Report

Solar Dehydrator

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Acknowledgement

Glossary

Abbreviation	Description
DIN	Deutsches Institut Für Normung
DIY	Do It Yourself
EPS	European Project Semester
EU	European Union
ISEP	Instituto Superior de Engenharia do Porto
LCD	Liquid Cristal Display
PMMA	Polymethyl methacrylate
R&D	Research and Development
SWOT	Strengths, Weaknesses, Opportunities and Threats
W	Watt
WBS	Work Breakdown Structure

1. Introduction

1.1 Presentation

Rike Brunke, Hubert Nogal, Dániel Berényi, Murat Güsan, Adrian de la Torre, Léonore Hood: We are six students of different cultural backgrounds and study fields. Together we form a team, working on one same project: building a fully functional Solar Dehydrator. Every team member has a specific role in this project, according to each person's strengths and weaknesses. However, we value teamwork and work together successfully and in joint effort, sharing our knowledge, in order to achieve our goal.

1.2 Motivation

The choice of this project was given by the consensus of all members according to our individual skills as future engineers. Although the Solar Dehydrator was not our first option, at some point, analysing and interpreting each one of the variety of proposals offered by the EPS direction, we thought convenient go and develop this product. The demands of the briefing fitted perfectly with the team, what establishes a high probability of success.

The main challenge is to innovate in the field of Solar Dehydrators. In advantage, we realized that its market is mostly focused and based on systems with energy supplies, and in terms of the non-energetic systems, there isn't a clear path to follow in the field of solar versions.

The lack of knowledge and experience in this project is not a weakness, but strength. It is a reliability of fresh ideas and non-common points of view to develop this product, such an ideal environment to break into with a new concept and to position our project as a benchmark in this sector.

1.3 Problem

We are tasked with building a solar dehydrator. The main obstacles of this task, which we have to overcome, are:

- Dry fruit and vegetable
- The dehydrator should be portable/mobile
- The device should be environmentally friendly and sustainable: the control and monitoring unit need to be powered by solar energy, which means we have to use a solar panel, connected to a battery
- The temperature has to be regulated and should not go above 70°: we will need to integrate motorized vents and possibly fans, as well as a functional automatic temperature sensor (programmed with Arduino)
- Since we have a limited budget for the equipment, we need to plan the list of materials carefully and do exact research
- We need to develop a marketing plan, find a market niche and a target group for our innovation

1.4 Objectives

Our goal is to build a fully functional, sustainable and environmentally friendly solar dehydrator. It should also be portable and easy to transport, so that it can be used in as many locations and situations as possible for an optimized use. Food dehydration is a process that has been used for decades and our objective is to develop a innovative yet simple device which gives our customers the possibility to do so efficiently and without wasting energy. We want to design our product so that it appeals to our specific target group. Next to the technical and sustainable part of the project, we also want to guarantee our customers that by using our product, they will consume food that is healthy, natural and rich in vitamins.

In order to accomplish this project and fulfill all our objectives, we will do some intensive research, gain solid knowledge on the subject and run some tests on our product, to get the best results possible.

1.5 Requirements

These specific features should be included in the solar dehydrator:

- The dehydrator should be portable/mobile (relatively light, reasonable dimensions, wheels)
- The inside temperature should not go above 70°C
- The dryer box needs to have a good isolation, so that the temperature is stable, it is important that there are now holes or cracks on the walls of the box. These would allow air to get in and out the box and would disturb the balance of the airflow. The two vents should absolutly be the only openings of the box.
- It needs temperature sensor and motorized vents and fans, in order to regulate temperature and air flow
- The controls should be powered by solar energy (a solar panel will be fixed on top of the dehydrator and connected to a battery)
- The device should be environmentally and sustainable (it should not need to be powered by electricity, but only by solar energy)

For the accomplishment of our project, we also have to meet these requirements:

- Use of existing equipment and/or low cost hardware
- Use of open source and freeware software
- Adopt the International System of Units
- Be compliant with the machinery EU Directive

1.6 Use Cases

Following features will define our solar food dehydrator and the situations in which it can be used:

- It will be portable (light-weighted and mounted on wheels) so it is easy to move around your garden or terrace (always move it out of the shade and into the sun) and to bring back inside your house in the winter or when it is raining.

- There will be between 3 and 5 drying shelves in the dryer box, so relatively large amounts of food can be dried at the same time. However, the shelves can be totally removed from the dryer box, so it is possible to use only 1 or 2, if there is less food to dry. The estimation of the size of each shelve is around 0,2 m^2. So the final product will have a dehydrating surface between 0,6-1 m^2, enough for a domestic use scenario.

- An absorber plate is installed underneath the drying shelves, in order to take in the water and moisture that drips out of the food. Our product comes with two absorber plates: after 2-3 uses, the used, moist plate should be removed and replaced with the second, dry one. The moist plate can be placed on a dry surface in the sun and be left to dry out again. This should not take more than one day. For the latest concept of our product we decided that we wouldn´t need an asorber plate any more:

The humidity and moisture that will be extracted from the food will automatically be rejected through the top air vent, thanks to the controlled air flow system (humid hot air rises). Our plan was to use micro fibre towels because they absorb moisture effeciently.

- All electronic and mechanical parts are powered by solar energy (a solar panel will be mounted on the roof of the dehydrator). The device does not need to be powered by any other source. In case of low sun radiation, energy will be stored in a battery, so the dehydrator can still function with all its features for several hours. Moreover, when the temperature starts to sink, the vents will be closed in order to trap and keep the heat inside the dryer box.

- In order to optimize the drying process, and thereby the results, the dryer comes with a built-in alarm (timer) which rings when the fruit is dried (according to average guidelines), a programmed temperature sensor which is connected to small motorized vents, which open or close automatically depending on the inside temperature of the box). Apart from these features, the dehydrator is to be handled manually.

- The dehydrator is designed to be used in countries with a reasonably high amount of sun radiation and low humidity during the summer and early autumn months, and where the climate allows you to grow your own fruit and vegetable outdoors. It is not designed for industrial purposes or mass production, but for private individuals, who own or have access to a garden or a terrace.

	Germany	Switzerland	France	Italy	Portugal	Spain
Average Temperature	22°C	22°C	20-30°C	25°C	24°C	26°C
Average number of rainy days per month	15	14	5 to 17	3	8	5
Average number of sunny days per month	6 hours/day 12 days	7 hours/day for 13 days	5-9 hours/day for 12-22 days	8,5 hours/day for 25 days	7,5 hours/day for 19 days	9 hours/day for 23 days

Table 1: comparison of climate conditions between countries

1.7 Functional Tests

In order to succeed with the full functionality of the Solar Dehydrator, the product has to be submitted to a variety of tests to warrant the optimum usability. These tests have to be not just with the proper operation of the product itself, so for the human interaction as well.

Mechanical tests are the main concern. Mechanical tests involve the correct function of each part of the Solar Dehydrator, such as quality of the assembly, safety tests and so on.

On the other hand, we have the electrical part that has to do with the autonomous control of the dehydration process. The handicap on this field is how to properly manage the variation of temperature. The Solar Dehydrator will be provided with built-in temperature sensors and a wastegate system for the purpose of keeping an ideal environment to dehydrate. Power supply tests have also to be done. One of the challenges of this project is to achieve the self-production and consumption of energy, avoiding all the contamination chain beyond energy companies. This is our little contribution to the world.

Finally, usability tests are a must. Even if the dehydrator does its work properly, an easy and intuitive design provides the customer with confidence and commitment towards the product and the company beyond.

1.8 Project Planning

In order to establish the project plan, Work Breakdown Structure was created, in which entire arrangements and work division of the project are included. What is more, the Gantt chart was developed in order to in further phases of the project. Complete effort to establish WBS and Gantt chart was done with the usage of Microsoft Project software. The service of program was presented during Project Management classes. The Work Breakdown Structure of our team is presented below.

1.9 Report Structure

Chapter	Description
1 - Introduction	Presentation of the main problems, motivation and objectives of the project
2 - State of the art	Description of different technologies already available on the market and presentation of selected one
3 - Marketing	Situation of the product and the company in the current market
4 - Sustainability report	Enhancement of sustainability in the engineering area including life-cycle and energy consumption analysis
5 - Ethical and deontological concerns	Legitimacy and legality analysis
6 - Project requirements and product development	Explanation of entire hardware and software and information concerning construction of the prototype
7 - Conclusion	Discussion about the project and further possible developments

2. State of the Art

2.1 Introduction

In this chapter, we will describe our product and its status in the current market. The aim is to give a clear overview of the design, functionalities and the components of our solar dehydrator, while comparing it to existing related products and the technologies used. In doing so, we will also justify the need of our product on today's market.

2.2 Related products and market competition

After having done some research about solar dehydrators and similar products on the current market, we have come to the conclusion that there are two major types of related products/projects:

- The first is executed on a larger scale and at an industrial level, however mainly in developing countries:

Companies such as “Shri Industry” and “NRG Technologists” provide the devices and facilities for drying large quantities of materials, using inly solar energy. Focusing on the example of “Shri Industry”, following observations have been made: Their dryers are conceived to be used on a larger agricultural level, for example by food processing companies (added value in foods such as fruit, nuts, vegetables), but also textile industries (fabric drying purposes). Their dehydrators are the size of small industrial greenhouses. They very much look like greenhouses on the outside, with a not quite transparent surface, which is however permeable to sunlight. There are openings on the top of the boxes, and a space between the material of the box and the ground enables the air to flow properly. The devices of “Shri industry” operate only on solar energy, and therefore avoid any power consumption. However, no controls or electronic components are used. Their goal is to manufacture modern, yet natural, sustainable and hygienic dehydrators. Shri Industry is based in India, their products are manufactured locally, and are targeted to Indian industries.

- Do It Yourself solar dehydrators:

As questions of health, sustainability and self-reliance take a growing place in developed countries around the world, more and more people show an interest in building their own solar dehydrator. After having done some research, it is easy to say that there is an increasing number of websites, books, health magazines or workshops dedicated to “green living” (sustainability, energy, healthy nutrition, etc.). Many of those platforms offer explanations, construction plans or tutorials for building a solar dehydrator by yourself. Companies such as “SunWorks tm” or “Build It Solar” even sell building kits which contain all the necessary materials and components. The user then has to put the device together. “Do It Yourself” solar food dehydrators are simple devices. The dryer box is usually made out of wood, sometimes metal, and one of the surfaces is a glass panel. The shelves are often similar to barbecue grids. Wholes are made at the top and at the bottom of the box to let the air flow.

- Other similar products exist on the current market, such as “Excalibur - America's best dehydrator” in the USA, the “Biochef” dehydrator in Australia, and various food dehydrators by “Severin”, a German company which specializes in kitchen utensils. However, all these products do not work with solar energy, but need a external power supply. In all these cases, the product itself is not designed to be autonomous or sustainable, and consume a big amount of energy (a power supply of 600-800W is necessary for the dehydrators to work).

- Additional competitors on the current market are: “Stöckli Dörrex”, a Swiss company which manufacture food dehydrators with synthetical drying grids, their price range starting at 109.90€; “Severin OD 2940”, a German company which produces dehydrators for fruit and vegetable that consume a relatively low amount of energy and sell their product for 50€; “Sedona TM”, another German company, who sell food dehydrators which require a 550W power supply, are bigger and heavier, and cost 399€; finally, the “Bomann DR 435 CB Dehydrator” produced by the German company, requires a 250W power supply, works with a similar air flow system to our product, and costs 25€ to 40€. However, none of these dehydrators work with solar energy: they require an external power source, meaning they have to be plugged into a socket in order to work and the user consumes and will pay for more energy.

- The main differences in our solar dehydrator, compared to all other related projects and products we have found during our research are the following:

Our product will be manufactured for and used by private individuals, at the same level as a kitchen utensil, for example. The manufacturing as well as the distribution will remain in Europe at first. This will enable us to observe the success our product has on a smaller and restricted geographical scale, before we decide to expand our market and export the product. Our target group and market are quite specific, so in our start-up phase, we want to concentrate on creating good customer relationships and make sure our product satisfies the consumer's needs. Furthermore, by limiting our territory of production and distribution, we reduce financial and environmental impact of transportation. The target groups of this specific solar dehydrator are private people (singles, couples or families) who own or have access to a garden or a terrace, and small farmers, who want to dry seeds for the next season's crops, or simply to preserve the surplus of harvested food. The dehydrator is professionally manufactured and well finished. The user to put any parts of the device together by himself. It is optimized for the drying of fruit and vegetables, which means a smaller range or products, but better results. The device is portable, user friendly and offers a simple yet modern control unit, powered by a solar panel.

2.3 Product Requirements and Functionalities

In order for our solar dehydrator to stand out next to all the similar products, these requirements must be fulfilled: Our product needs to be sustainable, practical, user friendly, as autonomous as possible, versatile and innovative.

The sustainability aspect is our main concern. Putting aside the fact that the very concept and use of such a product is sustainable (a way of preserving food naturally), our goal is to take this idea of sustainability further and integrate it into the product itself: All the materials we plan to use for the dehydrator are recyclable and/or long lasting ,such as wood, Polymathy Methacrylate (PMMA) or brass,. Furthermore, we want to focus on a low power consumption: The controls and other electrical components will be powered by solar energy (solar panel will be mounted on the back of the dryer box).

The height of the dehydrator when closed to be carried should be over 0.96 m and should not exceed 1.20 m. This height is determined by anthropometric measurements as shown in chapter 7.2.3 and also by the research of similar products as shopping trolleys. It also must be taken into account that there is a value of tolerance given by the grade of inclination at the time of transporting.

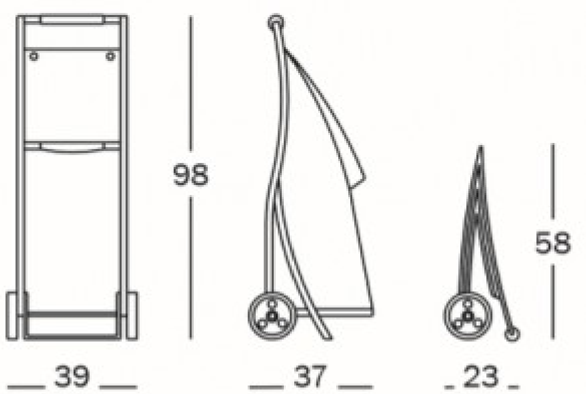


Figure 1: Example of shopping trolley measurements

A set of wheels will be mounted on its foldable legs, so the dryer is portable. The shelves that are in the dryer are box easily removable, in order to load and unload the food, and for cleaning purposes. These features make our product practical.

