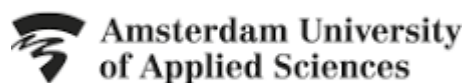


Circulair innovation bootcamp

Final joint report



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Introduction

We have chosen an international programme from three institutions: HVA Amsterdam, University of Applied Sciences Kempten and ULL Tenerife. In such a setting, groups work best together if they are diverse, open-minded, resilient and agile. To form innovative teams, we will be more successful if our teams have different points of view. So all teams consist of members from all three universities. For open communication, we turned on our webcams during the online sessions. In our discussions, we valued all opinions and emotions, we were curious, and we watched, spoke and listened a lot. The teams learned from outside sources and learned to integrate updates quickly into their group. We did not take our first idea as the final one, but kept looking at what was happening outside. Agile teams leave room for their creativity, building on their creative talent to form dream teams based on shared experiences. Agile teams thus communicate often and reward expertise, they make decisions quickly, so they can also improve quickly. So we stepped out of our comfort zone and learned something new. The bootcamp started on 10 October 2022. From this date until the 5th of November, we followed online classes on Tuesday and Thursday evenings. After that, we gathered enough knowledge to visit Tenerife for one week on campus hosted by University of La Laguna in Santa Cruz. We participated in a full fun week in Tenerife with all the international students. During the online- and physical sessions hosted by the teachers from the three institutions, we learned about the sustainable development goals, the 9-R model, circular business ideas and canvas, business models, presenting, pitching, design thinking, persona, business values, and prototyping. We also talked about cultural differences and similarities. During the free time we all met for dinner and drinks to get to know each other even better.

EAVE

EAVE is a new company, in business terms, since it has only 3 years since its creation. It is a company that since its inception has had in mind that we only have one planet so we must take care of it and take action to conserve it, as a sign of their concern in this regard is the name of the company that comes from Electric Avenue.

Why was it decided that the Canary Islands was the best location? This is due to the beneficial geographical location and an optimal climate almost all year round that the Canary archipelago possesses, since it offers the best conditions for taking advantage of nature's resources.

EAVE, using the climatic benefits, decided to venture its business in renewable energy, to contribute its grain of sand to the planet, more specifically in solar energy, i.e. solar panels.

Project - Sustainability and Innovation

Problem Statement

The main problem of the company EAVE consists in recycling photovoltaic panels (onwards PV panels) that have reached their expected lifetime of approximately 25-30 years and can no longer serve their original purpose. Therefore, the company would like to receive information and solutions on how and whether the individual components can be recycled.

Since the company was founded in 2019 and has therefore recently entered the Canary Islands market, it has not yet been confronted with the issue of recycling, as all the modules installed by the company are no more than three years old and are therefore at the beginning of their expected useful life cycle.

However, it is necessary to deal with this major recycling challenge today in order to be well prepared for the future and to be able to present concrete recycling solutions to customers once the useful life has been reached.

Even if EAVES customers have relatively new PV systems, the company still has to deal with the central question: What happens to the panels when they have reached their lifetime and can no longer be used? To ensure that EAVE is well prepared for the future and can present recycling solutions to customers today, the company commissioned the international project team Helios, consisting of students from various disciplines, to present possible recycling solutions.

Project Expectations

Regarding these issues, EAVE would like to have a better understanding on the economic costs and impacts recycling solar panels could have on their business. Furthermore, EAVE has the desire to have improved modelling structures that provide further analysis of efficiency loss and creates an overview of patterns of losses, depending on the location, proximity to the sea, solar radiation and altitude.

- As for recycling, the organisation would like to be capable of managing and maintaining a recycling plan. This plan should provide the organisation with the means to efficiently and effectively.
- Study the variables that may affect the lifetime of the solar panels and find a way to include that information in the model.

As a solution, we propose starting with a deep research on companies which have already experience in the field of recycling in Tenerife or in other parts of Spain. If there are not any companies recycling solar panels, the authorities should be warned about the lack.

Research Context

Circular Economy

At its essence, Circular economy is a new approach to the traditional model of production and consumption, as it focuses on sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. As a result, this new model aims to increase the life cycle of products, and in practice, this implies to reduce waste to a minimum. It creates a closed loop of sorts. The possible benefits, such as waste prevention and re-using, organisations could save money while also reducing the total annual greenhouse gas emissions. In addition, moving towards a more circular economy can reduce pressure on the environment, improve the security of the supply of raw materials, increase competitiveness, stimulate innovation, boost economic growth and create jobs. (European Parliament, 2015)

EAVE Product Analysis

Introduction

As the company's PV systems generally consist of PV panels, one or more batteries and an inverter, we have decided, together with EAVE, to find reuse and recycling opportunities separately for the above-mentioned product parts. Furthermore, the following paragraphs also include replacement components that are more environmentally friendly and can be recycled more easily. In the following paragraphs, a special focus will also be placed on the circular economy of the products.

Inverter

“The power signal supplied by an illuminated PV generator is in DC voltage, which must be conditioned to allow proper coupling to the grid. The power conditioning equipment, called DC/AC inverter, performs the conversion from DC to AC, meeting certain requirements in terms of rms voltage, frequency, harmonic distortion of voltage and current waves, efficiency and performance, electrical safety, etc.” (Lamigueiro, 2013)

Technological development has allowed a high degree of updating in terms of the technology of electricity production from photovoltaic energy, especially with regard to inverters, since, as stated by (Gonzales, 2020) these elements play a fundamental role in solar photovoltaic systems.

Digitalization and modernization have also influenced inverters, forming smart inverters, which have the ability to regulate frequency and voltage, and equipment necessary for monitoring, communication and control from distribution control centres. In the immediate future, smart inverters will become the "brain" of the PV system.

Whether they are conventional inverters or so-called "smart" inverters, they always have electronic parts that are critical to their operation and a physical enclosure to protect them from the elements. The company EAVE commercialised mostly the smart inverters, having as main suppliers GoodWee and followed by Victron.

Battery

At the moment, EAVE uses only different sizes of lithium-batteries, manufactured mainly by GoodWe, Cegase, BYD and Huawei. The most common battery model which is used by the Tenerife situated company is the GoodWe Type Lynx 5,4 kW, which has a weight of approximately 60 kilos.

There are several advantages why the company uses this kind of batteries (Relion, n.d.):

- Lightweight
- Temperature Tolerant
- Fast and safe charging
- Maintenance free
- More Usable Capacity
- Higher energy density

As mentioned above, lithium batteries have various advantages, but the disadvantages of the batteries outweigh on a long term perspective.

The disadvantages can be summarised by the following points (Electronics notes, 2019)

- Low safety
- Protection system required
- High transportation costs
- Difficult recycling
- Hazardous materials

Therefore, we started to search for companies recycling lithium batteries in Tenerife. As there is no one recycling these types of batteries in Tenerife, we searched for companies in the mainland in Spain. Additionally, we looked for companies which recycle lithium batteries within Europe as there are only a few companies across the world which do the recycling of lithium ion batteries due to the difficulty of recycling lithium batteries. The following are the companies that our group tried to contact in order to get the proper information as well as the respective costs for recycling.

1. AkkuSer - Finland
2. Dussenfeld - Germany
3. Redux - Germany
4. Umicore - Belgium
5. SNAM - France
6. Fortum - Finland
7. Accurec - Germany
8. Neometals - Austria

Though there were companies in the United States, China and various other countries we kept our perimeter of research to Europe considering the transportation costs in mind. We were able to get hold of the estimated costs of the recycling of lithium-ion batteries from a Spanish company called - Enviobat Espana S.L, which is a subsidiary of a French firm called Recupyl.

The estimated cost given by the firm was that it would take around 3,600 € in order to recycle 1000 kgs of lithium ion batteries.

1000kg / 57kg (weight of one battery used by EAVE) = ~17 batteries

3,600€/ ~17 batteries = 215€.

Hence we concluded that it would cost approximately 215€ for EAVE to recycle one of their batteries after it reaches its lifecycle. Due to the high costs and the difficulty of recycling lithium-ion batteries, we suggested replacing lithium batteries with other alternatives. The table below includes information on the advantages and disadvantages of the alternatives for the lithium batteries.

Alternative Batteries	Pros compared to Li-ion	Cons compared to Li-ion
Sodium-Ion Battery (Sodium-Ion Battery, 2022)	• Higher safety • Uses easily available material	• Lower energy density • Higher costs
Salt-water Batteries (Large.net, 2022)	• Higher Safety • Easily Recyclable • Uses non-hazardous materials	• Lower energy density • Higher Costs
Lead Acid Batteries (Marsh, 2022)	• Cheaper costs • Less hazardous material used	• Lower energy density • Higher efficiency • Longer life-span
Redox Flow Batteries (Gregus, 2021)	• Higher Safety • Longer life-cycle	• Heavier Weight • Lower energy density
Hydrogen Fuel Cells (Baum, 2022)	• Significantly greener technology • Uses easily available material	• Higher Costs • New Technology • No proper storage and transportation technology

Solar Panel

Solar panels, to put it simply, generate energy from solar radiation. The light, also known as electromagnetic radiation, is emitted by our sun. It captures this emitted radiation and turns it into other forms of energy, such as heat and electricity (Solar Energy Technologies Office, 2022). This technology commonly uses mirrors to reflect and concentrate sunlight onto receivers that collect solar energy, convert it to heat, which can then be used to produce electricity or stored for later use - using electric components (Solar Energy Technologies Office, 2022a). This electricity generation has a handful of dependencies on its effectiveness. As such, the amount of solar radiation that reaches any one spot on the Earth's surface, and the solar panels, varies according to (Solar Energy Technologies Office, 2022b):

1. Geographic location
2. Time of day
3. Season
4. Environmental factors such as landscape and weather

Since the Earth is a 'sphere' shaped object, the sun strikes the surface at different angles, ranging from 0° (above the horizon) to 90° (directly overhead). The angle also determines the effectiveness, as scattered rays and diffusion occur less, the less slanted the sun's rays are (Solar Energy Technologies Office, 2022b). This can be reflected in the location, time of day and seasons. Other environmental factors, such as landscape and weather heavily impact the solar panels capacity to general heat. For example, dusty environments combined with solar photovoltaic systems can reduce the efficiency by increments of 0.21% a day (Mejia, Kleissl, & Bosch, 2014). On the other hand, environments with relatively high humidity (69% - 75%) favours the increased output from solar panels (ref). This works well for Tenerife, as it can be considered a moderate to high humid country, depending on the season (annual average of 61.3%) (from: weather-and-climate.com).

When taking another look at the electronical components of solar panels, one can learn that Concentrating solar-thermal power (CSP) is one of the driving technologies behind the conversion of heat to energy. The concentrated sunrays are moved via mirrors onto the receiver, which in turn heat up liquid (Solar Energy Technologies Office, 2022a). This

thermal energy is used to spin a turbine or power an engine to, thus, generate electricity. However, this mechanism could also be used for other applications, like water desalination, enhanced oil recovery, food processing, etc. (Solar Energy Technologie Office, 2022a). Although, this is not our concern. In the case of our solar panels, the energy would be transferred into the battery, and depending on the situation, the inverter would take care of the grid system integration.

In our context, the solar panels use cell technology, by using photovoltaic (PV) silicon. With both technologies, heat is the wanted energy source from the radiation. However, with the cell a chemical process, which requires the heat, will store the energy without the need of a turbine (Solar Energy Technologies Office, 2022c). This chemical process, which occurs within the silicon cell, creates charges that consequently move electrons and create an electrical current from the top part of the crystals to the bottom part (TedX, 2016).

Solar cell researchers have investigated the ‘best’ cells based on turnover rate, meaning that there are many others (NREL, 2022). If interested, please take a look at the appendix. Unfortunately, the costs of solar (panel) technology has to be relatively cheap in order to create revenue and transform our energy source consumption. And we’ve come a long way, as the cost of solar energy has declined rapidly among all energy technologies (AE Solar, 2020; Shahan, 2014). Only somewhere nearing the end of the 1800’s, the french scientist Edmond Becquerel discovered the photovoltaic effect, at a surprising young age. Decades back, the first solar panels were coated in a layer of selenium with an extreme layer of gold, with an conversion rate of 1% (AE Solar, 2020; César Ramírez-Márquez & Martín, 2022). Luckily, this has changed. Let’s take a look at the components of a solar panel, and specifically ours.

