Automating Energy Baseline Development for Energy-Intensive Mining Systems In South Africa

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ETA OPERATIONS

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Background

•The mining industry is under pressure to reduce energy use (Ateba, Prinsloo & Gawlik, 2019).

•Timely energy efficiency intervention critical.

•A key step in such intervention is to develop baseline profiles (Barnard & Grobler, 2012).

•Energy data is one of the primary parameters used by mines to develop baseline profiles (Marais, 2024, Majola & Langerman, 2023).

Background

- Energy consumption datasets are inherently large (Benítez & Díez, 2022, Majola & Langerman, 2023).

No Tags	Resolution	Period: (Years)	No Data points	Scaling	Category
1	30	1	17 520	1	Simple
20	30	1	350 400	20	Normal
20	30	4	1 401 600	80	Seasonal
20	2	1	5 256 000	300	Fine data

- **The amount of data to be processed for baseline development is too large to process within a reasonable amount of time using the traditional methods.**
- As a result, there are delays in performance assessment.

Problem statement

- Traditional baseline profiling is time-consuming and leads to delays in performance assessment.
- Hinder timely identification of inefficiencies in energy-intensive mining systems.

Research Aim[1] & Objectives[2]

[1]Research aim:

- Automating baseline development is advantageous because it produces baseline profiles in reduced time and with minimised effort.

Research aim[1] & objectives[2]

[2]Research objectives:

Literature review summary

Author/Ref	Year	Evaluation criteria				Findings/ Method used
		Existing automated method	Mining industry	Energy-intensive systems	Time & effort reduction	
(Labbus et al.)	2019	✓	X	X	✓	Uses statistical methods and clustering algorithms, implemented using a Python framework.
(Chen et al.)	2020	✓	X	X	✓	Utilises standards-based compliance checking and automation steps, within a custom system architecture.
(Sarmas et al.)	2024	✓	X	X	✓	Applies machine learning and ensemble modelling theory, through a Python-based AI-empowered autonomous software systems.
(Cornaro et al.)	2019	✓	X	X	✓	Suggests mathematical and statistical methods which use optimisation algorithms with GenOpt, an optimisation program.
(Granderson et al.)	2017	✓	X	X	✓	Uses an automated M&V 2.0 tool to streamline the M&V process.
(Van As)	2017	X	✓	✓	X	Uses a regression model for the baseline development, realised in Excel.

Literature review summary

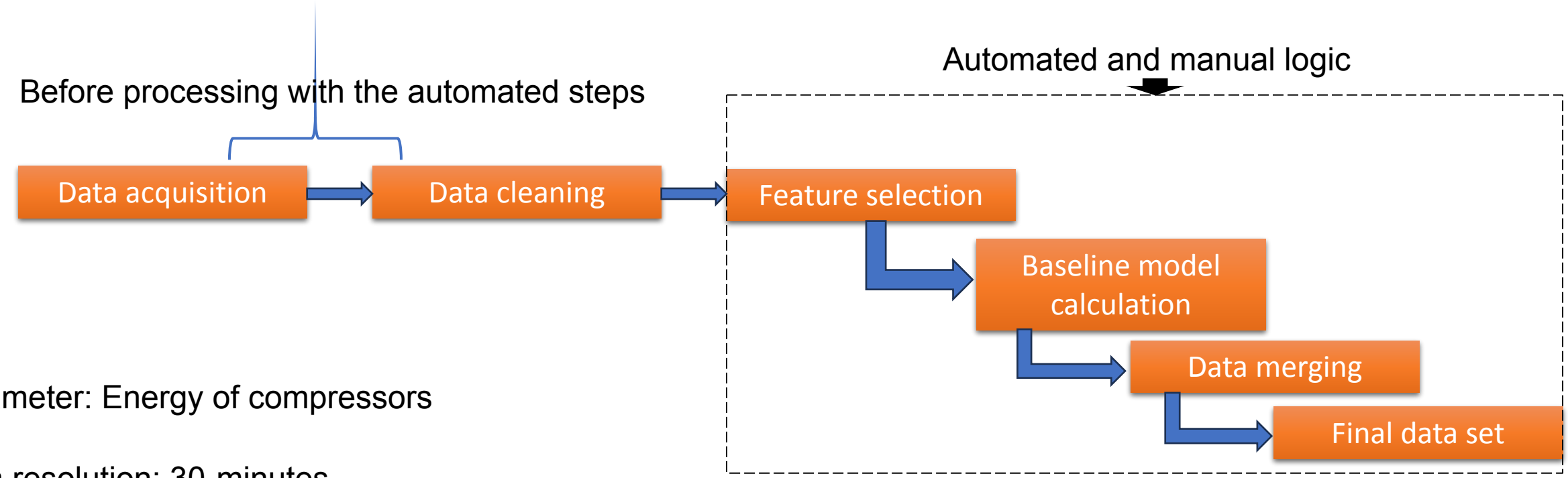
Research gap:

- Future work should therefore focus on developing an automated method to generate baseline profiles for energy-intensive systems in the mining industry, with the reduced time and minimised effort improvement.

