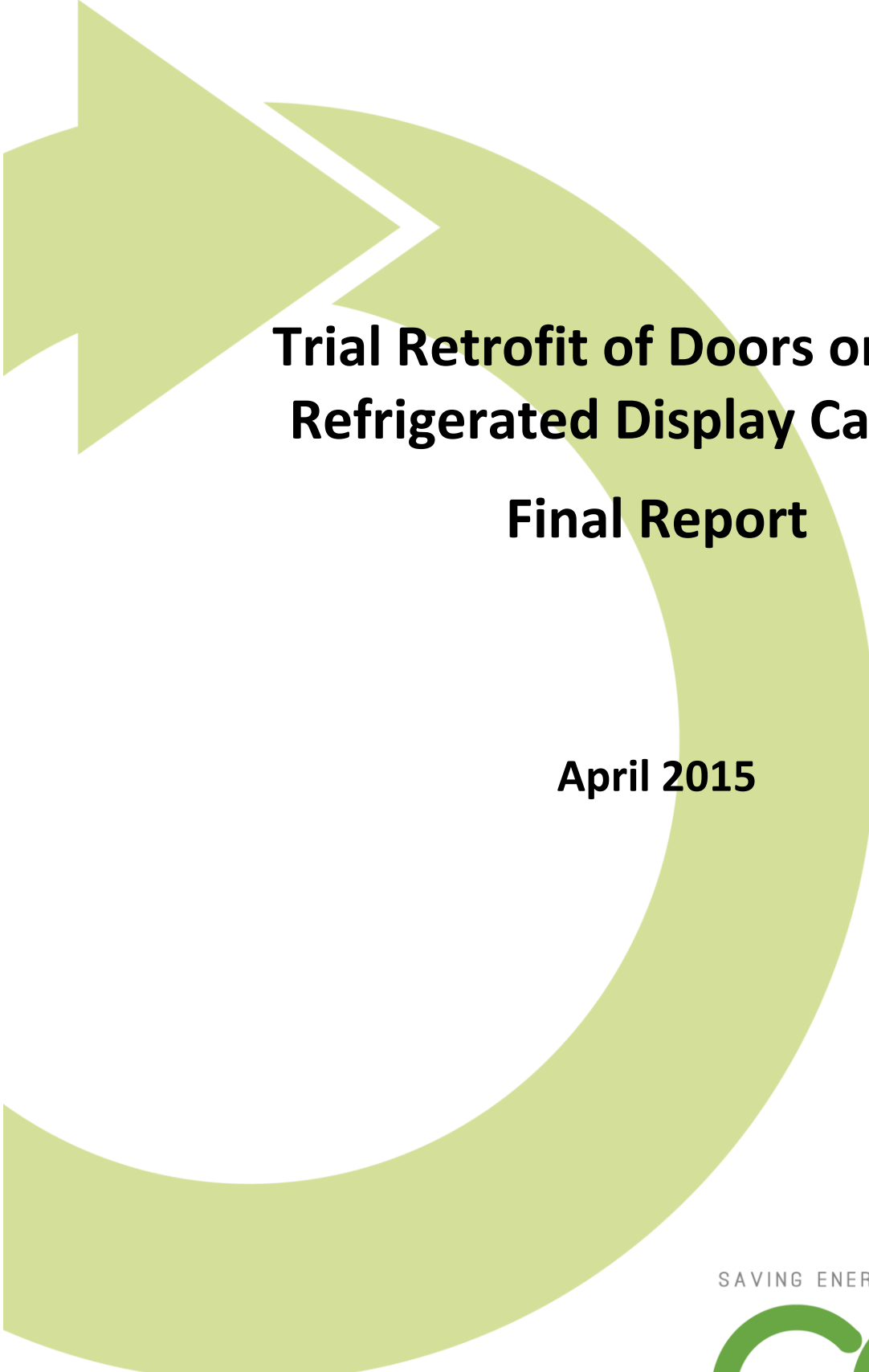


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Trial Retrofit of Doors on Open Refrigerated Display Cabinets

Final Report

April 2015

Quality Assurance Process

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SAVING ENERGY & OUR ENVIRONMENT



S Y S T E M S

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1 Executive Summary

- The focus of this trial was to quantify the energy savings, assess any impact on product sales, store temperature, cabinet operation, customer perception and acceptance of - doors retrofitted onto refrigerated dairy display cabinets
- Progressive Enterprises allowed the trial to proceed at Countdown Pukekohe South, compared with similar “control” (untouched) stores. This agreement contained a contingency clause where Progressive could order the doors to be removed in the event of sales falling by an intolerable amount, at the 3 month point. (The trial was to last for 12 months subject to no intolerable sales loss)
- A total of 58 doors were installed on the dairy cabinets (refrigerated display cases) in late June 2013
- Energy consumption immediately and significantly reduced by 42%. This exceeded the pre-trial expectation of 30%. This provides a simple payback for the doors of 3.5 years and a return on investment (ROI) of retrofit-able doors, of 29% (annual energy savings equivalent of approximately \$23,000)
- While the energy savings shown in similar overseas studies have been between 25-30%, we believe the increased savings level at Countdown Pukekohe South can be attributed to the higher ambient dew point in Auckland when compared to the subject overseas climates. Investigating the strength of the relationship between the local climate and the refrigeration system in further simultaneous trials could be useful – e.g. in a warm humid climate (Auckland), a dry climate (Christchurch) and a climate with mid-range humidity (Palmerston North)
- Aisle temperature improved and stabilized and this was reflected in customers’ perception of aisle comfort
- Measurements of the cabinet air intake and air discharge temperatures tended to support a position that the refrigeration system did not have to work as hard with doors attached. This observation was based on a more consistent set air intake and air discharge temperatures being achieved post-doors
- Sales of items within the (now enclosed) cabinets showed NO impact to staple items (\$ value of sales by product line). These were categorised as butter & margarine, cheese and yoghurt. Chilled juices and drinks also showed NO impact after doors were retrofitted
- However, an initial sales impact was seen on “non-staple” items. These items were categorised as quick & easy meals, entertaining, smallgoods and snacks
- Of these items, the quick & easy meals showed a reduction which did not appear to recover to pre-door sales levels within 12 weeks of the doors being installed. They reduced 5.23% compared to sales prior to the doors being installed
- The sales of entertaining products dipped but were already declining. However sales bounced back strongly in the period 7-12 weeks following installation. As a result, it was viewed that the doors did not impact sales of this product line

- Sales of smallgoods displayed a temporary reduction following the installation of the doors. Sales lifted by the seventh week and quickly returned to pre-doors levels
- The snacks product line showed a similar pattern as that evidenced for smallgoods, with an initial reduction in sales. They bounced back strongly within 5-7 weeks of the doors being installed
- There is also evidence to suggest that the sales growth for the trial store may have been slower than the average sales growth for other Countdown stores in the region. By seven weeks post installation, sales growth at Countdown Pukekohe South reached a similar level as pre-doors sales growth. This reinforced the view that where a sales impact was largely temporary in nature lasting for a period up to seven weeks following installation of the doors
- Unfortunately, the initial reduction in sales for a number of the non-staple items was enough to convince Progressive to exercise the contingency provisions and remove the doors. As sales data was not provided by Progressive until considerably later, this advice was not able to be independently verified
- Progressive provided subsequent advice that sales levels were improving, however, by this time a decision had already been made to remove the doors. Their own sales analysis had given rise to conflicted perceptions of tolerable changes in sales. The doors were removed from the cabinets in October 2013
- It is important to note that analysis of a full set of sales data was not possible. Sales data was only provided pre-doors, and post door installation for only 12 weeks but not for the after the doors were removed (late October and through November). Analysis of this sales data and in particular whether the sales figures materially changed following removal of the doors would have been invaluable. Never the less it is safe to say that a drop in sales did not occur for staple dairy items and chilled juices. A sales drop was temporary for other items except for quick and easy meals.
- The results of customer surveys taken in the month prior to and following the installation of the doors strongly supported doors on fridges with the number of customers in favour of doors on the dairy cabinets increasing from 53% in the pre-door survey to 99% following installation
- While the trial retrofit of doors on the dairy cabinets ended with the removal of the doors, the energy savings exceeded expectations.
- This report outlines the changes in energy use, percentage change of sales of grouped items in retrofitted enclosed cabinets, and customer responses. Recommendations are made for stores about what to consider/expect when retrofitting doors to cabinets or switching to enclosed cabinets – including the best food types to market within closed cabinets.

2 Introduction

The supermarket sector in New Zealand is an intensive user of our energy resources and it is generally accepted that approximately 50% of energy consumed within a supermarket is used in refrigeration. Although there has been some progress in the retrofitting of doors on certain cabinets, primarily alcohol cabinets, and the installation of lids on chest freezers, progress has been slower on retrofitting doors on open cabinets.

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.

A trial retrofit of doors onto open dairy cabinets, capturing and analysing the impact on energy use and sales, would enable supermarket operators to have a greater understanding of the costs and benefits of retrofitting doors on cabinets or using enclosed cabinets.

The Energy Efficiency and Conservation Authority (EECA) engaged ECOsystems Limited to provide services relating to a trial to retrofit doors onto open dairy cabinets and measure any impact on energy and sales.

The initial expectation was that energy savings in the vicinity of 30% would be achieved supporting a payback of approximately five years. 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.

To enable this trial to occur, an agreement was entered into with Progressive Enterprises for doors to be fitted to refrigeration cabinets at Countdown Pukekohe South in Auckland.

The trial was agreed initially to be 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 installed to assess changes in temperature
- Customer surveys were undertaken prior to and following installation of the doors
- Sales data for products within the dairy cabinets was received and analysed.

3 Core Objectives of the Trial

A number of core objectives were required to be delivered out of this trial including:

- Quantification of energy savings through retrofitting doors to dairy cabinets
- Modelling energy savings and GHG reductions that may arise out of the regulated retrofitting of cabinet doors and out of the installation of doors on cabinets through a supermarket's normal investment cycle
- Extrapolation of energy saving results across the New Zealand and Australian markets
- An assessment of the impact of retrofitting doors on product sales, the operation of the cabinets, store temperature and any other relevant factors
- An acknowledgement of any technical or practical lessons learned from the trial that may be of use to other stores or future studies

4 Key Project Milestones

Detailed below is a chronological outline of the key project milestones:

| | |
|-------------------|--------------------------------------------------------|
| 14 June 2012 | Progressive sign agreement to participate in the trial |
| 29 November 2012 | Contract between EECA and ECOsystems signed |
| 21 December 2012 | Energy and temperature loggers installed |
| 29 January 2012 | Order for the trial doors placed |
| 26 June 2013 | McAlpine Hussman commences installation of doors |
| 28 June 2013 | McAlpine Hussman completes installation of doors |
| September 2013 | Progressive issue instruction to remove the doors |
| 28 September 2013 | Expiry of minimum trial period for door installation |
| 20 October 2013 | McAlpine Hussman commences removal of doors |
| 21 October 2013 | McAlpine Hussman completes removal of doors |
| 18 June 2014 | Partial sales data received from Progressive |

5 Door Specifications

The doors selected for installation, based on price and acceptability to Progressive, were Bentcam double glazed Low E no heat hinged barn style doors. Bentcam is a Turkish based company specialising in the manufacture of glass doors.

The European standard for refrigerated display cabinets defines six climate classes against which manufacturers rate and test their products. The selected Bentcam doors were rated for operating conditions in Climate Class 3, which is deemed acceptable for refrigerated cabinets in stores which are air conditioned. The operating conditions for Climate Class 3 are a dry bulb temperature of 25°C and a relative humidity of 60%.

The doors were to be fitted to 10 MJC-216 dairy cases. Four doors were required on the 2.5m case and six doors were required on each of nine 3.75m cases. In total, 58 doors were required to be fitted across 10 cases.

Prior to ordering, these doors were test fitted onto dairy cases at the factory test room of McAlpine Hussman in Tauranga. In addition, a field test was carried out on a dairy case at Countdown St Lukes in Auckland. As a result of this testing, it was agreed that a number of minor modifications to the doors would be required prior to their installation:

- Trim heaters were required to be fitted to the base of the door frames to avoid sweating on humid days
- The cabinet expansion valve was required to be changed to reduce refrigeration duty
- An air deflector was required to be fitted to the return air duct to reduce the thermal loading at the base of the door frame
- Lower pitched fan blades were required to be fitted to reduce air velocity

Stainless steel door handles were also to be fitted to the doors prior to their installation.

Additional lighting was required to be fitted to ensure the product remained prominently displayed for retail sales. Two lighting products were tested, the Phillips Affinium LDM400 Value Plus 5700 Cool White LED and the Phillips InteGrade LED narrow beam.

At the time of installation, both lighting products were test fitted to the internal door mullions instore. The Phillips InteGrade fittings were deemed to look visually very good.

6 Installation of the Doors

The doors were installed over two nights in the last week of June 2013.

The dairy cases on which the doors were installed stock a range of standard refrigerated products. These include staple items such as butter, margarine and cheese through to a wide range of discretionary products.

The discretionary product range includes items which would not generally be considered as necessities such as pizza, pies, spreads and dips through to what are considered more high end products such as fresh pasta and pre-cut meats.

Following the first night's installation, McAlpine Hussman installers received very positive feedback from staff on the installation of the doors and in particular on the improved lighting of the product.

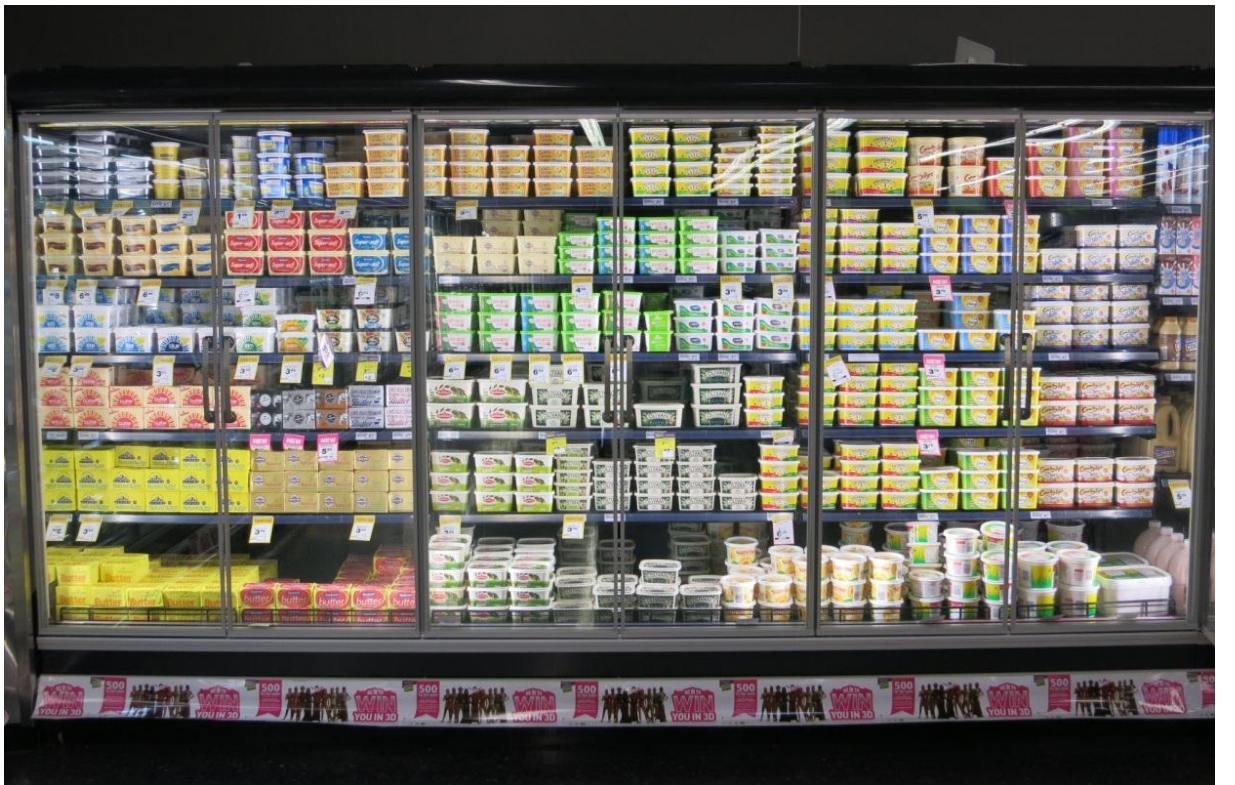
On the morning following completion of the installation, positive feedback was again received from both staff and customers.

Set out below are photos of the dairy cases at Countdown Pukekohe South before and after the installation of the doors.









7 Energy Savings Summary

7.1 Energy Savings – Financial Summary

Energy loggers were installed at the store to sub-meter the electricity use from the dairy cabinets. The dairy cabinets on which the doors were installed were “medium temp” refrigeration units within the store’s wider refrigeration system and the particular cabinets which were the subject of this trial were labelled as the “MT3” cabinets.

Commencing on the two days upon which the doors were installed (26-28 June 2013) an instant and dramatic decrease in energy use was evidenced. Table 1 below details the average electricity use prior to the installation of the doors and the reduction in electricity use following completion of the installation on 28 June 2013.

| 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

A significant 42% reduction in electricity use on the medium temp refrigeration system was evidenced.

From a financial perspective, based on this reduction in energy use and the delivered and installed cost of the doors, the simple payback from the installation of the doors is 3.5 years. The return on investment is 29%.

7.2 Energy Savings – Electricity use

Doors on refrigeration cabinets save energy by imposing a barrier between the chilled air inside the cabinets and the warmer air in the aisles and throughout the rest of the store. This barrier reduces the infiltration of warm air into the refrigerated cabinets resulting in the system using less energy to maintain the lower temperature conditions required.

Figure 1 below visibly demonstrates the sizeable and instant reduction in energy use following the installation of the doors in the last week of June. The two day period in which the doors were installed is highlighted by the green shading.

