certain percentage would retrofit their homes to increase the value, of which a low percentage would see an increase in value because purchasers would not likely have comparable data for other homes.

Table 8. Benefit Inputs, Sources and Assumptions

Benefit Component	Unit Benefit	Assumptions/Considerations	Sources
Utility consumption, Billing and Generation Data Process Efficiencies and Ongoing Utility Consumption Monitoring and Benchmarking	**Large commercial/ industrial customers (above 10,000 sq. feet):** • $180 in avoided costs annually per building (6 hours of effort at $30/hr)	• Benefits reflect total budget impact for a portfolio of buildings as well as effort required to collect and analyze data for a single building. • The benefits were distributed among each utility type (64% electricity, 22% natural gas, 14% water), based on stakeholder input as to the type of utility from which they would receive the most Green Button-related benefits, the frequency of billing by the utilities, and the granularity of data available. • Direct benefit of implementing Green Button.	• Stakeholder consultations and interviews
	Small commercial/ industrial customers: • $198 in avoided costs annually per building	• Benefits reflect total budget impact for a portfolio of buildings as well as effort required to collect and analyze data for a single building. • Assumption that small buildings (less than 10,000 sq. feet) would experience higher benefits than larger buildings because owners of smaller buildings have less sophisticated processes to collect and manage consumption data. • A 10% increase for this benefit category was attributed to the owners of small buildings category (in comparison to the avoided costs for large buildings), based on professional judgement. • Direct benefit of implementing Green Button.	• Stakeholder consultations and interviews
	Building Owners & Residential Customers: • Annual benefit (variable based on descriptions in Assumptions column)	• Benefits vary by implementation (DMD/CMD), new vs. current users of electronic data format, customer type, and building ownership status. • Greater value to customers not currently accessing data electronically. • Direct benefit of implementing Green Button.	• Stakeholder consultations and interviews

Benefit Component	Unit Benefit	Assumptions/Considerations	Sources
Utility consumption, Billing and Generation Data Process Efficiencies and Ongoing Utility Consumption Monitoring and Benchmarking (continued)	**Consultants/service providers (cleaning and consolidating data)** • Annual benefit • 6 hours of effort at $50/hour (1 hour for Natural Gas and Water) **Consultants/service providers (conducting audits)** • Annual benefit • $150 (electricity only) • $175 (electricity and Natural Gas) • $190 (all three utility types)	• Consultants/service providers would experience easier access to data and reduced effort for data cleaning and validation. • Benefits are per building using these services. • Assume 2% of commercial building stock uses these services. • Direct benefit of implementing Green Button.	• Stakeholder consultations and interviews
CDM/DSM Program Efficiencies and Innovations	• **Large LDC:** $10,000/year avoided costs • **Medium LDC:** $5,000/year avoided costs • **Small LDC:** $2,500/year avoided costs • **Large Natural Gas utility:** $5,000/year avoided costs • **Small Natural Gas utility:** $2,500/year avoided costs	• Most utilities reported they do not perceive the value proposition that Green Button could provide for their CDM/DSM program design and delivery models. However, they recognize it can bring some benefit to their operations (e.g. through applications that promote CDM/DSM programs or energy savings tips, through increased efficiencies for gathering consumption data for program delivery, customer negotiations, or evaluation). • The analysis therefore included a conservative estimate, based on experience evaluating CDM/DSM programs for electricity and natural gas utilities. While the estimate reflects a lack of specific data, it also reflects our understanding that the value is not zero. • No benefits were attributed to water utilities, considering their earlier stages in conservation program development compared to energy utilities. • Indirect benefit of implementing Green Button.	• Estimates based on utility interviews

Benefit Component	Unit Benefit	Assumptions/Considerations	Sources
Behaviour-Based Efficiency and Conservation	**Non-Residential Customers:** • 2% electricity and natural gas savings for participating customers (non-residential) **Residential Customers:** • 1% electricity and natural gas savings for participating customers (residential) **Water Utility Customers:** • 1% water savings for participating customers (residential and non-residential)	• Benefits allocated between utility types based on average energy consumption by sub-sector (residential, small commercial, large commercial, large industrial, and institutional). • Based on a conservative reduction of energy savings found to result from behavioural conservation programs designed around access to utility consumption data (access to data typically achieves between 4-12%). • Recognizes that savings achieved as a result of Green Button access to data may not achieve the same results as a utility-driven CDM/DSM program (utilities would not have control over all the solutions developed, quality of advice, and other factors). Behavioural-only programs typically achieve between 1 and 3%.[9] • Benefits assumed to be achieved either through existing CDM/DSM programs or outside of them (e.g. customers make the changes without receiving an incentive). The analysis does not differentiate between whether the savings are generated through utility program participation or not, as behavioural/operational benefits are assumed to require no cost/investment. • Benefits assume that utilities would have an opportunity to recruit participants to existing programs (whether or not customers take advantage of the opportunity) rather than assuming new programs will necessarily be developed that could duplicate/compete with existing savings opportunities. o This is a conservative assumption – new programs could improve the results. • New programs were excluded due to lack of information on the costs of new DSM/CDM programs based on Green Button information and because of concerns reported by electricity utilities with regards to behavioural savings and their potential contribution to Conservation First Framework 2020 savings targets. • Indirect benefit of implementing Green Button.	• Professional judgment applied to Murray, M. and J. Hawley. 2016. *Got Data? The Value of Energy Data Access to Consumers.* Mission:Data • Evaluation experience and research into behaviour-based energy savings.[8]

[9] See, for example: http://ilsagfiles.org/SAG_files/Evaluation_Documents/ComEd/ComEd_EPY7_Evaluation_Reports/ComEd_HER_Opower_PY7_Evaluation_Report_2016-02-15_Final.pdf (average of 1.15% - depending on cohort, savings range from 0.53% to 2.83% electrical savings)
http://www2.opower.com/l/17572/2013-08-22/bvhvp/17572/49284/25_ODC___Navigant_MA_Four_Year_Cross_Cutting.pdf (presents the findings of behavioural programs of Massachusetts program administrators for electricity and natural gas, which were typically around 1.5%)

Benefit Component	Unit Benefit	Assumptions/Considerations	Sources
Retrofit-Based Efficiency and Conservation	**Electricity customers:** • 10% electricity savings per building for participating customers (residential and non-residential) **Natural Gas customers:** • 4% natural gas savings per building for participating customers (residential and non-residential) **Water customers:** • 3% water savings per building for participating customers (residential and non-residential)	• Based on conservative reduction of typical energy efficiency evaluation results (not measure-specific), in which energy savings from deeper retrofits (e.g. insulation or building-envelope based) are often 20% or higher. • Savings estimated to be incremental to Conservation First Framework/Industrial Accelerator Program and DSM Framework targets. • Participation varies by sub-sector based on application of adoption curves (refer to Table 9). • We reduced utility results to account for a wide range of measures and retrofits, from simple measures such as selecting a more efficient appliance to a retrofit that improves the insulation level of the building. Therefore, overall savings would be expected to be lower than from a retrofit-only solution. • Benefits allocated between utility types based on average energy consumption by sub-sector (residential, small commercial, large commercial, large industrial, and institutional). • The analysis of retrofit benefits accounts for utility savings that occur only during the study period (5 years or 10 years, depending on the specific scenario), even though retrofit measures can produce savings over a much longer period. o This is a conservative estimate. While it reduces the potential benefits, it limits the risk of overstating the indirect benefits of Green Button and eliminates the uncertainty of the duration of those energy savings. • Benefits were assumed to be achieved either through existing CDM/DSM programs or outside of them (e.g. customers make the changes without receiving an incentive). • Indirect benefit of implementing Green Button.	• Estimates based on Ontario utility and other Canadian CDM/DSM Plans (e.g. New Brunswick and Nova Scotia) and average Ontario energy rates.

Benefit Component	Unit Benefit	Assumptions/Considerations	Sources
Reduced Utility Customer Care Efforts	• **Large LDC:** $10,000/year avoided costs • **Medium LDC:** $5,000/year avoided costs • **Small LDC:** $2,500/year avoided costs • **Large Natural Gas utility:** $5,000/year avoided costs • **Small Natural Gas utility:** $2,500/year avoided costs	• Applied to DMD/CMD (not DMD only) since bulk of customer care is for Residential customers who are not expected to participate in a DMD-only implementation to an extent that would demonstrate impact. • Annual cost savings per utility type and size. • Green Button can support new conservation programs based on easier and more streamlined access to consumption data and can reduce cost to procure such services through a single bridge to consumers' utility data. • Direct benefit of implementing Green Button.	• Stakeholder consultations and interviews

PENETRATION LEVEL

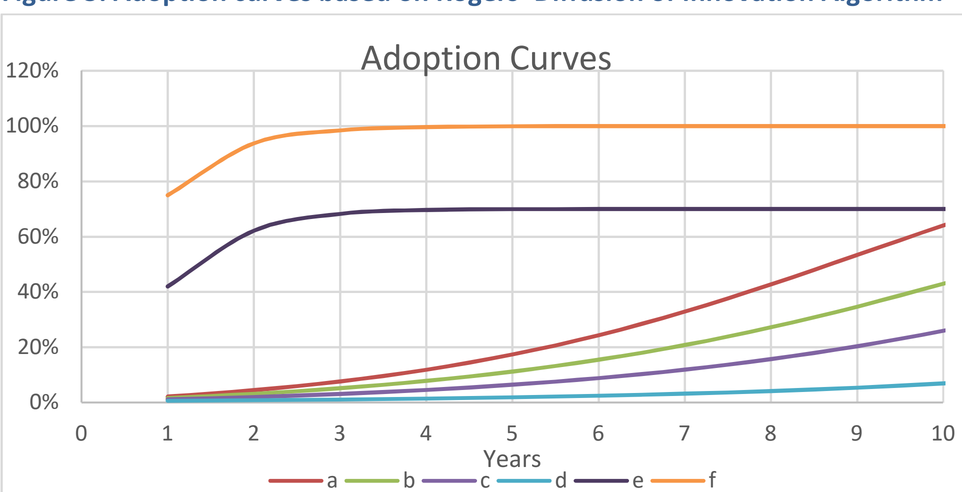
Everett Rogers, whose Diffusion of Innovation theory is used extensively in behavioural and technology-related research, identified that people will adopt new ideas or technologies at different stages, even though benefits may exist from inception. Green Button is no different: despite the benefits that increased access to utility data may have for all customers, some customers will adopt it early in the process (as was seen in the Green Button pilots), others will adopt it over time as it becomes more common and mainstream, and yet others likely never will. These trends are known as adoption curves.

The shape of adoption curves and rate of adoption however, can be different for different technologies and groups. For example, how quickly Green Button is used by a significant number or majority of customers will likely be different by customer group, depending on their individual data needs and requirements. For example, with the Large Building Energy and Water Reporting and Benchmarking initiative, we would expect large commercial, institutional, and industrial customers to adopt Green Button for data access purposes relatively sooner than a majority of residential customers.

For this reason, we developed individual adoption curves to represent the potential adoption of Green Button in the province, varying by benefit and cost category, but also by building type.

The following graph presents the different adoption curves that we applied to different groups using Rogers' Diffusion of Innovation theory, which outlines different ways in which innovations can be adopted based on the innovation itself, communications channels, time, and applicable social systems. The various curves (labelled with the letters a-f) have been applied to different stakeholder groups and benefits, as explained in Table 3 below the graph.

Figure 5. Adoption curves based on Rogers' Diffusion of Innovation Algorithm



The above penetration curves have been used for different benefits and building categories included in the model. The specific curves and rationales are outlined in Table 9 below.

Table 9. Penetration curves included in the analysis

Benefit/stakeholder	Category	Curve	Rationale
New users of utility data, owners/ managers of large and institutional facilities	Operational Efficiencies	a	Needs expressed during the consultation process were considerable; owner sophistication supports high penetration of Green Button
Retrofits to large commercial and institutional facilities	Increased conservation and energy efficiency	b	Limited to 25% of the building stock undergoing retrofits[10]
Operational benefits for large commercial and institutional facilities	Increased conservation and energy efficiency	c	Significant potential for building managers, resources available to actively manage utility consumption
Retrofits to small commercial buildings	Increased conservation and energy efficiency	c	Limited to 25% of the building stock undergoing retrofits[11]
New small commercial and residential users of utility data	Operational Efficiencies	d	Lower sophistication and availability to manage utility consumption data
Behavioural benefits for small commercial and residential buildings	Increased conservation and energy efficiency	d	Lower sophistication and availability to manage utility consumption
Retrofits to residential buildings	Increased conservation and energy efficiency	d	Limited to 25% of the building stock undergoing retrofits[12]
Large Building Energy and Water Reporting and Benchmarking (O.Reg. 20/17)	Operational Efficiencies	e	Assumes 35% would comply with regulations through means other than Green Button, such as hiring third-party consultants to capture, clean, and consolidate data (so a lower adoption curve has been selected than could be achieved from a technical perspective).
Current users of data (commercial, institutional, and industrial)	Operational Efficiencies	f	Automatic adoption of GB solution by proportion of customers accessing data as indicated by IT survey and interviews.

[10] Calculated based on common values for retrofit savings and research on additional savings (Hummer, J. and D. Brannan. 2014. *Quantifying Behavioral Spillover: The Overlooked, Uncounted Source of Program-Influenced Savings.* Behavior, Energy & Climate Change Conference.)

[11] Ibid

[12] Ibid

RESULTS OF THE ANALYSIS

As the analysis resulted in multiple iterations of very similar scenarios, this section provides an overview of the high-level results for each dimension of the analysis. In the following section, we provide the specific results of key scenarios that we believe warrant further consideration by the Ministry.

Benefit-cost ratios are provided for each result. As explained above, **if a ratio is positive, the benefits outweigh the costs of that scenario, so it is cost-effective. If it is negative, the costs exceed the benefits and the scenario is not cost-effective**. To make the consideration of such a wide range of scenarios simpler, we have colour-coded the tables: green means the combination of options (the scenario) is cost-effective; red means it is not.

GREEN BUTTON OPTIONS

The first dimension we analyzed was the consideration of Green Button implementation options: DMD only, or DMD and CMD together. The results show that, in general, a DMD/CMD implementation is more cost-effective across a range of scenarios.[13]

Table 10. Green Button DMD Scenario Cost-Benefit Results

Utility Type	Single Integrated Hosted		Multi-Integrated Hosted		Non-Integrated Hosted		In-House	
	5-year	10-year	5-year	10-year	5-year	10-year	5-year	10-year
Electricity	2.2	3.5	2.1	3.4	1.8	3.03	1.4	2.5
Electricity and Natural Gas	2.3	2.9	2.1	2.8	1.7	2.5	1.3	2.1
Electricity, Natural Gas, and Water	0.3	0.8	0.6	1.4	0.2	0.5	0.2	0.6
Natural Gas Component	2.4	1.8	2.1	1.7	1.9	1.4	0.5	0.8
Water Component	0.04	0.1	0.1	0.3	0.02	0.1	0.03	0.1

[13] The analysis was built up from a base case of electricity utilities implementing Green Button, to which natural gas utilities were added, and then water utilities. For this reason, in all results tables, the natural-gas-only and water-only components are based on incremental results (the differences in benefits and cost when the other utility types are removed), rather than on independent scenario assumptions.

Table 11. Green Button DMD/CMD Scenario Cost-Benefit Results

Utility Type	Single Integrated Hosted		Multi-Integrated Hosted		Non-Integrated Hosted		In-House	
	5-year	10-year	5-year	10-year	5-year	10-year	5-year	10-year
Electricity	4.1	3.6	4.04	3.6	3.5	3.5	3.2	3.4
Electricity and Natural Gas	4.4	3.8	4.4	3.8	3.9	3.7	3.5	3.6
Electricity, Natural Gas, and Water	1.9	2.8	1.8	2.8	1.4	2.5	1.1	2.3
Natural Gas Component	6.2	4.9	6.0	5.0	5.6	4.8	5.4	4.7
Water Component	0.5	1.1	0.5	1.04	0.3	0.8	0.3	0.7

As the tables above show, deploying Green Button Connect My Data (CMD) in conjunction with Download My Data (DMD) provides greater benefits than deploying DMD alone. While consistently formatted electronic data downloads (DMD-only) are beneficial for sophisticated customers, **the ability to develop tailor-made solutions and applications and create efficiencies with data transfer and authorization multiply the benefits** when CMD is added.

For this reason, for the remaining scenarios, we present the DMD/CMD option only.

UTILITY TYPE

As part of our analysis, we also examined whether the results changed, and to what extent, based on the type of utility to implement Green Button:

As shown in table 11 above, deploying Green Button for electricity and natural gas only is the most cost-effective option, with ratios ranging between 3.5 and 4.4 (meaning that benefits outweigh the costs by 3.5 to 4 times).

This scenario has the highest results because:

- **The benefits are greatest for electricity**: During stakeholder consultations and interviews, customers indicated they are most interested in energy efficiency and conservation for electricity and most often require data for internal reporting and benchmarking requirements. This perspective is supported by market pricing, with electricity having the highest average rate, followed by natural gas and then water.
- **The setup and integration costs for natural gas are comparatively low**: The setup and integration costs in relation to Green Button benefits are lower for natural gas utilities in comparison to electricity-only or with water utilities included because of the lower number of natural gas utilities.