To continue on the user friendly aspect, the dehydrator is equipped with two temperature sensors, one humidity sensor and an Liquid Crystal Display (LCD) screen (mounted outside of the box) which shows the user the measured values inside the dryer box. The user can thereby check for himself if the dehydrator is functioning properly. Also, there will be a built-in timer and alarm, so the user can set the approximate drying duration according to which type of food he is drying. The working process of the alarm system starts with the selection of the product it's going to be dehydrated. The processor makes an approximation of the end of the process and it's when the alarm does his job by awarding the user to check the current status of the food. Finally, a user manual comes with each purchased dehydrator to ensure the correct usage of the client towards the product.

Our product is autonomous because there is an air vent built in to the dryer box, which is programmed to open and close automatically depending on the inside temperature and humidity of the box. A controlled airflow is crucial for the drying process.

The dehydrator is versatile, which means it can be applied to multiple use cases: It can be used in different locations, such as private gardens, terraces, balconies or public parks. It can be left outside in summer (preferably sheltered!), but can easily be stored indoors, even in a small apartment. It can be used by people of all ages. The dehydrator is optimized for the drying of fruit and vegetables. However, seeds and herbs can be dried in it too.

All these features make our product unique and innovative.

2.4 The Heating Tunnel

The heating tunnel will be fixated to the bottom of the dryer box. The tunnel is hollow and open at both ends, in order to let the air pass through it. Inside the tunnel, along the whole length, a metal mesh will be fixed to its lower surface, in order to quickly heat up the air that passes through it. At the point where the tunnel touches the dryer box, there will be a vent, where the hot air of the tunnel flows into the dryer box. It will also provide a variation of the inclination in order to face more accurately the sun rays.

A study of the sun rays declination of Porto, Portugal, all around the whole year has been made thanks to Keisan Online Calculator, with a result varying between 55 and 17 degrees:

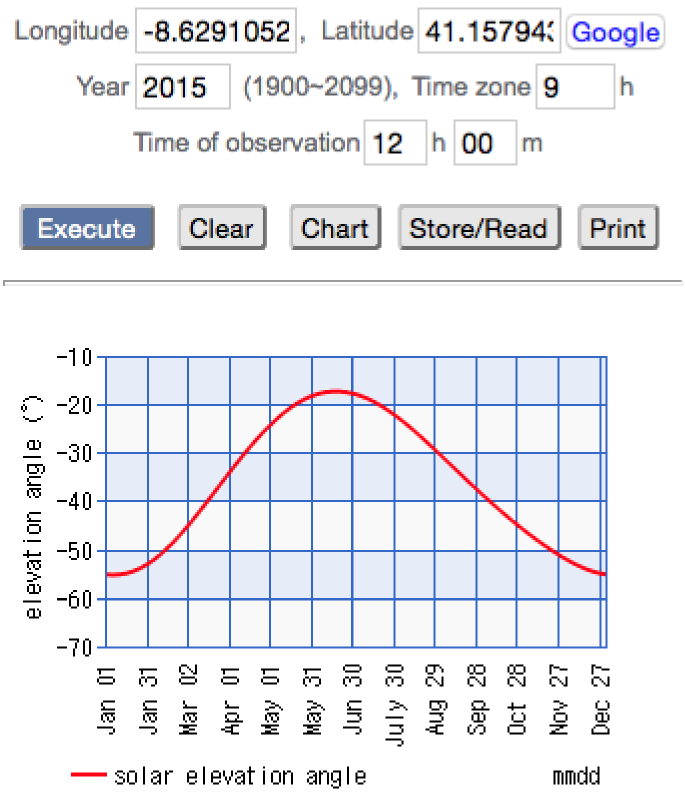


Figure 2: Sun rays declination in porto along year 2015

In terms of materials, the tunnel will be made out of wood with a plate of glass in the upper face. Glass is ideal for this work thanks to its properties as transparent and robust to keep in the heat while resisting the damage made by sunlight and rain and allows infrared rays come through to heat the air.

2.5 The Dryer Box

The dryer box is the main part of the dehydrator. It must be well designed and the material carefully chosen. As the dehydrator should be portable, the dimensions of the dryer box does not exceed $1m^2$ (one square meter). The walls of the box are made out of cedar wood, due to its appropriate properties in terms of wet conditions, were cedar good shows a high resistance to damage in front of other woods as pine wood for example. The front wall however, is made of PMMA, in order to let the sunlight enter the dryer box. This front surface is the “door” of the dryer box: Of course, the dryer box has to open and close easily, in order to load and unload the fruit and vegetable. Inside the box, five dryer shelves offer enough surface to dry a good portion of food. These shelves are fine metal (preferably brass) grids, and are easily removable, in the same way that oven grids are. The floor of the box will have small openings, for excess moisture to drip out if necessary. Two motorized vents - one at the top and one at the bottom of the box, where the tunnel is (see 2.4) - will open and close depending on the inside humidity and temperature level of the box. Usually, a constant air flow helps reduce the humidity level, so the vents should stay open most of the time.

Figure 3: Concept detail of the dryer box.

2.6 Electronic Controls and Solar Panel

The innovative and most complex part of our product is the control unit. For optimized results, the temperature, humidity and air flow inside the dryer box will be regulated automatically. Therefore, the dehydrator will be equipped with:

- an Arduino board will be fixed on the dehydrator, as the central controller for following components:

- two temperature sensors (fixed on the inside of the dryer box, one at the top and one at the bottom, in order to evaluate the temperature differences depending on the hight - the temperatures should be kept between 30°C and 70°C depending on what fruit or vegetable is drying)

- one humidity sensor (also fixed on the inside of the box, helps evaluate the level of humidity: inside the box, the air should be kept as dry as possible, so as not to damage or contaminate the fruit)

- one motorized vent on the top of the dryer box - this vents is crucial to a proper air flow. If the humidity level rises over a certain level, the vent should be open to the maximum, in order to let the humid air rise up and exit by the top vent and fresh, dry air enter from the bottom intake thanks to the nature of pressure, which always forces to maintain the same values.

- one LCD screen (mounted on the outside of the box, the screen displays the temperature and level of humidity inside the box, for the user to see at any time. It will also be connected to a small input keyboard, with which the user can manually configure certain settings)

- an alarm/timer (as a small bonus feature, the user will be able to set the approximate duration of the drying process, depending on the sort of fruit of vegetable he is drying - durations and temperatures are specified in the user manual - and the alarm will ring when the time is over, or simply as a warning, for the user to check on his food, halfway through the process)

- a solar panel (the panel will be mounted at the back of the dryer box, is such a way that its angle and position towards the sun can be changed easily if necessary. The solar panel is the power source of the electrical control unit of the dehydrator)

- a battery (connected to the solar panel, in order to store energy)

2.7 Conclusion

To conclude, it is safe to say that the concept of the solar dehydrator is far from being new. However, the current market for this kind of product is still limited. Solar dehydrators are being used more and more in developing countries such as India, to reduce waste, process the large surplus of harvested foods, and give added value to this food. These dehydrators are used on a relatively large agricultural scale. However, many of them are not ideal, when technical and sustainability aspects are taken into account. Products that are more similar to our dehydrator exist on the American and Australian market, but are still rare in Europe. Therefore, our most relevant competitor at the moment is the “Do It Yourself” (DIY) community, who share information on different platforms (websites, magazines…) about how to build your very own personal solar dehydrator. This “competitor” however, is not on the current economic market. A solar dehydrator similar to our's has not been released on the european market yet. The concept, the design, the eco-friendly materials and technical innovations make it more than worthwhile.

3. Project Management

3.1 Scope

The Project Scope pertains to the work necessary to deliver a product. Requirements and deliverables define the project scope, and it is critical that the stakeholder is in agreement with the information discussed in the proposed plan. In case if you start the project without knowing what you are supposed to be delivering at the end to the client and what the boundaries of the project are, there is a little chance for you to success. In most of the instances, you actually do not have any chance to success with this unorganized approach.

When it comes to our project, our scope is to build portable solar dehydrator for vegetables and fruits which will not be harmful for the environment with useful devices contributing to this process, such as temperature and humidity sensors, lcd display, automatic vents and alarm. In order to meet our expectantions, the solar dehydrator must be:

- user friendly
- light and small
- waterproof
- solid and sustainable
- environmental friendly

As far as deliverables are concerned, we are obliged to prepare:

- presentation and report
- Wiki webpage
- Leaflet
- Manual to our product
- poster
- video

3.2 Time

In order to illustrate a project schedule, we decided to use a Gantt chart. It is used in project management to create a clear picture of the steps which have to be taken during the project.

Our Gantt chart illustrates stages of our project from 2015-03-02, when it started, to the 2015-06-18, when the final presentation takes place. Every project task is shown as a bar with the starting and finishing date.

Gantt chart enabled us to instantaneously check at which stage of the project we are, if we have any delays, and what should be done in the nearest future. It is also an excellent tool to follow the work of our team during the EPS project. The chart is presented below.

3.3 Cost

Cost estimating is a basic activity in cost engineering. It is the process of developing an approximation of the probable costs of a product, program, or project, computed on the basis of available information. A cost estimate is often needed to support evaluations of project feasibility or funding requirements in support of planning. It is also used to establish a budget as the cost constraint for a project or operation, and to determine the most economical operation or method to manufacture a product. Furthermore, cost estimating is part of the Project Cost Management which includes the processes involved in planning, estimating, budgeting, and controlling costs so that project can be completed within the approved budget.

From the point of view of this EPS project it is vital to mention the so called manufacturing cost. It is the sum of costs of all resources consumed in the process of making a product. Costs of manufacture become a great concern to the profitability of a product. There exist numerous methods on how to conduct the cost estimation. The three most common are:

- Group Method - representatives of all the departments in the company state the costs for producing the product from their point of view.
- Comparison Method - compares the current project activities to previous, similar projects. The degree of similarity between the prior project and the current project affects the accuracy of the estimate.
- Detailed Method - the detailed approach uses bills of materials and drawings to estimate the cost of each item, subassembly, and main assembly. This method is also the most expensive to execute since it requires many hours of work to collect data and construct the estimates, but it is also the

most accurate method.

When it comes to types of costs direct and indirect (overhead) costs can be distinguished. In order to identify all the costs properly, one has to first break the project down into a set of definable tasks, and next estimate each task separately by means of cost.

Direct Costs
Are attributable to the project and are proportional to the number of units made. Those include:

- labour costs - cost of workers who can be easily identified with the unit of production. Depending on the type of manufacturing, particularly in labour-intensive processes, labour costs can be the dominant cost factor.
- material costs – costs of raw materials and devices used in the production.
- tooling costs – these are costs of tools and features are specifically for the manufacture of the product.
- utilities costs – include energy costs (electricity, gas, oil) as well as water, sewer, waste disposal, steam and other services.
- operating costs – costs of the things that are consumed during a production process (lubricants, towels, ear plugs, etc.).

Indirect Costs
Indirect costs, also called overhead, can be defined as costs incurred for the general operation of the business (necessary business expenses). They are not applicable to any one product, and consist of fixed and variable costs.

- indirect fixed costs – these are the costs which do not alter on the basis of the number of products produced. These can include: equipment, buildings, interest (debt), and insurance (fire, liability, etc.).
- indirect variable costs – costs that change with a change in the quantity of items produced. They can include: cleaning services, maintenance, engineering, R&D, sales, lighting and heating, office expenses, etc.

Taking into consideration our project, we are only exposed to direct costs, mainly material costs, as indirect costs are covered by the university. Our budget is 200 €, therefore it is crucial to find perfect balance between price and quality in order not to exceed the budget.

3.4 Quality

In order to deliver a high quality project following issues have to be concerned:

- Customer Satisfaction

If the customer doesn't feel the product produced by the project meets their needs or if the way the project was run didn't meet their expectations, then the customer is very likely to consider the project quality as poor, regardless of what the project manager or team thinks.

- Inspections, testinngs, requirements

Monitoring deliverables to evaluate whether they comply with the project’s quality standards and to identify how to permanently remove causes of unsatisfactory performance.

- Continuous Improvement

Continuous improvement is simply the ongoing effort to improve products, services, or processes over time. These improvements can be small, incremental changes or major, breakthrough type changes.

3.5 People

In order to work effectively as a team, division of work according to individuals strengths were made. The following table depicts how individual tasks were distributed accordingly.