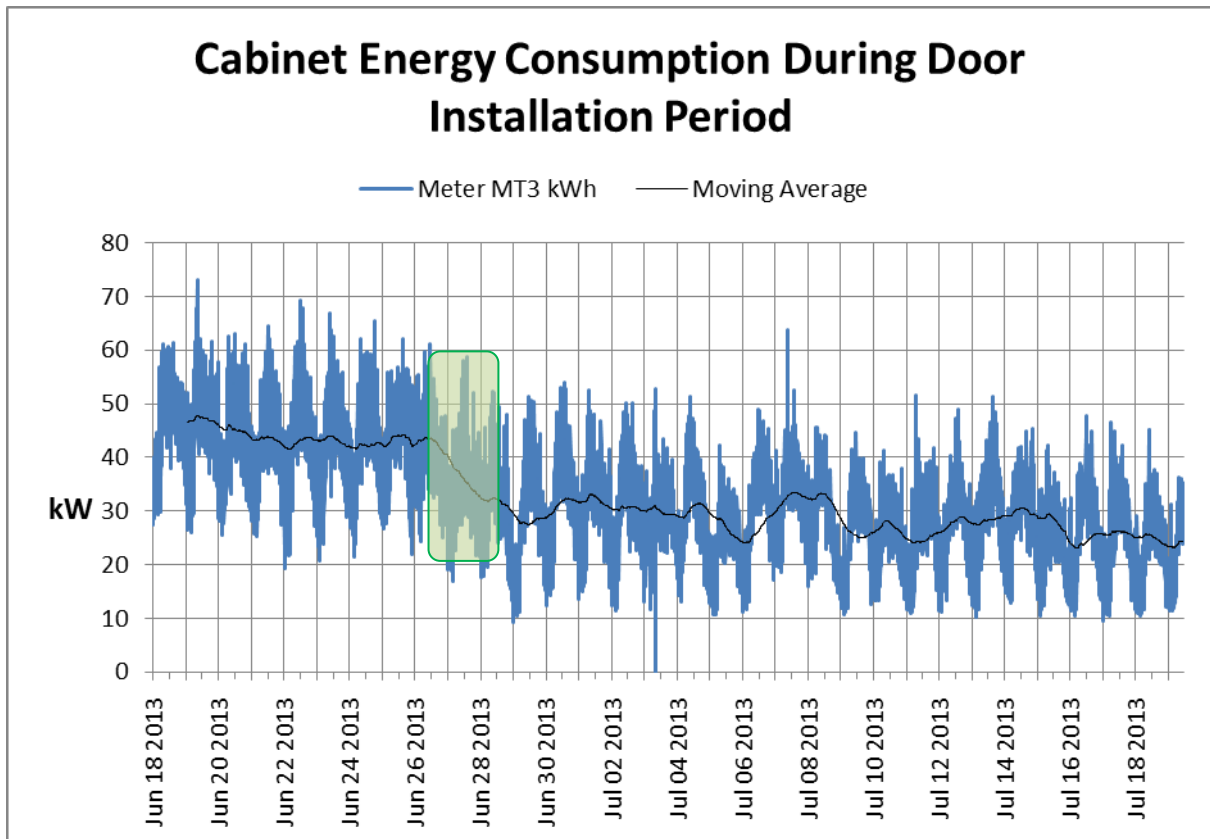


Figure 1. Cabinet Energy Consumption During Door Installation Period

Apart from the daily cycle of energy use, Figure 1 shows the moving average for consumption dropping from approximately 43 kW to approximately 28 kW.

No other changes to this MT3 system were made during the fitting of doors to the cabinets and the reduction in electricity consumption is solely attributable to the installation of the doors.

The doors were subsequently removed at the end of October 2013 and Figure 2 below shows the corresponding increase in energy use.

The two days upon which the doors were removed are again highlighted in green. The energy use from the MT3 cabinets shows a clear and dramatic increase.

No other changes were undertaken to the system during this period.

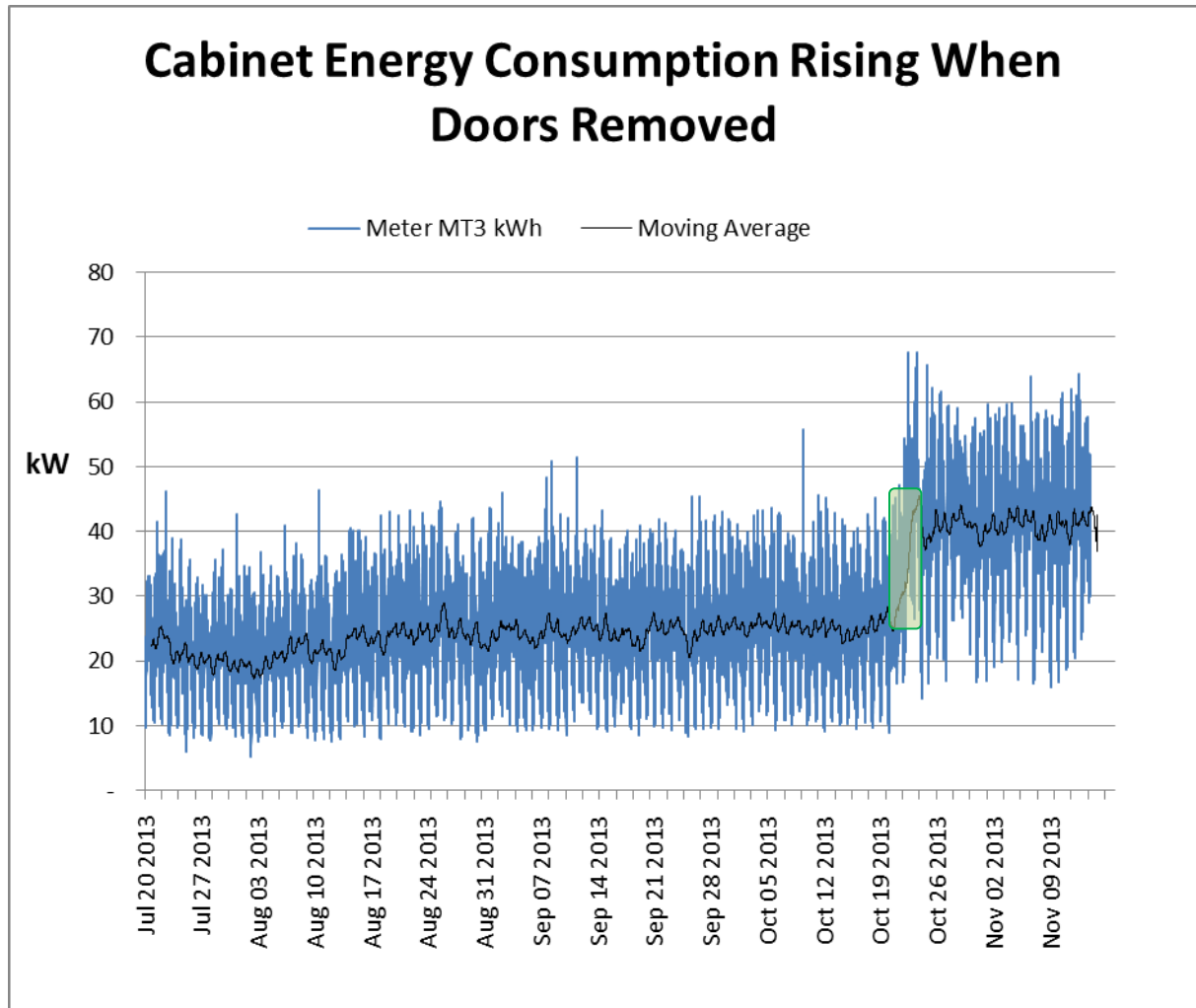


Figure 2. Cabinet Energy Consumption Rising When Doors Removed

8 Energy Savings – Extrapolation

8.1 Energy Savings

With no other changes being made to the medium temperature refrigerated cabinets during the period of this trial, and with the uniform decrease and increase in energy consumption evidenced upon the installation and removal of the doors, we are confident that the 42% energy savings can be solely attributed to the installation of the doors.

These savings are slightly greater than the initial estimate of energy savings which was in the vicinity of 30%.

Results from similar trials documented in two notable overseas studies found energy reductions following the installation of doors of 26% in a Swedish supermarket and 23% in supermarkets in the Midwest United States (refer section 15 below).

The energy savings observed in these two studies are materially lower than the energy savings measured at Countdown Pukekohe South.

We believe that the difference in results can be attributed to the higher ambient dew point in Auckland, the trial location, when compared to the subject overseas climates.

We expect the cold climates in Sweden and northern Midwest USA to have an average ambient temperature of $\sim 14^{\circ}\text{C}$ and 50% relative humidity, resulting in enthalpy (total heat content) of 28kJ/kg. By way of contrast, Auckland has an average ambient temperature nearer $\sim 18^{\circ}\text{C}$ and 80% relative humidity, producing enthalpy of 45kJ/kg.

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

The difference in enthalpy between the ambient conditions and refrigerated conditions in the overseas 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.

We believe this is the main factor in the increased savings levels when compared to the overseas studies.

8.2 Impact of Weather on Energy Savings

As noted above, we believe regional weather plays a large part in the value of energy savings achieved through the introduction of doors. In particular, the level of humidity present in a local environment.

As we have seen in the energy logging charts in section 8.2 above, the defrost cycle within a refrigeration system accounts for substantial energy use causing regular large peaks in energy consumption. A humid climate can significantly increase the amount of defrost energy required as it introduces more moisture into the cabinet. This moisture turns into frost requiring increased defrost cycles. The increased defrost activity introduces heat into the cabinet which then subsequently requires increased energy to bring the cabinet back down to the temperature setpoint.

All this activity, increased or reduced dependent on how dry or humid the ambient environment is, will deliver significant regional variation in the amount of energy savings the enclosure of refrigerated cabinets will deliver.

It would be beneficial to investigate this relationship further with trials in three locations, a warm humid climate such as Auckland, a dry climate such as Christchurch or the Hawke's Bay, and a climate with a mid-range humidity level such as Palmerston North or Whakatane.

These potentially significant regional variations present difficulties in making broad statements based on a generic extrapolation of energy savings from a single store in a sub-tropical city. Notwithstanding this difficulty, we have made some very broad and general assumptions about potential energy savings in the sections below.

8.3 Energy Savings in New Zealand

The New Zealand supermarket sector is dominated by two major players, Progressive and Foodstuffs. Between these two companies, there are over 360 large supermarkets within New Zealand (Countdowns, PAK'nSAVEs, New Worlds). These companies also have additional supermarket brands under which there are sizable stores such as the Super Value, Fresh Choice and Four Square brands that are additional to this number.

Noting the impact of regional weather, taking a conservative approach we could assume an average 30% savings level being achievable at most stores.

The size of the cabinets enclosed as part of this trial would represent a refrigeration system at the larger end of the scale in terms of New Zealand supermarkets, although many of the 360 major stores would be of a similar size. A conservative approach would provide an average system size across New Zealand stores 20% smaller than the system enclosed at Pukekohe South.

On this basis it is reasonable to assume that energy savings of at least 33GWh are available within the New Zealand supermarket sector if all dairy cabinet displays were enclosed.

8.4 Energy Savings in Australia

Australia houses more than 1,800 supermarkets, 80% of which are owned by the two largest operators, Woolworths and Wesfarmers (mainly through their Coles brand).

The Australian climate presents a substantial variation in regional weather patterns from the bone dry conditions in West Australia through to the extreme humidity in the tropical areas of the Northern Territory.

In addition, the size of the average Australian store and the corresponding scale of the refrigeration systems do not allow a sensible extrapolation of energy savings based on the data from Countdown Pukekohe South to be made.

We believe, tied in with an additional study across varying regions within New Zealand, a similar process undertaken across the Australian states would provide valuable evidence of the impact of regional weather on energy savings from the installation of doors. This larger pool of data could form the basis for a modelling tool to allow accurate estimation of energy savings across variable climates.

8.5 Greenhouse Gas Emissions

The energy savings evidenced at Countdown Pukekohe South would deliver a reduction in annual Greenhouse Gas Emissions of approximately 21 tonnes.

The 33GWh of energy savings conservatively estimated to be available within the New Zealand supermarket sector would deliver annual Greenhouse Gas Emission savings of approximately 4,520 tonnes.

9 Aisle Temperatures

The installation of the doors imposes a physical barrier between the refrigerated air within the medium temp cabinets and the warmer air circulating within the supermarket aisles. It is common within supermarkets to experience a significant cooling of store temperature while shopping in the aisles where the refrigerated cabinets are located. The cooler aisle temperature is the result of refrigerated cabinet air spilling into the aisle.

The customer survey undertaken at Countdown Pukekohe South underlines this experience with almost 30% of customers surveyed prior to the installation of the doors advising that they found the temperature in the refrigerated cabinet aisle uncomfortable (refer section 14.2.2 below).

To assess any change in aisle temperature as a result of the installation of the doors, temperature loggers were installed in the dairy aisle to measure any change in conditions when comparing aisle temperatures before and after installation of the doors.

Figure 3 below shows temperatures taken at the same location in the dairy aisle during March 2013 (shown in blue) compared to the temperature in the dairy aisle during August 2013 (shown in red).

The data displayed is for the same days of the week to provide as close a direct comparison as possible.

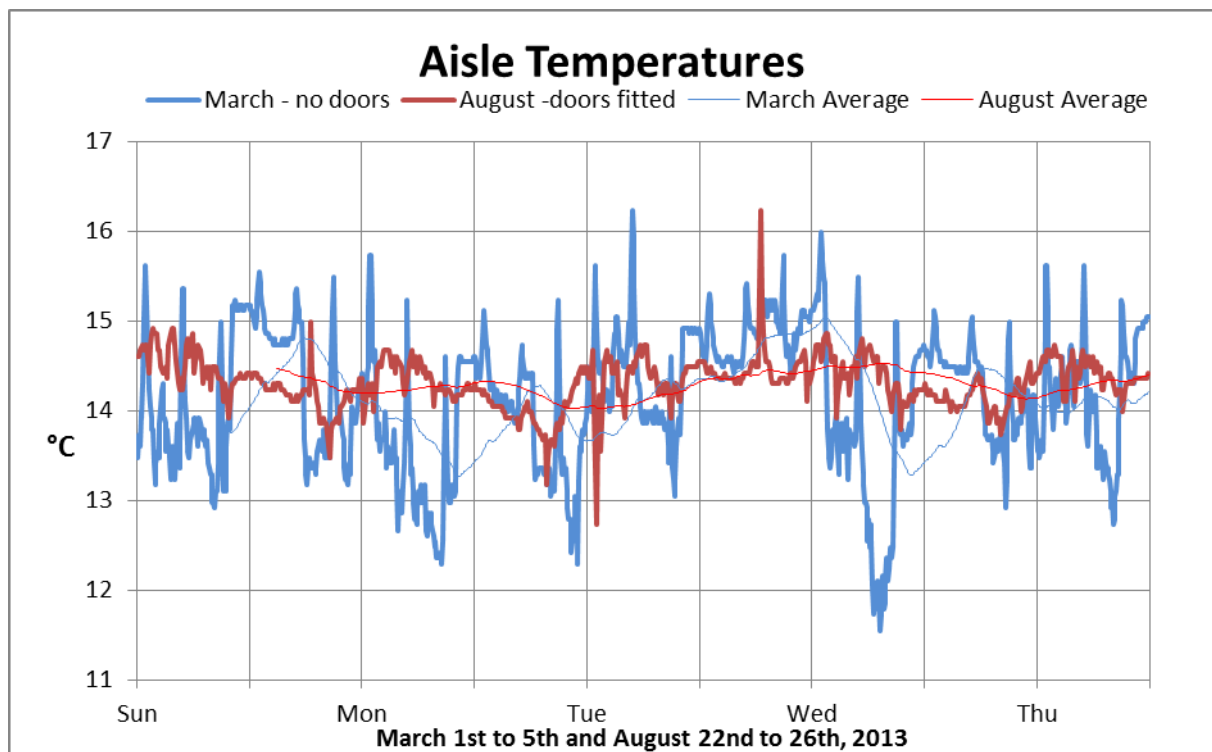


Figure 3. Aisle Temperatures

The supermarket at which this trial took place is air conditioned to control the temperature within the store and importantly to maintain consistent internal conditions. Progressive specify that the HVAC system maintain a year round temperature throughout the store of around 20°C and 50% relative humidity. As a result the average aisle temperature between the summer months (March) and the winter months (August) does not vary greatly.

This is despite a material variation in the local ambient temperature for Pukekohe for the same period sourced from records of the National Institute for Water and Atmospheric Research as shown in Table 2.

| | March 2013 | August 2013 |
|---------------------------|------------|-------------|
| Average Maximum Temp (°C) | 24.6 | 15.2 |
| Average Minimum Temp (°C) | 13.7 | 7.5 |

Table 2. Pukekohe Ambient Temperatures

Comparing the aisle temperature in the summer months to aisle temperature in the winter months also ensures that any temperature difference is real and well removed from any possible influence of the outside air temperature.

What is obvious from the aisle temperature readings is that while the overall temperature is similar, there is much less volatility of the aisle temperature after the doors were installed.

Prior to the installation of the doors, the average aisle temperature varies by at least 2°C with many low temperature “dips” apparent. After installation of the doors the average aisle temperature varied by only half a degree sitting consistently above 14°C.

We note numerous examples prior to installation of the doors of the aisle temperature dipping below 14°C. The only way the aisle temperature can drop as low as 14°C in the summer months is from cool refrigerated air spilling from the dairy cabinets into the aisle.

These temperature readings show how strongly the refrigerated cabinet air influences the aisle temperature. This can most obviously be seen when observing the timing and number of the cabinet defrost cycles.

Refrigerated cabinets require regular defrost cycles to be undertaken whereby heat is introduced into the cabinet to melt and remove frost build up. The cabinet controls require more defrost cycles to occur in the summer than the winter. During the period outlined in the chart above 27 defrost cycles were run from the 1st to the 5th of March and nine defrost cycles were from the 22nd to the 26th of August.

During the five day period in March, every one of the 27 defrost peak cabinet temperature cycles can be observed in measuring the aisle temperature showing the warmer cabinet air spilling into the aisle and directly causing a peak in aisle temperature.

In winter the defrost cycles occur only every 12 hours and we observe only two of the nine peaks being reflected in the aisle temperature in August showing that the cabinets must be retaining the warmer air.

By way of reference, the cabinet air discharge chart contained below (Figure 5) clearly shows the cabinet defrost cycles for the same period which can be compared to the aisle temperature chart above to see the relationship between cabinet defrost cycles and aisle temperature.

Without the doors being fitted, the refrigerated cabinet operation is impacting the aisle temperature. Visibility of this relationship supports the reduction in energy use with the 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 setpoint and therefore use less energy.

These findings are very strongly reinforced by the responses to the customer survey outlined in section 14 below. These results show a substantial improvement in customer perception of aisle comfort following installation of the doors with 99% of customers finding the dairy aisle comfortable following installation of the doors compared to only 31% of customers prior to the installation.

10 Cabinet Performance

10.1 Cabinet Air Intake Temperatures

Figure 4 shows the temperature of the cabinet air intake.

During summer the air entering the cabinet refrigeration system is significantly warmer during daytime without doors than measured during daytime in winter with doors.

