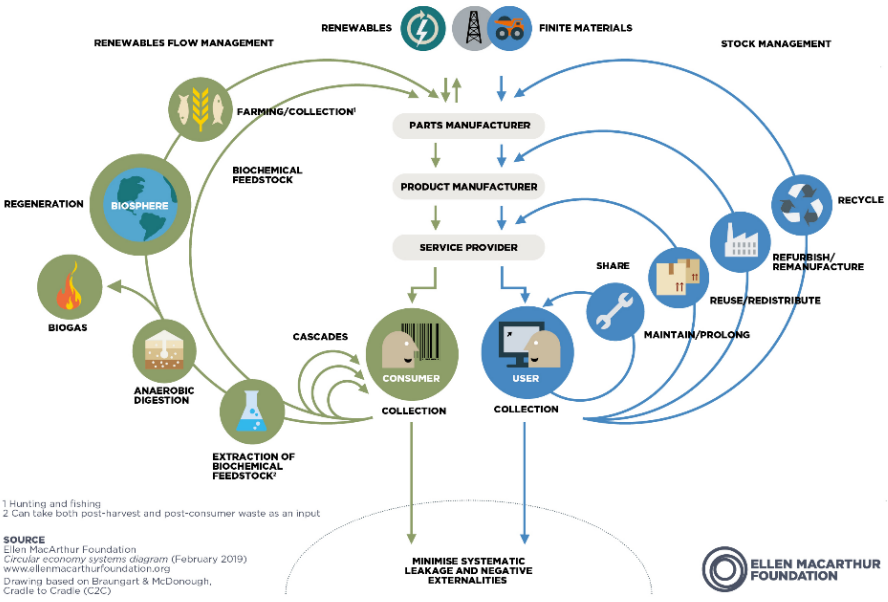
SUPER HEERO
Human Energy Efficiency Retrofitting Optimisation

CIRCULAR ECONOMY IN SUPERMARKETS

"Circular economy is a manifestation of economic models that highlight business opportunities where cycles rather than linear processes, dominate. It is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times." (Sustainability Guide, 2018)

To achieve circularity the social and economic sector must work together. The social sector play an important role because the implementation of this system thrives more easily if the society is opened to new routines, aspects, strategies, and methodologies. Circular economy is commonly confused with recycling but in fact it is just one of the strategies. "Circular economy seeks to rebuild capital, whether this is financial, manufactured, human, social or natural" (Ellen MacArthur Foundation, 2017) another definition "The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended" (News European Parliament, 2015) Circular economy is divided in two sectors, biological and technical; the biological sector is focused on the organic matter (flora and fauna) and the technical sector is more focused in the production. To illustrate this, Ellen MacArthur Foundation create a diagram to find relations and opportunities to implement circular economy.



Horizon 2020
European Union Funding
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Figure 1 Ellen MacArthur Foundation diagram

Retailers are key players of our economic system, “allowing consumers to access goods from many establishments. Thus, the functioning of the food supply chain has important ramifications on consumers (given that approximately 13% of their household expenditure is spent on food, as well as the functioning of a number of other essential economic sectors, such as agriculture, the food processing industry and retailers. Taken as a whole, the food supply chain generates value added of €715 billion per year, almost 6% of the EU GDP” (EY et al, 2014). Mentioned this, the importance to develop strategies and practices to make this sector sustainable, has become a priority. Introducing circular economy in the supermarket sector not only will help mitigate the environmental crisis but will promote the economic growth, aside from construct better consumption habits in the society.

SUPER-HEERO project aims to provide a replicable financial scheme for energy efficiency investment in small and medium supermarkets, based on stakeholder and community engagement. This project is related to the regulation mentioned below.

Table 1 CE regulations

Energy efficiency	No 1303/2013
	No 1305/2013
	No 1301/2013
	No 1300/2013
Stakeholders and community engagement	No 1304/2013
Financial scheme	No 1305/2013

As well, the project has strategies and objectives that are related to the policies included in the 2020 Cohesion Policy. Especially in the financial and environmental sector. Taking into accounts the following points:

- Contribute to tackling the climate crisis.
- Support of integrated sustainable urban development actions based on circular economy.
- Contribute to restructure industry.