Solar dehydrator	
Ideation	
Brainstorming	Adrian de la Torre[20%];Dániel Berényi[20%];Hubert Nogal[20%];Leo Hood[20%];Murat Güşan[20%];Rike Brunke[20%]
State of art	Adrian de la Torre[20%];Dániel Berényi[20%];Hubert Nogal[20%];Leo Hood[20%];Murat Güşan[20%];Rike Brunke[20%]
Concept definition	
Product feature	Adrian de la Torre[20%];Dániel Berényi[20%];Hubert Nogal[20%];Leo Hood[20%];Murat Güşan[20%];Rike Brunke[20%]
Design	Adrian de la Torre[20%];Dániel Berényi[20%];Hubert Nogal[20%];Leo Hood[20%];Murat Güşan[20%];Rike Brunke[20%]
Research	
Materials	Adrian de la Torre[15%];Dániel Berényi[20%];Hubert Nogal[15%];Leo Hood[20%];Murat Güşan[20%];Rike Brunke[20%]
Technologies	Adrian de la Torre[10%];Dániel Berényi[20%];Hubert Nogal[15%];Leo Hood[20%];Murat Güşan[20%];Rike Brunke[20%]
Life cycle	Adrian de la Torre[20%];Dániel Berényi[20%];Hubert Nogal[20%];Leo Hood[20%];Murat Güşan[20%];Rike Brunke[20%]
Production process	Adrian de la Torre;Dániel Berényi;Hubert Nogal;Leo Hood[50%];Murat Güşan;Rike Brunke[50%]
Planing	
Task allocation	Adrian de la Torre[20%];Dániel Berényi[20%];Hubert Nogal[20%];Leo Hood[20%];Murat Güşan[20%];Rike Brunke[20%]
Swot analysis	Hubert Nogal[60%]
Work breakdown stru	Adrian de la Torre[25%];Hubert Nogal[50%]
Gantt chart	Adrian de la Torre[30%]
Marketing	
Target group	Leo Hood[40%];Rike Brunke[40%]
Market niche	Leo Hood[50%];Rike Brunke[50%]
Marketing strategy	Leo Hood[20%];Rike Brunke[20%]
Marketing mix	Leo Hood[30%];Rike Brunke[30%]
Development	
Hardware	
Sketching	Adrian de la Torre[30%];Hubert Nogal
Pattern	Adrian de la Torre[40%];Hubert Nogal
Prototyping	Dániel Berényi;Hubert Nogal;Leo Hood[70%];Murat Güşan;Rike Brunke[70%];Adrian de la Torre
Testing	Dániel Berényi;Hubert Nogal;Leo Hood;Murat Güşan;Rike Brunke;Adrian de la Torre
Improvements	Dániel Berényi;Hubert Nogal;Leo Hood;Murat Güşan;Rike Brunke;Adrian de la Torre
Final touches	Dániel Berényi;Hubert Nogal;Leo Hood;Murat Güşan;Rike Brunke;Adrian de la Torre
Software	
Programming	Arduino[1];Adrian de la Torre[30%];Dániel Berényi[50%]
Testing	Adrian de la Torre[30%];Dániel Berényi[50%]
Optimalization	Adrian de la Torre[40%];Dániel Berényi
Build -up	
Manufacturing	metal grid;servomotor[1];solar panels[1];steel[1];temperature sensor[1];wheels[1];wood[1]
Assembly	Adrian de la Torre;Dániel Berényi;Hubert Nogal;Leo Hood;Murat Güşan;Rike Brunke
Testing	Adrian de la Torre[50%];Dániel Berényi[50%];Hubert Nogal[50%];Leo Hood[50%];Murat Güşan[50%];Rike Brunke[50%]
Final adjustment	Adrian de la Torre[50%];Dániel Berényi[50%];Hubert Nogal[50%];Leo Hood[50%];Murat Güşan[50%];Rike Brunke[50%]
Distibution	
Advertising	Rike Brunke[50%];Leo Hood[50%]
Selling	Rike Brunke[50%];Leo Hood[50%]

Figure 5: Distribution of individual tasks

3.6 Communications

Communication management takes into consideration information flow about every issue connected with our project between entire team in order to Communication is an essential part of conducting business, and therefore we are using various methods to communicate in our workplace.

Face-to-Face Communication
Most of the time our communication is based on meetings. These type of communication takes place at least once a week. Moreover, every week meeting with supervisors takes place on which entire problems and We strongly believe that face-to-face communication is the most efficient way of work.

Email
Email is a preferred method of communication with supervisors as we can discuss with them our dubts and issues anytime. Emailing enhances efficiency because it is quick to send and quick to respond to and you can even include attachments that are essential to the subject being discussed in the email conversation.
Facebook
It is cheap, user friendly and furthermore it is a fast way of communicating with each other. Furthermore, nowadays it is the most popular online social networking service.

3.7 Risk

Risk management is attempting to identify and then manage threats that could severely impact or bring down our project. Generally, this involves reviewing operations of our team, identifying potential threats to the project and the likelihood of their occurrence, and then taking appropriate actions to address the most likely threats. To be effective, risk management must be proportionate to the size and nature of our porject. Avoiding all risk would result in no achievement, no progress and no reward. The benefits of risk management in projects are huge. We can minimise the impact of project threats and seize the opportunities that occur. This allows us to deliver our project on time, on budget and with the quality results our project sponsor demands.
The biggest risks associated with our project are:

- inappropriate materials
- lack of experience and knowledge
- overexceeded budget
- poor design
- technical problems
- skipping deadlines
- conflicts with stakeholders

3.8 Procurement

Procurement management is known to help an organization to save much of the money spent when purchasing goods and services from outside. To do that we have to compare the cost of all items against quality. It's therefore crucial to manage suppliers performance carefully, to ensure that they deliverables meet our expectations. Although there may be several suppliers, who provide the same goods and services, careful research would show whom of these suppliers will give us the best deal for our project. Due to restrictions we are only allowed to use local Portuguese shops and websites. However, not all goods and services needed to be purchased from outside.

3.9 Stakeholders management

It is well known that to be successful, management of the stakeholders is extremely important. It is essential for us to know how we have to communicate with people who are involved in EPS and how much power and interest they have in our project. In order to know the stakeholder better as well as better understand their impact on our project, we have conducted a 'Stakeholder Analysis', which aims at knowing how to successfully get the support from different parties.

The analysis was made in four steps:

1. Defining all of the stakeholders.

2. Finding their interest in our project.

3. Finding the power they have over the project.

4. Mapping the stakeholders on the graph

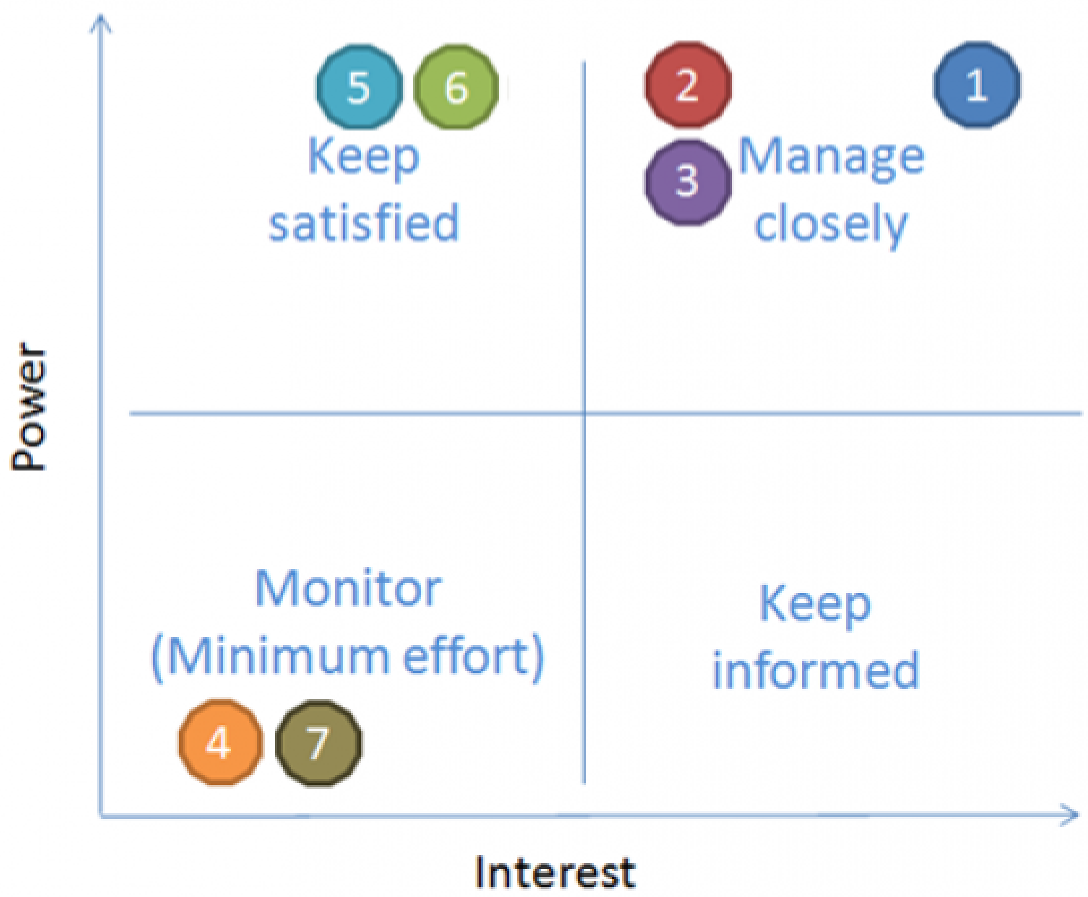


Figure 6: Stakeholders positioning

1. Team Members
The first and probably the most important stakeholder is our team. Indisputably, we have the highest level of power and interest over our project. The results depends mostly on our determination, motivation and time management. Others stakeholders can be very helpful with their knowledge and motivation, however the work is to be done by ourselves. All this makes us the most important stakeholder as we have to work for our success.
2. Supervisor Abel José Duarte
The second main stakeholder that we have identified is Abel José Duarte. As our supervisor he is a predominant stakeholder, and thus he definitely has a huge power over our project. In fact, he is following our work and gives us advice on how we should proceed. Moreover, he can provide us with his vast knowledge on dehydrating process. However, his interest in the project is a little bit lower than ours, but still very high as he wants us to do a great job. Due to the fact that he is an expert in the field, he will probably not learn anything new from our work.
3. Supervisor Paulo Ferreira

Paulo is another paramount stakeholder due to the fact of being our client. His requirements are crucial and must be taken into consideration in our project. Moreover, he is our Electronics Crash Course lecturer, therefore he can also provide us with tremendously important electronic information.

4. Solar dehydrator researchers

The next stakeholders that we have identified are the solar dehydrator researchers. We can benefit from all those researchers through the literature (reports, articles, etc.), because as far as our team is concerned, this literature is really important as it provides all the knowledge about this process. However, the researchers as individuals are not very important stakeholders as they neither have interest in our project nor direct influence on it.

5. Supervisors (jury)

Supervisors are really important stakeholders, because they have a very high level of power as they will grade us and they also show a pretty high level of interest due to the fact that they will read our report. Moreover, they will be present during the final presentation, therefore we have to try to satisfy their requirements.

6. Supervisor Benedita Malheiro

We identify Benedita as a stakeholder, because she is supervising the entire EPS program and because of her expertise in the team project management. As a head of entire supervisors she is very powerful in decision-making and everyone takes into consideration her opinion.Obviously, she wants every group to be successful and will expect a very professional and convincing presentation. However, she does not have a very high interest in our work as she overviews all the projects and cannot follow each group separately.

7. Society

Finally, we have identified society as a stakeholder of our project. Society has very low interest, because of quite low expectations and power with regard to our work. However, because healthcare is a very important domain in our society, we think that in the future we might be able to participate in the improvement of the quality of life.

3.10 Conclusion

Provide here the conclusions of this chapter and introduce the next chapter.

4. Marketing Plan

4.1 Introduction

The Solar Dehydrator is a product for a special market niche. Appealing to the potential consumer group requires a detailed marketing plan. The main goal is also to define our market, to make a segmentation and work out our location in this market. After different analysis which get explained in this report more detailed the other important aim of a marketing plan is to create a coordinated marketing mix for our consumer group. Marketing planning is therefore an important task in the company which should be characterized in part by a systematic approach on the other hand of creativity and flexibility.

4.2 Market Analysis

In a market analysis first of all we have to specify the entire target market in which we find ourselves with our product. In exchange for that we need to collect different information from secondary sources to identify the market potential and the need. Some sources are for example literature like market surveys, classified directory, data bases and as the most important thing the internet. The main goal here is to know in which market is a need for our product it´s really necessary to choose the right target market. A market analysis is not just past-and present oriented it is also possible to assume in potential events in the future. A lot of research is the most important step to do to find the proper market for your product. In our case with as our product is the solar dehydrator the whole market is drying something with the sun light. Since we are a start up company we will stay in the European market for now. To cover various fields in the market analysis requires a micro and macro analysis. These ones differ in the following: The macro analysis deals with influences from the external environment. For this purpose is operated by the Pestel analysis. The Pestel analysis consist of P for political like are there any laws or rules which influence our product in the target market, E for economic determinates that directly impacts a company and have resonating long term effects, S for social here cultural trends and demographics factors are examined, T for technological what kind of innovations in the technology there are which may affect operation for the industry and the company a detailed research is necessary, L for legality in an internal and an external view. In this part observing laws like safety standards and consumer laws. The last E for environment this one is the crucial aspect in the pestle analysis especially for certain industries where the climate and weather has an important role. According to this analysis there is an over view for the whole external environment for the market in which the product is situated. If we apply this analysis to our product we get following results:

For the P: We don´t have to pay a large attention for the political part because are located in the European market where are uniform laws also in the commercial way in the majority of the countries. Moreover our solar dehydrator is portable therefore not that big that there are no problems with prohibiting illegal building. Moreover the majority of the European countries are in a save political situation. For E like economic it is different because the solar energy is used worldwide and the market is still growing. In 2009 the photovoltaic solar industry generated 38,5G$ globally with sale of solar modules and the installation of solar systems. The largest market is in Germany that's the reason why we want to sell our product in this country as well although there are not that many hours of sunshine. But solar energy is quite favoured in Germany. [1] The market potential has not been exhausted. But in countries where there are subventions an assessment is difficult because with subventions there is no correct reflection from the purchasing power. Our concept just to use solar energy is quite new and it is seldom represented in the solar industry. Most of the companies which work in this industry sell solar energy in terms of photovoltaic or solar panel and thereby a mix from solar energy and electricity from a socket.

For S social part the demographic trend goes to an aging society therefore our product is not that big and it is portable.[2] So really easy to handle which makes it usable for all ages. Furthermore the cultural trend in many European countries goes in the direction to eat healthier and fruits and vegetable from an organic farmer. Various people don´t want belong to the "disposable society" any longer. The cancer rate is growing up in most of the European countries and there is still no complete know how for the reason to get cancer.

T the technology of the solar energy is constantly evolving. We try to be on the current technological level. Solar energy are already a few years on the market but to use it alone without any electricity is and for drying fruit is an innovation in this market segment. The solar electric energy demand has grown by an average 30% per annum over the past 20 years.[1]

L in the legality the most important object for our product that it is proof against fire. So a safety standard must be given. In other respects there are not that many laws for our product which influence the development. E in the environmental way we have to study the weather and select the countries where we want to sell the solar dehydrator. Our target market is deeply formed from the weather. So there must be a designated hour of sunshine hours and preferably not that much humidity.

Micro Analysis:

A micro analysis attend to analyse the internal environment from the company covered the definition of the market and the analysis of the industry. The research here is about the differentiation of the market and the customer, with regard to following questions who and where are the customers, which different channels of distribution will use the customer. Why the customer wants to buy our product or why he will prefer our product and how much is willing to pay for that. Another point of the micro analysis deals with the suppliers in the way who are our suppliers are they easy to find. Also here is to analyse the competition. Who and where is our competition and with a comparison about points like service, communication, sale service where are their distributions channels. Our market delineation is product related as the product was selected before a market analysis was done. The relative market is the whole solar electric energy market but we want to distinguish ourselves from the photovoltaic systems. We want to demonstrate to use the solar energy in as useful as possible without having a big installation of a system and especially without using normal electricity. Our product works in a natural way it´s not needed to have the solar dehydrator in the near of a socket. Additionally the solar dehydrator tend to private persons or families with their own garden or terrace. We don’t want operate with big companies. The solar electricity market is one part of our target market the other one is every tool for drying foodstuff except ovens. There are small dehydrators for the kitchen whereby it is possible to dry fruit vegetable and often meat as well. These dehydrators are in the methods and design are really similar to our product but the biggest and most important difference is that they need a socket. So there is no drying in a natural way and it is just for using inside. Likewise we find ourselves partly in the solar market and partly on the dehydration market. For both there are components which distinguish our product from the other providers/products.

