Packhouse Action Group Water and Energy Project

2023 Energy Usage Results

May 2025

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List of Abbreviations

CA	Controlled Atmosphere
CAPEX	Capital Expenditure
GWh	Gigawatt-hours
kWh	Kilowatt-hours
LED	Light-Emitting Diode
OPEX	Operational Expenditure
PLC	Programmable Logic Controller
PPA	Power Purchase Agreement
RA	Regulated Atmosphere
VSD	Variable Speed Drive

Definitions

Energy use intensity (EUI): This metric measures how much energy is used to produce a unit of output, like a unit of economic output (Gross Domestic Product) or a specific product or service. A lower EUI indicates that less energy is required to produce that output. EUI encompasses all forms of energy, including electricity, fossil fuels, and renewable sources.

Electricity use intensity: This metric focuses solely on the amount of electricity used to produce a unit of output. It's a more specialised measure, highlighting the specific role of electricity in energy consumption.

Energy Consumption: This refers to the overall use of energy resources, including fuels like diesel, natural gas, and even electricity itself. It encompasses the initial energy required to power a process.

Electricity Consumption: This specifically refers to the amount of electrical energy used to power devices or equipment. It focuses on the final form of energy, which is electricity.

1 Introduction

In 2021, Blue North Sustainability (Pty) Ltd. (Blue North) was contracted by the Packhouse Action Group (PAG) to conduct a study on the electricity consumption in pome fruit packhouse and cold storage operations (using 2020 data). In 2022 a second phase of this project was completed (based on 2021 data) and in 2023 a third phase of this project was completed (reflecting on 2022 data). This report is the fourth round of electricity intensities (2023 data). The objectives of the fourth phase were to:

- replicate the electricity use studies undertaken in the previous phases;
- conduct year-on-year electricity use intensity comparisons in the packhouse and cold storage operations;
- collect and analyse data on energy sources and cost;
- collect and summarise categorised data on energy management practices; and
- simplify data collection and data validation where possible.

This report presents the results from Phase 4 (2023 data) whilst addressing the key objectives and drawing a comparison between the electricity intensity results of previous phases – Phase 1 (2020 data) to Phase 3 (2022 data). The report also summarises the different energy management methodologies applied at the packhouses.

Water usage results can be viewed in a separate report.

2 Methodology

Previous participants and new potential participants were contacted via phone call, WhatsApp and email. New participants were offered the details of the project and a virtual onboarding session if they showed interest in participating. A training session was not required by previous participants, as the data collection tool updates did not change the tool format but provided a simpler, more user-friendly experience.

2.1 Development of the data collection tool

Electricity consumption, cost and source data was collected via the data collection tool. Additional questions were posed to each of the participating packhouses regarding their energy management practices. The data was sense checked by the project team to ensure consistency and accuracy. Data anomalies were discussed with participants and, where applicable, rectified or reasons for the anomalies were recorded.

Phase 4 followed a similar approach as the previous phases, with the following additions:

- incorporation of Phase 3's (2022) data to reduce errors and support data validation;
- amendments to data capture fields for a more accurate renewable energy cost calculation;
- additional data capture fields for renewable energy installations;
- amendments to data capture fields for improved generator efficiency calculation.

2.2 Scope of the data collection

The following three areas in pome fruit packhouses were investigated in terms of energy use intensity:

- **Packhouse operations,** including all operational electricity consumption in the packhouse (pre-sorting, packing lines, ablutions, canteens, and offices).
- **Controlled Atmosphere (CA) operations,** including all electricity consumption relevant only to CA operations (refrigeration plant, compressors, condensers, fans, cooling towers).
- **Regulated Atmosphere (RA) operations** – This includes all electricity consumption relevant only to RA operations (refrigeration plants, compressors, condensers, fans, cooling towers).

2.3 Participation

Thirty-two packhouses were contacted, of which nine packhouses provided data.

All packhouses who provided data were previous participants.

Two packhouses did not participate in this phase but showed interest in future data collection rounds. One new packhouse showed interest to participate, but in future rounds when they are more prepared to capture the required data.

Twelve packhouses did not provide any response to our request to participate and ten packhouses declined to participate.

The primary reasons for packhouses not participating are:

- Limited capacity for data collection.
- Lack of sufficient record-keeping, e.g., no metering or sub-metering.
- Limited resources (time and human resources) for data capturing.

2.4 Data quality and notes on the data

Table 1 summarises the quality of the data received from each of the participating packhouses, for each area of operation.

Table 1: Summary of packhouse data quality for the different areas/activities

Packhouse	Packing operations	CA operations	RA operations
A	Metered	Metered	Metered
B	Metered	Estimated[1]	Estimated[2]
C	Estimated	Estimated[3]	Estimated[4]
D	Did not participate in Phase 4		
E	Did not participate in Phase 4		
F	Did not participate in Phase 4		
G	Estimated	N/A	Estimated[5]
H	Estimated	Estimated, includes RA	Included in CA
I	Did not participate in Phase 4		
J	Did not participate in Phase 4		
K	Estimated	Estimated	Estimated
L	Estimated[6]	Estimated	Estimated[7]
M	Estimated	Estimated	Estimated
N	Did not participate in Phase 4		
O	Did not participate in Phase 4		
P	Metered	Estimated[8]	Estimated[9]
Q	Did not participate in Phase 4		

- All datasets for Phase 4 correspond to the 2023 calendar year (January to December).
- All kWh figures include grid, PV (solar) and generator electricity.
- Packhouses are anonymised in the report (named A to P, to adhere to the previous phases' convention).
- The data quality of total electricity usage is typically good, when the source is grid electricity and the data can be obtained from Eskom invoices, for example. Data quality remains an issue when the source is generator or solar energy.
- The allocation of the electricity to the various operations is also not always recorded and must be estimated.

[1] Pome fruit tonnes stored, & number of days stored in cold storage were estimated.
[2] Pome fruit tonnes stored, & number of days stored in cold storage were estimated.
[3] Pome fruit tonnes stored; number of days stored in cold storage & cold storage electricity use estimated.
[4] Pome fruit tonnes stored; number of days stored in cold storage & cold storage electricity use estimated.
[5] Pome fruit tonnes stored; number of days stored in cold storage & cold storage electricity use estimated.
[6] Pome fruit tonnes stored; number of days stored in cold storage & cold storage electricity use estimated.
[7] Pome fruit tonnes stored; number of days stored in cold storage & cold storage electricity use estimated.
[8] Pome fruit tonnes stored, & number of days stored in cold storage were estimated.
[9] Pome fruit tonnes stored, & number of days stored in cold storage were estimated.

3 Electricity Use Intensity Results

The following section presents the electricity use intensity results per packhouse operation.

3.1 Packing operations

3.1.1 Calculation

The metric for electricity consumption by packing operations, expressed in kilowatt-hours (kWh) per tonne of pome fruit packed, is calculated as follows:

Packing operations electricity consumption (kWh) / Tonnes of pome fruit packed

3.1.2 Results

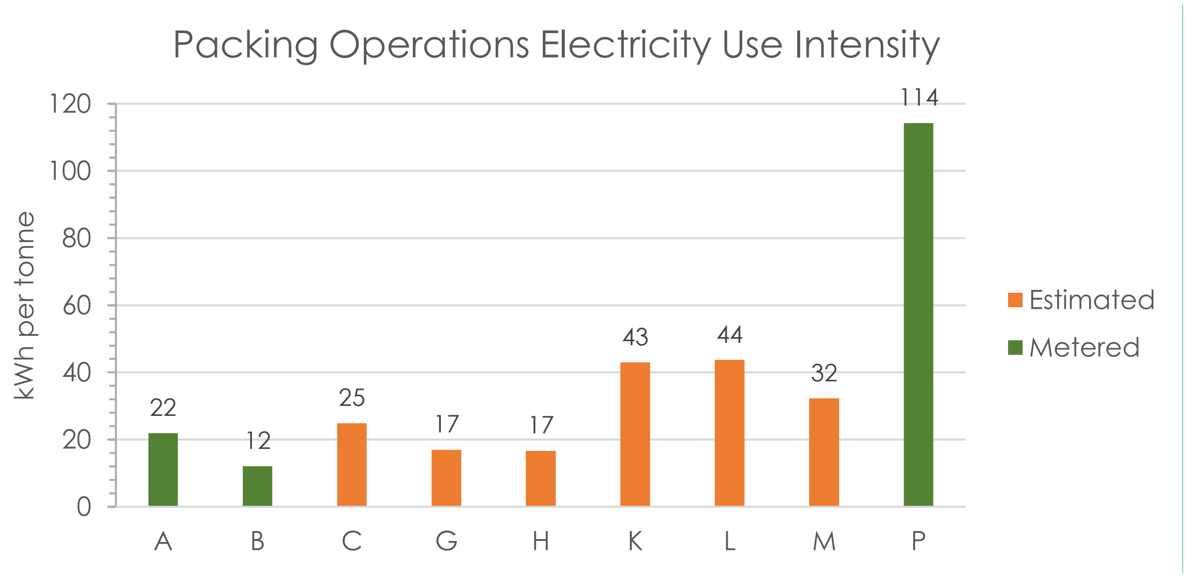

Figure 1: Electricity use intensity of the Phase 4 participant packing operations

Electricity use for packing operations is estimated when separate metering (sub-metering) is unavailable, and only total electricity consumption is measured.

