Sustainability Impact Assessment of a Refrigerator

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I would like to thank for his help to Doctor Holzbaur for all his knowledge that he has given me and as well, for directing me in the right way on this project. Moreover I also would like to be grateful to the student Walter Müller for his support.

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1. Introduction:

This project consists on design for sustainability, in our case, we would try to study the different types of fridges analysing how they and their characteristics impact on the environment to find out the reasons why they are not efficient enough to try to solve it in the future.

Nowadays, most of people have a fridge at home because it is nearly essential. So, the first step is to compare the energy that consumes a fridge during its life to the inconvenient and wasted time that have the people who have a life without fridge. In a fridge, we have to bare in mind the energy to produce the fridge, the transport and the electricity consumed in its life. On the other hand, we must think about what we have to do at the end of the fridge life cycle. If we have not a fridge, we have not electricity consumed but we have to go to buy daily. It supposes an every day wasting of time and in some cases fuel consumption that damage as well the environment.

We will compare and investigate the different types of fridges: Normal, Combi and American. The main different is the number of engines, the distribution between the fridge and the freezer and its efficiency. Also, we will have to bare in mind the number of people who will use the fridge in order to choose the appropriated capacity and reduce unnecessary consumption.

We will look forward what is offered by the different brands to find out how are actually technologically developed and how much the brands take care about the environment. Also, we will search which is the level used in the energy rank.

We will use the Ecodesign tools, baring in mind the Life Cycle Assessment, trying to make our best in the first part of the process to avoid posterior mistakes. Spending much time in the first part of the design process should be the key to success.

For that reason, we will try to implant new materials in order to reduce the environment impacts trying to use recyclable materials, thinking about the possible reusing of the materials for other things. Also we have to think an easy way to take the different parts of the fridge down for its posterior recycling or reusing.

As a conclusion and one of the first ideas for reusing the fridge could be to use the fridge at the end of its Life Cycle Assessment as a cupboard. We could take apart all the pieces for recycling or another reusing and use only the structure of the fridge reconverting as a cupboard. It would be an easy way to reuse the fridge for another thing. Moreover we have to bare in mind that nowadays the aspect of a fridge is very attractive and could be a new fashion.

2. History of the refrigerators:

Since the beginning of the times, people have been worried about the conservation of the food. Firstly, the only way that you could use to preserve aliments was putting them in ice or snow in a closed area. There were different manners to preserve the food like smoking, salting, oiling and brine, but all these techniques changed the flavour of these products, so the only good way to preserve the food was using the cold.

During the 18th century, Michael Faraday was investigating about that and he proposed a close circuit where a liquid flowed inside. His idea was that if he decreased the pressure of the liquid, it became cold, it evaporated and it changed into a gas. After that, he put the cold gas in contact to the interior of a recipient with ambient temperature. The gas went heater while the interior of the recipient went colder. Then, the gas continued by the circuit, went out of the recipient and it was compressed. With this, it condensed and heated a lot. This hot liquid was put in contact to the exterior. That was the reason why the outside was heating and the liquid was getting colder. The liquid flowed to the beginning and it started the process.

This idea was simple but great, because the refrigerant was compressed outside the recipient, but it was expander inside the recipient, so the recipient was getting cold. Repeating this process several times, they could get that the exterior was every time hotter and the interior colder until then, it seemed impossible.

The artificial refrigerated system using the Faraday's ideas was developed in 1748 by William Cullen. It was showed to the public in the University of Glasgow. However, the refrigeration was during the rest of the century only a scientist curiosity. On the other hand, until the 20th century that creations did not start to had a practical use.

The first company that constructed a domestic fridge was the American General Electric. Although it was made for the American Audiffren Refrigerating Machine Company. The first fridge that was commercialized in 1921 and it was more expensive than a car.

After some years, others companies including General Electric started to compete with the American Audiffren Refrigerating Machine Company. Then, the prices started to decrease but the problem was that the fridge was in the kitchen but the compression pumps had to be in the basements of the houses because they were really big. In this time the freezers started to be integrated in the refrigerators. Until then, the fridges couldn't make ice.

In 1927, the first fridges with compression pumps integrated appeared, it was the model Monitor from General Electric.

1. First General Electric commercial fridge (1927)

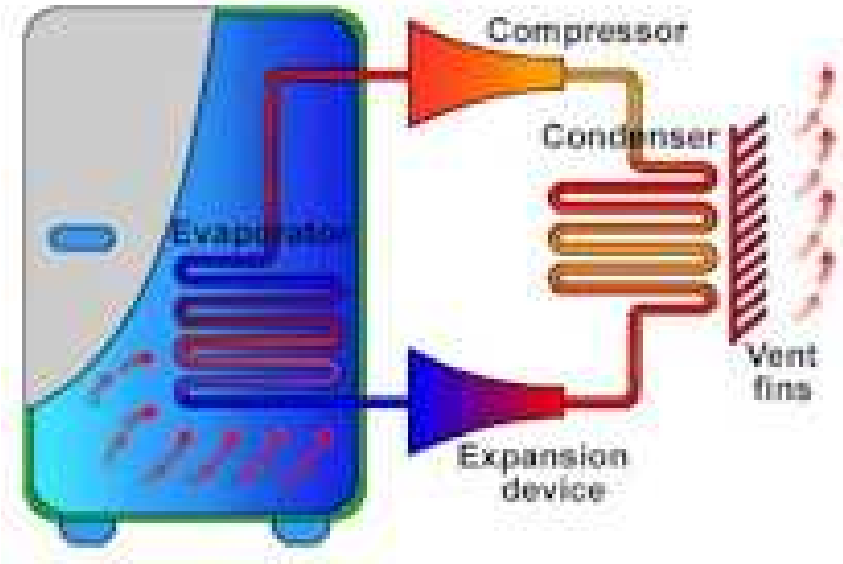
3. How the fridge operates:

The fridge is a refrigerator machine that works with a gas its evaporation point it is low. The purpose of that machine is to transport heat to the exterior of the fridge keeping the food cold.

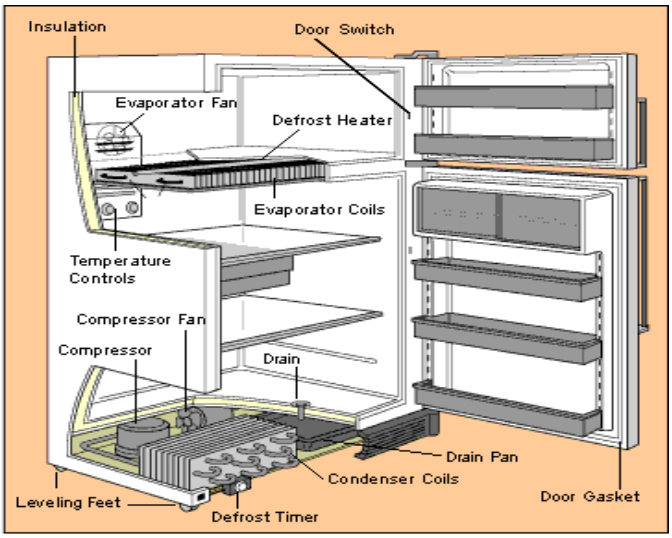
The refrigerator has a close circuit with two serpentines, an impulsion compressor, an expansion valve and a bunch of pipes that linked all the elements. One of the coils is situated inside and it is called evaporator. The other one is outside and it is used to name condenser. During the way into the fridge, the refrigerant liquid crosses the expansion valve and loses pressure. After that, it comes into the evaporator coil and it evaporates due to this expansion and the heat that takes from the food that is inside.

After the evaporator, in the way out, the refrigerator gas find the compressor that gives more pressure. With that increase, gas becomes liquid and it leaves the heat out within the external part of the pipes of the condenser.

This cycle it is repeated until the thermostat will order to stop it because the temperature demanded is got.



2. Graphic of how a fridge works.



3. Different parts of the fridge

4. Advantages / Disadvantages of having a fridge:

Advantages:

- Comfort: you do not need to buy daily. If you have a refrigerator at home you just have to buy your food once a week.
- If you want a cold drink you just have to open the fridge door.
- Store capacity: You can have a lot of food and choose every day what do you prefer.
- You can keep cooked food more days than if you do not have fridge.
- You can freeze some food and keep it well for a long time. Also if you have a freezer you can make ice.
- If your refrigerator is provided with an water and ice dispenser you do not have to buy water anymore. Thus, you will save a lot of money and you will not damage the environment with the plastic bottles.
- Moreover, with that system you do not have to open the fridge door to get the cold water, so you avoid a waste of electricity consumption.
- Also, with an ice-dispenser if someone wants a drink colder than the other, he does not need to turn up the temperature of the fridge; he just has to take some ice.

Disadvantages:

- The fridge consumes electricity energy. It damages the environment and has a cost.
- Although you do not have food inside the fridge, if the fridge is connected to the electricity, it is always consuming.
- Sometimes, the fridge is not full, so you are wasting an important amount of energy.
- The fridge always produces loud and it is increased when the engine is working.
- If you have ice-dispenser, when it is working, it produces so much loud.
- Also, with a water and ice dispenser the fridge needs a maintenance every year, it supposes an extra cost.
- From the back part of the fridge emerges heat that is wasted.
- The refrigerator occupied some place in the kitchen.

5. Advantages/disadvantages of not having a fridge:

Advantages:

- You do not consume energy/electricity from the fridge.
- The kitchen has not extra loud due to the fridge.
- You have more space in the kitchen.
- The kitchen is not warmer than if you had a fridge.
- You could choose every day what you want to eat because you have to go to buy daily.
- Every day you can eat fresh food.
- If you have to buy daily, you can take advantages into the offers.
- You do not have to spend a big amount of money to buy the fridge.
- If you do not have a fridge a home you avoid the maintenance.

Disadvantages:

- You have to go every day to the supermarket and waste some time.
- Depending on where you live, you need to use the car for buying. So, you waste energy on fuel consumption and money too.
- You can not store fresh food, ice creams, yogurts…, in your house.
- Almost all the food that you buy, you must to eat it in the same day.
- You can not get cold drinks.

6. Description of different types of fridges:

6.1 Conventional fridge: its main feature, it only has one compressor for the fridge and the freezer. There are models with one door with a small freezer inside. Also, there are others with two doors. In this case, the freezer has an independent door and it can be on the top or on the bottom of the refrigerator.

6.2 Combi fridge: it has a wide freezer on the low part and a fridge on the top. The main difference respect the conventional fridge is that it has two independent engines, one for the fridge and another for the freezer. That is the reason why it has a better performance and independent regulation of the temperature between the two compartments.

6.3 American fridge: it has a couple of doors in parallel distribution, one next to the other. Usually, the door that closes the fridge compartment is bigger than the other. Moreover, one typical feature of that sort of fridges is that they are provided with a mechanism to produce and distribute ice cubes.

7. The energetic efficiency:

Around 25% of the housing electrical consumption is due to the fridge. In all of its life, the fridge can consume the double of its purchase price in electricity.
In European Union, the energetic efficiency of a fridge is measured according to the average of electricity consumed by the same type of fridge with the same capacity, with an European values. There are three levels of efficiency admitted for the European fridges: A (the best), B and C (the worst). As well for the freezers D, E, F, G; for lower efficiencies. It is compulsory that the fridges have a sticker which indicates its energetic efficiency.
These levels were created in 1994. Later on, they were revised in 1999 and a new level more efficient called Energy+ was created for the fridges that were more efficient than the level A. The energetic efficiency of a fridge depends on its engine, its insulation, its capacity, its design and its refrigerant. The same fridge using a R600a refrigerant consume less energy than a R134a refrigerant.

Here is the table that indicates the energy efficiency, the index is calculated for each appliance according to its consumption and its compartments' volume taking into account the appliance type. The index is thus not calculated in KWh but in percent.
For example the fridge of category A+ with the same compartment's volume as a one of category D, uses 42% less energy.
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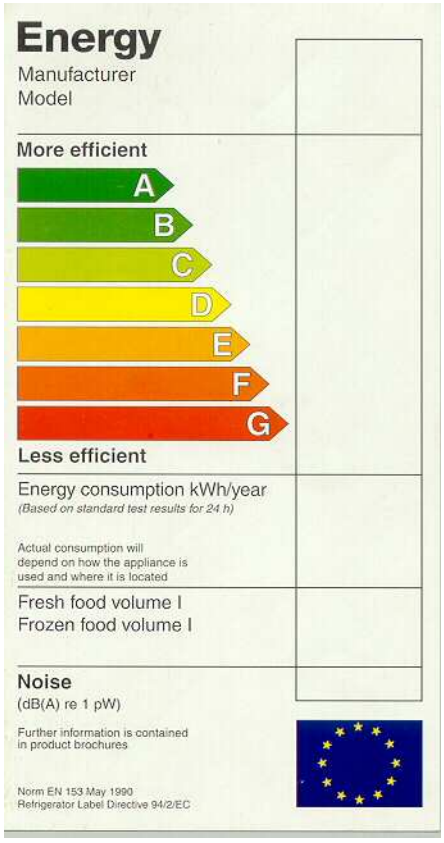


4. Example of EU efficiency label.

A++	A+	A	B	C	D	E	F	G
<30	<42	<55	<75	<90	<100	<110	<125	>125

The label also contains:

- the annual energy consumption in kW·h per year
- the capacity of fresh foods in liters for refrigerators and combined appliances
- the capacity of frozen foods in liters for freezers and combined appliances
- the noise in dB(A)

For cold appliances (and this product alone), for models that are more economical than those of category A, categories A+ and A++ have been assigned.

7.1 The European ecological label:

Here are the conditions that are required by a fridge to get the ecological label (Ecolabel):

- The efficient energetic level has to be superior than a fridge with the letter A.
- The refrigerant and the gas for the insulation foam can't damage the ozone layer.
- It can not flame retardants.
- The loud has to be inferior to 42 dB.
- It has to be design for an easy recycling and scraping.
- It has to attach instructions for an adequate environmentally use.
- It has to offer a recollecting plan for when it will not be useful.

Moreover, the manufacturer should offer three years of warranty and ensure spares during 12 years after finishing the production.

* We have to mention that all the EU labelling rule is in the annex in the Commission Directive 94/2/EC of 21 January 1994 implementing Council Directive 92/75/EEC with regard to energy labeling of household electric refrigerators, freezers and their combinations.

8. Types of cold:

8.1 Defrost Techniques:

Auto-defrost, automatic defrost or self-defrosting is a technique which regularly defrost the evaporator in a refrigeration system, refrigerator or freezer. Those techniques usually are called frost free or no-frost.
The mechanism on a fridge involves giving heat into the cooling element for a short period of time, melting any frost that has formed upon it and having it drain through a collecting duct at the back of the unit.
Inside the freezer, dry air is circulated around the cabinet using fans “dynamic”, whereas non-frost free ones are called “static”.
Instead of the traditional cooling elements assembled with the freezer liner, the auto-defrost elements are compact and they are separated from the main cabinet space, allowing them to be heated for short periods to dispose of any ice that has formed.
This technique was originally and is mostly applied to freezer compartments; it can also be used for refrigerators compartments.
A combined refrigerator/freezer which applies self-defrosting to the freezer compartment only is usually called "*partial* frost free", while one which one which also applies it to the refrigerator compartment is called "*total* frost free". The latter features an air connection between the two compartments, with the air passage to the refrigerator compartment regulated by a damper. This way, a controlled portion of the dry and fresh air coming from the dynamic cooling element located within the freezer can reach the refrigerator.
Some newer refrigerator/freezer models have built-in electronic sensors that monitor how many times each door is opened and could also average the door open time which will automatically adjust defrost scheduling, thereby optimizing power use.

Advantages:

- No need to manually defrost the ice buildup.
- Food packaging is easier to see because it is clear of frost.
- Most frozen foods don't stick together.
- Smells are limited, especially in total frost free appliances, since the air is constantly circulating.
- The system is more expensive to run due to 23% higher energy consumption although in total terms, it needs less energy. That occurs due to with that system it is not necessary to defrost. When an old fridge is defrosted, after that it needs a lot of energy to refrost the compartment, to keep the food frozen again. It suppose more energy that is used by the automatically system.

Disadvantages:

- A safety device is required to be connected with the heating element, due to the high instant-power values that can be reached.
- The temperature of the freezer contents rises during the defrosting cycles.
- On hot humid days condensation will sometimes form around the refrigerator doors.

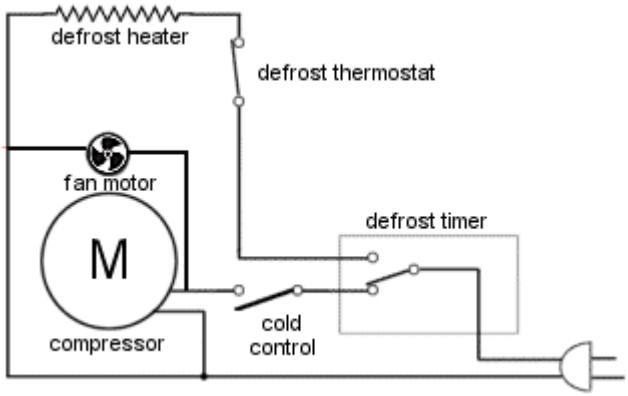
8.2 How does a frost-free refrigerator work?:

With a fridge without this system frost is formed around the coils that cool the freezer. If you let it build up long enough, the frost can occupied most of the fridge. Then here is no place to put anything in the freezer.

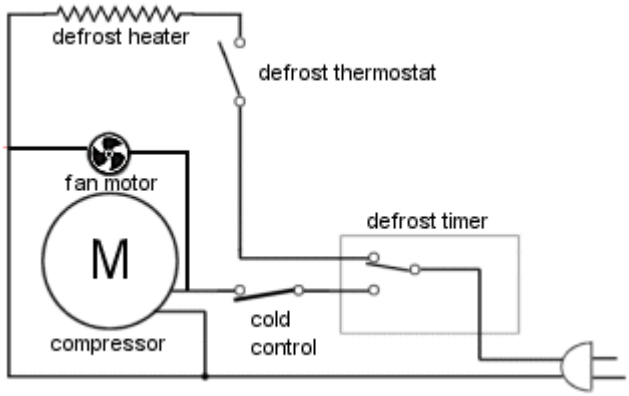
This frost forms when water vapor hits the cold coils. The water vapor condenses, it turns to liquid water. The same thing happens on the ice-cold freezer coils, except that when the water condenses onto the coils it immediately freezes.

During the cooling mode, the defrost timer closes a contact to the compressor circuit so it will run. The circuit to the defrost heater is open.

While in this mode, the thermostat (cold control) cycles the compressor and fan motors on and off to maintain an appropriate temperature.



5. Picture with the cooling mode



6. Picture with the defrost mode

The defrost timer eventually switches into defrost mode and supplies power to the defrost heater to melt any frost that has accumulated on the evaporator (cooling) coil.

The cold control contacts remain closed but since the defrost timer is no longer feeding power to that circuit, the compressor does not run.

