State of the art

Retail

Project: SME Energy CheckUP

Contract Number: IEE/13/384/S12.675577

Status: [Confidential]

Author: CIRCE

Co-funded by the Intelligent Energy Europe Programme of the European Union

www.energycheckup.eu

List of Contents

1 STATISTICS

Retail food stores in Poland are responsible for around 2% of total electricity consumption. They normally are classified as :

- hypermarkets - over 2500 m2 sales area
- supermarkets - 300 - 2500 m2
- convenience stores (very small and small) - less than 300 m2

The structure of the Polish shops looks as follow:

- convenience stores - 277 018
- supermarkets - 10 079
- hypermarkets - 938

Komentarz [DAZV1]: This nnumber is the number of convenience stores in Poland?

Yes.

Markets', supermarkets and convenience stores are intensive user of energy in all countries. Depends on country energy consumption is estimated to be 2% (Poland) 4% (USA) of total national electricity consumption. Average energy consumption for supermarkets is included in a period 420 kWh/m2 (Sweden) to 570 kWh/m2 (France) and 800 570 kWh/m2 (Poland). For small convenience stores it reach 470 kWh/m2 up to 650 kWh/m2 .

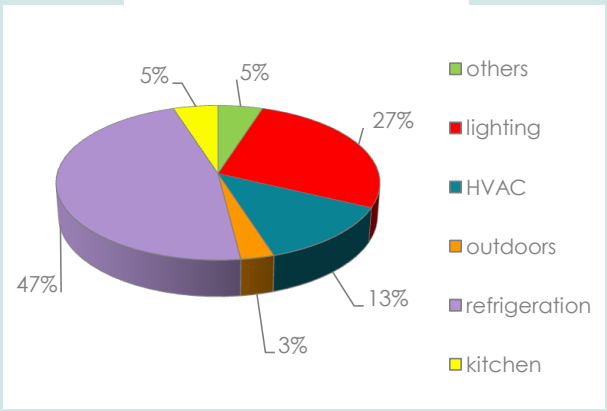

Fig. 1 Breakdown of energy usage in a medium-sized supermarket

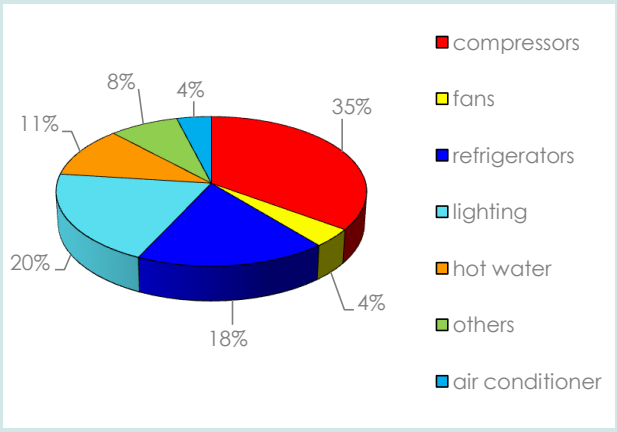

Fig. 2 Breakdown of the energy usage by the appliances in medium-sized supermarket

There is a great potential for improvement of energy systems in stores. The biggest may involve refrigeration systems, lighting and HVAC. Energy saving technologies such as heat recovery, defrost control system, energy efficient lighting, high efficiency motors can reduce considerably energy consumption both in small and big stores.

Fig. 3 presents the energy consumption for different public building in Poland [3].