While the most cost-effective option is electricity and natural gas only, **including water utilities is also cost-effective from a societal level when combined with electricity and natural gas**. However, this is primarily based on the benefits from electricity and natural gas outweighing the costs of implementing Green Button for water. In other words, implementing Green Button for water utilities in and of themselves is generally not cost-effective, because the costs outweigh the benefits when considering water on its own.[14]

Table 12. Green Button Implementation for Water Utilities Only

Option	Single Integrated Hosted		Multi-Integrated Hosted		Non-Integrated Hosted		In-House	
	5-year	10-year	5-year	10-year	5-year	10-year	5-year	10-year
DMD	0.04	0.1	0.1	0.3	0.02	0.1	0.03	0.1
DMD/CMD	0.5	1.1	0.5	1.04	0.3	0.8	0.3	0.7

This option is not cost-effective under most scenarios for the following reasons:

- **Higher integration costs**:
  - There are a large number of metered water utilities (515), and each one would incur integration and platform development costs.
- **Lower unit benefits per customer**:
  - Customers (excluding large customers) are generally not engaged or interested in water conservation.
  - Water utilities generally distribute bills on a less frequent basis, so there is less opportunity for customers to use the data or receive benefits.

Water may be cost-effective on its own over a 10-year horizon with a Single Integrated Hosted or Multi-Integrated Hosted implementations; however, the result is well within the potential for error. Nevertheless, in developing our analysis, we have erred on the side of being conservative rather than permissive in terms of benefits, so this scenario should not be dismissed solely on a quantitative basis. Additional considerations may demonstrate added benefits.

IMPLEMENTATION TYPE

Implementation type refers to the type of Green Button platform scenario assessed. As highlighted above, the differences between the implementation types are the following:

[14] Only water utilities with metering infrastructure were included in the analysis. Water utilities not included in the analysis are not generally planning to upgrade their infrastructure in the next five years.

- **Single Integrated (Hosted):** One Green Button hosted Software as a Service (SaaS) platform is used by each utility type (one each for electricity, natural gas, and water utilities).
- **Multi-Integrated (Hosted):** A limited number of Green Button hosted SaaS platforms are used by all utilities.[15]
- **Non-Integrated (Hosted):** Each utility has the option to develop/procure its own Green Button SaaS hosted platform.
- **In-House:** Each utility develops its own platform on its own IT systems.

In terms of Single Integrated (Hosted) and Multi-Integrated (Hosted), the same assumptions were used to develop costs and benefits for both scenarios. However, they were applied differently: we applied the costs to three platforms for the Single Integrated Scenario (one for each utility type) and twelve platforms for the Multi-Integrated Scenario (five for electricity and water, and two for natural gas), which increased the costs for the Multi-Integrated option. The results show that the Single Integrated Hosted implementation option is the most cost-effective option when implementing for all utility types over a five-year timeframe. However, the difference is only 0.1, which is well within a margin of error due to the high-level nature of the analysis. In addition, when implementing for all utility types over a ten-year timeframe or for electricity and natural gas only, both Single Integrated and Multi-Integrated implementations are equally cost-effective.

The assumptions for both the Single Integrated and Multi-Integrated hosted implementation scenarios were identical and further refinement and granularity of results is possible. For example, these scenarios do not fully explore all the potential synergies that may exist through a single or multi-hosted solution for electricity and natural gas utilities. More in-depth research and proposals or more refined quotes from Green Button hosted solutions providers could identify additional cost savings and would also provide an opportunity to increase the accuracy of the cost component of these scenarios. Similarly, the utilities' integration costs could be further researched to increase confidence in these assumptions. For example, they could demonstrate reduced costs in a Multi-Integrated Scenario due to increased competition.

A Non-Integrated Hosted option is assumed to increase costs because of the need to develop a greater number of platforms, and In-House implementation is the least cost-effective because IT hosting is not part of utilities' core business and is therefore the least efficient in terms of costs.

[15] This was a hypothetical scenario to demonstration potential synergies in limiting the number of providers; the same assumptions were used for this scenario as for the non-integrated, with the difference being the number of platforms developed and integrated.

Table 13. Green Button Implementation Type Cost-Benefit Results

Utility Type	Single Integrated Hosted		Multi-Integrated Hosted		Non-Integrated Hosted		In-House	
	5-year	10-year	5-year	10-year	5-year	10-year	5-year	10-year
Electricity	4.1	3.6	4.04	3.6	3.5	3.5	3.2	3.4
Electricity and Natural Gas	4.4	3.8	4.4	3.8	3.9	3.7	3.5	3.6
Electricity, Natural Gas, and Water	1.9	2.8	1.8	2.8	1.4	2.5	1.1	2.3

KEY SCENARIOS

This section provides an overview of the key scenarios resulting from the analysis. In general, all scenarios included the costs and benefits assumptions included above. Specific assumptions are provided in the explanations where warranted.

As indicated earlier in this report, our analysis is designed to be conservative, so some benefits that could not be quantified with a relative degree of certainty or documentation were excluded. In addition, because of the limited data for this relatively new initiative, some proxies have been used and high-level assumptions incorporated. Therefore, we recommend interpreting the results with caution, particularly with results for which the benefit-to-cost ratio is close to 1 or in which ratios are similar but not identical. In these cases, small deviations from the assumptions used can lead to different conclusions (e.g., the benefit/cost ratio can fall or rise above 1 or be ranked differently if assumptions change).

For this reason, results from this analysis should be used to guide, not dictate, decisions. Components and considerations not included in the CBA analysis (including qualitative benefits) should also be accounted for in the decision-making process.

SCENARIO 1: SINGLE INTEGRATED/MULTI-INTEGRATED HOSTED DMD/CMD (ELECTRICITY AND NATURAL GAS ONLY)

This scenario assumes that all Ontario's electricity and natural gas utilities would implement Green Button Download My Data (DMD) and Connect My Data (CMD) for all their customers. In doing so, we assume that there is either a single hosted Software as a Service provider providing this service for all utilities (Single Integrated) or a limited number would serve the market, each with its own platform that would be shared by multiple utilities (Multi-Integrated).

The key distinction between these scenarios lies in the number of independent Green Button Platforms included in the analysis, e.g., Single Integrated (3 platforms) and Multi-Integrated (12 platforms). The difference in the number of platforms included in the analysis translates to a cost reduction for the Single Integrated scenario compared to the Multi-Integrated scenario because there are fewer platforms included in this scenario. **There are no differences in the total value of benefits estimated under these two scenarios**, since there is no evidence that the number of independent Green Button platforms would modify the nature and/or value of the benefits generated by Green Button DMD or CMD.

These scenarios are arguably the most cost-effective implementation scenarios analyzed. They capture the vast majority of potential benefits while reducing the costs required for developing and delivering Green Button solutions.

The benefit-cost ratios estimated for these scenarios are of a sufficient magnitude for us to consider them to be highly cost-effective for the province.

SCENARIO 1A: SINGLE INTEGRATED HOSTED DMD/CMD (ELECTRICITY AND NATURAL GAS UTILITIES ONLY)

This section provides an overview of the costs and benefits, in dollars, incorporated within the analysis of a **Single Integrated Green Button implementation for electricity and natural gas utilities only**.

COSTS

The following table outlines the cost categories included in the analysis.

Table 14. Scenario 1A Cost Details

Cost Category	Cost Type	5-Year Analysis ($)	10-Year Analysis ($)	Scenario-Specific Assumptions
Implementation (Utility one-time setup and integration costs)	Direct	3,920,248	3,924,558[16]	The setup cost for the Single Integrated scenario assumes one setup cost per utility type. This is a conservative estimate based on input from a SaaS provider that indicated a cost per addition of utility type.
Operational Costs[17]	Direct	771,753	2,406,040	
Retrofit Costs	Indirect	11,172,735	67,265,834	
Total		**15,864,736**	**73,596,433**	

Operational costs are significantly higher over a 10-year timeframe than over a 5-year timeframe due to increased customer participation with Green Button. Operational costs are directly related to the number of participants. Retrofit costs are significantly higher over 10 years because individuals are less likely to undertake retrofits during the initial few years of Green Button. After implementation, customers will require time to receive their data, analyze it, determine next steps, and implement changes, which delays impacts from retrofits (on both the costs and benefits side) until later in the implementation period.

BENEFITS

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[16] While in reality the 5-year and 10-year one-time implementation costs would likely be identical, the analysis required a mathematical function to forecast implementation costs. The mathematical function forecasts the following rollout of Green Button through the first 5 years following enactment of the policy: 35%, 70%, 92%, 99%, 99.9%, which means that 0.1% of costs remained to be implemented after the 5-year rollout period and are reflected in the slight increase in one-time costs for the 10-year period.

[17] Sum of net-present value of annual costs over the timeframe.

The following table outlines the benefits categories included in the analysis. We note that **multiple benefits are included in each category, but to avoid double-counting overlapping benefits, they have been aggregated into these higher-level considerations**. The specific benefits included in each category are outlined in Appendix C.

Table 15. Scenario 1A Benefits Details[18]

Benefit Category	Benefit Component	Benefit Type	5-Year Analysis ($)	10-Year Analysis ($)
Operational Efficiencies	Utility Consumption, Billing and Generation Data Process Efficiencies	Direct	18,072,196	60,083,680
	Process Efficiencies (Large Building Energy and Water Reporting and Benchmarking requirements)	Direct	12,716,122	25,688,618
	Reduced Customer Care Efforts	Indirect	1,082,114	2,455,960
	CDM/DSM Program Efficiencies and Innovation	Indirect	893,384	2,027,619
Energy Efficiency and Conservation	Increased Conservation - Behavioural & Operational	Indirect	11,413,765	57,765,514
	Increased Conservation - Retrofits	Indirect	26,093,050	134,153,770
	Total		**70,270,632**	**282,175,160**

Benefits from improvement in customers' processes for accessing, cleaning, consolidating, analyzing, and reporting on their utility consumption, billing and generation data are also significantly higher over 10 years than over 5 years. During the initial period following enactment of the policy, customers with a direct interest in simplified access to building consumption data (because they already go through the process of accessing of requesting access to their consumption data in electronic format) are assumed to take advantage of Green Button features. During the next 5-year period, increased usage of Green Button is forecasted, leading to an increase in annual benefits.

Benefits resulting from retrofits are also significantly higher over 10 years than 5 for the same reasons that retrofit costs are higher: the impacts from retrofits will occur later in the period because it will take time for customers to make decisions and implement them.

RESULTS

Detailed results for the Single Integrated version of this scenario (Scenario 1A) are presented in the following tables.

[18] No scenario-specific assumptions required

Table 16. Scenario 1A Benefit-Cost Ratios

Ratio Type	5-Year Analysis	10-Year Analysis
Direct and Indirect Costs and Benefits	4.4	3.8
Direct Benefits and Costs only[19]	6.8	13.9

In this scenario, total benefits outweigh total costs by over 4 to 1 (over 5 years) or almost 4 to 1 (over 10 years). When analyzing direct benefits and costs only (excluding indirect considerations such as retrofits and program efficiencies, benefits outweigh the costs by almost 7 to 1 (over 5 years) or almost 14 to 1 (over 10 years).

Additional Results:

Table 17. Scenario 1A Energy and GHG Cumulative Impacts

Result	5-Year Analysis	10-Year Analysis
Electricity Savings	311 GWh	1741 GWh
Natural Gas Savings	1.65 PJ	8.67 PJ
GHG Reductions	168 kt CO_2e	947 kt CO_2e

To illustrate how the costs and benefits are distributed across stakeholder groups, we present the following tables.

Table 18. Scenario 1A Costs by Stakeholder Groups (5-year horizon)

Cost Component	Cost Type	Stakeholder Group			
		Electricity Utility ($)	Natural Gas Utility ($)	Customers[20] ($)	Total ($)
Implementation (One-time setup and integration costs)	Direct	3,380,494	539,754	-	**3,920,248**
Operational Costs[21]	Direct	456,696	315,057	-	**771,753**
Retrofit Costs	Indirect	-	-	11,172,735	**11,172,735**
Total		**3,837,190**	**854,811**	**11,172,735**	**15,864,736**

[19] Direct benefits and costs are a subset of total benefits and costs. However, the direct benefits and costs *ratios* are higher than the total ratios because the magnitude of benefits to costs is different for direct results than for total results.

[20] Includes all customer classes (Residential, Commercial, Industrial, and Institutional)

[21] Sum of net-present value of annual costs over the timeframe.

Table 19. Scenario 1A Benefits by Stakeholder Group (5-year horizon)

Benefit Category	Benefit Component	Benefit Type	Stakeholder Group					
			C&I ($)	Industrial ($)	Other[22] ($)	Residential ($)	Utility ($)	Total ($)
Operational Efficiencies	Customers' Utility Consumption, Billing and Generation Data Process Efficiencies	Direct	10,144,702	7,900	5,308,456	2,611,138	-	**18,072,196**
	Process Efficiencies (requirements)	Direct	12,631,762	84,360	-	-	-	**12,716,122**
	Reduced Customer Care Efforts	Indirect	-	-	-	-	1,082,114	
	CDM/DSM Program Efficiencies and Innovation	Indirect	-	-	-	-	893,384	
Energy Efficiency and Conservation	Increased Conservation - Behavioural & Operational	Indirect	9,753,339	14,529	-	1,645,898	-	**11,413,765**
	Increased Conservation - Retrofits	Indirect	20,106,940	77,336	-	5,908,773	-	**26,093,050**
	Total		**52,636,743**	**184,125**	**5,308,456**	**10,165,809**	**1,975,478**	**70,270,631**

[22] Other Stakeholders include third-party Energy Efficiency Consultants/Service Providers providing utility consumption monitoring services, energy assessments, and/or engineering services.

SCENARIO 1B: MULTI-INTEGRATED HOSTED DMD/CMD (ELECTRICITY AND NATURAL GAS UTILITIES ONLY)

The table below provides an overview of the costs and benefits, in dollars, incorporated within the analysis of a Multi-Integrated Green Button implementation for electricity and natural gas utilities only.

We note that all costs and benefits are the same as for the Single Integrated scenario except for the Implementation (one-time setup and integration) costs. This is why the scenarios are labelled 1A and 1B rather than as two different scenarios.

Table 20. Scenario 1B Cost Details

Cost Category	Cost Type	5-Year Analysis ($)	10-Year Analysis ($)	Scenario-Specific Assumptions
Implementation (One-time setup and integration costs)	Direct	4,101,232	4,105,742[23]	The setup cost for the Multi-Integrated scenario assumes: • 5 independent platforms for the electricity sector • 1 platform for the natural gas sector (because there are so few utilities) • 5 platforms for the water utilities
Operational Costs[24]	Direct	771,753	2,406,040	
Retrofit Costs	Indirect	11,172,735	67,265,834	
Total		**16,045,720**	**73,777,616**	

While most costs are approximately double when comparing the 10-year period to the 5-year period, the retrofit costs are significantly higher over 10 years because individuals are less likely to undertake retrofits during the initial few years of Green Button. After implementation, customers will require time to receive their data, analyze it, determine next steps, and implement changes, which delays impacts from retrofits (on both the costs and benefits side) until later in the implementation period.

[23] Differences between the 5-year and 10-year Implementation Costs are an artefact of the mathematical function used to forecast implementation costs. The mathematical function forecasts the following rollout of Green Button through the first 5 years following enactment of the policy: 35%, 70%, 92%, 99%, 99.9%.

[24] Sum of net-present value of annual costs over the timeframe.

Table 21. Scenario 1B Benefits Details[25]

Benefit Category	Benefit Component	Benefit Type	5-Year Analysis ($)	10-Year Analysis ($)
Operational Efficiencies	Customers' Utility Consumption, Billing and Generation Data Process Efficiencies	Direct	18,072,196	60,083,680
	Process Efficiencies (Large Building Energy and Water Reporting and Benchmarking)	Direct	12,716,122	25,688,618
	Reduced Customer Care Efforts	Indirect	1,082,114	2,455,960
	CDM/DSM Program Efficiencies and Innovation	Indirect	893,384	2,027,619
Energy Efficiency and Conservation	Increased Conservation - Behavioural & Operational	Indirect	11,413,765	57,765,514
	Increased Conservation - Retrofits	Indirect	26,093,050	134,153,770
	Total		**70,270,632**	**282,175,160**

Benefits from improvement in customers' processes for accessing, cleaning, consolidating, analyzing, and reporting on their utility consumption, billing and generation data are significantly higher over 10 years than over 5 years. During the initial period following enactment of the policy, customers with a direct interest towards simplified access to building consumption data (because they already go through the process of accessing of requesting access to their consumption data in electronic format) are assumed to take advantage of Green Button features. During the next 5-year period, increased usage of Green Button is forecasted, leading to an increase in annual benefit.

Benefits resulting from retrofits are also significantly higher over 10 years than 5 for the same reasons that retrofit costs are higher: the impacts from retrofits will occur later in the period because it will take time for customers to make decisions and implement them.

The remaining benefits are approximately double when comparing a 10-year horizon to a 5-year horizon, meaning that a relatively steady and regular pace of benefits are incurred each year.

RESULTS

Detailed results for the Multi-Integrated version of this scenario (Scenario 1B) are presented in the following tables.

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[25] No scenario-specific assumptions required

Benefit-Cost Ratios:

Table 22. Scenario 1B Benefit-Cost Ratios

Ratio Type	5-Year Analysis	10-Year Analysis
Direct and Indirect Costs and Benefits	4.4	3.8
Direct Benefits and Costs only[26]	6.8	13.6

ADDITIONAL RESULTS:

Table 23. Scenario 1B Energy and GHG Cumulative Impacts

Result	5-Year Analysis	10-Year Analysis
Electricity Savings	311 GWh	1741 GWh
Natural Gas Savings	1.65 PJ	8.67 PJ
GHG Reductions	168 kt CO_2e	947 kt CO_2e

Note that the energy and GHG impacts are identical to Scenario 1A, as the only differences between the two scenarios are in the costs; there are no differences in the benefits.