Once the defrost termination thermostat senses a set temperature, it opens the circuit to the defrost heaters, shutting them off. The timer remains in the defrost cycle until the timer advances back to the cooling mode. Since the limit switch is open, the heaters are no longer on for the rest of the cycle.

Every six hours or so, the timer turns on the heating coil. The heating coil is wrapped among the freezer coils. The heater melts the ice off the coils. When all of the ice is gone, the temperature sensor senses the temperature rising above 0°C and turns off the heater.

Heating the coils every six hours takes energy, and it also cycles the food in the freezer through temperature changes. Most large chest freezers therefore require manual defrosting instead -- the food lasts longer and the freezer uses less power.

9. Life Cycle Assessment (LCA):

According with the knowledge we have acquired from the book (Design for sustainability), now we can apply all that we have learned in the refrigerators ambit.

The Life Cycle Assessment (LCA) is a useful tool to evaluate the environmental aspects and potential impacts associated with a product and a service throughout its life span. Life Cycle Assessment considers products or services from a "cradle to grave" perspective. The International Organization for Standardization (ISO) describes that the basic aim of LCA is to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and materials used and wastes released to the environment, assessing the impact of the energy and materials used and released to the environment, and identifying and evaluating opportunities for environmental improvements (ISO 2002). ISO also specifies the general framework, principles and requirements for conducting and reporting life cycle assessment studies.
The complete LCA framework includes four phases shown Figure 1: goal and scope definition; inventory analysis; impact assessment, and interpretation. The goal and scope defines the purpose, intended audience, and system boundaries. The inventory analysis involves data collection and calculations to quantify material and energy inputs and outputs of a product system, and the impact assessment evaluates the significance of potential environmental impacts based on the inventory analysis. Finally, in the interpretation phase the analyst evaluates findings, reaches conclusions and makes recommendations (ISO 1997).

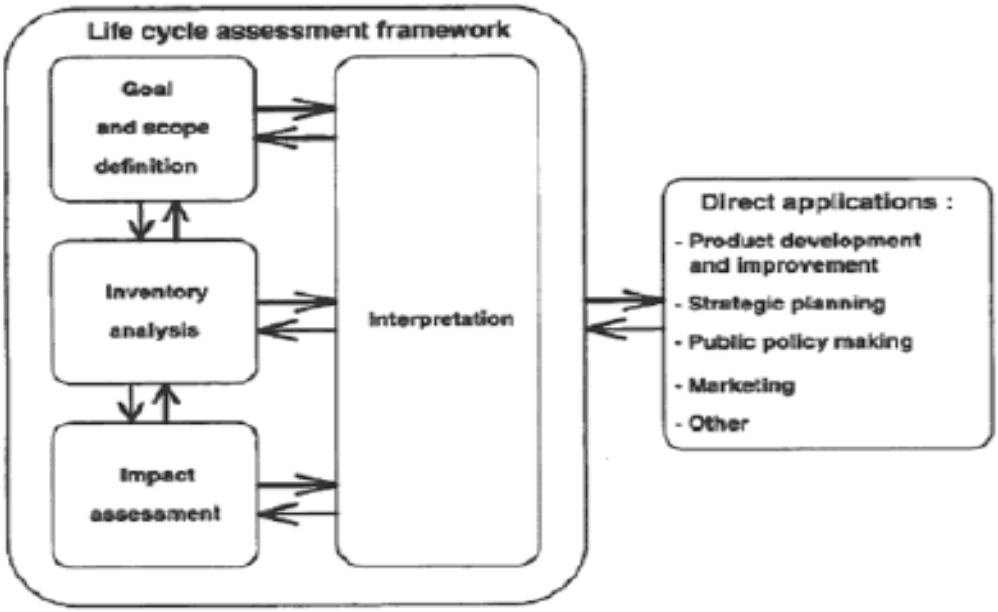
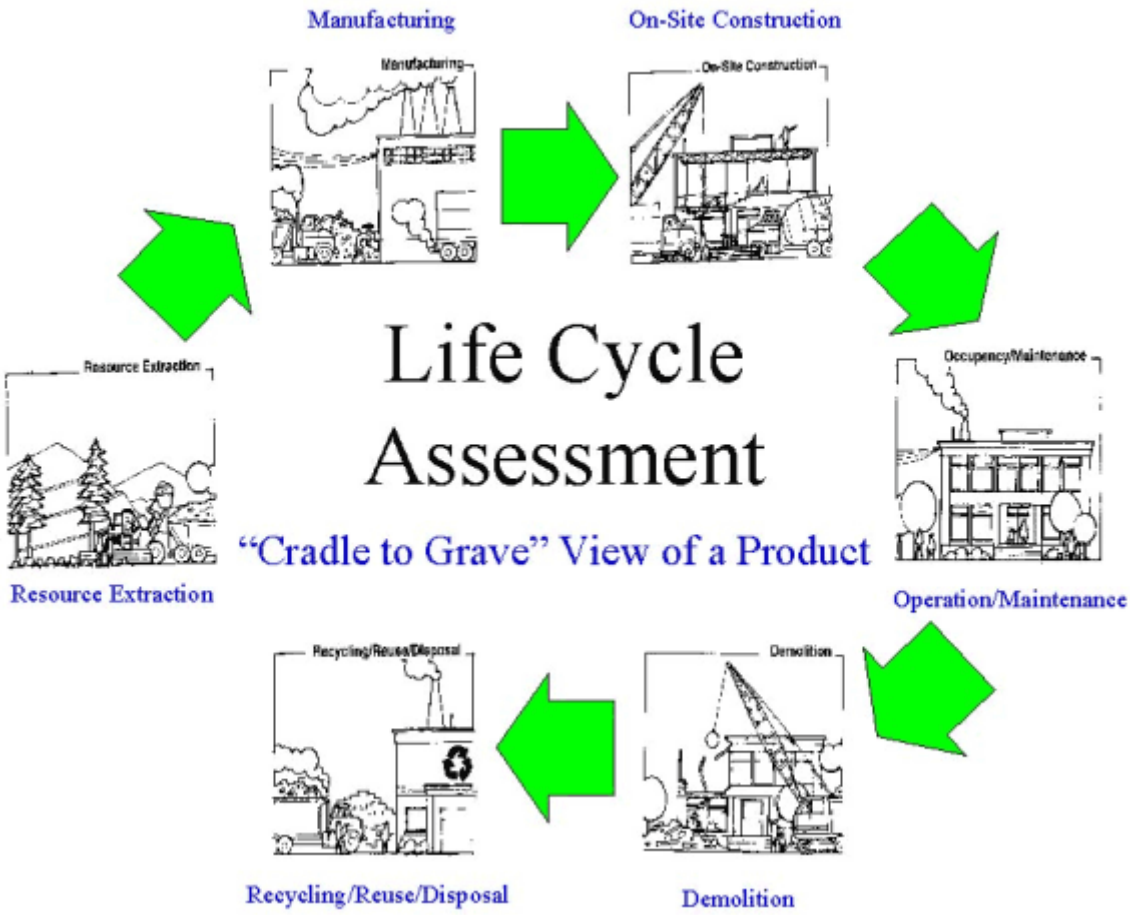


Figure 1 Phases of a LCA Study (ISO14040: 2006)

7. Diagram of the LCA



8. Process of the LCA

Let's see an example of the LCA according to JEMAI (Japan Environmental Management Association For Industry)

9.1 Material Production:

The largest group are ferrous materials account for 49%.
The second- largest group of materials used is plastics, although each refrigerator-freezer has slightly different materials composition of plastics (41%).
Non-ferrous metals include aluminium and copper. Other key materials are glass, refrigerant, and refrigerant oil (10%). Culture, food characterization and lifestyle can affect material compositions of refrigerators used in different countries. For instance, Japanese refrigerators have more thermoplastic and thermosetting resins used for separate compartments for fish, meat and vegetables. Hence, these differences can affect the LCA of each refrigerator type.

9.2 Manufacturing and Assembling (JEMAI 1995):

The second phase of the refrigerator-freezer life cycle is the manufacturing and assembly phase. This phase consists of four major manufacturing processes: (1) assembly of the cabinet, (2) assembly of the door, (3) process line of inner liner, inner door and resin and plastic parts, and (4) assembly of refrigeration components.
The first process, cabinet assembly is the fundamental process for manufacturing and assembly. This assembly is comprised of the following procedures: sheet metal processing including roll forming and spot welding, bonderizing and coating, polyurethane forming, installation of refrigerant components, refrigerant and refrigerant oil filling, performance testing for cooling capacity, attaching interior components, and packaging. The components and parts from three other manufacturing processes are installed with the cabinet assembly.
In the second assembly line process, cold-rolled steel for the door is galvanized and coated. Then after processing of the plate metal through pressing, bending, and other metal forming processes, sashes, inner reinforcing boards and hinge pins are attached.
Finally, the door is injected with foaming polyurethane foam.
The third process is a line of inner liner, inner door and resin and plastic parts.
Mainly this process begins with manufacturing plastic sheet from resin pallets with extrusion molding. From this sheet, some inner parts and the door are manufactured with vacuum forming. Also, injection molding is used to produce vegetable compartments, and ice trays. These resin and plastic parts are supplied to the door and cabinet assembly lines.
The fourth process for the refrigeration components consists of two assembly lines: (1) heat exchanger and pipes, and (2) motor compressors. Heat exchangers consist of pipes and fins. Fins are made of aluminium and pipes are made of either copper or
aluminium. Copper coils are processed to create pipes that are used for the cooling system.
After those pipes and aluminium rolling are cut, and attached with pressed aluminium fins, heat exchangers are completed with brazing. Those are supplied to the cabinet assembly process after testing for leakage. For motor compressors, at first metal casting is cut and polished, and then crankshafts, rotors, and stators are machined. Manufacturing of motor compressors is completed after plumbing, welding, and coating. Motor compressors also are tested for leakage and pressure, filled with nitrogen and refrigerator oils and then sent to the cabinet assembly process.

9.3 Use:

Previous LCA studies conducted in Europe, Japan and the U.S. indicate that 88% to 97% of total life cycle energy is consumed in the use phase regardless of the product size or lifetime (Foley; JEMAI 1995). These studies assume constant energy consumption throughout the refrigerator-freezer service life and ignore the refrigerator-freezer's decline in efficiency over time.

9.4. End-of-Life (demolition/recycling):

Why Do Refrigerator Recycling?

• Secondary unit programs usually cost-effective to electric utilities where natural gas is marginal supply

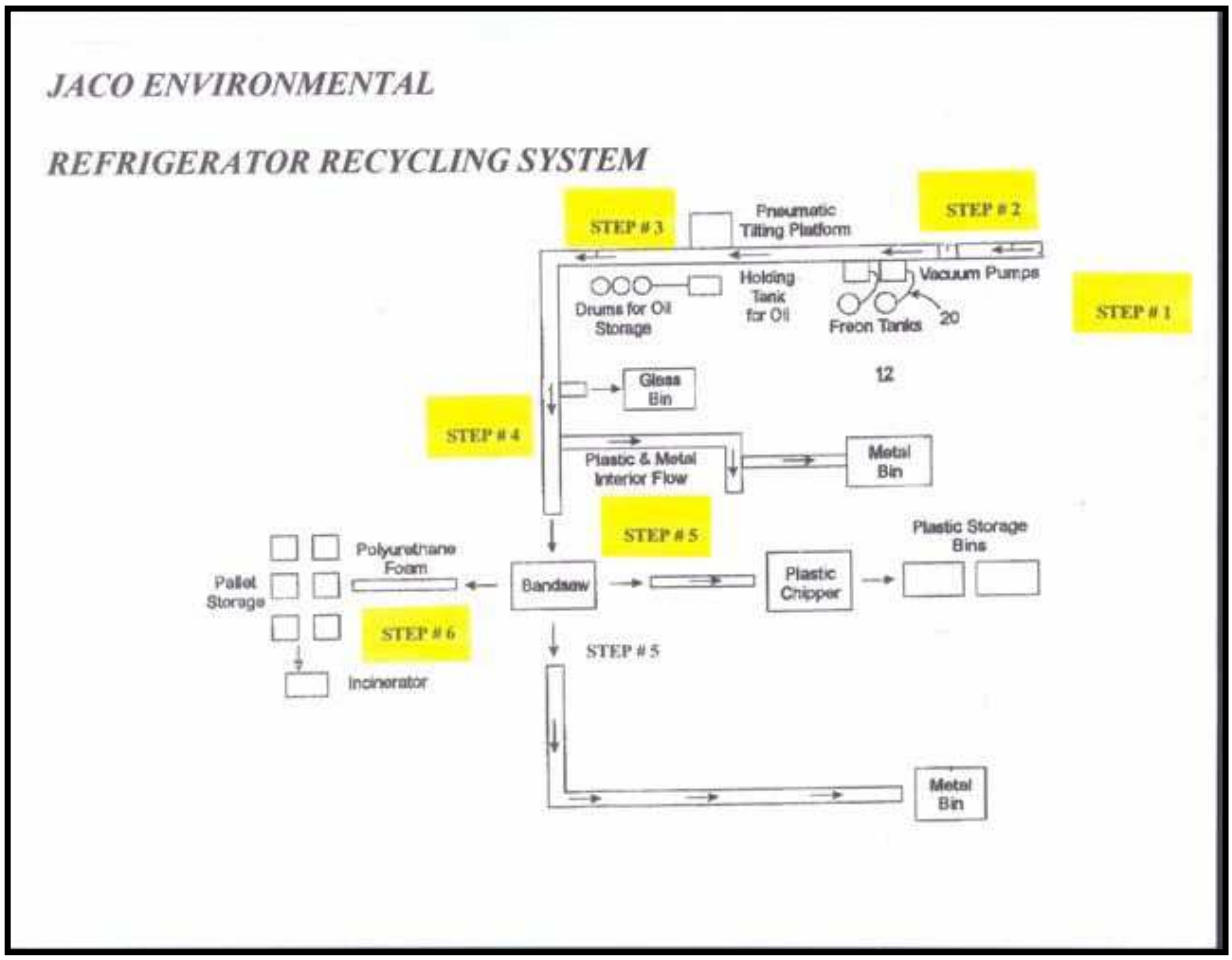
• Environmental benefits

– Properly dispose of oils, PCB's, & CFC-11 foam

– Properly recycle CFC-12, HFC-134a, steel, & aluminium

– Avoided landfill (mainly foam, glass, & plastic)

Recycling Process Overview:



9. Picture of the recycling process diagram

→ Fully permitted

→ Conducted in a clean, modern warehouse-like facility

10. Pictures of the recycling installation

• Step 1: Catalogue Unit, and Drill Core Sample

– Cataloguing involves recording unit number and originating utility information

– Core sample drilling involves boring 1” hole in unit side to inspect type of insulation (to see if CFC-11 present)

Step 2: Evacuate Freon

11. Picture of a worker extracting the Freon

• Step 3: Pump Oils from Compressor / Remove Capacitors

12. Picture of a worker dealing with pump oils

• Step 4: Remove Interior Shelving and Storage Bins
  – Harvests tempered glass, plastic, and metal

• Step 5: Cut Chassis into Pieces (shredding), and Harvest/Separate Foam, Metal, and Plastic

13. Picture of how the machines cut the chassis

• Step 6: Seal CFC-11 Foam in Bags (for Shipment to Incinerator)

14. Picture of how the Seal CFC-11 is foaming in bags

10. Life without fridge:

If you live 0 km away from the supermarket you have not to take the car to buy. If not, you have to use the car nearly everyday and it consumes an amount of fuel depending in two things: sort of car and distance to the supermarket. We have calculated that a person goes to buy 5 days per a week, so in a year he goes to buy 260 days.

Another important fact is the combustible that uses the car. It usually changes the number of litters per 100 km; and the annual cost of the fuel. Moreover, it also impacts in a different way on the planet because its energetic power is different. The energetic power of the diesel combustible is 8,96 kWh/L and the gasoline has an energetic power of 12,6 KWh/L.

All that aspects changes all the statistics. Here, there are the results above:

Consumption of the car/100km	kms	Consumption/ year (litters)	Cost/year (diesel)	Cost/year (gasoline)	Energetic consumption (gasoline) KWh/y	Energetic consumption (gasoline) KWh/y
5	1	13	14,3	16,9	116,48	163,8
5	5	65	71,5	84,5	582,4	819
5	10	130	143	169	1164,8	1638

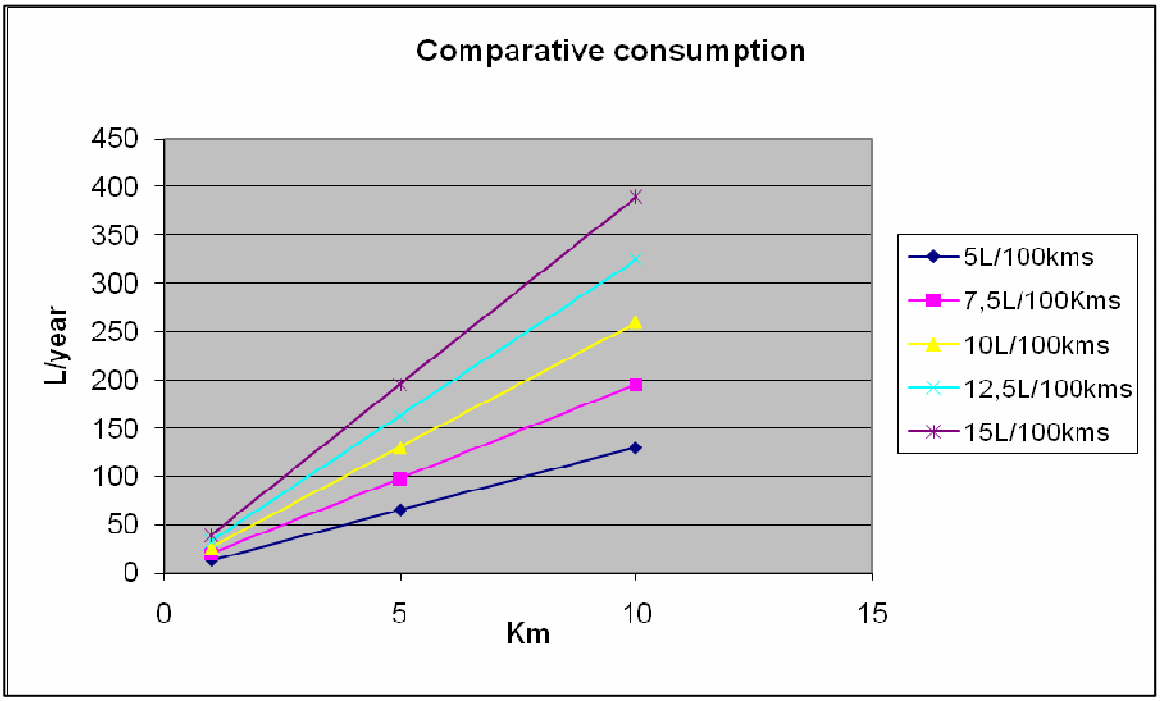
Consumption of the car/100km	kms	Consumption/ year (litters)	Cost/year (diesel)	Cost/year (gasoline)	Energetic consumption (gasoline) KWh/y	Energetic consumption (gasoline) KWh/y
7,5	1	19,5	21,45	25,35	174,72	245,7
7,5	5	97,5	107,25	126,75	873,6	1228,5
7,5	10	195	214,5	253,5	1747,2	2457

