2013 IMPACT EVALUATION OF INDUSTRIAL ENERGY EFFICIENCY PROGRAMS

ONTARIO POWER AUTHORITY

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ECONOLER

ACRONYMS

DES	Detailed Engineering Study
EUL	Effective Useful Life
IAP	Industrial Accelerator Program
LDC	Local Distribution Company
M&V	Measurement and Verification
NTGR	Net-to-Gross Ratio
OPA	Ontario Power Authority
PAC	Program Administrator Cost
PES	Preliminary engineering study
PSUI	Process and Systems Upgrade Initiatives
SCFM	Standard Cubic Feet per Minute
TRC	Total Resource Cost

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EXECUTIVE SUMMARY

This report presents results from the 2013 impact evaluation of the Industrial Accelerator Program (IAP) and the Process and Systems Upgrade Initiatives (PSUI). The 2013 impact evaluation was based on findings from: one in-depth interview with two members of the Ontario Power Authority (OPA) program staff, one in-depth interview with two members of CLEAResult, a desk review of six projects and six on-site visits.

PROGRAM OVERVIEW

In June 2010, the OPA launched the IAP to help industrial companies connected to the Ontario transmission system reduce their electricity use. The program is currently offered to all companies connected to the transmission system.

Created in January 2011, the PSUI is offered to companies connected to the distribution systems of local distribution companies (LDCs).

Both programs offer financial incentives on a range of projects according to their sizes and expected reductions in electricity consumption of facilities. Funding is also offered for preliminary and detailed engineering studies.

SUMMARY OF EVALUATION GOALS AND OBJECTIVES

The goal of this evaluation was primarily to quantify both net energy savings and net peak savings demand generated by the IAP and the PSUI in 2013. To achieve this goal, the following activities were conducted:

- Review the technical documentation and the calculation methodologies, including measurement and verification (M&V) plans, used for each project
- Conduct on-site visits to validate the proper installation of equipment and the assumptions made in the M&V plans
- Measure the level of distortion effects (free-ridership and spillover)
- Calculate verified gross and net savings
- Estimate effective useful life and calculate lifetime savings for each project
- Provide recommendations to improve the technical review and M&V procedures
- Evaluate the Total Resource Cost (TRC) and Program Administrator Cost (PAC)

SUMMARY OF IMPACT EVALUATION RESULTS

In 2013, a total of three participants completed a project in the IAP, and the same number completed a project through the PSUI.

Project Desk Review

The data provided by the program for each project were complete, comprehensive and sufficiently detailed so as to allow Econoler to carry out the project review. M&V plans were consistent and, for the most part, had all of the necessary information required to assess the annual gross energy savings. However, demand savings were generally not taken into account in the M&V plans, which led Econoler to estimate demand savings using assumptions based on data collected during on-site visits and knowledge of the industrial sector.

On-Site Visits

For the sites visited, the energy efficiency projects very closely matched the information presented in the technical documentation. The M&V procedures were also found to be conducted properly. As a result, only minor adjustments were made to gross savings following both the desk review and the on-site visits.

Savings Results

The impact evaluation revealed net energy savings of 8.027 GWh per year for the IAP and 2.604 GWh per year for the PSUI. It also revealed annual net peak demand savings of 0.678 MW per year and 0.297 MW per year, respectively. Realization rates for energy savings were high, as both negative and positive adjustments were made to the reported energy savings. Realization rates were lower for demand savings, because the OPA calculated these savings on the assumption that they were constant over the year. Therefore, verified peak demand savings sometimes differ significantly from the reported values.

Interviews conducted with participants showed that the free-ridership level was very low (1 percent for the IAP and 7 percent for the PSUI) and that no measurable spillover occurred for both programs; consequently, the net-to-gross ratios (NTGR) were close to 1.

The following tables present an overview of the impact evaluation results.

Table 1: Evaluation Results – 2013 Energy Savings

Program	Reported Annual Gross Energy Savings (GWh)	Verified Annual Gross Energy Savings (GWh)	Realization Rate	NTGR	Verified Annual Net Energy Savings (GWh)	Verified Lifetime Net Energy Savings (GWh)
IAP	7.537	8.108	108%	0.99	8.027	140.972
PSUI	3.207	2.800	87%	0.93	2.604	26.038
Total	**10.744**	**10.908**	**102%**	**0.97**	**10.631**	**167.009**

Table 2: Evaluation Results – 2013 Summer Peak Demand Savings

Program	Reported Annual Gross Demand Savings (MW)	Verified Annual Gross Summer Peak Demand Savings (MW)	Realization Rate	NTGR	Verified Annual Net Summer Peak Demand Savings (MW)
IAP	1.034	0.678	66%	1.00	0.678
PSUI	0.366	0.316	86%	0.94	0.297
Total	**1.400**	**0.993**	**71%**	**0.98**	**0.974**

CONCLUSION AND RECOMMENDATIONS

Overall, the 2013 impact evaluation demonstrated that the IAP and PSUI projects are well documented and monitored, which led to significant and measurable savings. Since each project was so well documented, Econoler had few new questions for participants during on-site visits and could concentrate on validating the content of the project file. Here again, very few discrepancies were found and resulted in only minor adjustments being made to energy savings. Econoler commends the OPA on the quality of its review process and recommends that it be maintained. Nevertheless, Econoler has the following recommendation to improve demand savings calculation for both programs in the future:

› **Include demand savings in the M&V plan**: While M&V plans for energy savings were generally well done and thorough, some measurements needed to accurately calculate demand savings were missing. Special attention should be given to projects which present a non-uniform demand profile over the year (such as refrigeration) or for which complex control sequences do not allow for the prediction of demand during peak periods (e.g., compressed air). Therefore, the OPA should request that the M&V plan include the collection of summer demand consumption data. This would make it possible to identify the data to be collected and measured in order to develop the hourly load profiles during the summer peak season.