Packhouse P's value relies on metered data from a paid third-party service. Potential issues such as meter faults or incorrect allocation could lead to overestimation.

When analysing the high-quality metered data, electricity consumption for packing operations ranged between 12 to 22 kWh per tonne of fruit. This is similar to phase 3's range of 14 to 33 kWh per tonne.

All packhouses employ energy-saving measures in their packing operations, further detailed in Chapter 9.1.

3.2 Cold storage operations

Cold storage significantly drives packhouse electricity demand. Current metering and record-keeping practices presented a data challenge. Due to limited data separation, controlled atmosphere (CA) storage electricity usage and regular atmosphere (RA) storage electricity usage were combined for packhouses with estimated data. In contrast, packhouse A, the only one with metered data, reported its CA and RA-storage use separately (refer to sections 3.3 and 3.4).

3.2.1 Calculation

The metric for electricity consumption by cold storage operations (CA and RA combined), expressed in kWh per tonne.day is calculated as follows:

Cold (CA + RA) storage operations electricity consumption (kWh) / cold (CA + RA) storage tonne.days

Tonne.days is the unit of measure used to express the time and tonnage of fruit storage.

The cold storage metric cannot only be based on tonnes of fruit stored, as cold storage protocols vary widely. Some packhouses store pome fruit for short periods (days or weeks), while others store fruit for longer (several months to almost a year). Using [tonne.days] the amount of electricity used to store one tonne of pome fruit for one day can be calculated, for example:

200 Tonnes stored for 1 day = 200 tonne.days
200 Tonnes stored for 3 days = 600 tonne.days

3.2.2 Results

Figure 2 displays the cold storage electricity use intensity based on the combination of CA and RA-storage, for all packhouses with estimated data.

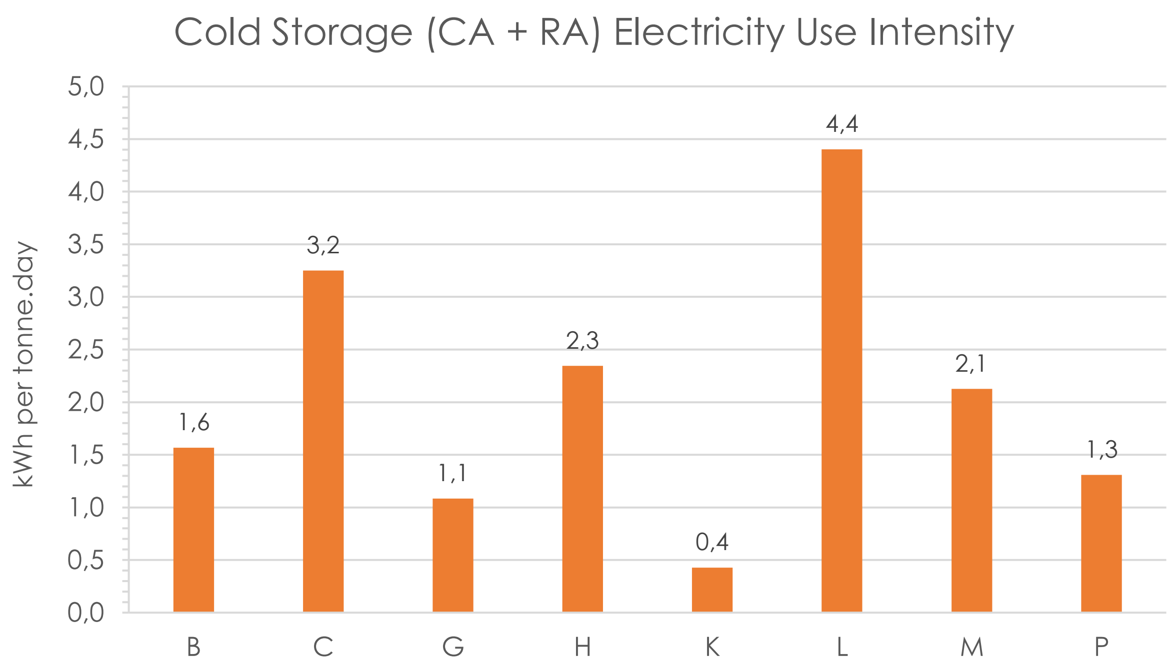

Figure 2: Cold storage electricity use intensity for Phase 4 participants with estimated data

Calculating cold storage electricity use intensity requires the allocated electricity, storage duration (days), and fruit tonnage. Consequently, any estimation in these factors—day count, tonnage, or electricity use for CA or RA-storage—results in an estimated intensity value. While an estimate is valuable, especially for future project phases, accurate data is preferable. From Figure 2, it is evident that the electricity use in CA and RA-storage varied significantly. Various factors could have contributed to these results including data estimations, making it difficult to distinguish between energy intensive activities and unreliable data.

Packhouse G only has RA-storage and no CA-storage.

Participants C and L showed the highest results for electricity use intensities as seen in Figure 2. Packhouse C's tonne-days and electricity use were estimated for both CA and RA storage, which may have led to an overestimation of its energy use intensity. Similarly, Packhouse L's estimated tonne-days and RA cold storage electricity use could account for its potentially inflated energy use intensity.

Some of the energy-saving practices that are utilised by the packhouses in their refrigeration operations in this data collection period are:

- Packhouse B has solar panels installed for their refrigeration.
- Packhouse C have variable speed drives (VSDs) installed on all major compressors to limit current surges during start-up.
- Packhouse M have high speed doors on all RA rooms and manages its underutilised cold rooms by combining them to save energy.

These practices demonstrate commitment to reduce electricity use intensity across the packhouses. Additional energy-saving techniques employed within refrigeration systems of all packhouses are summarised in section 9.2.

However, accurate metering systems are required to ensure precise data analysis for continuous improvement. Sub-metering CA and RA-storage will significantly enhance data quality and granularity. This improved detail will allow packhouses to precisely identify high energy consumption areas ("hotspots"), enabling targeted efficiency measures and maximising overall energy savings.

3.3 Controlled Atmosphere operations

3.3.1 Calculation

The metric for electricity consumption by CA operations, expressed in kWh per tonne.day is calculated as follows:

CA operations electricity consumption (kWh) / CA tonne.days

3.3.2 Results

Packhouse A was the sole provider of high-quality (metered) electricity consumption data for its CA operations, with an intensity result of 0.7 kWh/tonne.day as presented in Figure 3. These results align with a similar study by Bouwer[10], where the electricity use benchmark for the CA storage of apples was less than 1 kWh per Tonne.Day.