To illustrate how the costs and benefits are distributed across stakeholder groups, we present the following tables.

Table 24. Scenario 1B Costs by Stakeholder Group (5-year horizon)

Cost Category	Cost Type	Stakeholder Group			
		Electricity Utility ($)	Natural Gas Utility ($)	Customers[27] ($)	Total ($)
Implementation (One-time setup and integration costs)	Direct	3,561,478	539,754	-	**4,101,232**
Operational Costs[28]	Direct	456,696	315,056	-	**771,752**
Retrofit Costs	Indirect	-	-	11,172,735	**11,172,735**
Total		**4,018,174**	**854,810.5**	**11,172,735**	**16,045,720**

[26] Direct benefits and costs are a subset of total benefits and costs. However, the direct benefits and costs *ratios* are higher than the total ratios because the magnitude of benefits to costs is different for direct results than for total results.
[27] Includes all customer classes (Residential, Commercial, Industrial, and Institutional)
[28] Sum of net-present value of annual costs over the timeframe.

Table 25. Scenario 1B Benefits by Stakeholder Group (5-year horizon)

Benefit Category	Benefit Component	Benefit Type	Stakeholder Group					
			C&I ($)	Industrial ($)	Other[29] ($)	Residential ($)	Utility ($)	Total ($)
Operational Efficiencies	Customers' Utility Consumption, Billing and Generation Data Process Efficiencies	Direct	10,144,702	7,900	5,308,456	2,611,138	-	**18,072,196**
	Process Efficiencies (requirements)	Direct	12,631,762	84,360	-	-	-	**12,716,122**
	Reduced Customer Care Efforts	Indirect	-	-	-	-	1,082,114	**1,082,114**
	CDM/DSM Program Efficiencies and Innovation	Indirect	-	-	-	-	893,384	**893,384**
Energy Efficiency and Conservation	Increased Conservation - Behavioural & Operational	Indirect	9,753,339	14,529	-	1,645,898	-	**11,413,765**
	Increased Conservation - Retrofits	Indirect	20,106,940	77,336	-	5,908,773	-	**26,093,050**
	Total		**52,636,743**	**184,125**	**5,308,456**	**10,165,809**	**1,975,498**	**70,270,632**

[29] Other Stakeholders include third-party Energy Efficiency Consultants/Service Providers providing utility consumption monitoring services, energy assessments, and/or engineering services.

SCENARIO 2: SINGLE INTEGRATED/MULTI-INTEGRATED HOSTED DMD/CMD: ELECTRICITY, NATURAL GAS AND WATER

The second key scenario assumes that all of Ontario's metered electricity, natural gas and water utilities would implement Green Button Download My Data (DMD) and Connect My Data (CMD) for all their customers. The implementation could occur with either a single hosted Software as a Service provider providing the service for all utilities (Single Integrated) or a small group of Software as a Service providers serving the market through a limited number of platforms shared by multiple utilities (Multi-Integrated).

As with Scenario 1A and 1B (for Electricity and Natural Gas utilities only), the key distinction between these scenarios lies in the number of independent Green Button Platforms included in the analysis (i.e., Single Integrated (3) and Multi-Integrated (12). The difference in the number of platforms included in the analysis translates to a cost reduction for the Single Integrated Scenario compared to the Multi-Integrated scenario. On the benefits side, there are no differences between the two, as there is no evidence that the number of independent Green Button platforms would modify the nature and/or value of the benefits generated by Green Button CMD.

The benefit-cost ratios for these scenarios indicate they are cost-effective, albeit to a lesser extent than the electricity and natural gas-only scenarios. The lower benefit-to-cost ratio is primarily driven by:

- Higher setup and integration costs required by the large number of water utilities in the province (because each utility requires its own setup costs).
- A lower benefit for water utility customers than for electricity and natural gas customers relating to conservation and access to billing and generation data. Specifically, customers consider access to their water consumption and billing data to be of less value than access to their electricity and natural gas data, and they are less concerned about conservation opportunities. This lower level of concern results in fewer benefits when Green Button is implemented for water utilities.

These two factors considerably reduce the value proposition of this scenario from a purely numbers-based perspective. As noted above, however, additional considerations not included in the quantitative analysis may be equally important and should inform part of the Ministry's policy.

Additional synergies that reduce set-up and integration costs could have a profound impact on the result of this analysis, considering they would apply to a much higher number of utilities. For example, if only the largest water utilities were included in the implementation (the 37 largest utilities serve approximately 78% of Ontario's population), it would reduce the number of implementations drastically. Another example would be to set up a water-focused task force to explore options that reduce integration costs for small utilities.

SCENARIO 2A: SINGLE INTEGRATED HOSTED DMD/CMD (ALL UTILITY TYPES)

The table below provides an overview of the costs and benefits, in dollars, incorporated within the analysis of a Single Integrated Green Button implementation for all utility types.

Table 26. Scenario 2A Cost Details

Cost Category	5-Year Analysis ($)	10-Year Analysis ($)	Scenario-Specific Assumptions
Implementation (One-time setup and integration costs)	30,408,975	30,442,411	The setup cost for the Single Integrated scenario assumes one setup cost per utility type. This is based on input from a SaaS provider that indicated a cost per addition of utility type and was selected to provide a conservative estimate.
Operational Costs[30]	1,225,917	3,822,160	
Retrofit Costs	13,290,836	79,923,128	
Total	**44,925,728**	**114,187,699**	

As indicated above, implementation and operational costs are significantly higher because of the number of water utilities: 590 utilities are included in this scenario (of which 515 are water utilities), compared with 75 in Scenarios 1A and 1B. The number of utilities translates into a multiplication of these costs.

10-year costs are significantly higher than 5-year costs for the same reasons as Scenarios 1A and 1B: individuals are less likely to undertake retrofits during the initial few years of Green Button. After implementation, customers will require time to receive their data, analyze it, determine next steps, and implement changes, which delays impacts from retrofits (on both the costs and benefits side) until later in the implementation period.

[30] Sum of net-present value of annual costs over the timeframe.

Table 27. Scenario 2A Benefits Details[31]

Benefit Category	Benefit Component	Benefit Type	5-Year Analysis ($)	10-Year Analysis ($)
Operational Efficiencies	Customers' Utility Consumption, Billing and Generation Data Process Efficiencies	Direct	25,228,276	78,289,889
	Process Efficiencies (Large Building Energy and Water Reporting and Benchmarking)	Direct	14,835,476	29,970,054
	Reduced Customer Care Efforts	Indirect	1,639,242	3,720,413
	CDM/DSM Program Efficiencies and Innovation	Indirect	1,712,222	4,609,824
Energy Efficiency and Conservation	Increased Conservation - Behavioural & Operational	Indirect	14,071,675	71,530,678
	Increased Conservation - Retrofits	Indirect	26,802,103	137,226,936
	Total		**84,288,994**	**325,347,793**

Benefits from improvement in customers' processes for accessing, cleaning, consolidating, analyzing, and reporting on their utility consumption, billing and generation data are significantly higher over 10 years than over 5 years. During the initial period following enactment of the policy, customers with a direct interest towards simplified access to building consumption data (because they already go through the process of accessing of requesting access to their consumption data in electronic format) are assumed to take advantage of Green Button features. During the next 5-year period, increased usage of Green Button is forecasted, leading to an increase in annual benefit.

Benefits from increased conservation (retrofits and behavioural) are only marginally larger in this scenario than in Scenarios 1A and 1B because our research indicated that water conservation is not a primary concern for customers, who are more likely to invest in electricity and natural gas conservation.

RESULTS

Detailed results for the Single Integrated version of this scenario (Scenario 1B) are presented in the following tables.

[31] No scenario-specific assumptions required

Table 28. Scenario 2A Benefit-Cost Ratios

Ratio Type	5-Year Analysis	10-Year Analysis
Direct and Indirect Costs and Benefits	1.9	2.8
Direct Benefits and Costs only[32]	1.3	3.3

Scenario 2A, in which water utilities have been added to the analysis for a Single Integrated Hosted solution of both DMD and CMD, is cost effective when considering total costs and benefits.

While the analysis shows that considering direct costs and benefits only (i.e., excluding actions that are only indirectly resulting from a Green Button implementation, such as energy efficiency and conservation retrofits) is also cost-effective, the 5-year analysis is close enough to 1 (i.e., the benefits do not substantially outweigh the costs) that we cannot be confident in that particular result, since the data inputs and considerations are not granular enough to assume results close to 1 are definitely cost-effective.

However, we note that the analysis was designed to be conservative, in that we intentionally used mid-to-low range estimates of benefits, and mid-to-high ranges of costs, in order to provide as rigorous an analysis as possible within the scope of the work.

ADDITIONAL RESULTS:

Table 29. Scenario 2A Energy and GHG Cumulative Impacts

Result	5-Year Analysis	10-Year Analysis
Electricity Savings	311 GWh	1741 GWh
Natural Gas Savings	1.65 PJ	8.67 PJ
Water	1,567,203 m^3	8,466,860 m^3
GHG Reductions	168 kt CO_2e	947 kt CO_2e

To illustrate how the costs and benefits are distributed across stakeholder groups, we present the following tables.

[32] Direct benefits and costs are a subset of total benefits and costs. However, the direct benefits and costs *ratios* are higher than the total ratios because the magnitude of benefits to costs is different for direct results than for total results.

Table 30. Scenario 2A Costs by Stakeholder Group (5-year horizon)

Cost Category	Cost Type	Stakeholder Group				
		Electricity Utility ($)	Natural Gas Utility ($)	Water Utility ($)	Customers ($)	Total ($)
Implementation (One-time setup and integration costs)	Direct	3,380,494	539,754	26,488,727	-	**30,408,975**
Operational Costs[33]	Direct	456,696	315,057	454,164	-	**1,225,917**
Retrofit Costs	Indirect	-	-	-	13,290,836	**13,290,836**
Total		**3,837,190**	**854,811**	**26,942,892**	**13,290,836**	**44,925,729**

Table 31. Scenario 2A Benefits by Stakeholder Group (5-year horizon)

Benefit Category	Benefit Component	Benefit Type	Stakeholder Group					
			C&I ($)	Industrial ($)	Other[34] ($)	Residential ($)	Utility ($)	Total ($)
Operational Efficiencies	Customers' Utility Consumption, Billing and Generation Data Process Efficiencies	Direct	12,285,408	9,875	10,038,462	2,894,531	-	**25,228,276**
	Process Efficiencies	Direct	14,737,056	98,420	-	-	-	**14,835,476**
	Reduced Customer Care Efforts	Indirect	-	-	-	-	1,639,242	**1,639,242**
	CDM/DSM Program Efficiencies and Innovation	Indirect	-	-	-	-	1,712,222	**1,712,222**
Energy Efficiency and Conservation	Increased Conservation - Behavioural & Operational	Indirect	12,407,375	18,403	-	1,645,898	-	**14,071,675**
	Increased Conservation - Retrofits	Indirect	20,106,940	77,336	-	6,617,826	-	**26,802,103**
	Total		**59,536,779**	**204,035**	**10,038,462**	**11,158,255**	**3,351,464**	**84,288,994**

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[33] Sum of net-present value of annual costs over the timeframe.

[34] Other Stakeholders include third-party Energy Efficiency Consultants/Service Providers providing utility consumption monitoring services, energy assessments, and/or engineering services.

SCENARIO 2B: MULTI-INTEGRATED HOSTED DMD/CMD (ALL UTILITY TYPES)

The table below provides an overview of the costs and benefits, in dollars, incorporated within the analysis of a Multi-Integrated Green Button implementation for electricity and natural gas utilities only.

Table 32. Scenario 2B Cost Details

Cost Category	Cost Type	5-Year Analysis ($)	10-Year Analysis ($)	Scenario-Specific Assumptions
Implementation (One-time setup and integration costs)	Direct	31,338,419	31,372,876	The setup cost for the Multi-Integrated scenario assumes: • 5 independent platforms for the electricity sector • 1 platform for the natural gas sector (because there are so few utilities) • 5 platforms for the water utilities
Operational Costs[35]	Direct	1,225,917	3,822,160	
Retrofit Costs	Indirect	13,290,836	79,923,128	
Total		**45,855,172**	**115,118,164**	

The costs are the same in this scenario as for the Single Integrated (All Utilities) scenario except for the Implementation (one-time setup and integration) costs. This is because the only assumptions that changed for the Multi-Integrated Scenario were the number of platforms (12 compared to 3), which then increased the platform setup and integration costs. All other assumptions remain the same. This is why the scenarios are labelled 2A and 2B rather than as two different scenarios.

[35] Sum of net-present value of annual costs over the timeframe.

Table 33. Scenario 2B Benefits Details[36]

Benefit Category	Benefit Component	Benefit Type	5-Year Analysis ($)	10-Year Analysis ($)
Operational Efficiencies	Customers' Utility Consumption, Billing and Generation Data Process Efficiencies	Direct	25,228,276	78,289,889
	Process Efficiencies	Direct	14,835,476	29,970,054
	Reduced Customer Care Efforts	Indirect	1,639,242	3,720,413
	CDM/DSM Program Efficiencies and Innovation	Indirect	1,712,222	4,609,824
Energy Efficiency and Conservation	Increased Conservation - Behavioural & Operational	Indirect	14,071,675	71,530,678
	Increased Conservation - Retrofits	Indirect	26,802,103	137,226,936
	Total		**84,288,994**	**325,347,793**

The benefits for this Scenario are identical to those in the Single Integrated (All Utilities) Scenario, as our research indicated the benefits would not differ based on the number of platforms implemented.

RESULTS

Detailed results for the Multi-Integrated version of this scenario (Scenario 2B) are presented in the following tables.

Table 34. Scenario 2B Benefit-Cost Ratios

Ratio Type	5-Year Analysis	10-Year Analysis
Total	1.8	2.8
Direct Benefits and Costs only[37]	1.3	3.3

The results for this scenario are identical to the results for the Single Integrated scenario (2A) because the difference between the two are only related to the costs for developing 12 platforms (for Multi-Integrated) rather than 5 platforms (for Single Integrated). These costs are minimal compared to the overall costs, so the difference is eliminated through rounding the numbers to one decimal place. In other words, it is insignificant.

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[36] No scenario-specific assumptions required

[37] Direct benefits and costs are a subset of total benefits and costs. However, the direct benefits and costs *ratios* are higher than the total ratios because the magnitude of benefits to costs is different for direct results than for total results.

ADDITIONAL RESULTS:

Table 35. Scenario 2B Energy and GHG Cumulative Impacts

Result	5-Year Analysis	10-Year Analysis
Electricity Savings	311 GWh	1741 GWh
Natural Gas Savings	1.65 PJ	8.67 PJ
Water	1,567,203 m^3	8,466,860 m^3
GHG Reductions	168 kt CO_2e	947 kt CO_2e

To illustrate how the costs and benefits are distributed across stakeholder groups, we present the following tables.

Table 36. Scenario 2B Costs by Stakeholder Group (5-year horizon)

Cost Category	Cost Type	Stakeholder Group				
		Electricity Utility ($)	Natural Gas Utility ($)	Water Utility ($)	Customers ($)	Total ($)
Implementation (One-time setup and integration costs)	Direct	3,561,478	539,754	27,237,186	-	**31,338,419**
Operational Costs[38]	Direct	456,696	315,057	454,164	-	**1,225,917**
Retrofit Costs	Indirect	-	-	-	13,290,836	**13,290,836**
Total		**4,018,174**	**854,811**	**27,691,351**	**13,290,836**	**45,855,172**

[38] Sum of net-present value of annual costs over the timeframe.

Table 37. Scenario 2B Benefits by Stakeholder Group (5-year horizon)

Benefit Category	Benefit Component	Benefit Type	Stakeholder Group					
			C&I ($)	Industrial ($)	Other ($)	Residential ($)	Utility ($)	Total ($)
Operational Efficiencies	Customers' Utility Consumption, Billing and Generation Data Process Efficiencies	Direct	12,285,408	9,875	10,038,462	2,894,531	-	**25,228,276**
	Process Efficiencies	Direct	14,737,056	98,420	-	-	-	**14,835,476**
	Reduced Customer Care Efforts	Indirect	-	-	-	-	1,639,242	**1,639,242**
	CDM/DSM Program Efficiencies and Innovation	Indirect	-	-	-	-	1,712,222	**1,712,222**
Energy Efficiency and Conservation	Increased Conservation - Behavioural & Operational	Indirect	12,407,375	18,403	-	1,645,898	-	**14,071,675**
	Increased Conservation - Retrofits	Indirect	20,106,940	77,336	-	6,617,826	-	**26,802,103**
	Total		**59,536,779**	**204,035**	**10,038,462**	**11,158,255**	**3,351,464**	**84,288,994**

DIRECT AND INDIRECT COSTS

The tables on the following pages provide an overview of the total costs (in dollars) by key scenario, over five- and ten-year timeframes as well as subsequent breakouts of direct and indirect costs.

We note that these costs are high level and used to generate comparisons between potential scenarios; they are not implementation-level cost estimates.