1 PROGRAM BACKGROUND AND DESCRIPTION

In the province of Ontario, over 50 percent of all the electricity in the industrial sector is consumed by approximately 200 companies, which are all considered to be large electricity consumers. About a quarter of these companies are connected to the high-voltage transmission system in Ontario, while the remaining companies are connected to local distribution companies (LDCs). Given the consumption of these industrial companies, the Ontario Power Authority (OPA) launched the Industrial Accelerator Program (IAP) and the Process and Systems Upgrade Initiatives (PSUI).

1.1 INDUSTRIAL ACCELERATOR PROGRAM DESCRIPTION

In June 2010, the OPA launched the IAP to help industrial companies connected to the Ontario transmission system reduce their electricity use. After being initially offered only to certain eligible companies, the program was made available to all companies connected to the transmission system in October 2012. At first, the program included only a Process and Systems component, which covered different sizes of eligible projects for an Annualized Electricity Savings of minimum 100 MWh for a Micro Project and minimum 350 MWh for a Project. In December 2013, the OPA expanded the program to include a Retrofit component to provide incentives for equipment replacement. The Retrofit component includes three different tracks: Prescriptive, Engineered and Custom.

The projects completed in 2013 were all implemented through the Process and Systems component. For this component, financial incentives of up to $10 million for capital projects are based on the lesser of:

- $230 per MWh of annual electricity savings;
- 70 percent of the eligible project costs; or
- Achieving a one-year simple payback.

Funding is also offered for preliminary and detailed engineering studies. Detailed engineering studies (DESs) for viable energy projects are fully funded. Preliminary engineering studies (PESs) are funded up to $10,000 per project.

1.2 PROCESS AND SYSTEMS UPGRADE INITIATIVES DESCRIPTION

In January 2011, the OPA launched the PSUI for all eligible companies that are connected to the distribution system of an LDC and wish to reduce their electricity consumption. LDCs are responsible for working directly with participating companies.

The program covers different sizes of eligible projects from 100 MWh (small capital projects) to more than 350 MWh (projects).

Financial incentives of up to $10 million for capital projects are based on the lesser of:

- $200 per MWh of annual electricity savings;
- 70 percent of the eligible project costs; or
- Achieving a one-year simple payback.

Funding is also offered for engineering studies: DESs for viable energy projects are funded up to $50,000, while PESs are funded up to $10,000 per project.

Participants in both the IAP and the PSUI can choose between receiving their incentive payments during their project (advanced payment option) or once the project is completed and the measures have been verified (deferred payment option). If they choose the latter, participants must provide the OPA with a letter of credit and demonstrate a performance requirement of 80 to 90% percent of the electricity savings expected by the technical reviewer.

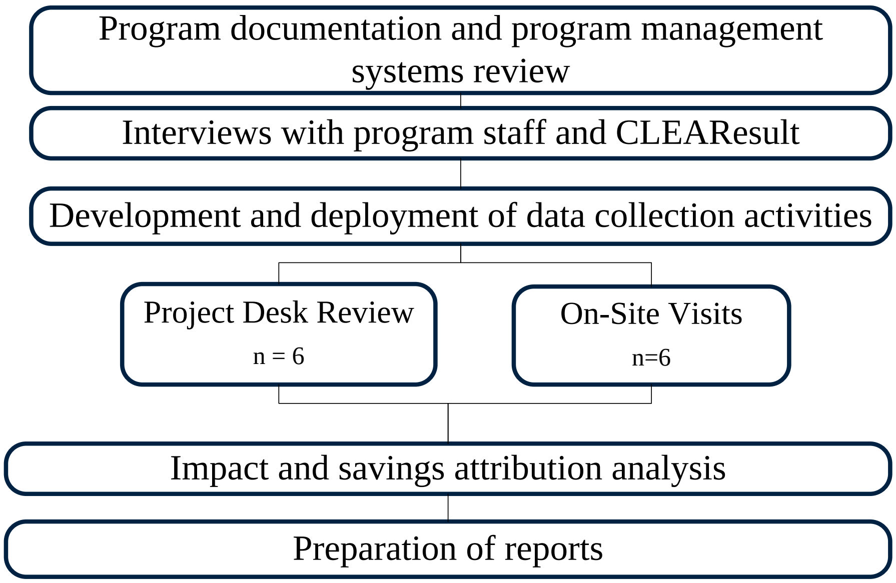
2 METHODOLOGY

This section reports on the methodology used to evaluate the IAP and the PSUI. More specifically, it presents the methodology used and the activities carried out for the impact evaluation.

2.1 METHODOLOGICAL MODEL

Figure 1 illustrates the research strategy and data collection activities used for the 2013 impact evaluation. Copies of the data collection tools used are included in the Appendices.

Figure 1: Methodological Model



2.2 METHODOLOGY DESCRIPTION

2.2.1 Analyzing Existing Program Documentation

Analyzing documentation was the first task in the impact evaluation of the IAP and the PSUI. At this stage, all of the available program information was reviewed.

The information analyzed was obtained primarily from the following sources:

- OPA website
- Program databases and management systems, including all project documentation

2.2.2 Interview with the OPA Staff

Econoler conducted one interview with the OPA staff in June 2014. The purpose of this interview was to discuss the evaluation plan and schedule, to learn about the two different program management systems, namely SharePoint and i-Con, to plan the on-site visits and to understand how demand and net savings are calculated in the database.

2.2.3 Interview with CLEAResult

In June 2014, Econoler conducted one interview with CLEAResult, who is responsible for the follow-up of the project pipeline, the technical review of each project, as well as measurement and verification (M&V). The goal of this interview was to learn about CLEAResult's involvement in the IAP and the PSUI and their processes in preparation for the on-site visits and the project desk review.