Methodology and model

Figure 3. Research design methodology for the case study (Teegavarapu et al., 2008).

Automated and manual method development logic

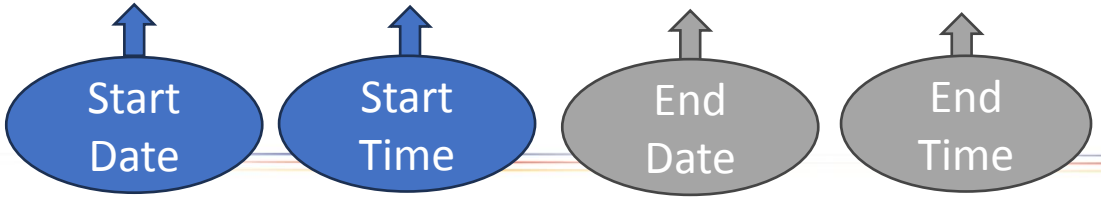


Parameter: Energy of compressors

Data resolution: 30-minutes

Baseline period:

From 01/01/2023 at 00:00 to 31/12/2023 at 23:30

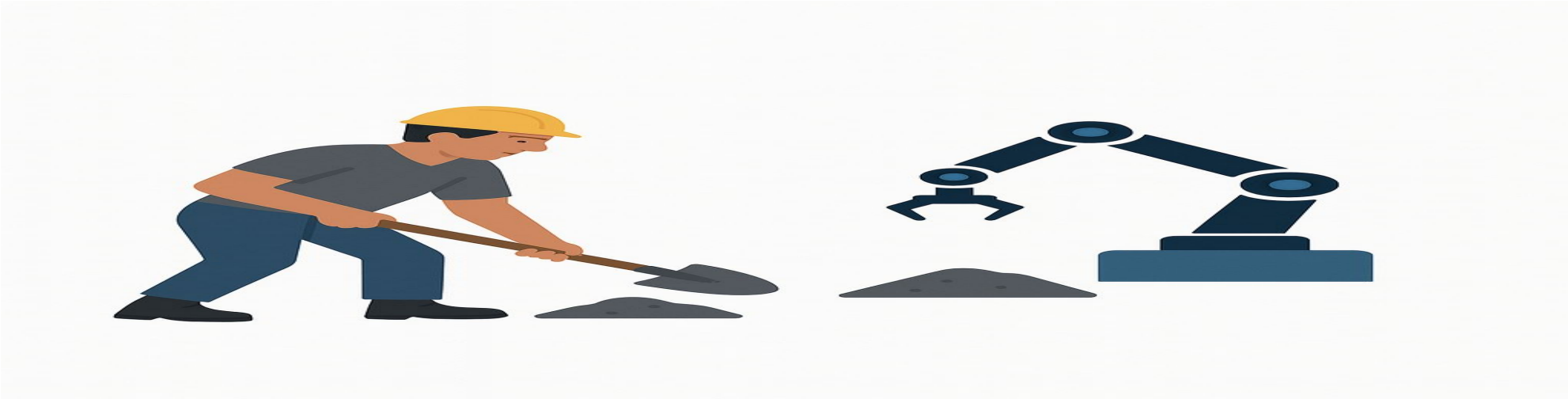


A tag refers to the data stream for a measured parameter for specific component.

E.g., a data stream for measuring the energy for Component X on Site Y can have a tag named: "SiteX_ComponentY_Energy"

Implementation

- In a case study involving an energy-intensive mining system, the presented automated method steps were implemented using the Python platform.
- In contrast, the traditional method was implemented using Microsoft Excel.
- Both methods processed 13 tags from the energy-intensive system.