FIVE-YEAR HORIZON

Table 38. Total Benefits and Costs, Combining Direct and Indirect (5-year horizon)

5 Years	Single Integrated Hosted		Multi-Integrated Hosted		Non-Integrated Hosted		In-House	
	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs
Electricity	$54,348,157	$13,239,659	$54,348,157	$13,420,643	$54,348,157	$15,353,563	$54,348,157	$17,153,013
Electricity and Natural Gas	$70,270,632	$15,864,736	$70, 270,632	$16,045,720	$70, 270,632	$18,255,315	$70, 270,632	$20,133,528
Electricity, Natural Gas, and Water	$84,288,994	$44,925,729	$84, 288,994	$45,855,172	$84, 288,994	$59,527,055	$84, 288,994	$73,435,858

Table 39. Breakout of Direct and Indirect Benefits and Costs, Single- and Multi-Integrated (5-year horizon)

5 Years	Single Integrated Hosted				Multi-Integrated Hosted			
	Benefits		Costs		Benefits		Costs	
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
Electricity	$24,638,139	$29,710,018	$3,837,190	$9,402,468	$24,638,139	$29,710,018	$4,018,174	$9,402,468
Electricity and Natural Gas	$31,903,633	$38,366,999	$4,692,001	$11,172,735	$31,903,633	$38,366,999	$4,872,985	$11,172,735
Electricity, Natural Gas, and Water	$42,555,032	$41,733,962	$31,634,892	$13,290,836	$42,555,032	$41,733,962	$32,564,336	$13,290,836

Table 40. Breakout of Direct and Indirect Benefits and Costs, Non-Integrated and In-House (5-year horizon)

5 Years	Non-Integrated Hosted				In-House			
	Benefits		Costs		Benefits		Costs	
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
Electricity	$24,638,139	$29,710,018	$5,951,095	$9,402,468	$24,638,139	$29,710,018	$7,750,544	$9,402,468
Electricity and Natural Gas	$31,903,633	$38,366,999	$7,082,579	$11,172,735	$31,903,633	$38,366,999	$8,960,793	$11,172,735
Electricity, Natural Gas, and Water	$42,555,032	$41,733,962	$46,236,219	$13,290,836	$42,555,032	$41,733,962	$60,145,022	$13,290,836

TEN-YEAR HORIZON

Table 41. Total Benefits and Costs, Combining Direct and Indirect (10-year horizon)

10 Years	Single Integrated Hosted		Multi-Integrated Hosted		Non-Integrated Hosted		In-House	
	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs
Electricity	$220,141,043	$60,938,670	$220,141,043	$61,119,853	$220,141,043	$63,155,925	$220,141,043	$65,199,079
Electricity and Natural Gas	$282,267,635	$73,635,939	$282,267,635	$73,777,616	$282,267,635	$76,187,875	$282,267,635	$78,477,384
Electricity, Natural Gas, and Water	$325,440,269	$114,227,205	$325,440,269	$115,118,165	$325,440,269	$129,204,994	$325,440,269	$143,778,684

Table 42. Breakout of Direct and Indirect Benefits and Costs, Single and Multi-Integrated (10-year horizon)

10 Years	Single Integrated Hosted				Multi-Integrated Hosted			
	Benefits		Costs		Benefits		Costs	
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
Electricity	$68,380,297	$151,760,747	$4,808,314	$56,130,356	$68,380,297	$151,760,747	$4,989,497	$56,130,356
Electricity and Natural Gas	$88,303,608	$193,871,551	$6,330,599	$67,265,834	$88,303,608	$193,871,551	$6,511,782	$67,265,834
Electricity, Natural Gas, and Water	$114,637,912	$210,709,882	$34,264,571	$79,923,128	$114,637,912	$210,709,882	$35,195,036	$79,923,128

Table 43. Breakout of Direct and Indirect Benefits and Costs, Non-Integrated and In-House (10-year horizon)

10 Years	Non-Integrated Hosted				In-House			
	Benefits		Costs		Benefits		Costs	
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
Electricity	$68,380,297	$151,760,747	$7,166,269	$56,130,356	$68,380,297	$151,760,747	$9,209,423	$56,130,356
Electricity and Natural Gas	$88,303,608	$193,871,551	$9,132,166	$67,265,834	$88,303,608	$193,871,551	$11,420,804	$67,265,834
Electricity, Natural Gas, and Water	$114,637,912	$210,709,882	$49,530,676	$79,923,128	$114,637,912	$210,709,882	$64,103,496	$79,923,128

QUALITATIVE BENEFITS

In addition to the purely numerical analysis presented above, Green Button provides additional benefits to customers, utilities and the Government. Benefits that were minimal, could not be quantified or estimated due to a lack of data, or could not be robustly or clearly attributed to Green Button were excluded from the analysis presented above. However, this does not mean they are not important considerations.

We recommend the Ministry's use the quantitative analysis provided above to inform its proposal. However, the proposal should not be limited to this assessment; qualitative benefits should also be considered. The following are benefits related to Green Button that were confirmed by our research but were not included in the quantitative analysis for the reasons explained above:

- **Increased energy efficiency awareness/education:** Customers benefit from increased awareness about energy efficiency and utilities benefit from opportunities to educate their customers through Green Button applications. While some of these benefits are quantified through increased conservation efforts resulting from access to data, our research indicates additional opportunities exist that would result in higher benefits were they able to be quantified or confirmed.

- **Increased real estate value:** Access to data about utility costs for buildings (homes and commercial buildings) can increase real estate value when these buildings are for sale. However, this value tends to increase over time, as the market becomes attuned to looking for, and basing decisions on, this type of information. For this reason, the benefits would not be material in the early years. In addition, they would not be material because they would be a subset (of buildings sold on the market) of a subset (of buildings that had retrofits resulting from Green Button). In addition, while initiatives such as Home Energy Rating and Disclosure are being examined and planned in Ontario, without an immediate launch, owners will not be required to provide this information, leading to even lower potential benefits due to lack of consistency until programs launch. For this reason, we were not able to estimate the impacts, and we expect them to be minimal in the early years. However, over time, we suggest these benefits will play a larger role in overall Green Button benefits.

- **Increased customer satisfaction:** While increased customer satisfaction as a result of customers understanding their utility consumption and changes to bills can be quantified in terms of survey scale results, it is difficult to convert this satisfaction to dollars saved on the part of utilities. There is not an automatic, direct link between customer satisfaction and reduced customer care centre calls, for example. Therefore, we were not able to include this benefit in the quantified analysis. Nevertheless, it can be an important benefit to utilities at a qualitative level.

- **Innovation in CDM/DSM programs:** Future CDM/DSM programs being developed as a result of Green Button Connect My Data, including to assist with Pay-for-Performance program design, are a very real possibility of a province-wide implementation of Green Button. We therefore included a token amount as an indirect benefit; however, it is not significant and not to the extent that could be expected for the following reasons:

- We did not have enough data to suggest the magnitude of such programs (either in terms of costs or savings).
- Concerned about the risk of relying on behavioural change to achieve their 2020 targets, electricity utilities were clear they were not specifically planning to design these programs in the near future.
- There is the potential for evaluation efficiencies related to easier, real-time access to consistent, machine-readable data; however, while utilities admitted this potential existed, they could not see how it could be executed.

We therefore believe there are benefits of CDM/DSM program innovation resulting from Green Button, but we were not able to quantify them to a great extent in the analysis.

- **Supporting government policy objectives:** An important benefit of Green Button is its ability to support government policy objectives, including helping to reduce fossil fuel emissions from enhanced customer access to utility data (as stated in Ontario's Climate Change Action Plan). Another example is the Minister's directive to the Ontario Energy Board to provide guidance and expectations to utilities within three parameters, one of which is customer control (defined as "providing the customer with increased information and tools to promote conservation of electricity". [39] The Board highlights Green Button as an example for utilities to provide consumption data to their customers in a user-friendly format in order to achieve customer control objectives. Green Button is able to support these, and other similar objectives. However, the quantified dollar value cannot be estimated and is therefore addressed qualitatively only.

- **Economic development and innovation (i.e., improved access to North American market, supporting development of innovative services):** Third-party solution providers/application developers indicated that a province-wide implementation of Green Button would provide them with an important opportunity to develop applications that could be used in a broader North American market and support the development of innovative services. In addition, customer access to data could result in job creation and positive economic impact in Ontario (through increased demand for consultant/service provider services, greater efficiencies in existing organizations, etc.). While some of these benefits can be quantified, to do so requires a great number of assumptions that we believed would reduce the robustness and validity of the outputs. We therefore elected to exclude them from the model and address them qualitatively.

[39] Ontario Energy Board. 2013. *Supplemental Report on Smart Grid.* EB-2011-0004. February 11, 2013.

CONCLUSION

Dunsky's cost-benefit analysis of mandating Green Button in Ontario, conducted for Ontario's Ministry of Energy, was designed to assess the cost-effectiveness of implementing Green Button across a range of scenarios, with variables focused on:

- **Green Button Options:** DMD only or DMD/CMD;
- **Utility Type:** Electricity, Natural Gas, Water; and
- **Implementation Type:** Single Integrated (Hosted), Multi-Integrated (Hosted), Non-Integrated (Hosted), In-House.

To develop inputs and obtain feedback on the results of the analysis, we consulted a broad range of stakeholders, including utilities, customers, government and intra-sector organizations, third-party service providers, and non-profit groups and associations.

The results of our analysis indicate that implementing Green Button in Ontario will be cost-effective from a societal standpoint. When focusing purely on the numbers, **implementing Green Button DMD/CMD across electricity and natural gas utilities is the most cost-effective path forward**.

Adding water utilities to the implementation is also a cost-effective scenario from a societal standpoint under a single-integrated or multi-integrated model. However, this is primarily based on the benefits from electricity and natural gas outweighing the costs of implementing Green Button for water. In other words, implementing Green Button for water utilities in and of themselves is generally not cost-effective, because the costs outweigh the benefits when considering water on its own.

In addition, implementing Green Button Connect My Data (CMD) in conjunction with Download My Data (DMD) provides the greatest benefits, and a single-integrated or multi-integrated implementation (with one, or a limited number of Green Button platforms for each utility type) is the most cost-effective implementation type, with negligible differences in results between the two.

We note that our analysis was high-level and designed to assess whether or not benefits outweighed the costs of a Green Button implementation. It does not contain enough granularity to assess actual implementation costs. Qualitative considerations such as such as increases in awareness of energy efficiency, real estate value, customer satisfaction, and CDM/DSM program innovation, and economic development and innovation, as well as support for government policy objectives would also increase the value of a Green Button implementation. They have not, however, been included within the quantitative analysis. For these reasons, any of the scenarios included in this report should be considered valid outputs to assist the Ministry in moving forward with a proposal for a Green Button implementation in Ontario.

APPENDIX A: COST-BENEFIT ANALYSIS RESULTS STAKEHOLDER PRESENTATION

ONTARIO GREEN BUTTON COST-BENEFIT ANALYSIS
Results

JULY 2016

dunsky
ENERGY CONSULTING

www.dunsky.com
(514) 504-9030 | info@dunsky.com

DUNSKY: OVERVIEW

CLIENTS (partial list)

EXPERTISE

- Energy efficiency and demand-side management
- Renewable energy and emerging technologies
- Greenhouse gas reductions

SERVICES

- Design and evaluation of programs, plans and policies
- Strategic and regulatory support
- Technical support and analysis

CLIENTELE

- Utilities
- Governments
- Solution Providers
- Large consumers
- Non-profits

TABLE OF CONTENTS

Overview

- Objective:
  - Assess the impacts of implementing Green Button in Ontario across a range of potential scenarios to help inform the Ministry of Energy's Green Button proposal.

March/ April
- Stakeholder consultations (focus groups) to introduce Green Button and to understand stakeholder data requirements and areas of benefits.

April/ May
- Interviews with identified stakeholders to gather information on costs and benefits related to Green Button implementation.

June
- Surveyed utilities and hosted Software as a Service (SaaS) Green Button implementation providers to help quantify costs and benefits.
- Additional secondary research to develop assumptions and gather data for additional costs and benefits.

COST-BENEFIT ANALYSIS METHODOLOGY

1. Stakeholder Consultations
2. Primary and Secondary Research
3. Inputs and Assumptions
4. Implementation Scenarios
4. Scenario Analysis

COSTS & BENEFITS – CATEGORIZATION

QUANTITATIVE

Direct (Layer 1A)

- Benefits and costs are a direct result of Green Button implementation
- Monetary value can be estimated based on available information

Indirect (Layer 2A)

- Indirect consequence of Green Button implementation
- Require an additional external influence or decision point in order to materialize
- Monetary value can be estimated based on available information

QUALITATIVE

(Layer 2B)

- Not included in Cost-Benefit Model
- Reported as “additional costs/ benefits”
- Used in overall analysis and policy recommendations

COSTS AND BENEFITS

- Quantitative categories included in the cost-benefit analysis are presented below.
- The analysis is conservative.
  - Benefits that were minimal, could not be quantified or estimated, or could not be attributed clearly to Green Button were excluded or included in the qualitative benefits.

	Item	Impacted Groups*	Category
Costs	• Implementation – one-time set-up costs (platform development and utility integration)	Hosted SaaS GB Implementation Providers, Utilities	Direct, Quantified
	• Operational - annual	Utilities	Direct, Quantified
	• Energy efficiency retrofits	Customers	Indirect, Quantified
Benefits (Quantified)	• Resource and time efficiencies due to simplified process and standard format related to accessing data (i.e., for internal or external monitoring, or benchmarking requirements) • Included for customers/service providers currently monitoring and benchmarking, and for new customer requirements resulting from Bill 135	Customers, Service Providers	Direct, Quantified
	• Increased energy efficiency and conservation (behavioural, operational, retrofit), both within and outside of existing CDM/DSM programs	Customers**	Indirect, Quantified
	• Reduced customer care effort	Utilities	Indirect, Quantified
	• CDM/DSM program efficiencies and innovations	Utilities	Indirect, Quantified

*Groups to which costs and benefits are assigned.
**Benefits are assigned to end-users only (not utilities) to avoid double-counting.

COSTS AND BENEFITS

- Qualitative categories are presented below but were not included in the cost-benefit analysis calculations.

	Item	Impacted Groups*	Category
Benefits (Not Quantified)	Increased energy efficiency awareness/education	Customers, Utilities	Direct, Qualitative
	Increased real estate value	Customers	Direct, Qualitative
	Increased customer satisfaction	Utilities	Direct, Qualitative
	Innovation in CDM/DSM programs	Utilities	Direct, Qualitative
	Supporting government policy objectives	Utilities, Government	Direct, Qualitative
	Economic development and innovation (i.e., improved access to North American market, supporting development of innovative services)	Service Providers, Government	Direct, Qualitative

*Groups to which costs and benefits are assigned.

KEY DRIVERS - COSTS

- Setup Costs
  - Setup costs are mostly influenced by the utility's integration services.*
  - For utility types with a significant number of individual utilities (e.g., water and electricity), the number of independent platforms represent a significant portion of the costs.
- Annual Costs
  - Ongoing annual costs are influenced mostly by the penetration of Green Button in Ontario.
  - Directly related to activity level on the platform.

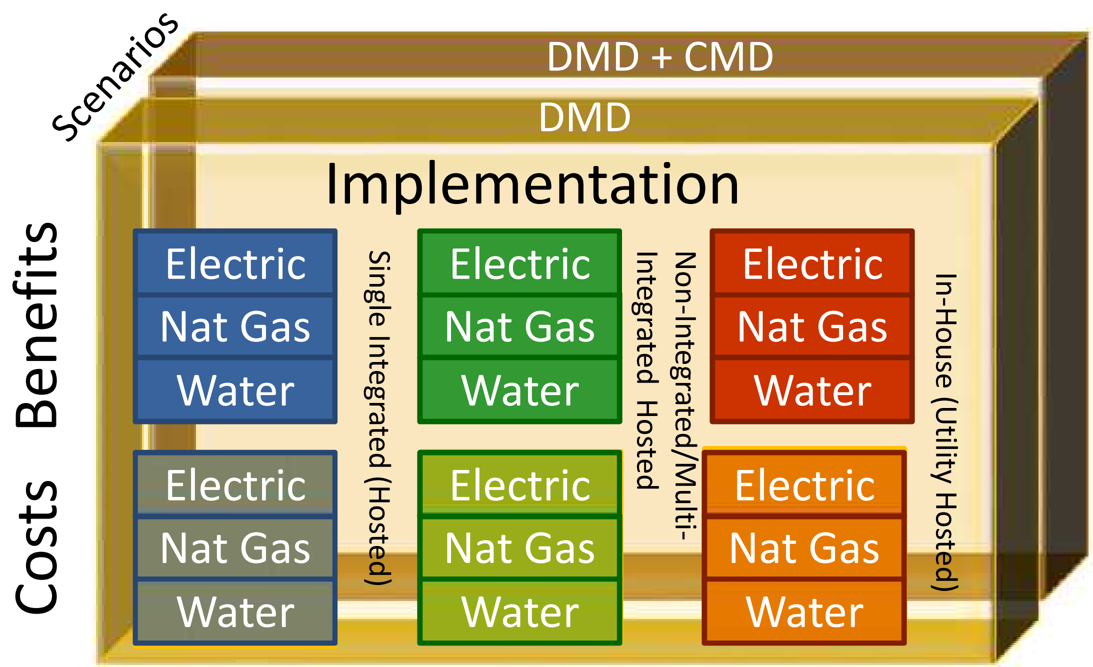
*i.e., integration with customer portals, Extract, Transform, Load (ETL) systems, meter data, MDM/R; testing; marketing; security and privacy validation.