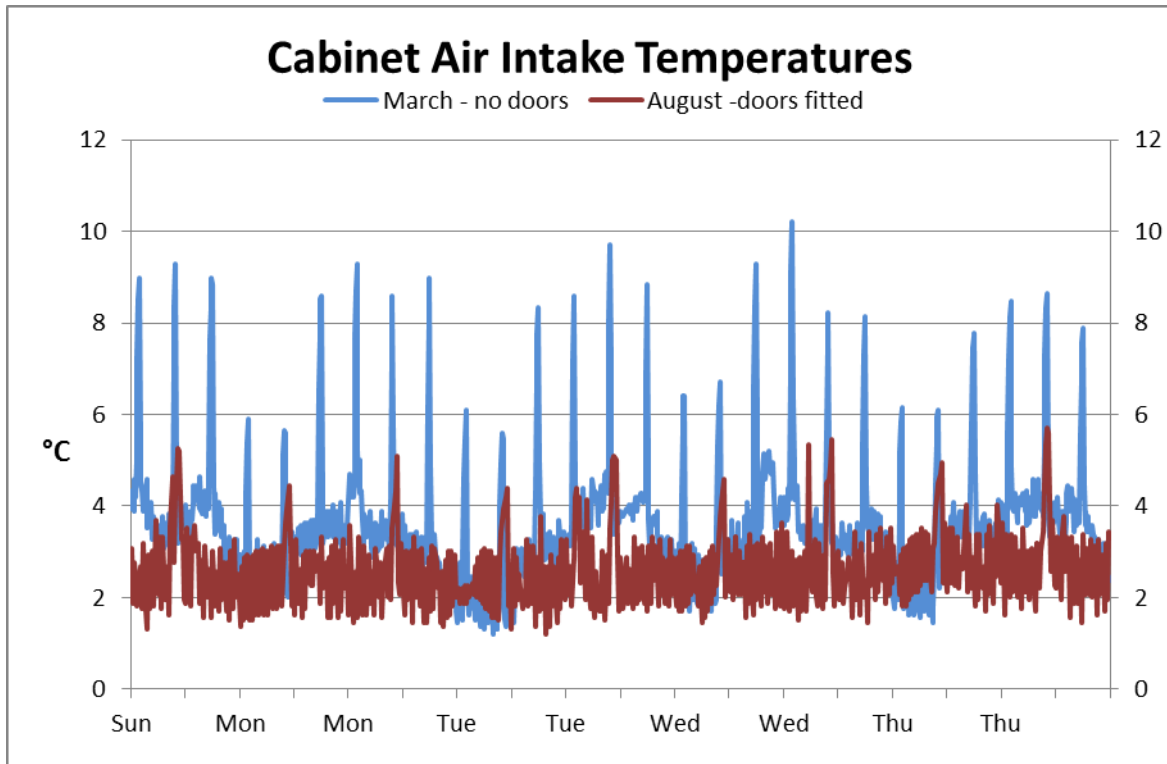


Figure 4. Cabinet Air Intake Temperatures

There are two possible explanations for this difference in temperature being either through the store having a lower background temperature during winter or alternatively the cabinets being affected by the warm store air.

The relatively consistent average temperature of the aisles when compared between summer and winter would tend to dismiss the background temperature being significantly cooler. The store air conditioning system seeks to achieve a relatively stable setpoint temperature throughout the year, holding the aisle temperature at a similar level whether summer or winter.

Accordingly, the variation in cabinet air intake during the daytime can be attributed to the warm store air infiltrating the refrigerated cabinets. The addition of the doors has reduced this infiltration and provided a consistently lower air intake temperature.

In Figure 4, the rise in air intake temperature during daytime is clearly evidenced with the blue line consistently rising above the red line during the middle of every day. At night time however, the blue and red lines hold to a similar level. This shows the air intake temperature in the cabinets to be similar regardless of being summer or winter, with or without doors.

It is assumed that this stability of temperature is due to there being less disturbances to the cabinets at night from the presence of customers, the movement of product and from the store air conditioning system.

The other noteworthy aspect of the air intake temperatures is that the volatility of temperatures evidenced in the aisle temperatures is replicated in the cabinet air intake temperatures when the doors were not in place.

10.2 Cabinet Air Discharge Temperatures

When the measurements of the air temperature being discharged from the refrigeration system are observed (see Figure 5), there is greater consistency with doors fitted due to the cooling system within the cabinets driving the cabinet space to achieve a temperature set point.

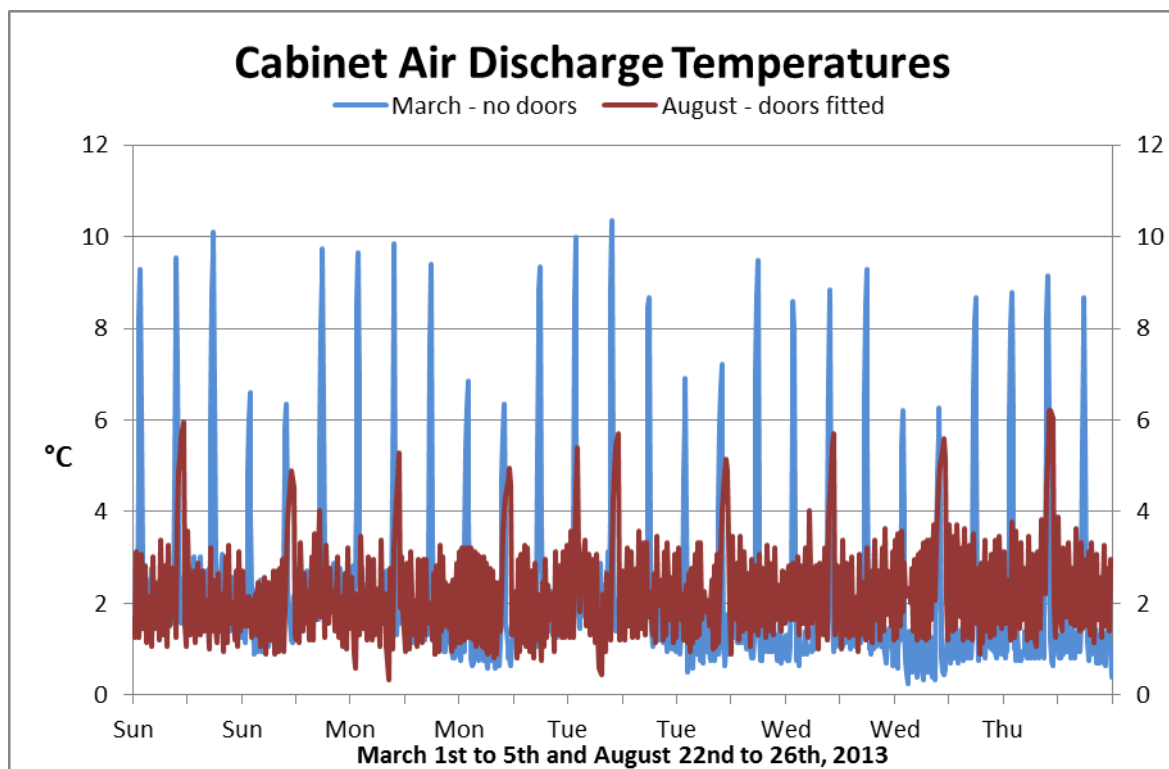


Figure 5. Cabinet Air Discharge Temperatures

What is also noticeable in Figure 5 is the discharge temperature being consistently colder in the second half of the week for the summer uncovered measurements. We were not able to determine the reason for this drop in temperature.

The refrigeration system is working harder during this period as demonstrated in Figure 6. The refrigeration work is proportional to the difference between the intake and discharge air temperatures – the delta in temperature. This temperature difference (*Cabinet dT*) is consistently greater for the second half of the summer week.

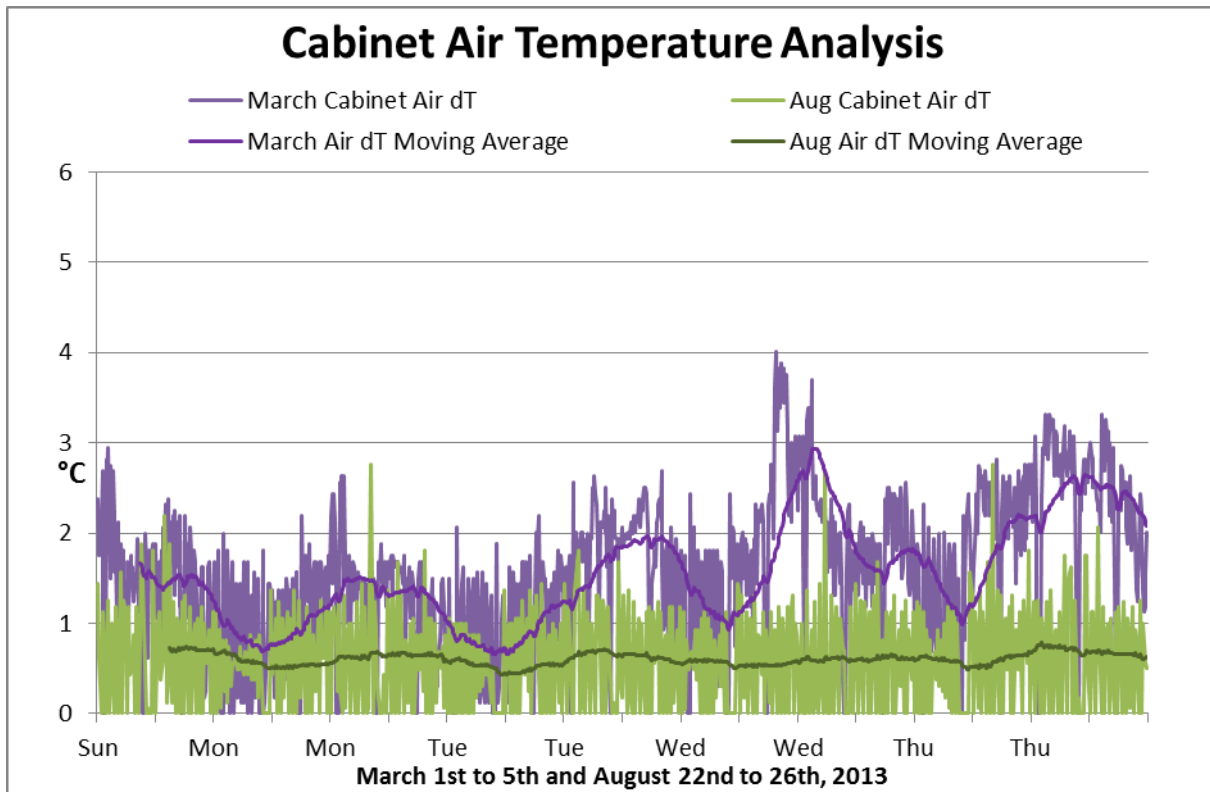


Figure 6. Cabinet Air Temperature Analysis

The winter period (coinciding with the doors being installed on the cabinets) has a relatively even temperature difference between cabinet intake and discharge.

The results from the aisle temperature measurements clearly show that the cabinet doors minimise the extent of air spillage and air mixing and reduce the temperature variations to the space around the cabinets. The consistency of temperature difference between cabinet intake and discharge with the doors installed provides evidence of the refrigeration system not needing to work as hard. This translates to better cabinet performance further supporting the rationale behind a reduction in energy use with doors installed.

The ability of the cabinets to maintain a lower and more consistent temperature will also assist in maintaining product quality and food safety.

11 Store Humidity

The relative humidity within the supermarket could be expected to be a significant energy consumption factor for open refrigerated displays. Moisture in the store air creates frost build-up on cold dry surfaces inside the cabinets. The supermarket selected to trial the doors has space air conditioning to provide more consistent indoor temperature and humidity conditions.

Absolute humidity is a measure of the mass of water per mass of air. There is approximately twice as much moisture held in summer outdoor air compared to winter outdoor air.

The cabinets defrost automatically (timer scheduled) to melt and remove frost build up. Defrosting is energy intensive and should be minimised. Energy is lost by adding heat to melt ice and additional energy is required to pull the cabinet temperature back down to the cooler refrigeration setpoint required.

Defrosting is obvious in Figure 7 where the large “spikes” in temperature are created by the system raising the surface temperature for short periods to melt frost and ice.

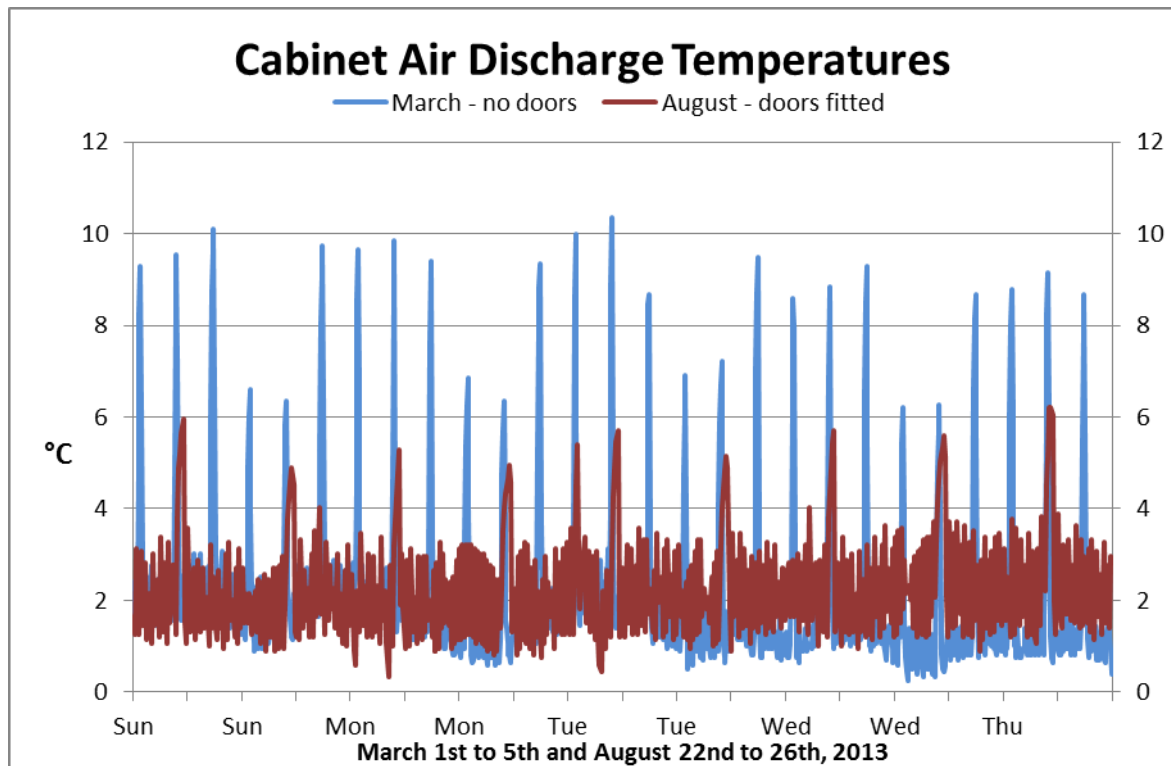


Figure 7. Cabinet Air Discharge Temperatures

The system defrosts more in summer than winter because the outside air absolute air humidity is greater in summer than winter.

The introduction of doors is expected to reduce this influence of outside air and absolute humidity by providing a barrier between the humid store air and cool dry cabinet air. Accordingly, while the number of defrost cycles required in winter is lower than the number required in summer, we would expect the total number of defrost cycles required to be reduced with the introduction of the doors due to the lower level of infiltration of humid store air into the cabinets, reducing frost build up.

During the measurement period we did note, as indicated in Figure 8, that the discharge temperature drops slightly towards the end of this test period (Tuesday) at the same time absolute humidity drops slightly. Surprisingly, energy consumption looks consistent with earlier in the week

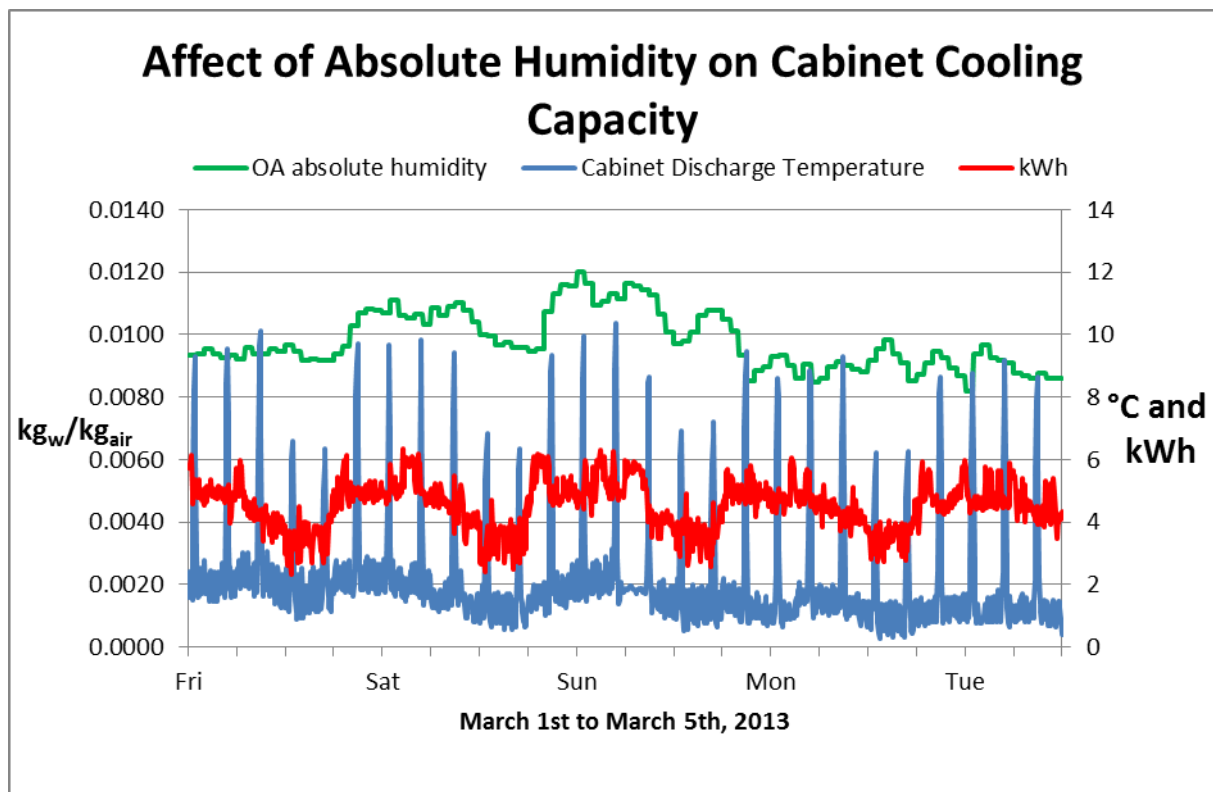


Figure 8. Affect of Absolute Humidity on Cabinet Cooling Capacity

We can speculate more of the total cooling capacity would be available for increased sensible cooling. The latent cooling demand (moisture related) is reduced by lower absolute humidity and less ice forming. The greater sensible cooling reduces the air temperature downstream of the cooling coil.

It is not apparent why the control system did not reduce cooling capacity and energy consumption during such a period. Further investigation would be required to determine this.

12 Analysis of Sales Data

12.1 Sales Impact Contingency Plan

As noted previously, the main 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.

To test this perception, a core deliverable of the trial was the analysis of sales data from products displayed in the dairy cabinets throughout the trial period. To mitigate the risk of a material impact on sales for Progressive, a contingency plan was included as one of the trial conditions to enable Progressive to remove the doors in the event that a material negative impact on sales eventuated. This was subject to a condition that the doors were to remain in place for a minimum period of three months. The intention in imposing a minimum period was to ensure the doors were not removed immediately in response to an instant negative customer reaction, but to allow a reasonable period for customers to adjust to the presence of cabinet doors and fall back into their normal buying behaviour.