EAVE has two main suppliers of solar cells. These companies being Longi, an organisation that develops large-scale power plants (ref) and CanadianSolar who focuses on providing various solar solutions (ref). EAVE mostly buys two specific solar panel models from these two suppliers. The first one being the panel from CanadianSolar - HiKu, High Power Mono Perc Module. Here are the following material components of this panel (CanadianSolar, 2019):

Specification	Data
Cell Type	Mono-crystalline (Silicone)
Cell Arrangement	144 [2 X (12 X 6)]
Dimensions	2108 X 1048 X 35 mm (83.0 X 41.3 X 1.38 in)
Weight	24.3kg (53.6 lbs)
Front Cover	3.2 mm tempered glass with anti-reflective coating
Frame	Anodized aluminium alloy
Junction Box	IP68, 3 bypass diodes
Cable	4 mm ² (IEC), 12 AWG (UL)
Cable Length (Including Connector)	500 mm (19.7 in) (+) / 350 mm (13.8 in) (-) customised length*
Connector	T6 or T4 series or MC4-EVO2 or MC4-EVO2A

The other solar model, from Longi, is aptly called - LR4-72HpH 430~460M. Here another table with the existing components of this panel (Longi, n.d.):

Specification	Data
Cell Type	Mono-crystalline (Silicone)
Cell Arrangement	144 (6 X 24)
Cable	4mm ² ,
Cable Length	+400, -200mm/+-1400mm length

Front Cover	Single glass, 3.2mm coated tempered glass
Frame	Anodized aluminium alloy frame
Weight	23.3kg
Dimension	2094 X 1038 X 35mm
Junction Box	IP68, three diodes

Although the panel and cable dimensions are different, the main materials and data remain quite similar. As the cell types are both mono-crystalline made from silicone, the frame is also from anodized aluminium alloy. Glass both covers the fronts of the panels and the cell arrangement is the same. Other types of crystals are used daily for different applications. Polycrystalline, Passivated Emitter and Rear Cell and Thin-film to name a few. Each one has its own advantages and disadvantages like economical costs, capacity, resilience and efficiency respectively (Aurora, 2021). EAVE has found that the mono-crystals work best regarding costs, effectiveness and provide margins.

One can take away the following - when working with the materials of solar panels, on wanting an alternative option instead of creating waste, one has to take in mind the following materials:

- Silicon, in mono-crystalline form
- Anodized aluminium alloy, that has been constructed into a frame
- Glass
- Junction box, usually aluminium, steel and plastic
- Diodes, usually silicon and germanium

Circular Economy Research

Recycling

Inverter

The electronic part of the inverter is the most susceptible to failure, especially in lower quality inverters (although these are cheaper). In particular, capacitors are the components with the highest incidence, as the technical support workers of the company inform us.

The electronic board is difficult to recycle, especially on the islands. After contacting several companies, we were told that they could take care of the collection but not the subsequent treatment. Some other companies, found in Spain (mainland) only recycle certain types of electronic cards (specifying weight and measures). We therefore considered that repair, where possible and profitable, would be a viable and circular option.

On the other hand, the "enclosure", the electronics casing of the inverter, is usually made of various metals, easily recycled in a normal recycling process (separating, melting and creation of big solid blocks to later becoming other products), although it could also continue to be used for the same purposes until the damage is significant.

However, we believe that the best recycling option is the one that does not have to be done, i.e. prevention. In the case of solar inverters, reported failures are directly related to efficiency peaks in the solar panels (e.g. caused by shading).

To prevent this problem, the design, choice and placement of the solar panels and their suitability for the site must be carefully considered.

In addition, regular maintenance plays a key role, since the dust particles can get into the inverter and do great damage to it.

We can not forget the importance of reversing the concept of "cheap electronics" through education and awareness raising, teaching the society that "throwing away" is not always the best solution, and returning to the fixing, as when it was necessary.

Solar Panels

One of EAVE's biggest difficulties is the way in which the solar panels are composed, as the manufacturing process begins when the solar cells are made from crystalline silicon that is melted and then mixed with gallium or boron to form wafers called silicon ingots. Phosphorus is then added to the silicon and, together with gallium or boron, gives the silicon its electrical capacity. This manufacturing process prevents the separation of elements of the panels as the assembly process has to be so precise that it leaves a compact form to prevent airborne particles from entering between the cells.

In a race against time, the search for a solution for the separation of the solar cells after the life expectancy is becoming complicated as there is currently no process to split them without altering or damaging the cells.

Reusing & Repurpose

Inverter

When repair is not possible, the creation of a "spare parts bank" that may be needed for future repairs or to create "replacement inverters", which can be used by customers whose inverters have had problems and who are entitled to a new one under warranty. Until the new installation, customers can continue to use their PV panels. This would be a new after-sales service that companies such as EAVE could implement.

Solar Panel

The European Union requires regulations concerning electronic waste, which is regulated by the Waste Electrical and Electronic Equipment (WEEE) Directive, 2002/96/EC. This law specifies how to deal with solar panels once the life expectancy of these is reached in the most appropriate way and being the duty of companies to inform their consumers the most optimal way for the recycling process.

On the other hand, Spain in addition to following the regulations of the European Union has regulations to measures implemented, for example, with the Royal Decree-law 110/2015 on electrical and electronic equipment and waste management that is based on the Spanish legal system 2002/96/CE. Spain in turn has two organisations in charge of solar panels: Recycla and PV Cycle.

Repairing

As it is mentioned above it's not possible to take in consideration that batteries or the inverters are part of the repair department due the difficulties that it shows to do so.

But in the other, when researching possible circular economy options for the solar panels, the organisation Solucciona caught our attention. The organisation describes itself as “[...] a pioneer in Spain offering recycling services for photovoltaic modules through Solrecycle technology, developed by our company” (Solucciona, n.d.). The organisation is able to repair used solar panels, and grant them a second life. It doesn't do this for free, as it assesses the economics by requesting data such as: number of modules, situation of modules, location and storage and visual inspection. However, after the provisioning of this service, EAVE can get rid of their waist, by removing it. One great detail however, is that the organisation is located in the mainland of Spain. Another, arguably more important, is the lacking vision of what happens after these 2nd generation solar panels. It is not ideal to move our problem to another organisation that grants no insight in this matter.

Economical Costs

Considering that the recycling process was feasible and viable, after the separation of the elements, there are certain companies that dedicate their business lines in these aspects. Since the components that are integrated in the PV panels, which will be detailed in the following section, the frame that holds the solar cells is made of aluminium, being an element that allows 100% of its recycling, we contacted one of the specialised companies, Rimetal located in the Canary Islands, to be more exact, in Tenerife.

On the other hand, if the main objective would be the recycling of the glass of the solar panels we have the availability of some companies for this purpose, Sigfito Agroenvases S.L., facilitating the access to all parts since they have fixed and itinerant containers in all the Canary Islands and in the peninsula. The glass that is part of the cells does not have the same luck as the aluminium, since in this case only 95% can be recovered and the Silicium 85%.

Regarding the company dedicated to the recycling of aluminium frames, the company Remital, indicates that for the recycling process they would charge 1.30€ per Kg and for standers a solar panel weighs 25 kilograms per square metre, so for EAVE it would mean an approximate cost of 33€.

On the other hand, for the crystals that are part of the PV panels that weigh approximately 10 kilograms per square metre, Sigfito Agroenvases offers the service of crystals for a price of 1 € per kg meaning that per square metre would cost EAVE approximately 10 €.

Business Idea

Due to the current problems faced by EAVE our team Helios came up with 2 business ideas that can help EAVE earn more revenue as well as higher recognition within the canary islands & mainland Spain. EAVE plans to expand to mainland Spain starting with big cities such as Madrid and Bilbao in the upcoming years.

Recycling of the PV panels is one biggest challenge that the company faces in the potential future and the first business idea would be to start a small scale education system or a small course/seminar session for people interested in working in the renewable energy sector within the Canary islands. The main goal of this business idea would be to educate individuals who are passionate about renewable energy on how solar panels function and teach them on the installation and working process of solar panels, batteries and the inverter all together.

This business idea would help benefit the firm in shaping and educating potential future employees. Educating individuals who are passionate about renewable energy in the field of solar panels would help EAVE gather like-minded individuals from the island to help improve the electricity and the energy condition of the island, which in the end helps EAVE work towards achieving the goal and fulfilling their vision. This business idea not only helps EAVE in securing potential employees but also helps train individuals on tackling the future problems such as recycling of the PV panels, batteries and the inverters.

During the trip to Mt.Teide, it was noticed that there were no street lamps on the road going up the volcano. Therefore team Helios's second business idea was to manufacture small street lamps by reusing the PV panels which can not generate large sums of electricity. With this business idea EAVE can tie-up with the government and also manufacture new solar street lamps which on a long run would attract tourists. The second business idea works in a win-win situation for EAVE and the government as the government benefits from attracting larger number of tourists for visiting and hiking Mt.Teide even during the night time and EAVE benefits by getting a government contract to manufacture street lamps from used PV panels or from new solar panels.

Future Value Propositions

Creation of new products from PV panels, only using the physical qualities. This option can be implemented when the product is not usable anymore but externally is in good condition.

- Pergolas

The PV panel is made from a structure of aluminium, that can be reinforced with other metals to create an outside deck. It can be installed in houses, businesses, terraces, etc. providing from shadow. Nevertheless we have to consider that the aluminium has a very light weight so it has to be installed in places where the wind is not too strong (that means not in the heights or the north-west of the islands).



Source: Endef

- House cladding

In the last few years we have seen new ways of construction, for example, houses made from shipping containers. If we can expect that the waste of PV panels will be enormous in the future and the unstoppable increase of population, we can uninstall them carefully and make new buildings from them. Here we have to study the security and isolation that this material can provide. Probably, it can be used in company with other components in order to make a living place.



Source: Cubiertas Diansa

- Bus shelters

As well as the houses, bus shelters can be built and reinforced. In this case it is not needed that the isolation is that effective, since it is not the first requirement of this construction. Also the walls made from the pv panels can be covered with ads, since public furniture is one of the most successful ways of marketing in Spain.

- Advertising hoardings

Related to the previous idea, we can create ads not only in bus stations but in traditional ways, such as billboards or hoardings.

- Decoration and shop windows for the sale of photovoltaic panels

Solar systems and panels companies need to have samples to show their clients. Maybe new but not working PV panels can be used for this purpose. Also, another way to “promote” their products is including them in the decoration of the company, for example: why not using an old PV panel as a table top?

All these solutions are feasible but we consider that the creation of PV panels is an investment of natural resources and in combination with other components make it a very useful technology, with a high potential inside.

This is the reason why we would like to present other ways to create new solar panels, less efficient but still useful. For that we have to take the solar cells that are capable of resisting a new life and instead of going to a recycling process, go to a reusing one.

Nowadays more and more products are made with PV panels on top, in order to avoid chargers or to follow the green tendency. On many occasions those PV panels produce a low amount of energy, which makes us think it can be a solution to our problem.

Products such as mobile power banks, solar camping lights, torches, radios are some of them. In spite of that, for the moment EAVE is only a commercial company, so it will be necessary to outsource that service.

Currently, as mentioned above, there are no feasible solutions for the recycling or reuse of solar panels, but thanks to the search for knowledge and human development, we have taken the first steps towards a feasible solution, which would not only benefit this sector but also the sustainability of the planet. This is thanks to studies and trials that began in 2016 with a group of Japanese scientists who investigated bacterial colonies for months. They analysed the bacteria extracted from waste polyethylene terephthalate (PET).

This bacterium was named *Ideonella sakaiensis*, it was not until 2018 that a group of British scientists, thanks to the previous research of the Japanese, achieved a small breakthrough with the creation of an enzyme from the bacterium that consists in the decomposition of plastic in a faster way but still not with the speed needed to solve the problem facing our planet.

With this solution, EAVE can face its main obstacle, the recycling or reuse of its solar panels, since this enzyme, by using plastic as a power source, allows the division of the components in a feasible and inoffensive way for the materials to be reused, such as the aluminium support and the connection cables for the elaboration of other PV panel units or the cells in other projects that have already been discussed.

