Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP)

Annex 44

Performance indicators for energy efficient supermarket buildings

Executive Summary

Operating Agent: The Netherlands

2017

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Summary

The work in IEA HPT Annex 44 "Performance Indicators for energy efficient supermarket buildings" has been focused on finding average values for the energy consumption of supermarket buildings, using easily available performance indicators. This information can be used by policy makers and researchers to set a reference for average supermarket energy consumption. It can also be used by supermarket owners to compare the energy consumption of a specific supermarket to the average consumption, and thus determine whether the specific supermarket is energy efficient or not.

- A supermarket is energy efficient when its total energy consumption is below 400 kWh/m^2.year compared to supermarkets from Denmark, Sweden and The Netherlands. The area (m^2) referred to is the total supermarket area.
- 400 kWh/m^2.year is the average energy intensity found for supermarkets in Denmark, Sweden and The Netherlands, with an average total area of 1360 m^2 and 73 opening hours per week. Corrections are presented for differences in size and opening hours.
- Based on the available measured data no relation could be found between the total energy consumption (heat & electricity) and the geographic region of the supermarkets; additional computer modelling in this case also did not provide such a relation.
- Developments, especially in refrigeration systems and lighting, lead to an increase of energy efficiency in new or refurbished supermarkets ranging from 1 - 10 % per year. Refurbishment therefore is an effective management decision to increase energy efficiency.

Supermarkets are defined as "retail sale in non-specialized stores, with food, beverages or tobacco predominating" which excludes small specialized stores and hypermarkets. The most common performance indicators for supermarkets are size (total area or sales area), opening hours, refrigeration system type, installed refrigerating capacity and climate or geographical location. More uncommon performance indicators are sales volume, year of construction (or refurbishment), management attitude and system control and dynamics. The sales volume does not influence the energy intensity.

The supermarket energy consumption comprises the consumption of all subsystems: lighting, electric equipment, heating and ventilation, air conditioning and refrigeration. Since the introduction of heat recovery from the refrigerating system, energy consumptions for heating and for cooling must no longer be treated separately.

Data from the countries participating in the annex (Denmark, Sweden and The Netherlands) shows a good similarity concerning average Energy Intensity, the average total yearly energy consumption per m^2 of supermarket area, of around 400 kWh/m^2.year (± 10%).

Data set.	Energy Intensity (kWh / m^2 per year)	
	Base: total energy / total area	Base: electrical energy / sales area
Sweden	396	
The Netherlands 2013	397	422
The Netherlands 2014	369	413
Denmark (2015)		390

The energy intensity decreases with increasing supermarket area, on a basis of approximately 1% for each 100 m² of additional total supermarket area.

The energy intensity increases when opening hours are extended, on a basis of approximately 0,5% for each additional (weekly) opening hour.

Data sets from the USA, Canada and UK show energy intensity values well above 400 kWh/m².year, partly relating to a higher number of opening hours per week.

Statistical analyses confirm that the simple approach of relating total energy consumption to supermarket area provides better results than other performance indicators based on the summed volumes or lengths of refrigerated display cabinets, or installed refrigeration capacity. For electrical energy consumption instead of total consumption, installed capacity is a good performance indicator.

Currently systems are introduced that can evaluate the refrigeration system's Coefficient of Performance (COP) and the efficiency in relation to an ideal refrigeration cycle (Carnot efficiency or system efficiency index, SEI). These values may provide good performance indicators in the future, but currently not enough measured data is available yet.

Two data sets from The Netherlands were available containing information on the presence or absence of 65 different energy saving options. It was attempted to extract relations between energy intensity and energy saving options from these data sets, but no statistically relevant relations could be extracted – neither by means of a t-test nor by means of a multi variable regression method.

The objective of the work in this Annex was to provide an estimate for the energy consumption of a supermarket, based on a variable number of performance indicators. With only one performance indicator used, the energy consumption will be a first estimate, but with more performance indicators used the estimated energy consumption will be more precise. Based on the work in this Annex, we suggest to use the yearly total energy consumption per sales area unit as the performance indicator to best provide a first estimate of energy consumption. However, the formulation of additional performance indicators for precision of the first estimate has not succeeded based on the available data.

One of the basic premises for the project was to use data from meters and sensors already available in the Building Management System and the subsystems for refrigeration systems controls etc. as stated in the legal text for Annex 44. This has not led to the desired result of an estimate more precise than the first estimate based on supermarket area. To reach that objective, we recommend to use methods based on a combination of measured data and computer modelling of supermarkets.

Supermarket energy consumption remains a field where improvements in energy efficiency can be made, as long as there are supermarkets with an energy intensity of 55 % above the average value and at the same time supermarkets that can do with only 60 % of the average energy consumption.

It is becoming a good practice to use heat recovery on supermarket refrigeration systems, but it is still uncommon to see these systems as heat pumps. The HPT can play a role in bringing the heat pump and refrigeration sectors closer together, to the mutual benefit of both sectors.

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