12.2 Decision to Remove Doors Based on Sales

From August onwards, Progressive indicated that the doors would be removed because while the staple items such as yoghurt and cheese had not been impacted, sales of discretionary items such as quiche, pizza and pasta had incurred an unacceptable reduction in sales. Prior to the doors being removed, no sales data was provided and accordingly no independent validation of the basis for this decision was able to be made.

However Progressive provided verbal advice that:

1. While the staple dairy items (butter, margarine, cheese and yoghurt) had not been impacted by the installation of the doors, there had been a material impact on the non-staple dairy cabinet items
2. Sales of these products had decreased despite significant promotions of these items being undertaken
3. Other Countdown stores within the same geographical area had shown an increase in sales of these items

In late September, Progressive advised that the latest sales data displayed a lift in sales of the discretionary items and Progressive management was keen to see a further tranche of sales data to determine if this lift in sales was a one off, or was potentially a return to acceptable sales levels. They subsequently confirmed that the lift in sales had been maintained. Unfortunately however, this lift was not sufficient to change their decision to remove the doors.

It should also be noted that in the period prior to and since the removal of the doors, Progressive advised that it had undertaken significant promotional activities focused on the discretionary refrigerated items that were the subject of concern with the sales data. This activity needs to be acknowledged when considering sales trends.

The doors were removed from the first four cases on the night of 20 October 2013 with the remainder of the doors being removed on the night of 21 October.

12.3 Sales Data

The doors were installed on 28 June 2013 and removed on 21 October 2013. (approx. 4 months). However sales data were only provided in June 2014 for the period of 31 March 2013 through to 29 September 2013. This provided sales data for 13 weeks of dairy sales prior to the installation of the doors and for 14 weeks of post-installation dairy sales.

No sales data was made available covering the period three weeks prior to the removal of the doors. Nor was the data made available for the period following the removal of the doors. Accordingly it has not been possible to analyse if there was any bounce in sales immediately following the removal of the doors.

However comparative data was made available for the dairy departments at 16 other Countdown stores in the geographical area surrounding Countdown Pukekohe South. This data was provided for a 24 week period covering 12 weeks prior to the door installation at Pukekohe South and the 12 weeks post installation.

As a result, comparative analysis of sales has only been undertaken across this 24 week period.

The results of the sales data analysis are contained in the following sections of this report. Due to issues of confidentiality and commercial sensitivity, all monetary sales values have been removed. In addition when viewing the charts, please note that the scale of the y axis is not consistent between charts contained within this section. The data analysed was dollar value of sales by product line.

12.4 Overall Dairy Cabinet Sales at Countdown Pukekohe South

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 at the store did display a decrease.

The overall decrease in sales across this entire 12 week period was -0.23% which in dollar terms equates to a total amount just exceeding \$100 and a weekly average of around \$10.

While this amount on its own is immaterial it is important that this figure is not viewed in isolation and is comparatively analysed with the sales across neighbouring Countdown stores. This analysis is detailed in section 13.7 below.

In addition, the decrease in sales needs to be viewed by product type to enable visibility to the variation of potential sales impact from the installation of the doors.

When viewed by product type, the variations are consistent with the advice provided by Progressive in September 2013.

Figure 9 summarises average weekly sales across the eight product sets contained in the dairy cabinets at Countdown Pukekohe South.

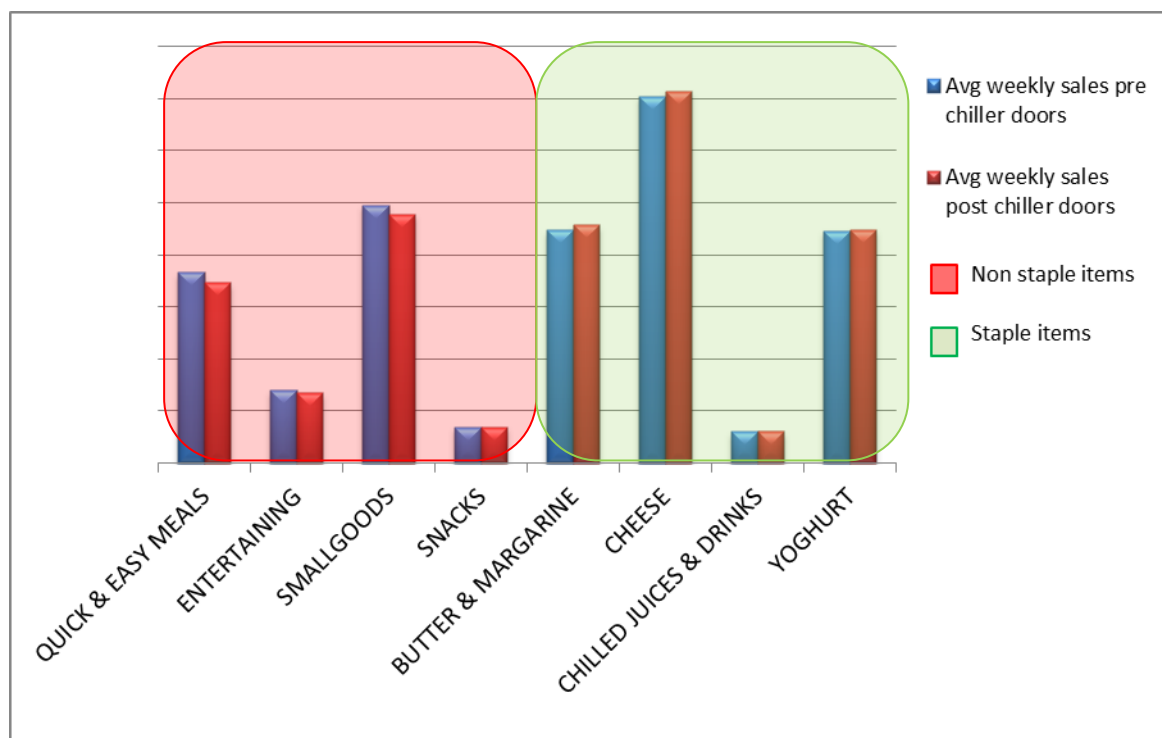


Figure 9. Countdown Pukekohe South Average Weekly Dairy Sales

Across this 12 week period the four product sets highlighted in the red box showed a decrease in average weekly sales while the four product sets highlighted in the green box showed an increase in average weekly sales.

Table 3 shows the variation (%) between average weekly sales prior to the installation of the doors and average weekly sales post the installation of the doors, with a negative value representing a drop in sales.

| Variation between Average Weekly Sales Pre and Post Installation of Doors | |
|---------------------------------------------------------------------------|---------------|
| QUICK & EASY MEALS | -5.23% |
| ENTERTAINING | -3.38% |
| SMALLGOODS | -3.39% |
| SNACKS | -0.15% |
| BUTTER & MARGARINE | 2.21% |
| CHEESE | 1.30% |
| CHILLED JUICES & DRINKS | 1.36% |
| YOGHURT | 0.46% |
| TOTALS | -0.69% |

Table 3. Countdown Pukekohe South Variation between Average Weekly Sales Pre and Post Installation of Doors

12.5 Reduction in Dairy Sales at Countdown Pukekohe South

Looking at sales at Countdown Pukekohe South across these eight product sets based on actual weekly sales data provides a good visual depiction of the impact of the door installation. The following four charts display the sales across the four product sets which experienced a decrease in average weekly sales, with the red line indicating the date on which the doors were installed. There appears to be a clear and significant decrease in sales of Quick & Easy Meals immediately following the installation. Sales fell 15% in the first week following door installation when compared to the week prior and a further 4% drop was evidenced in the second week. Week three displayed an unusual bounce back almost to pre installation levels, before sales continued to rise and fall still at a substantially lower level than before the doors were installed.

The first three weeks data provided by Progressive in respect of the Quick & Easy Meals contains two weeks' sales which are unusually low. These are highlighted by the red arrows in Figure 10. The first of these two weeks covers the Easter period but in respect of the second low week we are unsure as to whether this data is incorrect or there was some other reason contributing to these sales results. If we remove the first three weeks sales data which includes these two outlier results, the drop in average weekly sales for Quick & Easy Meals was 11%.

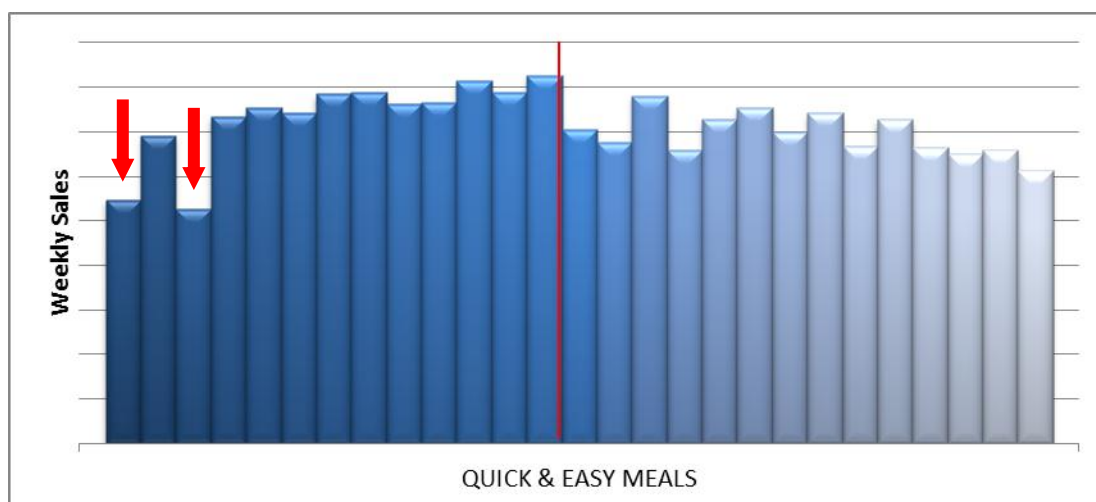


Figure 10. Countdown Pukekohe South Quick & Easy Meal Product Line Sales

This reduction in sales also needs to be viewed within the context of a trend of growing sales within this product line. Taking out the first three weeks data which contains the two outliers leaves 10 weeks pre installation data. A comparison of sales across the first five weeks with the second five weeks immediately prior to the installation of the doors shows an average 4% increase in sales of Quick & Easy Meals

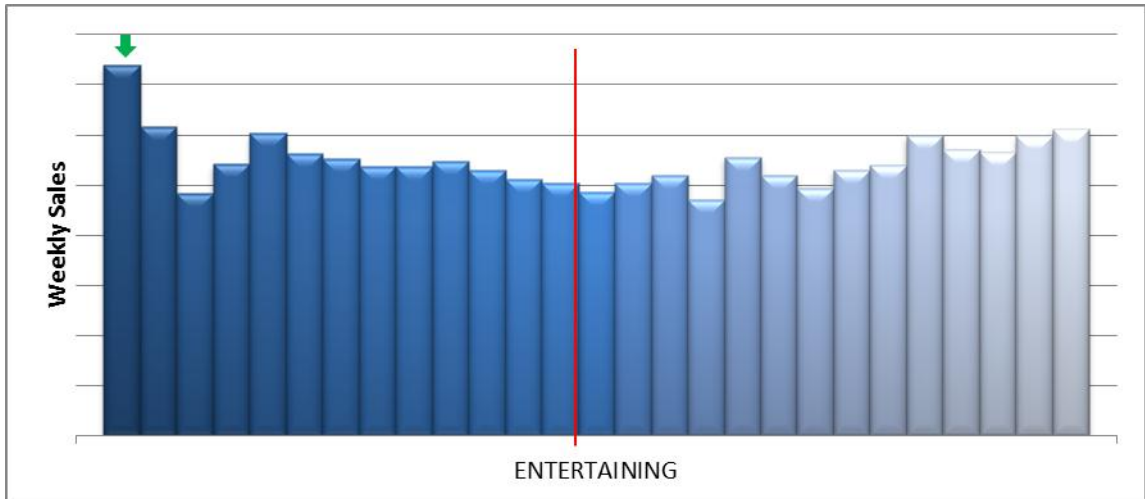


Figure 11. Countdown Pukekohe South Entertaining Product Line Sales

The week following installation saw sales within the Entertaining product line drop 4%, however, looking at the sales trend it is less clear what, if any, impact the doors had. The three weeks immediately prior to the installation saw sales reduce by 3%, 3% and 1% respectively. A declining sales percentage was evidenced consistently pre-installation.

Segmenting the available sales data into four periods based on:

- the six week period 7-12 weeks prior to installation
- the six weeks immediately prior to installation
- the six weeks immediately following installation
- the final eight weeks sales data available 7-14 weeks following installation;

the average weekly sales picture looks like this:

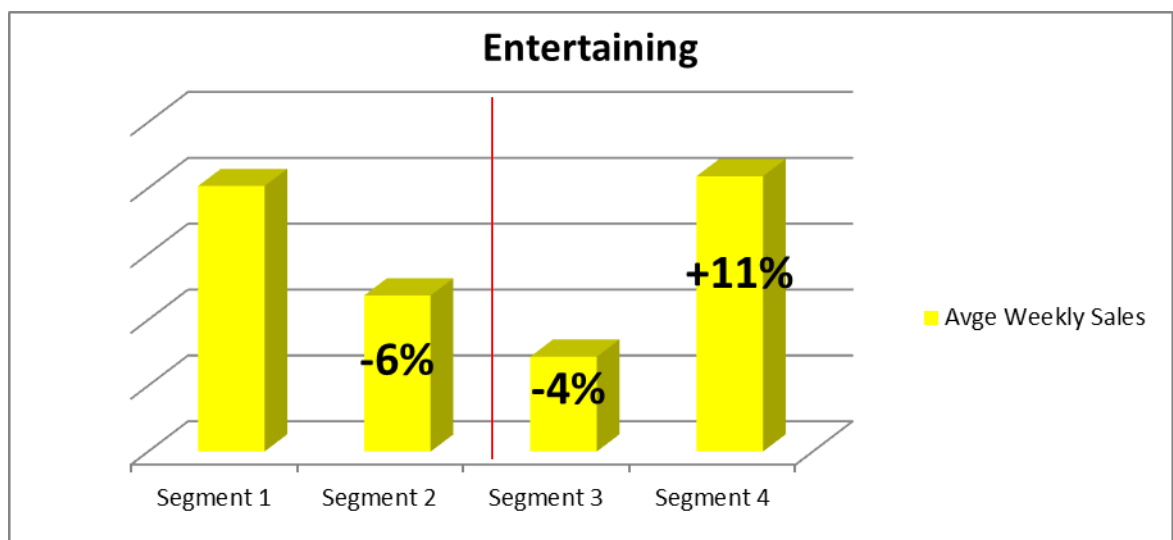


Figure 12. Countdown Pukekohe South Variation in Entertainment Product Line Sales

Please note that for the purposes of this analysis we have excluded the data from the first

week (highlighted by a green arrow in Figure 11). This week shows sales 20% higher than the next highest sales week across the 27 weeks of data provided and 36% higher than the average of the following 26 weeks. It should be noted that this coincided with Easter and there may be products contained within the “Entertaining” product line which experience increased sales tied in with the celebration of Easter. Aside from this assumption, we are unaware of any reason for this substantial increase and have excluded the data as an outlier.

The segmentation shown in Figure 12 shows a 6% decline in average weekly sales between segments one and two (before doors were installed), a 4% decline between segments two and three (the six weeks before and six weeks after installation), followed by an 11% increase between segments three and four (the six weeks immediately after installation compared to the period 7-14 weeks after installation).

Based on this data, it does not appear that the Entertaining product line was impacted by the installation of doors.

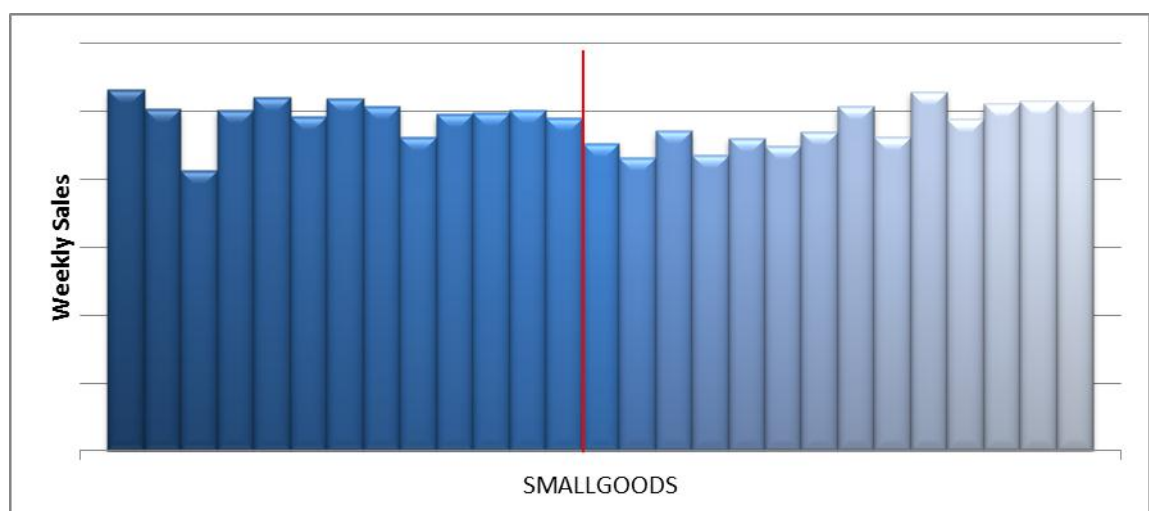


Figure 13. Countdown Pukekohe South Smallgoods Product Line Sales

The sale of Smallgoods showed a very stable sales pattern in the three months prior to the installation of the doors. However, the installation of the doors saw sales drop away with an 8% drop in the week immediately following installation. A reduction in sales continued for an extended period across the seven weeks following installation (30 June-11 August 2013) showing average weekly sales being 9% less than the period prior to installation.

For the subsequent period of seven weeks through to 29 September 2013, sales increased 11% over the previous period and 2% over the average weekly sales prior to installation. By the end of this period, sales had reached a similar level of week-on-week stability that was in evidence prior to installation of the doors. This suggests that any initial impact from the installation of the doors may have been transitional in nature and overcome within the three month period of the trial.