Another feasible solution is the potential collaboration with a company located in the peninsula, Solucciona Energia, which allows users who have already purchased solar panels and have already fulfilled their life expectancy or have been damaged to recover them and give them a second chance, meeting the expectations of consumers by collecting them for repair or buying them back from them. The company is based in Madrid, and EAVE sees great potential for collaboration between the two to offer a more complete service to its buyers.

On the other hand, researchers at Aalto University in Finland have begun to implement lignocellulose, which is a dry vegetable matter also called Biomass, being the most abundant and available raw material on earth, thanks to the implementation of this new material allows the replacement of those components that were not sustainable, such as plastic, the same glass or the same photovoltaic cells, allowing to obtain a higher efficiency. Thanks to this breakthrough it will allow this sector to grow and develop exponentially to a greener world.

EAVE Summary

Renewable energies are key in fighting climate change and going carbon neutral to achieve the goals set by various countries and companies around the world, but humanity also has to consider the effects and the negative impact of renewable energy technologies once the whole world is already using 'green energy'. EAVE assigned Team Helios the task to help them find solutions for recycling of various materials and parts that are used in the installation process of the solar panels. This was one of the main challenges given to our team by the firm. Our task was not only to find a solution to help recycle but also look into various reusing prospects of various materials which are used in the manufacturing process of these devices.

The devices used in the solar panel installation system do not work efficiently once they reach their life-span, which is an average of 20 to 30 years depending on various factors and conditions. The solar panel installation requires 3 basic devices - Solar panels, a battery and an inverter. We approached this challenge by dividing the whole installation system into 3 parts and focusing on two aspects to each part - recycling and reusing which also focuses on the circularity aspect of this project.

As recycling of most of the parts directly is very difficult, the solution that our team came up with to recycle the inverter is to separate most of the parts of the inverter and recycle individual material rather than the whole inverter. Most electronic equipment within the inverter is almost impossible in terms of reusing or recycling. We focused on segregating the case and the various parts in order to reuse them for the manufacturing of another inverter or sending the material to recycling companies.

In the last decade the cost of manufacturing solar panels has dramatically decreased with the increase in demand for solar energy. A solar panel consists of various materials such as aluminium, silicon, plastic, glass, germanium, etc. which are closely bonded together during the manufacturing process. As recycling of the PV panels also provides immense difficulty, various solutions were put forward by our team for the purpose of reusing the panels after they reach their lifecycle.

Recycling of all the material of the solar panel is not 100% possible in today's world, therefore we proposed separation of various metals and materials from the solar panel in order to send them to several companies. It would cost EAVE approximately 33€ to recycle the aluminium and 10€ to recycle the crystal per square metre of a solar panel.

Lithium-Ion batteries are one of the most common batteries used in the majority of the world currently but recycling of the batteries is one of the challenges that various companies and organisations are looking into in the current scenario. Though lithium-ion batteries are hard to recycle, there are various other alternatives that EAVE could consider and replace with. There are only a handful of companies that recycle lithium-ion batteries today, one of which said that it would cost EAVE approximately 215€ to recycle one lithium-ion battery.

As the current technologies do not provide the opportunity to recycle 100% of the solar panel system the team also looked into various futuristic technologies which could help EAVE recycle. One of the findings that we came across was an enzyme taken from a particular bacteria which would help increase the speed of decomposing plastic. This technology would help EAVE in their challenge of recycling solar panels in the future. The new research from last year from Aalto University has begun to implement Biomass as a new way to manufacture the PV panels as a better and more sustainable way with the final goal of a greener world.

Review on learnings: Team 2

Factual Learnings

- Understanding how components of solar panels system work together in order to generate electricity.
- The basic components of Circular economy and SDG's.
- The difficulty of recycling, reusing, repurposing or replacing components in combination with considering business.
- The need for new technology to separate the parts of the PV panels or design new PV panels in an easier way to recycle.
- The relative lack of research or business involved in the problem.
- Time management - working for a week in Tenerife, while having fun.

Social Learnings

- Working in a diverse team.
- Working with an organisation.
- Bring in different ideas from various backgrounds.
- Understanding how a start-up company works, compared to established organisations.
- Difficulties when identifying the stakeholder in our research: teachers or company. Sometimes the goal didn't match (ones on the economic and viable aspect and other on the innovation).

STV

Business idea

During our visit at the bootcamp, our team “Green Dream” has collaborated with the company STV to achieve the best sustainable option. At the beginning, the company presented us with their problem and what they needed us for.

We had to find alternative solutions to compensate for the CO₂ emissions of the company. STV is responsible for the technical services of machines of the company Coca Cola. Most of the CO₂ emissions come from the machines and their use of energy. In total they need to compensate for 39.319,44 TCO₂ (Total Carbon Impact).

The visit to the STV work area has helped us a considerable amount to inspire us. Although, we had to deal with other problems. We realised that STV had already considered many options for a sustainable addition to their company. Moreover, many possible alternatives for CO₂ reduction were not achievable, as STV does not own the machines, but Coca Cola, who decides on the structure and operation of the machines.

Nevertheless, working with STV in their headquarters, we found that they don't have any sustainable features around them, for example they use air conditioning in their office or have plastic plants as decoration, something that we could change. Also, they don't make use of renewable energy as well as their employees, they have very little idea about sustainability.

That is way, we came up with the idea of a net zero building for STV. We are aware that the company has decided to move offices and that is why we have been given this opportunity.

We plan to transform the main building in which STV operates, both the internal structure of the building with a Hybrid Aerothermal heat pump, as well as adding green walls as decoration and blinds and shutters to save energy. On the other hand, we have been thinking about green roofs together with solar panels to provide higher efficiency and a new means of transport that is not as polluting as the car. That's why we have come up with the idea of adding electric cars together with their charging stations on solar energy as well as bikes.

In order to achieve these new features, we have researched and collected information. So you will be able to see achieved examples of these new additions as well as their expected costs.

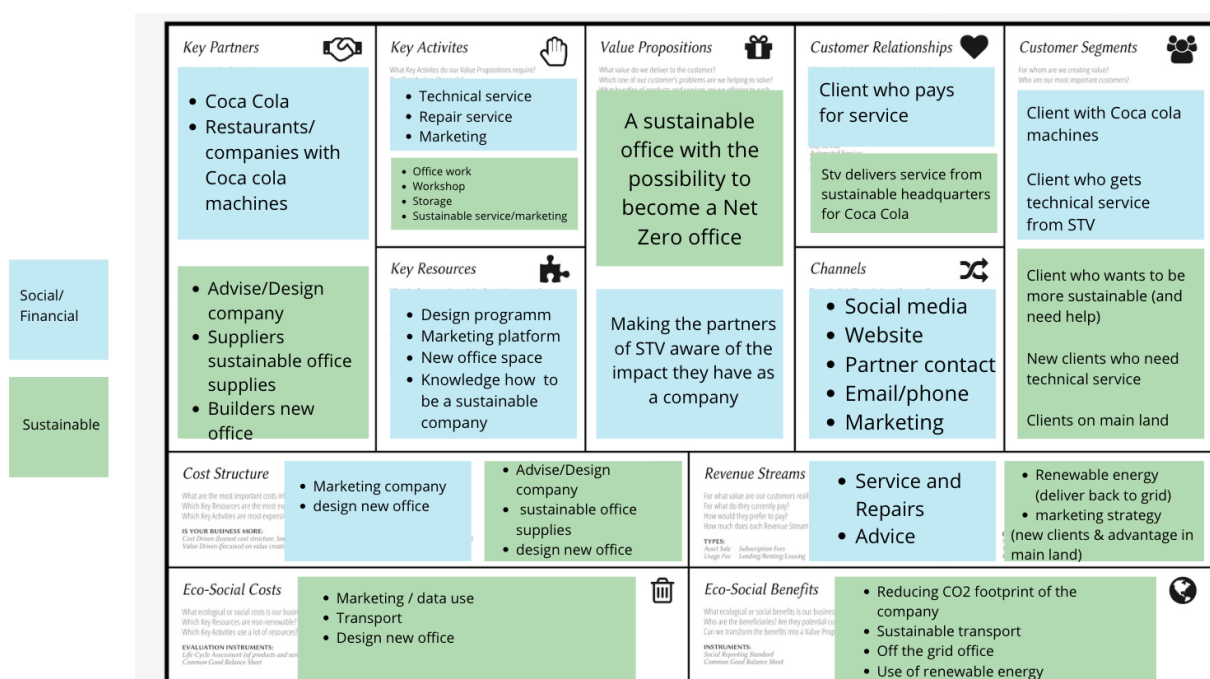
Customer problem

The problem of our company, called STV, is that we need to find alternative solutions to compensate for the CO2 emissions of the company. STV is responsible for the technical services of machines of the company Coca Cola. Most of the CO2 emissions come from the machines and their use of energy. In total they need to compensate for 39.319,44 TCO2 (Total Carbon Impact).

For now STV is working on a way to reduce the emission for bottle racks, vending machines etc. They are now thinking about compensating with planting trees but this isn't solving the whole problem, so we need to think of different ways to compensate for the CO2 emissions for the company.

Business Canvas

A Summary of the business plan and customer problem is projected in the sustainable business canvas below. This canvas includes the final value proposition for STV and all the additional elements are included.



Innovative value(s) proposition(s)

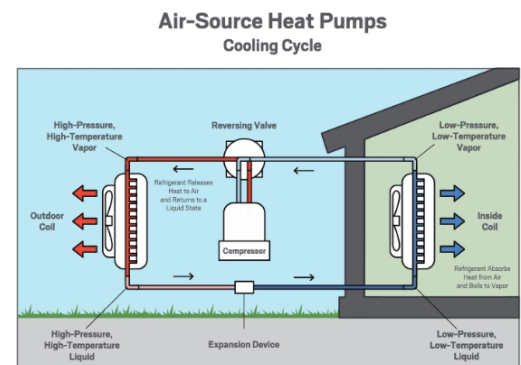
Hybrid Aerothermal heat pump

A sustainable way to cool and heat a building is with an aerothermal heat pump. This installation works on renewable energy such as solar panels. The most efficient heat-pumps are air-to-water heat pumps because they can heat, cool and heat your water.

How does the system work?

A hybrid aerothermal heat pump can also cool a building, which is the most common in Tenerife. The heat pump extracts heat from inside the building and transfers it outdoors like in picture 1. The heat from the inside/outside can also be used to warm the domestic water of the building.

The installation of this system takes minimal space. This system is compact and because it has cooling, heating and water heating it might even save space because you don't need other installations. The system needs an indoor fan, an outdoor fan and a technical room for the main system. (Ameren Missouri Savings, n.d.).



The size and placement of the system depends on how big the building is, how many rooms need cooling or heating and the type of machine.

The type of machine can be determined by the way you want to cool the building. The building can be divided in rooms, which determines how many cooling systems you need and how big the installation will be. For example if you need 4 rooms cooled, you need 4 fans in each room and a system that can support all 4 (Ameren Missouri Savings, n.d.).

Company

ECOFOREST is a company that specialises in sustainable heating and cooling systems for big buildings such as schools, offices. They deliver and install systems all over the world and already did some work in Spain as well. For example they installed a geothermal installation in the University of Vigo in Spain. The picture on the right is a picture of the installation room and can cool and heat the building of 1100 m² (Ecoforest. 2022, 2022). Another company that specialises in heat pumps in combination with solar panels is Solar in Spain. This company also installs systems like this and already did projects in Spain and other countries in Europe (Air Source Heat Pumps (ASHPs), n.d.).



Picture: (Ecoforest. 2022, 2022)

Costs

The average cost range of the installation of a hybrid aerothermal heat pump is between 3875-10.000. This depends on the square feet of the building and rooms that need cooling. A cooling system with 4 separate air units can cost 10.000. In the picture below you can see the capacity a system needs based on the square feet of the building or room that needs cooling.

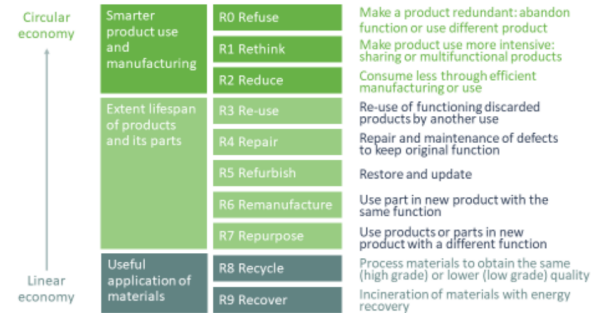
When you decide to invest in a cooling system such as a hybrid cooling system you should also take the savings in consideration. The choice for a hybrid cooling system can save between 20% and 80% of the energy bills in the future. In combination with solar panels on the roof you can be self sufficient and don't need energy from the grid anymore (Modernize. 2022, November 3).

