

AN OPEN-AND-SHUT CASE

During a trial to quantify the energy savings achieved by retrofitting doors to its refrigerated dairy display cases, a New Zealand supermarket chain saw an unexpected 42 per cent fall in energy consumption. However, what they did next was a surprise, reports **Sean McGowan**.



Retail supermarkets both here and in New Zealand, are intensive consumers of electrical energy, with 50 per cent of consumed energy used on refrigeration alone.

Many supermarket chains have made significant reductions in their energy consumption through selection of plant type, refrigerant and refrigeration cases. Yet there remains many more opportunities to further reduce energy.

Most supermarkets have bid farewell to the old (chest) freezer coffins in favour of upright freezers with clear glass doors. However, there remains a reluctance to adopt a similar approach to open dairy refrigeration cases.

Usually at the rear of the store, they store dairy items such as milk, butter, yoghurt, cheese, dips and smallgoods.

According to a report published by ECOsystems for the Energy Efficiency and Conservation Authority (EECA) in New Zealand, much of this reluctance is sales driven.

“The barrier to retrofitting doors on open cabinets appears to stem from a perception that they will impact a customer’s shopping experience, translating into a negative sales impact,” states the EECA report.

So under the engagement of EECA, ECOsystems set about on a trial retrofit of doors on open dairy refrigeration cabinets in an Auckland supermarket. Their aim was to capture and analyse the impact on energy use and sales.

“The initial expectation was that energy savings in the vicinity of 30 per cent would be achieved, supporting a payback of approximately five years,” the report, titled Trial Retrofit of Doors on Open Refrigerated Display Cabinets, says.

“This payback period is longer than generally acceptable within this sector, especially when combined with the perceived risk to sales. It is for these reasons that EECA decided a government-funded trial was required.”

PROGRESS WITH PROGRESSIVE

Soon after, one of New Zealand’s major supermarket operators Progressive Enterprises (operators of the Countdown chain) came on board, agreeing to have doors fitted to refrigeration cabinets at their Pukekohe South store.

The trial was agreed to run for a period of 12 months.

To gauge the effectiveness of the trial, energy-monitoring equipment was installed on the refrigeration systems. Temperature loggers were also installed to assess changes in temperature.

Customer surveys were undertaken before and following the installation of doors, and sales data for products within these cabinets was made available and analysed.

The doors selected for installation in this trial were European-made, double-glazed, low-E, no-heat, hinged, barn-style doors. These doors were rated for operating conditions in the European Climate Class 3, which prescribes a dry-bulb temperature of 25°C and a relative humidity of 60 per cent.

The doors were test fitted before the commencement of the trial at a factory test room. They were also tested during a field trial on a dairy case at another of the chain’s supermarkets in Auckland.

As a result of this testing, it was agreed that some modifications would be required before the installation for the trial. This included fitting trim heaters to the base of the door frames to avoid sweating on humid days; changing the cabinet expansion valve to reduce refrigeration duty; and fitting an air deflector to the return-air duct to reduce thermal loading at the base of the door frame.

To reduce air velocity, it was also agreed to fit lower-pitched fan blades. Additional lighting was also fitted to ensure products remained well lit during display. In this case, an LED narrow-beam product was used.

A total of 58 doors were fitted across 10 cases at the Pukekohe South store in late June 2013.

These dairy cases house a range of standard refrigerated product including staple items such as butter, margarine and cheese. They also include a wide range of “discretionary” items including pizza, pies, spreads, dips, fresh pasta and pre-cut small goods.

Immediately following the installation of the doors, positive feedback was received from both staff and customers.

TANGIBLE RESULTS

The dairy cabinets involved in the trial were a “medium-temp”, MT3-type unit within the store’s wider refrigeration system. Energy loggers were used to sub-meter the electricity use of the cabinets.

Within two days of the doors being installed, an instant and dramatic decrease in energy use was evidenced.