Competitor analysis:

Since we must define our competition in a broader sense, all the companies who are involved in food preservation and food processing methods are relevant to us. However, for this chapter, we will concentrate only on European companies and use cases, since our own company is still in the developing phase, and our product will only be manufactured and distributed in Europe for the time being.

Other food preservation and processing methods include freezing, pickling, making jam, preservation in salt, and smoking. All these methods are very different to drying food, which is why we don't consider them as actual competition. However, the process of drying food has advantages over the methods listed above:

- the process of smoking is restricted to fish and meat, whereas we specialize in the preservation of fruit and vegetable. Moreover, it requires a large amount of salt, and smoke components can infiltrate the food.

- foods that are preserved by freezing are prone to lose a certain share of vitamins, especially when they need to be thawed out and re-heated to eat or cook with. Furthermore, the thawed food has to consumed rapidly, since it tends to rot quickly.

- the process of making jam is a very long one and it requires the presence and attention of the person making it. What's more, is that jam contains a large amount of sugar, which makes food drying the healthier method. Finally, jam is usually eaten with other foods such as bread, whereas dried fruit can be eaten anywhere, at any time, on their own, as a small healthy snack.

- preservation in salt, like smoking, is mainly used for fish and meat and would not fit our purposes (fruit and vegetable). Moreover, the large amount of salt makes it rather unhealthy, especially when consumed regularly.

- the process if pickling is used a lot for vegetable, and comes closest to our food preservation method. However, pickling is done with vinegar, which would not work for fruit (for questions of taste). Furthermore, the peculiar taste of pickled food does not appeal to everyone.

For the reasons listed above, our actual competition will cover every company which dries any type of food and/or offers products for drying food, as well as the many companies who deal with solar energy. However, our competition in the field or solar energy companies is limited, since none of these companies engage in processing food. Our competition in a narrow sense are companies who offer relatively similar products, with the same benefits for the client as our product. Here, our rival-products are kitchen dehydrators for indoor use.

• The Stöckli Dörrex from Switzerland with synthetically grids a device for drying fruit, vegetable, mushrooms and herbs. The price started at 109.90 €.

• Severin OD 2940 from Germany this one is a device which need less electricity just 0.40 € for drying 300 g apple. It has 5 different essays which a ground of 31 cm^2 the time for drying is about 6h to 7h and the price is about 50.00 €.

• Sedona TM from Germany has a glass door and a small digital screen and less noise. Moreover it has 9 shelves but need 550 W and is with 10.6 kg really heavy and not easy to handle for everyone. For the drying is needed some films which must be ordered separately and the price is already by 399 €.

• Bomann DR 435 CB Dehydrator also from Germany with 5 shelves circulating air and a safety that the temperature doesn’t fell down around one point. This dehydrator needs less energy with 250 W and the price is about 25 € to 40 €.

For most of the dehydrators there is the suggestion to change the order of the shelves when half of the drying time is over.

Suppliers

Here we have to have a look if it is easy to find suppliers for our resources because if there are a lot of different suppliers for the same product usually the price is less. For the solar panel or wood especially for wood there are a lot of different suppliers for the sensors of the of temperature, the motor and the battery it is a little bit more difficult especially we just have the Portuguese market. In order that our main supplier is the ISEP faculty in Porto.

Target group

“The Greengineers Company” intends to reach a modern kind of customer, who is willing and able to invest in a sustainable, energy-saving way to prepare healthy food – by drying e.g. vegetables from their own garden. Meat and all kinds of animal products are excluded, this Solar Dehydrator is solely made for vegetarian and/or vegan foods. Nowadays, with a growing importance and public awareness of economic sustainability, and the consumer’s rising willingness to make a change and – most important – pay for it, solar-powered tools and products are gaining popularity and will be playing major roles in the near future, as fossil energy resources slowly come to an end. Meanwhile, the modern middle class people (and above) of all ages desire better food, as they have a growing awareness and understanding for a natural, healthy cuisine: the new Slow Food target group. This target group, as they aim to help the environment by “eating responsibly”, is likely to be attracted by a green, environmentally-friendly solar product which helps them fulfil their purposes of preparing healthy, organic food – at its best from their own garden and with a reduction of food waste due to its preservation through the drying process.

4.3 SWOT Analysis

The aim of the Strengths Weaknesses Opportunities and Threats (SWOT) analysis is to figure out the strengths and the weaknesses for the present time and the internal part. On the other side also the threats and the opportunities for the future which is the external part. The SWOT-analysis is an instrument for the strategic planning for companies it is important take the right marketing strategy.

Our strengths consist as we are very customer orientated and we are following the new and really important trend to be sustainable and green with the using of solar energy. Our clients are independent from the prices for the electricity. While we are an international team we have insights in different markets in form from a local view which is probably different which from some facts out of the newspaper. Our product is an innovation especially for Porto. One of the weaknesses from our project is the less time and the specified budget also no one of our team did a project like this before so there are not that much experience. We are surely inflexible with the prescribed deadlines so if something goes wrong is will be difficult to stay in time or fix it that the result is good. The opportunities be composed mainly of the demographic change and also the awareness for the environment and to eat healthy like the own dried fruit without any toxics in it. Another point is the development of the technology and the curiosity of working or more using solar energy. The largest threat for our product are the companies which prepare a lot of different kitchen staff like named in the competition analysis. These companies have a huge assortment and therefore it is possible for them to produce in a cheap way.

4.4 Strategic Objectives

Strategic objectives are require for new market recovery or the development of new sale areas. Thus the strategic marketing serve as a long-term marketing conception. Our main strategic objectives is to find the gaps in the market achieve new target groups and associated therewith the development of new markets. Moreover it is really important for us as we are a start up company that we will increase our name recognition. Since we are more public in Europe and have a save position in our target marketin the chosen contries we plan an expansion in two years. The plan implied to expand partly to the United States as California because here is also a high number of sunshine hours (8) [5].

4.5 Segmentation

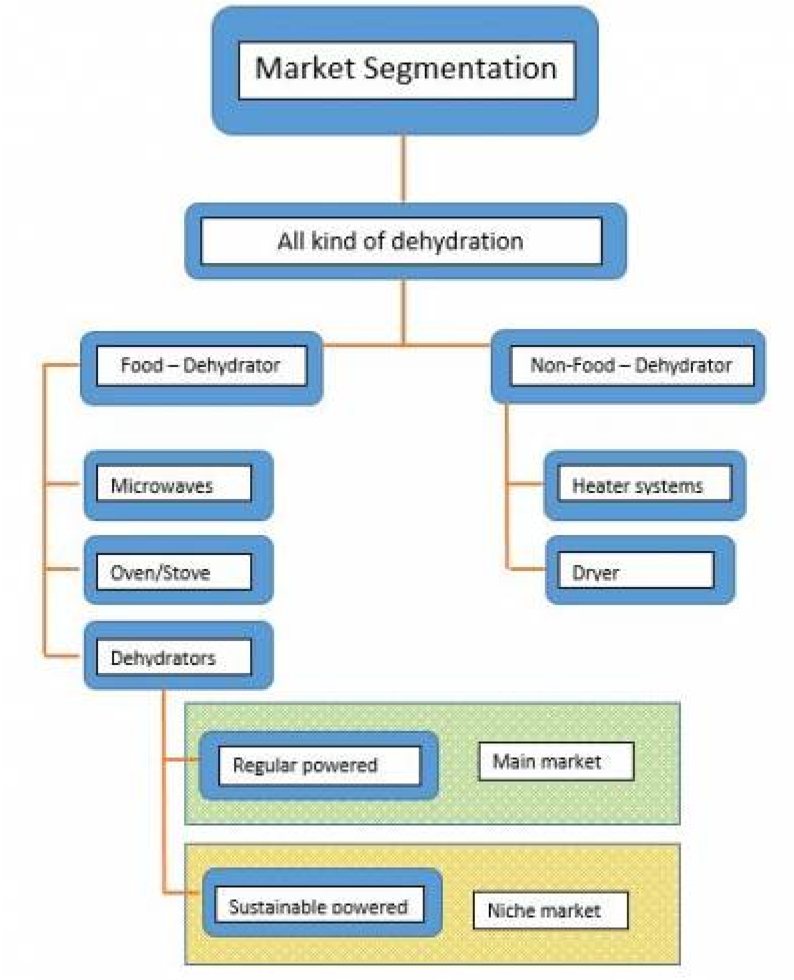


Figure 7: Market segmentation

In the market segmentation is the overall market divided into different market segments. The selection of these segmentation follow specify target criteria. Market segments can be classify by products or by customer. Customer segmentation are for example age, income, job or gender. The product segmentation can be done e.g. consumer goods or investment goods. Moreover there are segmentations with regard to demographical, geographical and psych graphical. The aims from a market segmentations especially in our case are:

• to find the neglected sub markets thus the market gap

• determination of the relevant sub-markets

• the accurate position for new products

• proper satisfaction of customers needs

The macro-geographical delimitation for our product is the market in Europe, the micro geographical delimitation are more or less similar habitats like people who has the opportunity to have a solar dehydrator on their own property. In psychographic regard we consider people with the same lifestyle. People who love the nature and prefer to eat something which was produced by their own.

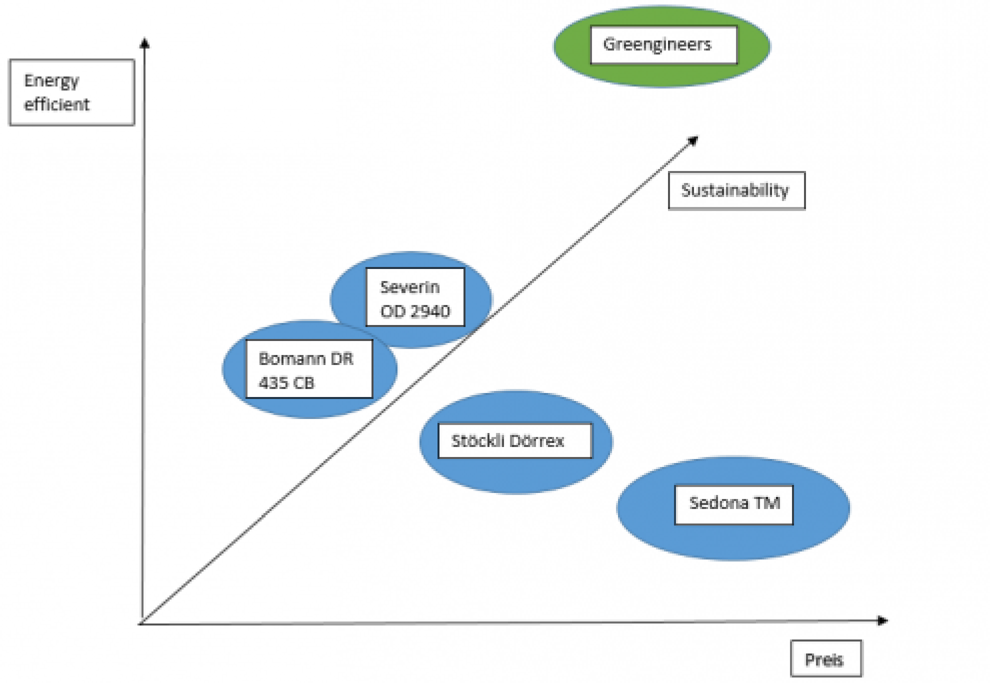


Figure 8: Market position in terms of ratio efficiency-price

4.6 Strategy/Positioning

Positioning

From the attached graphic can be inferred where we want to position ourselves against our competition. We place particular weight on the sustainability of our product and the energy efficiency of it. Our objective to be as sustainable as possible and at the same time be able to compete with our competitors in cost effective manner. So our differentiating feature is our sustainable product design. Because our product are designed in sustainable manner our production cost are higher and the consumer price are higher too. Our selling arguments are that through our sustainable power supply the consumer saves money on using the machine because there no costs for energy anymore. Furthermore our target group are people which have a strong feeling of connection the environment and place great value for eating healthy and save the world.

4.7 Adapted Marketing-Mix

Product

A product consist of a bunch of features that serve the creation of customer value. Our company the "Greengineers" will offer a solar dehydrator which should be portable and thus for private use. The main feature of our product is prepare healthy food by yourself and be there for environmentally friendly. Moreover with the preparing or preserving of the food we support our clients stopping with throw away so much food. Well now our we offer the possibility for our client to save money over years with saving energy costs and also costs for some type of food. The client has the opportunity to eat really healthy because or solar dehydrator dries in a slowly way where most of the vitamins are retained. Our product belongs to the durable goods. Our solar dehydrator is a mix between innovation and products which are already established in the market. There are already dehydrators for drying different things which works with solar panel but especially for this size and for drying fruit and vegetable they all work with socket electricity. Therefore we can speak of an innovation. Working just with solar panel also our differentiation from the competitors and we are as much sustainable as possible also with our commonly used resources.

Price

At the marketing tool price policy is the most important point to work out the optimum price for the product. Issues to consider are prime costs, the strategic positioning - request and the competition.

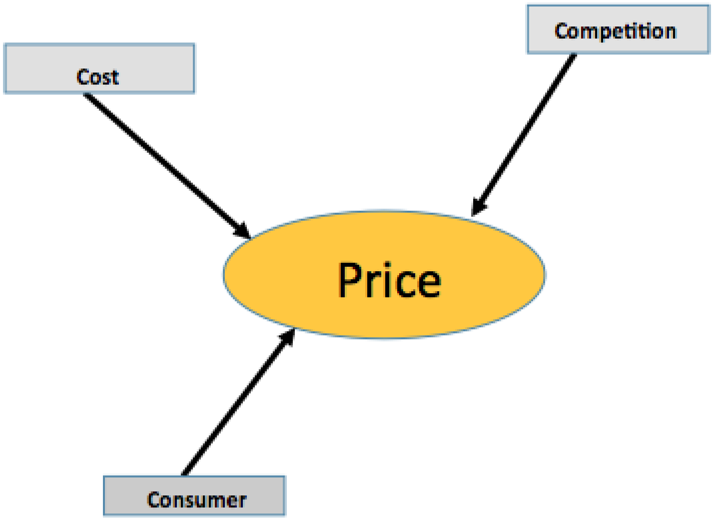


Figure 9: Price components

Basic characteristics price policy decisions are:

- fast implementation

- large impact force

- high speed of tremolo

There are two different strategies for define the price:

- Skimming strategy which implied relative high prices like skimming off the willingness among customers to pay. Thereby it´s possible to cover the costs of development quickly.