Ductless Heat Pump BTUs Needed	Room Square Ft.
6,000 BTUs	150 to 250 sf.
7,000 BTUs	250 to 300 sf.
8,000 BTUs	300 to 350 sf.
9,000 BTUs	350 to 400 sf.
10,000 BTUs	400 to 450 sf.
12,000 BTUs	450 to 550 sf.
14,000 BTUs	550 to 700 sf.
18,000 BTUs	700 to 1,000 sf.
21,000 BTUs	1,000 to 1,200 sf.
23,000 BTUs	1,200 to 1,400 sf.
24,000 BTUs	1,500 sf. +

(Modernize. 2022, November 3)

Circularity

Most people choose the hybrid cooling system because they want to be more sustainable or create a net zero home or office. To determine how circular/sustainable this way of cooling is we can look at the 9R model, you can see in picture 4. This hybrid form of cooling reduces the use of energy and fossil fuels to cool and heat a building. Therefore this system is on the level of R2 - Reduce in the circular stairs. This is pretty high and has the potential of becoming circular (*Projectenportfolio. n.d.*).



(*Projectenportfolio. n.d.*)

Domotica system

The future of sustainable buildings leads to a lot of technical systems in a building. A way to keep track of all those systems and automatization of the building is with a domotica system. A domotica system is a system which keeps track of systems such as heat pump installation, solar panels and can automatize blinds or shutters. The most common system that is integrated is the smart thermostat, an easy way to control the heating and cooling within the building (*Toepassingen Van Domotica in De Zorg | Beyer Installatie, n.d.*).

How does it work?

In a nutshell, all of the building's technical systems are controlled in one system. This system integrates all the technical systems in one unified system.

The field level is the foundation of a domotica system. It sensors and captures data from all the systems that are integrated and need to be regulated and controlled. You can also choose to integrate a security system to secure the system and the whole building.



Picture: (Domotica, 2022)

The automation level controls, regulates and monitors the systems within the building. These regulations are determined by the management level, which contains the parameters of each system. All this data is stored in a cloud and contains all the information about the building. You can also control and manage these systems by yourself by changing something within the system on a single screen like in picture 5 (*Global, n.d.*).

Company

INDOMOTIQ is a spanish company which specialises in domotica systems for homes and offices. They provide systems for hotels, restaurants, offices, industry workshops, schools and many more. with these systems you can control the temperature in the building, the blinds/shutters (when automated), security systems, see energy consumption and solar panels. The company also works with KNX systems which is an experienced company within domotica systems (*n.d. INDOMOTIQ*).



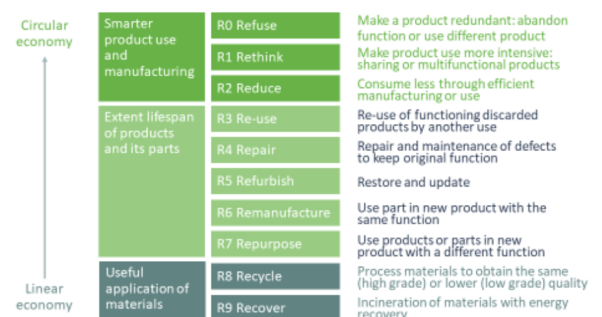
Picture: (*n.d. INDOMOTIQ*)

Costs

The costs of the installation of a domotica system lies between €1.000 and €5.500. This depends on how many systems need to be integrated and how high-tech you want the system to be. Also with an investment like this the savings need to be considered as well. With a system like this you can save energy use because you can turn off the system really easy. You can choose where and when you want the cooling systems and lightning turned on and off (*Electra Gigant, 2022*).

Circularity

Most people choose the domotica system to be more sustainable, save energy costs and regulate the systems easily. To determine how sustainable or circular this system is we can place this system within the 9R model. The domotica system is designed to reduce the need of technical systems and smart use of these systems to save energy. Therefore this system belongs to R2 Reduce because it reduces the use of energy and fossil fuels. This system is a great step in the direction of being circular.



(*Projectenportfolio. n.d.*)

Green roof

A green roof is a roof with a substrate on it where plants can grow on. This way the building is better for the environment and it also has positive outcomes for the company.

Benefits

A few advantages that a green roof has on a building:

- The plants keep the roof cool. (Using Green Roofs to Reduce Heat Islands, 2022)

The cooling is mainly caused by the moisture in the plants that slowly evaporates. The vegetation also has an isolating effect on the roof. There is still a need to isolate the roof with an isolation material to help keep the roof cool, but the plants do also help.

- The green roof increases the biodiversity in the area.

When there is not a lot of green around the area the green roofs can increase the biodiversity. Wild bees, butterflies and ground beetles are insects that can find food and shelter there.

- The green roof can storage water because the plant absorbs the water. (*Green Roof Water Retention*, 2019)

It's also possible to add a 'stormwater management roof'. This ensures that the water is stored during a storm. This will help prevent an entire public sewage system being overwhelmed. The roof will time-delayed run-off the stormwater. (*Stormwater Management Roof | ZinCo Green Roof Systems*, n.d.)

- Green roofs have a pretty long lifespan. The expectancy is around 40 to 50 years. (*An Introduction to Green Roofs*, n.d.)

Costs

The cost of a green roof really depends on the kind of roof the building has. The size of the roof is also a big influence. The Sedum Carpet is known for its low maintenance.

The average that is put on the website is between 50 and 100 euro. But in order to get a good idea of the costs, a quotation must be requested.

Circularity

With the green roof we are thinking a little bit of a way to refuse. The building doesn't need the airco as much as before, because the green roof keeps the building a little bit cooler.

It also increases biodiversity, as it was said before, which also influences the environment around the building.

ZinCo

A company that installs green roofs is ZinCo green roofs. They have placed green roofs on buildings on Tenerife before, like the one below here.

Green roofs on Tenerife (The Spectacular Steep Pitched Green Roofs Define the Appearance of the GF Victoria Hotel in Tenerife., n.d.)



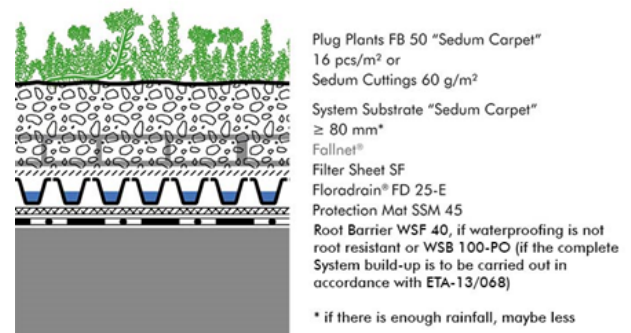
The 5-star luxury GD Victoria Hotel by the Grupo Fedola on the Costa Adeje has a green roof by this company.

Example of the solar panels on the green roof. (*An Introduction to Green Roofs*, n.d.)



There are also options to combine the green roof with the solar panels. This way the solar panels work more efficiently because they keep cooler. The efficiency can be increased by up to an average of 3,6 percent. (Peacock, 2021)

The photo above is an example of a green roof combined with the solar panels from ZinCo. The solar panels lay on a sedum carpet, you can see the structure in the picture below.



construction of the green roof (*Sedum Carpet* | *ZinCo Green Roof Systems*, n.d.)

some of the features of this structure are:

Build-up height	ca. 90 mm
Weight, saturated	ca. 95 kg/m ²
Water retention capacity	ca. 25 l/m ²

Solar panels

Benefits

For the new headquarters we also suggest solar panels on the green roof. The advantages for the building and the company are:

- The company and building are getting more self-sufficient.

When energy is getting more expensive, because of the war between Ukraine and Russia right now, the cost of energy prices are rising. When you put solar panels on the roof, energy prices remain constant.

- The costs as said above.

After some time you will have saved as much energy costs as the solar panels have cost and you will benefit financially from it.

- If the company will get electric cars in the future, they can get charged with the solar panels.

Costs

There are different types of solar panels. (Howell, 2022)

- The monocrystalline solar panels have a higher efficiency when exposed to direct sunlight.
- polycrystalline solar panels work better when diffused light falls on the solar panel.
- There is also the amorphous solar panel, which is the cheapest option on the market, but also has the lowest efficiency. So you will need more solar panels to get the same energy.

So to know which solar panel to choose you need to know how the roof is orientated and how the building is oriented towards the environment.

Solar panel output varies by model and ranges from around 250 to 450 Watts. The Wattage output rating represents how much energy the panel can produce per hour under standard testing conditions. (Ost, 2022)

To see how many solar panels you need, you need to know the amount of energy you are going to use and the type of solar panel.

Circularity

By getting solar panels we are using the rethinking from the 9R strategy. The company will be looking for other ways to get their energy.

By using the sun as a source the energy will be more sustainable because the sun does not have the same emission that for example gas has. The solar panels do have an impact on the environment, but significantly less than the other ways to get energy that are possible in this place.

EAVE

One of the other groups of the bootcamp were working with a company called EAVE. This is an example of a company that can provide solar panels on the island. (EAVE, 2022)

This way it is sure that the company can provide the solar panels for the island Tenerife.

Green walls

Green walls gained popularity during the last few years because they are not just beautiful to look at, but also have a lot of benefits. (Attention Required! | Cloudflare, n.d.)

Benefits

There are a lot of benefits of green walls. One of these benefits is that the green wall purifies the air in the office. This happens because as you should know plants produce oxygen for us to breathe. Green walls help you to improve your air and reduce the carbon emissions up to 25 %. It happens fast that a room gets stuffy and the green wall helps against that. The air gets purified the whole time which leads to less stuffy air and more ability to concentrate. If the air quality is better it also can reduce incidents of illness. This means that the employee's get less sick and are able to work more productively. The green walls are an improvement to the quality of the work environment, because employees tend to respond rather positively to green walls and plants in the workplace. (Attention Required! | Cloudflare, n.d.)

Green walls help to decrease the ambient temperature. Cooling down the office building can get expensive and the green walls help you reduce the costs by absorbing and reflecting some of the sunlight, which helps to cool down the office. (Attention Required! | Cloudflare, n.d.)



(Joyce, 2019)

Costs

A Green wall is an investment. But you will save money while having it. The costs can vary quite a lot. But normally a green wall installation will cost € 150 per square foot of wall. (Joyce, 2019)

Here is an example of the costs of a 500 square green wall from Lackey (n.d.):

Figure: (Lackey, n.d.)

Circularity

Green walls help the circularity of the workspace through reducing CO₂ that gets produced during working hours. It is also great for the work environment, because the people have more access to fresh air than in a normal office.(2022)

While looking at the 9R model we can clearly see that the green walls would belong to the Reduce category, because with the green walls you are able to reduce the CO₂ level of the company. It also helps to use less resources to cool down the office.

Terepia Urbana

Terapia Urbana is a business that invented a way of installing green walls. They are from Spain. The client has to make contact with the company for more information. They help the client design the perfect green wall for them. There are parts, like the colours of the plants and specific plants which the client can choose. After designing the wall, terapia urbana will install the wall. (*Jardines Verticales Sevilla, Jardin Vertical Para Empresas*, 2022)

Picture: (*Jardines Verticales Sevilla*, 2022)

Initial Start-up Costs	
Cost Of Moisture Barrier	\$1,250.00
Cost Of The Green Wall System	\$40,000.00
Cost Of Plant Material	\$14,400.00
Cost Of The Irrigation System	\$7,500.00
Professional Installation	\$13,000.00
TOTAL START-UP COSTS	\$76,150.00 (\$152.30/ Sq Ft)
On-going Running Costs	
Quarterly Licensed Irrigation Inspector	\$200.00 (est)
Regular Plant Maintenance Service	\$8,700.00/ annually
Plant Replacements	\$2,250.00/ annually
TOTAL ANNUAL COST	\$10,950.00
TOTAL 5 YEAR ESTIMATED COST OF A 500 Square Foot Live Green Wall: \$130,900.00	



Sustainable office supplies

Reusable coffee cups

There are many benefits in using reusable Coffee cups. On one side you will produce less waste and help the environment and on the other side is this Coffee cup biodegradable. It is made out of bamboo which means that when the life of the coffee cup is over you can soak the cup in boiling water and then throw it into the biodegradable bin or the compost. These coffee cups are reusable and reducible.(Amato, 2022)



(Ecoffee Cup, 2022)

This Coffee cup costs up to 10€ and exists in various styles (*Ecoffee Cup | Nisbets Catering Equipment*, n.d.)

