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## The Key Drivers For Energy Retrofitting Of European Shopping Centres

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### Abstract

This paper has as its main focus to define the drivers of retrofitting shopping centres. The drivers will provide the basis for developing energy retrofitting concepts, offering amongst other things, constructive technology, an understanding of typical functional patterns and socio-cultural aspects and an understanding of potentials associated with interaction with local energy grids. The primary focus of the study is energy use, but the fields of facilities, functions, management, ergonomics, safety and logistics are also studied, because sustainable shopping centres in addition to being energy efficient are commercially viable, accessible social arenas for all sections of society.

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### 1. Introduction

Retailing has undergone major changes in the last twenty or thirty years in both its commercial and economic organization as well as its geographical character. There have been major changes in ownership patterns leading to growth of large national and international corporate retailers at the expense of smaller more local operations. The way retailing is delivered to the public and self-service, spawning a variety of styles of selling, each requiring different types of location. The commercial success of different styles of selling depend increasingly upon the way

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we are able to create and offer comfortable, convenient and convivial environments to the consumer and decentralization in locations of consumer demand, away from inner city areas to the fringes of cities and beyond.

## 2. Objectives

The study investigates the efficiencies and inefficiencies associated with the everyday management, operation and use of shopping centres and aims to identify the drivers, barriers and potentials associated with the operation of shopping centres. These were used to define the specifications necessary to achieve effective energy investments within European shopping centres. The intention is to supply the shopping centre industry with tools and solutions which will transform them into lighthouses of energy efficient systems and architecture. The primary focus of the study is energy use, but the fields of facilities, functions, management, ergonomics, safety and logistics are also studied, because sustainable shopping centres in addition to being energy efficient are commercially viable, accessible social arenas for all sections of society.

## 3. Methodology

This work is based on literature reviews, questionnaires and interviews. It requires an analysis of the systemic inefficiencies associated with the fields of facilities, functions, management, ergonomics, economic models and logistics for European shopping centres. Data was therefore collected in a broad number of fields and over a wide geographic area [2]. In order to achieve the broad base of information required for the study a number of different methods, including quantitative, qualitative and desk top approaches, was selected. A survey or questionnaire is used when a research question requires a quantitative or numeric description of trends, attitudes or opinions from a population sample [1]. The intention has not been to test a hypothesis but to provide indicators with which to understand societal trends associated with energy efficiency and sustainability issues in shopping centres. The research project requires information about the current situation in Europe and a quantitative approach was chosen as the primary approach mainly due to a need for a quick and effective collection of data. Therefore, a web-based questionnaire was developed and distributed to the relevant stakeholders with the aim of providing a statistical understanding of phenomena associated with energy efficiency and sustainability in shopping centres, and of the relationships between them [2].

Complex processes involving stakeholders that may lead to the selection of inappropriate and energy-consuming technical solutions, building and land design, and choices of operations and maintenance are studied. This work provides an in-depth analysis of the building envelope and technical systems aiming to identify factors that influence the functional efficiency and energy consumption in shopping centres. The social environment, behavioural aspects are assessed and their influence on the decision-making process when implementing energy renovation measures considering six main fields: Facilities, Functions, Management, Ergonomics, Logistics, Economic models.

## 4. Results

The six fields have not been considered individually but as required in relation to four main sections: 1. User behavior of primarily customers; 2. decision making structures associated with owners/managers and tenants; 3. The systemic inefficiencies associated with the function and use of a shopping centre building; 4. Economic models that are used to sell energy investment to tenants.

### 4.1. The influence of user behavior on energy performance

The aspects which achieved the highest ratings in the three shopping centres are; customer satisfaction, safety, logistics, the range of products, access to public transport and car parking. These qualities are important when customers are choosing where to shop. Customers are satisfied with the shopping centres where the surveys took place, but they are also keen to improve the energy efficiency of shopping centres in general and energy efficiency is one of the aspects where they saw the greatest possibility for improvement. There are three main aspects associated with user behaviour and energy performance:

1. Customer knowledge or lack of knowledge is an important factor to be dealt with if shopping centres are to gain approval for actions associated with energy efficiency issues, or if customers are themselves going to demand energy efficient shopping centres.
2. Energy efficiency does not influence customer choice of shopping centre. Location is the most importance factor influencing customer choice of shopping centre. This is closely associated with the importance customers place on car-parking.
3. The physical framework provided by shopping centres does influence customer choice. However customers involved in the survey placed little importance on architecture and design when choosing where to shop. Owners and managers placed much more importance on physical structure and architectural quality ranked as highly as customer satisfaction and energy efficiency when suggesting the main reasons for a shopping centre upgrade. Tenants had customer satisfaction was their focus. The physical structure received less focus from tenants.