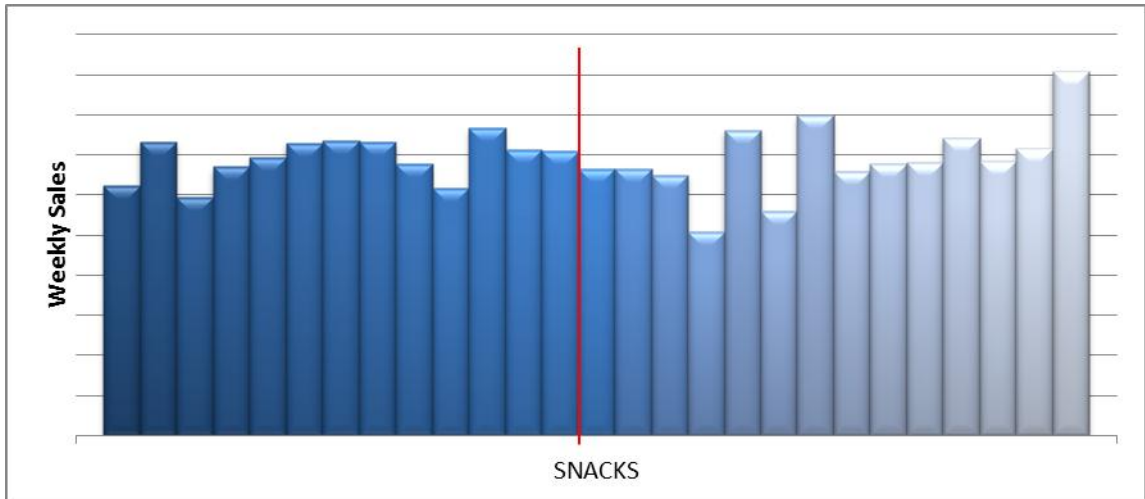


Figure 14. Countdown Pukekohe South Snacks Product Line Sales

Sales of refrigerated snacks saw an extremely small reduction in average weekly sales of -0.15% across the period for which data was provided. This reduction was attributable to the period within six weeks of the doors being installed which saw sales drop 6% in the first week and 8% across this six week period.

For the eight subsequent weeks (11 August – 29 September) sales increased 16% on the previous period and 6% over the average weekly sales for the three months prior to installation.

Again, this sales information tends to indicate that any impact was short term and mitigated within a couple of months of installation.

12.6 Increasing Dairy Sales at Countdown Pukekohe South

Sales data for the remaining four refrigerated product lines on which cabinet doors were installed showed an increase in average weekly sales. Sales for these products, Butter & Margarine, Cheese, Chilled Juices & Drinks and Yoghurt are detailed in the next four charts.

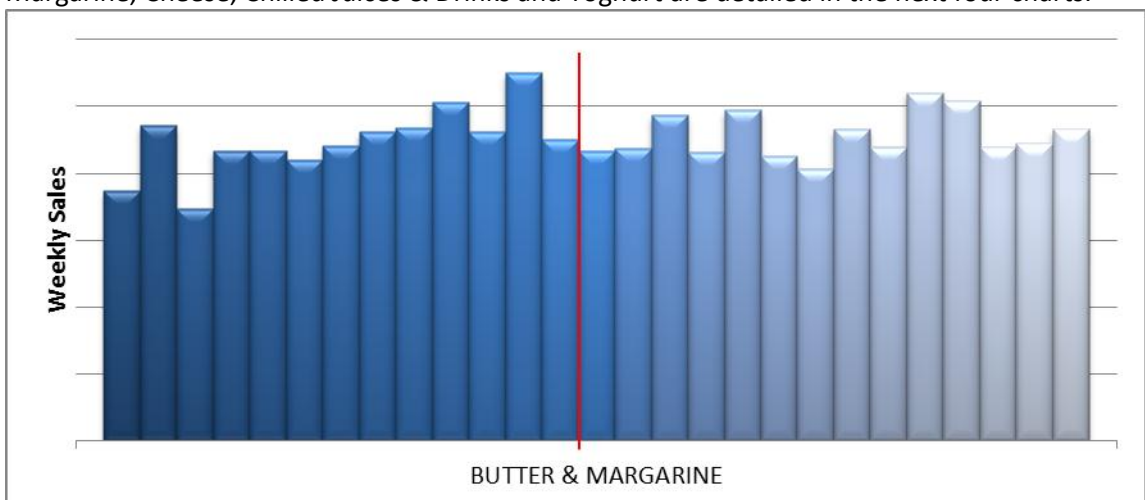


Figure 15. Countdown Pukekohe South Butter & Margarine Sales

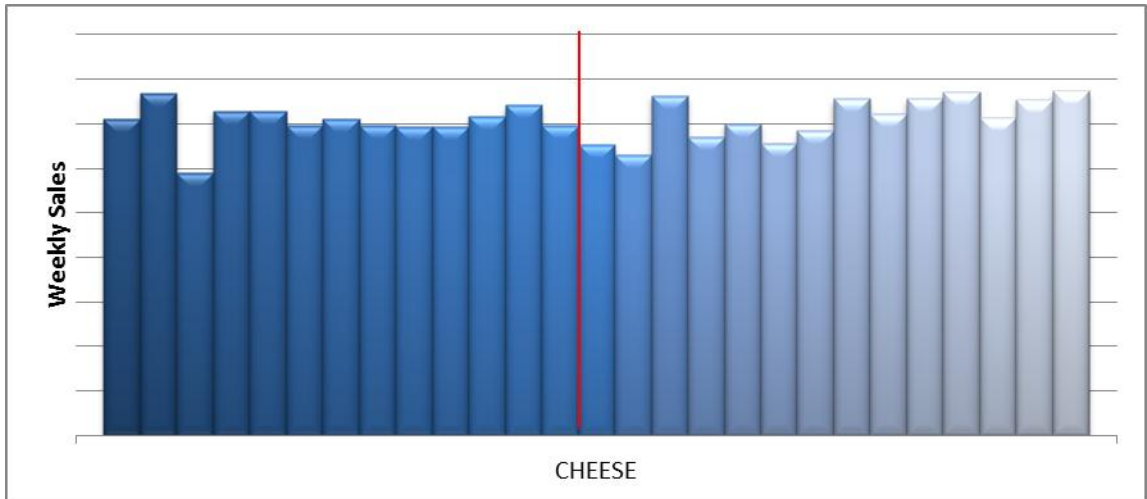


Figure 16. Countdown Pukekohe South Cheese Sales

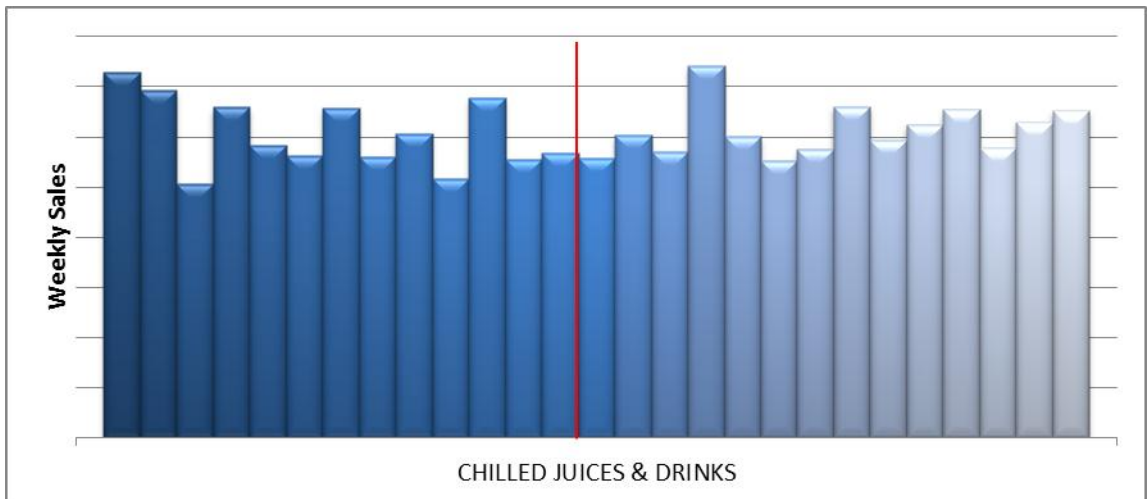


Figure 17. Countdown Pukekohe South Chilled Juices & Drinks Sales

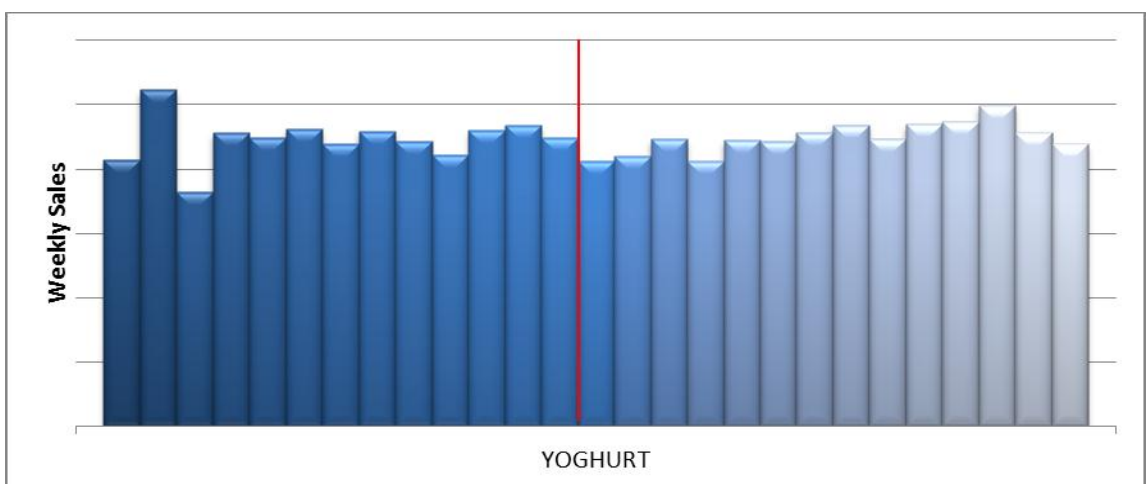


Figure 18. Countdown Pukekohe South Yoghurt Sales

Relatively small sales increases were experienced across all four of these product lines when comparing the pre-door and post-door sales data.

The one consistent trend across all four was a decrease in sales in the week immediately following installation. This ranged from a 2% decrease in Chilled Drink sales up to an 8% decrease in sales of Yoghurt. With the exception of Cheese, the other three product lines all experienced a subsequent increase in sales in the second week following installation.

In the third week following installation, all product lines with the exception of Yoghurt experienced sales exceeding the sales completed in the week prior to installation.

As a general trend, it took Cheese, Butter & Margarine and Yoghurt sales around seven weeks to consistently reach the level of sales experienced prior to the installation of the doors. Chilled drinks appeared to consistently exceed the pre-door sales figures after a period of only two weeks.

12.7 Comparative Dairy Sales within the Countdown Network

The sales trends within the subject store, Countdown Pukekohe South, cannot on their own be analysed to assess sales impact. It is necessary to also look at wider sales trends to determine if the installation of the doors put dairy sales at Pukekohe South out of step with the trading patterns at other stores.

For this reason, Progressive also provided sales data covering average sales of dairy products within 16 other Countdown stores in the same geographical region. This data showed 12 weeks average sales prior to the date of the installation of the doors at Pukekohe South and 12 weeks average sales following this date.

Figure 19 shows the variation between average pre and post door chilled product sales across the 17 stores.

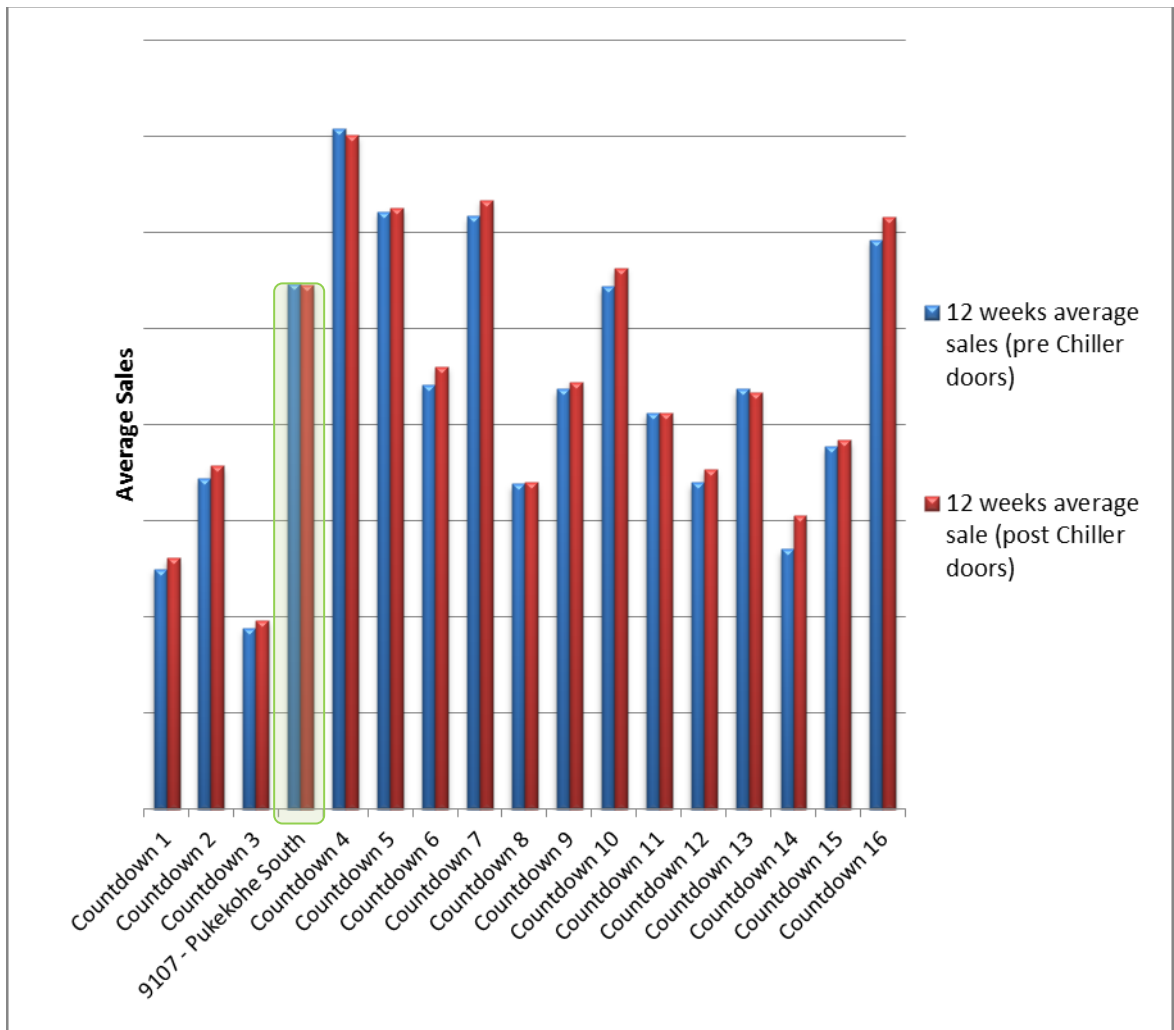


Figure 19. Comparative Dairy Sales within the Countdown Network

Countdown Pukekohe South (highlighted in green in the chart above) ranked 15th out of 17 stores in terms of sales performance and was one of only four stores which recorded a drop in dairy sales when comparing these two 12 week periods.

Figure 20 shows the percentage variation in sales across the 17 stores pre and post the installation date of the doors at Pukekohe South.

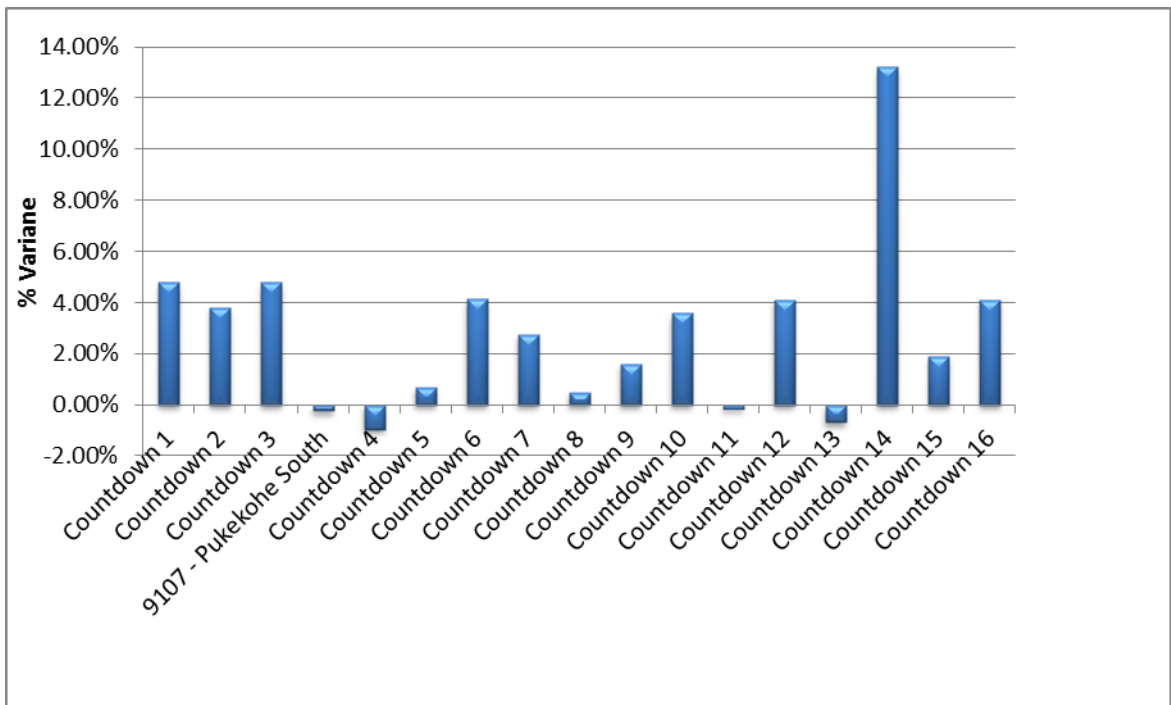


Figure 20. Percentage Variation in Dairy Sales within the Countdown Network

Excluding Pukekohe South, the average variation in sales was an increase of 3.01%.

As is also evident, sales at Countdown 14 are substantially greater than any other store and it would be reasonable in looking to gain a measure of average sales variation to also exclude this store. With Pukekohe South and Countdown 14 excluded, the average variation in sales was an increase of 2.32%.

With an average sales increase of 2.3% and negative sales growth at Countdown Pukekohe South of -0.23%, it can be assumed that the trial store is 2.5% below what it should have achieved from a sales perspective across this 24 week period.

Where this comparison resulting in the 2.5% differential is not equal however, is that we have a known difference at the trial store with the installation of cabinet doors.

A simple presumption would therefore attribute this 2.5% reduction in sales to the presence of the doors. In addition however, we have also looked at the sales data to determine if everything else is equal between the subject store and the sales figures across the 16 stores against which the sales performance at Countdown Pukekohe South is being compared.

The data available to us to try and gain an understanding of whether Pukekohe South would fit the profile for an average store in terms of sales growth is limited to the 27 weeks of data provided by Progressive. We have looked in particular at the 13 weeks of sales data for dairy sales prior to the doors being installed.

Of these 13 weeks, we believe there may be an integrity issue with the data for the week of 14 April. The sales for this week are 20% lower than the average sales for any other week in the data set with sales substantially lower across all eight dairy product sets. Unless store operations were disrupted during this week, we suspect data may be missing. For this reason we have excluded this week from our analysis and have focused on the remaining 12 weeks pre-door installation. This provides a conservative picture of sales growth.