Consumption of the car/100km	kms	Consumption/ year (litters)	Cost/year (diesel)	Cost/year (gasoline)	Energetic consumption (gasoline) KWh/y	Energetic consumption (gasoline) KWh/y
10	1	26	28,6	33,8	232,96	327,6
10	5	130	143	169	1164,8	1638
10	10	260	286	338	2329,6	3276

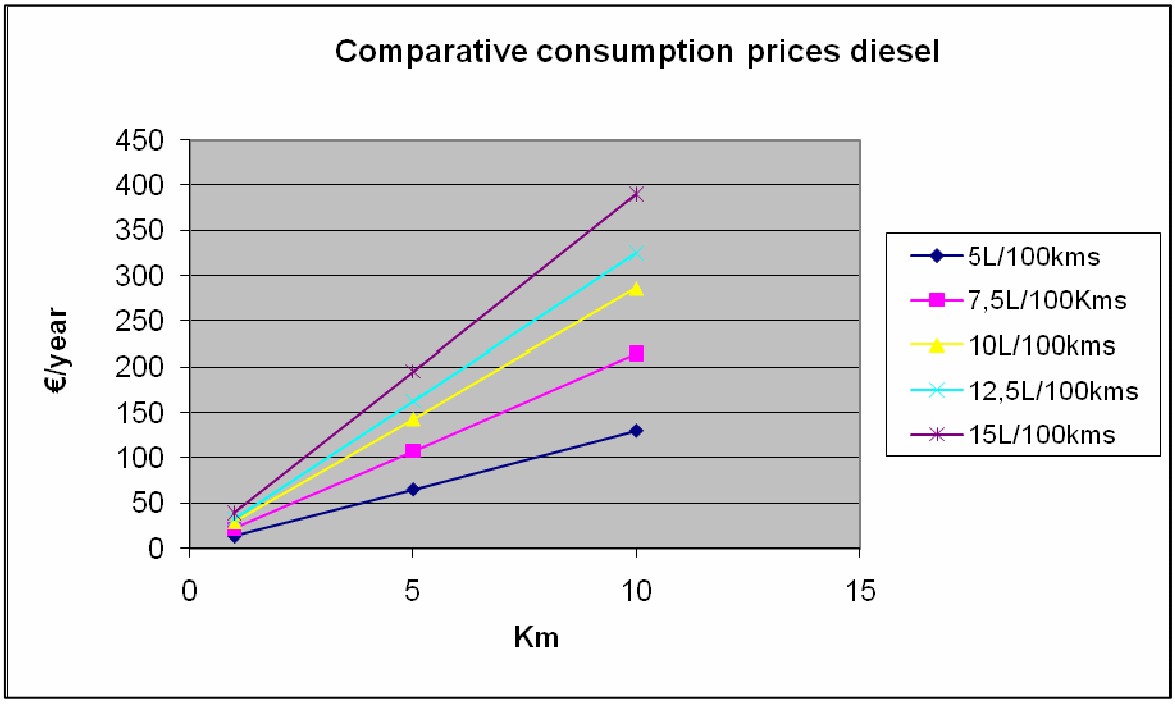
Consumption of the car/100km	kms	Consumption/ year (litters)	Cost/year (diesel)	Cost/year (gasoline)	Energetic consumption (gasoline) KWh/y	Energetic consumption (gasoline) KWh/y
12,5	1	32,5	35,75	42,25	291,2	409,5
12,5	5	162,5	178,75	211,25	1456	2047,5
12,5	10	325	357,5	422,5	2912	4095

Consumption of the car/100km	kms	Consumption/ year (litters)	Cost/year (diesel)	Cost/year (gasoline)	Energetic consumption (gasoline) KWh/y	Energetic consumption (gasoline) KWh/y
15	1	39	42,9	50,7	349,44	491,4
15	5	195	214,5	253,5	1747,2	2457
15	10	390	429	507	3494,4	4914

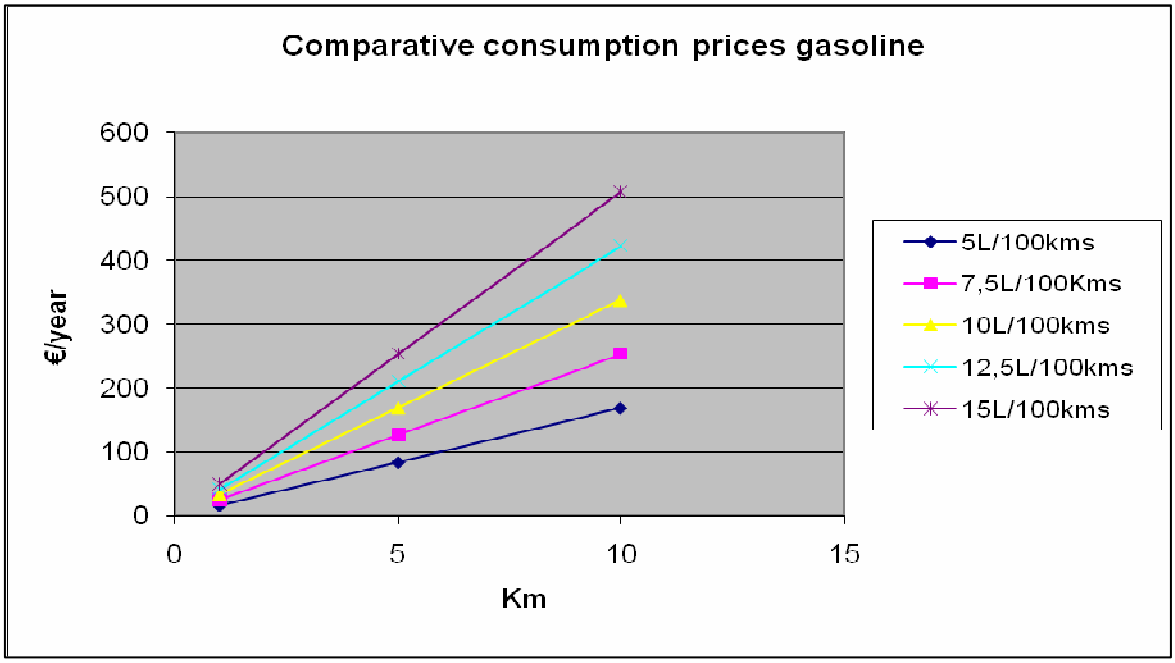
Here, there the visual graphic results of the study:



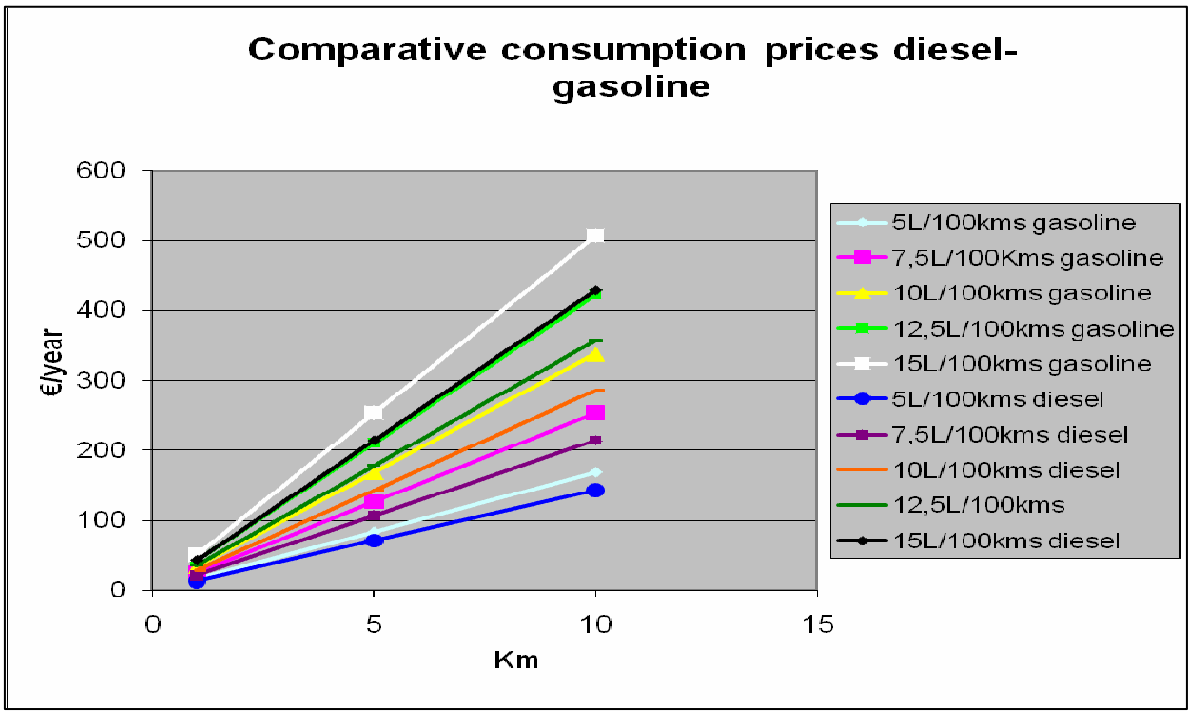
In this graphic we can see that the amount of consumption that is required to buy our food in a year is totally lineal. For that reason is essential to have a low consumption car if you have not a fridge at home.



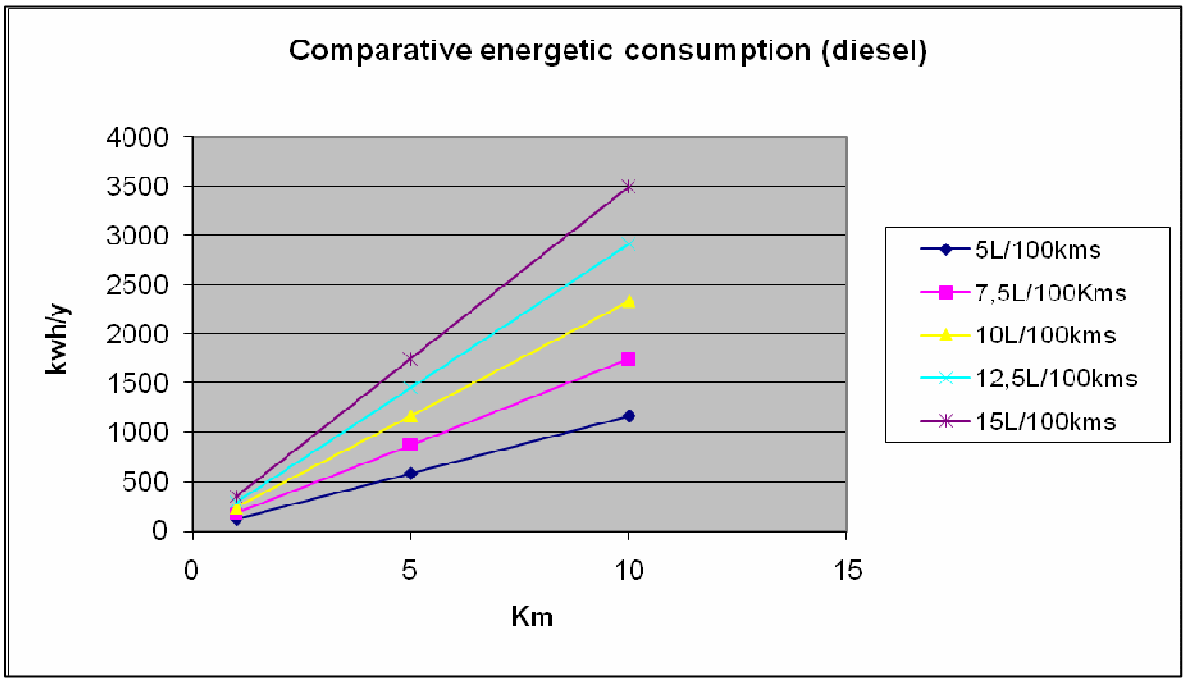
If the consumption is lineal, it is logical that the prices follow the same inclination.



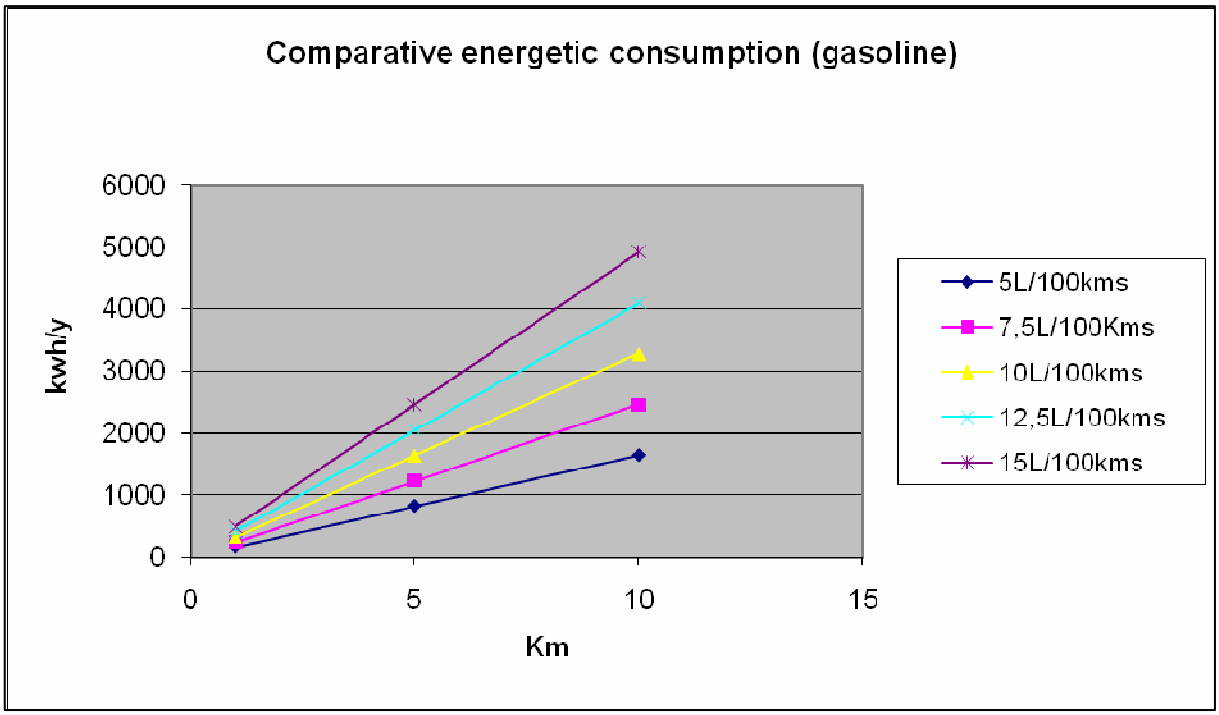
The same occurs with the consumptions in a gasoline car.



With this graphic we could find out the importance of the selection of the car in order to save money. For instance, if we compare a car with diesel consumption that consumes 15L/100km, it has to be a very powerful one; with a gasoline that consumes 12,5L/100km, consumption easy to get with a non-sporty car; we extract from the graphic that their annual cost are about the same. For that reason, it is fundamental to choose a diesel car with a reduced consumption.



As we mention before, the energetic consumption has to be lineal too.



As we see in these graphics, when you are looking for which are the impacts of not having a fridge at home, it is really important to know what kind of car you have because it can change all the statistics. The amount of petrol that is needed to buy the food for a year varies too much for not baring the fuel consumption in mind. For that reason, that point is essential in order to study the impacts of living without a refrigerator.
Another aspect that we can extract from that study is the amount of money that you must spend in a year if you have no fridge in your house. Of course, if you have a fridge at home you have to go once per week, but even this, the amount of money saved is significant.

11. Analysis and specifications of the different types of fridges:

11.1 American Fridges:

Electrolux ENS 5700 X Screenfridge

Capacity of the fridge: 335 l
Capacity of the freezer: 215 l
Total capacity: 567 l
Energetic level: A
Electricity consumption: 422 KWh/y
Noise pollution: 40 dB
Frozen capacity: 25 kg/ 24h
Autonomy: 20h
Type of cold: No frost/DME
Dimensions: High: 1800mm
Wide: 1190mm
Deep: 600mm

Specifications: Touch multifunctional screen: Which permits you surf on the net, watch the TV and know the food that you have of the fridge and its day of caducity. It also has self-closing doors and easy-open valve.

Electrolux ERL 6296 W

Capacity of the fridge: 357 l
Capacity of the freezer: 165 l
Total capacity: 522 l
Energetic level: A
Electricity consumption: 524 KWh/y
Noise pollution: 40 dB
Frozen capacity: 7,5 kg/ 24h
Autonomy: 4,7h
Type of cold: No frost
Dimensions: High: 1760mm
Wide: 905mm
Deep: 682mm

Specifications: Dispenser with 4 functions: water, ice-cubes, crushed ice and extra ice. Box with controlled temperature.

Bosch KAD 62S50

Capacity of the fridge: 355 l
Capacity of the freezer: 178 l
Total capacity: 533 l
Energetic level: A+
Electricity consumption: 467,2 KWh/y
Noise pollution: 44 dB
Frozen capacity: 12 kg/ 24h
Autonomy: 16h
Type of cold: No frost
Dimensions: High: 1756mm
Wide: 910mm
Deep: 761mm

Specifications: LCD screen touch control, dispenser of water and ice-cubes and antibacterial treatment. It also has Freshprotectbox.