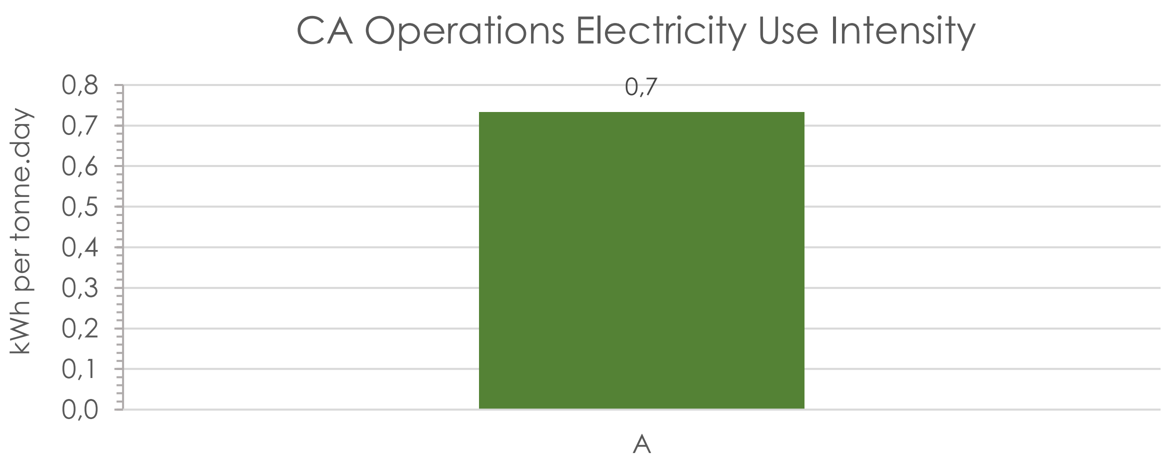

Figure 3: Electricity use intensity of the CA operation of Packhouse A

[10] https://postharvestinnovation.org.za/wp-content/uploads/2017/06/Energy-well-spent-PHI-Project-2014.pdf

3.4 Regular Atmosphere operations

3.4.1 Calculation

The benchmark for electricity consumption by RA operations, expressed in kWh per tonne.day of fruit stored, is calculated as follows:

RA operations electricity consumption (kWh) / RA tonne.days

3.4.2 Results

As with electricity use of the CA storage, Packhouse A was the sole provider of high-quality (metered) electricity consumption data for its RA operations. The result of 7.7 kWh/tonne.day is presented in Figure 3. This result is lower than the electricity benchmark of 8 kWh per tonne apples reported by Bouwer[10], potentially as a result of Packhouse A's initiatives to reduce overall electricity use within its operations.

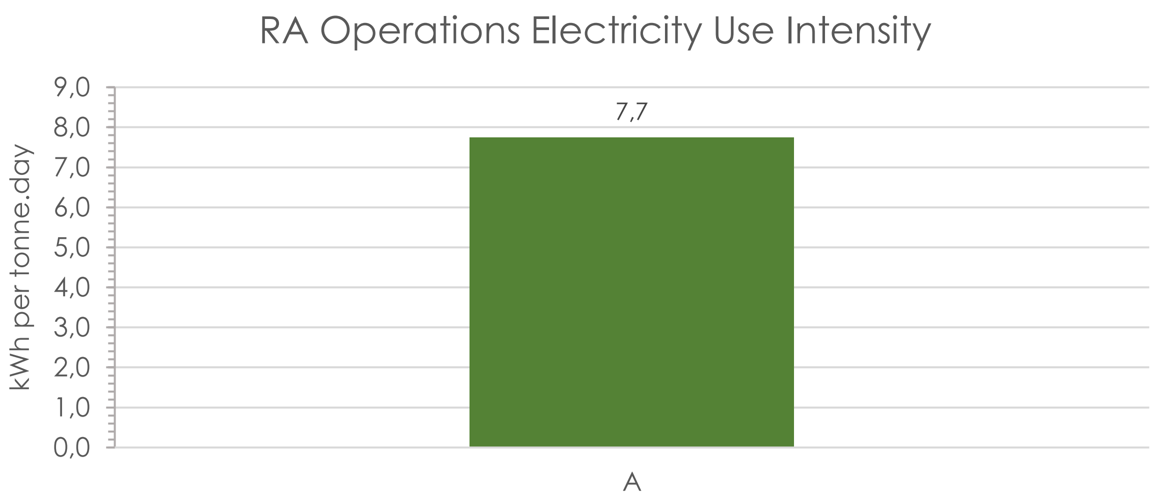

Figure 4: Electricity use intensity of the RA operation of Packhouse A

Packhouse A has VSDs installed on the majority of their CA and RA fans, and their condensers, fans and cold store lights are controlled by a Programmable Logic Controller (PLC) programme. Packhouse A also automatically switches off its lights during every lunch and tea break, demonstrating serious commitment to electricity use reduction efforts through measurable implementation strategies.

The energy-saving techniques implemented by other packhouses in refrigeration are summarised in Chapter 9.2.

4 Overall Packhouse Electricity Use Intensity Results

The overall electricity intensity metric, expressed in kilowatt-hour (kWh) per tonne of fruit packed, combines all measured electricity use for all packhouse operations, except for "other" categories (e.g. housing) that are unrelated to packhouse production activities. However, it's important to acknowledge the limitations of directly comparing this metric across different packhouses.

The overall packhouse electricity use intensity results provide a general indication of energy use per unit of fruit packed. However, the results in Figure 5 should not be directly compared between individual packhouses due to disparities in practices.

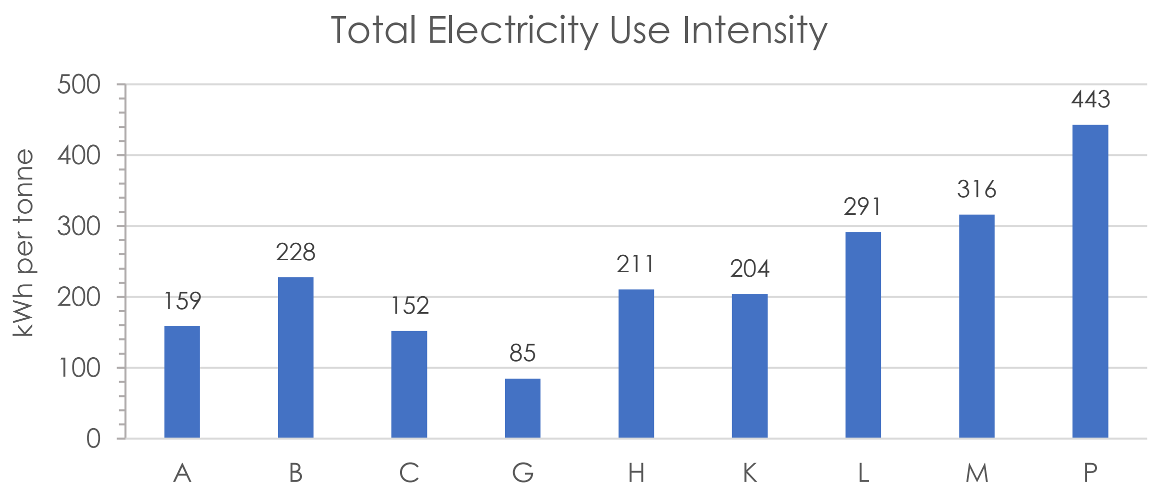

Figure 5: Total electricity intensity

When interpreting the electricity consumption data, it is important to note that the varied electricity use can be linked to:

- **Diverse operations:** Packhouses have unique facilities (e.g., CA storage) and strategies impacting energy needs.
- **Management practices:** Different approaches to energy management yield distinct consumption patterns.
- **Storage duration:** Variations in fruit storage duration can influence overall energy use.

The outlier value of Packhouse P could be due to the third-party meter that was used being faulty and leading to overstated energy use results.

When disregarding the above-mentioned outlier, the average electricity use per tonne of fruit packed in eight packhouses in 2023 was 206 kWh. Therefore, this data suggests an overall decrease in 2023 energy use compared to 2022 (Phase 3) which presented an average of 220 kWh for 12 packhouses that participated in Phase 3.

5 Packhouse Electricity Sources

Electricity used within the packhouses was sourced from the grid, solar and diesel generators. Reliance on generators as a back-up source for electricity has increased due to the increase in load shedding. The sources of electricity are displayed in Figure 6. Expectantly, grid electricity (e.g., Eskom) is the main source, supplying an average of 76% of the electricity used within the nine packhouses. As with Phase 3, eight packhouses make use of renewable (photovoltaic) energy. This addition of renewable energy is positive in terms of sustainability and cost savings, as explored in Chapter 7.

