A SYSTEMS APPROACH TO SUSTAIN RSA SECTION 12L TAX INCENTIVE PROJECTS

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ABSTRACT

Section 12L of the South African Income Tax Act (12L) incentivises companies towards improved energy efficiency (EE). Research shows that two key issues generally prevent eligible EE projects from achieving maximum 12L benefits: 1) poor data integrity which affects application compliance and 2) savings are not sustained throughout the assessment period. A need therefore exists to make use of intelligent data driven analyses to effectively identify these issues in order to maximise 12L potential.

This paper presents the development of a performance tracking and reporting system. This system monitors and analyses project data to identify potential anomalies. Once an anomaly has been detected, it triggers a report to notify and inform the end-user of the specific issue. This detection increases the opportunities to sustain targeted savings and improve data integrity.

The functionality of the system is illustrated by using three case studies. These case studies test whether the system can correctly identify and report anomalies. The value of the system is further validated by assessing the potential increase in savings due to timely corrective action. The paper concludes with a discussion of the benefits, including a potential increase of R 63.9 million in 12L related value.

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1. INTRODUCTION

Section 12L of the Income Tax Act (12L) incentivises energy efficiency by offering tax certificates valued at 95c per kWh for quantified energy savings [1]. However, this attractive offer is governed by strict Regulations and Standards [2][3]. Furthermore, the overall application and review process is diligently managed by SANEDI to ensure that the final claim is a compliant and conservative reflection of the true energy savings [4].

The value offering of 12L has made it an attractive research topic, driving further development and innovation in several areas including measurement & verification (M&V), data analytics, decision making and support systems [5 - 10]. One of these studies conducted by Campbell investigated the 12L feasibility of 47 industrial case studies [7]. An overview of the results is presented in the figure below.

![Figure 1-1: 12L feasibility evaluation results [7]](image)

The research identified two critical challenges: 1) 47% of the case studies showed viable savings potential, but could not be claimed due to poor data compliance and quality, 2) 45% of the case studies failed to achieve and sustain target savings for the full year of assessment [7][10][11]. Ultimately only 8% of the assessed case studies managed to receive a 12L benefit. It is therefore clear that a need exists to understand and address the issues limiting viable claims.

The topics of data quality and the sustaining of EE savings formed the core discussion and motivation of the authors’ research and subsequent methodology development. This paper presents a condensed version of the work performed [10]. The following sections will briefly discuss supporting literature before moving on to an overview of the systems approach developed to address the challenges. Finally results from several case studies are presented and discussed.

2. LITERATURE OVERVIEW

2.1 Introduction

The amount of data being generated by industries is set to double every two years [12]. The abundance of information potentially allows the impact of energy saving actions (ESAs) to be quantified at increasingly high levels of certainty [5]. However, the requirements stipulated for data used in 12L assessments is very strict. The availability of high quality, 12L compliant data is therefore critical for all potential claims. Section 2.2 will further discuss the role of data quality in M&V.

12L requires an application to show sustained savings for a full year of assessment [Regulations]. Unfortunately, research shows that the sustainability of energy efficiency projects over extended periods remains a challenge [11][13]. Failing to sustain the maximum project performance for at least a full year will affect claimant’s ability to receive the full 12L benefit. Section 2.3 will further discuss research relating to sustainability, as well as techniques for corrective action. The following sections present condensed versions of a detailed literature study conducted by the author [10].
2.2 The role of data quality in M&V

All 12L applications are assessed based on the M&V process prescribed by the SANS50010. Essentially, this process requires a point of reference (baseline) that can be adjusted to objectively compare operational performance pre- and post-energy saving action (ESA) [3].

The figure below illustrates the concept of how the energy savings can be quantified using a baseline (based on pre-ESA data) adjusted for post-ESA conditions (adjusted baseline). The difference between the adjusted baseline -how the system “would have” operated- and the actual energy consumption, depicts the energy saving attributed to the relevant ESA.