A shopping centre is more than what is directly perceivable to each customer and a fair judgement of i.e. recycling, energy efficiency or environmental friendliness in shopping centres requires more insight into the day-to-day operation of a centre and behind the scenes management. Importantly, the customer survey suggests that an environmentally friendly profile is not being communicated to customers.

#### 4.2. Decision making structures for customers, tenants and owners/managers

Three stakeholder groups have been considered, customers, tenants and owners and managers. The main findings from the three stakeholder groups are as follows:

Customers: Shopping centres are not chosen because of their energy efficiency, although the appearance of an energy efficient shopping centre could encourage “green” thinking. Customers have low awareness of energy efficiency in shopping centres. Customers are interested in lower prices and a wide range of products and this is not directly associated with an energy efficient renovation.

Tenants: the energy efficiency of shopping centres is not of primary importance. It is important to improve the flow of information about energy efficiency among employees in shopping centres. Energy performance certificates could be used to strengthen awareness of how energy efficiency influences stores or retail units.

Owners and managers: equal the main decision making group and they are interested in energy efficiency. However they are reluctant to spend large amounts of resources on renovation. The value of the building is an important to this group and therefore energy investments may be expected. Common certifications for energy efficient buildings are not considered suitable for shopping centres by this group, but a certification specifically for shopping centres could be a step towards encouraging interest about energy efficiency amongst owners.

#### 4.3. Systemic inefficiencies

This work considers four main areas which are a source of energy inefficiencies in shopping centres; lighting, HVAC measures, architecture and design which include ergonomics, safety, accessibility and building envelope.

Lighting: There are large inefficiencies associated with lighting as a general concept and among different lighting systems. Managers of shopping centers may not have strict restrictions from owners, but they are generally responsible for lighting only in common areas and exteriors, and importantly for all direct energy costs and lighting represents a key area for savings. Lighting is often spread over a large area, and centrally controlled systems are crucial to overall lighting management. It is essential to extend the use of daylight to additional floor areas and this can be achieved by opening additional building surface areas or by redirecting light in the building depth. Common areas are often daylit but shops and other sales areas are seldom daylit. This leads to an additional inefficiency, the use of daylight to an unreasonable level, due to overlit areas often found in common areas. Display lighting is important for drawing attention to showcase items and enhancing aesthetic quality, but many retailers use inefficient spotlights. LED together with controlled beam lighting can save energy while maintaining excellent color rendering. If windows also supply daylight, then integrated concepts for display lighting, daylighting (and inside exhibition of merchandise at shelves) must be developed. Sensitive adjustment of indoor luminance values generates the

requested result. Often daylight levels are higher than necessary which needs to be compensated for by the use of more artificial light in shops and sales areas.

In order to establish sufficient light levels the use of efficient light sources and electronic gear concerning energy demand is important. The environmental impact and life-cycle performance (including maintenance efforts) needs to be considered when choosing the most appropriate luminaires. Finally, automatic control regulation is essential and occupancy sensors for less used areas (such as back-of-store areas, staff rest rooms, storage areas and office space) that do not require light 24 hours a day should be installed. Replacing fixtures with T5 or T8 compact fluorescents will save even more energy.

**HVAC measures:** Quality control of the complete energy system is necessary throughout the entire building if energy-efficient solutions are to be met. This requires adequate information about building systems and assessment tools. A second requirement is a commissioning procedure that enables follow-up of the building performance during the building lifetime, thereby helping to detect systemic inefficiencies. A third requirement is comparative analysis including a detailed monitoring system to track energy use and fault detection, with yearly and hourly energy consumption profiles analyzed in a holistic manner.

**Building envelope:** Recommended levels of thermal insulation in the building envelope depend on the climate. Building energy use should be calculated and insulation levels optimized in relation to these variables. Single measures often do not yield cost-effectiveness but deep retrofitting (a number of measures implemented together) achieves high levels of energy savings. Ideally, this should be simulated using building performance simulation tools.