Results and analysis

- The two methods output identical baseline values

Method	Time (Seconds)	Number of processing steps	Reduction %
Manual	2 340	Mutiple manual processes & sheets	
Automated	5	Single-run command	99%

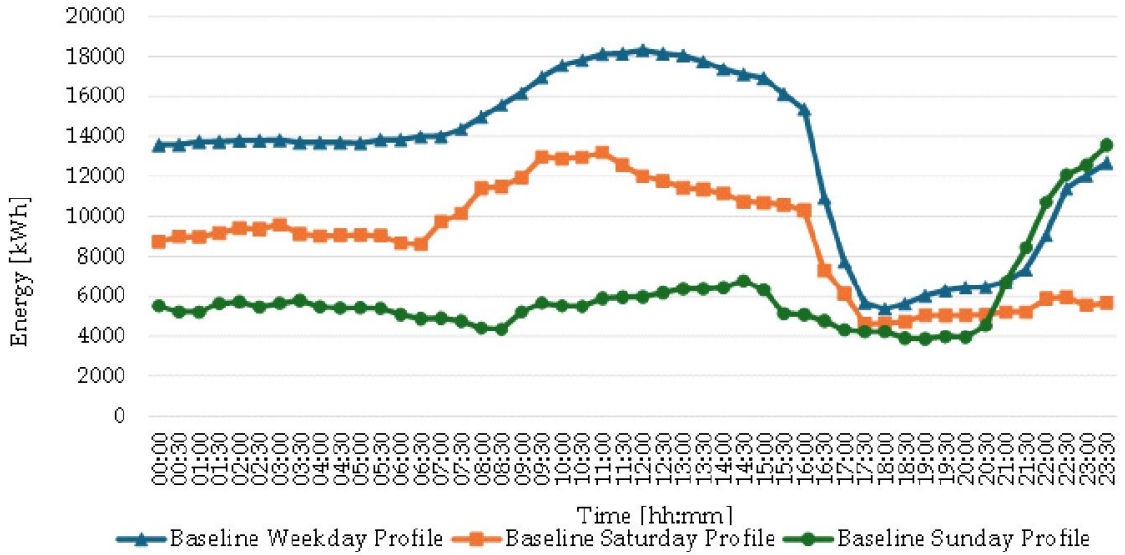


Figure 4. Baseline energy profiles for compressors.

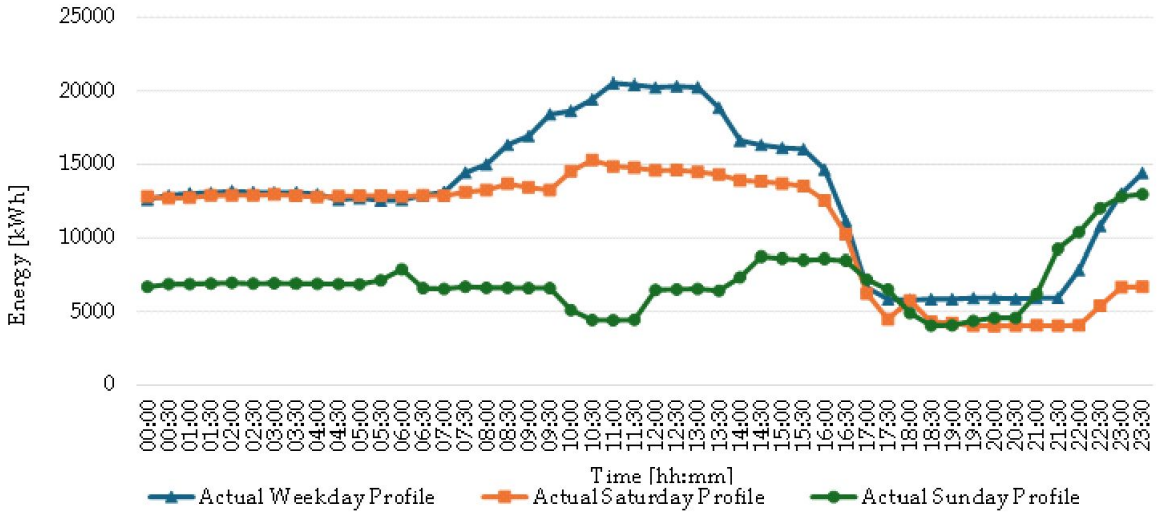


Figure 5. Measured energy profiles for compressors.

Conclusion and recommendation

- This study developed and evaluated an automated method on an energy-intensive mining system case study.
- The method was compared against a traditional approach to assess differences in time and effort.
- The results reflect a remarkable 99% improvement in reduction as well as minimised human intervention.
- The adoption of this automated method can reduce delays in performance assessment and promotes the timely identification of inefficiencies in energy-intensive mining systems.

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