![Figure 2-1: ESA general assessment approach [10]](image)

There are four basic boundary options that can be selected when developing a representative baseline [3][14]. These options are a) key parameter, b) all parameter, c) whole facility and d) calibrated simulation. The usability of the different boundaries depends on the nature of the ESA and available points of measurement. Ideally option B will be selected to fully measure and monitor all parameters encapsulating a specific ESA. The Figure below illustrates the application of the different boundaries applied to an industrial water cooling system [10].
The availability of multiple points of measurement combined with the different boundary selection options creates the possibility for several different forms of assessments [5 - 10]. The challenge for the M&V practitioner and other stakeholders is therefore to select an option that provides sufficient encapsulation and data for high-quality analyses (i.e. as many points as possible) and keep long-term compliance and sustainability in mind (i.e. using minimal points simplifies maintenance requirements).

The nature of data compliance and quality is not static. Unfortunately, a good data source can become a useless liability due to several factors. Data quality assessment is therefore critically important to ensure accurate results [5][9][11]. The figure below illustrates some common abnormalities that can occur due to faulty measurements or communication failures.

Figure 2-2: Layout of industrial water cooling system illustrating different boundaries [10]
These abnormalities exhibit known characteristics which can be used to quickly identify them in a dataset. Unfortunately, meters can also experience a drift in accuracy over time which will not necessarily be clearly discernible and therefore require regular checks and calibrations. The figure below illustrates the use of a cumulative sum (CUSUM) graph which can be used to track the effect of variance on a measurement or the consistency in a project’s performance [9]. A natural variance will result in a constant profile being maintained. However, a significant change will result in a visible departure from the normal trend.
The information briefly conveyed in this section supports the argument that data quality is fundamentally important, not only for 12L purposes, but also for general M&V work. Over time, the multiple combinations of boundaries and measurement points, together with varying compliance and quality lead to a significant amount of permutations that need to be assessed and monitored. These and other assessment techniques will be used as part of the methodology presented in the next section.

2.3 Sustainability of EE projects

Grobbelaar investigated the long-term sustainability of energy cost saving projects implemented by an energy services company (ESCo) [11][13]. The study found that projects generally performed well during the initial performance assessment (PA) period. The PA was typically conducted over three months under the strict supervision of the ESCo and client engineers. Unfortunately, the projects failed to sustain their initial performance assessment (PA). The failure was attributed to the lack of consistent supervision and poor data availability.

The figure below illustrates a case study’s monthly performance [11][13]. The green line shows the average PA performance and can be used as an indicator of the projects “best case” performance. The red line shows the contractual target and can be used as an indicator of a “reasonable” performance. The actual monthly performance is shown as blue bars and clearly illustrates the project’s failure to sustain either the PA or contractual target.

![Figure 2-5: Monthly performance assessment results [10, 11]](image)

Groenewald also evaluated the sustainability of five mining projects (similar to the case study presented above) [11]. The study quantified an overall monetary loss (linked to electricity costs) approaching R12.7 million over a 12-month period [13]. The significant financial losses, attributed to the lack of sustainable savings, prompted Groenewald to develop a performance centred maintenance strategy [11]. This strategy was based on the ISO 50001 plan-do-check-act (PDCA) cycle which is illustrated in the figure below.
The application of the ISO 50001 approach was deemed to be beneficial and helped to sustain savings. However, the overall process was still constrained in terms of time and cost by the various “human factors” present throughout the process. The next challenge is therefore to balance the cost, time and resulting quality presented by the abovementioned solution. The figure below illustrates the different trade-offs between these three value metrics [5].
From the figure it is clear that the ideal balance lies in the middle between cost, time and resulting quality. Fortunately, the availability of new software technology allows industry to significantly decrease costs, processing and review time without negatively affecting quality.