2.2.4 Project Desk Review

As part of the 2013 impact evaluation, Econoler reviewed all projects completed in 2013, i.e., three through the IAP and three through the PSUI. The main purpose of this verification was to review the project information stored in the SharePoint (IAP) and i-Con (PSUI) databases, in preparation for the on-site visits.

The project review process was primarily intended to identify the key project variables and assess the M&V results post-implementation. Specific focus was placed on reviewing the project summary documents, the engineering studies (where applicable), the final version of the documented M&V plans and the available quarterly M&V reports.

Econoler used the project desk review process to identify the specific changes made for each project, and to assess the suitability of the technical reviewer's M&V plans. Elements to be validated during the site visits were identified during these reviews and entered in the on-site visit protocol sheets.

2.2.5 On-Site Visits

In June 2014, on-site visits were conducted at the six 2013 participating facilities (three for the IAP and three for the PSUI). These site visits were done to verify that the proposed energy efficiency measures were operational and that M&V plans were carried out as written by the technical review team at CLEAResult. Econoler also collected additional supporting information during the on-site visits, which was used to provide an accurate understanding of the key project variables (e.g., technical specifications of new equipment, operating variables and schedules), and to observe the environment in which the measures have been implemented. During the visit, a standardized questionnaire was administered to the participant, in person, in order to evaluate the levels of free-ridership and spillover.

In preparation for the six on-site visits, Econoler developed a standardized data collection protocol. The purpose of the protocol was to ensure consistency of the collected information and to provide Econoler with a map of the projects carried out on each of the six sites. For each of the six site visits, the protocols were pre-populated with the following information:

- General project contact information
- Key project variables
- Description of the facility and typical operating schedules
- List of the potential interactive effects
- Summary of the project and associated changes made to equipment/process
- Summary of post M&V implementation results

A copy of the on-site visit protocol is included in Appendix I.

2.2.6 Impact and Savings Attribution Analysis

Econoler used the result of its desk reviews and on-site visits to establish the verified energy and demand savings for each project. In cases where the on-site visit provided additional or different information to that contained in the project documentation, modifications to the engineering calculation were made to account for these new elements. These were then coupled to the measured energy savings in the M&V reports, and annual verified energy savings were calculated and compared to those reported by the OPA. The demand savings were estimated based on the operation schedule validated on site and the power reduction, according to the OPA methodology. Finally, the answers provided by the participant to the free-ridership and spillover questionnaires were used to calculate the net-to-gross ratio (NTGR) for both energy and demand savings.

2.2.7 Preparation of Reports

The results of the impact evaluation, including the adjustments made to each project, the summary by LDC, the cost-effectiveness and the high-level findings, were provided to the OPA in a predetermined format prior to the submission of this report. This written report provides a certain level of detail and context to explain the impact evaluation work conducted by Econoler, the adjustments that were made to the reported savings, the final verified energy and demand savings and the possible improvements the OPA could make to its programs.

3 IMPACT EVALUATION

3.1 OBJECTIVE AND APPROACH OF THE IMPACT EVALUATION

The purpose of the impact evaluation is to determine the gross and net savings of the IAP and the PSUI for 2013. To do so, Econoler analyzed the following parameters:

› Reported gross savings, based on a desk review and on-site visits
› Free-ridership
› Spillover
› Effective useful life (EUL) of measures

Both energy and summer peak demand savings were considered in this evaluation.

The approach for the impact evaluation consisted of a review of technical documentation (including project review reports, M&V plans and M&V reports) followed by on-site visits. During the on-site visits, Econoler validated the calculation inputs used in the technical documentation, such as equipment specifications, operation schedules of existing and new equipment as well as optimization strategies. To do so, a visual inspection was conducted along with in-depth discussions with technical staff members.

Following this analysis, Econoler revised the reported annual energy and demand savings established by the OPA for each project. Energy and demand savings realization rates were then calculated for each project. In 2013, all projects implemented within that year were reviewed, and therefore no extrapolation of the sample impact results was required.

To establish net savings, two distortion effects were considered. Both free-ridership and spillover were assessed during the on-site visits by asking the participant a set of standardized questions. The average NTGR for each program was applied to the verified gross savings. The NTGR was obtained for both energy and demand savings through a weighted average of each participant's NTGR, based on their corresponding savings.

In addition, cost-effectiveness tests, namely the Total Resource Cost (TRC) and Program Administrator Cost (PAC), were also carried out based on the 2013 impact evaluation results.

3.2 DESK REVIEW AND ON-SITE VISIT RESULTS

This section provides a summary of findings made by Econoler during the desk review and on-site visits.

Overall the project documentation was extremely well done and provided ample information to validate energy savings.

The M&V plans and reports were very well done, and for most part, had all of the necessary information required to assess the annual gross energy savings. These documents are very comprehensive and provide a high level of accuracy for confirming annual gross energy savings. However, M&V plans could be improved by including a summary of the baseline equations and calculations used to determine the energy baseline. Moreover, the M&V process should be expanded to include both pre- and post-implementation demand calculations. Specifically, the OPA should consider adding summer demand savings to the M&V plan for future projects, with a focus on projects with non-uniform demand profiles (i.e., refrigeration projects vs. manufacturing). This would make it possible to identify the data to be collected and measured in order to develop the hourly load profiles during the summer peak season.

In short, the details of the implemented projects very closely matched what Econoler found on site during the six visits. Overall, the adjustments to the annual gross savings were small and minor, which speaks well of the program processes currently in place and the commitment of both the OPA and CLEAResult staff.