SIEMENS KA62DP90

Capacity of the fridge: 355 l
Capacity of the freezer: 178 l
Total capacity: 533 l
Energetic level: A+
Electricity consumption: 467,2 KWh/y
Noise capacity: 44 dB
Frozen capacity: 12 kg/ 24h
Autonomy: 16h
Type of cold: No frost
Dimensions: High: 1760mm
Wide: 910mm
Deep: 761mm

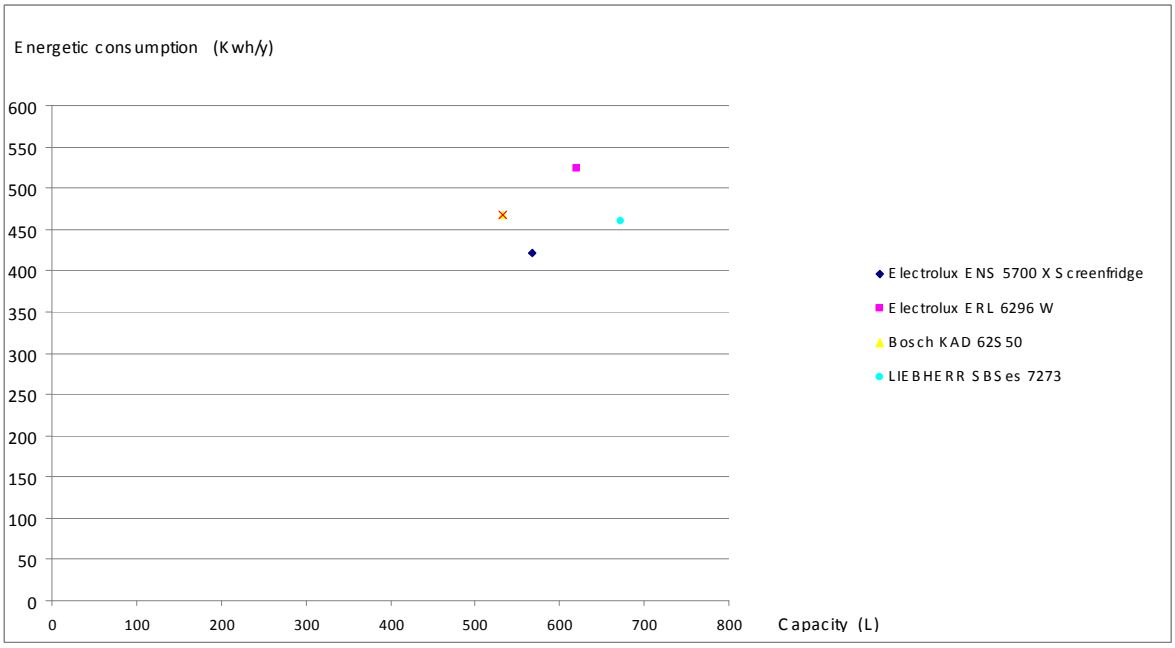
Specifications: complete stainless construction, screen touch control, dispenser of water and ice-cubes.

LIEBHERR SBSes 7273 PremiumPlus

Capacity of the fridge: 224 l
Capacity of the freezer: 237 l
Capacity of biofresh: 111 l
Total capacity: 672 l
Energetic level: A+
Electricity consumption: 460,6 KWh/y
Noise capacity: dB
Frozen capacity: 18 kg/ 24h
Autonomy: 43h
Type of cold: No frost (freezer)
Dimensions: High: 1852mm
Wide: 1210mm
Deep: 630mm

Specifications: ice-center: dispenser of water and ice-cubes. DrySafe and HidroSafe regulation. This fridge is provided with Homedialog-Sistem.

Here, there's a graphic where are related all the fridges that we have been analysed:



The most efficient fridge is the LIEBHERR. It has the biggest capacity, and one of the lowest consumption of energy, that's the reason why if we compare its capacity and its energetic

consumption with the others fridges it is the best. Also it has ice dispenser, DrySafe regulation and HidroSafe.

Then we find the Electrolux ENS 5700X fridge, it is supposed to be the worst because it is the only one that has A level in efficiency terms but for some reason it does not. Maybe, the reason why it happens is that it has not ice dispenser. But on the other hand, it has multifunctional touch screen. With this screen we can surf the net, watch the TV, know the food that you have inside and its caducity date.

In the third place, we have the Bosch KAD 62S50. It is also A+ rang level, ice and water dispenser and LCD touch control screen. Maybe for the last two specifications, it consumes quite energy.

The last one is the Electrolux ERL 6296W. It has an ice dispenser with 4 functions: water, ice-cubes, crushed ice and extra ice. Maybe for that reason it consumes pretty much.

11.2 Combi fridges:

LIEBHERR CNP 4056 Premium

Capacity of the fridge: 275 l
Capacity of the freezer: 89 l
Total capacity: 364 l
Energetic level: A++
Electricity consumption: 231 KWh/y
Noise pollution: <60 dB
Frozen capacity: 14 kg/ 24h
Autonomy: 30 h
Type of cold: No frost (freezer)
Dimensions: High: 2011mm
Wide: 600mm
Deep: 630mm

Specifications: LCD digital touch-screen, removable compartment Serve-Friendly.

LG GR-4696LCPN

Capacity of the fridge: 252 l
Capacity of the freezer: 88 l
Total capacity: 340 l
Energetic level: A++
Electricity consumption: 224 KWh/y
Frozen capacity: 12 kg/ 24h
Autonomy: 11,3h
Type of cold: No frost
Dimensions: High: 2000 mm
Wide: 595mm
Deep: 674mm

Specifications: LCD screen, Multi Air Flow and Bioshield.

BOSCH KGN 36S58

Capacity of the fridge: 221 l
Capacity of the freezer: 66 l
Total capacity: 287 l
Energetic level: A+
Electricity consumption: 280 KWh/y
Frozen capacity: 8 kg/ 24h
Autonomy: 17h
Type of cold: No frost
Dimensions: High: 1870mm
Wide: 640mm
Deep: 600mm

Specifications: LCD screen touch control, electronic control and special functions: eco, holidays and bottle timer. Humidity regulation box.

SIEMENS KG39FP71

Capacity of the fridge: 149 l
Capacity of the freezer: 68 l
Total capacity: 309 l
Energetic level: A+
Electricity consumption: 319 KWh/y
Frozen capacity: 14 kg/ 24h
Autonomy: 24h
Type of cold: No frost (freezer)
Dimensions: High: 2000mm
Wide: 600mm
Deep: 600mm

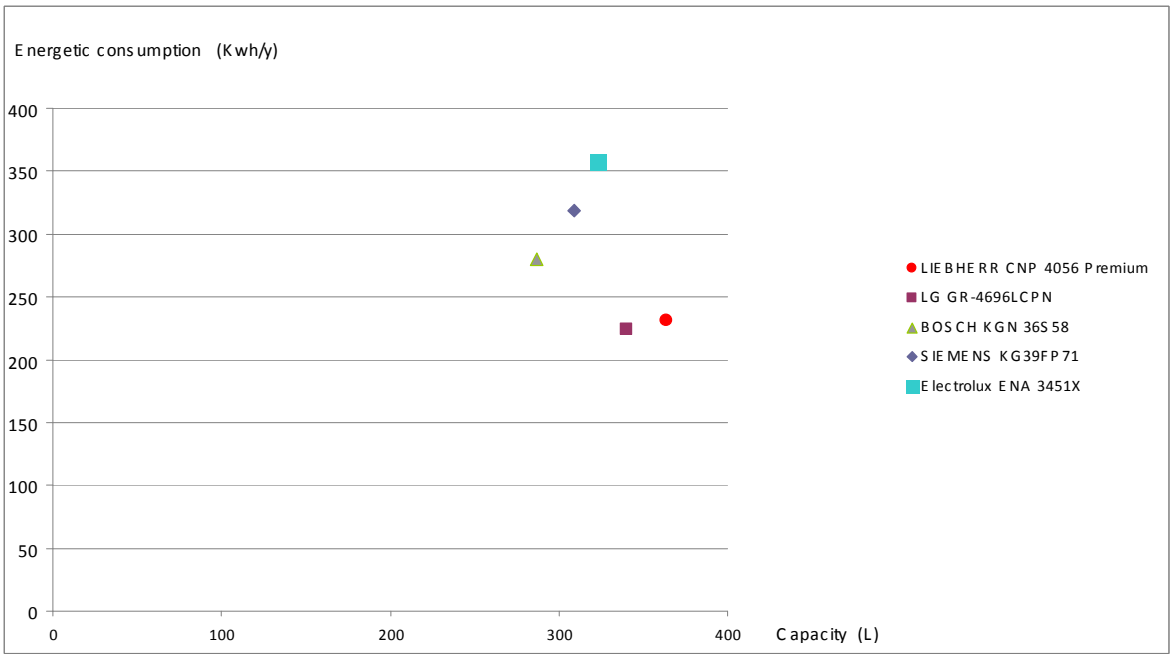
Specifications: LCD screen touch control and special functions: memory, eco, holidays and bottle timer. Electronic control.

Electrolux ENA 3451X

Capacity of the fridge: 245 l
Capacity of the freezer: 78 l
Total capacity: 323 l
Energetic level: A
Electricity consumption: 357 KWh/y
Noise pollution: 42 dB
Frozen capacity: 10 kg/ 24h
Autonomy: 6 h
Type of cold: Multilevel NF
Dimensions: High: 1850mm
Wide: 595mm
Deep: 632mm

Specifications: Electronic control DMT, display LCD, self-closing doors and low temperature box.

Here, there's a graphic where are related all the fridges that we have been analysed:



As we can see in the graphic the LIEBHERR CNP 4056 Premium is the most efficient fridge of the group and it occurs because it has best energetic rank that it could assume. It means that has the A++ level. Moreover, it has lots of benefits for the costumer like the LCD digital touch screen, a removable compartment Serve-Friendly and the best autonomy. It also has the best frozen capacity with 14kg/24h.

In the second place we find the LG GR-4696LCPN which also is very efficient due to it is A++ energetic level. It also has a good capacity and frozen capacity of 12kg/24h which is good too. On the other hand, its autonomy is less than the half of the LIEBHERR fridge.
In the middle, we have the BOSCH KGN 36S58 with A+ in the efficiency level. That fridge has the smallest capacity of this comparative but it has a good autonomy of 17h although its frozen capacity it is the worst.

Then, in forth position there is the SIEMENS KG39FP71. That fridge is quite similar to the previous BOSCH but it consumes more but it is more comfortable for the costumer due to its characteristics: it has better frozen capacity, better autonomy and more special functions.
The last one is the Electrolux ENA 3451X is the worst fridge of that comparative. For instance, it has the lowest autonomy (6h) and bad frozen capacity (10kg/24h). On the other hand, it has some good points like self-closing doors.

11.3 Simple fridges:

Electrolux ERN3420

Capacity of the fridge: 332 l
Capacity of the freezer: 0 l
Total capacity: 332 l
Energetic level: A
Electricity consumption: 176 KWh/y
Noise pollution: 34 dB
Dimensions: High: 1762mm
Wide: 540mm
Deep: 547mm

Specifications: Display LCD and electronic control.

Electrolux ERN 2372

Capacity of the fridge: 230 l
Capacity of the freezer: 0 l
Total capacity: 230 l
Energetic level: A+
Electricity consumption: 131 KWh/y
Noise production: 36dB
Frozen capacity: 0 l
Dimensions: High: 1224mm
Wide: 540mm
Deep: 549mm

Edesa SPORT-F13

Capacity of the fridge: 374 l
Capacity of the freezer: 0 l
Total capacity: 374 l
Energetic level: A
Electricity consumption: 147 KWh/y
Loud production: 37 dB
Frozen capacity: 0 l
Autonomy: 0 h
Dimensions: High: 1810mm
Wide: 595mm
Deep: 610mm

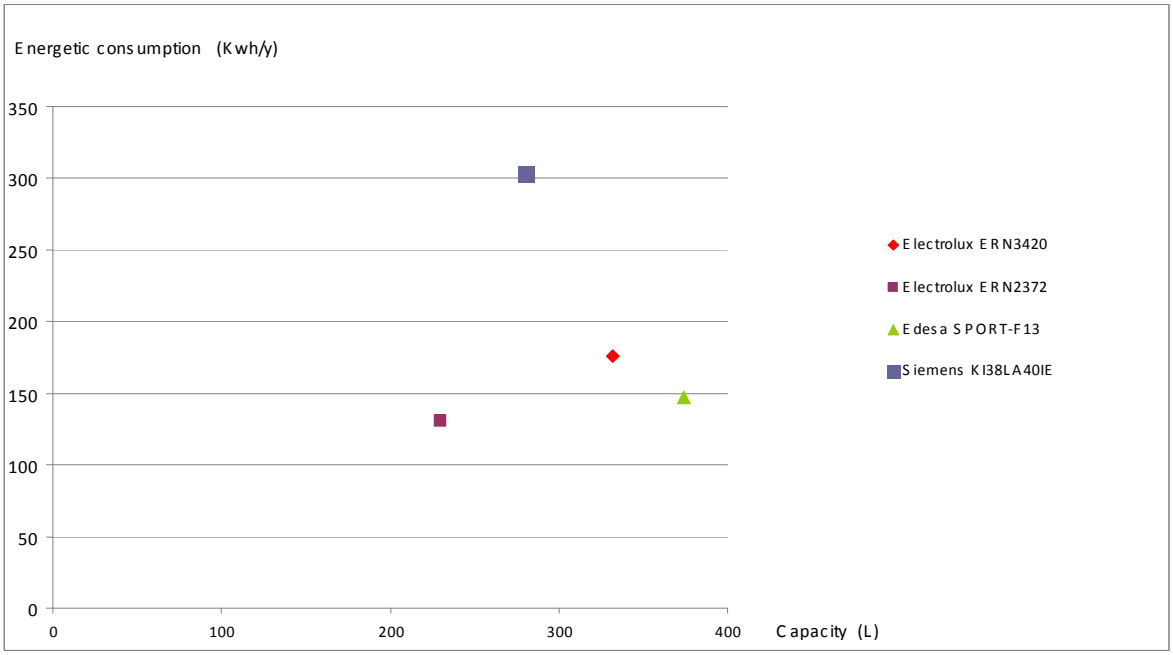
Specifications: homogeny cold around the entire fridge

Siemens KI38LA40IE

Capacity of the fridge: 244 l
Capacity of the freezer: 36 l
Total capacity: 280 l
Energetic level: A
Electricity consumption: 303 KWh/y
Frozen capacity: 3 Kg/24hl
Autonomy: 18 h
Dimensions: High: 1771,5mm
Wide: 538mm
Deep: 533mm

Specifications: Antibacterial system, environmental friendly refrigerant (100% CFC & HCF free)

Here, there's a graphic where are related all the fridges that we have been analysed:



First of all, we have to mention that the Siemens model is the only one that has freezer on it. For that reason, the electricity consumption is increased a lot.

The most efficient simple fridge of this comparative is the Edesa SPORT-F13. Therefore it has an A level in the efficiency rank. It also has the biggest capacity and the second lowest energetic consumptions, so if we compare its capacity and its energetic consumptions with the rest of the fridges it is the best.

After that we have the Electrolux ERN3420 which has less capacity than the Edesa. It has LCD display and electronic control. Maybe for that reason its consumption is bigger.

In third place we find Electrolux ERN 2372 that has a capacity of 230 litters, it is the smallest. Therefore, it has an A+ rank level.

The last one is the Siemens KI38LA40IE and as we have said before the reason why it consumes compatible too much is that it has freezer inside the fridge. His autonomy is very good and its frozen capacity is 3kg/24h.

12. Comparing the fridges with the same brand:

Here we will compare the different types of fridges of the same brand, the American fridges, the Combi fridges and the Simple fridges; to know which will be the best depending of our needs.

12.1 Electrolux fridges:

12.1.1 Electrolux American Fridges:

Electrolux ENS 5700 X Screenfridge

Capacity of the fridge: 335 l
Capacity of the freezer: 215 l
Total capacity: 567 l
Energetic level: A
Electricity consumption: 422 KWh/y
Noise pollution: 40 dB
Frozen capacity: 25 kg/ 24h
Autonomy: 20h
Type of cold: No frost/DME
Dimensions: High: 1800mm
Wide: 1190mm
Deep: 600mm
Price: 7235€

Specifications: Touch multifunctional screen: Which permits you surf on the net, watch the TV and know the food that you have of the fridge and its day of caducity. It also has self-closing doors and easy-open valve.

Electrolux ERL 6296 W

Capacity of the fridge: 357 l
Capacity of the freezer: 165 l
Total capacity: 522 l
Energetic level: A
Electricity consumption: 524 KWh/y
Noise pollution: 40 dB
Frozen capacity: 7,5 kg/ 24h
Autonomy: 4,7h
Type of cold: No frost
Dimensions: High: 1760mm
Wide: 905mm
Deep: 682mm

Price: 1695€

Specifications: Dispenser center with 4 functions: water, ice-cubes, crushed ice and extra ice. It also has a box with controlled temperature.

12.1.2 Electrolux Combi Fridges:

Electrolux ENA 3451X

Capacity of the fridge: 245 l
Capacity of the freezer: 78 l
Total capacity: 323 l
Energetic level: A
Electricity consumption: 357 KWh/y
Noise pollution: 42 dB
Frozen capacity: 10 kg/ 24h
Autonomy: 6 h
Type of cold: Multilevel NF
Dimensions: High: 1850mm
Wide: 595mm
Deep: 632mm

Price: 677€
Specifications: Electronic control DMT, display LCD, self-closing doors and low temperature box.

12.1.3 Electrolux Simple fridges:

Electrolux ERN3420

Capacity of the fridge: 332 l
Capacity of the freezer: 0 l
Total capacity: 332 l
Energetic level: A
Electricity consumption: 176 KWh/y
Noise pollution: 34 dB
Dimensions: High: 1762mm
Wide: 540mm
Deep: 547mm
Price: 625€
Specifications: Display LCD and electronic control.

Electrolux ERN 2372

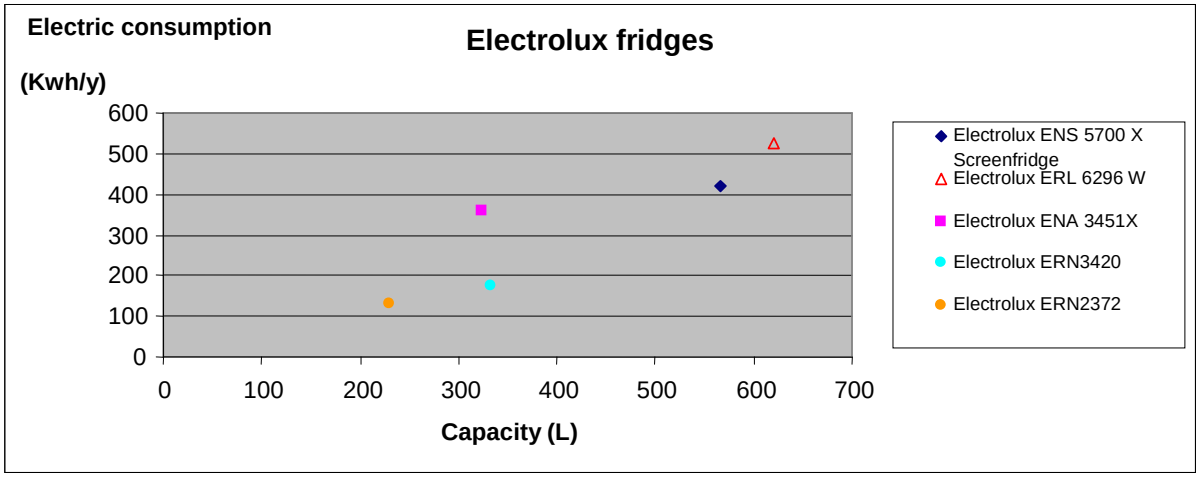
Capacity of the fridge: 230 l
Capacity of the freezer: 0 l
Total capacity: 230 l
Energetic level: A+
Electricity consumption: 131 KWh/y
Noise production: 36dB
Frozen capacity: 0 l
Dimensions: High: 1224mm
Wide: 540mm
Deep: 549mm
Price: 460€

Model	Type of fridges	Capacity (L)	Electric consumption (kph/y)
Electrolux ENS 5700 X Screenfridge	American fridges	567	422
Electrolux ERL 6296 W	American fridges	620	524
Electrolux ENA 3451X	Combi fridges	323	357
Electrolux ERN3420	Simple fridges	332	176
Electrolux ERN2372	Simple fridges	230	131

Model	Electric cost per year (€)	Electric cost per 10 years (Life of the fridge) (€)
Electrolux ENS 5700 X Screenfridge	92,6712	926,712
Electrolux ERL 6296 W	115,0704	1150,704
Electrolux ENA 3451X	78,3972	783,972
Electrolux ERN3420	38,6496	386,496
Electrolux ERN2372	28,7676	287,676

*Cost KWh (Stuttgart, Yellostrom) = 0,2196 €/KWh

Now we can see the comparative in the followed graphic:



In a quick look we can see the big difference between the simple fridge "Electrolux ERN2372" with the American fridges "Electrolux ENS 5700 X Screenfridge and ERL 6296 W". As we can see the simple fridge "ERN 2372" has the lowest consumption and the lowest capacity too. If we compare this simple fridge with the American fridges we see that the American fridges have almost the triple capacity and its consumption is four times highest. Comparing both American fridges, we see that "Electrolux ENS 5700 X Screenfridge" has 40l less of capacity than the "Electrolux ERL 6296 W", so the consumption of the first fridge is lower too. On the other hand, the first has more frozen capacity 25kg/24h in front of the 7,5kg/24h of the second; the same occurs with the autonomy, the first has 20h while the second one has a capacity of 4,7h. Comparing the specifications of the these fridges, the main difference is that the first has a Touch multifunctional screen that permit you surf on the net, watch the TV and know the food that you have of the fridge and its day of caducity. It also has self-closing doors and easy-open valve. Moreover, the second fridge has a dispenser center with 4 functions: water, ice-cubes, crushed ice and extra ice. It also has a box with controlled temperature. Comparing the prices about the both fridges the difference is that the first one is 5500€ more expensive than the other, this is due is the last model of the fridges with the best technology, so the costumer has to paid this price for being the first one to has this fridge, as an exclusive fridge. The price of the second is of 1695€ and the costumer can saved of buying water, so he will save more money then. Otherwise, it consumes a little bit more, so at the end of the fridge life cycle the costumer will pay 200€ extra for its electricity consumption in front of the first fridge.