2.4 Summary

The previous sections briefly touched on examples and illustrations obtained from available literature. The findings show that data quality plays a critical role in overall M&V work. A new 12L linked challenge is to ensure that data compliance and quality is sustained over the two-year period (baseline and assessment) typically required for a 12L application. Furthermore, an additional problem beyond data quality is the sustainability of achieved savings. Fortunately, the literature also shows that several separate solutions have already been developed for these issues [10]. However, the challenge is to ensure that these solutions are implemented with the optimal balance between quality, cost and time in mind. The following section will discuss the development of a system that integrates these existing solutions in an efficient manner.

3. GENERAL METHODOLOGY

The previous sections support the need for the development of an intelligent, data driven system to effectively monitor and support the sustainability of data quality and project performance. This section will give an overview of the methodology approach followed to address the need. The methodology is based on ISO 50001 PDCA principles and focuses on three key areas, namely; 1) Measure, 2) Monitor and 3) Analyse.

The methodology is designed on the premise that it will be incorporated into a software system and repeated on a continued basis (e.g. daily). Each key area (measure, monitor and analyse) will request specific user action only when needed (i.e. inputs or corrective action) before flowing to the next step. This approach will ensure that the system can autonomously operate as long as the specified criteria are met. Each focus area will now be discussed in more detail.

3.1 Measure

The first key area of the developed system is the collection of relevant measurement data. The architecture of the system is designed so that all raw data is centralised before being processed. The basic flow of data from point of measurement to the central server is illustrated in the figure below.

![Figure 3-1: Communication of data from site to server [10]](image)

In addition to the transfer of data from site to server, the data also needs to be contextualised before it can be effectively processed. The contextualising process (e.g. data type, unit of measure, description etc.) is done for each point of measurement and is further enhanced by completing additional checklist. The checklist serves as a tool to gather extra supporting information such calibration dates, expiry dates, certificates etc. Finally, all the relevant components can be combined using a processing script, producing a data file for further analysis. The process is illustrated in the figure below.
Figure 3-2 shows how the measured data obtained from the production environment and then centralised on a server (as illustrated in Figure 3-1) is combined with the user generated configuration (contextualised) data and finally sent to the Monitor phase as an integrated data file for further processing. The system configuration file is created when the system is setup for the first time, thereafter it only requires updates when system components / characteristics change.

3.2 Monitor

The next phase is to monitor the collected data. Here the tools discussed in Section 2.2 were incorporated into the digital system to quickly assess all measurements based on selected sets of criteria. If the monitored data passes the evaluation process it will move on to the Analyse phase. If not, an exception will be generated for corrective action. The figure below illustrates three basic test criteria (min/max, hanging and missing) that can be applied to all incoming data streams. The criteria can also be further refined to assess and identify more specific data anomalies.
A flag is created when the selected test criteria identifies a potential abnormality. The generation of a flag will also result in the generation of a daily exception report (summarising all the relevant flags for the specific day). The exceptions will furthermore be added to an “Exception Database” for later follow-up notifications.

The goal of the exception driven reporting is to selectively request human interaction only in the event of an abnormality occurring. This greatly reduces the amount of man hours previously required to monitor and assess all measured streams and allows operators more time to focus on the problematic areas.

This step ensures that only high-quality datasets are used for subsequent analyses (final step). This is achieved by using the test criteria as a filter, passing quality data and flagging potentially faulty data. The corrective action step allows for users to correct the faulty data, or at least assess the source of the fault so that future data will be useable.

### 3.3 Analyse

The final step in the methodology is to analyse the performance of the specific focus area / intervention. This step produces several outputs for corrective action and review in the form of performance tracking- and exception-reports. Ideally the analysis delivers a savings report that can be distributed to interested parties for review. Corrective action can then be implemented at user discretion. However, to ensure that any underperformance / abnormality is quickly identified two additional checks are implemented.