Eco-friendly cleaning supplies

Eco-friendly cleaning supplies and soaps are very important for a sustainable office. While cleaning a lot of product gets washed into the sewage, which is not good for the environment. Luckily there are easy and not too expensive alternatives to the toxic cleaning supplies. (Writer, 2020)

One of them is the products from blueland. They use biodegradable and non-toxic formulas and the packaging is refillable and they use recyclable material (Our Editors, 2022). Blueland makes cleaning supplies, hand soaps, toilet tablets and cleaner and more.

How does it work?

The clients get the bottles and tablets that they can resolve in warm water. The product resolves in the water and the product is ready to use. There is no Ammonia, no VOCs, no Parabens and no Phthalates in their products. This means the product is as optimal for the human and the environment as possible.

It helps the client to not spend as much money and to be more sustainable at the same time.

With this change the 2 Rs used of the 9R model are reduce and reuse.

The perfect starting kit would be the clean essentials kit, which includes

1 Foaming hand soap, 1 Multi-surface cleaner, 1 Bathroom cleaner, 1 glass + mirror cleaner

The kit costs around 40€ (Blueland, n.d.)

Picture:(Blueland, n.d.)



Blinds and shutters

What are blinds and shutters

Shutters are part of the collective name 'blinds'. These are made to prevent sunlight from entering a building. Often it is used to prevent sunlight from getting into your eyes or to prevent people from seeing inside.

However, they also have a good effect on the heat within a building. You can prevent the heat from entering a building from the outside. This means you don't have to cool the interior as much to make it a good temperature.

It is important that the blinds and shutters are on the outside of the building and that you keep them closed. This ensures that the sunlight and heat remain outside the building. If you have the blinds and shutters on the inside, the heat comes through the glass and is then stopped. This means that the heat does get into the building and it also gets warm inside.

It is possible to open the shutters. This is best done when you have a place where the sun doesn't shine. The shade ensures that it does not get hot on the inside and you still get a little light inside. (Breen, 2022)

What different shutter types are there?

There are two different types of blinds. First we have the 'Fixed Solar Shading'. These are the blinds that sit outside a building. These are really made to reduce the heat in the building and enhance the natural light that enters the building. It is important to note that they are often placed during the construction of the building and are therefore part of the design. You cannot change its position.

We also have the 'Dynamic Solar Shading'. These are also on the outside of the building, but are often installed later. The advantage of these blinds is that you can choose how close you want them. If it is very sunny, you can even choose to close them completely. (Fixed and Dynamic, 2020)

Circular shutters

At the moment there is no circular sun protection available yet. On the other hand, it is now possible to buy shutters made from 100% recycled material. The big advantage of these shutters is that it will cost less extra raw materials and is therefore better for the environment. (Solar Shading Systems | Smartlourve, n.d.)

What will it cost?

The costs of shutters vary widely. It is very important to look at the material of the shutters. The best shutters are the wooden version. The advantage of this is that they can handle temperature better. They are better able to keep the temperature outside. As a result, it will cost less to regulate the temperature in the building yourself. It is also true that you are working with natural material, which is also good for the environment. With natural material you get the least waste and you often need the least energy to turn it into something usable. (Houten Jaloezieën: Voor- En Nadelen, 2020)

The price of wooden shutters will be between €200 and €350 per window (Velez, 2022). This is quite a high price, but the advantage of these shutters is that they also last a very long time. You can count on these shutters to last about 20 to 25 years. So you can spread the costs over all those years and then the price is still reasonable. Apart from this, we have not yet taken into account the costs that you will pay less in energy by using good shutters (De Levensduur Van Zonwering, Hoe Lang Gaat Het Mee?, 2022).

Circularity

If we look at the 9R model for the shutters, the first one we can tick is the Recycle. If indeed a company is chosen that uses 100% recycled material, then that is very good for the environment.

We can then also take into account the function and the result of the shutters. These ensure that we get less heat in the building, so that we also reduce the energy consumption of air conditioning. As a result, it also relates directly to Reduce. Picture: (Bilt, 2016)



Transport

What are electrical cars

At the moment your technical service is driving around the entire island. We think it's great that you are busy developing a system that really looks at which of your employees is closest to a problem. This ensures that you have to travel as little as possible.

However, travelling is now done with vans that run on fuel (diesel or petrol). It would be nice if these vans were replaced by electric vans. The big problem with electric driving is that you cannot drive many kilometres. On an island the distance is limit and therefore it is a good alternative to use electric vans for this.

As soon as STV also has other company cars, it is also possible to replace them with electric cars. This also has a great advantage for the environment (Devos, 2017).



(Mercedes-Benz eCitan | Mercedes-Benz Bedrijfswagens, n.d.-b)

Bikes

When we visited STV, we noticed something. We saw that at the moment the two offices are a bit apart. You have the general office with the three different companies and the warehouse. In addition, you currently own another office containing the IT team. These two buildings are 5 minutes away from each other.

When we went to this company, we noticed that we did this by car. It was also true that we were with such a large group that one car was not enough and we therefore went with two cars.

It is a good solution to change the way of travelling, for such small distances. Perhaps it will be possible to cover this kind of distance with another type of transport from now on. We thought of (electric) bicycles ourselves. Bicycles are a good alternative, because they are easy to use and the weather is often nice in Spain. That way you don't have the problem that you arrive completely wet.

If we look at the emissions of a petrol car compared to an electric bicycle, we arrive at the fact that a petrol car produces 60 times more CO₂ than a bicycle per kilometre (Milieu Centraal, n.d.).



(TripAdvisor, 2022)

Charging stations (on solar energy)

To charge these vehicles, we can make good use of our own charging points. These points can be built on a parking lot at STV and to get electricity, we can use the solar energy supplied by the solar panels. As a result, we ensure that we can use the electricity that is generated more widely (Rooij, 2022).

If too much power is generated, you can supply this power back to the energy company. However, in the future too much energy can be returned. This will ultimately ensure that the energy companies receive too much power, so that they eventually ask for money to accept this power. A nice alternative to this is to use the battery of electric cars to store this energy. When a lot of energy has been produced, you can store it in the battery of the car and if it is still there and no energy has been generated yet, this power can be extracted from the car. As a result, you do not have to supply it back and you can use nicely generated power at another time (Pure Energie, 2022).



(Sinovoltaics, 2022)

What will it cost?

At the company I saw that you use small vans of the Mercedes Benz brand. A Citan is currently being used. Mercedes Benz does not yet have a Citan on the market that runs electrically. This has already been announced and, if all goes well, will be on the market at the beginning of 2023. This will be a nice alternative to the vans that are now used. Because it is not yet on the market, a price has not yet been announced (Mercedes-Benz eCitan | Mercedes-Benz Bedrijfswagens, n.d.).

At the moment there is already a larger variant on the market. Namely the Mercedes benz e-Vito. This is 80% charged within 35 minutes. In addition, it has a range of 286 km with a 100% battery. The starting price of this e-Vito is €48,855 (eVito Gesloten Bestelwagen | Mercedes-Benz Bedrijfswagens, n.d.).

The price of an electric bicycle varies widely. Most electric bicycles start from € 2000, - (eBike, n.d.).

Circularity

Now it's important that we look at the 9R model for transport.

When we look for a new solution for transport that is better for the environment, we are working on Rethink. After all, we are working on finding a better way to move around, with existing products.

In addition, we also take into account the amount of CO₂ that is produced. By choosing to switch from fuel to electric, we will also produce less CO₂. So we also take Reduce into account at the same time.

STV summary

After researching how we could balance the CO₂ emissions produced by the company, before proposing an external solution such as those proposed to us (like planting trees), we came to the conclusion that it is more efficient to refurbish the company and its infrastructure, both indoor and outdoor, thus solving the problem at its source and not repairing the consequences by the production.

Our renovations in the interior of the building will make STV a completely sustainable and green company. The fact that this radical change will make the company stand out from their competition and Coca-Cola will help them to achieve their goals and expand into the mainland.

The improvement of the interior will provide the employees with a better quality of work in a sustainable way. One of the most important innovations is the cooling system. Thanks to the installation of Hybrid Aerothermal, we will be closer to achieving our goal: a net zero building. We will be able to reduce a large part of the energy used by STV in air conditioning and the office can be cooled without the need to damage our environment.

What's more, with the help of the Demotica System, STV will be able to control its energy consumption and avoid unnecessary wear and tear and see its evolution as a net zero building.

In addition, the building could be fitted with blinds and shutters made from 100% recycled materials, so that the building would also remain warmer and prevent direct sunlight from entering, while still remaining bright.

Although these are the most effective new ideas for reducing consumption and being more sustainable, it is also worth mentioning green walls, for the benefits they provide, and replacing them with artificial plants, as, among their benefits, they help to purify the air inside the office and cool it down.

Other ideas we have come up with for internal refurbishments are to use reusable coffee cups to replace plastic coffee machines and eco-friendly cleaning supplies, which will indirectly help to avoid intoxicating the environment.

Among the external renovations, we consider the implementation of solar panels to be very important in order to be self-sufficient. We recommend putting a green roof under the panels as it has positive outcomes. This will increase biodiversity and also the efficiency of the solar panels.

For the part of the work that requires movement, we have thought of replacing the current cars with electric cars and bicycles, in order to minimise the use of fossil fuels. For recharging the electric cars, we believe that a charging station could be added, therefore be closer to being self-sufficient.

Of all the alternatives proposed to achieve net zero building, we recommend without fail the addition of a cooling system, electric cars, reusable coffee cups and solar panels with green roofs. With this, STV will be able to take a step towards sustainability and hence have a circular model. However, all the mentioned items are important to have in order to be a sustainable office. All of them considerably reduce CO₂ and also help the environment. With this new net zero building project, STV will be one step closer to extending to the peninsula and influencing it with these new sustainable ideas.

Review on learnings: Team 2

The points below are a summary of the learnings within this project.

- Working together with international students
- Seeing the company STV and their struggles regarding sustainability
- Improving english
- Gaining knowledge regarding sustainability issues in Tenerife (and other countries as Spain and Germany)

In these past few weeks the group learned how to work together even though there were some cultural differences due to all of the students being from different places. With time we managed to understand each other and how each of us works in a team. It was great to learn how to understand each other and how to work together.

We learned how we can work together with online tools like google meet and canvas, while living in different countries.

With this course we also managed to improve our English due to it being the only language that everyone spoke and because the class was in english.

The week in tenerife helped us to gain more trust between the members of our team. Through that week we learned that even if you don't know each other well, just a small amount of time together can change that view.

We learned not to give up even though all the odds were against us and we learned how to stay open minded to the problems arising.

We learned a lot about circularity and sustainability because of the research we did for STV, but also the lessons and lectures that we got from the teachers. Before the week in Tenerife we had courses in zoom, which were less educational because we did not get a lot of time and information. The information in the zoom classes were a bit superficial and maybe we could have learned more if we got more information about the company or sustainable companies.

With our group we brainstormed a lot to get information about the subject and in this process we also got the knowledge that we needed to be able to understand the project and to fulfil it.

We learned the most about sustainability thanks to the brainstorming, because there everyone looked for information and everyone understood different parts of sustainability and everyone was able to explain what they understood, in a way that the rest of the group understood it as well.

In the end we enjoyed the whole experience together and we really enjoyed the week in Tenerife. We learned a lot thanks to the trip to Tenerife and we are happy we got to experience this trip and project.