KEY DRIVERS - BENEFITS

- Benefits – ~85% in Commercial and Institutional (C&I) Sector
  1. Increased Conservation – Energy Efficiency (EE) Retrofit and Behavioural (indirect benefit from Green Button)
     - *Green Button provides customers with more timely and easier access to data so they are more likely to undertake EE actions*
     - *Greatest benefits are in C&I EE Retrofit*
     - *2nd greatest benefits are in C&I Behavioural and Operational*
  2. Future Large Building Energy and Water Reporting and Benchmarking requirements (Bill 135) (indirect benefit from Green Button)
     - *~18,000 buildings are expected to be required to annually report monthly energy and water consumption*
     - *Green Button provides a simplified process to collect this information*
  3. Increased Efficiencies in Consumption, Billing and Generation Data Processes – replace existing processes (direct benefit from Green Button)
     - *Reduced efforts to collect and process utility consumption data*
     - *Reduced efforts to collect and process utility bills*
     - *Reduced efforts for data validation and quality control*

SCENARIOS

- 3 Dimensions
  - **Utility Type:** Electric, Natural Gas, Water
  - **Implementation Type:** Single Integrated (Hosted), Multi-Integrated/Non-Integrated (Hosted), In-House
  - **Green Button Option:** DMD, DMD+CMD



GREEN BUTTON OPTION

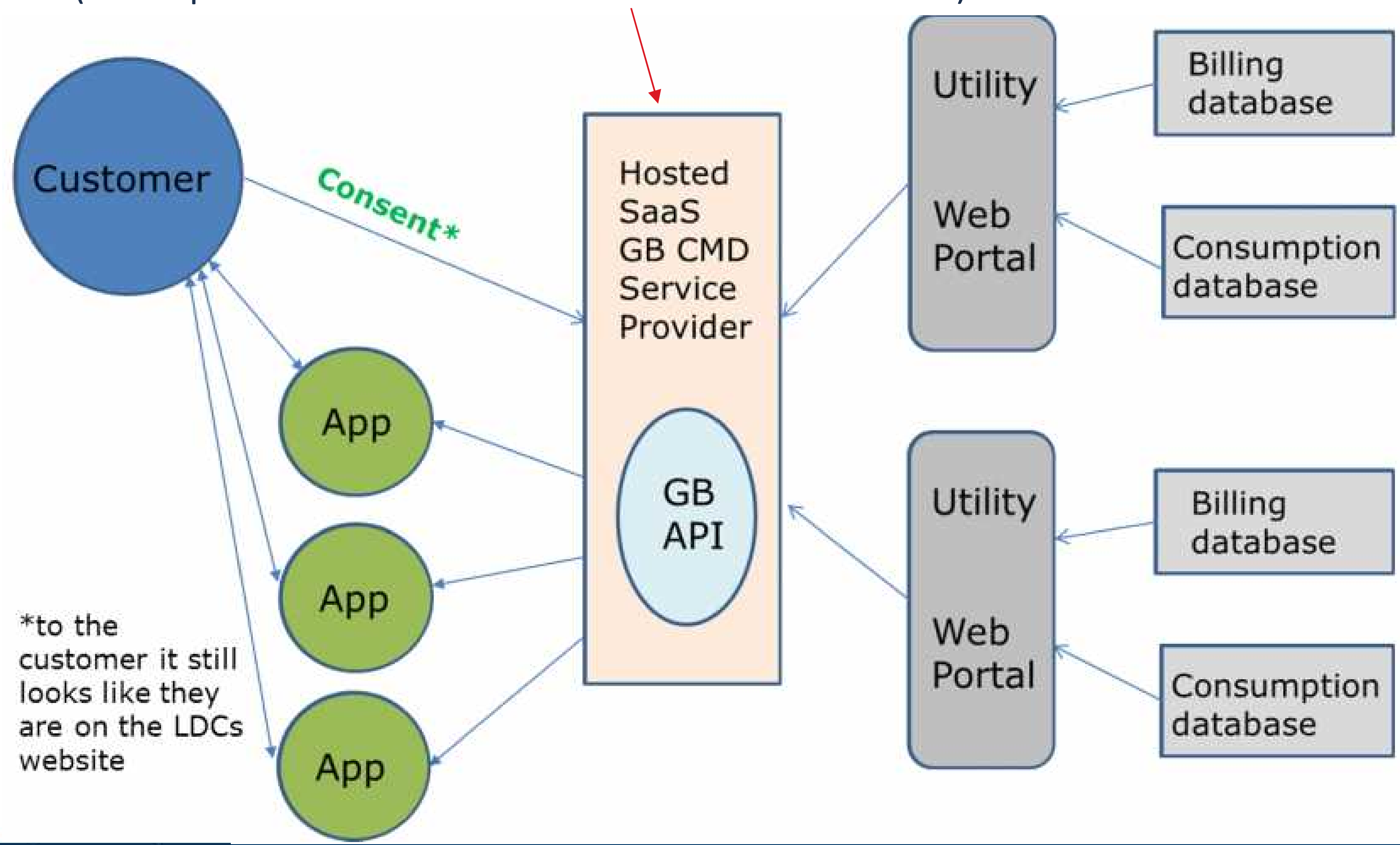
Option	Details
Green Button Download My Data (DMD)	• Provides customers with the ability to download their utility data directly, through their utilities' websites • Data is downloaded in XML and is provided in a consistent format
Green Button Connect My Data (CMD)	• Provides customers with the ability to share their data with solution providers and compatible databases in an automated way, based on consumer authorization • Process follows Privacy By Design principles

UTILITY TYPE

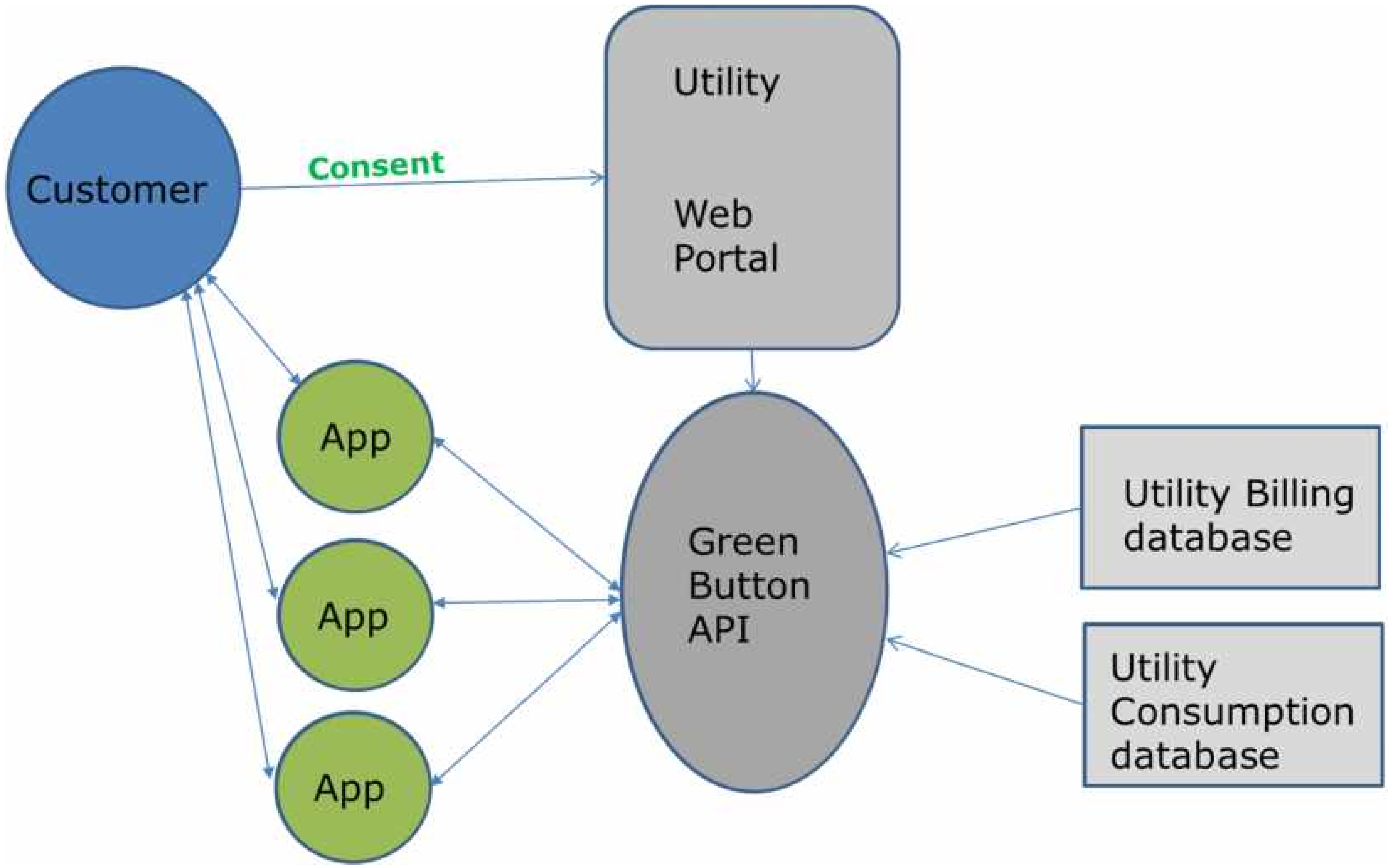
Utility Type	Key Factors in Analysis	Details
Electricity	Utility Population and Sizes	• 7 Large, 21 Medium, 44 Small
	Metering Infrastructure	• All are metered • Most have completed smart meter implementation for Residential and Small Commercial • Submeters exist for many buildings (but unknown to what extent by utilities)
	Total Number of Accounts	• 5,162,768 accounts
Natural Gas	Utility Population and Sizes	• 2 Large, 1 Small
	Metering Infrastructure	• All are metered • Combination of Automatic Meter Reading (AMR) and analog meters
	Total Number of Accounts	• 3,423,622 accounts
Water	Utility Population and Sizes	• 39 Large, 91 Medium, 550 Small
	70% of Small Water Utilities are Metered	• Only metered utilities included in analysis
	Of the Metered Utilities: Utility Population and Sizes	• 39 Large, 91 Medium, 385 Small
	Total Number of Accounts	• 4,955,366 accounts

IMPLEMENTATION TYPE: HOSTED

- Difference between hosted implementation types is in the number of providers (fewer providers creates efficiencies in cost and effort)



IMPLEMENTATION TYPE: IN-HOUSE



IMPLEMENTATION TYPE

Lower Cost →	Single Integrated Hosted	Multi-Integrated Hosted	Non-Integrated Hosted	In-House	→ Higher Cost
	Hosted SaaS provider implements Green Button for all utilities	Limited number of Green Button hosted SaaS platforms are used by all utilities*	Each utility has the option to develop/ procure its own GB SaaS hosted platform	Each utility develops its own platform on its own IT systems	
	3 implementation platforms (1 per utility type)	5 implementation platforms	591 implementation platforms	591 implementation platforms	
	Single platform development cost per utility type.	Platform development cost multiplied by 12	Multiple development costs	All utilities incur development costs	

*Hypothetical scenario demonstrating potential synergies

RESULTS

Context and Considerations

- Green Button is a relatively new standard, with little existing data on implementation.
  - Information gathered was largely new and primary-source based.
  - Data for some sectors and/or costs and benefits is more widely available than others.
  - Where detailed, granular data does not exist or the project scope did not allow for in-depth research, our team developed assumptions and proxies.
    - *The analysis shows scenarios that are cost-effective and ones that are not.*
    - *There is a margin of error associated with the results. Ratios should not be interpreted as exact; they should be interpreted as indicative.*
- Results are presented at the societal level, not for individual sectors or customer groups.
  - However, the results have been built up from inputs at the sector and customer-group level rather than developed from a top-down approach.
- Results include both direct and indirect benefits.

SUMMARY OF SCENARIO RESULTS

- Benefit/Cost Ratios of Green Button **DMD only**

Utility Type	Single Integrated Hosted		Multi-Integrated Hosted		Non-Integrated Hosted		In-House	
	5-year	10-year	5-year	10-year	5-year	10-year	5-year	10-year
Electricity	2.2	3.5	2.1	3.4	1.8	3.03	1.4	2.5
Electricity and Natural Gas	2.3	2.9	2.1	2.8	1.7	2.5	1.3	2.1
Electricity, Natural Gas, and Water	0.3	0.8	0.6	1.4	0.2	0.5	0.2	0.6
Natural Gas Component**	2.4	1.8	2.1	1.7	1.9	1.4	0.5	0.8
Water Component**	0.04	0.1	0.1	0.3	0.02	0.1	0.03	0.1

*Utility-hosted
**Incremental results

Summary of Scenario Results

- Benefit/Cost Ratios of Green Button **DMD/CMD**

Utility Type	Single Integrated Hosted		Multi-Integrated Hosted		Non-Integrated Hosted		In-House*	
	5-year	10-year	5-year	10-year	5-year	10-year	5-year	10-year
Electricity	4.1	3.6	4.04	3.6	3.5	3.5	3.2	3.4
Electricity and Natural Gas	4.4	3.8	4.4	3.8	3.9	3.7	3.5	3.6
Electricity, Natural Gas, and Water	1.9	2.8	1.8	2.8	1.4	2.5	1.1	2.3
Natural Gas Component**	6.2	4.9	6.0	5.0	5.6	4.8	5.4	4.7
Water Component**	0.5	1.1	0.5	1.04	0.3	0.8	0.3	0.7

*Utility-hosted
**Incremental results

RESULTS: GREEN BUTTON OPTION

- Deploying Green Button Connect My Data (CMD) in conjunction with Download My Data (DMD) provides greater benefits than DMD alone.
  - While consistently formatted electronic data downloads (DMD-only) are beneficial for sophisticated customers, the ability to develop tailor-made solutions and applications and create efficiencies with data transfer and authorization multiply the benefits when CMD is added.

RESULTS: UTILITY TYPES

- Deploying Green Button for electricity and natural gas only is the most cost-effective option.
  - The benefits are highest for electricity, and the costs are lower for natural gas because there are so few utilities.
- Including water is cost-effective from a societal level when combined with electricity and natural gas.
- However, this is primarily based on the benefits from electricity and natural gas outweighing the costs of implementing Green Button for water.
  - The majority of water utilities are small, with limited resources and minimal IT and metering infrastructure.
  - The costs to become “Green Button ready” would be significant for them, and the benefits are limited.
  - Only water utilities with metering infrastructure were included in the analysis. Water utilities not included in the analysis are not generally planning to upgrade their infrastructure in the next five years.

Water Utilities

- Implementing Green Button for all water utilities on their own (i.e. not combined with electricity and natural gas) is not cost-effective under most options due to:
  - Higher integration costs:
    - *Large number of metered water utilities*
    - *Each one results in multiplied integration and platform costs*
  - Lower unit benefits per customer. For example:
    - *Lack of engagement in water conservation (not including large customers)*
    - *Lower bill frequency (so less chance to use data/receive benefits)*
- Water **may** be cost-effective on its own with Single Integrated Hosted and Multi-Integrated Hosted implementations over a 10-year horizon.
  - The result is well within the margin of error.
  - However, in developing our analysis, we have erred on the side of being conservative rather than permissive in terms of benefits.

Option	Single Integrated Hosted		Multi-Integrated Hosted		Non-Integrated Hosted		In-House*	
	5-year	10-year	5-year	10-year	5-year	10-year	5-year	10-year
DMD	0.04	0.1	0.1	0.3	0.02	0.1	0.03	0.1
DMD/CMD	0.5	1.1	0.5	1.04	0.3	0.8	0.3	0.7

WATER UTILITIES

- There are some options that increase the cost-effectiveness of implementing Green Button for water utilities on their own, including implementing it only for the largest utilities:
  - 37 utilities, representing ~78% of the population
  - Lower integration costs:
    - *Fewer number of utilities, reducing integration and platform costs*
  - Larger number of customers per utility, reducing the per-customer cost

Deployment	Non-Integrated Hosted		Single Integrated Hosted		In-House*	
	5-year	10-year	5-year	10-year	5-year	10-year
DMD/CMD	1.7	1.7	1.2	1.8	0.8	1.4

RESULTS: IMPLEMENTATION TYPE

- The Single Integrated Hosted implementation is the most cost-effective option when implementing for all utility types.*
- Single Integrated and Multi-Integrated Hosted are equally cost-effective when implementing only for electricity and natural gas.
- A Non-Integrated Hosted option is assumed to increase costs because of the need to develop a greater number of platforms.
- In-House Hosting is the least efficient because it is not part of utilities' core business.

*For Green Button DMD+CMD over 10 years, a Multi-Integrated implementation has the same cost-benefit ratio as the Single Integrated option.