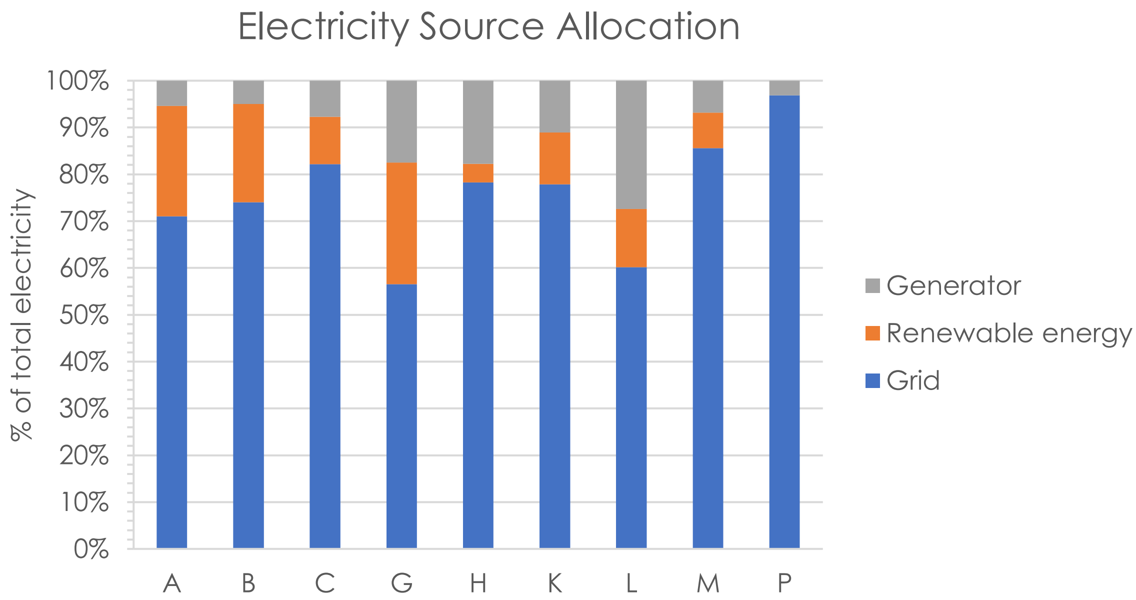

Figure 6: Electricity sources per packhouse

6 Packhouse Electricity Use Profiles

A breakdown of electricity consumption across packhouses can offer valuable insights for potential reduction strategies. Figure 7 presents the percentage of electricity used for various areas and activities within each participating packhouse, excluding activities not related to production (e.g. electricity used for housing).

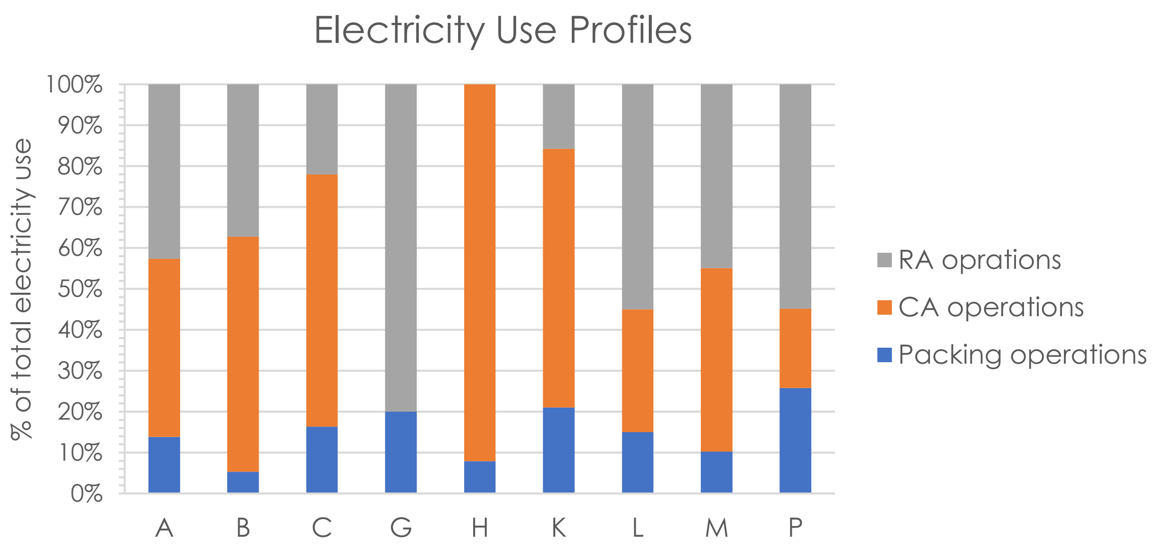

Figure 7: Electricity usage profile per packhouse

It is evident from Figure 7 that CA and RA-storage operations consume more electricity than packing operations across all packhouses. This is expected. The average split of electricity use for the three activities/areas, excluding Packhouse G which only has RA storage, are 39% for RA-operations, 46% for CA-operations, and 15% for packing operations.

Packhouse A provided accurate data, and this profile can be used for comparison in future phases. Packhouse H does make use of RA storage, but energy use could not be distinguished from CA storage due to lack of sub-metering. Variations in electricity use profiles among participating packhouses stem from:

- **Incomplete Metering:** Reliance on estimated data due to a lack of meters.
- **Unallocated Consumption:** Single meters measuring multiple areas (lack of sub-metering).
- **Data Recording Errors:** Inconsistent or inaccurate data entry.
- **Diverse Operations:** Different operational models, including the presence or absence of CA and RA-storage.
- **Diverse Energy Practices:** Varying energy management approaches.
- **CA Storage Differences:** Variations in capacity and operational strategies.

Improving data collection and standardising metering practices will allow for more accurate comparisons.

7 Electricity Cost

7.1 Total electricity cost per kWh

The total electricity cost comprises the cost of grid electricity, renewable energy, and diesel used in generators.

In this phase, renewable energy only included solar (PV) electricity, and the cost of the renewable energy calculation only considered OPEX (including repairs and maintenance) and the financing cost (interest on CAPEX) of renewable energy consumed in 2023.

The formula for calculating the total electricity cost per kWh was as follows:

Grid electricity cost (ZAR) + Generator fuel cost (ZAR) + Renewable (PV) OPEX cost (ZAR) + Interest on renewable energy CAPEX (ZAR) / Total electricity consumption (kWh)

Figure 8 presents the total electricity cost (ZAR per kWh) for each packhouse, excluding Packhouse H. Packhouse H's renewable energy CAPEX interest was based on estimated data. Apart from this exception, the remaining data, sourced from metered readings or invoices, is considered high quality. Only five of the eight packhouses using renewable energy (C, H, K, L, and M) provided renewable energy cost data.

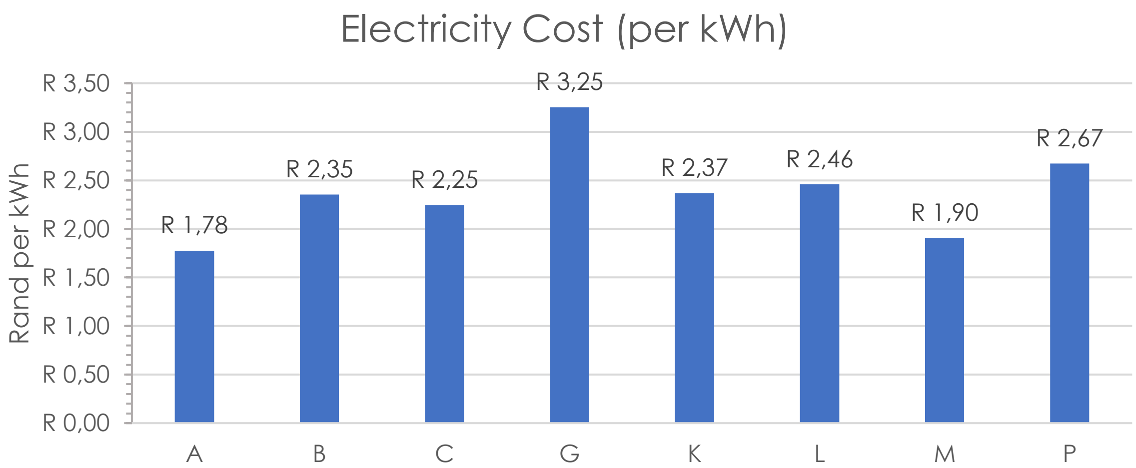

Figure 8: Electricity cost for each packhouse

The average electricity cost for the packhouses in 2023, excluding the outlier and estimated data, was R2.25 per kWh used, a notable increase from the average cost of R1.63 per kWh in 2022.

7.2 Electricity cost per source

Figure 9 presents the costs for the electricity sources that supplied each packhouse.