The kilowatt refrigeration load had fallen from 41.8kW to 24.4kW following the installation, delivering a significant 42 per cent reduction.

Dairy Cabinet Electricity Analysis				
	Average Amps*	kW **	Annual Cost (kWh) ***	Annual Cost (\$) ****
Before 28 June	67.04	41.8	366,182	\$54,927
After 28 June	39.07	24.4	213,388	\$32,008
Savings	42%	42%	152,794	\$22,919

- * Average amps refrigeration electrical draw measured hourly before and after the doors were fitted
- ** kW refrigeration load before and after doors were fitted
- *** kW refrigeration load extrapolated over 8,760 hours to provide annual kWh
- **** Electricity tariff assumed as 15c/kWh

Table 1: Dairy Cabinet Electricity Analysis

Based on this reduction in energy use, and the cost of the door retrofit, the simple payback from the installation was calculated at 3.5 years, with a return on investment of 29 per cent.

Additionally, the retrofit would deliver an annual reduction in greenhouse gas emissions of approximately 21 tonnes.

“No other changes to this MT3 system were made during the fitting of doors to the cabinets,” the report says. “And the reduction in electricity consumption is solely attributable to the installation of the doors.”

These savings far outstripped those of similar trials previously conducted in a Swedish supermarket (26 per cent reduction), and another supermarket located in mid-west USA (23 per cent reduction).

The report attributes the difference in results to the higher ambient dew point of Auckland’s climate.

“We expect the cold climates in Sweden and northern midwest USA to have an average ambient temperature of ~14°C and 50 per cent relative humidity, resulting in enthalpy (total heat content) of 28kJ/kg,” the report says.

“By way of contrast, Auckland has an average ambient temperature nearer ~18°C and 80 per cent relative humidity, producing enthalpy of 45kJ/kg.

“The internal fridge conditions require a temperature of 4°C and 95 per cent relative humidity, giving enthalpy of 16kJ/kg.

“As the difference in enthalpy between the ambient conditions and refrigerated conditions in the overseas

Aisle temperatures

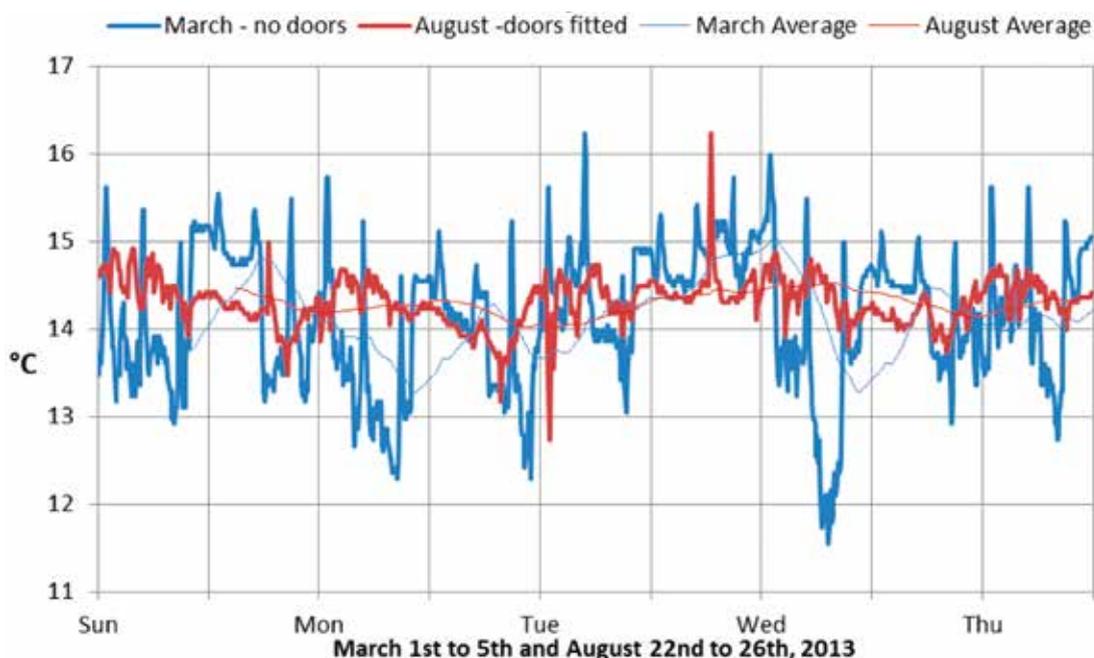


Figure 1: Aisle Temperatures.