- New business models and competitiveness responding to the needs of circularity.
- Financial stability in terms of availability of resources, better sharing of financial risk and higher financial leverage.

All around the world Supermarkets have become an essential service in our life. It is where people buy some medicines, house supplies, stationery and among other things but mainly food. Supermarkets are crucial in our day to day, so their incorporation to Circular Economy will ensure a better transition to sustainability.

Supermarkets have applied different strategies and practices regarding to circular economy, they are divided mainly in three types:

- **Bioclimatic design and architecture**
  - Elements that are integrated in the facilities or construction design.
- **Technical energy efficiency**
  - Technologies and devices directly related to energy.
- **Indirect strategies**
  - Strategies and practices that involve a third party.

In SUPER-HEERO project the circular economy strategies will be focus on the implementation of technologies and devices to make efficient use of energy in supermarkets, that will help them to reduce their energy costs and reduce the emissions associated with this. The main applications in this field are mentioned below.

Technical energy efficiency applications

Technologies and devices directly related to energy efficiency that reduce costs and helps the reduction of green-house gases generated from the energy consumed. Some of the most common applications are the following:

- **Renewable energy:** Solar cells in places with high UV rays reduce the cost in general electricity bills; sometimes when the generated electricity is higher than the consumption the electricity is “sold” to other companies or the public electricity generator. Depending on the country policies and establishments are the benefits that come along with renewable energy investment.

- **CO_2 refrigeration:** The principals supermarkets products are food and depending on the product is necessary to use a refrigeration system for their storage. One of the challenges was to find a refrigerant system efficient and less pollutant than others. “The last years, the use of CO_2 as refrigerant is a revisited idea in order to avoid the use of harmful working fluids. Especially,

after the EU F-Gas Regulation 517/2014, the usual refrigerants are substituted with natural refrigerants such as CO_2, propane and NH_3. However, the CO_2 seems to be the most attractive choice due to the high flammability of the propane and the high toxicity of the NH_3." (Evangelos et al. 2019) The advantages are:

  - Higher thermal conductivity
  - Density
  - Latent heat
  - Specific heat capacity
  - Lower dynamic viscosity compared to the other hydrofluorocarbons (HFCs)
  - Low toxicity, flammability, and global warming potential (GWP) are extra advantages.

- **LED lighting (light-emitting diode):** "Quality LED light bulbs last longer, are more durable, and offer comparable or better light quality than other types of lighting… use at least 75% less energy, and last 25 times longer, than incandescent lighting." (Energy.Gov, 2021)

- **Real-time energy measurement monitoring:** the goal of these types of technologies is to save energy and have the better performance as possible. With measurement on each device which consumes energy, the supermarket would monitor if there were any waste of energy, an inefficiency and take quick actions to solve the problems.

Below is a summary of some supermarkets that have implemented energy efficiency technologies in their stores and their results. The table is taken from the document "Eco-friendly Supermarkets – an overview" from SuperSmart (Mazyar Karampour et al,2016).

Table 2 Supermarkets with energy efficiency technologies

SuperMarkets	Year	Results and Strategies
HEB Austin, Texas	July 2013	Slashed its energy use by an estimated **64%** over the grocery store national median. **60%** percent reduction of regulated potable water

		○ Refrigeration/cooling systems, daylighting integrated with computer automated LED lighting, efficient equipment, and careful building design. H-E-B is the first supermarket retailer in North America to use a whole-store propane refrigeration system.
Aldi Süd Rastatt Rastatt, Germany	2010	**23%** reduction in energy demand, compared with standard specific energy consumption of Aldi supermarkets. ● Efficient refrigeration and HVAC with an integrated CO2system ● Lighting controlled depending on the amount of daylight. ● Use of surplus heat from cooling – possible to use the refrigeration system as a heat pump. ● Energy flow monitoring ● Automatic system control ● Regenerative and passive cooling ● Demand controlled ventilation by CO2censors. ● Heat recovery in ventilation system via rotary heat exchanger.
ICA Kvantum Täby Täby, Stockholm, Sweden	2013	**9%** less energy consumption by using ejector, comparing Oct. 2014-May 2015 (non-activated ejector) and Oct. 2015-May 2016 (activated ejector) ● First ejector-based system in Sweden ● One liquid ejector ● Glass doors on cabinets and freezers ● Real-time energy measurements monitoring ● 4 K higher MT evaporation temperature by using ejector.
Tegut supermarket Marburg-Cappel, Germany	2014	Overall estimated energy saving of **30%** comparing to conventional supermarkets. The first supermarket to receive the German ecolabel BlueAngel, in 2015. ● Integrated CO2refrigeration + heating system ● Photovoltaic (PV)panels on the roof, 90 kW capacity ● Glass doors, LED lighting and EC fans in the cabinets ● LED lighting