TITSA

Introduction of TITSA

On March 17th of this year, the Governing Council approved the preliminary text of the Canary Islands Circular Economy Law, whose need is to convert the waste generated by all economic activities on the islands into resources and furthermore the establishment of mandatory recycling. (Europa Press, 2022)

The primary goal of this regulation is to reduce waste generation and its impact on the environment, as well as to maximise the quality of products or resources, all while contributing to the battle against climate change. The broad concepts that comprise this statement are the joint responsibility of public administrations, businesses, and society as a whole. All of these sectors must be actively involved in this, assuming responsibility for implementing the circular economy model in their respective fields. (Europa Press, 2022)

This work on a circular economy is crucial to slowing climate change. The world must take action to address the climate issue, and material recovery can help. The International Resource Panel of the United Nations concluded that natural resource extraction and processing account for around half of all global greenhouse gas emissions. When created thoughtfully and inclusively, the circular economy has the ability to protect the environment, enhance economics, and elevate social justice. From the start, sustainability necessitates social fairness. How we take, use, and dispose of our resources can have a disproportionate impact on already disadvantaged communities. (Environmental Protection Agency.gov, 2022)

The government of the Canary Islands has reminded all economic sectors, including TITSA, that they must begin taking efforts to participate in the circular economy plan. The first aim of the company was to reduce and recycle the garbage generated by their workshops.

TITSA (Transportes Interurbanos de Tenerife) is one of Spain's most major public transportation companies. The company is owned by the island government of Tenerife.

TITSA offers a broad variety of interurban transportation services to island road travellers. Furthermore, it provides transportation for schools and the private sector. With 570 vehicles, TITSA has one of the most modern bus fleets in Europe. TITSA also has 1722 people who work all around the island. Employees operate in a variety of areas, including 1318 drivers and traffic officers, 190 mechanics who do bus maintenance and repairs, and 110 administrative staff. The value proposition of TITSA aims to provide a public road transport service in Tenerife that meets the requirements and expectations of the island's population. (TITSA, n.d.)

As team Green Mobility 4 Future, our initial task was to provide TITSA with an analysis of how to reduce the current costs of their waste management and suggesting a guideline which contains different strategies to reduce, recycle and reuse waste by, for example, classifying waste into hazardous and non-hazardous.

This should help the company and their employees to set various goals in terms of waste reduction and how to handle the produced waste in the upcoming years in order to allow TITSA to contribute to the environmental sustainability plan.

When we visited the company in Tenerife, we discovered that in order to reach their goals, they needed to address internal issues first. We discovered that the corporate culture is not as healthy as it should be, that there is a lack of contact between employees in the office and their colleagues in the workshops, that trash was not adequately separated, and that the goal and vision were not obvious to the workers.

A tree's growth is influenced by several elements. Some factors can be controlled to ensure that the tree grows and remains healthy. Droughts, for example, are uncontrollable external variables. Some things, however, can be modified, such as the soil and soil culture. TITSA appears to us like a tree. TITSA requires a healthy culture in order to expand. As a result, droughts can also be endured. With our current initiatives, we hope to contribute to the establishment of a foundation for growth through corporate culture.

In order to contribute to the circular economy and establish a healthy corporate culture TITSA should follow our four techniques to accomplish internal and external desired goals. These approaches build on the company's current situation, but are designed to improve it. Among other things, the revision of the values and the identity is discussed, a circular economy workshop is described in more detail, as well as an idea box and finally the process of joining a network.

Approach 1

What is the problem?

There is a lack of motivation, trust and purpose that results in employees who don't have a strong connection to the company they work for. While taking interviews with the employees of Titsa this came forward, that to feel valued in a company there should be three things provided; they want purpose in what they do, they want automatic working and to master certain skills. Right now they don't feel like this situation is provided and their only motivation is money.

When asked what they stand for and who the company was there was no clear answer this suggests that there is no clear company identity which they can stand behind. It results in employees not rooting for the company, they would even avoid the company outside working hours.

So there is a big problem with the motivation, trust and purpose which result in a distancing of the employee from Titsa. The company would do good to change certain aspects so that further distancing is avoided and the employees can be proud again to work for Titsa.

How to solve this problem?

These problems can be solved when change is applied. The suggestion is to find a consulting company which can analyse your company values and identity. They should research what makes the employees proud to work for Titsa and how everybody can be included in this. Also an important thing to research is how you can combine the identity of the company to the values of its employees. This will improve their motivation and they feel heard. An easy way to implement this is to make a vision board which includes the values and identities.

Give them time to master the skill of fixing a bus and give them the knowledge to learn the new skills needed. By doing this they have the feeling of improving themselves in an automatic way. This improves the situation you currently have where they don't feel like they get room to improve.

By making these changes you improve on the three pillars of feeling valuable at work; mastery of skills, automatic working and a purpose that will lead to many benefits for your company.

The benefits of this problem are huge, because the problem is also big, maybe even the most important in the company. We found this out with our project group by visiting the company twice. On the first visit, we got to see their workshop and saw some possible improvements and problems. During the second visit, we presented our own findings and possible solutions to the company. As a group, we found out that there is a bigger problem than just the one-time improvement of sustainability.

It became clear that the corporate culture inside the company wasn't right, also the relationship between employees and employers and their mindsets wasn't really on the spot. We think it should really improve in circularity. When this is improved, and we see a better structure inside the company, the benefits are very useful to improve the circularity. We came up with some benefits.

Implementation of circularity

If there is little to no vision on how to improve the circularity within the company, then there isn't going to change much. Changing the overall mindset of the employers and employees and making them feel responsible for the circularity will result in improvement in circularity. Implementing circularity is a real team job. So everyone, from workmen to managers should participate in this process. Moreover, another crucial aspect for implementing circularity must be taken into consideration, namely the corporate culture of Titsa.

The successful implementation of circularity into Titsa requires a deep change of its corporate culture. A corporate culture could be defined as “the specific collection of values and norms that are shared by people and groups in an organisation and that control the way they interact with each other and with stakeholders outside the organisation” (Hill, Schilling and Jones, 2017). The implementation of circularity requires a shift in employees' and managers' values and behaviours towards circularity principles (Baumgartner, 2009; Kiesnere & Baumgartner, 2019; Siebenhüner & Arnold, 2007).

Thereby, the willingness of employees to protect ecosystems by reducing the negative impact of the company is needed for this shift. All employees should focus on responsible consumption. Additionally, the corporate culture should promote reuse and recycling with an emphasis on long-term value creation in accordance with circularity principles (Salvioni and Almici, 2020).

However, it can be problematic to integrate circular values into corporate culture. (Doppelt, 2003). Organisational or corporate culture can be seen as a significant barrier towards implementing circularity (Linnenluecke & Griffiths, 2010). Considering the above-mentioned aspects, the shift in the corporate culture and the mindset of all employees requires a great change in the company itself, which concerns and empowers everyone from top management to a bus driver.

The importance of active leadership is highlighted as the essential factor to transform organisations towards sustainability and circularity (Mendoza et al., 2019a; Millar et al., 2012). However, there is a lack of awareness among leaders regarding this topic in public organisations according to the studies (Domingues et al., 2017; Mendoza et al., 2019b). The deficits in leadership commitment is considered to be a cultural challenge hindering public companies to implement circularity (Droege et al. 2021c). All this indicates the need of management empowerment as well as the relevance of it for Titsa.

According to the research, the most crucial aspects of promoting a change in a company include role modelling throughout the organisation, engagement of employees with a convincing case for change and empowerment of passionate change leaders at all levels of an organisation.

The first aspect implies the enabling of all management levels to become change leaders. These change leaders should be seen as role models, who set a meaningful example, regarding what is expected from all employees. In particular, this includes managing, embracing and promoting changes for establishing circularity. (Jorgensen et al., 2015). These leaders can thereby persuade or convince employees of the importance of circularity. Additionally, they may build teams and give rewards and recognition.

Moreover, their responsibilities may include training and educating their colleagues. That may allow them to become change leaders as well, who would implement the change further. (Kanter (1999) and Lozano (2009)).

In order to act as change leaders, managers should know how to implement and promote change successfully. This may require a coaching program, which focuses on the key elements of change management and circularity. Additionally, skill building activities and workshops may be needed for management as well as for workers. All these should be focused on how to communicate change to employees successfully, how to gain their commitment and how to empower them during the change processes. Furthermore, the change leaders should be held accountable for a successful transition of the company into circularity. According to the IBM research, all aspects mentioned above are considered to play a key role in managing transformation (Jorgensen et al., 2015).

The change journey may be started with creating a sense of urgency to transform, building leading teams, then establishing and communicating a vision with clear goals. This could involve all stakeholders. Finally, one needs to monitor progress, to make adjustments and to scale the change up. (Doppelt, 2003; Kotter, 1995; Zaak, 2015). Collaborative efforts and participative initiatives such as group work and seminars are considered to be good leverage points for transformation towards circularity, particularly in public organisations (Bögel et al., 2019).

Communication plays a key role in any kind of change process (Doppelt, 2003; Kotter, 1995). In order to actively engage employees during the change journey, one needs to establish a dialogue at all levels of an organisation. This may require a change of communication, or its way. It implies the need of using not only a top-down but also a bottom-up communication approach, particularly regarding the change activities. That may require implementation of multiple communication channels. For instance, one could use collaboration tools, like Slack or Asana and also social media channels. This would allow to gather employee's feedback and encourage communication in all directions, not just top-down. Thereby it would be possible for change leaders to become acquainted with the feedback of their employees and, more importantly, they would know how to manage transformation in a better way.

This clearly indicates the importance of using digital technology and new communication channels for managing change effectively. However, establishing a dialogue at all levels is only a step towards a successful transformation. More importantly, the leaders must consider the employee's suggestions and act upon them. This would demonstrate to employees, that they have been heard and, more crucially, that they can make a difference. According to the research, this is considered to be a key driver for a successful change (Jorgensen et al., 2015).

Circularity assessments, reporting and stakeholder engagement strategies are also crucial for a successful transformation (Mendoza et al., 2019a). These in combination with organisational indicators may help to aggregate and to communicate the crucial information. Additionally, it may help to establish dialogue and engagement with employees as well as to increase general awareness and acceptance of circularity in public organisations (Domingues et al., 2015; Droege et al., 2021a; Ramos & Moreno Pires, 2013). Furthermore, assessing progress reports and indicators allows to establish accountability and motivate stakeholders to implement the change. Thereby it would be also possible to monitor progress without difficulty (Ball & Grubnic, 2007; Doppelt, 2003).

Nevertheless, managing and implementing change of mindset of employees requires not only managers as role models, but also empowerment of new change leaders at all levels, particularly those, who are close to a shop floor. These change leaders are likely to have more impact on the behaviours and mindset of workers than the leaders in formal positions of management. Due to the fact that newly empowered change leaders are close to those workers, who work on the shop floor, it is much easier for them to communicate change effectively. Additionally, they know how to implement the change and what impacts it would have on the workers. This way of change communication is likely to be more successful than the one, which is only pushed through the hierarchy. Managing and leading transformation into circularity should not be the responsibility of management only. It should be possible for every employee at every level to be actively involved in it (Jorgensen et al., 2015).

To sum up, a shift towards circularity requires altering corporate culture and values of Titsa as well as managing change processes. In order to achieve this, all management levels must act as role models as well as be held accountable for the implementation of change.

Additionally, a properly functioning communication must be established, which allows to actively engage employees. Moreover, passionate leaders at all levels of an organisation must be empowered, who would have an influence on the employees' mindset. Combining all these aspects would allow Titsa to transform its corporate culture into a circularity centred one.

Improved mindset for future

Another benefit to this solution is the improved mindsets for all employees of the company. We spoke with employees in the workshop about their motivation and why they go to work. Things we made up from their answers were that they go to work for the money and not for another reason. If there is a coherent team working in the workshops with the same positive mindset that are motivated and willing to improve in circularity, then the performance and results of their work will also improve. For instance, separating waste in the right bins will be done better. When visiting the company we saw that this is already done quite well with a lot of different bins to sort the waste, but what was inside the bin wasn't always correct.

Also, when your employees are going to work with joy and are proud of their work, then they are more likely to stay at the company and won't leave the job, so less fluctuation in employees. We spoke to one of the managers at Titsa, she said that it's not easy to recruit employees for the company, because people don't really want to work there. This is another reason why it is important to invest in your people: to not make them leave the company.

For the future, it's always important to have a firm foundation to build on. 'If you have a bad foundation to build on, then your building will be crooked.' From a good structure, other solutions can be implemented. The other solutions to the circular economy problem can be found later in this document.

Costs

The solution to this problem comes with costs to solve them. The costs are estimated and may change in reality.

Vision boards

The main objective of a vision board would be to communicate the values of Titsa to its employees. These values could include circularity and satiability as the main pillars, as well as equality, a strong feedback culture and empowerment of every employee. This would be of assistance for Titsa to transform its corporate culture. That would allow to build a foundation for a transformation into circularity.