In the middle of the graphic we see two fridges with almost the same capacity but with a big difference between their electric consumption. This is due to one is a simple fridge "ERN 3420", so it hasn't freezer and the other is a Combi fridge "ERN 3451 X" with freezer, as this fridge has freezer and it uses two engines, that explains this big hole between their energetic consumption. If we compare the prices between this simple fridge and the combi we have to said that for a difference of only 50€ the costumer can have a combi fridge, that maybe will be better for his comfort. But the costumer has to know that with the combi fridge, the

consumption will be higher and at the end of the fridge life-cycle he will pay 400€ more that if he had had a simple fridge. So the customer has to know very well his necessities.

Comparing the simple fridge “Electrolux ERN 3420” and the “Electrolux” the main difference is the capacity of the fridge, the first one has 100 litters more than the other. But on the other hand the second has a better energetic level A+ in front of the A energetic level of the first, this means that the second fridge consumes less electricity. So the customer has to know more or less how much capacity he needs.

Now is the costumer who has to know his necessities for choose the best type of fridge for him. And it’s interesting to know if for him it’s very important the comfort, the aspect, and the facilities that the fridge provides him. The costumer also can know how much he will pay at the end of the fridge life cycle so he can know which fridge will be economically better for his necessities and the cost of the use of the refrigerator during these years.

Electrolux Characteristics	N°engines	Freezer	Capacity (L)	Defrost system	Energetic level	Consumption (Kwh/year)	Dispenser	Tipe of screen	Price (€)
Model									
Electrolux ENS 5700 X Screenfridge	2	X	567	No frost/ DME	A	422	-	LCD screen, internet tv	7235
Electrolux ERL 6296 W	2	X	522	No frost	A	524	X	-	1695
Electrolux ENA 3451X	2	X	323	Multilevel NF	A	357	-	Display LCD	677
Electrolux ERN3420	1	-	332	-	A	176	-	Display LCD	625
Electrolux ERN 2372	1	-	230	-	A+	131	-	-	460

After see this graphic and as a conclusion we can do a comfort classification in our point of view for the customers:

1. Electrolux ERL 6296 W, we have choose this fridge in first position due to it is the fridge with more advantages for customers, it has center dispenser, so the customers don't need to buy water anymore, they only have to go to the fridge, the same with the ice-cubes.
2. Electrolux ENS 5700 X Screenfridge, it has the highest technology and the main advantage is that has a LCD screen touch control, where the customer can watch the TV, surfing the net, introduce the date of caducity of the food. But for all this reasons the customer has to paid a lot of money, this means that the costumer has the last fridge and it's an exclusive symbol.
3. Electrolux ENA 3451 X, the advantages for the comfort of the costumer are that it has an electronic control DMT, display LCD, and a self-closing doors and low temperature box that helps a little bit to avoid losing electricity.
4. Electrolux ERN 3420, it has a display LCD and electronic control.
5. Electrolux ERN 2372 hasn't any advantage for the comfort of the costumer.

12.2 Bosch – Siemens fridges:

We compare these two brands together because nowadays they are very similar, so we will can know the difference and similitude's about this brands.

12.2.1 Bosch – Siemens American fridges:

Bosch KAD 62S50

Capacity of the fridge: 355 l
Capacity of the freezer: 178 l
Total capacity: 533 l
Energetic level: A+
Electricity consumption: 467,2 KWh/y
Noise pollution: 44 dB
Frozen capacity: 12 kg/ 24h
Autonomy: 16h
Type of cold: No frost
Dimensions: High: 1756mm
Wide: 910mm
Deep: 761mm
Price: 2199€
Specifications: LCD screen touch control, dispenser of water and ice-cubes and antibacterial treatment. It also has Freshprotectbox.

SIEMENS KA62DP90

Capacity of the fridge: 355 l
Capacity of the freezer: 178 l
Total capacity: 533 l
Energetic level: A+
Electricity consumption: 467,2 KWh/y
Noise capacity: 44 dB
Frozen capacity: 12 kg/ 24h
Autonomy: 16h
Type of cold: No frost
Dimensions: High: 1760mm
Wide: 910mm
Deep: 761mm
Price: 2099€
Specifications: complete stainless construction, screen touch control, dispenser of water and ice-cubes.

12.2.2 Bosch – Siemens Combi fridges:

BOSCH KGN 36S58

Capacity of the fridge: 221 l
Capacity of the freezer: 66 l
Total capacity: 287 l
Energetic level: A+
Electricity consumption: 280 KWh/y
Frozen capacity: 8 kg/ 24h
Autonomy: 17h
Type of cold: No frost
Dimensions: High: 1870mm
Wide: 640mm
Deep: 600mm
Price: 852€

Specifications: LCD screen touch control, electronic control and special functions: eco, holidays and bottle timer. Humidity regulation box.

SIEMENS KG39FP71

Capacity of the fridge: 149 l
Capacity of the freezer: 68 l
Total capacity: 309 l
Energetic level: A+
Electricity consumption: 319 KWh/y
Frozen capacity: 14 kg/ 24h
Autonomy: 24h
Type of cold: No frost
Dimensions: High: 2000mm
Wide: 600mm
Deep: 600mm
Price: 980€
Specifications: LCD screen touch control and special functions: memory, eco, holidays and bottle timer. It also has electronic control.

12.2.3 Bosch – Siemens Simple fridges:

Siemens KI38LA40IE

Capacity of the fridge: 244 l
Capacity of the freezer: 36 l
Total capacity: 280 l
Energetic level: A
Electricity consumption: 303 KWh/y
Frozen capacity: 3 Kg/24hl
Autonomy: 18 h
Dimensions: High: 1771,5mm
Wide: 538mm
Deep: 533mm
Price: 855€

Specifications: Antibacterial system, environmental friendly refrigerant (100% CFC & HCF free)

Bosch KDV33X15

Capacity of the fridge: 235 l
Capacity of the freezer: 66 l
Total capacity: 301 l
Energetic level: A++
Electricity consumption: 196 KWh/y
Frozen capacity: 3 Kg/24hl
Autonomy: 26 h
Dimensions: High: 1700mm
Wide: 600mm
Deep: 600mm
Price: 637€
Specifications: Antibacterial system.

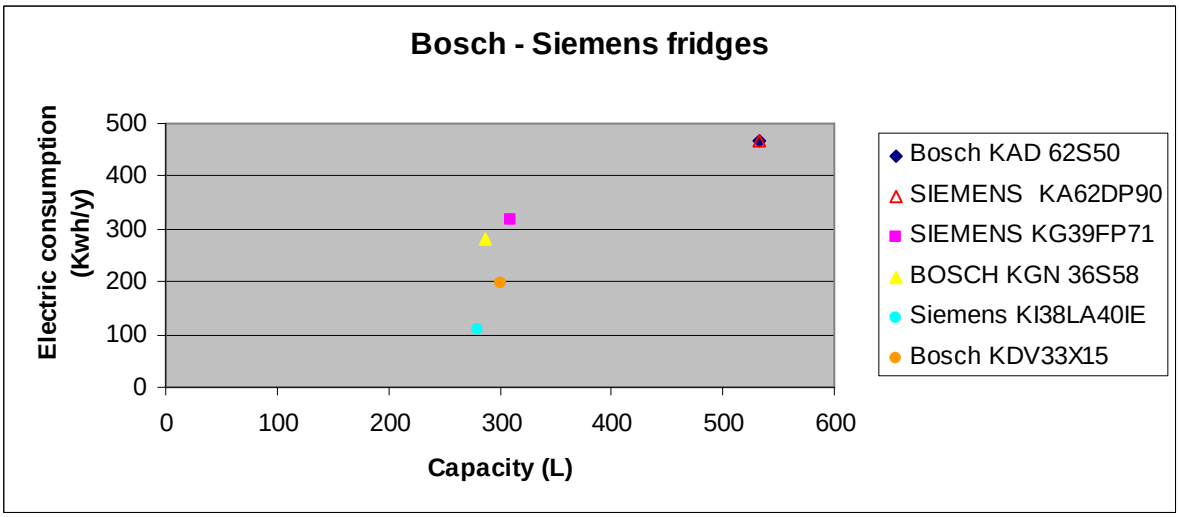
Model	Type of fridges	Capacity (L)	Electric consumption (Kwh/y)
Bosch KAD 62S50	American fridges	533	467,2

SIEMENS KA62DP90	American fridges	533	467,2
SIEMENS KG39FP71	Combi fridges	309	319
BOSCH KGN 36S58	Combi fridges	287	280
Siemens KI38LA40IE	Simple fridges	280	108,21
Bosch KDV33X15	Simple fridges	301	196

Model	Electric cost per year (€)	Electric cost per 10 years (Life of the fridge) (€)
Bosch KAD 62S50	102,6	1026,0
SIEMENS KA62DP90	102,6	1026,0
SIEMENS KG39FP71	70,1	700,5
BOSCH KGN 36S58	61,5	614,9
Siemens KI38LA40IE	23,8	237,6
Bosch KDV33X15	43,0	430,4

*Cost KWh (Stuttgart, Yellostrom) = 0,2196 €/KWh

In the followed graphic we can see the comparative about the Bosch – Siemens fridges:



In the first place we can see as one of the best the Simple fridge "Siemens KI38LA40IE" although it has the worst capacity, only 280 l and it has the lowest electric consumption. And if we compare the Siemens simple fridge with the other simple fridge "Bosch KDV33X15" we have to said that it has almost the double electric consumption and the difference about their capacity is only 21 l. Moreover if we compare the price of both fridges, we don't have any doubt that the Bosch is much better than the Siemens, because apart from all the advantages that we said is 200€ cheaper and in ten years the costumer will save 200€ for its electricity consumption.

In the middle there are the Combi fridges, although having almost the same capacity than the Simple fridges, they have a highest electric consumption due to they use two engines and its frozen capacity is highest too. Comparing both Combi Fridges we have to said that “Bosch KGN 36S58” has 22 l of capacity less than the “Siemens KG39FP71” and a lowest frozen capacity that’s the reason why its electric consumption is lower than the Siemens fridge. Both fridges have LCD screen touch control, electronic control and special functions: eco, holidays and bottle timer. The only difference is that the Bosch fridge has a humidity regulation box. Comparing the price, we see that the Bosch is 100€ cheaper than the Siemens, due to its less capacity, less frozen capacity and less autonomy. On the other hand the Bosch has a humidity regulation box, so the costumer has to decide if he will want to paid 100€ more for these advantages or not.

At the end, we have to say; that the big difference we can see in the graphic is with the American fridges “Bosch KAD 62S50” and “Siemens about the rest of the fridges. The have a bigger capacity, nearly 250 l more than the other fridges and its electric consumptions its around 467 kwh/y. Apart from that, the American fridges have a highest frozen capacity, autonomy and some advantages for the comfort of the costumer as LCD screen touch control, dispenser of water and ice-cubes and antibacterial treatment. The difference between these American fridges is that the Bosch also has Freshprotectbox and the price, the Siemens is a little bit cheaper than the Bosch. If we compare the prices we have to mention that the Siemens is 100€ cheaper than the Bosch fridge, the reasons are that the Bosch model has some more specifications and that the costumer paid a little bit more for considerer its popular reconnaissance that they have won in the last years.

BOSCH SIEMENS Characteristics	N°engines	Freezer	Capacity (L)	Defrost system	Energetic level	Consumption (Kwh/year)	Dispenser	Tipe of screen	Price (€)
Bosch KAD 62S50	2	X	533	No frost	A+	467,2	X	LCD Display	2199
SIEMENS KA62DP90	2	X	533	No frost	A+	467,2	X	LCD Display	2099
BOSCH KGN 36S58	2	X	287	No frost	A+	280	-	LCD Display	852
SIEMENS KG39FP71	2	X	309	No frost	A+	319	-	LCD Display	980
Siemens KI38LA40IE	1	X	280	-	A	303	-	-	855
Bosch KDV33X15	1	X	301	-	A++	196	-	-	637

After the graphic we can know the comfort list of the fridges:

1. Bosch KAD62S50 is the most comfortable fridge because it has LCD screen touch control, dispenser of water and ice-cubes and antibacterial treatment, it also has fresh protect box.
2. Siemens KA62DP90 has a screen touch control, dispenser of water and ice-cubes and it has a complete stainless construction.
3. Siemens KGN 36S58 has a LCD screen touch control and special functions: memory, eco, holidays and bottle timer and it also has an electronic control.
4. Bosch KGN 36S58 has a LCD screen touch control, electronic control and special functions: eco, holidays and bottle timer. It also has a humidity regulation box.
5. Bosch KDV33X15 because only has the comfort for the costumer that has more capacity with less consumption than the 6th fridge.
6. Siemens KI38LA40IE hasn't any comfort for the costumer and has less capacity and more consumption than the 5th fridge.

12.3 Liebherr fridges:

12.3.1 Liebherr American fridge:

LIEBHERR SBSes 7273 PremiumPlus

Capacity of the fridge: 224 l
Capacity of the freezer: 237 l
Capacity of biofresh: 111 l
Total capacity: 672 l
Energetic level: A+
Electricity consumption: 460,6 KWh/y
Noise capacity: -
Frozen capacity: 18 kg/ 24h
Autonomy: 43h
Type of cold: No frost
Dimensions: High: 1852mm
Wide: 1210mm
Deep: 630mm
Price: 3802€

Specifications: ice-center: dispenser of water and ice-cubes. It also has a DrySafe and HidroSafe regulation. This fridge is provided with Homedialog-System.

LIEBHERR SBSes 7212 Comfort NoFrost

Capacity of the fridge: 390 l
Capacity of the freezer: 261 l
Total capacity: 651 l
Energetic level: A+
Electricity consumption: 461,9 KWh/y
Noise capacity: -dB
Frozen capacity: 20 kg/ 24h
Autonomy: 43h
Type of cold: No frost
Dimensions: High: 1852mm
Wide: 1210mm
Deep: 630mm
Price: 1465€

Specifications: FrostSafe-System, They are a boxes closed for all its sides.

12.3.2 Liebherr Combi fridge:

LIEBHERR CNP 4056 Premium

Capacity of the fridge: 275 l
Capacity of the freezer: 89 l
Total capacity: 364 l
Energetic level: A++
Electricity consumption: 231 KWh/y
Noise pollution: <60 dB
Frozen capacity: 14 kg/ 24h
Autonomy: 30 h
Type of cold: No frost
Dimensions: High: 2011mm
Wide: 600mm
Deep: 630mm
Price: 1134€
Specifications: LCD digital touch-screen, removable compartment Serve-Friendly.

LIEBHERR CTNP 4753 Premium

Capacity of the fridge: 329 l
Capacity of the freezer: 84 l
Total capacity: 413 l
Energetic level: A+
Electricity consumption: 339,5 KWh/y
Noise pollution: <60 dB
Frozen capacity: 11 kg/ 24h
Autonomy: 24h
Type of cold: No frost (freezer)
Dimensions: High: 1860mm
Wide: 750mm
Deep: 630mm
Price: 1563€

Specifications: Acoustic signal alarm advice of opened door on the fridge and freezer. Acoustic and light signal advice when something wrong has happened.

12.3.3 Liebherr Simple fridges:

LIEBHERR K 4220 Comfort

Capacity of the fridge: 390 l
Capacity of the freezer: 0 l
Total capacity: 390 l
Energetic level: A+
Electricity consumption: 148 KWh/y
Noise pollution: <60 dB
Frozen capacity: -
Type of cold: SuperCool
Dimensions: High: 1852mm
Wide: 600mm
Deep: 630mm
Price: 666€

LIEBHERR KBes 3660 Premium BioFresh

Capacity of the fridge: 311 l
Capacity of the freezer: 0 l
Total capacity: 311 l
Energetic level: A+
Electricity consumption: 163 KWh/y
Noise pollution: <60 dB
Autonomy: -
Type of cold: BioFresh
Dimensions: High: 1655mm
Wide: 600mm
Deep: 630mm
Price: 1262€

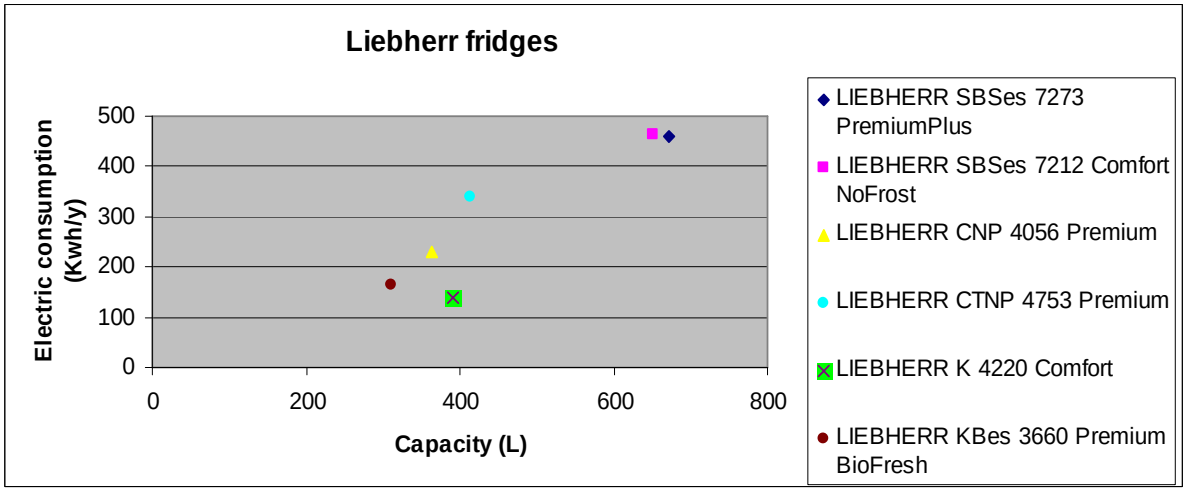
Specifications: Three boxes Biofresh, one DrySafe and two HydroSafe.