		• Energy management system according to DIN EN ISO50001
REMA 1000 Kroppanmarka **Trondheim, Norway**	2013	Reduction in annual energy demand 30%, in comparison with a standard Norwegian supermarket Reduction in CO2emissions~30 % Won the Energy Saving Prize in Trondheim (Energispareprisen) in 2014.
		• Integrated refrigeration system with heat recovery at multiple temperature levels, CO2as the refrigerant. • Controlling technologies for optimized, easier operation. • AHU unit adapted to supermarkets All waste is sorted and recycled, and customers may also return several types of waste for recycling at the entrance.
NorgesGruppen Auli, Norway	2014	Expected **50 %** reduction in energy use compared with a similar sized store.
		• Integrated refrigeration system with heat recovery, based on CO2as refrigerant. • LED lights in the cabinets as well as in the store • 1300 m2solar panels on the roof, which should give ~150 kW. • Extra heat exchanger before compressor to ensure dry inlet.
Iper Hypermarke Milan, Italy	2015	Energy savings of up to **50%** are expected. The centre is LEED Gold certified, designed, and constructed to use less water and energy and reduce greenhouse gas emissions.
		• CO2refrigeration system using multi-ejector technology, designed for energy-efficient operation at ambient temperatures up to 38 °C • Heat recovery for DHW production • Integrated control of light, HVAC and refrigeration; control system designed by Danfoss

Walgreens store Evanston, Illinois, U.S.	2013	**60%** saving in energy consumption. • Window glass with light redirecting film technology redirects 80% of the direct solar radiation to the ceiling reducing glare and enhancing natural daylight penetration. • Solar PV installation covering the entire roof area • 2 wind turbines. • CO2refrigeration system with heat recovery for the ventilation air heating and DHW pre-heating. • AC+ parallel compression. • "False load" heat exchanger in gas cooler for extra heat recovery. • Power measurement and visualization. • LED technology installation with an automatic light control system with daylight sensing zone. • Motorized aperture in the roof controls natural ventilation for pre-conditioning. • Centralized, demand-controlled ventilation system based on CO2 levels in retails space with single-zone air handling units for local temperature control.

Considering the table before, there are many ways to introduce an efficient technology to consume less energy. It is important to consider that every supermarket is different therefore to select the best solutions it is necessary to know and consider their location, distribution, facilities, and products. What can be conclude is that LED lighting, is a viable technology to apply no matter the consideration mentioned before because lightning is something that is required in all buildings. As well, the supermarkets that show the highest reduction in energy consumption are the ones which change the refrigeration technology, meaning that refrigeration consume a considerable quantity of energy in the supermarkets. By identifying the places that consumes more energy inside the supermarket it is possible to look up to more efficient technologies that can reduce the energy consumption.

SUPER-HEERO has two main elements regarding to CE; the first one is the energy efficiency introduced in the supermarket. We can relate this with three sections of the Ellen Macarthur Foundation; maintain/ prolong, reuse/redistribute, and refurbish/redistribute. As an overall resume, this slope is about to instal or substitute technologies and equipment in the supermarket such as lightning, HVAC, and door cabinets.

Secondly are the financial schemes or circular business models (CBM) involved in with the technology providers and the supermarket clients. For this slope the

involvement of the technology provider and the supermarket client is crucial. With each of the involved the CBM applied are different forthcoming there will be a deepest explication of CBM such as leasing, technology as a service and more.