The vision boards that are placed in the buildings will have a price of €50,- approximately. The costs of the vision boards are made up of thinking about what should be on the board. This may take some time for employees: coming up with ideas, reviewing them and verifying the ideas with the employers. Then, the material costs of the board. They are very low. The price for the board is €50 per unit. The more boards placed, the lower the cost per unit, because thinking of the idea is a one time process and placing them will only cost material costs.

The idea of the vision boards is very cost effective. The prices to pay are low and the results are great.

Consultancy company

The other solution was hiring a consultancy company. This will require a higher cost, but will also solve the biggest problem in the company. After doing some research on the internet, we have estimated the costs at around €500,- per hour. We saw some examples of companies charging €100,- per hour, others asked €1000,- per hour. The price of hiring a consultant is also dependent on the experience of the company and their previous results. According to Green (2021), an experienced freelancer can ask up to €200,- an hour, however, a new consultant may rather ask €50,- an hour.

Director of business development of IRI (a market leading consultancy company), Orechwa, with over 25 years experience in the industry, says that very large management consultancy companies may ask an hourly rate that quickly can go up to €1.000,- an hour. (2022) The costs for the company are mainly in researching the problem and coming up with a solution

Approach 2

Workshop Content

The second approach we suggested to Titsa was a circular economy workshop which is feasible in the company. The idea behind it was to sensitise not only the management but also the employees in the office and in the workshops (Titsa has workshops all over the island of Tenerife. In these workshops, the buses are maintained or repainted, among other things. This creates different types of rubbish.) about the waste they produce, how they can separate it efficiently and correctly and therefore making it easier in the whole waste circle to recycle or reuse materials. The workshop should also help the culture in the company and bring together the employees, as the Titsa employees themselves told us, that there is a gap between management, the office employees and the workshop employees. These gaps among staff make it difficult to push forward and achieve a common goal, here focusing on waste management and circularity, if not acting as one team - one company.

Another idea behind the workshop is that general topics, such as what circular economy means, are explained to all employees, and in addition specific training takes place according to work location - i.e. office or workshop - as different types and amounts of waste are generated in both areas. Most of Titsa's waste is produced in the workshops, which is why the following focus is on the workshop staff and how they can be helped through the circular economy training. There is a lot of different waste in the workshops produced, in addition to paper and plastic also spray cans, batteries, filters, oils or even contaminated waste like metal.



Used spray cans and bus filters

Circularity can be difficult to grasp if you have never dealt with it before or been educated about it, but should apply and implement it properly. Therefore, at the beginning of the workshop, the term circularity will be explained to all workers by giving examples, such as the banana plantation. For example, the water used to wash the bananas in the production hall is then treated so that it can be used to water the banana trees on the plantation. The leaves of the trees are not thrown away but sold on and bananas that do not meet the standards are fed to animals. This example shows how supposed waste is reused and given a new, environmentally friendly purpose by not simply destroying it. It should help employees to get a better understanding of circularity and that it is about putting back everything related to the production or maintenance into the system to get as much value out of the resources and materials utilised. Building on this newly gained basic understanding of circularity, it is then possible to delve deeper into the subject matter and relate more clearly to Titsa.

We tried to figure out in which parts the company already tries to be more sustainable and where circularity can already be seen. This is also what is supposed to happen in the workshop. The employees should work out where they feel the company is sustainable and where it is not. The company for example uses renewable energy in the form of solar panels on the roofs. However, it must be mentioned here that the electricity generated from this is sold on, as this brings more profit than using it oneself. The price for the purchased electricity is lower, which means that profit can be made by selling the electricity generated by the solar panels for a higher price. The assessment of the employees helps to see to what extent they have dealt with this matter and have an eye for it.

For this, small groups are formed and a brainstorming is done, afterwards their results are presented and are recorded by the workshop leader. These results can then be built upon and also to see in which areas the employees need to be informed more.

While visiting the company we experienced that the workshop already had different bins for waste separation. This was supported by pictures and short descriptions above the bins to make it more clear which waste has to go where.



TITSA's waste separation bins

Nevertheless, it was reported to us that the employees have difficulties in separating waste and continue to do so incorrectly in some cases but they desire to do it right. The circular training is intended to provide the opportunity to list the different types of waste generated and to determine where more bins need to be placed in order to be able to separate better and correctly. Together with the staff, a list is drawn up showing all the waste and in which bin it should be disposed of in each case. These lists are then posted in the workshops in different places, for example near the waste bins or on the information board, so that every employee has access to them at any time and can inform themselves in case of uncertainty.

The involvement of the employees is particularly important here, as they know best what materials and waste generated by the buses they have to deal with on a daily basis. Furthermore, the employees should name the specific materials they have difficulties with in order to figure out exactly in which bin they need to be thrown or whether, as already mentioned above, completely new bins have to be installed. The waste separation should be as simple as possible for the employees and not hinder them in their daily work, but give them the feeling that they are doing something good for their company and the environment by separating efficiently.

As mentioned above the workshop focuses on the problem of waste reduction and separation of the company. It also aims to bring the people as individuals together and become a better team. We were told that there are difficulties and differences not only in communication but also on a personal level between the staff and their tasks. The workshop aims to bring the staff closer together through joint team building tasks, like Icebreaker exercises combined with team building theory, so that they get to know each other better and appreciate each other's work.

Learning goals & changes in behaviour

Every employer wants employees who are constantly developing and learning. Employee training should support this process for the benefit of the company and the people who work there.

However, effective in-company training must be well planned and implemented.

The purpose of staff training is to further educate the employees of a company. They can learn and deepen both technical and social skills. From group seminars to individual coaching: employee training can take many forms. Such training measures are an important instrument of human resource development. The demands of working life are constantly changing and new ones are being added. This also applies to TITSA. In order for TITSA and the people who work there to keep up, they have to keep learning; it is not for nothing that the term "lifelong learning" is used.

As an employer, TITSA must therefore make offers for the training and further qualification of their employees. In the end, everyone benefits from this.

There are several goals in general that can be reached by implementing workshops for employees.

To name some of them:

- Employees learn new skills. They become more productive and deliver better results.
- Employees stay motivated and satisfied because they can develop personally.
- Employees can be given more responsibility and leadership.
- Instead of hiring new employees, current employees can be trained for new tasks.
- Instead of dismissing employees when their jobs are eliminated, they can be retrained.
- Cooperation and cohesion in the teams are improved.

As we have found that the corporate culture should basically be strengthened at TITSA, different workshops with different objectives can be offered.

One goal we pursue with the idea of introducing employee workshops is to familiarise all employees with the company values. Once TITSA has developed its corporate values, vision and mission, this content can be communicated in workshops. This helps each employee to identify with the company. The employees feel they belong to the company and can therefore act in accordance with its values. This also includes the careful handling of waste and waste reduction. The employees' sense of responsibility can be strengthened if they feel part of the company and its successes.

Another goal of the workshops is to bring employees from different parts of the company closer together. This could also be a part of the circularity workshops. At present, TITSA is divided into two areas of the company, the office area and its employees, and the workshop area and its employees. It is important that the employees from both areas see themselves as a whole company and that there are no distinctions between the areas.

Another aim of the workshops is to develop the employees' knowledge. This can concern different areas, but primarily circularity, both waste reduction and waste handling.

As TITSA is a government-owned company, it differs in many ways from other companies in the private sector. There are structures, processes and decision-making channels that need to be taken into account. It is important for employees to understand these circumstances and learn to deal with them properly.

Therefore, one of the aims of these workshops is to train the staff on how to make their decisions, prepare decision papers and make proposals to the government in a profitable way.

Workshop execution - Next steps

In order to facilitate the implementation and conception of these workshops for TITSA, we would like to make a suggestion below as to how the planning of these workshops could look and what tasks TITSA could be faced with.

1. Determine workshop content

At the beginning, TITSA should clearly define the workshop content and thus also the duration of the workshop. In the first workshop we recommend TITSA to communicate the vision, mission and values of the company as well as the circularity aspects. The duration of the workshop should be limited to one day at the beginning, as this workshop should be offered to all employees of the company.

2. Workshop conception

In the next step, a concept of the workshop should be created and an agenda with concrete methodologies should be drafted. The day should be divided into three sessions, each with breaks. The morning could be dedicated to values, vision and mission, the afternoon to the introduction of circularity and end with interaction and exercises.

3. Design workshop documents

Based on the concept and the contents, training materials can be created. Ideally, this should include a PowerPoint and training material that employees can take home with them.

4. Commission a training institute

An experienced trainer is usually necessary for the successful implementation of a workshop, TITSA should contact a training institute. They can suggest different methodologies and provide pedagogical support for efficient implementation.

5. Fix dates and place

Once the essential aspects of the planning have been done, dates can be set. Several and sufficient dates should be offered so that each staff member can be trained at one workshop.

6. Assign participants to the dates

We recommend that TITSA does not randomly assign participants or even let them assign themselves. An important goal of the workshop is to connect employees within the company in different areas. Therefore, the selection of participants should be well planned and structured. At each training session, employees from different work areas should be assigned and ideally those who have not yet had close contact with each other. This also applies to the age and gender distribution when planning participants.

Approach 3

As a third approach we put forward the introduction of a so-called “Idea Box”. Such a box empowers workers to make their voices heard. The basic aim is to generate ideas to improve the situation in terms of sustainability and circularity.

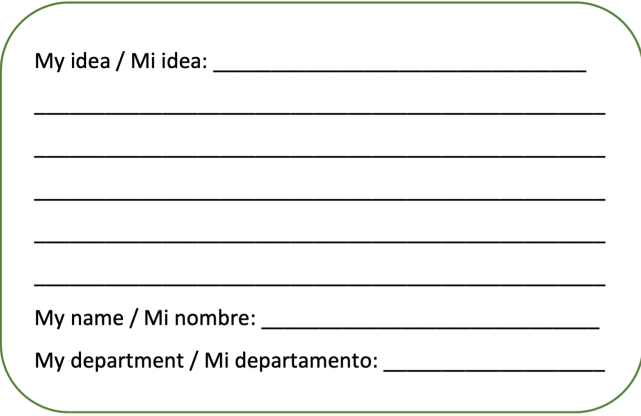
This Idea Box should be accessible to all employees, no matter whether they work in a workshop or in an office. The box also contributes to improving the company's culture and eliminating the gap between management, office staff and workshop workers by making all ideas heard.

Required material

To implement this proposal, TITSA needs to acquire boxes. We suggest ordering customised boxes with the same corporate design as already used for the culture board described in approach 1.

In addition, pens and cards are required. Again, the corporate design developed before in approach 1 can be used. (Additionally the pens can not only be used for the Idea Boxes but also be distributed to the employees so that they can use them in their daily work. That's how they see it and are confronted with it every day.)

For the cards, it must be decided what is written on them and how they are designed. We suggest that employees can write their names and the department they work for on the card. However, if they do not wish to do so, they can leave the field blank and submit the idea anonymously. Furthermore, there needs to be enough space on the card for the proposed idea. The following illustration shows a possible card (not yet with corporate design).



My idea / Mi idea: _____

My name / Mi nombre: _____

My department / Mi departamento: _____

Putting it to action

The Idea Boxes cannot just be placed somewhere without informing the staff about them. First of all, the employees must attend training on Circularity as described in approach 2 in order to understand what it is about. During these training sessions, the employees can also be informed about the Idea Boxes. It is important to explain to them the purpose of these boxes. Furthermore, they need to be motivated to keep their eyes open while working and to write all kinds of ideas they have on the cards. They need to know that there is no “wrong idea”.

Once the boxes have been integrated, the ideas need to be emptied and discussed on a regular basis. There could be certain people that empty the boxes monthly and do some more research on the ideas before they are discussed in meetings. If ideas may not be entirely clear and more information is needed, the person who wrote it on the card can be contacted (in case he or she hasn't written the idea anonymously). There could also be the opportunity that employees themselves elect certain people for a working group that empty the boxes, sort the ideas beforehand as well as organise and moderate the meetings, where the ideas are presented and discussed. This would have the advantage that all types of professions are integrated and not only a certain department that works in the office. All employees need to be given the opportunity to participate at the meetings.