3.3 GROSS SAVINGS RESULTS

Once the M&V plan and procedure were validated, the verified annual gross energy savings were calculated by extrapolating the results from the M&V reports. The extrapolation of the energy savings measured during the M&V period over the full year was done using a rule of three. For each project, seasonal variations were analyzed to ensure that the extrapolation remained valid. In cases where measurements spanned 2013 and 2014, all results were averaged and annualized. These annual gross energy savings were considered valid for 2013 and for subsequent years over the effective useful life of the project implemented. When appropriate, adjustments were made to take into account elements that were not captured by the M&V.

The verified annual gross summer peak savings were calculated in accordance with “EM&V Protocols and Requirements,”[1] with preference given to the direct method of demand savings calculation. In a number of cases, the indirect method had to be utilized, since there were not sufficient M&V data or equipment data to support the direct method of calculation.

3.3.1 IAP

The following subsections outline the verification procedure that Econoler followed when evaluating the annual gross energy and summer peak demand savings for each of the three IAP projects. The validation process varied slightly depending on the project and was tailored to the specific measures being verified.

Free Cooling Project

<u>Energy Savings</u>

The gross reported savings for the free cooling project were calculated using blended M&V data from the first quarter and a portion of the first-year reports (which excluded the first-quarter results). Upon analysis, Econoler decided that the first-year report, which covered the entire seven months of the free cooling operation, was more representative of the actual annual savings. Since the actual measured savings were considered adequate and representative of the project savings, the first-year report data were used to establish the verified annual gross energy savings and no subsequent adjustments were performed.

[1] Ontario Power Authority, “EM&V Protocols and Requirements,” 2011, pp. 102–118.

Demand Savings

The OPA established the gross reported peak demand savings by dividing the energy savings over the total free cooling operating hours. However, the verified savings were determined to be zero, since the project does not generate any savings during the summer months. Indeed, free cooling savings are generated only for the seven-month period spanning the two years from October to April.

Utilities Sludge Dewatering Project

Energy Savings

The gross reported savings for the utilities sludge dewatering project were based on the first-quarter M&V results, which were annualized using a ratio of annual days per year as opposed to the number of days in the M&V reporting period.

Following the project review and the on-site visit, Econoler made two adjustments to establish the verified annual gross energy savings.

The first adjustment was to change the ratio used to annualize the first-quarter M&V results, as the reporting period was actually 92 days as opposed to 90 days used in the reported savings calculation. Although there were some available second-quarter M&V data, they were excluded from the annualized calculation, as the client commented that some changes to the process were made during the measurement period. These changes caused an increased runtime for the two remaining vacuum filter drums, which was not representative of typical operation.

The second adjustment made to the reported energy savings was to add savings for the compressed air reduction achieved from transitioning from the vacuum filter drum system to the belt presses. The project documentation indicated that each of the old vacuum filter drum consumed 400 SCFM and the belt presses required no compressed air. For this adjustment, Econoler used the average power to compressed air flow ratio (i.e., kW/SCFM) for the facility, which was calculated from M&V data for a separate project implemented by the same client on their compressed air system. The ratio was multiplied by 400 SCFM and the recorded runtimes for each of the two belt presses as defined in the first-quarter M&V report. The resultant savings were then annualized using the ratio presented above and added to the annualized first-quarter M&V results.

Demand Savings

The annual gross reported summer peak demand savings for this project were based on the reported energy savings divided by the estimated operating hours.

Since there were no M&V data available for the summer peak period, the demand savings were based on the measured power consumption of the new equipment during the first quarter, as well as the measured power of old equipment as per the M&V plan.

The M&V data for both the first and second quarters indicate that the old equipment still runs occasionally, so Econoler made the conservative assumption that at least one of the old vacuum filter drums could be running at any time during the peak summer period. Additionally, it was assumed that before the vacuum filter drum was turned on, both belt presses were operational, since the back-up vacuum filter drum is generally used when there is a surplus of sludge to be treated.

Compressed Air System Improvements Project

<u>Energy Savings</u>

The annual gross reported savings for this project were calculated using an annualized ratio of the measured savings from the M&V reports of the first three quarters. All energy savings from the first two quarters M&V reports were used, as well as a third of the data collected during the third-quarter M&V report. Only a portion of the third-quarter report was included in the calculation in order to avoid double counting the winter months, since the first-quarter report already covered the winter months.

For the verified annual gross energy savings, Econoler made two adjustments. The first adjustment was to make a small correction to the annualized ratio. The second adjustment was to remove the savings from the reduction of compressed air consumption by 400 SCFM during hours when vacuum filter drums were in operation due to the sludge dewatering project (implemented by the same participant in the same facility as presented above).

The annual ratio correction used a revised multiplier of 365/271 to better represent the total number of days during which M&V data were collected over the three quarters. For the second adjustment, the compressed air savings calculation used in the sludge dewatering project was subtracted from the annual savings to avoid double counting. No seasonal adjustment was made for summer production, as the client confirmed verbally that process has no discernable variation throughout the year.

<u>Demand Savings</u>

To calculate the gross annual reported summer demand savings, the OPA assumed that savings were equally distributed over the year, and therefore divided the annual energy savings by 8,760 hours. The on-site visit allowed Econoler to verify that the load profile for the process is constant for a normal operating year. Since no more precise data were available, Econoler also used the indirect method and calculated constant demand savings over 8,760 annual hours of operation. The slight difference between the reported and revised demand savings is due to the adjustment made to the energy savings, as explained previously.

3.3.2 PSUI

The following subsections outline the results of the evaluation of the annual gross energy and peak summer demand savings for each of the three PSUI projects.

Refrigeration Upgrade Project

<u>Energy Savings</u>

The annual gross reported energy savings for the refrigeration upgrade project were based on the first three quarterly M&V reports, which included two baseline scenarios. The reported savings used the average savings calculated from both scenarios and were then annualized using a ratio in order to consider the proportion of a full year covered by the M&V period.