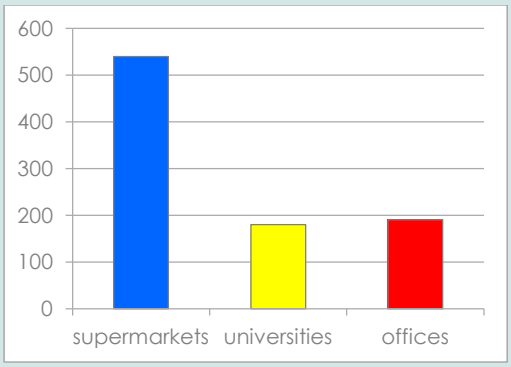

Fig. 3. Average energy consumption in public buildings in Poland in kWh/m^2*a

Depends of equipment the total energy consumption in the stores depends on several others factors such as:

- geographic location
- building size and location of the store in the building
- age
- operating hours
- quality of maintenance

Savings potential can be reach by three ways:

1. technological changes
   - refrigerators and other equipment
   - lighting
   - motors
   - HVAC
   - domestic hot water
2. behavioural changes
   - habits of the store employees
3. organisational change
   - energy control systems
   - bill monitoring
   - trainings for staff and management

2 ELECTRICITY CONSUMPTION IN THE RETAIL SECTOR

2.1 Refrigeration display cabinets

These devices are responsible for a high electricity consumption. The heat and moisture exchanged between the products in the cabinet and the store environment affect significantly this consumption. Infiltration causes about 70-80% of the cooling load for a typical open vertical display cabinet.

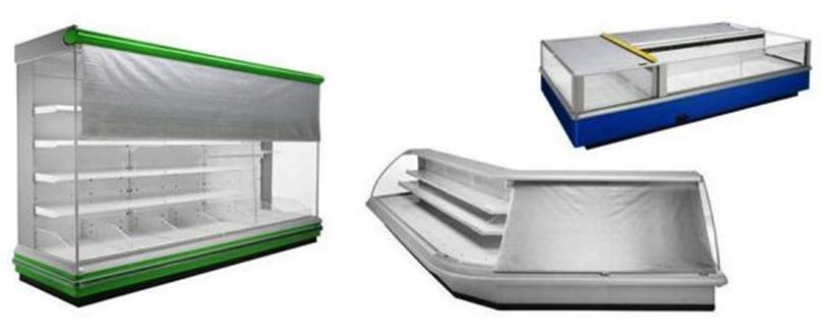

Figure 1. Night curtains for cabinets

The reason of avoiding doors in cabinets is to eliminate barriers between customer and product. Ways of reducing the infiltration load are to improve significantly the performance of the air curtains used to reduce ambient air infiltrations into the cabinet, the use of night blinds during periods when the

store is closed or the use of the glass doors. Installing glass doors can reduce the infiltration and heat losses of cabinets even by 50%.

Savings through the use of night blinds depends on the temperature, the quality of the blind and its fitting on the cabinet and the on-off cycle of the blind. The use of the night blind could generate energy savings up to 20%. They are mainly used on stand-alone cabinets in rather smaller retail stores.

The internal loads of cabinets from fans gains, which are proportional to the energy consumed by the fan, can be reduced by using more efficient fans and more efficient motors.

2.2 Lighting

Lighting plays an extremely important role in the food retails industry, by attracting customers. Lighting has to present the products in the most attractive way for customers, especially in such a department as meat, vegetables and other fresh products.

Lighting is responsible for up to 33% of total electricity consumption in supermarkets, and even higher in hypermarkets and malls (48%). The stores mainly use fluorescent tubes (T8 and T12) and most commercial refrigerated cabinets also use fluorescent linear tubes. Although these lamps are of high

efficiency they are not ideal for this purpose, due to ineffective operation at cold temperatures.

Modern supermarkets are mainly equipped with T5 fluorescent tubes with proper light reflectors and electronic ballasts.

The average lighting level has to be about 1000 lux and Color Rendering Index (CRI) should exceed 85. (Beyond the performance of the light source it is still important the overall efficiency of the entire luminaire - reflector, ignition).

The LEDs technology have a very diverse performance and taking into account their current price, do not always come out so cost effective, but including other factors (eg, lower heat radiation and consequent savings on air conditioning, or durability - reducing the replacement cost) seem that soon, it will be a widespread lightning technology in commercial applications.