The formula for calculating the renewable energy cost is as follows:

(OPEX (ZAR) + interest on CAPEX (ZAR))/ Total renewable energy consumed (kWh)

The figure below shows the distribution of electricity cost per source for the participating packhouses. From this figure it is evident that in 2023, electricity from generators was the most expensive whereas the cost of renewable energy was the least expensive. This trend was also apparent in previous years of this study. It is recommended that packhouses further investigate renewable energy and battery storage solutions to mitigate the impact of load shedding and achieve long-term cost savings, despite the initial investment.

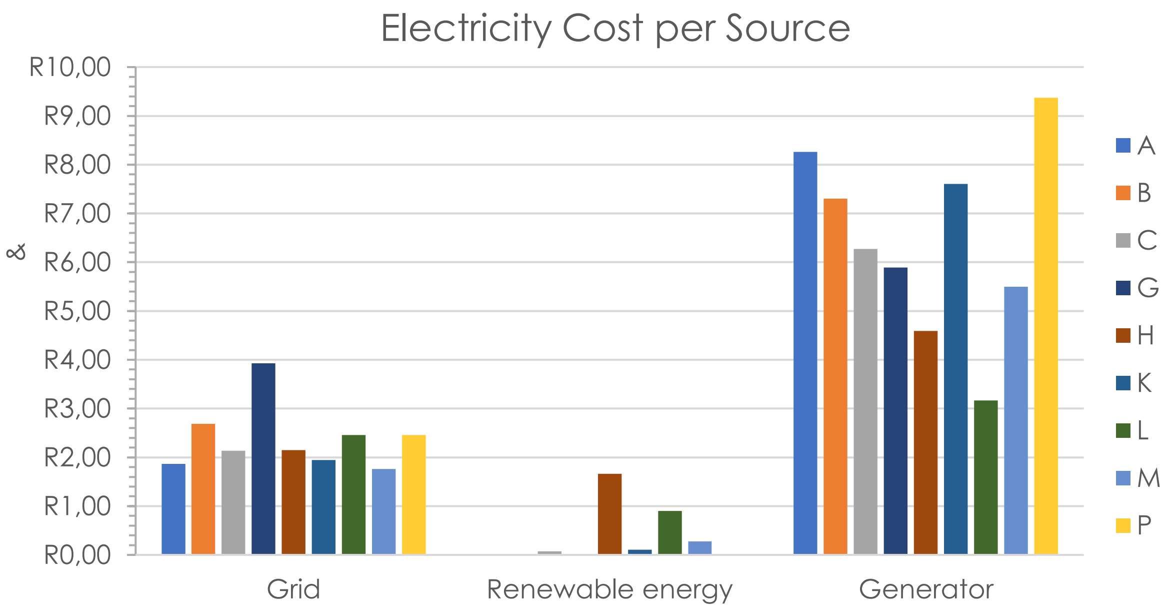

Figure 9: Cost per electricity source for each packhouse

Packhouse H's renewable energy financing cost (interest cost only) was estimated. Apart from the two aforementioned cases, the quality of the cost data was generally very good. The sources of this data are:

- Eskom or municipal invoices for the grid electricity costs.
- Packhouse-owned meter readings or financial statements for renewable energy and generators.

The average grid electricity cost per kWh for 2023 was R2.38. This is notably higher than the R1.87 per kWh reported for 2022 grid electricity costs in Phase 3. The observed increase aligns with the 18.65% tariff hike authorised by NERSA in 2023. For more information on the grid electricity pricing, Eskom's Tariffs and Charges Booklet[11] can be consulted.

Figure 10 presents the source of generator electricity by model/type that was employed among the packhouses during Phase 4. Scania is the most popular generator model employed by the packhouses, followed by Volvo.

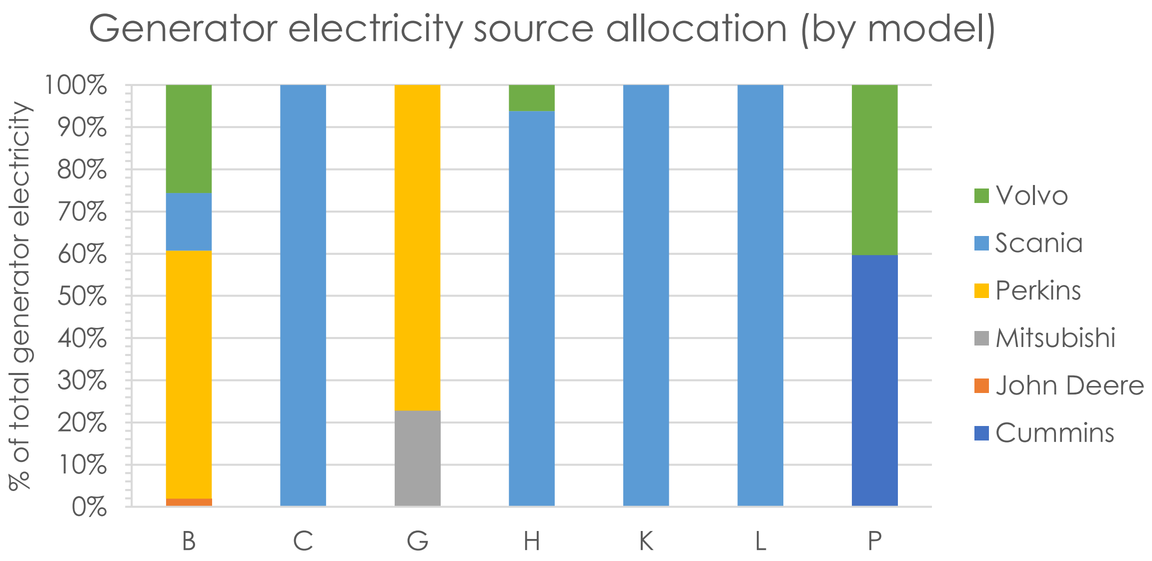

Figure 10: Generator electricity source allocation by model

Figure 11 represents the efficiency of the different generator models (litres of diesel per kWh). Packhouse A and M could not supply electricity use per generator model/type and are therefore not present on the graphs.

Generator efficiency for Scania units ranged considerably among the packhouses, from 0.13 litres of diesel per kWh up to 0.36 litres per kWh. Notably, the Volvo generator used by packhouse L achieved the best efficiency at 0.12 litres of diesel per kWh. At the other end of the spectrum, the John Deere generator, found only at packhouse B, had the poorest efficiency at 0.96 litres per kWh. This could be due to it being an older model type with reduced efficiency over years of use.

[11] https://www.eskom.co.za/distribution/wp-content/uploads/2023/10/9454J-Eskom-Tariff-booklet-Interactive-final.pdf

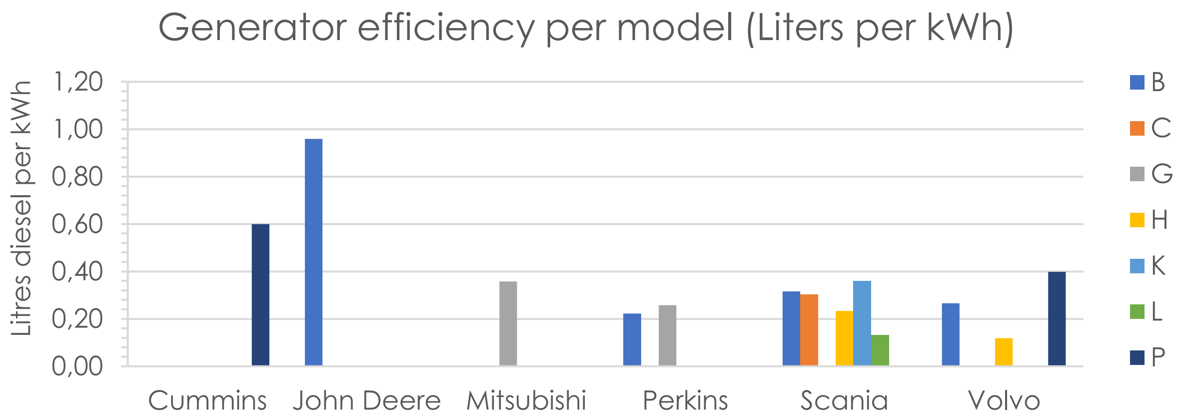

Figure 11: Generator efficiency per model

8 Year-on-Year Analysis

Year-on-year comparisons offer valuable insights into energy consumption reduction efforts.