- Penetrations strategy this one implied relative low prices. The goal here is to get in a fast way a relative high market share.

For our product the skimming strategy makes more sense at this moment because our develop costs are high and our market is not that big. Moreover we offer a high quality product which comprised that we use high quality resources as well. Another important point for our company is the sustainability which also might be connected with higher costs in the beginning. We operate just in a small market niche so it is important for us to cover our prime costs but also protect our position in our target market. So we will adapt our price to the properties of our product.

But we cannot set up a price yet because we are not ready with the development. First of all we need the prototype which we will build at ISEP and have a look if everything is working that our calculation to be right. After that we know the main part of our prime cost and are able to figure out a price for our product. We know already that we are in our first years in the European market thus we have geographic price differentiation.

Promotion

The third P stands for Promotion – how I do reach my target group? Which instruments of communication should I use? In the promotion you have to think about the message of communication the average and the communication supports. The instruments which are used are depending of the target group. Nowadays there so many possibilities these are the classical ways of promotion print promotion, promotion in the television or cinema, also in the radio or the old way outdoor advertising. But today there are also methods like online marketing which is still growing, mobile marketing, direct marketing, public relation, sponsoring, trade shows and many other ways also. Which instruments are suitable for our company?

We want to practise online marketing it is really common and has compelling advantages as it is not that expensive and there are a lot of different possibilities to operate with it. Moreover it has a high accessibility for different target groups, the flexible individualization is also very high in this communication instrument. We want to create our own web page and a Facebook page which reflect our company.

Another instrument which is suitable for us is the trade show. Most of the people who coming to a target show are interested in the products so there is more or less just the target group represented. That affect makes it easier to lead a conversation sale. At a target show we could present the whole product and also the outcome – the dried fruits and vegetables. In additional on this way it is easier to start a good long life customer relationship.

Direct marketing is another instrument which represented our company well. At the direct marketing we could offer some samples of our dried fruits and tell the potential customer how our product works and what does our company. . Especially in Porto we could organize our Direct Marketing at the Riverside at the weekends like all the other small trader. At the Riverside are not just Portuguese people but also a lot of tourists from different countries so this is a really good way to promote our product “international”.

The last instrument is the outdoor advertising that’s a low cost opportunity to reach many different people.

Place

This part of the Marketing Mix is about in which way our product achieve to our clients. Following decision areas must be worked out.

- Formation of the distribution system

- Formation of the selling activities

- Arrangement of the relationship with the suppliers

The operating system consist of distribution institutions which are combined to channel of distribution.

There are direct and indirect distribution channel. Indirect means that not the company as self sell the product to the client but rather that the distribution works through another company. We will do the direct one because we want to stay in a close contact with our clients. Furthermore there are some important advantages for the direct sales we have the full control about our sales quantity and the directly communication with our clients. So if something wrong it is possible for us to react in a fast way to fix a problem. The disadvantage is that we have the marketing oriented effort by our own.

Another important question is - how we want to stay in contact with our clients? Through our chosen promotion ways we will have direct personal contact in terms of fairs but also with our online marketing impersonal medial contact.

We will sell our product in the business to consumer way because we will stay in personal contact with our clients to have the chance to change something quickly if something is wrong or to get improvement suggestions for future of our product.

Our main distributions channel for the first two years will be the Internet we are gonna to sell the solar dehydrator on our homepage. In additional with it we try to sell some products directly on the fairs, where we present the solar dehydrator.

Also really important for the future of our company is to think about a warehouse for our resources and products, as well about the packaging that this is as much sustainable as possible. Moreover another essential point the transport from our solar dehydrator to the client in an easy and quickly way.

The main important fact of the marketing mix is that the 4 Ps settle with each other. If everything fits with each other and the client is willable to pay the determined price a successful market launch should be given.

4.8 Budget

For an effective marketing mix and good promotion it is essential to have enough money. Especially in the first year within you want to increase the name of the company and get customer you maybe spent more money for promotion.

Our disposal is about 5000 € for the first year. We have to decide which are the main suitable promotions for us that we have the highest benefit. Mainly we chosen promotion channels which are cheap as the Facebook page which is completely free of charge. We will need a small part of the money for:

- Webpage/homepage (0.20 -0.50€) per month [3]

- Booth fee for the fairs (depending which one and where)

- Direct marketing spread samples in the street and at the riverside.

The outdoor marketing like print marketing is the most important point but there are also high price fluctuations which depending on the country. In Germany one super poster is around 878.55€ [4]. As you can see all public promotion is really expensive so it is important try to deal in a most efficient way with the money. That means we have to try to use free promotion as much as possible like visiting every free events which adapt to our product. We just need two people from the team to present our companies on events or trade fairs so it is possible to visit more than one at the same time.

4.9 Strategy Control

Controll

The last step in a marketing plan are the controls it is also a really relevant because without controls you cannot see if you achieve your goal. For the marketing plan there are two different controls the success control and the personal control. The success control is about to review the economic efficiency and also the progress of the whole marketing plan.

The second control is the personal control, here the people who are realizing the marketing plan are controlled.

Both of these controls have to be performed constantly, than it is possible to react as early as possible to change something in terms of the promotion or the personal part.

An option to have an easier control is to define some key performance indicators as the profitability of products, markets and clients. With this key performance indicators it is possible to react before a failure happens.

In our case are following points which need to be checked:

- How rentable are our promotion actions, if necessary we have to change them and try other marketing methods.

- Our quality – we want to guarantee that we have high quality and equally that the resources are on a high level of sustainability.

- The relationship with the customers – we operate in a small market niche therefore it is necessary that we control and cultivate our relations ship to our customer.

So you see that control is really important you always need to control if you plan something otherwise you won´t notice it if something goes wrong. If we implement all these controls we will have a good organized and structured Marketing plan.

4.10 Conclusion

In the marketing plan you analyse you figure out the needs of customers and normally after that you develop a product. In our case we did it the other way around because we chose first all for the product which we want to develop and start with the marketing plan after the first steps of developing. We did a market analyse based on macro and micro environmental level as carry out the PESTLE analysis and analyse the competition. With this information we define our target group and specify our market segment. Afterwards we positioned our company in the chosen market segment. As we are a start up company and still in the development phase we want to stay in Europe for the first two years and chosen special countries where we want to sell our products. We will follow the business to customer system to have a close contact with our customer and a well long life relationship with them.

In the marketing mix we tried to connect the price, product, promotion and place in a best way as possible that it fits to the needs of our customers. The goal is it to have perfect mix as a fair adapted price, be at the correct place at the correct time. And choose an excellent promotion strategy who woo a large number of new clients. Another point here is figure out the suitable distribution channel. We chose the business to customer system to have a close contact with our customer and a well long life relationship with them.

Summarized we will build a portable solar dehydrator for individual people for every ages who have a garden or terrace. This dehydrator will works with solar energy so there are no more costs of electricity during use the dehydrator. With this special function we fill a relatively new market niche in this field.

5 Eco-eficiency Measures for Sustainability

5.1 Introduction

Let’s start with an analogy to introduce this concept. Imagine the world we form part of as a tree. Imagine any kind of tree, and now try to figure out how to make it grow as perfectly as a tree can grow. The cornerstone of the growth has to be with three factors: light, air and substrates. The light provides the necessary energy to transform the substrates into nutriment while the air works, as complementary contribution in the chemical process, to provide enough carbon to the substrates to transform them into carbohydrates. That said, it’s inconceivable trying to make it grow ignoring light in the process, or ignoring the substrates or the air as well. This capricious triangle is what sustainability is about.

Sustainability is the action of finding equilibrium between three primordial and basic factors in the evolution of the human being, such as social, economical and environmental. Each and everyone of these three topics is essential having them under control to ensure a prosperous life, not only about everything that surrounds our company as a product contribution to the world, but a contribution direct to the world itself. This balance is achieved through the imposition of various conditions that affect all the different factors mentioned before in the way to build a harmonic relation between them during the whole cycle of the process.

The main principle is as easy as every action done has to satisfy the human needs of actual generations without compromising the welfare of the incoming generations. Keeping awareness capable of avoiding the human to self-destruct itself, not only in actual situation, but also throughout its existence.

In so far as our company wants to be considered as a sustainable example, a series of measures have been carried out to achieve this target. We have crumbled each and every one of the actions in terms of social, economical and environmental, which are presented below.

5.2 Environmental

The environmental impact is maybe one of the most disputed factor in the society nowadays, and this is why most of the people tend to associate directly sustainability with environmentally friendly, even when it's just a part of it.

To have an idea of how much can we contribute in reducing the environmental impact, we have divided the whole process into two differenced parts: Manufacturing and Use. The main goal of doing this is to have a clear view of most of the actions that concerns to our project and to the environment.

5.2.1 Manufacturing

5.2.1.1 Materials

This section concerns to the most relevant materials in the Solar Dehydrator.

Most of the product is going to be made from a singular material. By using less kinds of materials is a good point to limit the scope in order to increase the control of life of the residues not only by the point of view of the obtaining, also for the future life cycle.

As far as we pretend to base most of the product in a single material it has to accomplish some expectations as environmental friendly in obtention, distribution and refusal.

In an ideal system, our company would be producer and provider of our own materials, but this is near to a utopia. All the requirements to make this possible are totally out of range. To ensure a good behavior in the environmental aspect, we look forward to a material that is provided under a sustainable control on the process. This means that the times of production are over the established minimums to ensure the total recovery of the environmental properties.

With the objective of providing a constant power supply to the electronic system, the Solar Dehydrator needs to have an incorporated battery. The programmed obsolescence is a fact and it is not also a problem towards the customer, it is a problem towards the amount of energy necessary to the recyclability and maintaining of the nature. A long-life battery will decrease most of the impact, looking always for a good ratio life-impact.

Not all the materials are going to have an excellent result in sustainability terms, and this is why we need to reduce the amount of harmful materials by increasing the quantity of eco-friendly ones. The total sum of this materials is quite reduced so even when we cannot avoid the contamination, it is pretended to approximate this values to a negligible point.

5.2.1.2 Process

It must be considered that a Solar Dehydrator is not a product with a high sells-flow. It is convenient to adapt the rhythm of the production to the rhythm that the market imposes, and take advantage of this opportunity to do things in a proper way.

The waste reduction is also a must. Every excess of material it's not just an economical cost, but also an energetic chain that is wasted in vain. Second life solutions have to be studied. Most of them are probably to not provide any kind of economical benefit, but it is all about symbiosis, our dumps may be others solution.

Finally, one of the determinant factors is location. Although we try to avoid non-sustainable actions internally, our way of planning the business can make us fail in the external part, and this still affects directly to our company sustainable plan. Our location is going to be in Europe, Portugal exactly. As far as we know that, the majority of the materials are going to be bought locally. It doesn't ensures the best option, but thinking as a new company, our chances are quite limited and this is what more odds gives us to trust in.

5.2.2 Use

In terms of usage, we are limited to mention that our approach of the functionality of the Solar Dehydrator is based mostly in exploiting as much as possible the energy given by the sun, what supposes a big amount of energy save.

We must take into account not only the energetic saving of our system, but also the energetic saving that supposes the fact of reducing the market consumption of the foods that are dried by increasing its lifespan.

5.3 Economical

The food dehydrators market is very specific and reduced, and if we talk about the solar food dehydrator it's almost non-existent. This means that companies that are in competing in this market have a high risk. Due to dis risk, most of the products have a really high price in relation with what the customer is really buying.

From the intern economical point of view fair quality-price ratio is our main aspiration. By fair it is not pretended to be sold as a gift, but as a real value. Nowadays most of the market products are under the constant renovation with *facelifts* that in an unfair way refuse stablished technologies or usage processes and properties. By producing a well-crafted and designed product, with long-life expectations a consumerism reduction can be provided.

Finally, if we think about a favorable scenario where our product has massive sells, we could talk about a possible reduction of over-consumerism in our society. This fact could reduce the necessity of growing most of the foods in short ranges of time, causing an increase of the quality of the products. But this is not a realistic scenario. The impact of the Solar Dehydrator is going to be really small, but we must not forget that every action counts.

5.4 Social

As the environmental sustainability requires a preservation of the nature, the social sustainability requires a preservation of the well being of the human race as a society. Maslow's pyramid is the best example to describe the needs of each and every human as individual.

Going from the inside to the outside, the employees are the main resource we have. By creating a good environment inside the company we obtain commitment towards the company. Their needs are our needs.

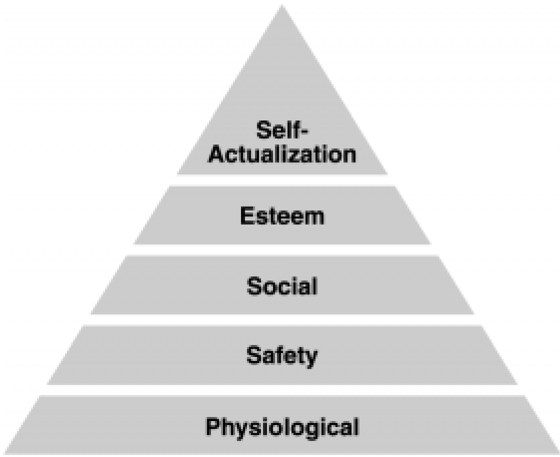


Figure 10: Maslow's pyramid

Flexible working is one of the hardest but better ways to demonstrate faith in the employees, and they will payback by themselves with their best.

As we provide a product defined as healthy and eco-friendly, an immersion in this two topics is mandatory. It won't only give benefits in terms of knowledge and a fresh point of view, also affecting to their lives. The immersion in the psyche of the employees turns out into a common path of thinking, and it is reflected unconsciously in the personal and profesional development.

Mens sana in corpore sano

Next step is taking care about the ones we have a direct relation with, suppliers. Our strong values reflects the willing on change, and this is how we understand the progress of society. The suppliers are expected to pass a minimum of requirements to be part of our mission. The connection between companies with same aspirations make the gears work smoothly. A previous analysis and study of our suppliers not only keeps us in our way, it also can illustrate us with some knowledge to improve.