Looking at the sales data for Countdown Pukekohe South for the period prior to the installation of the doors, we compared average sales from the first six weeks (start of April to early May) with average sales from the subsequent six weeks (mid May to end of June). The increase in average sales between these periods is 0.97%. So leading into the installation of the doors the average dairy sales growth figure at Countdown Pukekohe South was less than half the average of the comparison stores during the 12 week post installation period.

While not an exact comparison, this does provide us with an indicator that sales growth at Pukekohe South may have been below average regardless of the installation of the doors.

Figure 21 compares sales growth pre and post doors at Pukekohe South with average sales growth across the other 15 Countdown stores (excluding Countdown Manurewa).

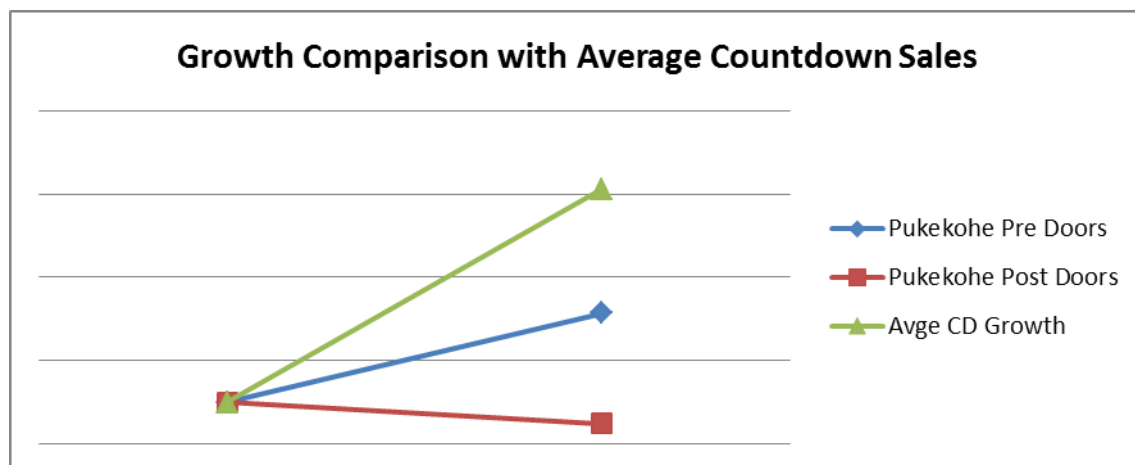


Figure 21. Countdown Pukekohe South Growth Comparison with the Countdown Network

Of the eight product lines for which sales data was provided, with the exception of Quick & Easy Meals, those products whose sales appeared to be initially impacted by the installation of doors generally showed a return to pre-doors sales levels by week seven.

If we assume the first seven weeks following installation includes some form of temporary sales impact, we can look at the second seven week period following door installation and compare this with pre door sales to assess a more normalised growth rate for the store.

Making this comparison at Countdown Pukekohe South, dairy sales for the period 7-12 weeks following installation of the doors compared to dairy sales pre door installation,

increased by 1.03%. This is equivalent to the pre installation growth rate for this store as shown in Figure 22.

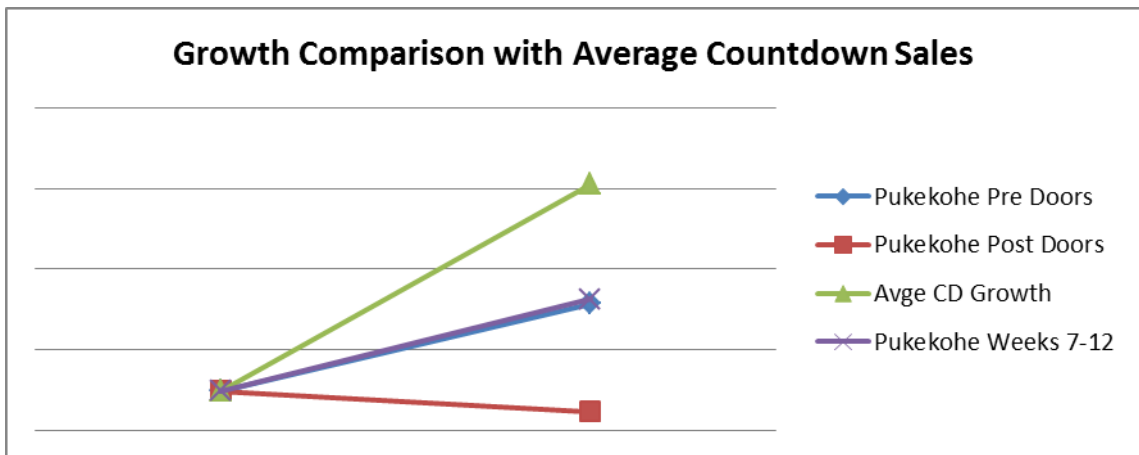


Figure 22. Countdown Pukekohe South Growth Comparison with the Countdown Network – Pre and Post Doors

Figure 22 tends to indicate that following an initial drop in some product areas across the first 6-7 weeks, sales then return to pre-door installation levels with no impact, material or otherwise, on product sales.

Figure 23 compares dairy sales pre and post door installation for four Countdown stores to provide a further measure of dairy sale trends. These four stores are Pukekohe South, Botany Downs which has the greatest dollar value in dairy sales, Papatoetoe that has the lowest dollar value in dairy sales, and Papkura that has the median dollar value in dairy sales.

The solid black line represents the date of the installation of the doors, and the dotted red lines for each store demonstrate the sales trend from the date of installation until the end of the data reporting period.

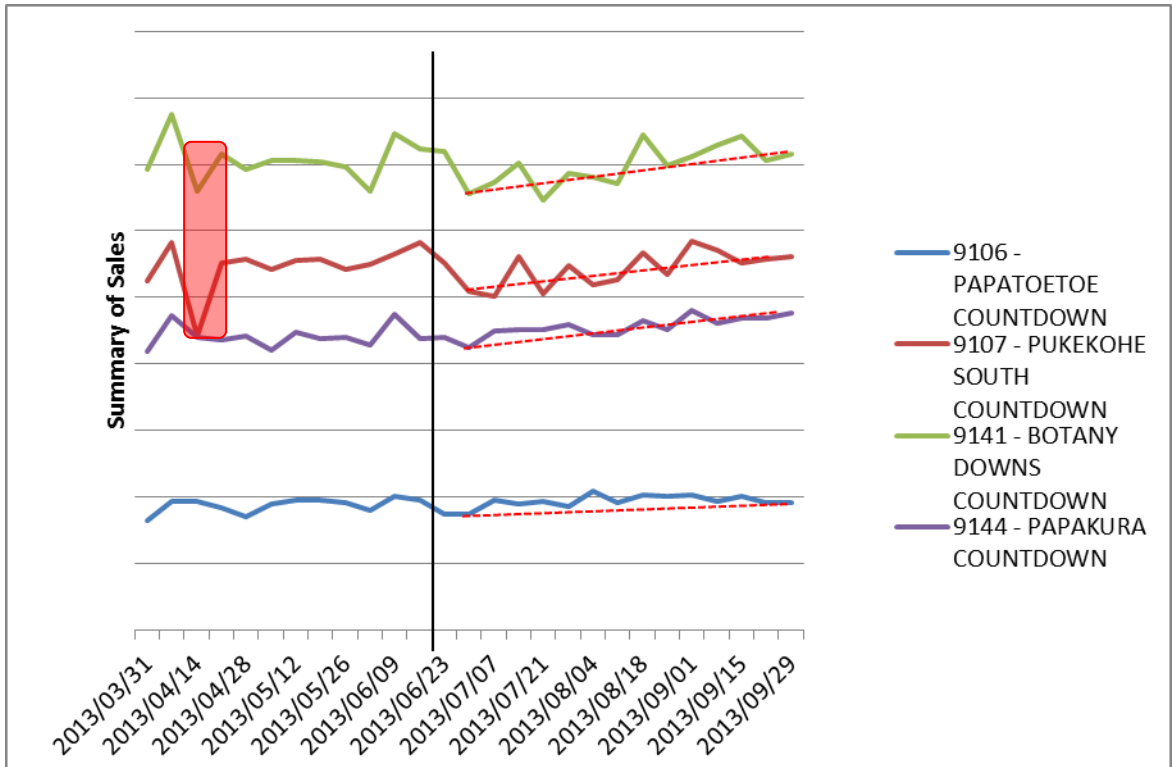


Figure 23. Pre and Post Door Dairy Sale Trends Sample

Across this period, all four stores show a positive overall sales trend of a very similar percentage with the red dotted line showing the smoothed sales growth trend for each store. When comparing the variation in dairy sales across the four stores for the weeks 30 June and 29 September (trend line), we can identify an increase in dairy sales of 10.1% for Papatoetoe, 10.3% for Pukekohe South, 9.2% for Botany Downs, and 12.5% for Papakura. The average increase in spend is 10.5%.

Also of note is the fact that in the week the doors were installed, there was a similar downwards trend in sales across all four stores, although the three comparison stores bounced back in the week following while Countdown Pukekohe South showed a further decrease in the following week before beginning to rise.

Figure 23 also shows the sales data from the week of 14 April (highlighted in red) which we have excluded from our analysis above due to the unusual nature of the sales value compared to the other 12 weeks prior to the installation of the doors.

12.8 Average Spend Per Customer from Dairy Department

Progressive also provided comparative information on the average dairy spend per customer. This tracks the average spend per customer of items within the dairy cabinets. This includes both staple items and non-staple discretionary products covering all the product lines detailed in Figure 9.

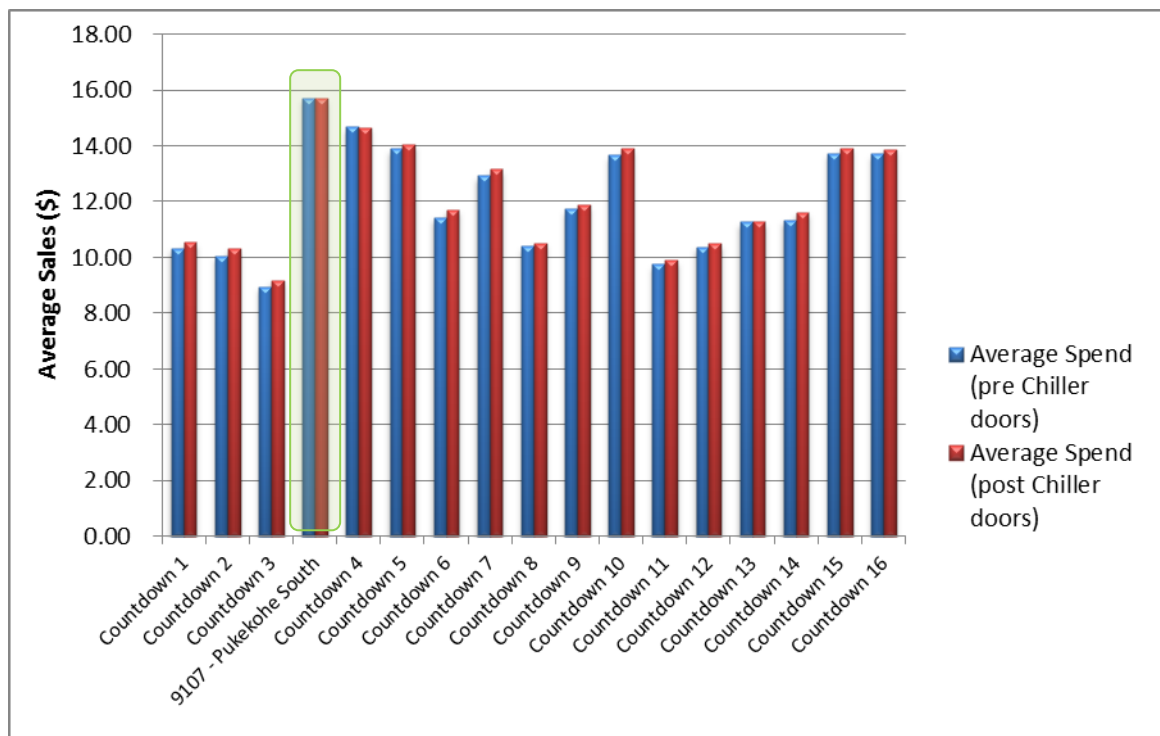


Figure 24. Average Dairy Spend per Customer

Three stores recorded a decrease in the average dairy spend per customer with Countdown Pukekohe South being one of these stores showing a decrease of \$0.02 per customer. Across the remaining 14 stores there was an “average spend” increase of \$0.19. The percentage variation in average spend ranged from an increase of 2.60% down to -0.16% at Pukekohe South.

13 Customer Survey Results

13.1 Survey Structure

While the natural assumption pre-installation was that energy savings would be achieved, the unknown factor was whether the installation of doors would have an impact on customer buying behaviour, evidenced through a reduction in sales.

The attitude of customers towards the installation of doors on the dairy cases is a key driver of the commercial viability of their installation. From the perspective of the food retailer, in this case Progressive, there is a reluctance to install anything that can be seen as a barrier between customers and their products. Clearly the installation of doors on the dairy cabinets can be viewed as such a barrier.

To assess customer attitudes, ECOsystems undertook two customer surveys. The first was on 29 May 2013 (149 customers surveyed), in the month prior to the doors being fitted, and the second was on 11 July 2013 (138 customers surveyed), in the month following 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, ease of use, comfort levels with respect to the surrounding aisle and the cabinets themselves. The survey questions are detailed in Table 4:

| # | Pre-installation Survey | Post-installation Survey |
|---|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| 1 | Do you believe doors on refrigeration will have a positive effect on energy use and the environment? | Do you believe doors on refrigeration will have a positive effect on energy use and the environment? |
| 2 | Do you believe doors on refrigeration will have a negative effect on your shopping experience? | Do you believe doors on refrigeration have had a negative effect on your shopping experience? |
| 3 | How easy is it to use this dairy cabinet? | How easy is it to use this dairy cabinet? |
| 4 | Is the product cold enough when removing it from the cabinet? | Have you noticed a change in product temperature since the doors have been installed? |
| 5 | How do you find the temperature in this aisle? | Is the product cold enough when removing it from the cabinet? |
| 6 | Are you in favour of doors on refrigerators? | How do you find the temperature in this aisle? |
| 7 | | Are you in favour of doors on refrigerators? |

Table 4. Customer Survey Structure

13.2 Key Findings

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.

Despite this however, prior to the installation of the doors a material number of customers (24%) also believed that the installation of doors would have a negative effect on their shopping experience. This customer perception reinforces the concerns held by the retailer that the installation of doors may have a negative impact on sales. At the same time it should be noted that 73% of respondents believed that the installation of doors would not have a negative effect on their shopping experience.

Once the doors were installed, the response to this question substantially improved.

Post-installation, the percentage of customers who believed the doors would have a negative effect on their shopping experience dropped from 24% to only 1%. Correspondingly, the percentage that believed the doors would not have a negative impact jumped from 73% to 97%.

Some of this pre-installation negativity may have been due to a perception of the doors making the cabinets more difficult to use. This perception was not borne out in the follow-up survey, with the positive reaction to the doors being reinforced by a number of other benefits. These benefits can be summarised through the following survey results:

13.2.1 Produce Colder

Following the installation of the doors, 99% of respondents found the product to be cold or very cold compared to 68% of respondents prior to the installation of the doors, an increase of 31%.

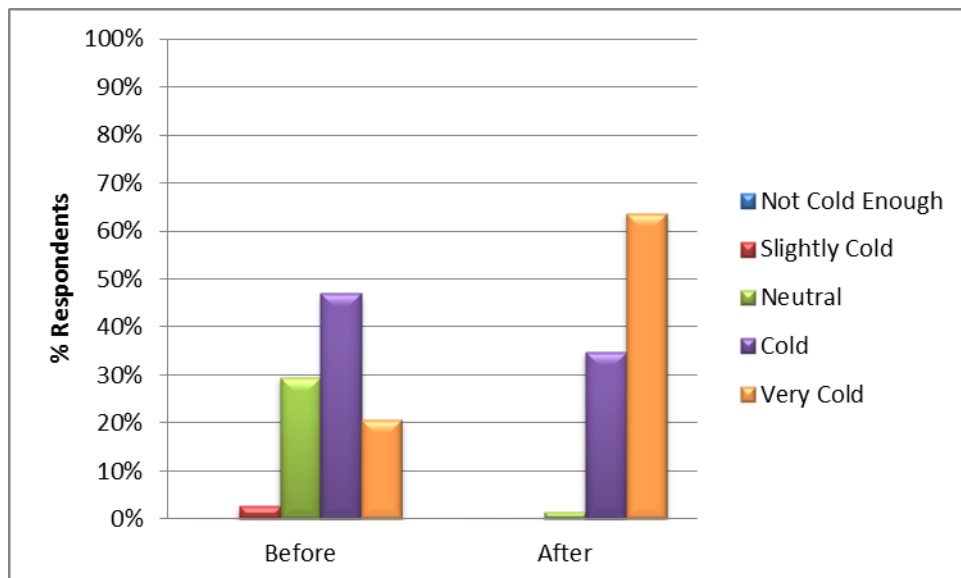


Figure 25. Customer Survey Question 4 – Is the Product Cold Enough?

13.2.2 Improved Aisle Comfort

A substantial improvement in customers' perception of dairy aisle comfort was evidenced in the survey results. While pre-installation 29% of customers found the dairy aisle uncomfortable and 31% found the aisle comfortable, post installation 99% of respondents found the aisle comfortable with those finding it very comfortable increasing from 7% pre door installation to 70% post installation of the doors.

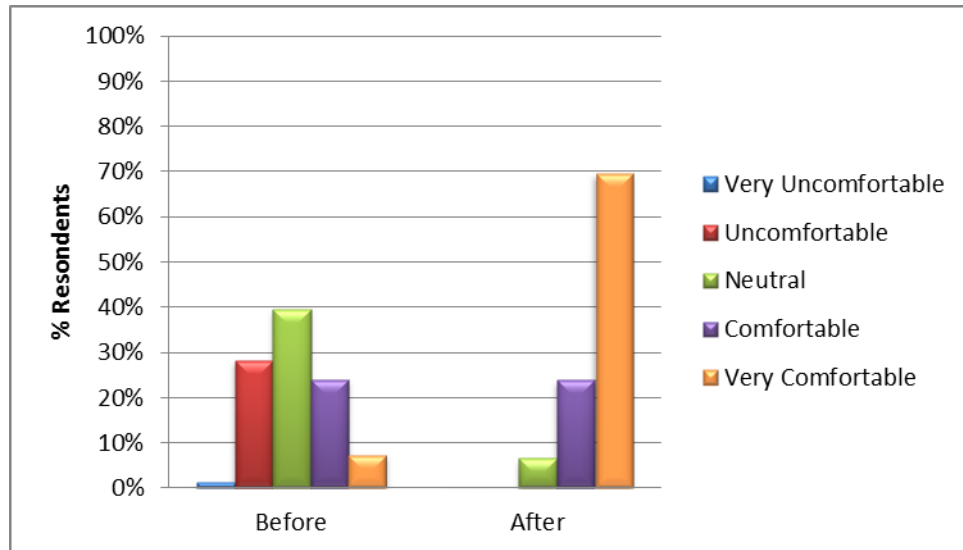


Figure 26. Customer Survey Question 5 – How do you find the Aisle Temperature?