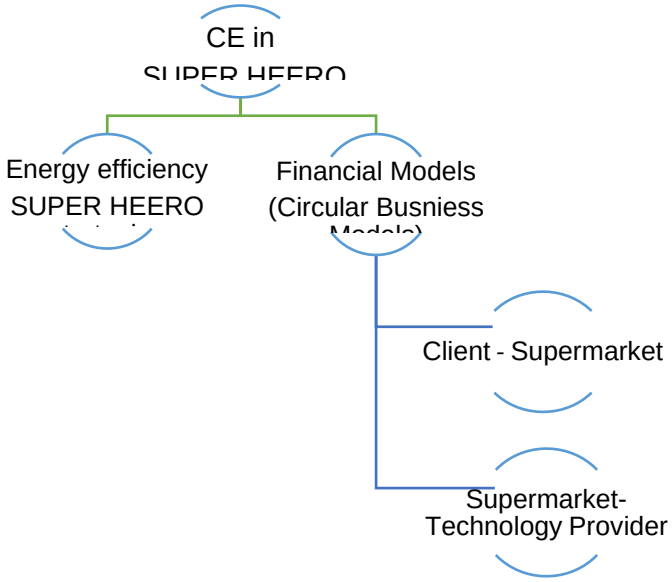

Figure 2 CE in SuperHeero

With the implementation of these strategies, it is expected that SUPERHERO can reach a symbiosis between the three main characters, supermarket clients (general public), supermarket and technology and equipment supplier/ provider.

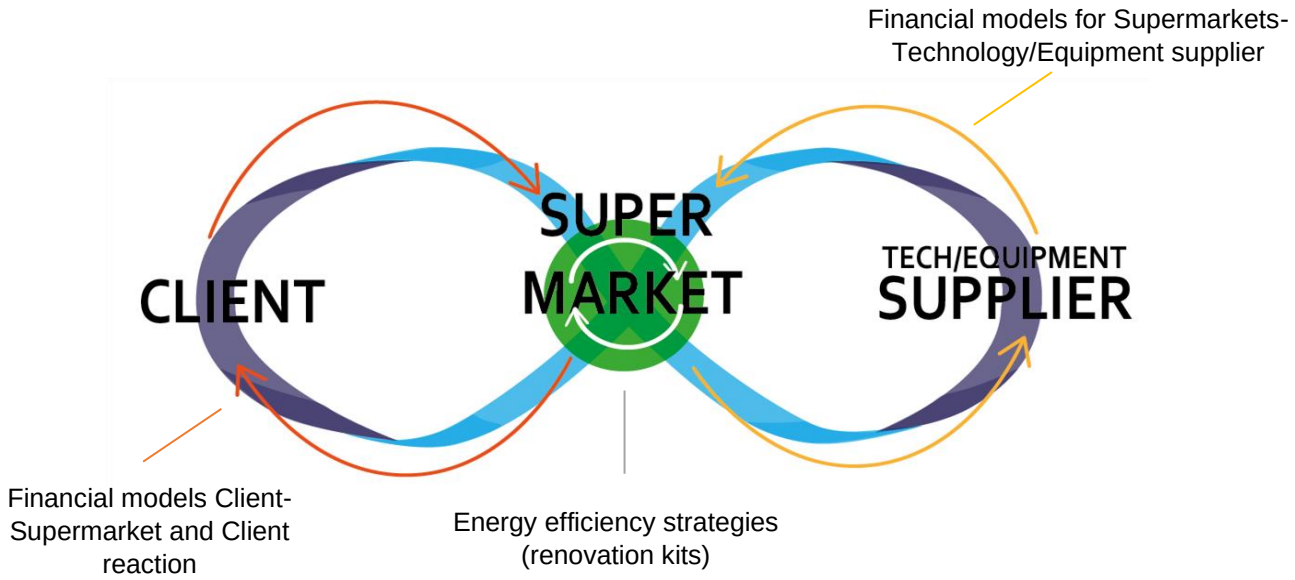

Figure 3 SuperHeero symbiosis

Finally, the circularity in SUPER-HEERO is constituted by a system which looks to increase the energy efficiency in the supermarkets by prolonging, redistribute and refurbish technology and equipment through circular business models with the technology providers, incorporating the participation of the supermarket final client. Making an impact from the provider to the final customer. SUPER-HEERO is part of the circular economy projects that are carried out around Europe in order to achieve a more sustainable pathway in our society, with efficient and a safer economic growth.

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