**Architecture and design:** Shopping centres are complex buildings with a complicated layout, with sophisticated utility plants and a very high concentration of customers and workers, the latter making repetitive material handling tasks. These factors, as well as the large amount of young workers, imply serious ergonomic issues and H&S hazards. There is a consistent set of regulations and guidelines related to ergonomics and H&S, but the options for their implementation are diverse and may have implications for energy efficiency.

Integrated design solutions are more effective than individual actions in improving the quality of the built space, both energy and design wise. Universal design is associated with ergonomics and accessibility, and has implications for the design of sustainable shopping environments. Accessibility and ergonomics are not drivers for energy use reductions, but combining these actions with those aimed at achieving energy use reductions will increase the energy impact. Owners, managers and tenants should therefore be encouraged to work with more than one action at once. It is suggested here that the aim to provide good shopping centre architecture has the potential to be a driver for achieving energy use reductions, because applying the available best solutions to support stakeholder needs, today also means applying the most energy efficient solutions.

#### 4.4. Legal/economic issues between owners and tenants

Legal and economic issues affect how costs associated with the day to day running of the shopping centre, maintenance and upgrades are distributed among stakeholders, and they influence stakeholder actions with regards to energy retrofitting. It is suggested here that actions to achieve energy use reductions will be implemented if they are seen within the wider context of retail success and profits "successful retailers will be those who respond most positively to the changing patterns of shopping behavior.

If communicated effectively to the different stakeholder groups and when combined with efforts to respond to changing patterns in shopping behavior, legal and economic actions could become direct drivers for deep energy retrofitting. In addition the inclusion of non-technical clauses for example requiring energy use reductions or the meeting of energy targets in in tenant leases will support the more technical actions, potentially strengthening their impact. A number of legal and economic issues which influence stakeholder activity in shopping centres were identified about user behavior. These are:

- Customers: price of goods, free parking
- Tenants: sales maximisation and profits, rental costs, billing systems, reduced costs, transparent billing systems, green leases, length of leasing period
- Owners and managers: sales maximisation and profits, rental costs, billing systems, reduced costs, high occupancy, building codes, property value

- Community: Building codes, jobs and revenue

Not all of the aforementioned aspects have implications for deep energy retrofitting. Free parking although it affects customer choice, is an example of this. Aspects such as sales maximization and profits do not at first glance appear to have anything to do with deep energy retrofitting, but they are important to owners, managers and tenants. The whole retrofitting process has implications for profits and the price of goods, because it can have implications for property value and the rental price. These can in turn affect occupancy levels and thereby the popularity of shopping centres among tenants and customers. In addition although tenants and managers are interested in sales maximization and profits, their attitudes towards how and why this is to be achieved vary. The goal of the owners is to increase property values while tenants aim to minimize rent and ancillary rental costs. This section will therefore consider billing systems, overheads/running costs, green leases and the length of the leasing period. These aspects affect the relationship between owners, managers and tenants.

## 5. Conclusions

Most of the European shopping centres are already built, but there is still huge potential for energy savings due to the practice of regular rehabilitation and redesign of shopping centres. Efforts to improve energy efficiency and provide sustainable solutions for shopping centres must take this tendency into account. This state of constant flux offers the advantage of regular opportunities to improve the technical systems, such as lighting and ventilation, or the building envelope and monitoring systems. Consideration of these aspects along with the other drivers has the potential to achieve significant energy reductions and IEQ improvement.

### Indirect drivers

Changing shopping habits and user behaviour influences the non-energy related retrofitting activity. These retrofitting actions may affect energy use in shopping centres and they have the potential to be associated with energy retrofits.

Waste recycling is important on all main stakeholder levels. It is directly related to their own understanding of what sustainability is. For owners and tenants it affects their reputation and influences how they market themselves. It has an impact on user knowledge about sustainability issues and user knowledge has the potential to be a driver for energy retrofits. However at the moment lack of knowledge may be understood as a barrier for energy retrofits. For customers to demand energy use reductions or the retrofitting of shopping centres they need to have more knowledge about energy use, be given a clear indication about energy use, through for example the architecture and design of the shopping centre (visualising through architecture), and their shopping habits should be affected by a change in the price of goods. If retrofitting has implications for what customers pay for goods then this can affect their decision about where to shop which will in turn influence how owners, managers and tenants decide to act.