Typical LED Products used in supermarkets:

LED Tubes (T8 and T12 linear fluorescent replacement)

Pros	Cons
○ Low initial cost of upgrade from T8 or T12 fluorescent tubes. ○ LED tubes are virtually maintenance free.	○ Limited life span of LED due to limited capability of heat spreading. ○ Higher replacement cost due to replacement frequency

LED Ceiling Panels (mostly fluorescent replacement)

Pros	Cons
○ There is more space in light fixture for proper, solid heat radiator and as a result much longer life span of LEDs ○ Wide range of power LEDs can be used ○ Lower replacement cost then LED tubes (due to modular build and lower replacement frequency)	○ Higher initial cost then LED tubes ○ Higher cost of maintenance due to presence of the heat radiator which should be kept clean.

LED High Bays (Halogen, MH, LPS, HPS replacement)

Pros	Cons
○ There is more space in light fixture for proper, solid heat radiator and as a result much longer life span of LEDs ○ Wide range of power LEDs can be used ○ Lower replacement cost then LED tubes (due to modular build and lower replacement frequency)	○ High bay lighting should be avoided in supermarkets (role of light is illuminating stocked products not just a store area) ○ reaching 1000lx of the flux on the floor surface requires the use of powerful fixtures which might cause unpleasant glare ○ higher cost of maintenance

LED Flood lights and accent lights (metahalogen replacement)

Pros	Cons
○ higher energy efficiency then meta halogens ○ lower heat radiation - important for lights over fresh fruits , vegetables and chilled areas ○ lower maintenance and replacement costs	○ Even high CRI rated LEDs might suffer from a lack of red color illumination. (there are available solutions)

Savings between 25%-35% of the electricity consumption are possible by using the most efficient lamps with control systems and maximising the use of daylight.

Additional saving can be achieved by the:

- installation of the occupancy sensors
- upgrading lighting to more efficient ones (T8 or T5 instead T12)
- in case of T12 or T8 upgrading power supply to electronic ballasts.
- Installing good quality light reflectors for fluorescent linear tubes.
- dimming
- modular configuration of light fittings (ex. allow using every 4th light source - reducing flux from 1000lx to 250lx during stocktaking or cleaning and in all cases outside store operating hours).
- arranging walk in case areas – low bay retail areas with displays illuminated by accent lights (ex. liqueur department).
- replacing high-pressure sodium lamps by metal halide lamps (ex. on car parks)
- upgrade to LED lighting (ex outdoor signage)

2.3 HVAC

The energy consumption of the HVAC systems in retail food stores varied between 15%-25%, depending on the heating system design, geographic location of the store and controls. Although different types of systems are applied in the stores most common at the moment is air constant volume system, supplying heating, cooling and ventilation to the stores by the conditioning air in the central plant and providing it through overhead distribution ductwork to the all parts of the store.

It must be also noticed, that in stores significant infiltration takes place through entrance doors and this influence demand for fresh air. These doors are very often protected by air curtains or automatic doors. But even than infiltration still have an impact on HVAC load.

Other possibilities for energy conservation in HVAC systems is to use variable space temperature set=points based on the outdoor temperature and better zonal control to provide low level of humidity close to the refrigerated display cabinets to reduce frosting and defrosting losses.