As a result of the on-site visit, Econoler concluded that the assumptions of the Baseline Scenario 2 were not representative of how the equipment operates under normal conditions. Specifically, the M&V baseline assumed that four compressors (3 × 50 HP and 1 × 25 HP) would run 100 percent of the time. However, the client confirmed that the facility normally had two compressors running, and stated that the only time four compressors had been running was during the peak of summer. On the other hand, Baseline Scenario 1 was representative, as it assumes that the equipment run times for the baseline would be the same as the run times measured during the reporting periods. The savings are therefore based on the assumption that the baseline runs at full load (i.e., without control) for the measured operating hours, and that the savings are generated from the control system optimization, which allows the fans and compressors to operate at part load to meet actual demand. Therefore, Econoler elected to use the savings results only from Baseline Scenario 1. The results were then annualized using a ratio of 365/271, which represents the period of a full year divided by the actual reporting periods covered by the three quarterly reports.

Demand Savings

The reported summer peak demand savings were based on the annual energy savings derived from the three quarters of M&V results, and divided by 8,760 hours of operation.

To calculate the verified summer peak demand savings of this project, Econoler used the indirect calculation method based on the second-quarter M&V results only, since this period best represents the summer period. As was the case for the verified energy savings, the Baseline Scenario 2 was not used. The peak summer demand savings were calculated by dividing the second-quarter verified savings by the number of hours covered by this quarterly report.

Compressed Air Blow-off Reduction Project

Energy Savings

The compressed air blow-off reduction project was in operation and generating savings at the time of Econoler's on-site visit. Due to issues with the final commissioning process, the project had not yet undergone the first quarterly reporting period, therefore there was no available M&V report to use for verifying the savings. However, the participant did make raw M&V data available. The reported savings were calculated before these data were provided, and therefore were based on the assumption that 21 percent of the annual expected savings would be achieved during the reporting period.

The verified energy savings calculated by Econoler were based on measured data provided by the client, which spanned April 2013 to March 2014 and included the electricity consumption and flow rate. Using the data set provided, a baseline consumption ratio of 0.143 kWh/m^3 of compressed air was calculated. The data from September 2013 (project implementation) to March 2014 was used to calculate the same ratio for the project post-implementation, which resulted in a new ratio of 0.134 kWh/m^3 of compressed air.

Using the flow data provided from the full set (335 days), Econoler calculated the adjusted annual compressed air production. Using this value, an adjusted baseline and a post implementation consumption value were calculated. The verified annual energy savings are based on the difference between the adjusted baseline and the measured consumption.

Demand Savings

The same preliminary measured data provided by the participant were used by the OPA to estimate the peak summer demand savings by dividing the annual energy savings by the estimated hours of operation of 8,760 hours per year.

During the site visit, Econoler verified that there was no significant seasonal variation within the process. Therefore, to establish the verified summer peak demand savings of this project, Econoler used the same approach as the OPA, assuming constant operation throughout the year. The small difference between the reported and verified demand savings is a result of the adjustment made on the annual energy savings calculation.

Compressed Air System Upgrade Project

Energy Savings

The reported energy savings were calculated by the OPA using the first-quarter M&V report.

At the time of the evaluation, a second M&V report had been made available, so Econoler took it into account to calculate the verified energy savings. During the on-site visit, Econoler verified the equipment changes, and the client validated the annual operating schedule for the compressed air system. No issues were found with the underlying baseline assumptions or with the available M&V reports, and therefore the savings were calculated using the first- and second-quarter data. The verified energy savings were annualized using a ratio that represented the period of a full year over the actual reporting periods covered by the two quarterly M&V reports.

Demand Savings

The OPA reported peak summer demand savings were based on the reported annual energy savings (using only the first-quarter M&V results) and the assumption that demand savings were equally distributed throughout the year.

During the site visit, the client confirmed that there was no significant seasonal variation in compressed air requirements. Since no additional measurements were available for demand, Econoler also used the indirect method to establish the verified summer peak demand savings of this project, but included the results provided by both the first- and second-quarter M&V reports. Hence, the verified demand savings were calculated using the verified energy savings for the first two quarters and were then divided by the 4,392 hours covered by the reporting period.

3.3.3 Realization Rate

Realization rates were calculated in the same manner for both the IAP and PSUI projects, using the verified annual gross savings and the gross annual savings reported by the OPA. The realization rate calculations were carried out in accordance with the equations listed below.

$$\textbf{Realization Rate (Energy)} = \frac{\textbf{Verified annual gross energy savings (GWh)}}{\textbf{Reported annual gross energy savings (GWh)}}\ \boldsymbol{x}\ \mathbf{100}\%$$

$$\textbf{Realization Rate (Demand)} = \frac{\textbf{Verified annual gross summer peak demand savings (MW)}}{\textbf{Reported annual gross demand savings (MW)}}\ \boldsymbol{x}\ \mathbf{100}\%$$

3.3.4 Overall Annual Savings

The adjustments and annualizing calculations were applied to all projects as described above, and the resultant savings and realization rates for both programs are presented in the following tables.

Table 3: 2013 Annual Gross Energy Savings

Program	Reported Annual Gross Energy Savings (GWh)	Verified Annual Gross Energy Savings (GWh)	Realization Rate
IAP	7.537	8.108	108%
PSUI	3.207	2.800	87%
Total	**10.744**	**10.908**	**102%**

Table 4: 2013 Annual Gross Demand Savings

Program	Reported Annual Gross Demand Savings (MW)	Verified Annual Gross Summer Peak Demand Savings (MW)	Realization Rate
IAP	1.034	0.678	66%
PSUI	0.366	0.316	86%
Total	**1.400**	**0.993**	**71%**

Since Econoler made both negative and positive adjustments to energy savings, the realization rates for energy savings were high for both programs (108 percent for the IAP and 87 percent for the PSUI). However, because demand savings were calculated by the OPA assuming that they were constant over the year, they sometimes differ significantly from the verified value calculated by Econoler based on the summer peak demand. Indeed, the technical review and on-site visits allowed Econoler to gain a better understanding of the yearly demand profile and to perform more precise calculations in some cases.