Finally, at the end of this chain we've got the customers. Once we've applied these measures should be enough from us to justify to the customer our sustainability plan, but we need to include them as well. A familiar relation with the customer is known that ensure a strong union between them and the company. The company is not only about to sell and make profit, it's about to provide a satisfactory service. Customer service is implemented with social skills and the product itself provides a user friendly relation, attracting the attention of everyone around the product.

5.5 Life Cycle Analysis

The life cycle is the study and analysis of the whole situations and processes all along the product service, since the day it is manufactured until the day it is refused. So it’s directly related to the environmental sustainability.

In terms of materials the consideration has to do with the obtaining of the goods, the manufacturing phase, maintenance and the refusal end.

In order to provide some comfort to the customer we need to find the way to involve the customer in the life cycle process. The materials are going to be chosen wisely to avoid any alteration all along its lifespan.

As mentioned before high percentage of the Solar Dehydrator is going to be made from a singular material, which pretends to provide a long-life quality product with almost none maintenance and a high rate of recyclability. This and most of rest of materials and components are expected to last more than the whole product itself.

About processes has been taken in account that our implication in the obtaining and manufacturing of most of the products is quite limited so we must center our attention in the steps of the process we have fully control. On the score of reducing the environmental impact not only materials must be studied, also how are we supposed to design the Solar Dehydrator to make it as recyclable as possible. In terms of processes and design it requires a smart design, easy to assemble and disassemble, avoiding excess of energy and time consumption in both phases. A good point is also the disposition of the materials, preventing to mix materials that once the Solar Dehydrator is refused.

5.6 Conclusion

Eco-friendly may be the closest adjective to the Solar Dehydrator. It is true that sustainability is not all about environmental, it also must concern about the economical and social aspects, but it is a fact that it has a strong value in terms of eco-sustainability. The implementation of a system capable of self-supply al the energy needed is just the tip of the iceberg. A brainwash in society is needed to make it realize that the industrialization is not the only chance. Nature is totally able to provide us most of our needs as the dehydration of food in this specific case. By implicating people to develop his own goods or needs we are growing a sustainable seed in their conscience. Being realistic, our market niche pretends to be very limited, but it has to be said that the world mentality is changing little by little into a green thinking. The road is hard, but there's no road if we don't walk step by step.

6. Ethical and Deontological Concerns

6.1 Introduction

“Ethics is knowing the difference between what you have a right to do and what is right to do.” - Potter Stewart

In this chapter we will present five main ethical and deontological concerns and prove how we apply them to our work. These are ethical issues on Engineering, Sales and Marketing, Academic concerns, environmental impacts and liability. We have to concentrate to all ethical concerns. The Solar dehydrator, what we are developing will follow the rules listed above. These ethical concerns cannot be missed because we have to care about future customers, reputation and reliability.

6.2 Engineering Ethics

Engineering Ethics is the study of moral issues and decisions confronting individuals and organizations engaged in engineering. The Study of related questions about moral conduct, character, ideals and relationships of people and corporations involved in technological development. Engineers Uphold and advance the integrity, honour and dignity of the engineering profession by:

- Using their knowledge and skill for the enhancement of human welfare.

- Being honest and impartial, and serving with fidelity the public, their employers and clients.
- Striving to increase the competence and prestige of the engineering profession.
- Supporting the professional and technical societies of their disciplines.

There are rules to the Engineering Ethics in the “Professional Engineering Code of Ethics”. We are going to keep and use this standards during and after the construction of the project.

1. Hold paramount the safety, health, and welfare of the public. The users’ safety and health is the most important. Based on these will we design our dehydrator. We use high quality of materials. We take care of avoidance of burning injury. Besides we keep in mind the sustainability.

2. Take care for the relationship of each employer or client. We treat understanding and respectfully all team members, recognizing their unique contributions and capabilities. We will be honest and polite with each customer, and serving with fidelity the public, their employers and clients.

3. Perform services only in their areas of competence. We are different engineers with different knowledge and from several countries. Each of us have a diverse background. We try to keep a contact with the right person/expert. And we don’t want to make something if is not in our field of study.

6.3 Sales and Marketing Ethics

Sales and Marketing Ethics are basic principles and values that govern the business practices engaged in promoting products or services to consumers. With our solar dehydrator a main marketing idea is that the system is very sustainable. We would like to create a product that will not pose a menace. Its structure will enable safe use. Our plan is to create an appliance that as far as possible is the most environmentally friendly.

6.3.1 Pricing

Following ethical guidelines in pricing means prices have to be clear without hidden charges. The consumer has to know how much he is going to pay when he makes the purchase. Your prices have to reflect both the cost you incur in delivering the product or service and the value the customer expects to receive.

In our case we have the price for the product itself and we could guarantee that there are no more cost for electricity. We also will offer a guarantee for two years that means if there is something brocken by reason of bad material our client get the repair for free. We offer a long life and sustainable product the price is adapted to our quality.

6.3.2 Products

We would like to provide a product for future customers with good quality. Ethical sales and marketing offer only safe products that are suitable for their intended use.

We offer a high qualitiy product which ensures correct functionality. There are no hidden information, we just use natural and high qualitiy resources for our product. So we guarantee that the product works in a right way.

6.3.3 Promotion

Sales and marketing include promoting your products and services to potential customers. Ethical promotion portrays your offers honestly and accurately, without links to attractive lifestyles that are not relevant. You have to promote your products and services on their own merits and highlight those features that members of a target market might find valuable when promoting to that market segment.

Following these ethical guidelines is good for the business practice because it increases the customer satisfaction.

In our promotion we don´t want to use improper pictures to get attention from the clients. We want to follow the ethical guidelines we will tell the truth in our promotion. Our photos or images reflect our product so the vegetable and fruit looks like that and are be eatable.

6.4 Academic Ethics

Academic integrity/ethics is the moral code or ethical policy of academia. This includes values such as avoidance of cheating or plagiarism, maintenance of academic standards, honesty and rigor in research and academic publishing.

Plagiarism: an act or instance of using or closely imitating the language and thoughts of another author without authorization and the representation of that author's work as one's own, as by not crediting the original author.

Cheating: trying to present a work that one is not own or using forbidden methods to pass an exam.

Working in cooperative with other team members requires mutual respect, understanding and trust. We are able to assistance ourselves at difficulty.

To achieve the goal of having a fresh idea by offering a new concept we don't want to have any contamination of external information. Plagiarism is totally avoided in our project, but it has to be said that we don't have enough knowledge about all the fields required for the Solar dehydrator. Many research is going to be done, but the way to maintain a fair use of this information without trying to show it as genuine knowledge, all the external information is going to be referenced in the bibliography section.

Figure 11: Academic ethic's concerns

6.5 Environmental Ethics

Environmental ethics refers to the moral relations between human beings and their natural environment. More specifically, it refers to the value that mankind places on protecting, conserving, and efficiently using resources that the earth provides.

We will try to apply the following points to our solar dehydrator:

- Ensure the appropriate humidity.
- Create the right temperature.
- Maximize production capacity as much as possible with the minimum energy.
- Choose products that are the most environmental friendly
- To extend the dehydrator's life choose high quality.

Figure 12: Environmental care

6.6 Liability

The last but not least point that we have to talking, it's about the liability. To avoid unpleasant situations there are many rules that we have to take in consideration. And unconditionally we must to keep the rules and be ready to face the consequences. To decrease the number of possibilities that such a situation happens we have to always care about our liability to:

- The law
- Supervisors
- Environment
- Future customers
- EU and local government directives

Our solar dehydrator is meeting with following directives:

- Directive 2006/42/EC on machinery
- Electrical Safety: Low Level Voltage Directive
- Restriction of Hazardous Substances (ROHS) in Electrical and Electronic Equipment Directive
- Mandatory adoption and use of the International System of Units

We must to do everything to avoid accidents that could risk the customers' health. Our product will be tested so it is not dangerous or injurious to humans in any way.

6.7 Conclusion

We will take in consideration all the rules of ethics during the build of dehydrator because this is essential for project working. We strongly believe that thereby we will reach the desired result.

7 Project Development

7.1 Introduction

This Project phase is about the tangible part of the development of the product. The result must show the best qualities always adapted to the requirements of the client and the budget limitation as well. The information shown in the Architecture chapter are hypothesis. The proposals are given based in theoretical knowledge giving feasible solutions, therefore some of the information may vary along the project development with the target of adapting and improving the final qualities of the product.

First concept design was done at the beginning of the project to materialize the idea of the product, but it is all about conceptualization. The final design may notably vary from this first sketched and rendered design.

Figure 12: First concept render in dehydrating position

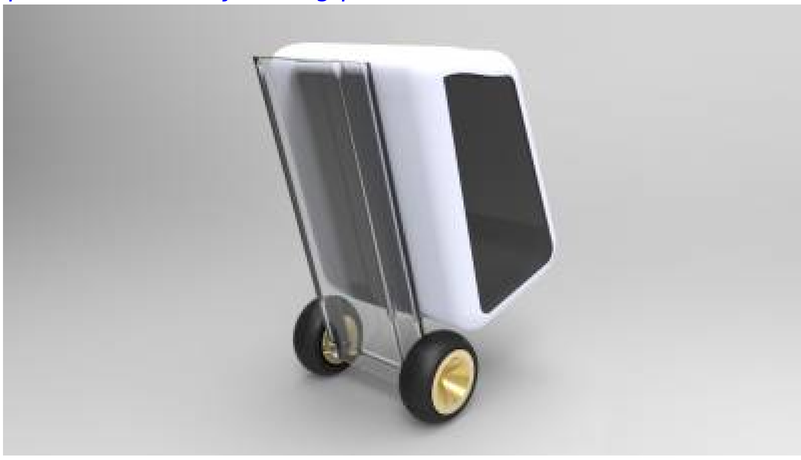


Figure 13: First concept render in portable position

7.2 Architecture

The architecture of the Solar dehydrator although it looks simple at first glance, its simplicity is the main handicap of this project. Such a basic working system that requires so little becomes a real challenge at the time of presenting a full range of improvements without ending up in a hard and complex solution.

From the functional point of view, the target is maintaining the common design of the market solar dehydrators adapting an electronic control system for maintaining the interior of dehydrating chamber in optimum conditions for the process. Another good point to develop is conferring a character of mobility to the product, adapting the requirements to physical customer usage needs.

To accomplish this process is necessary contemplating a temperature and airflow values inside the dehydrating chamber. The own nature of the hot air, which density is inferior to the cold air, works as an engine creating a circulation of air from the lower levels to the upper ones. The scheme of the airflow is based in a vertical way. Thanks to that fact, the air will come into the dehydrator by the down side and then will be rejected, once it has been used to heat and dehydrate the chamber and food, through an air vent allocated in the top of the Solar dehydrator.

It was also considered controlling the intake temperature of the air to prevent an interruption of the process due to airflow without the temperature values required. An air vent right in the intake would control the quantity of air coming inside. This hypothesis was rejected. In case of implementing this hypothesis we would have problems of pressure inside the dehydration chamber, not permitting the hot and wet air going outside the chamber. Moreover, in the worst case it would allow air coming inside by the outtake air vent, what would suppose a big problem in terms of humidity.

In order to explain the concept design, first of all it's going to be presented the bases of the Solar dehydrator operations:

The performance of the system is based in the dehydration of food thanks to a constant airflow coming through it. Ideal conditions for the air are low values of humidity and high values of temperature. The more temperature the air has, the more total capacity of absorbing humidity it has.

Airflow movement is produced in a natural way, so the objective is introducing hot air into the chamber, fill it with as many humidity as possible and reject it quickly to avoid the contamination of the becoming air and the food itself.

How to implement this process in real life?

An analysis of the different sections of the project is presented below, differencing between mechanics, electronics and anthropometrics.

7.2.1 Mechanics

The principle of air heating is made through contact heat transfusion. The power source is the infrared light of the sunrays. To capture this energy there is a heating tunnel. This tunnel with prism shape is opaque by all of its faces but the upper one, which is transparent to favour the light come through. The interior of the tunnel is almost empty but for a metal grid disposed all along with the objective of trapping the heat and transfer it to the air current that flow around it.

Once air is heated, it must be transported to the dehydrating zone. To achieve that, the tunnel must have an inclined ascendant position giving direction to the air to go directly inside. The inclination is going to be variable to suit with the incident angle of the sunrays depending on the month of the year it is being used. The legs allocated in the rear part of the product will enable the variation of inclination of the tunnel.

In the interior of the dehydration chamber the food is settled over grids that allow the air come through in a vertical way. There are various levels of grids to permit the most quantity of food being dehydrated.

In terms of temperature, it must be avoided overheating values to prevent the food getting ruined. Depending of the aliment there are specific values. Some examples a grosso modo of optimum values in the dehydrating process:

Food	Time
Asparagus	5-6 hours
Beans	8-12 hours
Beets	8-12 hours
Broccoli	10 -14 hours
Cabbage	7-11 hours
Carrots	6-10 hours
Celery	3-10 hours
Corn	6-10 hours
Cucumber	4-8 hours
Eggplant	4-8 hours
Greens	3-7 hours
Mushrooms	3-7 hours
Okra	4-8 hours
Onions	4-8 hours
Parsnips	7-11 hours
Peas	4-8 hours
Peppers	4-8 hours
Popcorn	4-8 hours
Potatoes	6-14 hours
Pumpkin	7-11 hours
Summer Squash	10-14 hours
Tomatoes	5-9 hours

Figure 14: Table of temperature and times of dehydration in terms of the product

An air vent in the top of the dehydrator is the attendant to control the temperature values by opening and closing the chamber. A servomotor that works under the orders of a processor performs this action. The processor does permanent temperature lectures. This air vent is also under the clue of humidity levels, so if the humidity values are also over the optimums, the processor will also send an opening order to avoid the food to get cooked.

Mobility in the dehydrator is favoured by a modular design. The heating tunnel can be displaced with a way guides and adapt its position with the dehydration chamber, performing a unique body. In the lower part of the tunnel a pair of wheels is settled, making the usage and transportation of the product more pleasant.