3 ENERGY EFFICIENT IMPROVEMENT

As it was mentioned above the main energy consuming sources are:

- Cooling
- Lighting (outdoor and indoor);
- Heating, ventilation and air conditioning;
- Domestic hot water (DHW) production;

Cooling devices	***Energy efficiency measures***
refrigerators/freezers	• *appliances in A+++ class* • *doors covered open shelves* • *temperature sensors* • *high efficiency motors and drives*
vertical cabinets	
horizontal cabinets	
display shelves	

Lighting devices	*Energy efficiency measures*
Halogen	• *twilight sensor* • *movement detector* • *dimmer* • *timer* • *astronomical clock* • *electronic ballasts instead of magnetic* • *high quality reflectors for fluorescent tubes* • walk in case areas – arrange low bay retail areas with displays illuminated by accent *lights (ex. liqueur department)*
CFL	
Fluorescent light	
Mercury light	
Low pressure sodium light	
High pressure sodium lamp	
Light sign	
LED	

HVAC devices	*Energy efficiency measures*
District heating	• *air curtains over doors and delivery gates(reducing infiltration)* • *heat recovery* • *apply a reflective surface to the roof to reduce the cooling capacity required to condition the store in the summer months* • *Install ceilings fans - in the summer a breeze increases comfort throughout the stores which allows the temperature to be set a little warmer to save cooling costs. In the winter ceiling fans move warm air that rises back down the walls and to the sales floor to make people more comfortable with less heat*
Boiler/condensing boiler	
Cogeneration/tri-generation	
Air conditioner	
Solar cooling	
Heat recovery	
Geothermal, water, air - heat pump	

DHW production

Retail stores have all the water uses - from sanitary fixtures up to surrounding green area irrigation. Markets possess certain specialized water uses that provide large water conservation opportunities. The most notable is the water used to cool the condensers units for the refrigeration systems, such as display coolers and freezers, storage coolers and freezers, etc. In addition, hot water is used in the cleaning and preparation of the fresh produce, meats, and fish before the products are put onto the shelves.

DHW devices	***Energy efficiency measures***
Solar thermal panels	• *high efficient water heaters* • *thankless heaters producing hot water on demand* • *heat exchanger to capture wasted heat of the stores refrigerator rack system and use it to heat water for restrooms*
Boiler/condensing boiler	
Biomass boiler	
Heat pump	
Cogeneration plants	

4 REFERENCES

1. Main Statistical Yearbook of Poland 2013, Central Statistical Office 2013
2. Najnowsze trendy w urządzeniach chłodniczych supermarketów (New trends in refrigerators system in supermarkets). LUNDQUIST Per. G Chłodnictwo 11/2000.
3. Plan działań na rzecz zrównoważonego zużycia energii dla Warszawy w perspektywie do 2020 roku (Sustainable Energy Action Plan for Warsaw in 2020 hprizont). Załącznik do uchwały nr XXII/443/2011 Rady m. ST. Warszawy z dnia 08.09.20011
4. System Klimatyzacji dla supermarketów (AC System for supermarkets). K. Trzos .Chłodnictwo& Klimatyzacja 6/2011.
5. Urządzenia chłodnicze w supermarketach (Cooling system in Supermarlets). W.ZAzaremski, Chłodnictwo& Klimatyzacja 4/2000.
6. Energy consumption and conservation in food retailing - S.A. Tassou; Applied Thermal Engineering 31, 2-3 (2010) 147"
7. Formal based methodologies for the design of stand alone display cabinets, D. Datta, R. Watkins, S.A. Tassou. Final report to DEFRA, November 2005
8. A two-dimensional CFD Model of Display Case. D.Stribling, S.A. Tassou, D.Marriott, ASHRAE Transactions Research, vol. 103, part 1 (1977)
9. Effect of night blinds on open integral display cabinets, D. Datta, R. Watkins, S.A. Tassou Proceedings of 3rd International Conference on Heat powered cycles HPS 2004, Larnaca October 2004
10. Class covers on refrigerated display cabinets, S, A, van der Sluis. TNO Report, nr. 034.68803 (2007)
11. Economic note on UK Grocery Retailing Department of Environment Food and Rural Affairs, DEFRA (2006. May 2006
12. LICEA Project - Narodowa Agencja Poszanowania Energii 2013.


SME
Energy CheckUp


NAPE
NARODOWA
AGENCJA
POSZANOWANIA
ENERGII S.A.

www.nape.pl