South Africa's energy crisis intensified significantly in 2023, with a record 21 715 Gigawatt-hours (GWh)[12] of load shedding experienced across 332 days[13] of Eskom-implemented power cuts. This represents a dramatic increase compared to the 11 529 GWh load shed in 2022[13]. The situation had been considerably less severe in preceding years, with 2 521 GWh affected in 2021 and only 1 798 GWh in 2020[13]. This represents a twelve-fold increase in load shedding between 2020 and 2023, which compelled a greater reliance on diesel generators by packhouses as seen in the previously discussed results.

The figure below illustrates the electricity intensity for packing operations over the years. Since 2022, packhouses B, K, L and M have demonstrated a decreasing trend in electricity use per tonne of fruit packed (Figure 12). Notably, Packhouse B has achieved a consistent yearly decrease since Phase 1. This improvement can be attributed to two key factors: an increase in packed tonnage from 2020 to 2023, and the implementation of energy-saving practices, such as the adoption of energy-efficient motors and LED lighting. Packhouses A and C demonstrated stable electricity use within their packing operations over the years. In contrast, packhouses G, H, and P experienced increases in packing electricity use intensity during the same period. The aforementioned packhouses all had lower packing volumes as a result of weather damage within their respective regions, which may have contributed to higher electricity use per ton of fruit packed since 2022.

[12] https://www.resbank.co.za/content/dam/sarb/publications/occasional-bulletin-of-economic-notes/2024/recent-gdp-growth-outcomes-exceed-expectations-despite-record-power-outages-april-2024-01.pdf
[13] https://iol.co.za/news/politics/2024-02-14-how-south-africas-load-shedding-crisis-escalated-over-17-years/

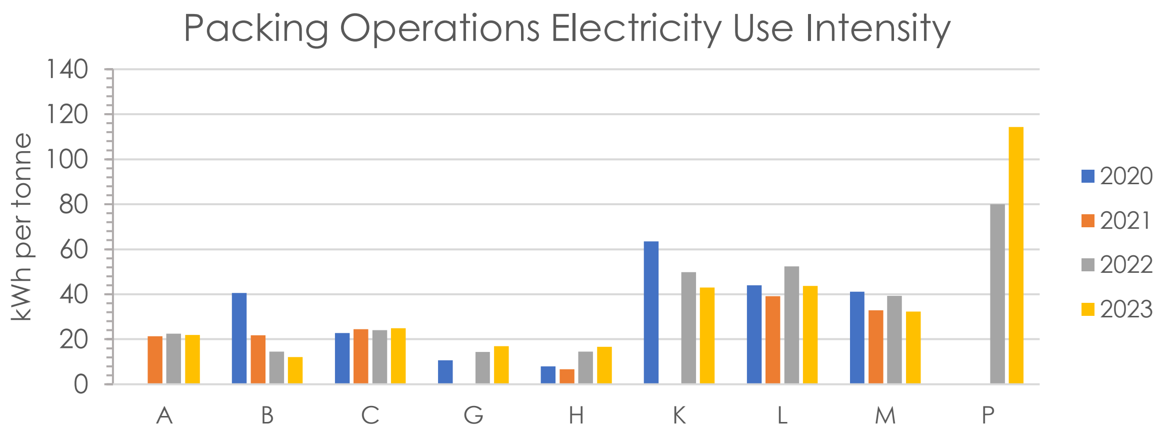

Figure 12: Year-on-year comparison of packing operations electricity use intensities

The year-on-year comparison (Figure 13) was conducted using consumption data for both CA and RA-storage to ensure reliable results, as most packhouses do not have measures in place to accurately separate electricity consumption data between the storage operations.

In Figure 13, Packhouse P was excluded from the visual analysis because its 2022 cold storage electricity consumption estimate (5.3 kWh per tonne.day) was an outlier compared to its 2023 metered data (1.3 kWh per tonne.day).

Packhouses A, K and M showed decreasing trends since 2022 in their electricity consumption per tonne-day of cold storage, while packhouses G, H and L showed an increasing trend since 2022. Packhouse B and C have shown stable electricity use intensity since 2022.

Reasons for variation in cold storage electricity use intensities among the packhouses can be investigated in future phases by considering the different storage protocols.

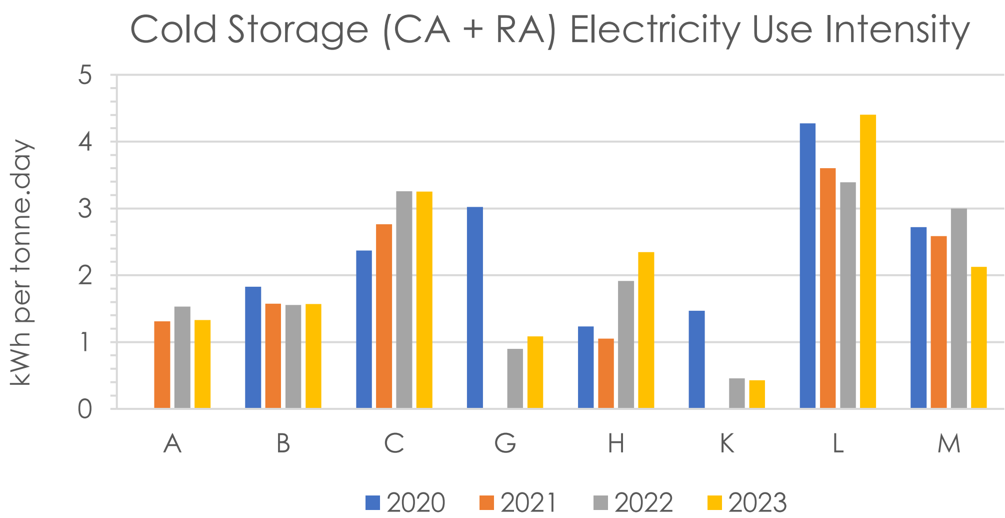

Figure 13: Year-on-year comparison of cold storage operations energy use intensities

From the overall (total) packhouse electricity intensity results (Figure 14), Packhouses A, K, L, and M showed decreasing trends since 2022, while Packhouses C, G, H and P each reflected an increase in electricity use intensity. Packhouse K has achieved a marked decrease in its overall electricity consumption from 2020 to 2023, indicating successful energy efficiency initiatives.

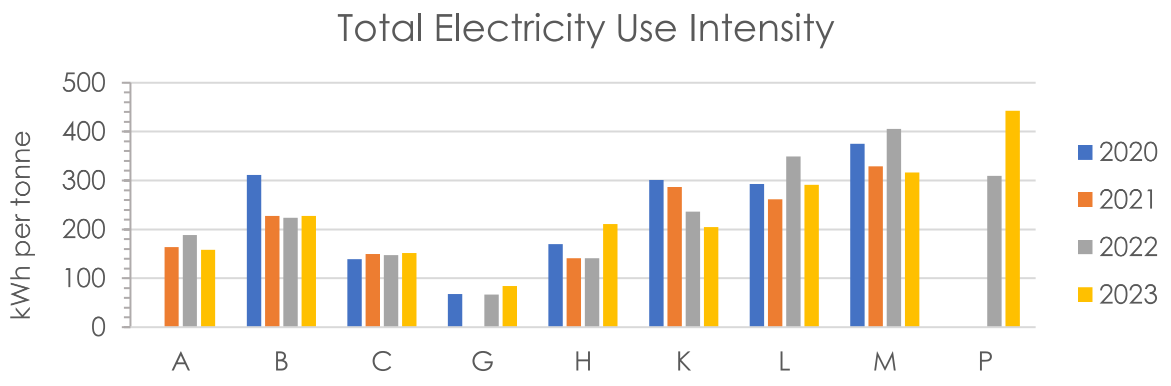

Figure 14: Year-on-year comparison of overall packhouse electricity use intensities

Figure 15 illustrates the percentage allocation of electricity sources for all packhouses from 2021 to 2023. Data for 2020 was excluded because generator information was not collected during Phase 1, making it incomparable with subsequent phases. From the figure it is evident that there was an overall greater reliance on renewable energy and generators in 2023 compared to previous years. This is mainly due to a high level of load shedding hours in that period but can also represent an increase in uptake of reduction measures within packhouses by employing renewable power sources rather than grid electricity. The average percentage reduction in grid electricity use between 2022 and 2023 was 19%. If this trend persists, overall electricity use intensity and cost should reduce significantly.