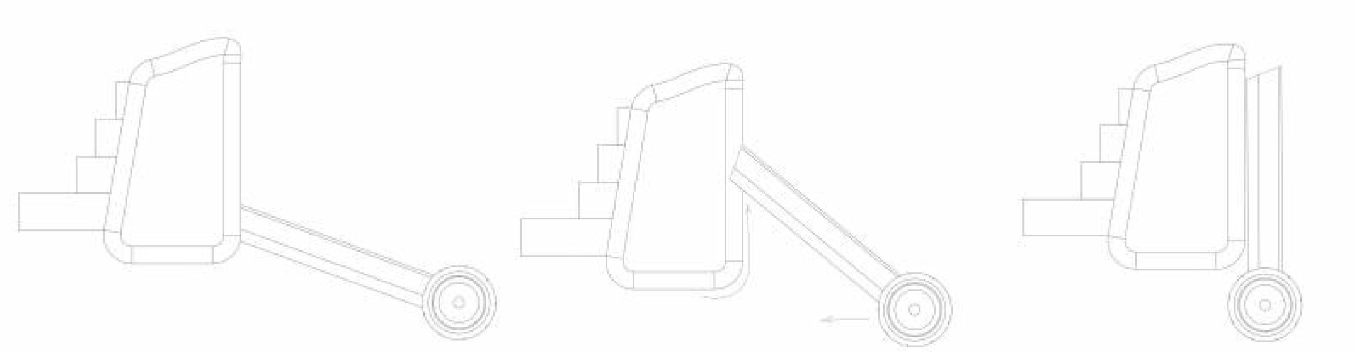


Figure 15: Conceptual storyboard of transformation from static to portable

Another problem to take into account is the isolation of the food to bugs and other physical agents from the exterior that can affect in a negative way to the food. The use of nets in both intakes to prevent the entry of unwanted solids is mandatory.

To illustrate some of the design changes in a graphic way, in the following pictures details as the allocation of the air vent, the interior guides of the new shelves and the initial idea of the rear support system. Also are included some of the different parts draws with references to the main measurements of each. In the assembly draws it is shown in the three critical positions. Lowest position in operation, highest position in operation and compact position, prepared to be carried out. In the compact position must be taken into account that this is not the position the user is going to held while the transporting, it is just reflected the maximum point of attack.

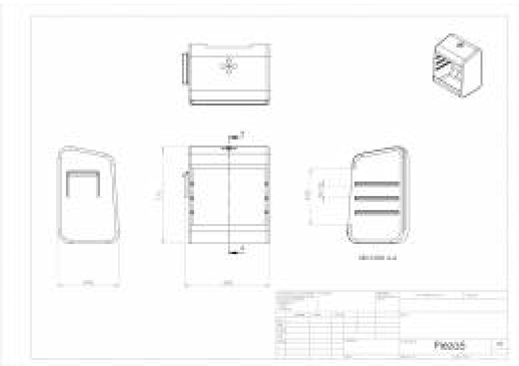
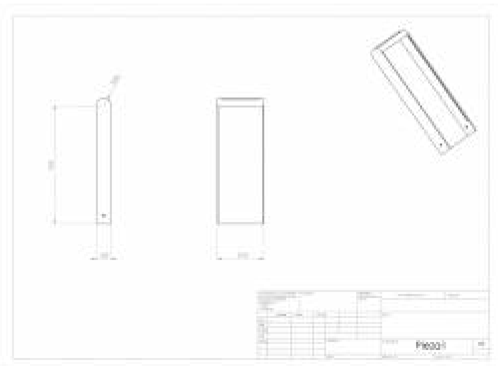
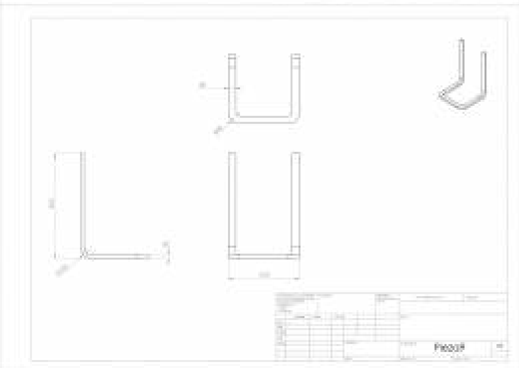
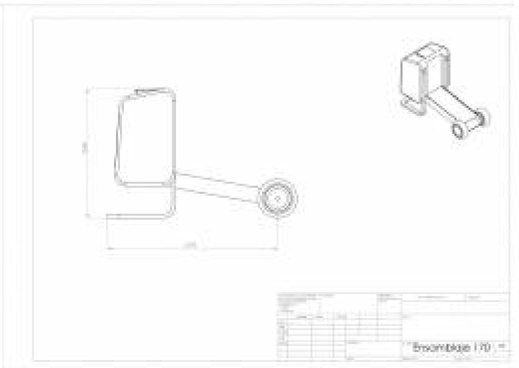


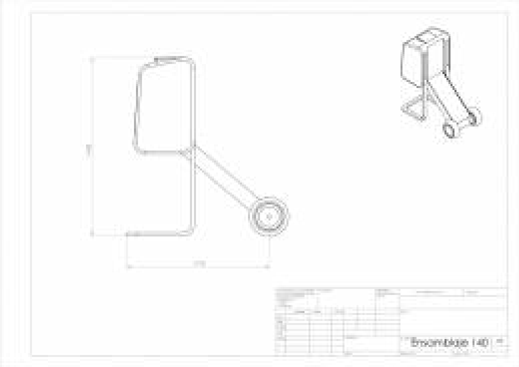
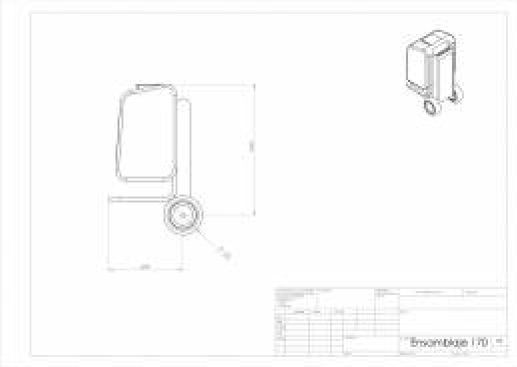
From left to right:

Figure 16: Solar dehydrator detail nº1

Figure 17: Solar dehydrator detail nº2

Figure 18: Solar dehydrator detail nº3

From left to right and from up to down:

Figure 19: Dehydrating box main measurements

Figure 20: Heating tunnel main measurements

Figure 21: Legs main measurements

Figure 22: Solar dehydrator with tunnel at 10º of inclination main measurements

Figure 23: Solar dehydrator with tunnel at 40º of inclination main measurements

Figure 24: Solar dehydrator in portable position main measurements

7.2.2 Electronics

Once the whole functions are presented, it is needed to perform the whole control of the process.

As mentioned before, a variety of sensors have to be controlled in order to actuate the servomotor and achieve an ideal atmosphere inside the chamber. But this is not all. It has been proposed creating a full autonomous system. A system capable of self-supplying energy to avoid unnecessary energy consumption from the net, positions the dehydrator as a 100% solar product.

Adapting a self-power supply system is not enough. As soon as the sun goes out, the photovoltaic panels may not offer enough energy to support the system and make it shut down. The integration of a battery to the system provides a constant supply. This battery is directly connected to the processor, having the photovoltaic panel in a background feeding the battery. To ensure the security to the components and to the user, as soon as a photovoltaic panel is being used, it is required to adapt a solar charge controller in between the battery and the panels.

Concerning to the user experience, we want to give an intuitive and kind interaction between the product and the customer. The system is supported with an LCD display that shows directly to the user all the information needed to start the process. To interact with the system it is also required some keyboard or any kind of control to give the user the chance to select his different needs depending on the requirements on the food that is going to be dehydrated.

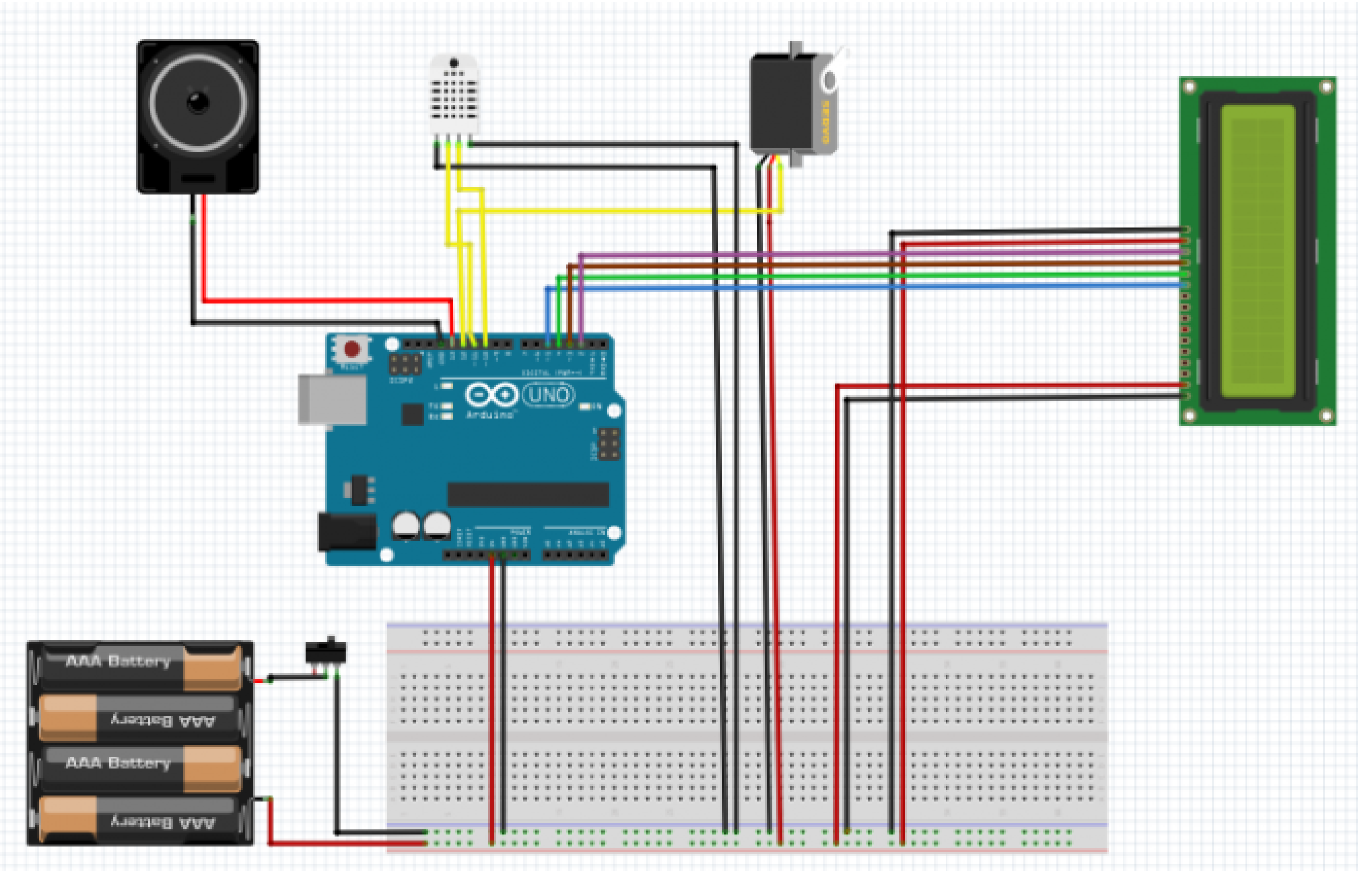


Figure 25: Electronics graphic scheme aproximation

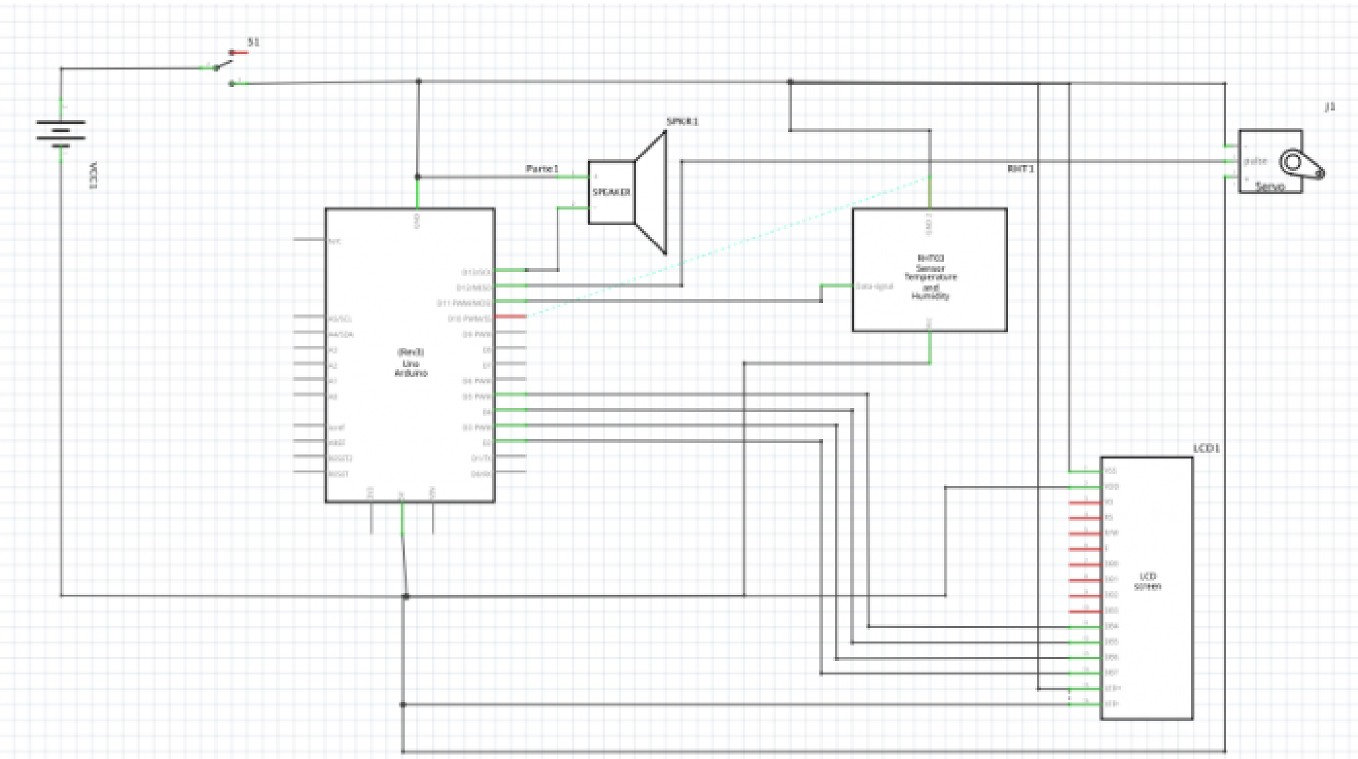


Figure 26: Electronics wire scheme aproximation

An approximation of the circuit is shown above. Due to the limitations of the program it was not possible to add the photovoltaic panel and with the correspondent regulator. Also the battery is not as shown in the images. It's just a representation of the whole system connections.

