Results showed that there are surprisingly large differences in energy cost and consumption between facilities. In these variances lie the opportunities for improved energy efficiency. The analysis of consumption has created a comparable measure to serve as a baseline for future improvement, and the quantitative results provide a means of setting targets and developing improvement action plans.

Cold storage was found to be the most energy intensive process and also showed the greatest potential for energy efficiency improvement in the short- to medium term. Energy efficiency improvements lie primarily in the management practices applied and the control of major refrigeration units like compressors, condensers and fans.

The energy crisis in South Africa has recently translated into significant hikes in the cost of electricity. This has come at a time of global recession and uncertainty regarding the prices that export fruit will be able to command on international markets. At the same time pressure is being exerted by markets around the world that suppliers of fresh produce demonstrate the environmental sustainability of their production and processing operations and contribute to the global quest for diminished carbon emissions. In this regard, an acceptable energy audit process to assess compliance to certain supermarket standards has been lacking.

Fruit pack houses and cold stores use electricity to power a wide variety of machines required to transform the harvested product into attractive, pre-cooled, palletized and containerised consignments ready for transport to port terminals. Having a measure of the amount of energy used in these various operations is the first step in bringing about an awareness of the areas that should be targeted to conserve electricity and fuel usage. In isolation, however, such information is of limited value. More importantly, pack house and cold store managers need to know how the energy usage and costs of their units compares with that of other similar farming and processing operations. This requires that information from an energy benchmarking study be generated and then made available to industry. This information will assist managers to identify and apply corrective actions to processes where inefficient energy practices are being applied.
Against this backdrop South Africa’s post-harvest innovation programme, a public/private initiative, was formed with the goal of improving the international competitiveness of the South African fruit industry through innovations within the supply chain. As part of this process the Programme elected to support a project to develop a benchmarking system for energy consumption at pack houses and cold stores.

This paper reports on the methodology used and the findings of the study.

Methodology

Nature of the fruit industry

The fruit export industry has some unique characteristics that are not similar to other industries. The focus is on the production and packing of fruit and this is where most of the resources, knowledge and research are applied. Most of the businesses like packhouses and cold stores lack the in-house competence for electricity consumption and analysis. Information on these is also not readily available, since it was not part of the historical focus area. Technical information about equipment is not available on site as third party service providers offer that service to these facilities.

The facilities are owned and managed by private entities. In a large industrial group of companies an improvement program can be launched by senior management via the reporting structures. In the decentralised fruit industry another approach was needed to motivate participation in such a program.

These were two of the main reasons for the launch of a benchmarking system to kick-start an energy efficiency program in the fruit facilities.

The size of the fruit export industry can be summarized as follows:

- 1.7 mt of fruit exported per year
- 300 GWh electricity for irrigation, packhouse activities and cold storage.

The collective is quite a large consumption of electricity and the challenge is to find a way to reach the hundreds of facilities so that they can contribute to the energy saving initiative.

Benchmarking

Lots of literature is available on benchmarking and ways to apply it for various purposes. The following definition is applicable for this study:

“Benchmarking is the process of comparing performance against the practices of other leading companies for the purpose of increasing performance.”

Units of measure

The selection of an appropriate unit of measure is key to the success of a benchmarking exercise. The challenge is to define the unit of measure in such a way that the result is not influenced by less important variables. The following units were defined:

- **Electricity cost**
  - The total cost paid for electricity per kWh used (c/kWh). The total cost includes energy charges, admin charges, maximum demand charges and any other cost on the bill.

- **Packhouse consumption**
  - The kWh electricity used per ton of fruit (kWh/ton).

- **Cold store consumption**
  - The kWh electricity used to keep one ton of fruit cold for one day, after removal of field heat. (kWh/ton-day). This definition was developed specifically for this industry.
Another cause for errors.

Documents. The unfamiliar terms were data to be copied by hand from source systems has caused some detailed

The lack of appropriate information

Data transfer

the major application groups.

Most facilities have good information

for financial and operational data,

Electricity split

Many facilities have a shared supply of electricity feeding a packhouse,

cold stores and in many cases some houses and farming equipment as well.

Submeters were not available in most cases. Assistance was needed to split

the consumption into application groups. This was done by means of sampling,

theoretical calculations and modelling techniques. An example is provided in

Fig. 1.

Terminology

The concepts of kWh and kVA were not used on a regular basis in these facilities. Errors in data accumulation could be expected in such an environment.

Information systems

Most facilities have good information systems for financial and operational data, but nothing on electricity consumption in the major application groups.

Data transfer

The lack of appropriate information systems has caused some detailed data to be copied by hand from source documents. The unfamiliar terms were another cause for errors.

Energy audit

The solution to the above potential problems was to do a complete energy audit on the information supplied. In many cases, the formulas and methods had to be adapted to obtain results with the available data supplied.

Results

Cost benchmarking

The benchmarking results for 2010 appear in Fig. 2. This exercise needs to be repeated every year due to inflationary increases. The results show a wide variation in cost per kWh, from 38 c/kWh to 131 c/kWh. This is a result of different electricity suppliers, tariff structures and the appropriate use of tariff packages like “time of use”. The results show in quantitative terms how much a facility can save in electricity cost by applying some of the above solutions, if applicable to its situation.

Packhouse benchmarking

The benchmarking results appear in Fig. 3. The variation is also very wide between 15 kWh/ton and 44 kWh per ton. This shows that some packhouses use three times more electricity to pack the same unit mass of fruit. The facilities with the higher consumption can analyse their situation and apply corrective action to consume less energy. The current situation and a target value is available as input to the improvement action plan. Contributors of energy consumption in packhouses are the movement of fruit on conveyors, lights, carton erecting machines, sorting tables, water pumps and dryers.

The productive use of equipment, as indicated by the throughput per hour, has a large impact on the electricity consumption per ton. The reason for this is that most of the equipment is running at operation hours and is not dependent on the volume at any time.

Cold store benchmarking

The benchmarking results for cold stores appear in Fig. 4. It shows a variation between 5.5 kWh/ton-day and 9.5 kWh/ton-day. The variation can be caused by a number of reasons, and the most obvious are not always the real causes. One example is ambient temperature and the removal of field heat. Results have shown that these factors are not significant to the variation, but rather that operating practices play a much greater role than anticipated.

The refrigeration equipment in an industrial application is more complex and has many variables to control for an optimum solution. One important aspect is the balance between the different units in such a refrigeration plant. The units influence each other and a suboptimum setting can cause greater consumption at a unit - leading to a less efficient situation.

Another type of benchmarking is applied on the ratio of electricity consumption between the units. A variation to the norm can indicate where the improvement opportunities are. One example of such a breakdown is given in Fig. 5.

Conclusions

The study has shown that a benchmarking approach is a good tool to use as a starting point for an industry where there are many participants with similar processes.

The benchmarking results provide information on energy consumption in packhouses and cold stores that was not available before. The quantitative results set a baseline for future improvements and act as a motivator for facilities to participate in the energy efficiency program. The quantitative results also serve as a guideline for setting improvement targets.

Large variations in all the benchmarking results are an indication of the improvement potential. The relative position of a facility leads to the identification of improvement areas. Improved energy efficiency is achieved by more suitable equipment, but also adapted management practices in the application and utilisation of that equipment. The benchmarking approach has provided a solution to the fruit export industry and can also be applied to other industries to stimulate an energy efficiency improvement program.

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