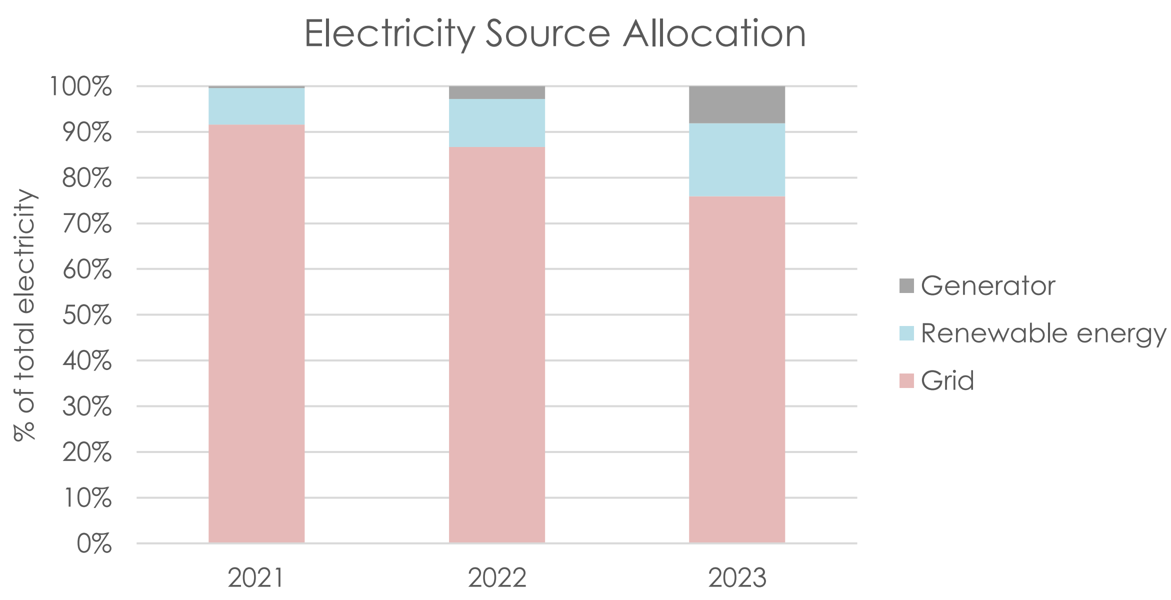

Figure 15: Year-on-year comparison of electricity sources

9 Energy Management Practices

Information on energy management and energy-saving practices within the participating packhouses were gather through structured questionnaires. This section presents a summary of these results.

9.1 Pre-sort/packing line

All packhouses indicated that they apply energy-saving practices in the pre-sorting and packing lines. The various practices that were applied in 2023 by each packhouse are visually presented in the graph below.

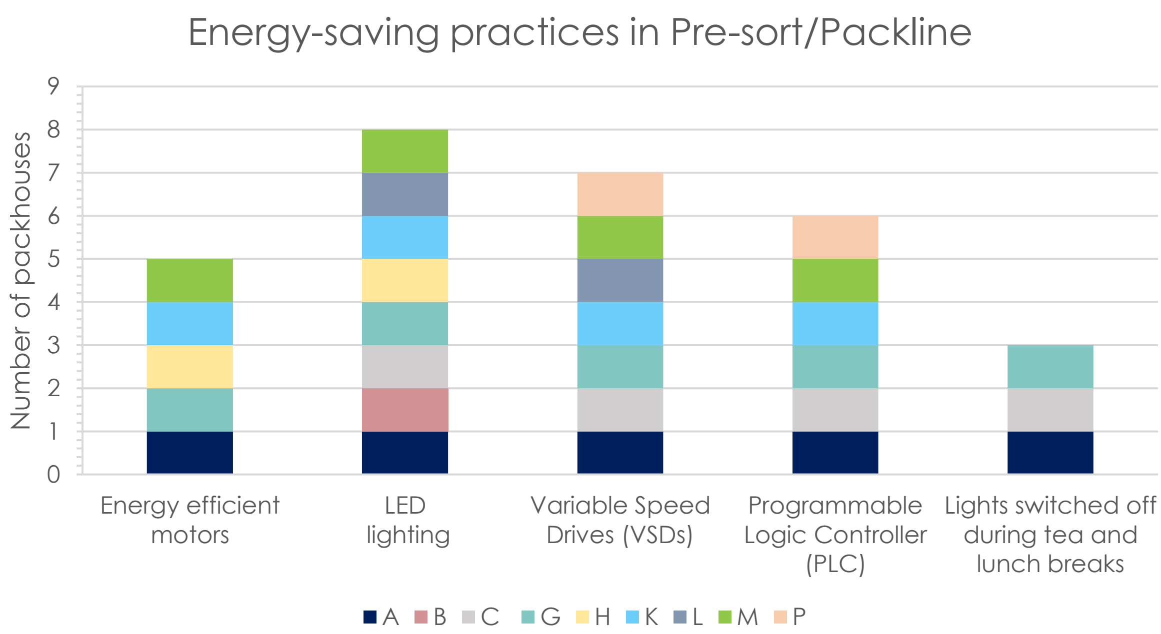

Figure 16: Energy-saving practices applied in the presort and packing line

- 67% packhouses used energy-efficient motors.
- 89% of the packhouses have LED lights installed.
- 78% of the packhouses made use of VSDs.
- 67% of the packhouses have PLCs installed.
- 33% of the packhouses switch off the majority of their lights during employee tea and lunch breaks. Besides saving electricity, it raises awareness and reinforces a culture of efficient resource use.

9.2 Refrigeration

All packhouses indicated that they apply energy-saving practices in the refrigeration plants. The results are illustrated in the figure below.

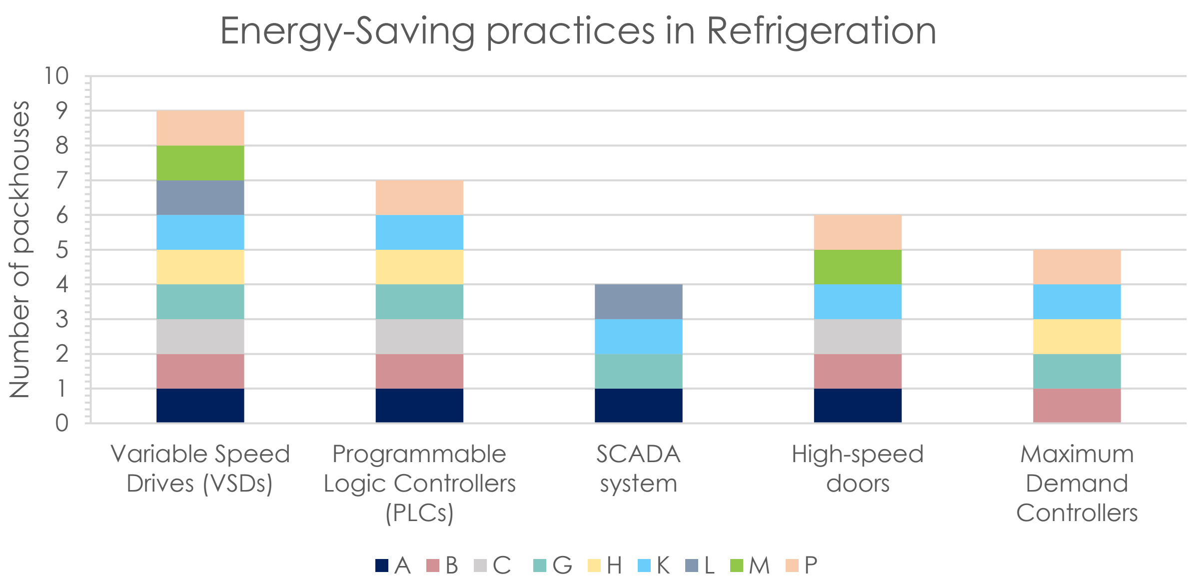

Figure 17: Energy-saving practices in the refrigeration operations

- All of the packhouses have VSD motors installed on compressors and fans in the cold storage units.
- 78% of the packhouses use a PLC program to manage their condensers, which allows only the necessary compressors to operate.
- 44% of the packhouses use a SCADA system to manage energy use.
- 67% of the packhouses have high-speed doors installed. High-speed doors reduce energy losses by reducing the time an opening between cold rooms is exposed to direct airflow and hereby minimising heat lost from the premises or gained from outside.
- 55% of the packhouses use maximum demand controllers to optimise peak energy usage.

9.3 Ablutions, canteens and offices

All of the packhouses apply energy-saving practices in their ablutions, canteens and offices, of which the results are presented below.