KEY SCENARIO 1: SINGLE INTEGRATED/MULTI-INTEGRATED HOSTED ELECTRICITY & NATURAL GAS

Dimension	Results	
Cost-Benefit Ratio	**5-Year Horizon**	4.4
	10-Year Horizon	3.8
Utility Type		Electricity and Natural Gas
Implementation		Single Integrated Hosted; Multi-Integrated Hosted
Green Button Option		Download My Data and Connect My Data

KEY SCENARIO 2: SINGLE INTEGRATED HOSTED
ELECTRICITY, NATURAL GAS & WATER

Dimension	Results	
Cost-Benefit Ratio	**5-Year Horizon**	1.9
	10-Year Horizon	2.8
Utility Type	Electricity, Natural Gas and Water	
Implementation	Single Integrated Hosted	
Green Button Option	Download My Data and Connect My Data	

KEY SCENARIO 3: MULTI-INTEGRATED HOSTED
ELECTRICITY, NATURAL GAS & WATER

Dimension	Results	
Cost-Benefit Ratio	**5-Year Horizon**	1.8
	10-Year Horizon	2.8
Utility Type		Electricity, Natural Gas and Water
Implementation		Multi-Integrated Hosted
Green Button Option		Download My Data and Connect My Data

APPENDIX B: COST-BENEFIT ANALYSIS INPUT ASSUMPTIONS

General Inputs:

General Input	Source	Notes
Discount Rate (Societal): 2%	IESO real discount rate (CDM EE Cost-Effectiveness Test Guide): http://www.ieso.ca/-/media/files/ieso/document-library/conservation/ldc-toolkit/cdm-ee-cost-effectiveness-test-guide-v2-20150326.pdf?la=en Ontario long-term bond rates: http://www.ofina.on.ca/pdf/bond_issue_details_DMTN228_to_R19.pdf	Adjustment to IESO real discount rate of 4% (CDM EE Cost-Effectiveness Test Guide) to reflect conservative view of 30-year Ontario real bond rates of 1.2%). The social discount rate represents the public benefit perspective of the Green Button framework, and based on industry practices, normally reflects the long-term treasury bonds borrowing rates. For the Green Button Framework analysis, considering the IESO social discount rate, a 2% social discount rate was selected.
Inflation Rate: 1.7%	Ontario's annual inflation rate in June 2016: http://inflationcalculator.ca/2016-cpi-and-inflation-rates-for-ontario/	As per leading industry practices, the cost-effectiveness analysis uses real values, and do not require adjustments for inflation.
Monetary values base year: 2016	Costs and benefits are expressed in 2016 values.	
Participation in Green Button	Rogers' Diffusion of Innovation	Varies by cost/benefit category

Population Inputs:

Group to which Costs/Benefits are Assigned	Sub Group	Population	Source	Submeter penetration	Source
Buildings/ Facilities	Large Commercial	32,011	Statistics Canada, Survey of Commercial and Institutional Energy use - Buildings 2009	0.03%	Estimates developed from IT Survey
	Small Commercial	112,672	Statistics Canada	0.40%	
	Large Industrial	120	Statistics Canada	0	
	Institutional	19,630	Statistics Canada	0.03%	
	Residential	3,342,822	Statistics Canada, Private Households, by structural type of dwellings	3.40%	
Total Utility Accounts per customer type	Large Commercial	54,706	OEB 2014 Yearbook of Electricity Distributors; Utility IT Survey; For water utilities: based on proportion of electric to water accounts	0.03%	Estimates for percentage of accounts by customer type developed from IT Survey
	Small Commercial	432,565		0.40%	
	Large Industrial	120		0.00%	
	Institutional	19,637		0.03%	
	Residential	4,655,740	OEB 2014 Yearbook of Electricity Distributors; Utility IT Survey; For water utilities: based on population in each municipality, average numer of individuals per household in Ontario	3.40%	
Electricity Utility	Large	7	OEB 2014 Yearbook of Electricity Distributors		
Electricity Utility	Medium	21	OEB 2014 Yearbook of Electricity Distributors		
Electricity Utility	Small	44	OEB 2014 Yearbook of Electricity Distributors		
Natural Gas Utility	Large	2	OEB 2014 Yearbook of Natural Gas Distributors		
Natural Gas Utility	Small	1	OEB 2014 Yearbook of Natural Gas Distributors		
Water Utility	Large	39	http://www.watertapontario.com/asset-map/utilities/water-and-wastewater-utilities		
Water Utility	Medium	91	http://www.watertapontario.com/asset-map/utilities/water-and-wastewater-utilities		
Water Utility	Small	385	Assumes 70% are metered (IT Survey); http://www.watertapontario.com/asset-map/utilities/water-and-wastewater-utilities		

Costs:

Category and Input	Source	Notes
One-Time Green Button Implementation Costs		
Use Case: Set-Up and Integration Costs - One Time - DMD/CMD		
Key Inputs:		
Platform Setup Costs	Stakeholder Interviews, Solution Providers survey	Includes front-end solutions, cloud services, Green Button platform, development and testing, and registration costs
Utility Integration Costs, variable by utility size	Stakeholder interviews with Ontario GB Pilot utilities	Includes ETL protocols and other integration costs such as integration with customer portals, meter data, external testing and validation, etc.
Variability by implementation scenario	Professional judgement and stakeholder interviews	Setup Costs account for the number of platforms in each implementation scenario (single integrated = 3 (1 per utility type), in-house/non-integrated = 591 (1 per utility), multi-integrated = 12 (5 per utility type except 2 for natural gas)
		Efficiencies increase from in-house, to non-integrated, to single-integrated. Separate assumptions were not developed for multi-integrated hosted (centralized assumptions were used with a simple multiplication of development costs)
Forecasted Participation	Professional judgement	100% implementation within 4 years: 35%, 70%, 92%, 100%
		Accounts for current implementation of DMD and CMD in electricity utilities
Use Case: Set-Up and Integration Costs - One Time - DMD		
Key Inputs:		
Platform Setup Costs	Stakeholder Interviews, Solution Providers survey	Includes front-end solutions, cloud services, Green Button platform, development and testing (including of required security and privacy mechanisms and protocols), and registration costs
Utility Integration Costs, variable by utility size	Stakeholder interviews	Subset of DMD/CMD costs, based on cost breakdown and professional judgment. Includes ETL protocols and other integration costs such as integration with customer portals, meter data, external testing and validation, etc.
Variability by implementation scenario	Professional judgement and stakeholder interviews	Setup Costs account for the number of platforms in each implementation scenario (single integrated = 3 (1 per utility type), in-house/non-integrated = 591 (1 per utility), multi-integrated = 12 (5 per utility type except 2 for natural gas)
		Efficiencies increase from in-house, to non-integrated, to single-integrated. Separate assumptions were not developed for multi-integrated hosted (centralized assumptions were used with a simple multiplication of development costs)
Forecasted Participation	Professional judgement	100% implementation within 4 years: 35%, 70%, 92%, 100%
		Accounts for current implementation of DMD in electricity utilities

Annual Green Button Implementation Costs		
Key Inputs:		
Annual Variable cost by participating customer	Stakeholder Interviews	Costs are for maintenance and ongoing operations
Impact of Implementation Scenarios	Professional judgement and stakeholder interviews	Efficiencies increase from utility-hosted, to non-integrated hosted, to single-integrated.
Forecasted Participation	Modeled through the Adoption/Penetration Rate analysis	

Retrofit Costs		
General Notes:	Costs are total measure costs.	
	They do not include potential costs from new programs developed as a result of Green Button or additional program administrator costs that could be incurred due to higher participation in CDM/DSM programs (which are not a one-to-one relationship).	
Key Inputs:		
Unit Costs of Retrofit Activity ($/conservation benefit)	Ontario utility and other Canadian CDM/DSM Plans	Water: assumes similar cost per benefit value as electricity
Forecasted Participation	Rogers' Diffusion of Innovation	Uses the same adoption rate as retrofit activity (see benefits).

Benefits:

Category and Input	Source	Notes
Utility Consumption, Billing and Generation Data Process Efficiencies		
Customers		
General Notes:	**GB Phase:** DMD and CMD do not bring the same value to participants	
	Customer Type: Residential and Small Commercial customers have less sophisticated processes to collect and analyze consumption data - GB translates into higher unit benefits	
	Current Practices: Customers already accessing consumption data in e-format will have lower benefits than new participants	
	Utility Type: The benefits are higher when more utility types are involved. Customers need to access or request data to each utility type individually.	
	Ownership Status: C&I Building Owners and Property Managers are experiencing higher benefits: benchmarking efficiencies, more use cases for energy tracking.	
Key Inputs:		
Value by customer participating through a CMD solution (quantified through avoided costs)	Stakeholder consultations and interviews	
Assigning benefit unit value	Source Data: interviews with stakeholders	Stakeholders clearly identified electricity as the key utility consumption data that would provide the majority of benefits for a GB implementation. The distribution reflects the feedback provided by stakeholders.
Benefits for a new user of utility data through CMD, for electricity	Stakeholder consultations and interviews	Distribution by utility type based on the value of each utility type's data to customers (+/-64% of total benefits attributed to electricity)
Benefits for a new user of utility data through CMD, for natural gas	Stakeholder consultations and interviews	Distribution by utility type based on value of each utility type's data to customers (+/-22% of total benefits attributed to natural gas
Benefits for a new user of utility data, through CMD, for water	Stakeholder consultations and interviews	Distribution by utility type based on value of each utility type's data to customers (+/-14% of total benefits attributed to water)
Benefits for existing users of utility data in e-format	Interviews with Stakeholders & Professional Judgement	Incremental benefits to current process. Benefits stem from simplified process and standardized format. A minimal dollar value was assigned because several of the key benefits were already being experienced by those customers.
Benefits for tenants	Professional judgement used to link to study addressing behavioural spillover effects	
Assigning customers to appropriate category		
Existing users of utility data in e-format	Utility IT surveys	
O.Reg. 20/17	Communication with the Ministry of Energy; Ministry of Energy "Energy use and greenhouse gas emissions from the Broader Public Sector: 2014" (reporting and non-reporting organizations).	Institutional buildings accessing data through the EBT Hub are excluded from this class. Includes the 10% of federal and provincial institutional buildings not included in O.Reg. 397/11
New C&I users of utility data	Communication with the Ministry of Energy; Ministry of Energy "Energy use and greenhouse gas emissions from the Broader Public Sector: 2014" (reporting and non-reporting organizations).	Remaining proportion of population of C&I buildings not currently accessing consumption data or subject to O.Reg. 20/17
New residential users of utility data	See number of customer accounts and number of buildings in General Inputs	
Forecasting Penetration		
Based on diffusion of innovation algorithm	Rogers' Diffusion of Innovation	This theory has been applied successfully to DSM/CDM programs to forecast participation.
Parameters of Algorithm	Professional judgement based on barriers for each customer type, considering sophistication in consumption data management, resource availabilities (lower penetration for small commercial and residential)	
	Other requirements (compliance to O.Reg. 20/17)	

Benefits (continued):

Category and Input	Source	Notes
Utility Consumption, Billing and Generation Data Process Efficiencies		
Customers		
Use Case: Increased Conservation: Behavioural & Operational		
General Sources:	Literature review including: - Murray, M. and J. Hawley. 2016. Got Data? The Value of Energy Data Access to Consumers.Mission:Data. - Navigant Consulting Inc., 2016. Home Energy Report Opwer Program PY7 Evaluation Report: Commonwealth Edison. - Opinion Dynamics. 2013. Massachusetts Cross-Cutting Behavioral Program Evaluation Integrated Report: Massachusetts Energy Efficiency Advisory Council and Behavioral Research Team.	
General Notes:	Conservation savings achieved as a result of increased access to data.	
	Does not differentiate between savings within and outside of CDM/DSM programs.	
	Does not include potential savings resulting from new programs developed as a result of Green Button.	
	Behavioural savings from access to consumption data have been evaluated to vary between 4 and 12%, depending on the technology involved and engagement methodologies.	
	The model assumes a conservative 1% for behavioural savings to recognize that the utilities do not have control over the engagement.	
	The penetration curve selected were modest, and reflects early evidence of use of GB-enabled apps in other jurisdictions.	
	A DSM-driven GB-related program would elicit a much higher level of participation than what is included in the model. Current behavioural programs available (Home Energy Report) claim 1 to 2% savings across the entire population receiving the reports. Savings by individual customers attributable to reports can be much higher than this.	
Key Inputs:		
Average Building Electricity Consumption	Average Electricity Intensity in Ontario, based on NRCAN's Comprehensive Energy Use Database	Conservative estimates were used due to unknowns regarding actual impacts
Average Building Natural Gas Consumption	Average Electricity Intensity in Ontario, based on NRCAN's Comprehensive Energy Use Database	Conservative estimates were used due to unknowns regarding actual impacts
Average Building Water Consumption	Calculated from Total Water Consumption per Capita (Sustainable Water Management Division, Environment Canada. 2011 Municipal Water Use Report – Municipal Water Use 2009 Statistics), Residential Water Consumption per Capita, number of accounts.	Assuming water consumption across customer class is proportional to electricity consumption. Conservative estimates were used due to unknowns regarding actual impacts
Value of Conservation	Avoided Costs - based on Union Gas DSM Plan 2015-2018 , app. B (the Plan includes avoided costs for natural gas, electricity, and water	Conservative estimates were used due to unknowns regarding actual impacts
Conservation Level	Literature Review of conservation programs based on access to utility consumption data (Murray, M. and J. Hawley. 2016. Got Data? The Value of Energy Data Access to Consumers. Mission:Data)	Conservative estimates were used due to unknowns regarding actual impacts
Calculation:		
Behavioural & Operational Savings Unit Value per building type	Average Building Utility Consumption by building type * Avoided Costs * Conservation Level	
Electricity Retrofit Savings	Ontario utility and other Canadian CDM/DSM Plans and average energy rates	
Natural Gas Retrofit Savings	Ontario utility and other Canadian CDM/DSM Plans and average energy rates	
Water Retrofit Savings	Conservatively estimated based on electricity/natural gas potential savings (Ontario utility and other Canadian CDM/DSM Plans and average energy rates)	Conservatively estimated based on electricity/natural gas potential savings
Forecasting Penetration		
Based on diffusion of innovation algorithm	Rogers' Diffusion of Innovation	This theory has been applied successfully to DSM/CDM programs to forecast participation.
Parameters of Algorithm	Professional judgement based on barriers for each customer type, considering sophistication in consumption data management, resource availabilities (lower penetration for small commercial and residential)	
Results:		Residential: Participation after 5 yrs is 1% of total customers
		Commercial participation after 5 yrs: large: 6%, small: 2%, institutional: 6%

Benefits (continued):

Category and Input	Source	Notes
Utility Consumption, Billing and Generation Data Process Efficiencies		
Customers (continued)		
Use Case: Increased Conservation: Retrofit		
Key Inputs:		
Average Building Electricity Consumption	Average Electricity Intensity in Ontario, based on NRCAN's Comprehensive Energy Use Database	
Average Building Natural Gas Consumption	Average Electricity Intensity in Ontario, based on NRCAN's Comprehensive Energy Use Database	
Average Building Water Consumption	Calculated from Total Water Consumption per Capita, Residential Water Consumption per Capita, number of accounts per capita	Assuming water consumption across customer class is proportional to electricity consumption
Value of Conservation	Avoided Costs - based on Union Gas DSM Plan 2015-2018, app. B (the Plan includes avoided costs for natural gas, electricity, and water)	
Conservation Level	Savings estimation based on evaluation experience and Ontario utility and other Canadian CDM/DSM Plans.	Conservative Estimate - 10% savings - average of retrofit activities considering several achieve 20% more savings with utility conservation programs.
Calculation:		
Behavioural & Operational Savings Unit Value per building type	Average Building Utility Consumption by building type* Avoided Costs * Conservation Level	
Forecasting Penetration:		
Based on diffusion of innovation algorithm	Rogers' Diffusion of Innovation	This theory has been applied successfully to DSM/CDM programs to forecast participation.
Parameters of Algorithm	Professional judgement based on barriers for each customer type, considering sophistication in consumption data management, resource availabilities (lower penetration for small commercial and residential)	
Results:		Residential: Participation after 5 yrs is 0.4% of total customers - this captures conservation activities requiring expenditure
		Commercial participation after 5 yrs: large: 0.7%, small: 0.12%, institutional:0.7%

Category and Input	Source	Notes
Solution Providers		
Use Case: Ongoing Utility Consumption Monitoring and Benchmarking		
Key Inputs:		
Average benefit per building, per building type, utility type	Interviews with Stakeholders	This benefit is included as a dollar value reflecting reduced effort to access utility consumption data for monitoring and benchmarking activities
Forecasting Penetration		
Based on diffusion of innovation algorithm	Rogers' Diffusion of Innovation	This theory has been applied successfully to DSM/CDM programs to forecast participation
Parameters of Algorithm	Professional judgement based on barriers, interviews with stakeholders	
Use Case: Engineering Services - One-Time Services Requiring Utility Consumption Data		
Key Inputs:		
Average benefit per building, per building type, utility type	Interviews with Stakeholders	This benefit stems from reduced effort to access utility consumption data to conduct engineering analysis
Forecasting Penetration		
Based on diffusion of innovation algorithm	Rogers' Diffusion of Innovation	This theory has been applied successfully to DSM/CDM programs to forecast participation
Parameters of Algorithm	Professional judgement based on barriers, interviews with stakeholders	

Category and Input	Source	Notes
Utility Reduced Customer Care Effort		
Key Inputs:		
Annual Cost Reduction- reduced customer care efforts - by utility type and size	Stakeholder Interviews, Utility IT Surveys	
Forecasting Penetration	Professional Judgement	100% implementation within 4 years: 35%, 70%, 92%, 100%

Category and Input	Source	Notes
Utility CDM/DSM Program Efficiencies and Innovations		
Key Inputs:		
Annual Cost Reduction- CDM/DSM Program Efficiencies and Innovations - by utility type and size	Values estimated based on Stakeholder Interviews	This is a token benefit expressed in $ per utility