None of the 138 customers surveyed post-installation found the dairy aisle uncomfortable.

13.2.3 Customers Supportive of Doors on Refrigerated Cabinets

Prior to the installation of the doors, 53% of respondents were in favour of doors on fridges, with 28% not caring and 19% not in favour. Post installation, 99% were in favour of doors on fridges, with 1% having no opinion. Not one of the 138 customers surveyed was against the installation of doors on fridges once the doors had been installed.

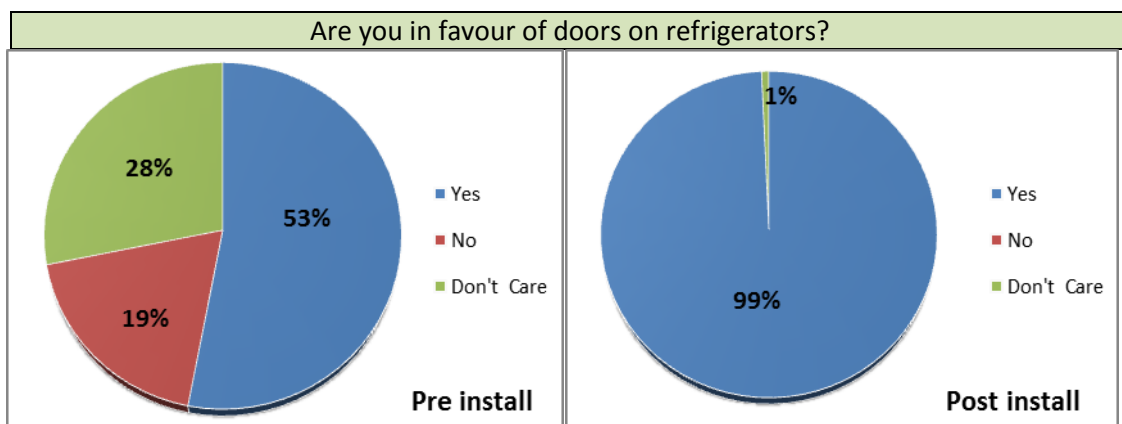


Figure 27. Customer Survey Question 6 – Are you in favour of Doors on Fridges?

With almost one in four customers believing pre-installation that the installation of doors would have a negative impact on their shopping experience, there is a strong correlation between the perceived concerns of the customers and the perceived concerns of the retailer of a negative impact on sales.

However, a comparison of the pre-installation survey results with the results achieved post-installation shows overwhelming support for the installation of doors. Ease of use was not seen as an issue, the product was perceived to be colder and the aisle was significantly more comfortable. The survey results point heavily towards a more enjoyable shopping experience.

A more detailed analysis of the Customer Survey findings is attached in **Appendix One**.

14 Support from Other Studies

While there have been studies undertaken in other regions investigating the energy reduction benefits of installing doors on refrigerated supermarket cabinets, there is very little evidence of studies covering a complete investigation of energy savings, impact on sales and customer perception.

Despite the lack of comprehensive analysis, the study results that have been published do show a good level of support for and alignment with the findings of this trial.

14.1 Lindberg et al, 2008

In 2008, Lindberg et al published a paper titled “*Supermarkets, Indoor Climate and Energy Efficiency – Field Measurements Before and After Installation of Doors on Refrigerated Cases*”.

This paper presented the results of a retrofit of glass doors on vertical display cabinets in a Swedish supermarket. The doors were fitted on cabinets housing meat and on dairy cabinets. The results focused on the impact of the doors on the internal store climate, the energy performance of the cabinets and sales. In terms of each of these areas:

- *Energy use* – the electrical supply to the vertical display cabinets decreased by 26%. It was noted that the doors reduced the temperature of the produce and accordingly, there may be room to adjust the cabinet temperature to increase energy savings further
- *Internal store climate* – a reduction in internal cabinet temperature and an increase in aisle temperature was observed. In addition, customers were surveyed about comfort levels before and after the doors were installed. While in general this survey showed customers found the environment comfortable both before and after doors were fitted, there was a trend towards customers finding the aisle temperatures both warmer and slightly more comfortable after the doors were fitted

- Sales – while sales figures were not published, the study did conclude, “*The customers are not negatively affected by the installed doors and sales numbers have not been lower due to the installations.*” They went on to note, “*This comparison is done only for a shorter period and longer measurements are needed in order to see how and if the doors have affected the sales numbers.*”

Findings on reduced energy use, improved store environment and lack of sales impact all support the similar findings in this trial.

14.2 Fricke & Becker, 2010

In 2010, Fricke & Becker published a study based on results from two supermarkets located in the Midwestern United States. This study sought to compare the energy savings and impact on product sales between a typical open refrigerated display case and a typical glass-doored refrigerated display case.

Unlike the previous study and this trial which involved retrofitting doors onto existing cabinets and measuring the results before and after the installation, this project involved both stores receiving new refrigerated units, one enclosed with doors and one being an open display. At the first store an old open dairy cabinet was replaced with a new doored dairy cabinet and an old open beer cabinet was replaced with a new open beer cabinet. At the second store an old open beer cabinet was replaced with a new doored beer cabinet.

This study produced the following results:

- *Energy use* – energy consumption was measured and compared based on per unit length of the respective open and doored refrigeration cabinets. The results showed that the open display cabinets consumed approximately 1.3 times more energy than the doored cabinets. This equates to energy savings of around 23%. Two other points of note arose out of the energy measurements. First, a significant portion of the energy savings achieved by the use of doors was offset through the energy involved in the use of anti-sweat heaters on the doors. Second, where the energy consumption of the open display cabinet varied significantly from day-to-day, the doored cabinet exhibited a relatively consistent day-to-day electrical load
- *Sales* – for both sales of beer products and sales of dairy products, there was found to be no significant difference in sales on the doored cabinets compared to the open display cabinets. This conclusion was based on the mean weekly quantity of product sold

Findings on reduced energy use and no significant impact on sales support the similar findings in this trial. It should be noted that during E3’s initial discussions with the industry over the “In from the Cold” recommendations paper, the industry felt that “statistical significance” did not mean *no impact*, even if it might have been temporary.

14.3 Judith Evans, Background Paper, 2014

A background paper was produced in 2014 titled, *“Are doors on fridges the best environmental solution for the retail sector?”* This paper, authored by Judith Evans, was presented as a background paper for debate by The Institute of Refrigeration (IOR). The IOR is a United Kingdom based charitable organisation with their stated purpose being to improve the application of refrigeration for the general good of society.

While largely referencing Lindberg et al and Fricke & Becker as the two most comprehensive studies, the paper does introduce further variables which are stated to impact the size of energy reduction achieved by the installation of doors. These variables are the number of door openings, the door itself, the integrity of the door seals and the level of infiltration during door openings.

In particular it was noted that the number of door openings in supermarkets can range from two door openings per hour up to 60 openings per hour. The number of door openings can significantly raise the amount of infiltration into the cabinet.

This paper also noted the benefits in reducing the range in temperature across the cabinet with the introduction of doors. In particular it was stated, *“With less range in temperature the shelf life of food will be more uniform.”*

While this paper largely reinforces the results of the first two studies, it does open up an area for further investigation in respect of the rate and impact of door openings, an area not investigated in this trial.

15 Expectations when Retrofitting Doors on Cabinets

Based on the experience from the trial at Countdown Pukekohe South, we can form a general view of what supermarket operators should expect when retrofitting doors to refrigerated dairy cabinets or switching to enclosed dairy cabinets.

Any stores considering a similar initiative should expect the following:

- Energy savings - instant energy savings of more than 30%, however, in areas of increased humidity, energy savings closer to 40%. Energy loggers or energy submeters should be installed to separate off the energy use for the system to be enclosed to enable accurate measurement and verification of energy savings
- Aisle temperature - an instant improvement in the aisle temperature and also a more stable and consistent aisle temperature. The installation of temperature loggers is recommended to measure this impact
- Customer response – an overwhelming positive response from customers following installation. It is important when choosing the doors to carefully consider the type of handles for ease of use, any additional lighting to ensure the product is prominently displayed and anti-sweat heaters to prevent condensation accumulating on the doors
- Sales of staple items – no sales impact should be expected on staple product lines
- Sales of discretionary product lines - the potential for an initial temporary impact on discretionary product sales may be noticed for 6-7 weeks following installation. To mitigate this risk additional promotional activity could be considered
- Fine tuning – it is important following installation to carefully monitor the cabinets to maximize the energy savings available. Consideration in this regard should be given to whether the number of defrost cycles can be reduced, whether the cabinet temperature can be optimized with the produce being more easily held at a lower level with doors installed and an fine tuning of the heating, ventilation and air conditioning system which may be available due to a lower level of cold air being circulated through the store

Careful planning and the setting of realistic expectations is required to support the successful installation of doors on refrigerated units, or use of enclosed cabinets.

16 Conclusion

The purpose of this trial was to test the commercial feasibility of installing doors on refrigerated dairy cabinets. The feasibility was to be seen through an assessment of the value of the energy savings achieved through the installation of doors compared against any impact on sales.

As expected, the energy savings have proven to be material and added benefits will also be achieved through improved performance of the dairy cabinets. The 42% energy savings measured, exceeded both the pre-trial expectation and the results published in similar overseas studies. We believe the increased energy savings can largely be attributed to the local climate and in particular, Auckland's high relative humidity. Preventing the infiltration of this warm moist air into the cabinets should result in greater energy reductions than can be achieved in climates with a drier air content.

We have also seen a significant relationship between the temperature in the dairy cabinets and the temperature in the adjacent aisle. This confirmed that with no doors present, the warm store air infiltrates the refrigerated cabinets and the cool refrigerated air leaks into the aisles. This relationship is so strong when no doors are present, that the aisle temperature clearly displays a sharp increase as the cabinets run a defrost cycle.

The volatility in aisle temperature without doors also evidences the pressure the refrigeration system places on the store's air conditioning system. While the store is air conditioned to a fixed temperature setpoint, the temperature in the dairy aisle regularly varies 2-3°C. This volatility is virtually eliminated with the presence of doors and as a result, we would also expect additional energy savings to be achieved out of the store's air conditioning system being under less pressure with a reduced amount of mixing between the warm store air and the cool cabinet air.

A full analysis of sales data was not possible because key data for the period immediately prior to and following the removal of the doors was not provided. Despite this, the data that was provided indicates that any sales impact was only temporary in nature for the majority of items. Staple dairy items (butter & margarine, cheese and yoghurt) and chilled juice and drinks showed no impact. Sales of non-staple products varied. Entertainment products, smallgoods and snacks displayed a noticeable drop in sales but recovered to pre-door sales levels within seven weeks. Unfortunately sales of the quick & easy meals did not appear to recover over the 12 weeks of data provided, having dropped by 5.23%.

Customer perception of the doors as captured in the customer survey was overwhelmingly positive and pointed towards an improved shopping experience. A customer survey taken in the month following the installation of the doors compared to a similar survey taken in the month prior to the doors being installed, showed the number of customers in favour of the doors increased from 53% to 99%.

Temperature logging and customer feedback show the product is maintained at a lower and more stable temperature which improves product quality and health and safety.

17 Appendix One – Detailed Customer Survey Results

ECOsystems surveyed customers in the dairy aisle on 29 May 2013, prior to the doors being fitted, and on 11 July 2013 following installation, to find out if customer views had changed.

Customers were asked to respond to a structured survey developed by ECOsystems around their views on the energy efficiency of the cabinets, ease of use, comfort levels with respect to the surrounding aisle and the cabinets themselves.

Results for Respondents: Question One

Do you believe doors on refrigeration will have a positive effect on energy use and the environment?

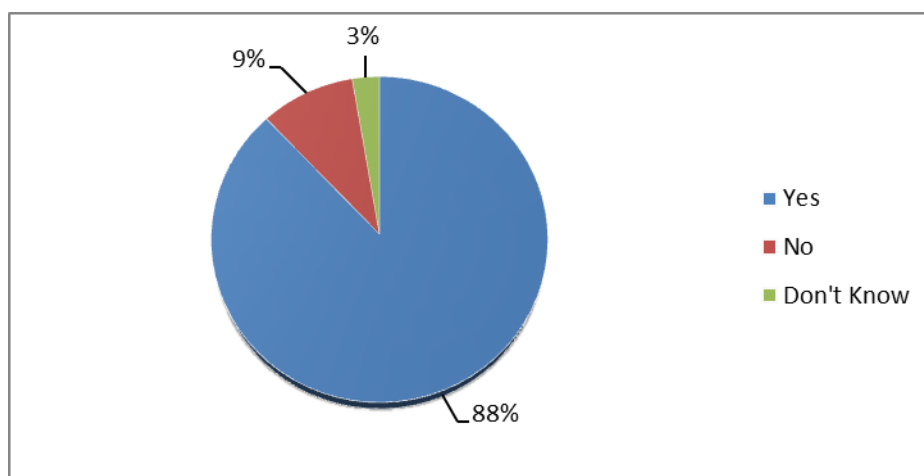


Fig 1: Response to Question 1 (pre installation).

A total of 149 individuals surveyed responded to Question 1. 88% of respondents believed that installing doors on refrigeration cabinets would have a positive effect on the environment. 9% believed that it would not have a positive effect, while 3% of respondents were unsure as to whether or not this would make an impact.

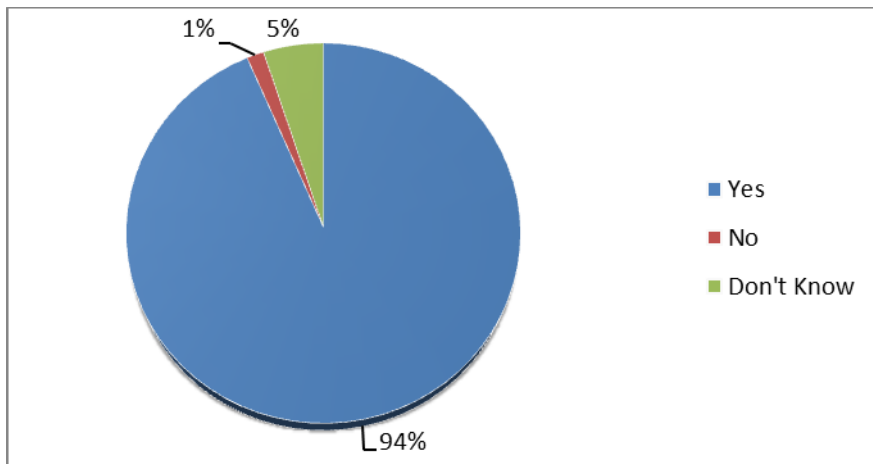


Fig 2: Response to Question 1 (post installation).

Of the 138 respondents surveyed after the doors were installed, 94% believed that doors on refrigeration would have a positive effect on the environment. Only 1% believed that it would have a negative effect, while 5% of respondents were unsure as to whether or not the installation of the doors would have an impact.

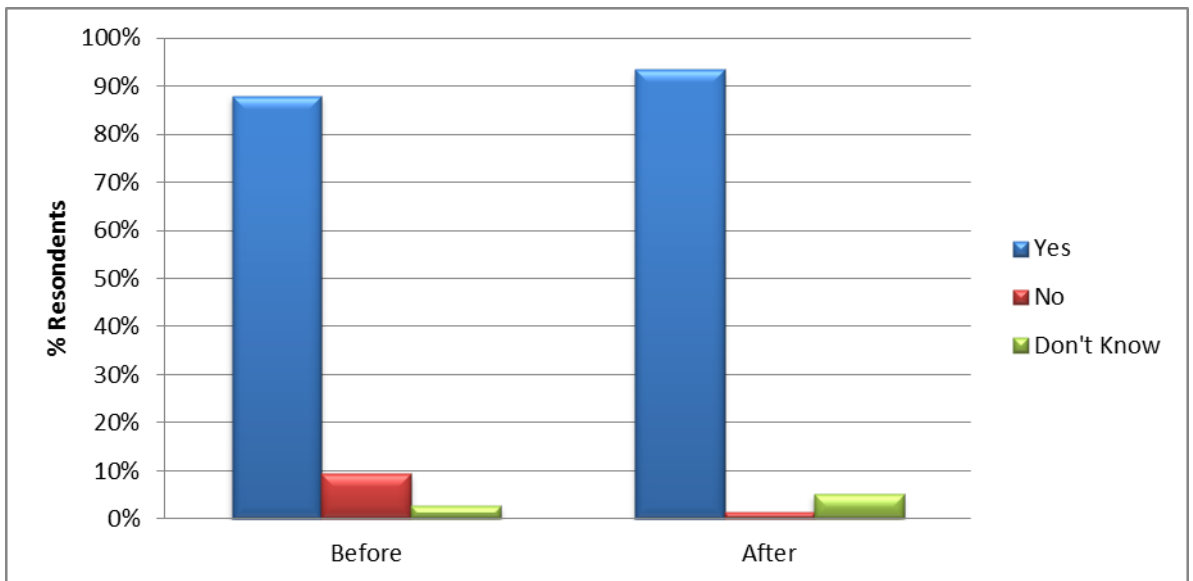


Fig 3: Comparison of results from Question 1 (pre and post installation).

Once the doors were installed, customer views on whether the doors would make a positive impact on energy use increased by 6%. The percentage of respondents who were unsure or believed that there would be a negative impact on energy use, decreased by 50% from 12% to 6% compared to pre installation. The installation of doors on refrigeration elicited a positive response from survey respondents with a marked increase in those who believed that their installation would have a positive impact on energy conservation and the environment.

Results for Respondents: Question Two

Do you believe doors on refrigeration will have a negative effect on your shopping experience?

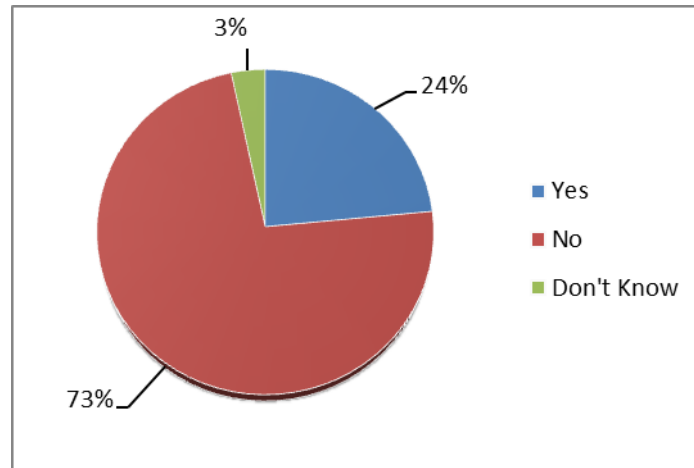


Fig 4: Response to Question 2 (pre installation).

A total of 149 individuals surveyed responded to Question 2. 73% of respondents believed that installing doors on refrigeration would not have a negative effect on their shopping experience. 24% believed that it would have a negative effect, while 3% of respondents were unsure as to whether or not this would have an effect.