The example process illustrated in the figure below combines relevant measurements using specific, predetermined calculations (e.g. methods discussed in section 2.2 and 2.3) to identify abnormalities. The complexity of this calculation depends on the complexity of the underlying system and selected analyses. Regardless, the use of an automatic performance assessment produces outputs that can prompt users to perform corrective action when needed.

![Implementation of the developed system diagram](image)

#### Figure 3-4: Methodology - Analyse phase [10]

The results from this assessment are reviewed using two separate approaches. The first merely tests whether the project has achieved its pre-set daily target. An exception report is generated when it fails to achieve the target. This report (similar to previous flags) will be sent to the relevant personnel for corrective action.
The combined results are also included in a CUSUM assessment model. The goal of this assessment model is to review general project performance over an extended period. Various factors can impact daily performance, potentially creating erratic noise and thereby clouding the ability to do a holistic assessment. The CUSUM model dampens these erratic events, producing a general trend illustrating overall project performance. A significant change in the slope of the trend can be used to indicate recurring changes in project performance. The assessment and interpretation of the CUSUM tool requires a management level review. It is therefore included in a regular monthly feedback report.

3.4 Summary

The general methodology was developed to address two key concerns, data quality and sustained savings. The approach focused on centralising and integrating site data for automatic, predetermined calculations. Human intervention is only requested when exceptional events occur. This automation significantly reduces the amount of human time required for general assessments, instead allowing the time to be spent focused on understanding and solving the flagged problems. The next section will illustrate the working of the methodology on industrial case studies.

4. DISCUSSION OF RESULTS

4.1 Overview

The developed methodology was tested by applying it in the mining and metal processing industries. All identifying details have been removed to honour confidentiality agreements signed with the various parties. The results presented in the next section will only showcase selected examples from the case studies. This is done with the focus on brevity and with the goal to illustrate basic functionality. More detailed descriptions and discussions of each case study is available in the author’s full work [10]

4.2 Case studies

The first step in the methodology is to collect and contextualise the relevant measurements. The table below illustrates an example of the general information captured as part of the initial checklist / setup process.
The next step is to monitor and assess the quality of the various streams. This was done using the following basic test criteria: missing, hanging, below minimum, or above maximum. The figure below illustrates the aggregate “Error count” for the various events each day. A quick assessment of the results clearly shows that there was a significant increase in errors in August 2014.

**Table 4-1: Case study result - Illustration of an “Input Checklist” [10]**

<table>
<thead>
<tr>
<th>Input Checklist</th>
<th>Case study C site</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>Facility</td>
</tr>
<tr>
<td>Components</td>
<td>Whole facility</td>
</tr>
<tr>
<td>Boundary Selection</td>
<td>Intensity</td>
</tr>
<tr>
<td>M&amp;V Model</td>
<td>Production [T]</td>
</tr>
<tr>
<td>Energy Driver</td>
<td>Daily</td>
</tr>
<tr>
<td>Energy Carrier</td>
<td>Facility electricity usage [kWh]</td>
</tr>
<tr>
<td>Carrier Resolution</td>
<td>Daily</td>
</tr>
<tr>
<td>Maximum Capacity</td>
<td>Production: 400 T</td>
</tr>
<tr>
<td></td>
<td>Electricity: 100 MW</td>
</tr>
<tr>
<td></td>
<td>Reductants: 1 000 MW</td>
</tr>
<tr>
<td>Minimum Capacity</td>
<td>Production: 1650 T</td>
</tr>
<tr>
<td></td>
<td>Electricity: 5 880 MW</td>
</tr>
<tr>
<td></td>
<td>Reductants: 9 700 MW</td>
</tr>
<tr>
<td>Compliance</td>
<td>Eskom Invoices</td>
</tr>
<tr>
<td>Target savings</td>
<td>130 GWh</td>
</tr>
<tr>
<td>Implementation start date</td>
<td>N/A</td>
</tr>
<tr>
<td>Baseline start date</td>
<td>1 January 2014</td>
</tr>
<tr>
<td>Assessment start date</td>
<td>1 January 2015</td>
</tr>
<tr>
<td>Corrective action personal</td>
<td>N/A</td>
</tr>
<tr>
<td>Project manager</td>
<td>N/A</td>
</tr>
</tbody>
</table>
The figure above focused on the overall error counts, but the same process can also be applied to individual points of measure over the total aggregate of available data. The figure below illustrates the total error count for several meters. It is clear that the “Air Flow” meter has significant issues with missing data. Presenting results in this format enables the relevant persons to focus their attention on the primary, and most significant causes of flags.