3.4 NET-TO-GROSS RATIO

The NTGR evaluation was based on a self-report approach which relied on a series of questions designed to measure the influence of the program on participants' decision whether to implement energy efficiency projects.

This section presents the methodology used to convert the responses obtained into an appropriate NTGR. The NTGR calculation method includes the assessment of two key distortion effects: free-ridership and internal spillover. Once each effect is quantified, the NTGR is calculated using the following equation.

$$NTGR = (1 - \%\ Free\text{-}ridership + \%\ Internal\ spillover)$$

The next section outlines how the two above-mentioned distortion effects have been calculated for both the IAP and PSUI.

3.4.1 Free-Ridership

Free-ridership occurs when participants declare that they would still have implemented the energy efficiency measures in the absence of the program. To evaluate this effect, Econoler conducted a questionnaire with each participant during on-site visits. Each time, it was verified that the respondent was well aware of the decision-making process that occurred within the company to ensure that answers were accurate.

The questionnaire aimed to evaluate two components of free-ridership. First, the intention component determines how the project likely would have differed if the respondent had not received the program assistance. The influence component assesses the impact various program elements had on the decision to do the project the way it was done. For each item, the participant is asked to rate the influence on a scale of 0 to 10.

The intention and influence components are then averaged to obtain a specific value for each project. The algorithm behind this calculation is presented in Appendix II.

Two distinct averages of the overall free-ridership level are calculated for each program: one for energy savings and one for demand savings. These weighted averages are based on the energy and demand savings values of each project.

Using this approach, the following levels of free-ridership were determined.

Table 5: Free-Ridership Levels for the IAP and the PSUI

Free-Ridership	IAP	PSUI
On Energy Savings	1%	7%
On Demand Savings	0%	6%

These results must be analyzed with caution, since the number of projects was very small for both programs; hence it is possible that the free-ridership levels are not representative of what will occur in future years when a larger population will be surveyed. Indeed, almost all participants were very large manufacturing plants; as such, they have strict rules for investment. Most participants mentioned that a maximum simple payback period of two years was required for any investment project to go forward, and in all cases but one, the incentive was necessary to reach this payback period.

3.4.2 Spillover

The internal spillover effects are defined as the additional energy and demand savings that may be generated due to program influence without any direct financial or technical support from the program (technical assistance, incentives, on-bill financing, etc.).

During on-site visits, participants were questioned in order to determine whether they had implemented other energy efficiency projects for which they did not apply to an OPA program. If this was the case, the energy savings of the project were estimated, and the factor of influence of their previous participation in the IAP or the PSUI was evaluated on a scale of 0 (no influence on their decision to go forward with another project) to 10 (extremely influential in their decision).

The level of spillover was nil for both programs. Some participants stated that while they did a new energy efficiency project every year, their participation to the OPA program had no influence on their practices. Other participants implemented other energy efficiency projects, but outside of Ontario.

3.4.3 NTGR Calculation

Using the equation presented in Section 3.3 and the previous results for free-ridership and spillover, the NTGR is calculated for both energy and demand savings of each program, as shown in the table below.

Table 6: NTGR Ratios for the IAP and the PSUI

NTGR	IAP	PSUI
On Energy Savings	0.99	0.93
On Demand Savings	1.00	0.94

3.5 NET SAVINGS RESULTS

This section presents the net savings, both on an annual and a lifetime basis, along with the analysis of the TRC and PAC.

3.5.1 Overall Annual Savings

The verified net annual savings for the program were estimated using the NTGR calculated in the previous section. The following equation was used to calculate the net savings.

Verified net savings = Verified gross savings × NTGR

This equation was used for both energy and demand savings. The results obtained for each program are presented in the following tables.

Table 7: 2013 Verified Annual Net Energy Savings

Program	Verified Annual Gross Energy Savings (GWh)	NTGR	Verified Annual Net Energy Savings (GWh)
IAP	8.108	0.99	8.027
PSUI	2.800	0.93	2.604
Total	**10.908**	**0.97**	**10.631**

Table 8: 2013 Verified Annual Net Summer Peak Demand Savings

Program	Verified Annual Gross Summer Peak Demand Savings (MW)	NTGR	Verified Annual Net Summer Peak Demand Savings (MW)
IAP	0.678	1.00	0.678
PSUI	0.316	0.94	0.297
Total	**0.993**	**0.98**	**0.974**

3.5.2 Effective Useful Life of Measures

In order to evaluate the verified lifetime net energy savings, the EUL of measures was validated by Econoler. This value corresponds to the minimum life expectancy of all major pieces of equipment for a project. For each project, the EUL presented in the project review report was considered and validated with the participant during on-site visits. To evaluate the possibility of a dual baseline (step-down) in annual energy savings, questions were asked concerning the age of existing equipment and its planned replacement. A step-down might occur if the old equipment was planned to be replaced at some point during the EUL of the new efficient equipment and the standard efficiency of new equipment at that time was higher than the current baseline.

Using a weighted average based on verified annual savings, the EUL for the IAP and the PSUI was estimated to be 18 years and 10 years, respectively. The main change Econoler encouraged was to increase the EUL value of one project for the IAP above the standard 10-year period. Indeed, the technical review suggested that the life expectancy of each new piece of equipment was a minimum of 25 years. Since Econoler agreed with this evaluation, the project was considered to have a EUL of 25 years.