Model	Type of fridges	Capacity (L)	Electric consumption (Kwh/y)
LIEBHERR SBSes 7273 PremiumPlus	American fridges	672	460,6
LIEBHERR SBSes 7212 Comfort NoFrost	American fridges	651	461,9
LIEBHERR CNP 4056 Premium	Combi fridges	364	231
LIEBHERR CTNP 4753 Premium	Combi fridges	413	339,5
LIEBHERR K 4220 Comfort	Simple fridges	390	138
LIEBHERR KBes 3660 Premium BioFresh	Simple fridges	311	163

Model	Electric cost per year (€)	Electric cost per 10 years (Life of the fridge) (€)
LIEBHERR SBSes 7273 PremiumPlus	101,1	1011,5
LIEBHERR SBSes 7212 Comfort NoFrost	101,4	1014,3
LIEBHERR CNP 4056 Premium	50,7	507,3
LIEBHERR CTNP 4753 Premium	74,6	745,5
LIEBHERR K 4220 Comfort	30,3	303,0
LIEBHERR KBes 3660 Premium BioFresh	35,8	357,9

*Cost KWh (Stuttgart, Yellostrom) = 0,2196 €/KWh

Now we can see the comparative of the Liebherr fridges in the followed graphic:



In this graphic we can see that the Simple fridge "Liebherr K 4220 Comfort" is a very good fridge, because with a capacity of almost 400l has only a electric consumption of 138 kwh/y. This is due to this fridge hasn't a freezer part, it is its main disadvantage. If we compare this fridge with the other simple fridge "Liebherr KBes 3660 Premium BioFresh" we see that the last fridge with the lowest capacity has the highest electric consumption. This is caused by its

type of cold, called BioFresh. Both fridges have A+ energetic level that's the reason why they have low electricity consumption. Comparing the prices we have to say that there is a big difference between these fridge, the second one cost the double than the first one, the reasons can be explained by the different type of cold, because the second has biofresh boxes, Drysafe and Hydrosafe. So we think that for a costumer the first one is a very good fridge if he doesn't need a lot of comfort features.

Comparing the combi fridges, the "Liebherr CNP 4056 Premium" is better than "Liebherr CTNP 4753 Premium". Because with a difference of capacity of only 50l the first fridge consumes less electric consumption 231 kwh/y in front of the 339,5 kwh/y of the other. The explanation of this difference is that the first one has A++ energetic rank and the other is A+. So, within ten years, with the first fridge we will save more energetic consumption and more money too, about 240€ in ten years. Another advantage of the first one is that has more autonomy and frozen capacity. As we can see it will be better to buy the A++ fridge than the other. Moreover if we compare the price of both fridge we have to said that the first one is 400€ cheaper than the second one, the reason why it occurs is that the second fridge, has more capacity, its specifications as the acoustic signal alarm advice of opened door on the fridge and freezer, acoustic and light signal advice when something wrong has happened and its better aesthetic aspect. So we are pretty sure that we will recommend to the costumer to buy the first one for all its advantages.

With a capacity around 650l we have the American fridges, they are very similar. Both fridges have A+ energetic level, an electric consumption of 460 kwh/y and autonomy of 40h. The main difference is that "Liebherr SBSes 7273 Premium Plus" has some BioFresh boxes and an ice center dispenser. On the other hand the "Liebherr SBses 7212 Comfort No frost" has a little bit more frozen capacity. Comparing the prices we can observe that the first one costs the double than the second one for some reasons: it has 20l more of capacity and its specifications like the center dispenser, the homedialog-system, the drysafe and hydrosafe regulation. But we have to bare in mind that with the center dispenser the costumer doesn't have to buy water anymore, so he has to calculate this comfort and how much money he will save without buying water.

LIEBHERR Characteristics	N°engines	Freezer	Capacity (L)	Defrost system	Energetic level	Consumption (Kwh/year)	Dispenser	Tipe of screen	Price (€)
Model									
LIEBHERR SBSes 7273 PremiumPlus	2	X	672	No frost	A+	461	X	Display LCD	3802
LIEBHERR SBSes 7212 Comfort NoFrost	2	X	651	No frost/Frost save system	A+	462	-	-	1465
LIEBHERR CNP 4056 Premium	2	X	364	No frost	A++	231	-	Display LCD	1134
LIEBHERR CTNP 4753 Premium	2	X	413	No frost	A+	340	-	-	1563
LIEBHERR K4220 Comfort	1	-	390	Supercool	A+	148	-	-	666
LIEBHERR KBes 3660 Premium BioFresh	1	-	311	Biofresh	A+	163	-	-	1262

Here we can see the followed list, classified according to the comfort for the costumer:

1. Liebherr SBSes 7273 PremiumPlus is the most comfortable due to it has ice-center: dispenser of water and ice-cubes, a DrySafe and HidroSafe regulation and is provided with Homedialog-System.
2. Liebherr SBSes 7212 Comfort No-Fros because has more capacity than the next of the fridge, and also it has FrostSafe-System.
3. Liebherr CTNP 4753 Premium due to its capacity and also has acoustic signal alarm advice of opened door on the fridge and freezer. Acoustic and light signal advice when something wrong has happened.
4. Liebherr CNP 4056 Premium because has fridge and freezer, and also it has LCD digital touch-screen, removable compartment Serve-Friendly.
5. Liebherr K 4220 Comfort it hasn't so good specifications than the last fridge but on the other hand it has more capacity and this has more value.
6. Liebherr KBes 3660 Premium BioFresh it has three boxes Biofresh, one DrySafe and two HydroSafe but has the less capacity.

12.4 LG fridges:

12.4.1 LG American fridges:

LG GRP2376EXR

Capacity of the fridge: 378 l
Capacity of the freezer: 228 l
Total capacity: 606 l
Energetic level: A
Electricity consumption: 508 KWh/y
Frozen capacity: -
Autonomy: -
Type of cold: No frost
Dimensions: High: 1753 mm
Wide: 894mm
Deep: 753mm
Price: 1755€
Specifications: LCD screen, water and ice centre dispenser, Minibar box in the fridge door, Magic Crisper case that controls the humidity.

LG GRB2371EWR

Capacity of the fridge: 378 l
Capacity of the freezer: 246 l
Total capacity: 624 l
Energetic level: A
Electricity consumption: 561 KWh/y
Frozen capacity: 12kg/ 24h
Autonomy: -
Type of cold: No frost
Dimensions: High: 1753 mm
Wide: 894mm
Deep: 753mm
Price: 987€
Specifications: LCD touch screen, Magic Crisper case that controls the humidity.

12.4.2 LG Combi Fridges:

LG GR-4696LCPN

Capacity of the fridge: 252 l
Capacity of the freezer: 88 l
Total capacity: 340 l
Energetic level: A++
Electricity consumption: 224 KWh/y
Frozen capacity: 12 kg/ 24h
Autonomy: 11,3h
Type of cold: No frost
Dimensions: High: 2000 mm
Wide: 595mm
Deep: 674mm
Price: 936,57€
Specifications: LCD screen, Multi Air Flow and Bioshield.

LG GR4197EXD

Capacity of the fridge: 211 l
Capacity of the freezer: 104 l
Total capacity: 315 l
Energetic level: A+
Electricity consumption: 294 KWh/y
Frozen capacity: 6 kg/ 24h
Autonomy: -
Type of cold: No frost
Dimensions: High: 1896 mm
Wide: 595mm
Deep: 651mm
Price: 605€

Specifications: Digital touch screen, Multi Air Flow that keeps the cool more time, Bioshield system that inhibits the growth of bacteria by the door seal, Magic Crisper case that controls the humidity and 0ºZone Fresh for keep the meat and fish.

12.4.2 LG Simple fridges:

LG GR-181SA

Capacity of the fridge: 162 l
Capacity of the freezer: 18 l
Total capacity: 180 l
Energetic level: A
Electricity consumption: 165 KWh/y
Frozen capacity: -
Autonomy: -
Type of cold: -
Dimensions: High: 600 mm
Wide: 550mm
Deep: 850mm
Price: 225€
Specifications: Bioshield system that inhibits the growth of bacteria by the door seal.

LG GC-051SNB

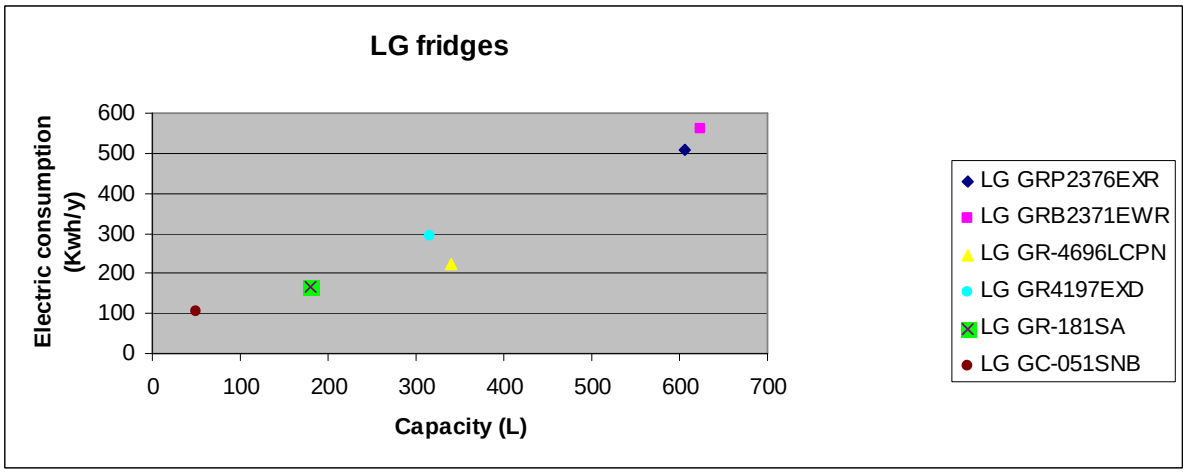
Capacity of the fridge: 50 l
Capacity of the freezer: 0 l
Total capacity: 50 l
Energetic level: A+
Electricity consumption: 106 KWh/y
Frozen capacity: -
Autonomy: -
Type of cold: -
Dimensions: High: 501 mm
Wide: 443mm
Deep: 450mm
Price: 175€
Specifications: Manual temperature control inside.

Model	Type of fridges	Capacity (L)	Electric consumption (Kwh/y)
LG GRP2376EXR	American fridges	606	606
LG GRB2371EWR	American fridges	624	624
LG GR-4696LCPN	Combi fridges	340	340
LG GR4197EXD	Combi fridges	315	315
LG GR-181SA	Simple fridges	180	180
LG GC-051SNB	Simple fridges	50	50

Model	Electric cost per year (€)	Electric cost per 10 years (Life of the fridge) (€)
LG GRP2376EXR	133,1	1330,8
LG GRB2371EWR	137,0	1370,3
LG GR-4696LCPN	74,7	746,6
LG GR4197EXD	69,2	691,7
LG GR-181SA	39,5	395,3
LG GC-051SNB	11,0	109,8

*Cost KWh (Stuttgart, Yellostrom) = 0,2196 €/KWh

In the followed graphic you can see the comparative about LG fridges:



First of all we can see a big difference about the capacity and energetic consumption caused by the different type of fridges. The fridges with less capacity are the simple fridges, LG GC-051SNB and LG GR-181SA. The first one is like a very little minibar fridge, this can explain that although it has A+ energetic level if we compare it with the second one, we have to said that the last one is better due to with 100l more of capacity its consumes only is increased

60kwh/y more. Moreover, it is just a little bit bigger, it has a freezer of 18l and the difference of the price between them is only 50€. So as a conclusion, we noticed that if you want a small fridge with freezer the second is better in all its features than the first.

In the middle of the graphic there are the Combi Fridges. With a quick look, we can see as the LG GR4197EXD has less capacity and more electric consumption than the LG GR-4696 LCPN. This is due to the LG GR4197EXD has only A+ energetic level in front of the A++ energetic level of the second. The first has less frozen capacity, but it has better features and is 300€ cheaper. But we have to mention that considering the fridge life cycling of ten years the second one will be more profitable.

The fridges with the highest capacity are the American fridges situated in the right position of the graphic. Both fridges have almost the same capacity around 600l, the same electric consumption around 500kwh/y and the same energetic level. The main difference is that the first fridge has ice and water dispenser, and a “minibar” box on the fridge door. That characteristics could be more comfortable for the customer and that’s the reason why it is more expensive, the difference in price with the second fridge is 800 €. The customer will have to choose if he wants to pay this money for these comfortable features.

LG Characteristics	N°engines	Freezer	Capacity (L)	Defrost system	Energetic level	Consumption (Kwh/year)	Dispenser	Tipe of screen	Price (€)
Model									
LG GRP2376EXR	2	X	606	No frost	A	508	X	Display LCD	1755
LG GRB2371EWR	2	X	624	No frost	A	561	-	Display LCD	987
LG GR-4696LCPN	2	X	340	No frost	A++	224	-	Display LCD	936
LG GR4197EXD	2	X	315	No frost	A+	294	-	Display LCD	605
LG GR-181SA	1	X	180	-	A	165	-	-	225
LG GC-051SNB	1	-	50	-	A+	106	-	-	175

1. LG GRP2376EXR due to its capacity and it has LCD screen, water and ice centre dispenser, Minibar box in the fridge door, Magic Crisper case that controls the humidity.
2. LG GRB2371EWR has more cacpity than the first but it hasn't ice center dispenser. Also it has LCD touch screen, Magic Crisper case that controls the humidity.
3. LG GR-4696LCPN because its capacity and it has LCD screen, Multi Air Flow and Bioshield.
4. LG GR4197EXD has less capacity but has another avantatges as Digital touch screen, Multi Air Flow, Bioshield system, Magic Crisper and 0ºZone Fresh for keep the meat and fish.
5. LG GR-181SA because has more capacity than the last and also it has Bioshield system.
6. LG GC-051SNB has Manual temperature control inside.

12.5 Edesa fridges:

12.5.1 American fridges:

We have to said that this brand doesn't produce American fridges as we know, but it gives the possibility to make an American fridge with the side by side system. It consists in a "cooler" that is only a fridge without freezer with freezer.

12.5.2 Combi fridges:

Edesa POP F-67

Capacity of the fridge: 279 l
Capacity of the freezer: 69 l
Total capacity: 348 l
Energetic level: A
Electricity consumption: 385 KWh/y
Loud production: 42 dB
Frozen capacity: 5kg/ 24h
Autonomy: 10h
Type of cold: No frost
Dimensions: High: 2010mm
Wide: 600mm
Deep: 610mm
Price: 609€

Specifications: Acoustic signal alarm advice of opened door on the fridge, homogeny cold around the entire fridge

Edesa Roman F63

Capacity of the fridge: 242 l
Capacity of the freezer: 69 l
Total capacity: 311 l
Energetic level: A
Electricity consumption: 365 KWh/y
Loud production: 42 dB
Frozen capacity: 5kg/ 24h
Autonomy: 10h
Type of cold: No frost
Dimensions: High: 2000mm
Wide: 600mm
Deep: 610mm
Type of cold: No frost
Price: 450€

Specifications: Acoustic signal alarm advice of opened door on the fridge, homogeny cold around the entire fridge.

12.5.3 Edesa Simple fridges:

Edesa SPORT-F13

Capacity of the fridge: 374 l
Capacity of the freezer: 0 l
Total capacity: 374 l
Energetic level: A
Electricity consumption: 147 KWh/y
Loud production: 37 dB
Frozen capacity: 0 l
Autonomy: 0 h
Dimensions: High: 1810mm
Wide: 595mm
Deep: 610mm
Price: 485€

Specifications: homogeny cold around the entire fridge. And it's constructed by sheet iron painted.

Edesa Metal-F14

Capacity of the fridge: 374 l
Capacity of the freezer: 0 l
Total capacity: 374 l
Energetic level: A
Electricity consumption: 147 KWh/y
Loud production: 37 dB
Frozen capacity: 0 l
Autonomy: 0 h
Dimensions: High: 1810mm
Wide: 595mm
Deep: 610mm
Price: 679€

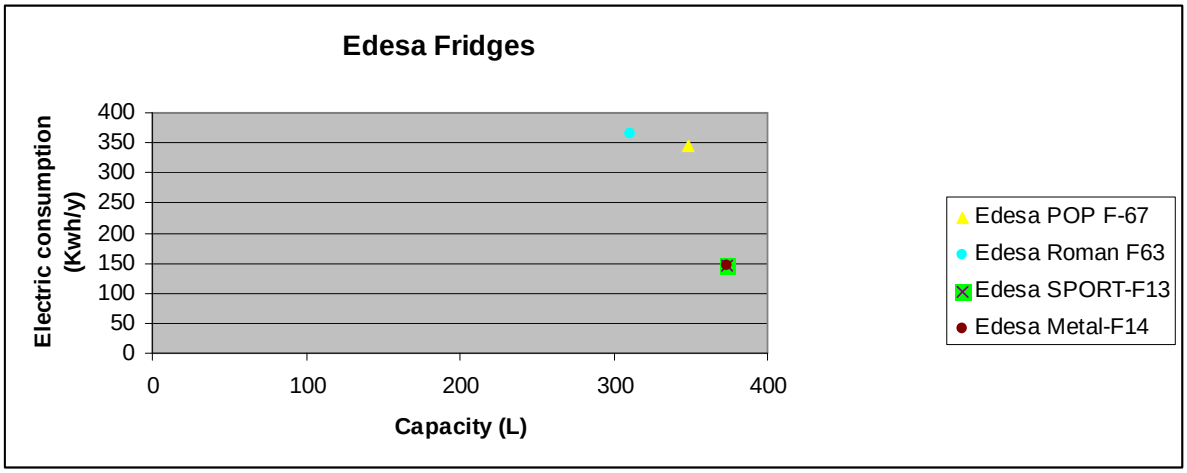
Specifications: It is constructed by inox sheet. Also it has a layer of non-marking protection.