APPENDIX C: COSTS AND BENEFITS OVERVIEW TABLE

	Customer Groups																													
	Property Owners/Managers															Tenants/Residents														
	Large Commercial			Small Commercial			Large Industrial			Institutional			Residential			Large Commercial			Small Commercial			Large Industrial			Institutional			Residential		
Benefits	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual
Utility Consumption, Billing and Generation Data Process Efficiencies																														
Energy tracking (voluntary and internal) - customers who currently gather and track data	Y			Y			Y			Y			Y			Y			Y			Y			Y			Y		
Energy audit efficiencies																														
Energy tracking																														
Energy and water reporting and benchmarking																														
Consistent machine readable data among multiple utilities																														
Increased data (consumption, billing and generation) accuracy/ quality																														
Simplified data sharing authorization process																														
Increased frequency and granularity of utility data																														
Energy and water reporting and benchmarking - customers' future data collection related to Bill 135	Y			Y			Y			Y			Y			Y			Y			Y			Y			Y		
Energy audit efficiencies (new customer requirements)																														
Energy tracking (new customer requirements)																														
Energy and water reporting and benchmarking																														
Consistent machine readable data among multiple utilities																														
Increased data (consumption, billing and generation) accuracy/quality																														
Simplified data sharing authorization process																														
Increased frequency and granularity of utility data																														
Increased operational efficiencies within utilities from improvements to IT systems																														
Increased Conservation																														
Non-retrofit savings		Y			Y			Y			Y			Y			Y			Y			Y			Y			Y	
Greater behavioural-based conservation																														
Greater operational savings in buildings																														
Increased CDM/DSM program participation																														
Increased energy efficiency retrofit savings		Y			Y			Y			Y			Y																
Increased energy efficiency / conservation education																														
Increased CDM/DSM program participation																														
Other Conservation																														
CMD/DSM program efficiencies and innovations																														
New CDM/DSM program design based on Green Button																														
CDM/DSM program implementation efficiencies																														
CDM/DSM program evaluation efficiencies																														

Quantitative input into model	Benefit that is not broken out quantitatively in the model	Category Heading

	Customer Groups																													
	Property Owners/Managers															Tenants/Residents														
	Large Commercial			Small Commercial			Large Industrial			Institutional			Residential			Large Commercial			Small Commercial			Large Industrial			Institutional			Residential		
Benefits	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual
Increased Real Estate Value			Y			Y			Y			Y			Y															
Customer Service Benefits																														
Reduced customer care effort																														
Increased customer satisfaction / engagement																														
Improved customer access to data																														
Support government policy objectives																														
Reduce/remove barriers to reporting & benchmarking requirements																														
Support OEB's customer education/customer control goals																														
Support Ontario's Conservation objectives and Climate Change Action Plan																														
Economic Development and Innovation																														
Job Creation																														
Improved Access to North American Market																														
Support new use cases and development of innovative services																														
Costs																														
GB Implementation Costs																														
GB infrastructure - cloud services, platform																														
GB infrastructure - front end																														
Security and privacy																														
Third-party applications - registration and testing																														
GB Utility Integration																														
Integration with customer portal																														
Computer information systems Extract, Transform, and Load (ETL) protocols																														
Meter Data																														
Integration with third-party meter data management																														
Testing																														
Marketing																														
Security and privacy																														
Increased energy efficiency retrofit costs		Y			Y			Y			Y			Y																

Quantitative input into model	Benefit that is not broken out quantitatively in the model	Category Heading

Benefits	Utilities																										
	Electric Utilities									Natural Gas Utilities						Water Utilities											
	Electricity (Large)			Electricity (Medium)			Electricty (Small)			Natural Gas Utilities (Large)			Natural Gas Utilities (Small)			Water Utilities (Large)			Water Utilities (Medium)			Water Utilities (Small)			Water Utilities (linked to LDC)		
	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual
Utility Consumption, Billing and Generation Data Process Efficiencies																											
Energy tracking (voluntary and internal) - customers who currently gather and track data	Y			Y			Y			Y			Y			Y			Y			Y			Y		
Energy audit efficiencies																											
Energy tracking																											
Energy and water reporting and benchmarking																											
Consistent machine readable data among multiple utilities																											
Increased data (consumption, billing and generation) accuracy/ quality																											
Simplified data sharing authorization process																											
Increased frequency and granularity of utility data																											
Energy and water reporting and benchmarking - customers' future data collection related to Bill 135	Y			Y			Y			Y			Y			Y			Y			Y			Y		
Energy audit efficiencies (new customer requirements)																											
Energy tracking (new customer requirements)																											
Energy and water reporting and benchmarking																											
Consistent machine readable data among multiple utilities																											
Increased data (consumption, billing and generation) accuracy/quality																											
Simplified data sharing authorization process																											
Increased frequency and granularity of utility data																											
Increased operational efficiencies within utilities from improvements to IT systems																											
Increased Conservation																											
Non-retrofit savings																											
Greater behavioural-based conservation*																											
Greater operational savings in buildings*																											
Increased CDM/DSM program participation*																											
Increased energy efficiency retrofit savings																											
Increased energy efficiency / conservation education			Y			Y			Y			Y			Y			Y			Y			Y			Y
Increased CDM/DSM program participation*																											
Other Conservation																											
CMD/DSM program efficiencies and innovations		Y	Y		Y	Y		Y	Y		Y	Y		Y	Y			Y			Y			Y			Y
New CDM/DSM program design based on Green Button			Y			Y			Y			Y			Y			Y			Y			Y			Y
CDM/DSM program implementation efficiencies			Y			Y			Y			Y			Y			Y			Y			Y			Y
CDM/DSM program evaluation efficiencies			Y			Y			Y			Y			Y			Y			Y			Y			Y

Quantitative input into model	Benefit that is not broken out quantitatively in the model	Category Heading

	Utilities																										
	Electric Utilities									Natural Gas Utilities						Water Utilities											
	Electricity (Large)			Electricity (Medium)			Electricty (Small)			Natural Gas Utilities (Large)			Natural Gas Utilities (Small)			Water Utilities (Large)			Water Utilities (Medium)			Water Utilities (Small)			Water Utilities (linked to LDC)		
Benefits	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual
Increased Real Estate Value																											
Customer Service Benefits																											
Reduced customer care effort	Y			Y			Y			Y			Y			Y			Y			Y			Y		
Increased customer satisfaction / engagement			Y			Y			Y			Y			Y			Y			Y			Y			Y
Improved customer access to data			Y			Y			Y			Y			Y			Y			Y			Y			Y
Support government policy objectives																											
Reduce/remove barriers to reporting & benchmarking requirements																											
Support OEB's customer education/customer control goals																											
Support Ontario's Conservation objectives and Climate Change Action Plan																											
Economic Development and Innovation																											
Job Creation																											
Improved Access to North American Market																											
Support new use cases and development of innovative services			Y			Y			Y			Y			Y			Y			Y			Y			Y
Costs																											
GB Implementation Costs	Y			Y			Y			Y			Y			Y			Y			Y			Y		
GB infrastructure - cloud services, platform																											
GB infrastructure - front end																											
Security and privacy																											
Third-party applications - registration and testing																											
GB Utility Integration	Y			Y			Y			Y			Y			Y			Y			Y			Y		
Integration with customer portal																											
Computer information systems Extract, Transform, and Load (ETL) protocols																											
Meter Data																											
Integration with third-party meter data management																											
Testing																											
Marketing																											
Security and privacy																											
Increased energy efficiency retrofit costs*																											

*Included as a cost/benefit to end users (customers) rather than utilities

	Additional Stakeholders														
	Government									Third Parties					
	Gov Depts			IESO			OEB			SaaS GB Implementation Providers			EE/Technical Service Solution Providers		
	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual
Utility Consumption, Billing and Generation Data Process Efficiencies															
Energy tracking (voluntary and internal) - customers who currently gather and track data										Y			Y		
Energy audit efficiencies															
Energy tracking															
Energy and water reporting and benchmarking															
Consistent machine readable data among multiple utilities															
Increased data (consumption, billing and generation) accuracy/ quality															
Simplified data sharing authorization process															
Increased frequency and granularity of utility data															
Energy and water reporting and benchmarking - customers' future data collection related to Bill 135										Y			Y		
Energy audit efficiencies (new customer requirements)															
Energy tracking (new customer requirements)															
Energy and water reporting and benchmarking															
Consistent machine readable data among multiple utilities															
Increased data (consumption, billing and generation) accuracy/quality															
Simplified data sharing authorization process															
Increased frequency and granularity of utility data															
Increased operational efficiencies within utilities from improvements to IT systems															
Increased Conservation															
Non-retrofit savings															
Greater behavioural-based conservation															
Greater operational savings in buildings															
Increased CDM/DSM program participation															
Increased energy efficiency retrofit savings															
Increased energy efficiency / conservation education						Y									
Increased CDM/DSM program participation															
Other Conservation															
CMD/DSM program efficiencies and innovations												Y			
New CDM/DSM program design based on Green Button															Y
CDM/DSM program implementation efficiencies															Y
CDM/DSM program evaluation efficiencies						Y									

Quantitative input into model	Benefit that is not broken out quantitatively in the model	Category Heading

	Additional Stakeholders														
	Government									Third Parties					
	Gov Depts			IESO			OEB			SaaS GB Implementation Providers			EE/Technical Service Solution Providers		
	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual	Direct Quant	Indir. Quant	Qual
Increased Real Estate Value															
Customer Service Benefits															
Reduced customer care effort															
Increased customer satisfaction / engagement															
Improved customer access to data															
Support government policy objectives															
Reduce/remove barriers to reporting & benchmarking requirements			Y												
Support OEB's customer education/customer control goals									Y						
Support Ontario's Conservation objectives and Climate Change Action Plan			Y			Y			Y						
Economic Development and Innovation															
Job Creation			Y							Y			Y		
Improved Access to North American Market			Y									Y			Y
Support new use cases and development of innovative services												Y			Y
Costs															
GB Implementation Costs															
GB infrastructure - cloud services, platform															
GB infrastructure - front end															
Security and privacy															
Third-party applications - registration and testing**															
GB Utility Integration															
Integration with customer portal															
Computer information systems Extract, Transform, and Load (ETL) protocols															
Meter Data															
Integration with third-party meter data management															
Testing															
Marketing															
Security and privacy															
Increased energy efficiency retrofit costs															

**Included within costs to utilities but not for SaaS implementation providers as it is a business-related cost built into existing costs

APPENDIX D: CONSERVATION METHODOLOGY

The following section walks through the methodology, assumptions and inputs used to estimate impacts from increased conservation activity resulting from improved access to utility consumption and billing data. We use building retrofits as the basis of the example, and **the same methodology is used for behaviour-based conservation**.

INCREASED CONSERVATION

ALGORITHM

Our general methodology links estimated energy and water savings to avoided costs to derive an annualized benefit from energy conservation. The general algorithm used is:

Conservation Benefit = Unitary Benefit * Participation

Unitary Benefit = % Savings * Annual Consumption * AC

Where:

- **Conservation Benefit:** Total annual conservation benefits from increased retrofit activity
- **Unitary Benefit:** Average annual benefit value per participant
- **% Savings:** Percentage of total building or house consumption saved through retrofit
- **Annual Consumption:** Total yearly building or house consumption (electricity, natural gas or water)
- **AC:** Utility avoided costs
- **Participation:** Annual number of participants

Where additional information was available to assess the unitary benefit value, an alternative approach based on the available information was used. This is notably the case for natural gas benefits in the residential sector. For natural gas savings, Union Gas presents unitary savings for its Home Renovation program. Considering that in the residential sector, the vast majority of benefits would be derived from measures and technologies covered under the Union Gas program, it was deemed a good representation of energy efficiency improvements.

The annual benefit value per participant is a model input, and the participation level is calculated through application of penetration curves. Inputs and assumptions used for each of these variables are presented below.

UTILITY SAVINGS

The impacts of increasing access to utility consumption and billing data has the potential to induce increased conservation activities, both through increased home and building retrofit activities (envelope improvements, high-efficiency HVAC equipment, etc.) and other actions requiring investments from the participants.

Residential Sector

For the residential sector, annual incremental savings are presented in the following table:

Utility Type	Annual Savings: Retrofit-Based Efficiency and Conservation	Annual Savings: Behaviour-Based Efficiency and Conservation
Electricity	10%	1%
Natural Gas	12%	1%
Water	3%	1%

Electricity Savings: Participants in Ontario's ecoENERGY retrofit program have realised a 20% reduction in their annual energy consumption.[1] More specifically for electricity, a Canmet Energy Study[2] has identified average potential savings representing 11% of individual home baseload electricity consumption (defined as lighting, major appliances, common plug-load and other atypical loads). We used 10%, which is lower than both these values, to ensure our analysis was conservative.

Natural Gas Savings: The potential measures to reduce consumption are essentially covered by Union Gas Home Renovation programs. Union Gas 2015-2020 DSM Plan provides information that allows us to calculate the average natural gas savings of 1,039 m^3/year for participants in the program. Considering that those natural gas savings were derived from utility programs, and that envelope improvements have higher barriers to participation (access to capital, discretionary measures, etc.) only 30% of those savings have been retained for the cost-benefit analysis.

Water Savings: In the absence of robust data on potential water savings improvements, a conservative 3% of annual load savings was used to estimate impacts.

[1] Natural Resources Canada, ecoENERGY Retrofit Statistics, August 1st, 2012.

[2] Canmet ENERGY: Base-Load Electricity Usage – Results from In-home Evaluations, 2012.

Commercial Sector

For the commercial sector, annual incremental savings are presented in the following table:

Utility Type	Annual Savings: Retrofit-Based Efficiency and Conservation	Annual Savings: Behaviour-Based Efficiency and Conservation
Electricity	10%	2%
Natural Gas	4%	2%
Water	3%	1%

Electricity and Natural Gas Savings: Annual savings factors were derived from Ontario's potential studies[3]. The economic potential was used as a representation of potential energy savings for the average C&I building in Ontario. Recognising that the economic potential (24% of commercial sector consumption for electricity and 23% for natural gas) represents all the savings economically feasible in buildings, the results from the potential studies were reduced to account for several barriers not addressed by increased access to energy consumption and billing information. The conservative estimates used for the analysis are also meant to reflect *incremental* savings specifically due to increased access to information. Specifically, for natural gas savings, we took into consideration the magnitude of required investments to achieve savings (i.e., most measures will require significant upfront capital investments to be realized). This is less of an issue for electricity measures, since lighting and plug load improvements can be individually procured for a reasonable cost.

For water savings, in the absence of robust information assessing the economic potential, we have used a conservative estimate of 3% annual savings.

[3] (ICF International, Natural Gas Potential Study, June 2016. http://www.ontarioenergyboard.ca/oeb/_Documents/EB-2015-0117/ICF_Report_Gas_Conservation_Potential_Study.pdf;
Nexant Achievable Potential Study: Short Term Analysis, June 2016. http://www.ieso.ca/-/media/files/ieso/document-library/working-group/aps/aps-short-term-analysis-2016.pdf

BASELINE ANNUAL CONSUMPTION

Baseline average consumption was used to calculate unit annual savings per home or per building.

Residential Sector

Annual Utility Consumption – Residential Sector		
Utility Type	Annual Consumption	Source
Electricity	5,454 kWh	• Natural Resources Canada *Comprehensive Energy Use Database*, Residential Sector, Ontario, table 1 for 2014. o Total residential electricity consumption is reported as 118.7 PJ for 5,196,000 households. o For the purpose of the analysis, we used 85% of the calculated average consumption, considering notably the evolution of codes and standards and their potential impacts on electrical savings.
Natural Gas	2,600 m^3	• Navigant. *Analysis Investigating Revenue Decoupling for Electricity and Natural Gas Distributors in Ontario*, March 2014.
Water	213.5 m^3	• Environment Canada, *2011 Municipal Water Use Report:* o Assumes 225 liters per capita per day • Statistics Canada, *2011 Census*: o 2.6 persons per household

C&I Sector

The following values were used for the annual utility consumption for non-residential buildings in Ontario.

Annual Utility Consumption – Commercial and Institutional Sector				
Utility Type	Small Buildings (less than 10,000 ft^2)	Large Buildings (more than 10,000 ft^2)	Institutional	Source
Electricity (kWh)	42,464	508,905	344,105	Natural Resources Canada's Comprehensive Energy Use Database for the Commercial and Institutional Sector
Natural Gas (m^3)	7,442	89,912	60,309	
Water (m^3)	3,441	41,240	27,885	

The energy consumption values for non-residential buildings were derived from Natural Resources Canada's Comprehensive Energy Use Database for the Commercial and Institutional Sector. The total energy consumption by energy source for and total Floor Space was used to estimate an average energy intensity (GJ/m^2) for the C&I sector. This resulted in an average energy intensity of 116,25 kWh/m^2 for electricity and 20.374 m^3/m^2 for natural gas. The energy intensity factor was then applied to average building size for small, large and institutional buildings based on information from the Survey of Commercial and Institutional Energy use – Buildings 2009 (Detailed Statistical Report December 2012).

Building Size (ft^2)	Average Size	Count	Distribution	Estimated Electricity Consumption (kWh/yr)	Natural Gas Consumption (m^3/yr)
Less than 5,000	2,500	80082	49%	26,999	4,732
5,000-10,000	7,500	32141	20%	80,997	14,196
10,000 to 50,000	30,000	39054	24%	323,988	47,319
50,000 to 200,000	125,000	10103	6%	1,349,950	189,277
Greater than 200,000	200,000	2157	1%	2,159,920	378,554

The average energy consumption for small, large and institutional buildings were estimated through a weighted average of buildings for small (less than 10,000 ft^2), large (more than 10,000 ft^2) and institutional (more than 5,000 ft^2).

Information for water consumption for non-residential accounts is not readily available. Our analysis used a water use intensity of 380 L/ft^2[4] applied to the average size to estimate annual water consumption per building size.