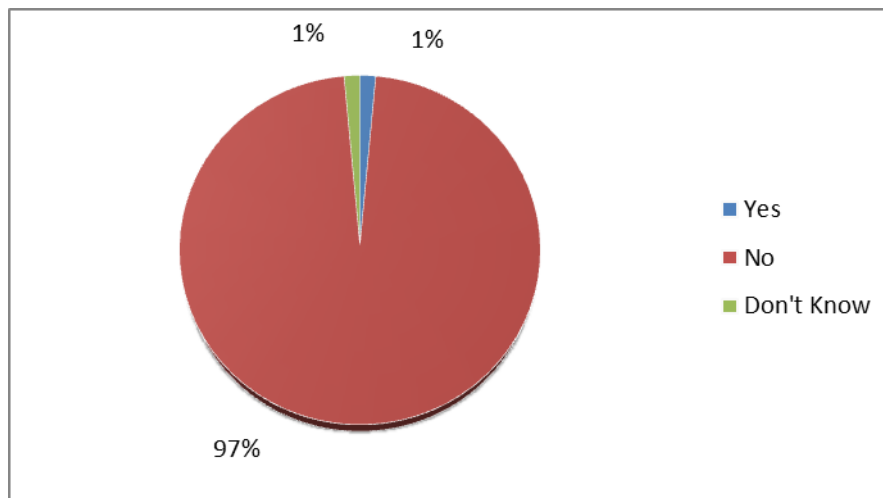


Fig 5: Response to Question 2 (post installation).

Of the 138 respondents surveyed after the doors were installed, 97% of respondents believed that installing doors on refrigeration would not have a negative effect on their shopping experience. 1% believed that it would have a negative effect, while 1% of respondents were unsure as to whether or not this would have any effect.

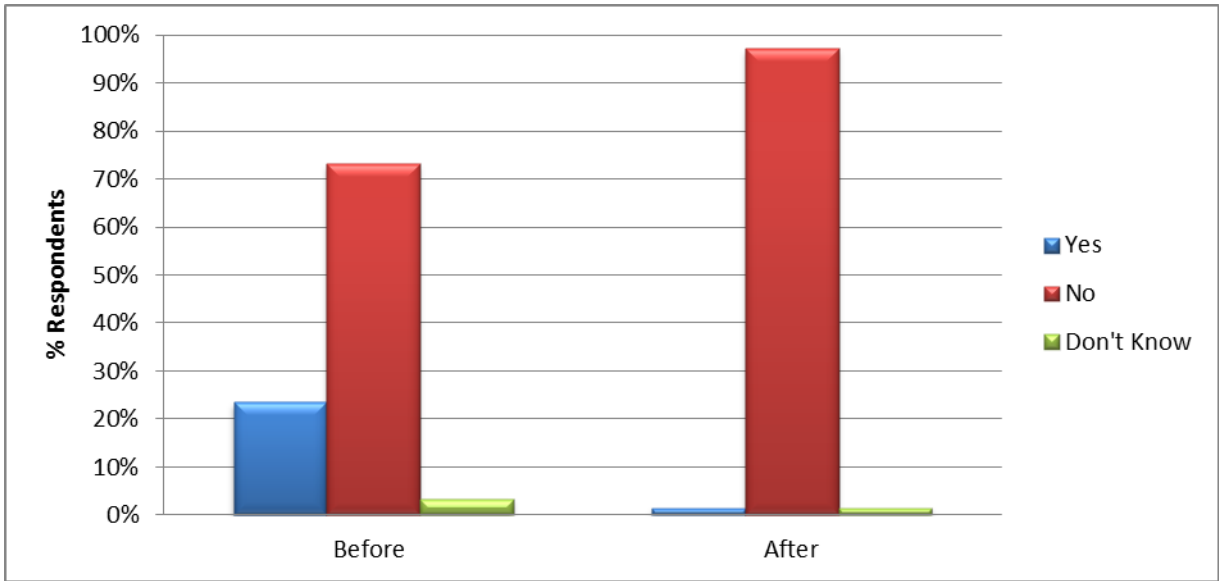


Fig 6: Comparison of results from Question 2 pre and post installation.

After the installation of the doors, customer perception that the doors would have a negative effect on their shopping experience decreased by 22%.

Results for Respondents: Question Three

How easy is it to use this dairy cabinet?

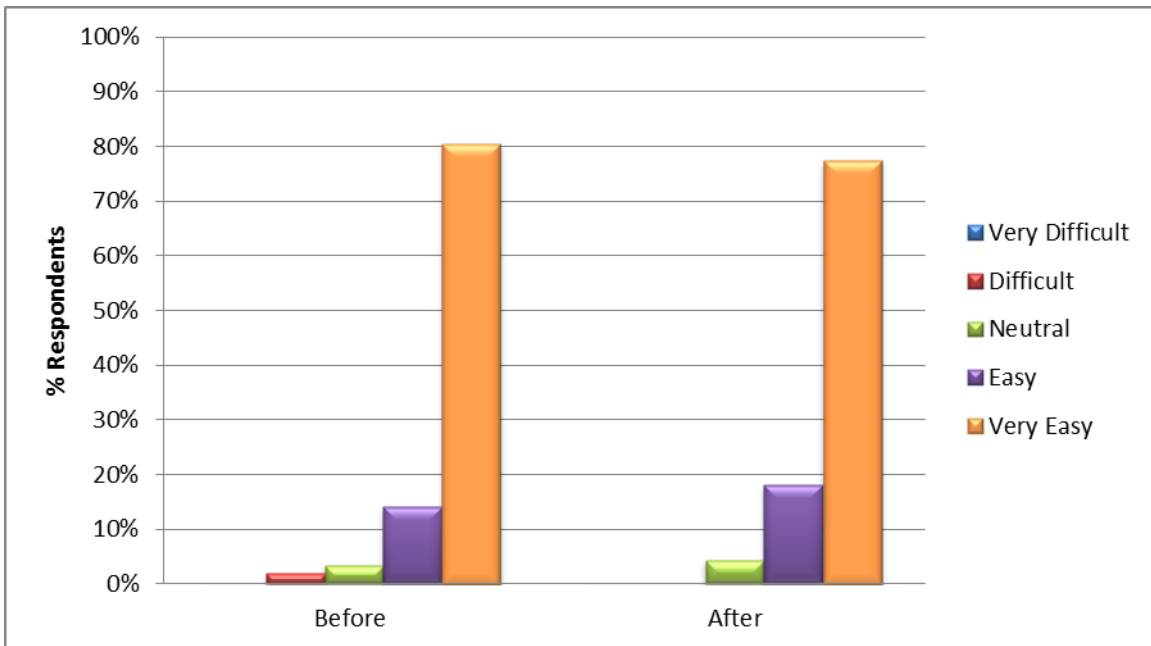


Fig 7: Response to Question 3.

Of the 149 customers surveyed prior to installation, 95% of respondents felt that the dairy cabinets without doors were easy or very easy to use. This increased to 96% post

installation ($n=138$), demonstrating that the majority of customers surveyed felt the dairy cabinets were easy to use whether doors were installed or not.

Results for Respondents: Question Four

Have you noticed a change in product temperature since the doors have been installed?

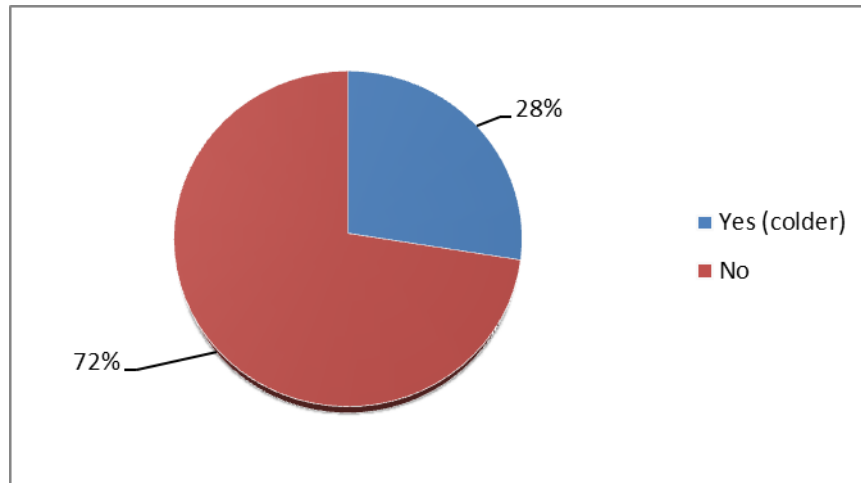


Fig 8: Response to Question 4.

Of the 138 customers surveyed, 72% did not notice a change in product temperature since the installation of the doors. 28% of respondents noted that the product was now colder post installation. This would indicate that nearly three quarters of the customers surveyed did not notice a change in product temperature for better or worse, and the remaining quarter noticed a positive change since the doors were installed.

Results for Respondents: Question Five

Is the product cold enough when removing it from the cabinet?

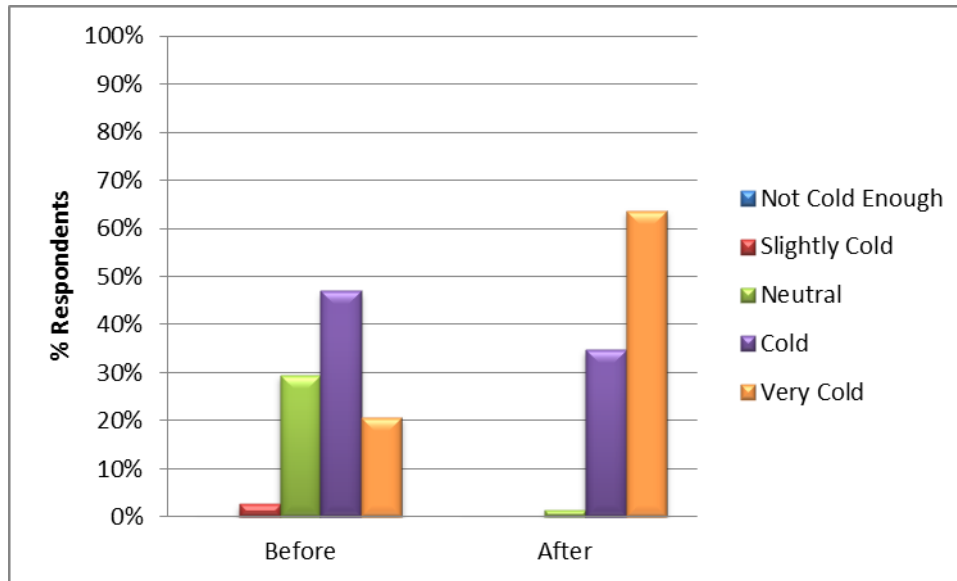


Fig 9: Response to Question 5.

Of the 149 customers surveyed prior to installation, 68% of respondents felt the product was either cold or very cold. Post installation however, 99% of customers felt the product was cold or very cold, demonstrating that the installation of doors on refrigeration cabinets has had a noticeable effect on customers' perception of product temperature.

Results for Respondents: Question Six

How do you find the temperature in this aisle?

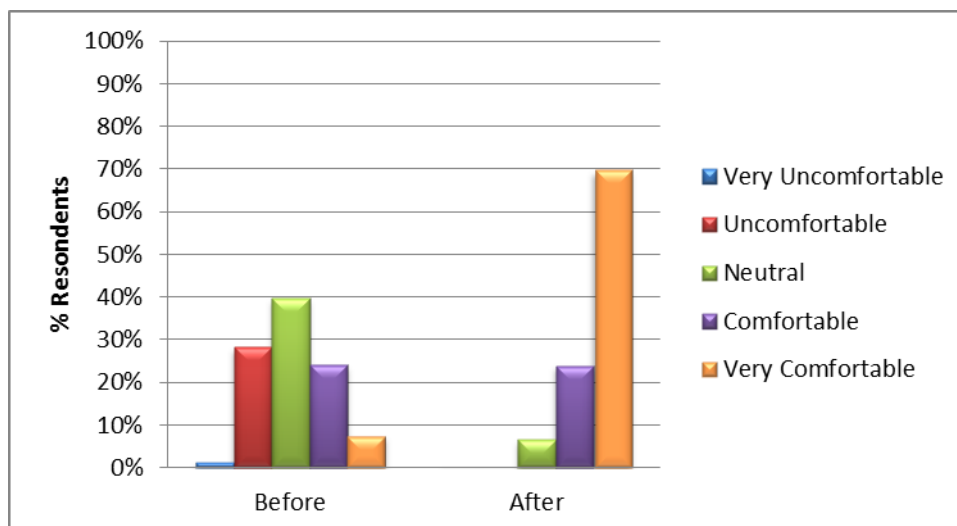


Fig 10: Response to Question 6

Of the 149 customers surveyed prior to installation, 40% of respondents did not have a view on whether the temperature in the aisle was comfortable or not. In addition, 29% of respondents indicated that it was uncomfortable and only 31% felt the temperature was sitting at a comfortable level. Post installation, the number of customers who felt the temperature was comfortable or very comfortable increased to 94%. Compared to the temperature prior to the doors being installed, 64% of respondents noticed a marked difference in the temperature in the aisle and that the temperature was more comfortable.

Results for Respondents: Question Seven

Are you in favour of doors on refrigerators?

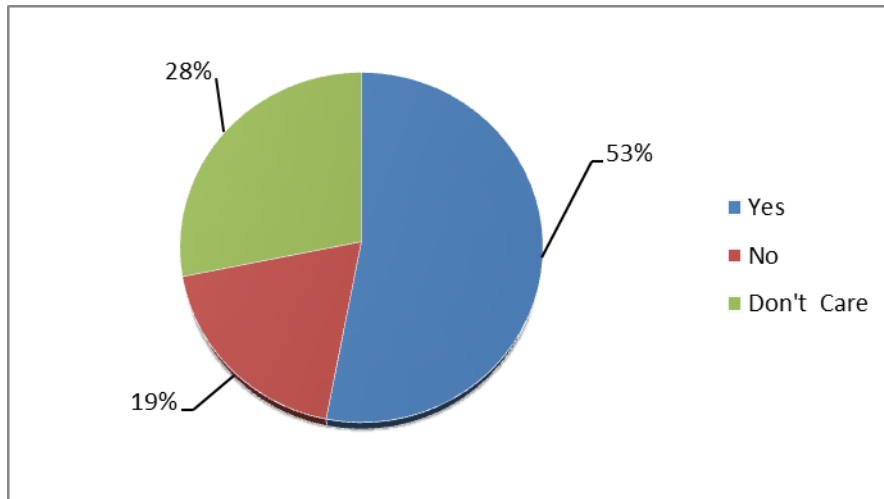


Fig 11: Response to Question 7 (pre installation).

Of the 149 individuals surveyed prior to door installation, 53% of respondents were in favour of doors on fridges, with 28% not caring and 19% not in favour.

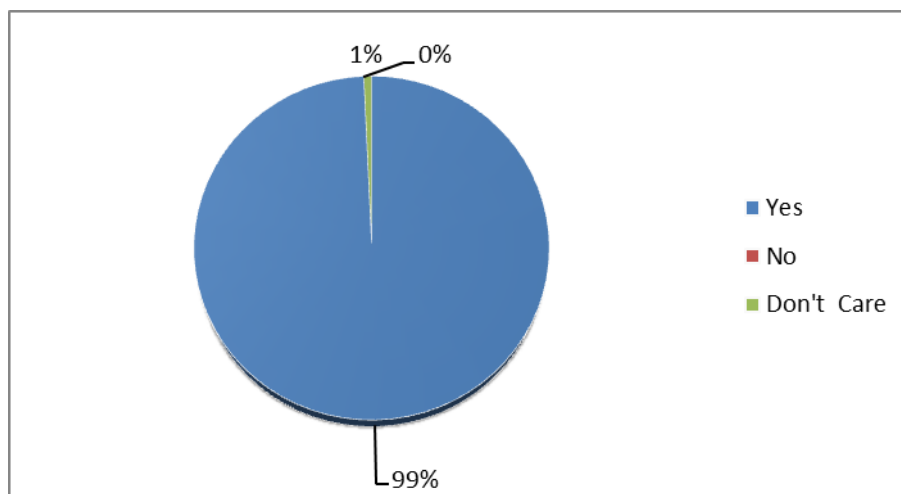


Fig 12: Response to Question 7 (post installation)

Of the 138 respondents surveyed, 99% of the population were in favour of doors on fridges when surveyed post door installation, with only 1% not having an opinion. None of the customers surveyed expressed that they did not favour doors on fridges.

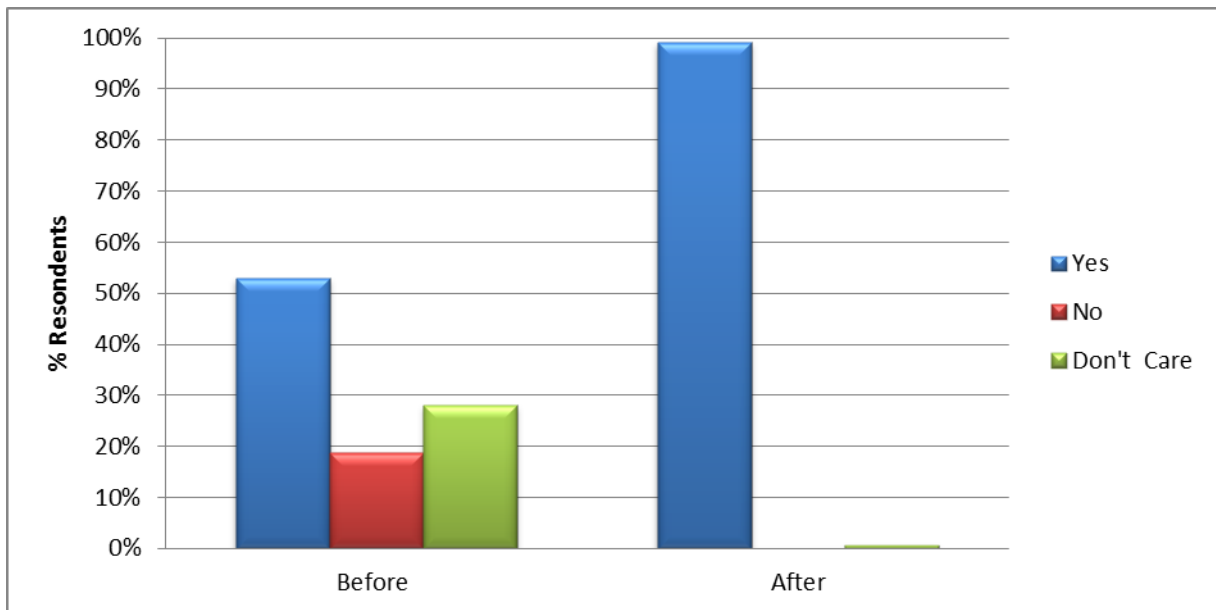


Fig 13: Comparison of results from Question 6 pre and post installation.

Before the doors were installed on the refrigeration cabinets, just over half of all customers surveyed were in favour of doors on fridges. However post installation of the doors, the number of customers in favour of doors on fridges increased by 46%, with only one customer expressing that they did not care.