Model	Type of fridges	Capacity (L)	Electric consumption (Kwh/y)
Edesa POP F-67	Combi fridges	348	345
Edesa Roman F63	Combi fridges	311	365
Edesa SPORT-F13	Simple fridges	374	147
Edesa Metal-F14	Simple fridges	374	147

Model	Electric cost per year (€)	Electric cost per 10 years (Life of the fridge) (€)
Edesa POP F-67	75,8	757,6
Edesa Roman F63	80,2	801,5
Edesa SPORT-F13	32,3	322,8
Edesa Metal-F14	32,3	322,8

*Cost KWh (Stuttgart, Yellostrom) = 0,2196 €/KWh

In the followed graphic we can see the comparative about Edesa fridges:



In this graphic the main difference that we can considerer is the difference between the Simple fridges on the right position of the graphic with the combi fridges.

Comparing the combi fridges “Edesa POP F-67” and “Edesa Roman F63” we have to say that both fridges are very similar. They have the same freezer capacity 69l, the same frozen capacity 5kg/24h, the same autonomy 10h and they use No-frost type of cold. The main difference consists only in the difference of the capacity of the fridge, the first one have 37l more of fridge capacity, it consumes 20kwh/y more than the other fridge. Also both fridges have the same specifications: acoustic signal alarm advice of opened door on the fridge, homogeny cold around the entire fridge. If we look their prices the first one is 150€ more expensive than the second due to its more fridge capacity.

If we compare the simple fridges with the combi fridges with a quick view, we can see that the simple fridges have more fridge capacity and its electric consumption is less than the half about the electric consumption of the combi fridges. This is due to the combi fridges have two engines, one for the fridge and one for the freezes, this can explain why they have more electric consumption. The simple fridges of Edesa, “Edesa SPORT-F13” and “Edesa Metal-F14” are almost equals. Their fridges capacities are 374 l, their energetic level are A, their electricity’s consumptions are 147kwh/y and they have the same dimensions. The difference

between both fridges consists in the materials construction. The second one constructed by inox sheet and also it has a layer of non-marking protection. On the other hand the first one is constructed by iron sheet. Comparing the prices we have to said that the first fridge is 200€ cheaper than the second, the reason that explains this is its specifications.

At the end we have to mention that for only 69l of freezer the difference with the electric consumptions is very high, so for the costumer if he doesn't need a freezer should be better to choose one of the simple fridges. Comparing the prices between the Simple fridges and the Combi fridges we notice that are very similar, but considering ten years as the fridge life cycle with a Simple fridge one; the costumer will save between 400-500€. So the costumer has to know very well if he needs a fridge with freezer or not.

edesa Characteristics		N°engines	Freezer	Capacity (L)	Defrost system	Energetic level	Consumption (Kwh/year)	Dispenser	Tipe of screen	Price (€)
Model										
Edesa POP F-67		2	X	348	No frost	A	385	-	-	609
Edesa Roman F63		2	X	311	No frost	A	450	-	-	450
Edesa SPORT-F13		1	-	374	kind of No frost	A	147	-	-	485
Edesa Metal-F14		1	-	374	-	A	147	-	-	679

Now you can see a refrigerator classification according to its comfort:

1. Edesa POP F-67 because it has fridges and freezer and it has more capacity than the other fridge with freezer, it also has acoustic signal alarm advice of opened door on the fridge, homogeny cold around the entire fridge.
2. Edesa Roman F63 due to it has fridge and freezer too, but it has less capacity than the first. Also it has the same specifications than the first one like acoustic signal alarm that tells you when the door is open and homogeny cold around the entire fridge.
3. Edesa Sport F-13, we have to say that the third and the fourth fridges are very similar, according to its price and our point of view due to this fridge has homogeny cold around the entire fridge and it's constructed by sheet iron painted, we have decided to put it in third place.
4. Edesa Metal F-14, the only difference with the third one is that it's constructed by inox sheet and has a layer of non-marking protection.

12.6 Final Analysis

Characteristics	N°engines	Freezer	Capacity (L)	Defrost system	Energetic level	Consumption (Kwh/year)	Dispenser	LCD screen	Price (€)
Model									
LIEBHERR SBSes 7273 PremiumPlus	2	X	672	No frost	A+	461	X	Display LCD	3802
Electrolux ERL 6296 W	2	X	522	No frost	A	524	X	-	1695
Bosch KAD 62S50	2	X	533	No frost	A+	467,2	X	LCD Display	2199
LG GRP2376EXR	2	X	606	No frost	A	508	X	Display LCD	1755
Edesa POP F-67	2	X	348	No frost	A	385	-	-	609

No we can see the final analysis with the best refrigerator of each brand. Let's go to see the final classifications and say which should be the best fridge:

1. Liebherr SBSes 7273 PremiumPlus, this is the best fridge due to two main reasons. First of all we have to say that is the fridge with the highest capacity and on the other hand it has the second lower consumption. So, that means that is the best fridge, because we can put more food inside with a less electricity consumption. The reasons that can explain this is its A+ energetic rank. Also we have to say that this fridge has an ice-center dispenser of water and ice-cubes, DrySafe and HidroSafe regulation and is provided with Homedialog-System.

2. LG GRP 2376 EXR, this American fridge is in second place because has the second higher capacity and the third lower consumptions. It's very similar to the third fridge because it also has a center dispenser of water and ice, but if we compare their prices the third is 400€ more

expensive, and in ten years with this fridge we only pay 300€ more for its electricity consumption and it has more capacity so that's the reason why it's in second place.

3. Bosch KAD 62S50 is in the third place; due to it has the third higher capacity and the third lower consumption. It has a LCD screen touch control, dispenser of water and ice-cubes and antibacterial treatment. It also has Freshprotectbox.

4. Electrolux ERL 6296W is in this position because has the second worst capacity and the worst consumption of the comparative. It also has dispenser center with 4 functions: water, ice-cubes, crushed ice and extra ice. It also has a box with controlled temperature.

5. Edesa POP F-67 is in the last position due to it has the worst capacity, on the other hand has the lowest consumption. The main difference with the others is that this is a combi fridge and the others are American fridges. Also we have to mention that this is the fridge with the worst comfort for the customer, that's the reason why it is in the last position too. We have to declare a good thing about it, its price is very competitive.

13. Which is the impact of an ice dispenser?

13.1 Flake Icemakers:

Flake icemakers use the same system as cube icemakers, but they have an additional component: the ice crusher.
Like the normal icemaker, this machine uses a set of heat-exchanging coils and a stream of water to build up a layer of ice. But in this system, the coils are positioned inside a large metal cylinder. Water passes through the cylinder, as well as around its outer edges. The passing water gradually builds up a large column of ice surrounding the cylinder from the inside and outside.

As with a cube icemaker, a solenoid valve releases hot gas into the cooling pipes after a set length of time. This loosens the ice column so it falls into the ice crusher below. The ice crusher breaks the ice cylinder into small pieces, which pass on to a collection bin.

The size of the ice bits depends on the crusher mechanism. Some crushers grind the ice into fine flakes, while other crushers produce larger, irregularly shaped ice chunks.

There are many variations on these designs, but the basic idea in all of them is the same. A refrigeration system builds up a layer of ice, and a harvesting system ejects the ice into a collection bin. At the most basic level, this is all there is to any icemaker.

13.2 Water and ice-cubes dispenser:

Refrigerators have certainly increased in cost over the last few years and when we take into consideration all the electronic and convenience features, it's no wonder. The thing is, are you paying more for your refrigerator investment than you really need to? Will you use all these additional features and are they worth the cost?

Features like through-the-door ice and water dispensers considerably increase the cost of this major kitchen appliance. There are things to consider when choosing a model with this feature to ensure that the convenience will overpass the additional cost and compensate this particular design feature.

15. Picture of a Center-dispenser

Here are a few points to bare in mind:

-A refrigerator with water or ice dispensing requires plumbing installation. It supposed and added cost and a complication. You will have to look for someone who know where the dispenser can be plumbed into a water line and know as well how install it.

-An ice dispenser reduces the freezer capacity of the refrigerator. That could be a problem specially if you live in a hot climate, sometimes you should have another individual freezer.

-An ice dispenser reduces even further, the amount of freezer space in a side by side model (American fridge) or refrigeration compartment in a french-door refrigerator (Combi fridge), because you lose the door shelf storage space. If this is not a concern, water dispensing can be very convenient and can even encourage your family to drink more water.

- Another important point is the quality of the water. It may need to also be considered. You should to consider that water dispensing refrigerators have added filtration features. Otherwise, if you tend to use bottled water due to the taste or quality of your local water, you may not appreciate the benefits of on-board refrigerator water dispensing.

-If your local water supply comes from a lake or well source, filtration may be required not only for water quality but to prevent ground sediment accumulation which can cause problems in your dispensing unit.

- Most refrigerator water dispensing models do not allow sufficient room height to accommodate single-sized water bottle filling. Usually they are designed for a quick glass of water.

-These features will increase slightly the energy use of your refrigerator, but since there is no need to open the refrigerator door to drink cold water, you can actually save on energy costs in the long run.

-If you pay for water by liters, a water dispenser will eliminate running the faucet for several seconds to draw cold water, reducing the amount of water you use in your home.

Once you've considered all the benefits as well as the trade-offs of on-board water and ice features, you'll be better equipped to start shopping for your new refrigerator, and ready to enjoy all its features.

13.3 Refrigerators water dispenser or refrigerated bottles, which of those damages less the environment?

We can ask ourself how the different systems of getting cold water impacts. We analise the most important aspects.

For instance, on opening the refrigerator door. The energy loss from briefly opening the refrigerator door is minimal. This happens because the air does not have a high specific heat capacity, so cooling the new air in the refrigerator does not use a lot of energy. Let's say that there are 300l of air space in your refrigerator (or a standard 600l refrigerator that is half full). If we assume that opening your refrigerator door replaces all of that cold air with ambient room-temperature air, that has to be cooled down to refrigerator temperature we are talking about 6.9 kJ (kilojoules), which is less than 0.002 kWh, or about the amount of energy contained in 1.5 calories.

With ice cubes it's going to be the same story. The different is that the ice maker uses electricity, whereas filling ice cube tray manually doesn't. One could also argue that filling ice cube trays means leaving the refrigerator door open longer, making the two alternatives a bit closer.

16. Picture of a refrigerator with center-dispenser

As we have seen, the water and ice-cubes dispenser is not always just an added comfort feature. Always it increases the cost of the fridge, it has to be installed by a plumber, it has at least filter maintenance, it has got an added electric consumption and with a good use of a fridge, the energy wasted to get cold water cooling bottles is the same as the dispenser. So, it is an expensive comfort characteristic.

14. The running costs of a fridge are the same as without it?

We have been comparing different kinds of fridges, with different capacities, different consumptions, different features..; in order to find out how these characteristics affect in their price, how they impacts in the environment and why it happens.
At the same time, we considered that we had to study what happen if we don't have a fridge at home, how it impacts in the environment and which economic cost supposes it.
For that reasons we tried to created an equation that compares the two lives in energetic terms and economic terms as well.

FP= Price of the fridge which includes transport.
10EC= Price of the electric consumption for 10 years
F= Cost of the fuel consumption for 10 years once a week
M= Maintenance (If it is needed (about 80€ a year, in ten years 800 €)
R= Recycling cost (usually are included in the buying-price)
5F= Cost of the fuel consumption for 10 years 5 times a week

*All the prices are taken in €.

$$\mathbf{FP+10EC+F+M+R=5F}$$

FP= Price of the fridge which includes transport. **10EC**= Price of the electric consumption for 10 years **F**= Cost of the fuel consumption for 10 years once a week (€) **M**= Maintenance (If it is needed (about 80€ a year, in ten years 800 €) **R**= Recycling cost (usually are included in the buying-price)	**5F**= Cost of the fuel consumption for 10 years 5 times a week

Let´s see some examples:

Imagine you are a rich person and you don't care too much about the environment, you want a new fridge and you want one of the best of the market. Of course, you have a sporty gasoline car that consumes 15 L/100km. So, you buy a new Electrolux ENS 5700 X Screenfridge that costs 7235€. Its electric cost for 10 years is 927 €. You live 2,5 km far away from the supermarket, then you spent 5 km on your way. In these 10 years your car consumes a total of 382,5L. It supposes a total cost of 495€. This kind of fridges requires an annual inspection in order to check that everything works properly and to change the filters. So you have an extra cost of 800€ in these ten years. In that case, the recycling costs are included in the price of the

fridge. So, if you put together all these costs the sum amounts into 9457€ while if you haven't a fridge at home, your costs for going daily tot the supermarket suppose 2535€.

In this occasion, having this fridge at home supposed spending more than three and a half times more money. Of course, the comfort benefits that you have with this fridge you will never obtain with another kind of refrigerator. So, if you are a very rich non-conscious person, you can apply for; otherwise it makes no sense.

Another case, could be if you live with your family 5 km far away from the supermarket and you have a gasoline car its consume is 10 L/100km. You go to the refrigerators shop and get a new LG GR-4696LCPN which is adequate for the needs of your family. That Combi fridge costs 936 €. The cost of the electric consumption in the next 10 years will be 747 € and our car will consume 510 litters of gasoline, 663€. That fridge does not require maintenance. So having this fridge during 10 years suppose spending 2346 €. We have to compare this amount with the consumption of the car 5 times a week for ten years and it amounts 3380 €.
We can extract from this example that its more comfortable and cheaper to live with a fridge, thus in that case there no choice.

Another example, you live alone and you need a fridge with freezer with an adequate capacity for just one person. So, probably you will choose a simple fridge. Imagine as well you have a new diesel car that consumes 7,5 litters per 100km and you live 5 km from the nearest supermarket. You buy the Bosch KDV33X15 with a cost of 637€. The cost of the electrical consumption will be 430€ and in these 10 years your car will consume an amount of 510 litters and it will cost you in ten years 561€. This fridge is quite simple, so it doesn't need annual maintenance. The total cost of having a fridge at home will be 1628€. On the other hand if we will live for ten years we will spend 2860€.

In that case, having a fridge at home is 1232€ cheaper that living without one. Moreover it provides you a life more comfortable, so in that case, it is obvious that having a fridge at home just give you advantages.

The same happens with the energetic impacts:

E= Energy needed to build up a new fridge.
T= Energetic consumption needed in the transport
F = Energetic consumption due to the fuel consumption of the car for 10 years once per week into the supermarket
R= Energy needed on the recycling of the fridge

5F= Energetic consumption due to the fuel consumption of the car for 10 years five times per week into the supermarket

E+T+F+R=5F

E= Energy needed to build up a new fridge. **T**= Energetic consumption needed in the transport **F** = Energetic consumption due to the fuel consumption of the car for 10 years once per week into the supermarket **R**= Energy needed on the recycling of the fridge	**5F**= Energetic consumption due to the fuel consumption of the car for 10 years five times per week into the supermarket

We can't analyse any example in terms of energy consumption because we have not access into the data of the companies. We can't know for example how much energy is wasted to build up a fridge.

That are just theoretical equations, so many factors could vary this studies. For instance, the weather could affect into the consumptions of the car, the fridge could work more or less than 10 years, the car also have a maintenance not included in that study, tires for example; so many things that make that formula just theoretical, not empirical and just unreal.
But at least, we think it is a good comparative in order to find out which are the models that for price or for an elevate impacts due to the consumption; we should to reject immediately.

15. Innovation for the refrigerators:

15.1 Shelves-cube on the back of the fridge:

An easy way to take advantage of the heat that is ejected by the backside of the fridge would be creating a shelf behind the refrigerator where you could hold on the dishes. The meals will keep its warms without using any extra consumption, any extra wasting of energy. The shelf has to be provided with a lid that closes the cube and the upper part of that cube-shelf is pricked in order evacuated the heat when the compartment is collapsed.
Probably in a convectional home fridge it doesn't make sense because the heat that the machine give away is not enough to keep warm a shelf like that but maybe in a restaurant or in a refrigerated warehouse it would be useful.
The negative aspect would be that you can't position the fridge as usual, in front of the wall, to open the lid of the cube-shelf. On the other hand if the lid was in the lateral disposal that problem won't exist.
We considered that is important to give up a solution with this heat that is wasted by the refrigerator machines but that reason, because if is not used is wasted.

17. Example of Shelves-cube innovation

15.2 Solutions for the recycling:

At the end of the fridge life, we have to recycling all the parts of the refrigerator. An easy way to recycling should be use the as cupboard. We can take out all the pieces of the refrigerator for its posterior recycling or reusing and use only the structure of the fridge reconverting as a cupboard. Nowadays, most of the fridges have an accurate exterior aspect, this make it in our opinion very attractive and could be, why not, a new fashion.

In the followed picture you can see a fridge converted as a cupboard. You can use this cupboard to keep clothes, shoes or tools in the garage for instance. You can reconvert the fridge as you need or you want. So you can give another life to the structure of the fridge. Moreover, you can change the aspect of the refrigerator painting it, or decorating it. This should be an easy way to reuse the fridge for another thing and recycle its pieces and engines.

18. Example of a fridge reuse into a cupboard

16. How we can save energy?:

16.1 Tools/methods to save energy:

Refrigerators used to consume more energy than any other home appliance, but in the last twenty years great strides have been made to make refrigerators more energy efficient. In the early 1990s a competition was held among the major manufacturers to encourage energy efficiency.

-An auto-defrost unit uses a blower fan to keep moisture out of the unit. It also has a heating coil beneath the evaporator that periodically heats the freezer compartment and melts any ice buildup. Some units also have heaters in the side of the door to keep the unit from "weeping." Manual defrost units are available in used-appliance shops or by special order. All this things help to raise the energy efficiency.

-Among the different styles of refrigerators, top-freezer models are more efficient than bottom-freezer models of the same capacity, which are in turn more efficient than side-freezer models. Models with through-the-door ice units are less efficient than those without.

-Minimize the time you spend with the door open. Opening and closing the door has a very minor effect, as we have found, but leaving it open causes heat loss due to radioactive heat transfer, meaning that the food in your refrigerator actually begins to warm, requiring more cooling.

-Unless you use a great deal of ice cubes, you may have noticed that the ice cubes in your automatic ice maker shrink over time. This is due to sublimation, where the ice essentially evaporates. If most of your ice cubes are evaporating, why make them in the first place? Simply turn off your ice maker and switch to "ice cubes" made from granite for cooling you beverage of choice.

-Right placement is very important for saving energy. Don’t place the fridge/freezer near cooker or oven and avoid direct sunlight. Place the fridge/freezer preferably into a cool environment, but not below the temperature, which is allowed by climate class of this fridge/freezer. Maintain a good ventilation, so that warm air can be easily removed.

-The storage space of the refrigerator should be utilized whenever possible to ensure an efficient work. Because the cooled food stores the cold better than the surrounding air.

Even a 10 year-old refrigerator may be costing you money when compared with a newer, more efficient model.

16.2 Examples of thrifty models:

Let's see some examples peculiar Companies or models related to saving energy:

-Dr. Tom Chalko in Australia has developed an **external thermostat** to convert any chest freezer into a chest fridge using only about 0.1kWh per day—the amount of energy used by a 100 watt light bulb in one hour.