AVOIDED COSTS

Annual resource benefits for all utility types were calculated using a fixed discount rate based on information provided in the Union Gas 2015-2020 DSM Plan, Appendix B. Electricity and water avoided costs remain constant in real value, whereas natural gas avoided costs vary annually. To simplify analysis, the cost-benefit models has assumed constant real avoided costs for each utility

[4] This water use intensity was derived from the City of Orillia Water Conservation and Efficiency Plan – 2014. The Plan indicates a 1,476 m^3 per non-residential connection. Considering Orillia is a small city, we have assumed that most of those connections would be in the small building category.

type. For natural gas, baseload avoided costs have been selected to remain conservative. The following table presents the avoided costs used in the analysis.

Utility Type	Avoided Costs
Electricity	0.1128 $/kWh
Natural Gas	0.21378 $/m^3
Water	2.2729 $/m^3

PARTICIPATION RATE

Participation rates for increased retrofit activities were based on the adoption curves developed for the cost-benefit model (see Penetration Level on page 26 of the report).

The table below presents the annual participation as a % of eligible population.

	Year									
	1	2	3	4	5	6	7	8	9	10
Small Commercial & Residential	0.66%	0.87%	1.13%	1.48%	1.93%	2.50%	3.24%	4.20%	5.41%	6.96%
Large Commercial, Industrial & Institutional	1.66%	3.20%	5.23%	7.86%	11.24%	15.52%	20.82%	27.22%	34.69%	43.04%

Eligible Population

The following table presents the eligible population for each customer class included in the analysis. We further include an applicability factor to further reduce the proportion of GB participants estimated to conduct retrofit activity due to increased accessibility to consumption and billing data. This was done to ensure our analysis was conservative and is highlighted as the Eligible Population in the table below.

SubGroup	Population (Number of Buildings)	Applicability Factor	Eligible Population	Source
Large Commercial	32,011	25%	8,003	Calculated from Survey of Commercial and Institutional Energy use – Buildings 2009 and Submeter Penetration Estimates developed from IT survey
Small Commercial	112,672	25%	28,168	
Large Industrial	120	25%	30	
Institutional	19,630	25%	4,908	
Residential	3,342,822	25%	835,706	

CALCULATION EXAMPLE

Below, we present the calculations conducted to evaluate the benefits for the DMD/CMD Electric Utility Only Scenario.

Unitary Benefit = % Savings * Annual Consumption * AC

Unit Benefit

Customer Class	% Savings (1)	Annual Consumption (kWh) (2)	Avoided Costs ($/kWh) (3)	Unit Benefits ($) (1)*(2)*(3)
Residential	10%	5454	0.11	60
Small Commercial	10%	42,464	0.11	467
Large Commercial	10%	508,906	0.11	5,598
Institutional	10%	344,105	0.11	3,785
Large Industrial	10%	763,359	0.11	8,397

Eligible Population

Customer Class	Population (1)	Applicability (2)	Eligible Population (1) * (2)
Residential	3,342,822	25%	835705
Small Commercial	112,672	25%	28168
Large Commercial	32,011	25%	8003
Institutional	19,630	25%	4908
Large Industrial	120	25%	30

ESTIMATION OF COSTS

The calculation of costs was conducted at a high level, as the cost-benefit analysis was focused on the overall impacts of a Green Button implementation rather than a measure-level analysis.

CALCULATION OF COST ESTIMATES

Because the benefits of increased conservation (energy savings) are calculated on an annualized basis, the costs are as well in order to ensure alignment. Our methodology for estimating costs is as follows:

- The energy savings as calculated in earlier sections of this appendix were used as a starting point.
- As a starting point, we used cost-benefit results from the Union Gas 2015-2020 DSM Plan to estimate the costs of the energy savings that were calculated. The Union Gas Plan was used as it provided the most detail for an entire portfolio.
- We made adjustments for applicable factors:
    - For the Residential Sector, because Total Resource Cost (TRC)-Plus values are available for the home renovation rebate, we incorporated those values and removed the generic 15% non-energy benefits adder from the DSM Plan.
        - We removed costs unrelated to energy retrofits (for example, audit costs), which resulted in costs being calculated as 89 percent of the TRC-plus costs.
        - This provided a cost-to-benefit ratio of 0.69 for natural gas.
        - For electricity and water, we applied a slightly lower ratio of 0.65. This decision was based on professional experience and a comparison of the results with measure-level annualized cost-to-benefit values from the IESO's Technical Reference Manual as well as internal sources from prior work.
    - For the Commercial, Industrial and Institutional Sector we followed the same methodology without the home renovation input adjustment. This resulted in 0.494 for natural gas and a 0.5 ratio for electricity and water.
- We applied these cost ratios to the annual benefit value to estimate the annualized costs.

Annual Benefits

Conservation Benefit = Unitary Benefit * Participation

Customer Class	Unit Ben ($) (1)	Eligible Pop. (2)	Annual Benefits ($) (1) * (2) * Adoption Curve for each year; Net Present Values use a 2% discount rate										
			Yr1	Yr2	Yr3	Yr4	Yr5	Yr6	Yr7	Yr8	Yr9	YR10	NPV (10yr)
Adoption Curve Res & Small Commercial			0.66%	0.87%	1.13%	1.48%	1.93%	2.50%	3.24%	4.20%	5.41%	6.96%	
Adoption Curve Large Commercial, Institutional, Large Industrial			1.66%	3.20%	5.23%	7.86%	11.24%	15.52%	20.82%	27.22%	34.69%	43.04%	
Residential	60	835,705	330,505	433,984	568,022	741,455	965,542	1,254,543	1,626,377	2,103,314	2,712,641	3,487,147	12,291,436
Small Commercial	467	28,168	86,733	113,889	149,064	194,578	253,384	329,226	426,805	551,967	711,870	915,122	3,225,605
Large Commercial	5,598	8,003	743,665	1,433,572	2,342,994	3,521,211	5,035,421	6,952,824	9,327,177	12,194,321	15,540,816	19,281,542	65,651,588
Institutional	3,785	4,908	308,356	594,421	971,506	1,460,046	2,087,903	2,882,941	3,867,450	5,056,291	6,443,892	7,994,959	27,221,980
Large Industrial	8,397	30	4,182	8,061	13,175	19,800	28,315	39,096	52,447	68,569	87,387	108,421	369,163

CALCULATION OF GREENHOUSE GAS REDUCTIONS

Greenhouse gas (GHG) reductions are calculated by multiplying the energy impacts as described above by the emissions factors provided by the Ministry of Energy:

GHG Reduction = Energy Savings * Emission Factor

As with other inputs, GHG emissions factors may not be up to date with current Ontario government GHG calculation assumptions because of the timeframe in which the analysis was conducted.

APPENDIX E: ADDITIONAL SCENARIO ANALYSIS

This appendix, developed in 2017 after the initial cost-benefit analysis was completed, provides additional results for Scenarios 1B (Multi-Integrated Hosted DMD/CMD for Electricity and Natural Gas utilities) and 2B (Multi-Integrated Hosted for All Utility Types), using a real discount rate of 3.5%, which has been used by the Ministry of Energy in other recent analyses.

SCENARIO 1B: MULTI-INTEGRATED HOSTED DMD/CMD (ELECTRICITY AND NATURAL GAS UTILITIES ONLY)

Table 1. Scenario 1B Cost Details

Cost Category	Cost Type	5-Year Analysis ($)	10-Year Analysis ($)	Scenario-Specific Assumptions
Implementation (One-time setup and integration costs)	Direct	3,982,723	3,986,847[1]	The setup cost for the Multi-Integrated scenario assumes: • 5 independent platforms for the electricity sector • 1 platform for the natural gas sector (because there are so few utilities) • 5 platforms for the water utilities
Operational Costs[2]	Direct	735,433	2,182,967	
Retrofit Costs	Indirect	10,573,953	60,072,210	
Total		**15,292,109**	**66,242,024**	

[1] Differences between the 5-year and 10-year Implementation Costs are an artefact of the mathematical function used to forecast implementation costs. The mathematical function forecasts the following rollout of Green Button through the first 5 years following enactment of the policy: 35%, 70%, 92%, 99%, 99.9%.

[2] Sum of net-present value of annual costs over the timeframe.

Table 2. Scenario 1B Benefits Details[3]

Benefit Category	Benefit Component	Benefit Type	5-Year Analysis ($)	10-Year Analysis ($)
Operational Efficiencies	Customers' Utility Consumption, Billing and Generation Data Process Efficiencies	Direct	17,221,476	54,410,886
	Process Efficiencies (Large Building Energy and Water Reporting and Benchmarking)	Direct	12,143,948	23,695,626
	Reduced Customer Care Efforts	Indirect	1,029,360	2,252,663
	CDM/DSM Program Efficiencies and Innovation	Indirect	849,831	1,859,779
Energy Efficiency and Conservation	Increased Conservation - Behavioural & Operational	Indirect	10,821,748	51,787,669
	Increased Conservation - Retrofits	Indirect	24,721,779	120,255,887
	Total		**66,788,142**	**254,262,509**

RESULTS

DETAILED RESULTS FOR THE MULTI-INTEGRATED VERSION OF THIS SCENARIO (SCENARIO 1B) ARE PRESENTED IN THE FOLLOWING TABLES.

BENEFIT-COST RATIOS:

Table 3. Scenario 1B Benefit-Cost Ratios

Ratio Type	5-Year Analysis	10-Year Analysis
Direct and Indirect Costs and Benefits	4.4	3.8
Direct Benefits and Costs only[4]	6.5	13.0

To illustrate how the costs and benefits are distributed across stakeholder groups, we present the following tables.

Table 4. Scenario 1B Costs by Stakeholder Group (5-year horizon)

Cost Category		Stakeholder Group	

[3] No scenario-specific assumptions required

[4] Direct benefits and costs are a subset of total benefits and costs. However, the direct benefits and costs *ratios* are higher than the total ratios because the magnitude of benefits to costs is different for direct results than for total results.

	Cost Type	Electricity Utility ($)	Natural Gas Utility ($)	Customers[5] ($)	Total ($)
Implementation (One-time setup and integration costs)	Direct	3,458,565	524,157	-	**3,982,723**
Operational Costs[6]	Direct	435,205	300,228	-	**735,433**
Retrofit Costs	Indirect	-	-	10,573,953	**10,573,953**
Total		**3,893,770**	**824,385**	**10,573,953**	**15,292,109**

[5] Includes all customer classes (Residential, Commercial, Industrial, and Institutional)
[6] Sum of net-present value of annual costs over the timeframe.

Table 5. Scenario 1B Benefits by Stakeholder Group (5-year horizon)

Benefit Category	Benefit Component	Benefit Type	Stakeholder Group					
			C&I ($)	Industrial ($)	Other[7] ($)	Residential ($)	Utility ($)	Total ($)
Operational Efficiencies	Customers' Utility Consumption, Billing and Generation Data Process Efficiencies	Direct	9,667,413	7,554	5,056,785	2,489,724	-	**17,221,476**
	Process Efficiencies (requirements)	Direct	12,063,383	80,564	-	-	-	**12,143,948**
	Reduced Customer Care Efforts	Indirect	-	-	-	-	1,029,360	**1,029,360**
	CDM/DSM Program Efficiencies and Innovation	Indirect	-	-	-	-	849,831	**849,831**
Energy Efficiency and Conservation	Increased Conservation - Behavioural & Operational	Indirect	9,243,371	13,761	-	1,564,616	-	**10,821,748**
	Increased Conservation - Retrofits	Indirect	19,031,618	73,190	-	5,616,971	-	**24,721,779**
	Total		**50,005,785**	**175,069**	**5,056,785**	**9,671,311**	**1,879,191**	**66,788,142**

[7] Other Stakeholders include third-party Energy Efficiency Consultants/Service Providers providing utility consumption monitoring services, energy assessments, and/or engineering services.

SCENARIO 2B: MULTI-INTEGRATED HOSTED DMD/CMD (ALL UTILITY TYPES)

Table 6. Scenario 2B Cost Details

Cost Category	Cost Type	5-Year Analysis ($)	10-Year Analysis ($)	Scenario-Specific Assumptions
Implementation (One-time setup and integration costs)	Direct	30,432,861	30,464,379	The setup cost for the Multi-Integrated scenario assumes: • 5 independent platforms for the electricity sector • 1 platform for the natural gas sector (because there are so few utilities) • 5 platforms for the water utilities
Operational Costs[8]	Direct	1,168,226	3,467,786	
Retrofit Costs	Indirect	12,578,686	71,377,618	
Total		**44,179,773**	**105,309,783**	

Table 7. Scenario 2B Benefits Details[9]

Benefit Category	Benefit Component	Benefit Type	5-Year Analysis ($)	10-Year Analysis ($)
Operational Efficiencies	Customers' Utility Consumption, Billing and Generation Data Process Efficiencies	Direct	24,054,230	71,046,545
	Process Efficiencies	Direct	14,167,939	27,644,897
	Reduced Customer Care Efforts	Indirect	1,559,328	3,412,449
	CDM/DSM Program Efficiencies and Innovation	Indirect	1,627,629	4,201,293
Energy Efficiency and Conservation	Increased Conservation - Behavioural & Operational	Indirect	13,340,724	64,123,022
	Increased Conservation - Retrofits	Indirect	25,395,815	123,019,789
	Total		**80,145,666**	**293,447,994**

RESULTS

DETAILED RESULTS FOR THE MULTI-INTEGRATED VERSION OF THIS SCENARIO (SCENARIO 2B) ARE PRESENTED IN THE FOLLOWING TABLES.

[8] Sum of net-present value of annual costs over the timeframe.

[9] No scenario-specific assumptions required

Table 8. Scenario 2B Benefit-Cost Ratios

Ratio Type	5-Year Analysis	10-Year Analysis
Total	1.8	2.8
Direct Benefits and Costs only[10]	1.3	3.1

To illustrate how the costs and benefits are distributed across stakeholder groups, we present the following tables.

Table 9. Scenario 2B Costs by Stakeholder Group (5-year horizon)

Cost Category	Cost Type	Stakeholder Group				
		Electricity Utility ($)	Natural Gas Utility ($)	Water Utility ($)	Customers ($)	Total ($)
Implementation (One-time setup and integration costs)	Direct	3,458,565	524,157	26,450,138	-	**30,432,861**
Operational Costs[11]	Direct	435,205	300,228	432792	-	**1,168,226**
Retrofit Costs	Indirect	-	-	-	12,578,686	**12,578,686**
Total		**3,893,771**	**824,385**	**26,882,930**	**12,578,686**	**44,179,773**

[10] Direct benefits and costs are a subset of total benefits and costs. However, the direct benefits and costs *ratios* are higher than the total ratios because the magnitude of benefits to costs is different for direct results than for total results.

[11] Sum of net-present value of annual costs over the timeframe.

Table 10. Scenario 2B Benefits by Stakeholder Group (5-year horizon)

Benefit Category	Benefit Component	Benefit Type	Stakeholder Group					
			C&I ($)	Industrial ($)	Other ($)	Residential ($)	Utility ($)	Total ($)
Operational Efficiencies	Customers' Utility Consumption, Billing and Generation Data Process Efficiencies	Direct	11,708,323	9,443	9,576,590	2,759,875	-	**24,054,230**
	Process Efficiencies	Direct	14,073,947	93,992	-	-	-	**14,167,939**
	Reduced Customer Care Efforts	Indirect	-	-	-	-	1,559,328	**1,559,328**
	CDM/DSM Program Efficiencies and Innovation	Indirect	-	-	-	-	1,627,629	**1,627,629**
Energy Efficiency and Conservation	Increased Conservation - Behavioural & Operational	Indirect	11,758,678	17,431	-	1,564,616	-	**13,340,724**
	Increased Conservation - Retrofits	Indirect	19,031,618	73,190	-	6,291,008	-	**25,395,815**
	Total		**56,572,566**	**194,055**	**9,576,590**	**10,615,498**	**3,186,957**	**80,145,666**

DIRECT AND INDIRECT COSTS

The following table provides a breakout of direct and indirect benefits and costs for two key scenarios. We note that these costs are high level and used to generate comparisons between potential scenarios; they are not implementation-level cost estimates.

Table 11. Breakout of Direct and Indirect Benefits and Costs, Single and Multi-Integrated (10-year horizon)

10 Years	Single Integrated Hosted				Multi-Integrated Hosted			
	Benefits		Costs		Benefits		Costs	
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
Electricity	$62,275,755	$136,049,865	$4,578,270	$50,137,048	$62,275,755	$136,049,865	$4,754,206	$50,137,048
Electricity and Natural Gas	$80,428,288	$173,834,221	$5,993,878	$60,072,210	$80,428,288	$173,834,221	$6,169,814	$60,072,210
Electricity, Natural Gas, and Water	$104,514,518	$188,933,476	$33,028,644	$71,377,618	$104,514,518	$188,933,476	$33,932,165	$71,377,618

ADDITIONAL COST-BENEFIT RATIO RESULTS FOR THE MULTI-INTEGRATED HOSTED SCENARIOS

The following table provides updated cost-benefit ratios for multi-integrated scenarios. Most of the results are the same as when a 2% discount rate is used, since the relative change in results is applied to both costs and benefits.

Table 12. Green Button DMD/CMD Multi-Integrated Scenario Cost-Benefit Results

Utility Type	5-Year	10-Year
Electricity	4.04	3.6
Electricity and Natural Gas	4.4	3.8
Electricity, Natural Gas, and Water	1.8	2.8
Natural Gas Component	6.1	4.9
Water Component	0.5	1.0

50 Ste-Catherine St. West, suite 420, Montreal, Quebec, Canada H2X 3V4 | T. 514.504.9030 | F. 514.289.2665 |
info@dunsky.com