3.5.3 Lifetime Energy Savings

To obtain the verified lifetime net energy savings, the verified annual net energy savings for each year of the EUL were added up, for each project of both the IAP and the PSUI. Because there was no case of step-down in savings identified for any project, the net lifetime energy savings are equal to the net annual savings multiplied by the EUL. Demand savings are also expected to remain constant over the entire EUL.

Table 9: 2013 Verified Lifetime Net Energy Savings

Program	Verified Lifetime Net Energy Savings (GWh)	Average EUL (years)	Verified Lifetime Net Energy Savings (GWh)
IAP	8.027	18	140.972
PSUI	2.604	10	26.038
Total	**10.631**	**16**	**167.009**

CONCLUSION AND RECOMMENDATIONS

In 2013, three projects were completed under the IAP and three projects under the PSUI. To evaluate the impact of these programs in 2013, Econoler conducted a series of activities, namely the revision of the program documentation, interviews with the OPA and CLEAResult staff, review of technical documentation and M&V reports for each project, on-site visits to each facility to validate the content of the project file, as well as interviews with each participant to measure free-ridership and spillover. The information collected during these activities allowed Econoler to establish the verified gross and net savings of each project implemented through the IAP and the PSUI in 2013.

The 2013 impact evaluation results demonstrated that the programs achieved net energy savings of 10.631 GWh per year (8.027 GWh for the IAP and 2.604 GWh for the PSUI) and net peak demand savings of 0.974 MW per year (0.678 MW for the IAP and 0.297 MW for the PSUI).

The realization rates for gross energy savings were high (108 percent for the IAP and 87 percent for the PSUI), since Econoler made both negative and positive adjustments to energy savings. On the other hand, adjustments to demand savings were more significant; the on-site visits enabled Econoler to obtain more details on the demand profile and the variation of demand savings throughout the year. This resulted in more precise calculations to establish demand savings during the summer peak period (which differed from the OPA's reported values) and led to lower realization rates.

Distortion effects had a small impact on both programs: free-ridership levels on energy savings were found to be 1 percent and 7 percent, respectively, for the IAP and the PSUI and no spillover was identified. Consequently, NTGR values were close to one.

The EUL for each project was validated and used to calculate its net lifetime energy savings. Using a weighted average based on verified annual savings, the EUL for the IAP and the PSUI was estimated to be 18 years and 10 years, respectively. This resulted in verified lifetime net energy savings of 167.009 GWh (140.972 GWh for the IAP and 26.038 GWh for the PSUI).

The TRC and PAC were calculated for both programs. These cost-effectiveness tests showed that neither program is cost-effective for 2013. The net benefit ratios for the TRC were established at 0.51 for the IAP and at 0.10 for the PSUI. For the PAC, the results are also below 1 (0.36 for the IPA and at 0.08 for the PSUI). The low benefits obtained in 2013 in comparison with the high costs associated with the design and delivery of the programs can explain these results. This kind of situation is frequently observed during the first years of a program. The implementation of large-scale projects can extend over a long period of time, resulting in only a small number of projects being completed after the first years of program implementation.

Overall, Econoler assessed that the IAP and the PSUI projects are well documented and monitored, which led to significant and measurable savings. Since each project was so well documented, Econoler had few new questions for participants during on-site visits and could concentrate on validating the content of the project file. Here again, very few discrepancies were found and resulted in only minor adjustments being made to energy savings. Econoler commends the OPA on the quality of its review process and recommends that it be maintained. Nevertheless, Econoler has the following recommendation to improve demand savings calculation for both programs in the future:

- **Include demand savings in the M&V plan**: While M&V plans for energy savings were generally well done and thorough, some measurements needed to accurately calculate demand savings were missing. Special attention should be given to projects which present a non-uniform demand profile over the year (such as refrigeration) or for which complex control sequences do not allow for the prediction of demand during peak periods (e.g., compressed air). Therefore, the OPA should request that the M&V plan include the collection of summer demand consumption data. This would make it possible to identify the data to be collected and measured in order to develop the hourly load profiles during the summer peak season.

APPENDIX I
ON-SITE VISIT PROTOCOL

1. General Information

Site Visit Date:

Project ID:	ProjID	Contact Name:	
Project type:	Project Type	Contact Phone:	
Company name:		Email:	
Address:			

List of people met during the visit:

Type of Industry:

Automotive Manufacturing		Steel Manufacturing		
Food Processing & Storage		Other (specify)		*Specify:*

2. Key Project Variables

Variable Descriptions: *Pull key project variables and listed KPIs from M&V Plan*

NOTE: PC Users "Alt+Enter" for new line in cell. MAC Users "CMD+Option+Enter".

3. Facility Operation Schedules

Facility Description: *Outline a quick description of the facility and its primary operation/purpose.*

NOTE: PC Users "Alt+Enter" for new line in cell. MAC Users "CMD+Option+Enter".

Facility annual schedule: *Fill the table below for each occupancy schedule reported by the site contact as occupancy could vary for each section of the facility. Use additional sheets if necessary.*

Description	1 - Normal Schedule		2 - Specify:		3 - Specify:	
	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends
Number of days with regular schedule per year						
Number of days with regular holidays schedule per year						
Number of days with no occupancy per year (For example: seasonal closure)						
Total number of days per year	0	0	0	0	0	0
	Total = 261	Total = 104				

Facility daily schedule: *Fill the table below for each occupancy schedule reported by the site contact as occupancy could vary for each section of the facility. Use additional sheets if necessary.*

Schedules		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Holidays
Schedule 1: Normal	*Time of use (e.g. 8:00 am to 5:00 pm)*								
	Hours per day								
Schedule 2 (specified above)	*Time of use*								
	Hours per day								
Schedule 3 (specified above)	*Time of use*								
	Hours per day								

4. Interactive Effects

Interactive Effects? *YES* ☐ *NO* ☐ ***If YES the fill in the table below for each heating system at the site***

Briefly describe interactive effects for the project.