-Energy Star is an international standard for energy efficient consumer products. It was first created as a United States government program by the Clinton Administration in 1992, but Australia, Canada, Japan, New Zealand, Taiwan and the European Union have also adopted the program. Devices carrying the Energy Star logo, such as computer products and peripherals, kitchen appliances, buildings and other products, generally use 20%–30% less energy than required by federal standards. However, many European-targeted products are labeled using a different standard, TCO Certification, a combined energy usage and ergonomics rating from the Swedish Confederation of Professional Employees (TCO) instead of Energy Star.

19. Energy Star Logo

Usually the refrigerators with that logo have more prestige because this means that their efficiency is one of the best. Normally, they are more expensive.

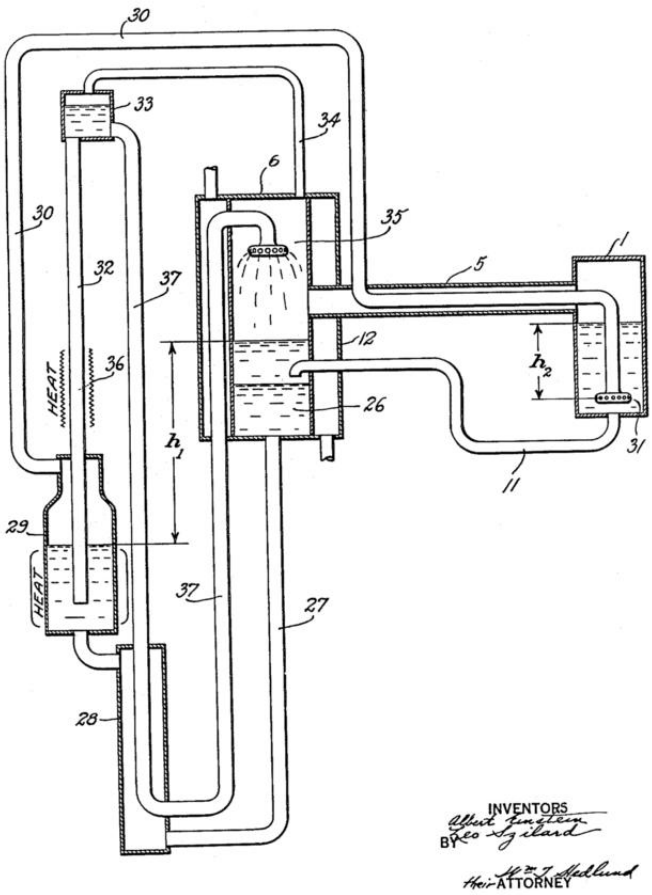
-Einstein refrigerator: manufactured by Johnson Controls. Scientists at Oxford University have reconstructed a refrigerator invented in 1930 by Albert Einstein in their efforts to replace current technologies with energy efficient green technology. The Einstein refrigerator operates without electricity and uses no moving parts or greenhouse gases.
The machine is a single-pressure absorption refrigerator, similar in design to a gas absorption refrigerator. The refrigeration cycle uses ammonia pressure-equalizing fluid, butane refrigerant, and water absorbing fluid, has no moving parts, and does not require electricity to operate, needing only a heat source, e.g. a small gas burner or electric heating element.

The ammonia is introduced into the evaporator, causing the refrigerant to evaporate, taking energy from the surroundings, due to the fact that the partial pressure of the refrigerant is reduced, and the mix of gasses then passed through to a Condenser heat transfer condenser where it comes into contact with the absorption liquid. Since ammonia is soluble in water and butane is insoluble, the ammonia gas is absorbed by the water, freeing the butane. Heat is thus first given from the butane to the ammonia as the gasses mix, and then from the ammonia to the water, as the ammonia leaves the butane, taking heat with it, and dissolves into the water. The butane then assumes the pressure inside the condenser, which is enough to make it liquefy. Since butane's specific gravity is less than that of ammonia in solution in water, the liquid butane floats on top of the ammonia solution. The liquid butane then passes back to the evaporator to repeat the cycle. The ammonia solution flows to a heat exchanger where a heat source drives it from the water as a gas again and it returns to the evaporator.

The Einstein refrigerator has been described as "noiseless, inexpensive to produce and durable".

Improving of the Einstein fridge:

In September 2008 it was reported that Malcolm McCulloch of Oxford University was heading a three-year project to develop more robust appliances that could be used in locales lacking electricity, and that his team had completed a prototype Einstein refrigerator. He was quoted as saying that improving the design and changing the types of gases used might allow the design's efficiency to be quadrupled.



20. Picture of Einsteins fridge

17. Conclusions:

At the end of our Final Thesis, we have learned to analyze the different aspects of the refrigerators that are in the market in order to find out which is the most efficiency fridge in the market and how it affects in his cost.

One of the first deductions that we got was that habitually the most expensive refrigerator is not the best in terms of efficiency. On the other hand, normally, the cheapest fridge is not the worst. So, when you want to buy a new fridge you should to bare in mind a lot of aspects.
First of all, before buying a fridge you should to know which capacity you will need, in other words, how many people will use this fridge. Then, you have to choose if you want a freezer or not. If you do not want it, you just have one option, a simple fridge without freezer; if you need it, you have try between one (Simple fridge) or two engines (Combi or American fridge). Once did that selection, you have to decide which will be the price that you will be willing to pay for the comfort. These would be the steps for a new refrigerator purchase. As we have seen in our researches, at the end of the Life Cycle of the fridges, the models with the best energetic rank level, have a lowest final cost than the others, so you have been saving money. For that reason, we recommend always spending the money in the efficiency of the machine at the beginning of the Life Cycle, in the moment of the purchase.

Also we have seen how the different comfort characteristics affect into the cost and the energetic consumption of the refrigerator. For instance, we discovered that having or not a water and ice dispenser doesn't affect too much in the energetic consumption but it has an extra cost in the fridge.

Another important aspect that we have found out, from our study baring in mind what is more profitable if we have a fridge at home or we go to buy daily, is that having a normal fridges at home you have a Life Cycle lower running cost that if you haven't. That results have been verified with the equation, which relates the costs and the energy used in both life styles, we have found as it is explained in the work. Thus, this means that having a fridge at home is more economical. However, there´s an exception in these analysis, we are refereeing to a really expensive fridge that the study reveals that a life with it was more expensive that going to buy the food daily in a car with one of the highest consumptions of the comparative. We deducted that this refrigerator is only for rich people that are not very conscious with the environment.

During this project, we have noticed that actually the fridges are technologically high developed but there is still a lot to do with the damage that they produced, particularly with the materials and the recycling.

We had a couple of ideas to improve the actual fridges but we couldn't develop too much because we couldn't deal with a company that offers us the opportunity and the tools to implant these ideas on a production line. That's the reason why we are not sure if those are good ideas or not because we hadn't the chance to test them empirically.

Apart from this, we have to say that with that work we learnt a lot of knowledge that will be very useful in a short term future.

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[3]- Milar, 2009, *"Cold-Wash Guide 09/10"*, pages 2-41.

[4]- Milar, 2009, *"Integration Guide 09-10"*, pages 54-63.

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Annex

*** Commission Directive 94/2/EC of 21 January 1994 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations.**

Official Journal L 045 , 17/02/1994 P. 0001 - 0022
Finnish special edition: Chapter 13 Volume 25 P. 0249
Swedish special edition: Chapter 13 Volume 25 P. 0249

COMMISSION DIRECTIVE 94/2/EC

of 21 January 1994

implementing Council Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Community,

Having regard to Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources of household appliances (1), and in particular Articles 9 and 12 thereof,

Whereas under Directive 92/75/EEC the Commission is to adopt an implementing directive in respect of household appliances including refrigerators, freezers and their combinations;

Whereas electricity use by refrigerators and freezers accounts for a significant part of total Community electricity demand; whereas the scope for reduced energy use by these appliances is substantial;

Whereas CEN (European Committee for Standardization) standard EN 153 provides a method for measuring the consumption of energy of refrigerators, freezers and their combinations;

Whereas the Community, confirming its interest in an international standardization system capable of producing standards that are actually used by all partners in international trade and of meeting the requirements of Community policy, invites the European standards organizations to continue their cooperation with international standards organizations;

Whereas the European Committe for Standardization and the European Committee for Electrotechnical Standardization (Cenelec) are the bodies recognized as competent to adopt harmonized standards in accordance with the general guidelines for cooperation between the Commission and these two bodies signed on 13 November 1984; whereas, within the meaning of this Directive, a harmonized standard is a technical specification (European standard or harmonization document) adopted by CEN or Cenelec on the basis of a remit (mandate) from the Commission in accordance with the provisions of Council Directive 83/189/EEC of 28 March 1983 laying down a procedure for the provision of information in the field of technical standards and regulations (2), as last amended by Commission Decision 92/400/EEC (3), and on the basis of those general guidelines;

Whereas the measures set out in this Directive are in accordance with the opinion of the committee set up under Article 10 of Directive 92/75/EEC,

HAS ADOPTED THIS DIRECTIVE:

Article 1

1. This Directive shall apply to electric mains operated household refrigerators, frozen food storage cabinets, food freezers and their combinations. Appliances that may also use other energy sources, such as batteries, are excluded.

2. The information required by this Directive shall be measured in accordance with EN 153 of May 1990 or with harmonized standards, the reference numbers of which have been published in the Official Journal of the European Communities and for which Member States have published the reference numbers of the national standards transposing those harmonized standards. The information relating to noise, where applicable, shall be measured in accordance with Council Directive 86/594/EEC (4).

3. The harmonized standards referred to in paragraph 2 shall be drawn up under mandate from the Commission in accordance with Directive 83/189/EEC.

4. 'Dealer', 'supplier', 'information sheet', and 'supplementary information' shall have the meanings set out in Article 1 (4) of Directive 92/75/EEC.

Article 2

1. The technical documentation referred to in Article 2 (3) of Directive 92/75/EEC shall include:

- the name and address of the supplier,

- a general description of the appliance, sufficient for it to be identified,

- information, including drawings as relevant, on the main design features of the model and in particular items which appreciably affect its energy consumption,

- reports of relevant measurement tests carried out under the standards referred to in Article 1 (2) of this Directive,

- operating instructions, if any.

2. The appliances covered by this Directive shall be divided into the 'categories' set out in Annex IV.

3. The label referred to in Article 2 (1) of Directive 92/75/EEC shall be as specified in Annex I to this Directive. It shall be placed on the outside of the front or top of the appliance, in such a way as to be clearly visible, and not obscured.

4. The content and format of the fiche referred to in the third indent of Article 2 (1) of Directive 92/75/EEC shall be as specified in Annex II to this Directive.

5. In the circumstances covered by Article 5 of Directive 92/75/EEC, and where the offer for sale, hire, or hire purchase, is provided by means of a printed communication, such as a mail order catalogue, then that printed communication shall include all the information specified in Annex III to this Directive.

6. The energy efficiency class of an appliance shall be as specified in Annex V.

Article 3

Member States shall take all necessary measures to ensure that all suppliers and dealers established in their territory fulfil their obligations under this Directive.

Article 4

1. Member States shall adopt and publish the provisions necessary to comply with this Directive by 31 December 1994. They shall immediately inform the Commission therof. They shall apply those provisions from 1 January 1995.

When Member States adopt these provisions, these shall contain a reference to this Directive or shall be accompanied by such reference at the time of their official publication. The procedure for such reference shall be adopted by Member States.

2. Member States shall communicate to the Commission the text of the provisions of national law which they adopt in the field covered by this Directive.

Article 5

This Directive shall enter into force on the 20th day following its publication in the Official Journal of the European Communities.

Article 6

This Directive is adressed to the Member States.

Done at Brussels, 21 January 1994.

For the Commission

Abel MATUTES

Member of the Commission

(1) OJ No L 297, 13. 10. 1992, p. 16.

(2) OJ No L 109, 26. 4. 1983, p. 8.

(3) OJ No L 221, 6. 8. 1992, p. 55.

(4) OJ No L 344, 6. 12. 1986, p. 24.

ANNEX I

THE LABEL

Label design

1. The label shall be in accordance with the following illustrations:

Notes on label

2. The following notes define the information to be included:

Note:

I. Supplier's name or trade mark.

II. Suppliers model identifier.

III. The energy efficiency class of an appliance shall be determined in accordance with Annex V. The appropriate letter shall be placed at the same level as the relevant arrow.

IV. Without prejudice to any requirements under the Community Eco-label award scheme, where an appliance has been granted a 'Community Eco-label award' pursuant to Council Regulation (EEC) No 880/92 (1) a copy of the Eco-award mark (the flower) may be added here. The 'refrigerator/freezer label design guide' referred to below, explains how the Eco-award mark, may be included in the label.

V. Energy consumption in accordance with standards referred to in Article 1 (2) but expressed in kWh per year (i.e. per 24 hours × 365).

VI. Sum of net storage volume of all compartments that do not merit a star rating (i.e. operating temperature > - 6 °C).

VII. Sum of net storage volume of all frozen food storage compartments which merit a star rating (i.e. operating temperature ≤ - 6 °C).

VIII. Star rating of frozen food storage compartment, in accordance with standards referred to in Article 1 (2). Where this compartment does not merit any stars, this position shall be left blank.

IX. Where applicable noise measured in accordance with Directive 86/594/EEC.

NB:

The equivalent terms in other languages to those described above are given in Annex VI.

Printing

3. The following defines certain aspects of the label:

>REFERENCE TO A GRAPHIC>

Colours used:

CMYK: cyan, magenta, yellow, black.

Example: 07X0: 0 % cyan, 70 % magenta, 100 % yellow, 0 % black.

Arrows:

- A: X0X0,
- B: 70X0,
- C: 30X0,
- D: 00X0,
- E: 03X0,
- F: 07X0,
- G: 0XX0.

Outline colour X070.

All text is in black. The background is white.

Complete printing information is contained in a 'refrigerator/freezer label design guide' obtainable from:

The Secretary of the Committee on Energy Labelling and Standard Product Information for Household Appliances

Directorate-General for Energy DG XVII,

Commission of the European Communities,

200 Rue de la Loi,

B-1049 Brussels.

(1) OJ No L 99, 11. 4. 1992, p. 1.

ANNEX II

THE FICHE

The fiche shall contain the following information. The information may be given in the form of a table covering a number of appliances supplied by the same supplier, in which case it shall be given in the order specified, or given in the description of the appliance:

1. Supplier's name or trade mark.

2. Supplier's model identifier.

3. Type of appliance as follows:

>TABLE>

4. The energy efficiency class of the model as defined in Annex V, expressed as 'Energy efficiency class . . . on a scale of A (most efficient) to G (least efficient)'. Where this information is provided in a table this may be expressed by other means provided it is clear that the scale is from A (most efficient) to G (least efficient).

5. Where the information is provided in a table, and where some of the appliances listed in the table have been granted a 'Community Eco-label award' under Regulation (EEC) No 880/92, this information may be included here. In this case the row heading shall state 'Community Eco-label award', and the entry shall consist of a copy of the Eco-award mark (the flower). This provision is without prejudice to any requirements under the Community Eco-label award scheme.

6. Energy consumption in accordance with standards referred to in Article 1 (2) but expressed in kWh per year (i.e. per 24 hours × 365), described as: 'energy consumption XYZ kWh per year, based on standard test results for 24 h. Actual energy consumption will depend on how the appliance is used and where it is located.'

7. Net storage volume of fresh food storage compartment (5 °C) in accordance with standards referred to in Article 1 (2) - omit for classes 8 and 9.

8. Net storage volume of frozen food storage compartment, in accordance with standards referred to in Article 1 (2) - omit for classes 1, 2 and 3. For class 3 appliances the net volume of the 'ice box'.

7 and 8. For classes 2 and 10 the net volume of each compartment should be listed, in accordance with standards referred to in Article 1 (2).

9. Star rating of frozen food storage compartment, if any, in accordance with standards referred to in Article 1 (2).

10. The mention 'no frost' may be included here when in accordance with the definitions given in the standards referred to in Article 1 (2).

11. 'Power cut safe Z h' defined as 'temperature rise time' in accordance with standards referred to in Article 1 (2).

12. 'Freezing capacity' in kg/24 h in accordance with standards referred to in Article 1 (2).

13. 'Climate class' in accordance with the standards referred to in Article 1 (2). Where appliance is of 'temperate' climate class this may be omitted.

14. 'Noise', where applicable, measured in accordance with Directive 86/594/EEC.

Where an appliance contains compartments other than a single fresh food compartment and a single frozen food compartment, extra lines may be added at 7, 8, 9, 10, 11, 12 and 13 to include the information in respect of these compartments. In this case the naming and order of listing of the compartments shall be consistent. Where the design temperature of a compartment does not conform

to the star rating system, or the standard fresh food compartment temperature (5 °C), this design temperature shall be given.

The information contained in the label may be given in the form of a copy of the label, either in colour or in black and white. In this case the further information given only in the fiche must still be included.

Note:

The equivalent terms in other languages to those described above are given in Annex VI.

ANNEX III

MAIL ORDER AND OTHER DISTANCE SELLING

Mail order catalogues and other printed communications referred to by Article 2 (5) of this Directive shall contain the following information, given in the order specified:

1. Energy efficiency class (Annex II, point 4)
2. Energy consumption (Annex II, point 6)
3. Net volume of fresh food compartment (Annex II, point 7)
4. Net volume of frozen food compartment (Annex II, point 8)
5. Star rating (Annex II, point 9)
6. Noise (Annex II, point 14)

Where other information contained in the product information fiche is provided, it shall be in the form defined in Annex II and shall be included in the above list in the order specified for the fiche.

The size and font, in which all the information referred to above is printed, shall be legible.

Note:

The equivalent terms in other languages to those described above are given in Annex VI.

ANNEX IV

CATEGORIES

The appliances covered by this Directive shall be divided into the following 'categories':

1. Household refrigerators, without low temperature compartments.
2. Household refrigerator/chillers, with compartments at 5 °C and/or 10 °C.
3. Household refrigerators, with no-star low temperature compartments.
4. Household refrigerators, with low temperature compartments *.
5. Household refrigerators, with low temperature compartments **.
6. Household refrigerators, with low temperature compartments ***.
7. Household refrigerator/freezers, with low temperature compartments *(***).
8. Household food freezers, upright.
9. Household food freezers, chest.
10. Household refrigerators and freezers with more than two doors, or other appliances not covered above.

ANNEX V

ENERGY EFFICIENCY CLASS

The energy efficiency class of an appliance shall be determined in accordance with the following Table 1:

>TABLE>

Where:

'energy efficiency index' (expressed as a percentage) = annual energy consumption of appliance (1) / standard annual energy consumption of appliance

'standard annual energy consumption of appliance' (expressed in kWh/year) = M × adjusted net volume + N

and

adjusted net volume (expressed in litres) = net volume of fresh food compartment + ` × net volume of frozen food compartment.

The values of M, N and ` are taken from Table 2.

>TABLE>

(1) In accordance with Annex I, note V.