### Drivers for energy retrofits

The need to reduce energy use in shopping centres is in itself a driver based on the needs to reduce operational costs and overhead costs.

Lack of knowledge among stakeholder levels is a barrier to energy use reductions. Increasing knowledge will potentially function as a driver for implementing actions to achieve energy use reductions.

Costs associated with retrofitting may be both drivers and barriers. Reducing overheads and operational costs may be considered a driver for energy retrofitting among stakeholders. However if the costs of implementing energy efficient measures outweigh the costs achieved by energy use reductions then the measures will not be implemented.

There are, however a number of major challenges which are barriers to achieving the desired energy reductions.

Customers are not demanding energy use reductions in shopping centres and as long as there is no direct demand then shopping habits cannot be considered a driver. This may potentially be a hindrance to owners, managers and tenants. They are not pushed by customer demand to take direct actions and as long as their profits remain stable or continue to increase this will not change. However consumer awareness is increasing. Increasing knowledge about the implications of their actions in shopping centres may put pressure on the industry to increase their actions aimed at energy use reductions.

In addition, the lack of knowledge among a large group of employees in shopping centres is hindering the work towards energy use reductions in shopping centres. On the other hand, increasing knowledge about energy use in shopping centres on all stakeholder levels is a potential driver for energy efficient upgrades.

Upgrade costs and rental costs are closely associated, if a retrofitting process is extensive and costly it may be expected that this will influence the price of renting retail space in the shopping centre. Owners, managers and tenants aim during rehabilitation to balance the need to be attractive and up to date with being cost effective. If rental prices are too high this may affect retail profits and cause problems for owners, managers and tenants (This includes customers, because rental overheads affect the price that they are willing to pay for the goods and services shopping centres offer). Cost reduction may be understood as a driver for energy retrofits, because the value achieved by reducing overheads/rental costs and operational costs may be seen to outweigh the costs associated with the retrofitting. However, the drivers and barriers for an energy related retrofit should be seen in collaboration. This is because although there is positive momentum associated with the need to reduce energy use in shopping centres; if the costs are too high for the stakeholders, a deep energy retrofit will not be conducted.

Sustainable solutions require the inclusion of socio-cultural actions. Owners and managers are interested in reducing energy use, but both customers and tenants have limited knowledge about energy use in shopping centres. Customer needs and interests are at the centre of attention in shopping centres, and because customers are not interested there is a danger that other stakeholders will not focus on energy use reductions. Tenants are responsible for a large part of energy use in shopping centres, and this disinterested energy use implies an acute need to work on changing attitudes and aspirations in the everyday activities in shopping centres.

We cannot expect shopping centres to disappear and take their energy use problems with them, the number of shopping centres continues to grow and the GLA in existing shopping centres are growing. Customers will continue to focus on commodities and location if they are not encouraged by those who own and run shopping centres and stores to shop more sustainably. Shopping centres have a responsibility to encourage sustainable customer satisfaction. If owners, managers and tenants provide shoppers with sustainable retail environments it may be assumed that shoppers will, to an increasing degree, demand that all shopping centres are sustainable, which will have implications for the design of shopping centres. The retail market needs to change how it presents itself to customers, through for example shopping centre design and it requires greater focus on customer awareness with regard to energy use.

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### References

- [1] Cresswell, J.W. (2009) *Research Design: Qualitative, Quantitative and Mix Method Approaches*. Third Edition. Sage. London.
- [2] Woods, R., Mellegård, S., Schlanbusch, R.D., Haase, M., Skeie, K.S., Deferrari, A., Cambronero Vazquez, M.V., Ampenberger, A., Bointner, R. (2015), Deliverable 2.2 report – Shopping mall inefficiencies, EU FP7 project CommONEnergy – Reconceptualizing Shopping Malls, [http://www.commonenergyproject.eu/uploads/deliverable/file/2/WP2\\_D2.2\\_20150130\\_P07\\_Shopping\\_malls\\_inefficiencies\\_NotPrintable.pdf](http://www.commonenergyproject.eu/uploads/deliverable/file/2/WP2_D2.2_20150130_P07_Shopping_malls_inefficiencies_NotPrintable.pdf), access date: April 2015