climates is less than half that of Auckland, it follows that doors should have a greater positive impact on the energy consumption in an Auckland store when compared to the reduction in consumption in these overseas climates.”

Extrapolating the savings evidenced at the Pukekohe South supermarket, the report stated that an average 30 per cent saving in electrical consumption would be achievable across most of New Zealand’s 360-plus large supermarkets.

Even when considering the various sizes and number of open refrigerated dairy cabinets across these stores, the report says energy savings of at least 33GWh are available within the New Zealand supermarket sector if all dairy cabinets were enclosed.

Such industry-wide savings would deliver annual greenhouse gas emission savings of approximately 4,520 tonnes.

THE CUSTOMER EXPERIENCE

Of course, energy savings are all well and good so long as the customer is not unduly affected.

The attitude of customers towards the installation of doors on the dairy cases is a key driver of the commercial viability of their installation. However, there remains reluctance on the part of food retailers such as Progressive to install anything that can be perceived to be a barrier between customers and their products.

During the trial, significant effort was made to survey the customer experience within the supermarket.

Both before and after the installation of the doors, customers in the dairy aisle were approached and asked to respond to a structured survey around their views on the energy efficiency of the cabinets, their ease of use, comfort levels in the aisle and the cabinets themselves.

“Both pre and post installation, the vast majority of customers clearly understood that the installation of doors would have a positive effect on energy use and the environment,” says the report.

Despite this, 24 per cent of customers believed the installation of doors would have a negative impact on their shopping experience, reinforcing the well-held view of retailers.

However, once the doors were installed, the response to this question improved substantially. Only 1 per cent of customers surveyed believed the doors negatively impacted on their shopping experience.

About 99 per cent of customers found the product to be “cold” or “very cold” after the door installation, compared to 68 per cent prior.

A substantial improvement in customers’ perception of dairy aisle comfort also followed the installation of the doors.

Before their installation, 29 per cent of customers found the dairy aisle uncomfortable, with 31 per cent finding it comfortable.

To assess any change in temperature as a result of the door installation, temperature loggers were installed in the dairy aisle. The data taken from these revealed that before the door installation, the average aisle temperature varied by at least 2°C with many low temperature “dips”. After the installation, the average aisle temperature varied by only 0.5°C, constantly sitting above 14°C.

“These temperature readings show how strongly the refrigerated cabinet air influences the aisle temperature,” says the report.

It is noted that the timing and number of cabinet defrost cycles plays a significant role in changes to the aisle temperature, with summertime requiring more defrosts than winter.

“Without the doors being fitted, the refrigerated cabinet operation is impacting the aisle temperature,” the report says. “Visibility of this relationship supports the reduction in energy use, with cabinets being able to retain cool air, and also better retain heat during defrost cycles, when the doors were fitted. As a result, the cabinet will not have to work as hard to maintain the required temperature set-point and therefore use less energy.”

These findings were subsequently found to be reflected in the customer surveys taken after the doors were installed.