This template or sketch is valuable for a short future to test the circuit requirements in a proper way before doing the physical circuitry. Voltmeters, Ammeters and Ohmeters are provided in the software, so the fully regulation of values according to the data sheet of every component is going to be study thanks to this application.

7.2.3 Anthropometrics

“Design for humans”

This is the slogan that better fits this chapter.

Anthropometrics has to do with the adaptation of every product to the physical properties of the human being. The adequacy of the measurements of the Solar dehydrator have as a goal a comfortable use towards the final user. It’s the final detail that makes a functional product into a pleasant product.

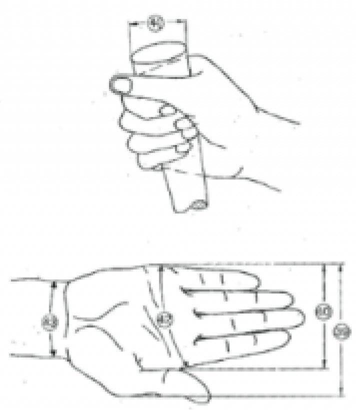
The study is mostly focused around the portability aspects of the product. The determination of the size is dependent of the physical values of the final customer. Females and males are taken into account to realize an universal design. The necessary values are shown in anthropometric studies under the control of international regulations as Deutsches Institut für Normung (DIN).

	HOMBRES			MUJERES		
DESIGNACIÓN	VALOR LÍMITE INFERIOR	VALOR MEDIO	VALOR LÍMITE SUPERIOR	VALOR LÍMITE INFERIOR	VALOR MEDIO	VALOR LÍMITE SUPERIOR
EN POSICIÓN ERGUIDA						
A. ALCANCE HACIA DELANTE	662	722	787	662	722	787
B. PROFUNDIDAD DEL CUERPO PARADO	233	276	318	233	276	318
C. ALCANCE HACIA ARRIBA	1910	2051	2210	1910	2051	2210
D. ESTATURA	1629	1733	1841	1629	1733	1841
E. ALTURA DE LOS OJOS PARADO	1509	1613	1721	1509	1613	1721
F. ALTURA DE LOS HOMBROS	1349	1445	1542	1349	1445	1542
G. ALTURA DE LOS CODOS DESDE EL PISO	1021	1096	1179	1021	1096	1179
H. ALTURA ENTRE PIERNAS	752	816	886	752	816	886
I. ALTURA DE LA MANO	728	767	828	728	767	828
K. ANCHO DE HOMBROS ENTRE ACROMIOS	367	398	428	367	398	428
L. ANCHO DE LA CADERA	310	344	368	310	344	368
EN POSICIÓN DE SENTADO						
A. ALTURA DEL CUERPO DESDE ASIENTO	849	907	962	849	907	962
B. ALTURA DE LOS OJOS DESDE ASIENTO	739	790	844	739	790	844
C. ALTURA DE LOS HOMBROS	561	610	655	561	610	655
D. ALTURA DE LOS OJOS DESDE ASIENTO	193	230	280	193	230	280
E. ALTURA DE LAS RODILLAS	493	535	574	493	535	574
F. LARGO DE PANTORRILLA A PIE	399	442	480	399	442	480
G. DISTANCIA DE CODO A PIE DE AGARRE	327	362	389	327	362	389
H. PROFUNDIDAD DEL CUERPO SENTADO	452	500	552	452	500	552
I. DISTANCIA NALGA RODILLA	554	559	645	554	559	645
K. DISTANCIA NALGA PIE	964	1035	1125	964	1035	1125
L. ESPESOR DEL MUSLO	117	136	157	117	136	157
M. ANCHO SOBRE LOS CODOS	399	451	512	399	451	512
N. ANCHO DE ASIENTO	325	362	391	325	362	391

Figure 27: Anthropometric body measurements

Specifying about the product, two important variables are the size of the handle to carry the Solar dehydrator, and the maximum points of mobility of the arm in a rear and extended position.

The diameter of the handle has to be under some maximum values to avoid the sliding off the hand and also a minimum values to avoid an excess of weight pressure in the palm or fingers of the user.



Dimensiones en cm	PERCENTIL					
	HOMBRES			MUJERES		
	5%	50%	95%	5%	50%	95%
39. ANCHO DE LA MANO INCLUYENDO DEDO PULGAR	9,8	10,7	11,6	8,2	9,2	10,1
40. ANCHO DE LA MANO EXCLUYENDO EL DEDO PULGAR	7,8	8,5	9,3	7,2	8,0	8,5
41. DIÁMETRO DE AGARRE DE LA MANO*	11,9	13,8	15,4	10,8	13,0	15,7
42. PERÍMETRO DE LA MANO	19,5	21,0	22,9	17,6	19,2	20,7
43. PERÍMETRO DE LA ARTICULACIÓN DE LA MUÑECA	16,1	17,6	18,9	14,6	16,0	17,7

* Las medidas corresponden al anillo descripto por los dedos pulgar e índice

Figura 3.9. Medidas de la mano (Según Norma DIN 33 402. 2° parte).

Figure 28: Anthropometric hand measurements

In order to determine the height of the Solar dehydrator, the optimum angle of movement has to be studied and fitted between the commodity values of mobility of the user arms. By determining the shoulder and hand heights and the maximum angles of mobility a range of correct actuation can be calculated providing the correct position of usability of the product.

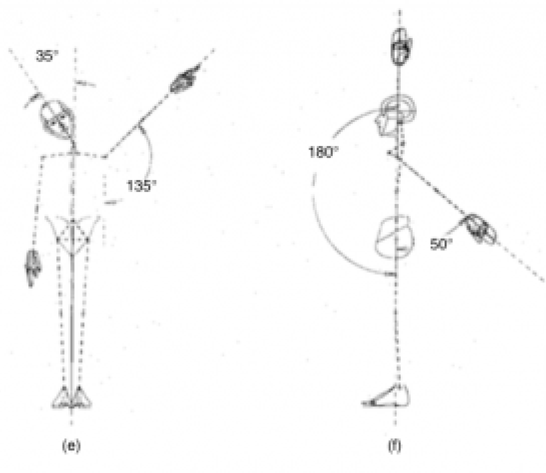


Figure 29: Anthropometric angles of arm attack measurements

This is the main anthropometric data to take into account in the final development of the physics and shape of the Solar dehydrator. Moreover, other aspects will be studied as far as we can intervene in its performance. Aspects as storyboard facilities, intuitive solutions or expression of information.

7.3 Components

- **Temperature Sensors:**

Temperature sensor	Temperature range (°C)	Accuracy (°C)	Input voltage (V)	Price (€)
LM35DZ	0 - 100	±0.5	4 - 30	2.34
ds18b20	-55 - 125	±0.5	3.0 - 5.5	4.5
595-LMT86LP	**-50 - 150**	**±0.4**	**2.2 - 5.5**	**0.905**

- **Humidity Sensors:**

Humidity sensor	Input voltage (V)	Temp operation range (°C)	RH accuracy (%)	Price (€)
HTU21D	**2.5 - 3.6**	**-40 - +125**	**±2**	**12.52**
HIH6030-021-001	2.3 - 5.5	-40 - +100	±4.5	6.03
634-SI7021-A20-GM1	1.9 - 3.6	-40 - +125	±3	5.47

- **Temperature+Humidity Sensors:**

Temp + Humid sensor	Input voltage (V)	Temp operation range (°C)	Temp accuracy (°C)	RH accuracy (%)	Price (€)
DHT11	3 - 5	0 - 50	±2	±5	4.6
DHT22	**3 - 5**	**-40 - +80**	**±0.5**	**±5**	**9.27**
RHT03	3.3 - 5.5	-40 - +80	±0.5	±2	9.36
AM2302	3.3-5.5	-40 - +80	±0.5	±2	13.97

1x DHT22 Humidity + Temperature sensor

Combined temperature and humidity sensors are usually shown as high quality products, and they also go by the hand of a good ratio in terms of price.

- **LCD:**

LCD	Type	Supply Voltage (V)	Price (€)
Itead 1602 LCD	SHIELD + KEYBOARD	5	6,70
ARDUINO LCD MODEL: PTR001467	**SHIELD + KEYBOARD**	**5**	**14,76**
16×2 Character LCD (Parallel Interface) - Model INM-0286	EXTERNAL	5	11,01
LCD 16×2 Powertip PC1602LRS-FWA-B-Q	EXTERNAL	5	12,98

1x ARDUINO LCD MODEL: PTR001467

- **Servomotor:**

Servomotor	Input voltage (V)	Temp operation range (°C)	Torque (kg/cm)	Current compsuntion (mA)	Price (€)
Futaba S3003 Multi Purpose Servo Motor	4,8	-20 to 60	3.2	-	15,93
Hitec HS-422 Deluxe Servo Motor	4,8	-20 to 60	3	520	15,93
Servo FS5106B - Generic High Torque Standard	**4,8**	**-30 to 80**	**5**	**980**	**13,16**
Hitec HS-311 Servo Motor	4,8	-20 to 60	3	-	10,58

1x Servo FS5106B - Generic High Torque Standard

In order to prevent any system failure, it was decided to choose a high quality servomotor. The specifications fit with our requirements, specially in terms of temperature operation range, which is one of our biggest handicaps. The torch provided is high enough for our air vent and the price is what finally makes it really valuable.

- **Power supply:**

Battery	Type	Output voltage (V)	Maximum output Current (A)	Price (€)
ULTRACELL UL1.3-6	Lead-Acid	6	1,3	4,18
KINGMAX BATTERY	Li-Po	7,4	1	10,50
USB Battery BAT01025	Li-Po	5,5	1-2	33,20
USB/SOLAR Battery BAT01022	Li-Po / Solar	5-9	1-2	29,20
HR9-6| Lead-Acid | 6 | 120 |21,40				

1x HR9-6 Lead Acid Battery

This battery is focused for domestic use as for kids toy-cars kid for example. Ensures safety, low maintenance and allows the connection to a rechargeable source, as it is a solar panel in this case.

- **Tunnel transparent sheet:**

Transparent sheet	Type	UV Stability	Toughness	Transparency	Infrared permittivity	Scratch resistance	Price
Ceramic	**Glass**	**EXCELLENT**	**POOR**	**EXCELLENT**	**EXCELLENT**	**EXCELLENT**	**GOOD**
Polymeric	**PMMA**	**EXCELLENT**	**FAIR**	**EXCELLENT**	**GOOD**	**VERY GOOD**	**HIGH**
Polymeric	PET	VERY GOOD	EXCELLENT	VERY GOOD	-	GOOD	GOOD
Polymer	PC	VERY GOOD	EXCELLENT	EXCELLENT	-	VERY GOOD	HIGH

Glass: 0,3m^2 (0,85m * 0,35m) x 4mm of thickness is required.

PMMA: 0,4 m^2 x 4mm of thickness is required.

- **Wood:**

Wood	Resistance	Maintenance attention	Price
Pine	Low resistance to humidity. Low resistance to impact. Fair resistance to strength	High	Low
Iroko	**High resistance to humidity. Good resistance to impact. Good resistance to stress.**	**Very low**	**Average**
Cedar	High resistance to humidity. High resistance to impact. Very good resistance to stress.	Very low	High
Cork	High resistance to humidity. High resistance to impact. Low resistance to stress.	Low	Low

4m^2 x 10mm of thickness required.

Any of the woods shown above can be used for our project. Cedar is the most valuable one but the price can exceed the budget estimated for this product. Iroko is the second option due to its good properties in terms of wet conditions. Third one would be Cork, also looking for the wet conditions, but with cork we may find some problems of stiffness. Finally Pine wood has a good price and with te correct maintenance by the customer can be a long-life product. We'd like to avoid pine to reduce the maintenance of the product and facilitate and improve the comfort of the customer.

- **Buzzer:**

1x PTR000607 - Buzzer 5V

The buzzer requirements are very basics. It is only expected to emit any kind of sound to attract the attention of the user in order to check the food out. A basic and cheap buzzer is enough to satisfy the necessities of the product.

- **On/Off switch:**

1x Rocker Switch - SPST (round) - Modelo INM-0744

Necessary to connect and disconnect the electronic system whenever it is not being used. This component will decrease the energy consumption while it is not being used.

- **Processor:**

1x Arduino UNO Rev3

Arduino provides the project everything that's needed and expected in terms of functionality of the electronic system. Arduino UNO has been chosen thanks to his compatibility with the LCD+KEYBOARD SHIELD chosen and also for the number of pins provided by this specific model, which fits perfectly with our requirements.

- **Solar pannel:**

Solar panel measurements should be below 0.3 m * 0.5 m and able to charge a battery of 6V. The panel is preferred to be polycristaline to avoid the decrease of production common in monocristaline panels when the temperature increases over 25ºC.

- **Voltage regulator:**

A Voltage regulator is needed according to the solar panel requested. In order to protect the battery from a possible overproduction of the solar panel it is mandatory to install a security regulator in between both components to ensure a long-life and secure product.

- **Metal sheet:**

4x Steel Metal Lath (0.85 m * 0,35 m approximate measurements)

This is the most common metal heater sheet used for solar dehydrators. The reason is that the mesh provides a high rate of heat transference from the steel to the air.

7.4 Functionalities

7.5 Tests and Results

7.6 Conclusion

The Solar Dehydrator as a product is mostly defined at this point. The whole of the functionalities have been limited and defined and structural measure references have been developed. The first part of the process has been mostly accomplished, but this doesn't mean the end of research and optimization of the product.

Until this point, theoretical concepts are defining the product, but what it's going to really define the final product is the performance developed in the tangible part of the project, the creation of a physical product. This part requires the fully attention of the team in order to analyze if the product is achieving all the goals pretended. This means there will be changes in the idea, loads of test phases to provide a quality product and the constant research to optimize the system as it's expected from the client.

8. Conclusions

8.1 Discussion

Provide here what was achieved (related with the initial objectives) and what is missing (related with the initial objectives) of the project.

8.2 Future Development

Provide here your recommendations for future work.

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Appendices