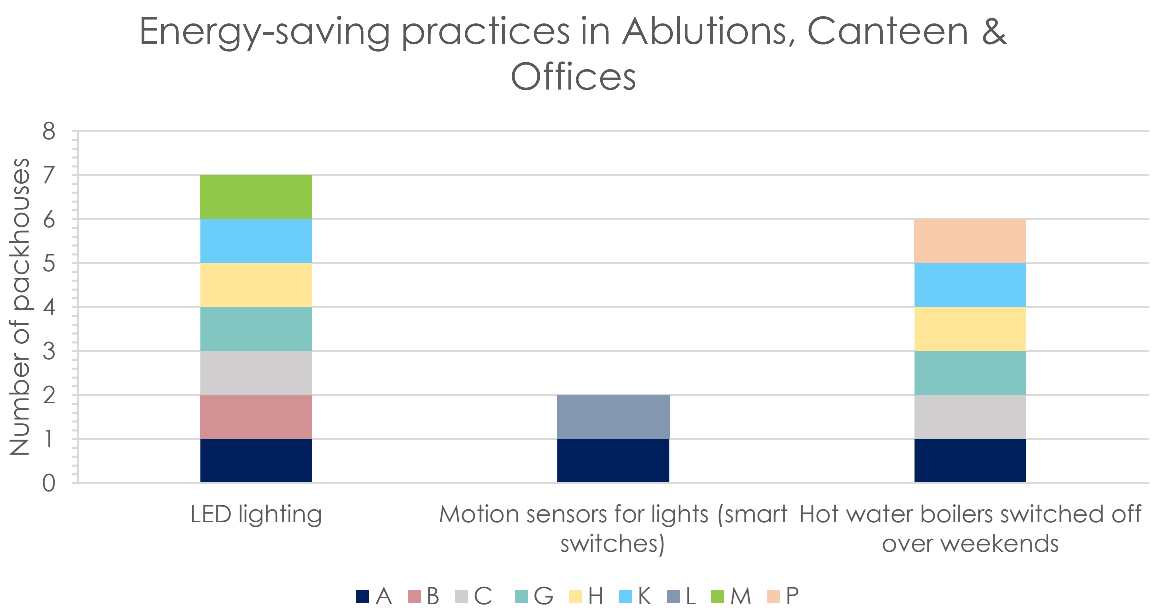

Figure 18: Energy-saving practices in ablutions, canteens and offices

- Seven of the packhouses make use of LED lights in their staff facilities.
- Two packhouses use motion sensors on office lights.
- Six packhouses switch off hot water boilers at the close of business on a Friday and only restart them on Mondays.

These energy-wise measures are easily implementable, whilst making a contribution to overall packhouse energy efficiency.

9.4 Additional energy-saving practices

Apart from solar system installations, three packhouses indicated that additional energy management practices are applied.

- Packhouse G installed smart switches to switch off lights, compressors and motors remotely.
- Packhouse H has timers in their cold rooms that switch off cooling fans during peak demand hours.
- Packhouse K has Power Factor Correction on its main electrical. This packhouse does energy monitoring for optimal energy use.
- Packhouse L switches its plant room off whenever possible.

9.5 Cost savings from implementing energy saving practices

Among the packhouses surveyed, five were able to provide an estimate of cost savings, averaging R2 078 984 (1.293 GWh) per packhouse, that was achieved through the implementation of energy efficiency measures. The estimate was not linked to a specific practice, but just an estimation of overall savings associated with all applied energy-saving practices. While these estimates reflect overall savings from multiple initiatives rather than a single practice, future data collection will aim to disaggregate these savings, linking specific financial benefits to individual energy management practices for greater clarity and targeted improvements.

10 Conclusion

The energy use project continued to deliver significant value, shown through nine participants for Phase 4 also participating in previous phases. Enhanced data sense-checking, driven by the inclusion of data from previous phases and new solar installation information, provided a richer context and clearer insights into energy consumption trends. Furthermore, refining data collection for renewable energy costs yielded more accurate results, strengthening the foundation for informed management decisions.

It's highly encouraging to see all participating packhouses now consistently employing energy-saving practices across all operational areas, instead of just some areas as reported in previous phases. This widespread adoption, supported by packhouse-provided data demonstrating cost and energy savings, highlights a maturing commitment to efficiency within the industry. The increasing reliance on solar energy sources is a particularly positive development, underscoring a strategic shift to counter severe load shedding. With rising electricity and diesel costs and disruption of operations by load shedding now a reality for business in South Africa, packhouses should continue prioritising renewable energy and battery storage systems over costly diesel generators to enhance operational resilience and secure long-term cost benefits.

With four years of robust data, the project provides insight to understanding year-on-year energy consumption trends. While some packhouses demonstrate a positive decreasing trend in energy use intensity, achieving widespread reduction across the board remains a key objective.

Continued challenges in accurate metering and record-keeping, especially in cold storage where electricity use is often undifferentiated, limit the ability to pinpoint energy hotspots and unlock true value for efficiency gains. Addressing these metering limitations will be crucial for guiding more precise energy management decisions. Future efforts should also focus on overcoming participation hurdles through optimised project timing and targeted industry incentives to expand data collection and foster broader adoption of best practices.

11 Recommendations

This section highlights recommendations for implementation by industry and packhouses.

Industry ESG reporting:
Industry ESG reporting will play an increasingly important role in future. Establishing ESG data collection and reporting systems takes time. Fortunately, this project has established energy data collection, methodology and tools. It is recommended that Hortgro places a requirement on packhouses to at least report the following via the PAG project:

- Overall energy use [kWh]
- Energy use per source [kWh]

Industry-Wide Action:

- **Metering Campaign:** Launch an industry-wide campaign or standard to promote consistent metering and recording, whilst ensuring data integrity across packhouses. This initiative, previously recommended and supported by PAG members, should be budgeted for in the next funding cycle.
- **"Energy Heroes" Initiative:** Implement a recognition program (e.g., "Energy Heroes") to celebrate and incentivise packhouses demonstrating energy use excellence, encouraging wider participation. Year-on-year reductions in energy consumption can be recognised through a designated award system.

To further refine energy **data collection** and analysis in future and ensure even more valuable data is yielded, the following recommendations are proposed:

- Diagnose the root causes of packhouse **metering challenges**. This information will inform targeted support and improvements to the data collection process.
- Solicit **feedback** from participants regarding the data collection tool and process. This input will guide efforts to enhance user-friendliness and efficiency.
- Continue the **annual data collection** to solidify energy consumption **trends**. This longitudinal perspective is crucial for establishing reliable results.
- Gather information on **cold storage protocols**. This standardised data will facilitate data categorisation and allow for more accurate comparisons.

In addition to the data collection recommendations, here are actionable steps for **packhouses** to reduce their consumption and incorporate renewable energy sources:

Improved Metering and Record-keeping:

- The installation of submeters is recommended for enhanced data quality and hotspot identification.
- Packhouses are encouraged to record tonnages and duration of cold storage.

General Packhouse Energy-Saving Measures:

- **Optimise refrigeration systems:** Regularly maintain and service refrigeration equipment and consider energy-efficient models, to ensure peak efficiency.

- Install **occupancy sensors** in areas like offices and break rooms, to automate lighting control and prevent unnecessary energy use.
- Ensure proper **ventilation system** maintenance and explore options for more energy-efficient models with variable speed drives or heat recovery capabilities.
- **Invest in building envelope improvements:** Building insulation and air sealing minimise heat gain or loss, leading to reduced reliance on heating and cooling systems.
- **Behavioural change programs:** Promote employee awareness of energy-saving practices through communication campaigns. Encourage responsible behaviour like switching off lights and equipment when not in use.

Renewable Energy Integration:

- **Evaluate on-site renewable energy generation:** Conduct feasibility studies to assess the potential and economic viability of renewable energy systems.
- **Power purchase agreements (PPAs):** Consider entering PPAs with renewable energy providers to purchase clean electricity at competitive rates.
- **Advocate for renewable energy policies:** Engage with policymakers and industry associations to support policies that incentivise and facilitate the adoption of renewable energy sources.

By following these recommendations and participating in the data collection process, packhouses can contribute to reducing their environmental impact and achieving greater energy efficiency. Ongoing data analysis is crucial for identifying further areas for improvement and measuring the effectiveness of implemented strategies year-on-year.