Affect of absolute humidity on cabinet cooling capacity

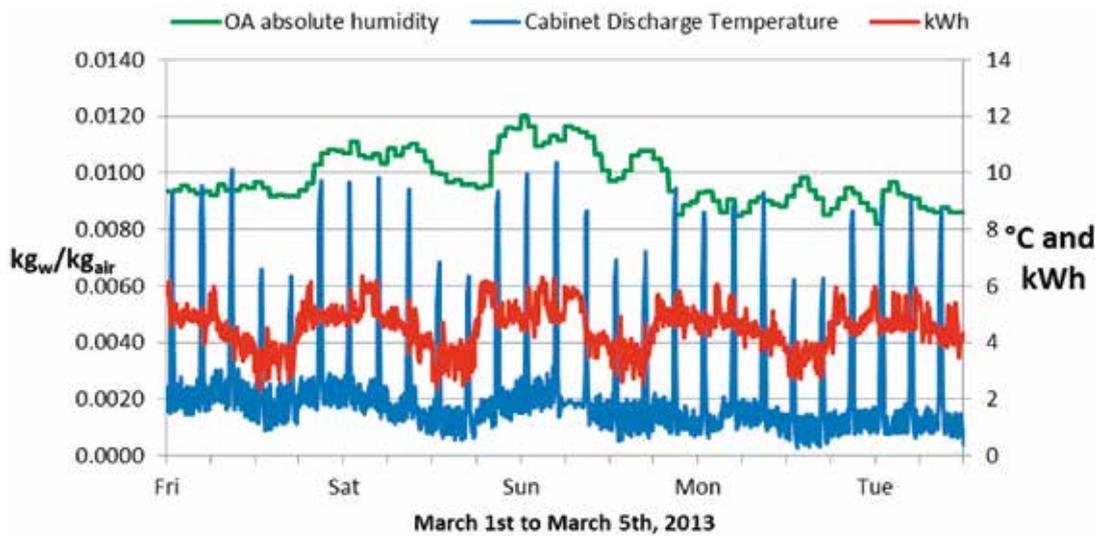


Figure 2: Cabinet Air Intake Temperatures

Cabinet air discharge temperatures

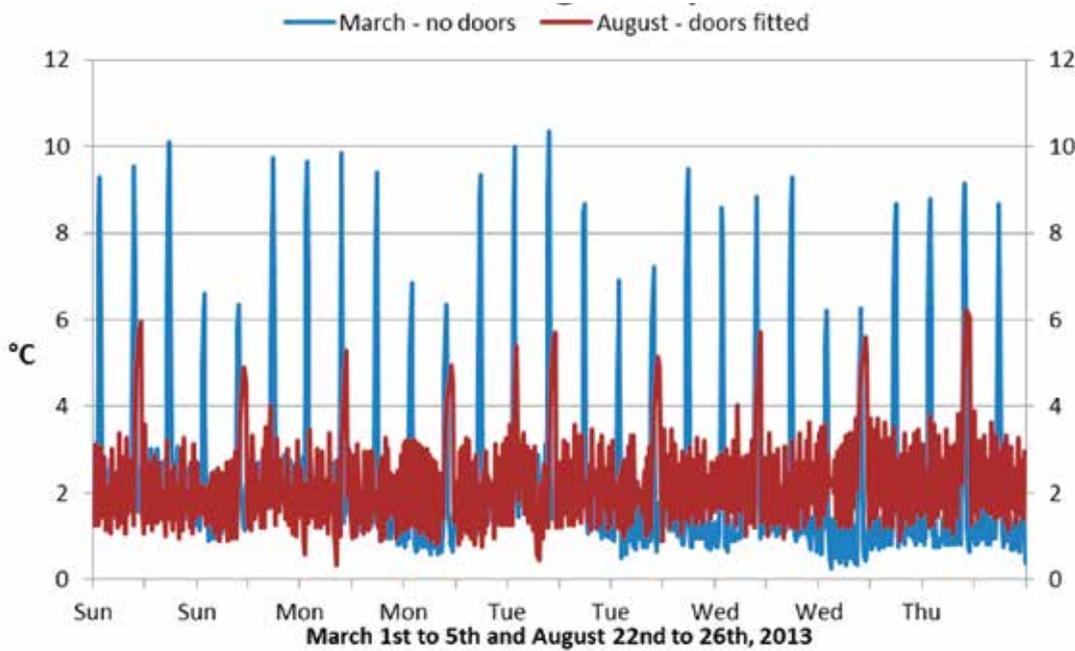


Figure 3: Cabinet Air Discharge Temperatures

A substantial improvement in customer perception of aisle comfort was found, with 99 per cent of customers finding the dairy aisle comfortable. Those finding it very comfortable rose from 7 per cent to 70 per cent.