5. Building Heating/Cooling System Description

Heating Systems *Fill the table below for each heating system at the site.*
Not applicable if no interactive effects have been identified.

Description	Heating system 1	Heating system 2	Heating system 3	Heating system 4
Energy source *(electricity, natural gas, oil, etc.)*				
Heating system type *(electric resistance, furnace, heat pump...)*				
Nominal capacity *(indicate the unit – kW, Mbtu/h...)*				
Heating system **efficiency or COP**				
If any, changes in building **set points** (occ./ unocc. temp., % hum)				

Cooling Systems *Fill the table below for each cooling system at the site.*
Not applicable if no interactive effects have been identified.

Description	Cooling system 1	Cooling system 2	Cooling system 3	Cooling system 4
Energy source *(electricity, natural gas, oil, etc.)*				
Cooling system type *(compressor, absorption...)*				
Nominal capacity *(indicate the unit – kW, tons, etc.)*				
Cooling system **SEER or COP**				
If any, changes in building **set points** (occ./ unocc. temp., % hum)				

6. Pre-Visit Assessment of the Project

Indicate the key observations from the feasibility study and M&V report analysis. These notes will serve on site to guide the visit and identify the main information to collect and/or verify.

7. On-Site Observations and Findings

Report the on-site visit and indicate the key observations and findings made on site.

8. M&V Post Implementation Results

Report the on-site visit and indicate the key observations and findings made on site.

Seasonal Load Profile? ____ *(Y/N)* *Summer Load Variations?* ____ *(Y/N)*

	Year # 1		Year # 2				
	Results (MWh)	Percent of Expected (%)	Results (MWh)	Percent of Expected (%)	Period Start Date	Period Finish Date	Days in Period
Q#1							
Q#2							
Q#3							
Q#4							

Notes: *Insert Comments from M&V Reports*

9. Free-ridership and Spillover Assessment

Free-Ridership Questionnaire Completed?		(Y/N)	Spillover Questionnaire Completed?		(Y/N)

10. Energy and Demand Savings Adjustments

Reported Energy Savings from Tracking Sheet:		MWh/yr	Energy Savings from Contract (for ref.):		MWh/yr
Reported Demand Savings from Tracking Sheet:		kW	Demand Savings from Contract (for ref.):		kW

Verified Savings by the Evaluator

Final Project Impacts at the Meter

Verified Energy Savings:		**kWh/yr**	**Realization Rate - Energy Savings:**		**%**
Verified Summer Demand Savings:		**kW**	**Realization Rates - Demand Savings:**		**%**

Note: Summer demand savings to be carried out in accordance with OPA procedure.

11. Additional Notes (if required)

NOTE: PC Users "Alt+Enter" for new line in cell. MAC Users "CMD+Option+Enter".

Total Project Savings:	***Energy Savings (kWh) =***	
	Demand Savings (kW) =	

APPENDIX II
FREE-RIDERSHIP ALGORITHM

FR1. Prior to participating in the program, was the purchase and installation costs of the project included in your company's capital budget? 1. Yes 2. No 99. Don't know/Refused	Used for FR5 scoring
FR2. Had your company ALREADY ordered or purchased all of the equipment to be installed through the project BEFORE your company heard about the program? 1. Yes 2. No 99. Don't know/Refused	Used for information purposes only
FR3. Which of the following is most likely what would have happened if you had not received the rebate from the OPA? 1. Canceled or postponed the project at least one year 2. Reduced the size, scope, or efficiency of the project 3. Done the exact same project (no change) 99. Don't know/Refused	**SCORE FR3** IF FR3 = 1 → 0% IF FR3 = 2 → ASK FR4a IF FR3 = 3 → ASK FR5 IF FR3 = 99 → 25%
FR4a. By how much would you have reduced the size, scope, or efficiency? Would you say a… 1. Small amount 2. Moderate amount 3. Large amount 99. Don't know/Refused	**SCORE FR4a IF FR3 = 2** IF FR4a = 1 → 37.5% AND ASK FR4b IF FR4a = 2 → 25% AND ASK FR4b IF FR4a = 3 → 12.5% AND ASK FR4b IF FR4a = 99 → 25%
FR4b. Please describe what your company would have changed about the size, scope, or efficiency of the project	Used for consistency check with FR4a
FR5. Now I want to focus on what it would have cost your company to implement the project without the rebate from the OPA. How likely is it that your company would have paid the full cost to complete the same project at the same time? Would you say… 1. Very likely 2. Somewhat likely 3. Not too likely 4. Not at all likely 99. Don't know/Refused	**SCORE FR5 IF FR3 = 3** IF FR1 = 1 AND IF FR5 = 4 → 25% OTHERWISE: IF FR5 = 1 → 50% IF FR5 = 2 → 37.5% IF FR5 = 3 → 25% IF FR5 = 4 → 0% IF FR5 = 99 → 37.5%
Intention Score (MAX 50%)	**FR3 OR FR4a OR FR5**
FR6. I'm going to read a list of items about the program. Please rate each item on how much influence it had on the decision to complete the project the way it was done. Please use a scale from 0, meaning no influence, to 10, meaning the item was extremely influential in your decisions. **FR6a.** The OPA staff such as your Business Manager or The LDC staff **FR6b.** The technical studay and recommendations **FR6c.** The OPA rebate for the project **FR6d.** The OPA marketing **FR6e.** The OPA information about energy **FR6f.** Was there anything else that was highly influential in your decision to complete the project in the way that you did? (If so, record answer and score its influence on a scale of 0 to 10)	FR6 = 50% - [MAX(FR6a : FR6f) x 5%]
Influence Score (MAX 50%)	**FR6**
Final Free-Ridership Level	**Intention Score + Influence Score**