The analyze step in the methodology focuses on evaluating the performance of the project with the intent of sustaining savings. The figure below illustrates the savings assessment for a specific project.
Assessing the daily results shows that the project initially achieved its target, but started to underperform on the 4th of January. At this point the relevant personnel will have been alerted to the underperformance. However, it is clear that the project continued to underperform for a full two weeks before the issue could be corrected.

The final step in the process is to assess the overall performance of the project. The figure below shows the baseline period (blue), followed by the assessment period (orange). The example was selected because it clearly illustrates the change in trend in two areas between the baseline and assessment (i.e. when the project started working) and post August 2015 when data loss occurred (red block).

The figure (above) also shows the effect of correcting the data loss (orange vs. red line). The general trend of the graph (illustrated by black dotted lines) gives a point of reference on project performance. If the graph follows the general trend; it indicates that performance is sustained. If the graph angles above the line, it indicates an increase in performance and vice versa where dipping below the line indicates a decrease.
4.3 Potential value

This paper started with an excerpt from Campbell’s feasibility study on 47 potential 12L claims [7]. The study highlighted two main challenges / reasons for failure: the sustainability of savings and poor data quality. The table below gives a breakdown of the assessed case studies.

Table 4-2: Case study result - Illustration of an “Input Checklist” [10]

<table>
<thead>
<tr>
<th>Industry</th>
<th>Total number of cases</th>
<th>Reason for failure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lack of savings</td>
</tr>
<tr>
<td>Cement industry</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Platinum industry</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Gold industry</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>Steel industry</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Chrome industry</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Petrochemical industry</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>47</strong></td>
<td><strong>21</strong></td>
</tr>
</tbody>
</table>

The case studies presented in section 4.2 highlight some of the outputs from the author’s primary research [10]. Based on these case studies, the estimated avoidable energy efficiency savings loss (per project) was between one and two GWh per annum. If these results are extrapolated back to the case studies presented in the table above the estimated energy efficiency savings lost exceeds 60 GWh, or R60-million in 12L tax certificate equivalent value (roughly R20-million in actual tax savings). Furthermore, the additional energy cost impact was estimated at R43-million per annum, based on Eskom TOU tariffs [10]. The quantification figures are a rough estimate but still clearly illustrate the potential benefits.

5. CONCLUSION

The Section 12L energy efficiency tax incentive presents significant value to industry. Previous research highlighted two major challenges, namely; data quality and the sustainability of savings. This paper gave a basic overview of literature-based techniques and result in order to convey the relevant background and context.

The presented methodology strives to follow a systems approach to integrate the various solutions obtained from literature. The final solution adds additional value by limiting the need for human interaction. This is achieved by flagging selected events thereby focusing attention where it is required.

The methodology was applied to three industrial case studies. Selected results illustrate examples of graphical outputs to showcase the functionality of the system. The potential value of the solution is estimated by extrapolating the avoidable losses (energy savings) quantified by the case studies back to the 47 case studies originally evaluated by Campbell. The resulting potential exceeds R60-million in 12L certificate value plus an additional R43-million in electricity costs. Ultimately the solution shows that there are definite benefits to using new technology together with exiting research to improve on current challenges.
6. BIBLIOGRAPHY