Such agreement also translated into customer support for doors on refrigerated cabinets.

Before the installation, only 53 per cent of customers were in favour of the doors, rising to 99 per cent following their installation.

“Not one of the 183 customers surveyed was against the installation of doors on fridges once the doors had been installed,” says the report.

BARRIER TO SALES

With the main barrier to retrofitting doors on open cabinets stemming from a perception that they impact a customer’s shopping experience and therefore translate to a negative impact on sales, it was important that the trial took sales data into consideration.

So as to mitigate the risk of a material impact on sales for Progressive, a contingency plan was included as

one of the trial conditions. This allowed Progressive to remove the doors (after a minimum three-month period) in the event that a material negative impact on sales eventuated from their installation.

Sales data was analysed for the period March 31, 2013 to September 29 2013 – taking in 13 weeks of dairy sales before the doors were installed, and 14 weeks following their installation.

For comparison, data was analysed over a 24-week period, covering 12 weeks before and after the door retrofit.

“Based on the sales for the 12 weeks leading up to the installation of the doors at Countdown Pukekohe South compared to the sales in the 12 weeks following installation, dairy sales did display a decrease,” notes the report.

A fall in sales in the week following the installation of the doors was also a trend evidenced across all eight product categories.

Cabinet performance

As the store air conditioning system seeks to achieve a relatively stable set-point temperature all year round, the aisle temperature is held at a similar level whether in summer or winter.

Accordingly, it was found that the variation in cabinet air intake during the daytime could be attributed to the warm store air infiltrating the refrigerated cabinets. As such, the installation of the doors reduced this infiltration and provided a consistently lower air-intake temperature.

When the measurements of the air temperatures being discharged from the refrigeration system were observed, there was found to be a greater consistency. Doors fitted due to the cooling system within the cabinets drove the cabinet space to achieve a temperature set-point.

“As a general trend, it took cheese, butter and margarine and yoghurt sales around seven weeks to consistently reach the level of sales experienced prior to the installation of the doors,” the report says.

“Chilled drinks appeared to consistently exceed the pre-door sales figures after a period of only two weeks.”

The overall decrease in sales across the trial period was -0.23 per cent, which in dollar terms amounted to a little over \$100 and a weekly average of around \$10.

Progressive also supplied data on the average dairy spend per customer for analysis, allowing ECOsystems to compare the Pukekohe South store against 16 other Countdown supermarkets.

This revealed that the trial store was one of three to show a decrease in average dairy spend per customer, of \$0.02 per customer.

Across the other 14 stores, there was an average spend increase of \$0.19.

ONLY THE BRAVE

Despite the electrical energy reductions of 42 per cent, shortened payback period and strong customer support for doors on the refrigerated dairy cabinets, Progressive exercised its right to have the doors removed.

The company sighted the negative impact on the sale of discretionary items such as quiche, pizza and pasta as being an unacceptable reduction that it could not further tolerate.

Despite subsequent advice revealing that sales levels were improving, the doors were removed in late October 2013.

Whether the long-term presence of the doors would have seen a natural return to pre-installation sales levels remains unknown.

But one thing is for certain: doors on refrigeration cabinets represent a significant energy-saving opportunity for both the supermarket and HVAC&R industries that should be further pursued.

As the old adage goes, the customer knows best. ▲

Source: Trial Retrofit of Doors on Open Refrigerated Display Cabinets, by ECOsystems Limited for the Energy Efficiency and Conservation Authority (EECA) New Zealand.