What can also be implemented is a reward system for the best ideas in order to increase staff participation. Of course, only ideas that are not submitted anonymously can be rewarded.

Benefits

One advantage of the Idea Boxes is that TITSA can gather ideas from staff that would otherwise not have come to light. Each staff member works in different areas and can therefore contribute ideas on the topic of circular economy from different angles. In this way, the goal of a circular economy can be achieved together. In addition, the Idea Boxes make the employees feel that their ideas are heard and matter. This can also give employees the feeling that they are part of a big team where their contribution is important. What's more, the Idea Box brings the employees of the different professional groups and departments into contact with each other. In this way, prejudices can be reduced and more equality can be achieved.

Costs

The monetary investment for the boxes is not very high. It can be assumed that the boxes cost about 25 euros each and that about 20 boxes are required in order to be easily accessible to all staff members. Furthermore, the new pens with the company's values on them can be ordered for the whole company. Therefore, TITSA can benefit from economies of scale. The cards are assumed to cost approximately 25 ct each. We would recommend ordering about 5,000 cards to start with.

Next Steps

To introduce the Idea Boxes, the following next steps are recommended:

- Design and acquire boxes, pens, cards
- Introduce Idea Box concept to staff (after staff has learnt about circularity)

Approach 4

Titsa currently has no investors because it is a public company that only gets cash injections from the government. This situation makes it difficult for Titsa to become sustainable because the technology and moving towards sustainability itself is expensive. A network of international public transport companies can share in knowledge, technology and best-practices. Titsa would do well to join such a network – and such a network already exists: the International Association Public Transport.

Innovative value(s) proposition(s)

It is valuable for Titsa to join this network because they do not have to reinvent the wheel. Along with Titsa, there are around 180 other companies with similar concerns in the network. By joining forces, each company in the network gets the most out of it. In fact, when Titsa shares a best practice with the other companies, Titsa makes a much bigger impact because all the other companies can benefit along with it. These other companies are in the same sector but are certainly not competitors. After all, a bus company from the Netherlands will not take customers away from a Spanish bus company, but they do share the same concerns.

Approach: Network Building

There is a network of Public Transport Companies around the world -- called the International Association Public Transport -- Titsa is not yet a member of this -- but both are working on sustainability. For example, well known firms from the Netherlands, Spain, and Germany like Connexxion, Alsa, and DB are members. 180 companies that level together working on different components, including sustainability. If Titsa becomes a member, they become part of those 180 companies that all jointly invest in sustainability. Companies in this network help each other. Currently, Titsa has no investors because it's all in the hands of the government. But with joining this network, Titsa can benefit from investors related to this network.

International Association Public Transport

These 180 companies all work together on various components which also includes sustainability - So why become a member? Because then TITSA immediately becomes part of the network of 180 companies that all collectively also invest in sustainability - think about collaborating with other companies and members on the sustainability issue for example.

The International Association Public Transport is mainly concerned with the list of following themes:

- Business & HR
- Combined Mobility
- COVID-19
- Design & Culture
- Digitalisation
- Exhibition
- Informal Transport
- Marketing
- Organising Authorities
- Research in Mobility
- Security & Cybersecurity
- **Sustainable Development**
- Transport & Urban Life
- Transport Economics
- Vehicles & Equipment

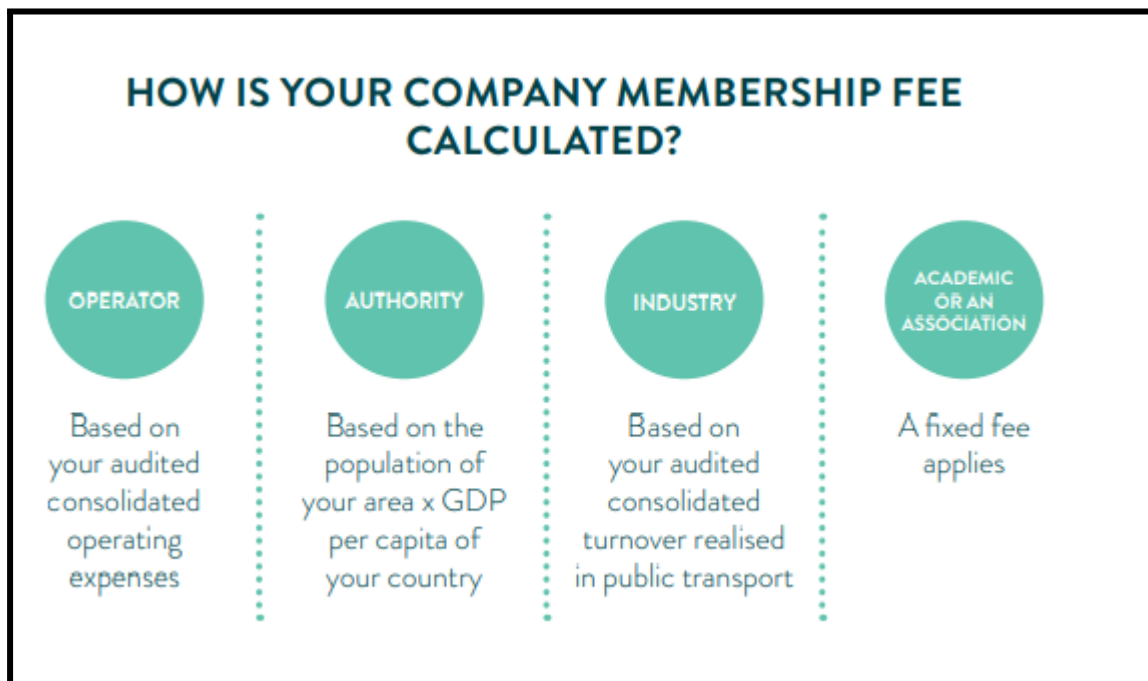
Sustainable Development

At UITP they talk a lot about sustainable urban mobility and across the public transport sector. But what does sustainable actually mean? And how does UITP integrate messages about sustainability into UITP's accessibility plans? Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Without sustainable mobility, sustainable development is not possible.

The UN Sustainable Development Goals (SDGs) are the blueprint for achieving this vision: a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate change, environmental degradation, peace and justice. The 17 goals are all interrelated, and to leave no one behind, it is important to achieve them all by 2030 (The International Association Public Transport, U. (2022)).

How to become an official member of UITP

By being part of UITP, you automatically qualify for one of our three service packages, tailored to suit all varieties of organisations and companies depending on size and scope. How they calculate the membership fee depends on the company's core business activity.



Excerpt website of IATP

There are 3 types of member fees:

1. Member companies whose membership fee is under €2.500
2. Member companies whose membership fee is between €2.500 and €19.999
3. Member companies with membership fees starting at €20.000

All membership types are inclusive of 7.5% European contribution and exclusive of VAT. (UITP, 2020)

Circularity Sustainable Aspects

Combining their strengths, each company on the network makes the most out of them. Basically, whenever Titsa is sharing a good example of the use of a best procedure with the other companies, Titsa creates a way bigger impact because all the other companies can benefit along with it.

Competitors

When examining the situation regarding current means of transportation, TITSA is the only public transportation company operating on the island of Tenerife. Nevertheless, one could consider direct and indirect competitors which meet the same need for the customer. This section is going to compare and contrast the competitors' models and strategies with our custom-made circular strategy package designed for TITSA.

Firstly, as a direct competitor, offering a similar product with comparable characteristics the tram could be considered an alternative way of commuting. On the one hand, studies have shown that CO₂ emissions from tramways are 30% lower than the ones from Bus Rapid Transit (BRT) systems operated by hybrid buses (Hodgson et al., 2013). This percentage would be even larger if compared to a conventional diesel engine-based bus management system like TITSA. On the other hand, though a considerable drawback of this direct competitor is the fact that the local tramway only connects the capital to the university area, thus failing to cover the needs of the vast population living on the island. Hence, the connectivity limitations outweigh the positive impact of a smaller carbon footprint.

Secondly, indirect competitors, offering different products serving as substitutes comprise electric bikes, scooters and motorcycles. These arguably carbon neutral means of transportation are also constrained to small commuting distances, thus failing to satisfy the local demand (Werle & Laumer, 2022).

Lastly, taxis can be considered as a third competitor. Although there are no coverage constraints, as compared to public transportation, the CO₂ emissions are significantly higher and also the accessibility to customers is reduced due to a considerably higher price-range.

Having outlined the main direct and indirect competitors' strengths and weaknesses, the next step is to compare and contrast with our multi-approach proposal for improvement of TITSA's future sustainable development. In order to achieve the higher purpose of circularity, the full package of solutions needs to be implemented. There exist complementarities between the different approaches and ideas, which create synergies leading to a healthier company from the roots. The implementation of our proposal would mean a greater competitive advantage for TITSA over other possible competitors who do not have a circular economy action roadmap. Furthermore, if compared with the status quo, a personalised set of solutions for the improvement of the company from the roots to the crown would not only improve circularity, but also teach the future generations the right values to achieve a greater impact with their actions.

TITSA Summary

Research on circular economy tends to be linked to multidisciplinary and findings often involve cross-cutting issues. Circularity has permeated all economic sectors and firms are elaborating their strategic plans towards an improved management of their resources. The rising global population and the environmental challenges associated with that have obliged the United Nations to set specific goals for a more efficient and carbon neutral use of existing resources. In particular, The United Nations Economic Commission for Europe (UNECE) has identified waste management as one of the most pressing objectives on their agenda (UNECE, 2021). Furthermore, aside from the latter some of the key measures of the Spanish Action Plan on Circular Economy involve “*Employment and Training*” as well as “*Awareness and Participation*” and “*Research, Innovation and Competitiveness*”.

Taking all the above mentioned into account, our multi-approach solution package has targeted the majority of the key points required from an institutional point of view.

Hence, the findings of our work would be an invaluable asset to the company in their journey towards the creation of their own circular economy plan. To summarise, Approach 1 provides solutions related to the “*Awareness and Participation*” target, Approach 2 addresses both “*Waste Management*” and “*Awareness and Participation*” objectives. Furthermore, due to the importance of consolidating corporate culture in order to reach the higher purpose of circularity, Approach 3 contributes with other solutions to the “*Awareness and Participation*” target. Lastly, Approach 4 sheds light on proposals in the realm of “*Research Innovation and Competitiveness*”.

Moreover, throughout the whole course, both teams have been guided by the 9R circular framework in order to identify innovative solution proposals (Kirchherr et al., 2017). Following this structure has enriched the idea creation process and, thus has contributed to a more diverse set of solutions for the company.

The Titsa staff responsible for us were a great help throughout the process, providing us with facts and figures and patiently answering our questions.

This helped us to come up with a new plan with proposals in a very short time, addressing the culture issue as well as the big goal, the circular economy. The four approaches we presented to the company, which have already been explained in more detail, appealed to the company very much and will be actively tried to be implemented in the future. This made us as a team all the more happy, because on the one hand we were able to help the company with our approaches and ideas, and on the other hand we were able to contribute to the circular economy of Tenerife and initiate changes.

Individual personalities turned into two teams at the beginning, which in the end found each other and worked together as an even stronger, more effective team. Of course, working together in a large team was not always easy, as many agreements and good communication were indispensable, and not everything always went smoothly at first, but we nevertheless found our way around well and were able to make use of our different cultural and professional backgrounds to present diverse approaches, creative ideas and an all-encompassing solution-oriented overall result, with which everyone was satisfied and Titsa was able to convince.

Review on learnings: Team 3

We learned that one has to look behind the façade. Often there is much more behind a problem to be solved than it seems at first sight. We also realised that one can only come to a solution by digging deep and asking lots of questions to get an overview of the situation. Only with the PowerPoint we initially received from Titsa, we would have come to a completely different outcome. We would have divided the waste into hazardous and non-hazardous waste and researched which waste can be reduced to its source, as it was stated in the instructions. However, Titsa itself had already done a lot of research and invested a lot of time in this. The groundwork has been laid by the company, the various bins for recyclable materials are available and the instructions can be clearly read on them. However, they are not followed by the staff. Without the face-to-face meetings and the questions we asked, we probably wouldn't have found out that there was a problem in the company culture and that therefore, the employees are not motivated to engage in waste management.

We also learned that it is important to be open-minded at all times, think in all kinds of directions and not give up while digging deeper into the problem. All the ideas we had prepared beforehand, we had to be put aside, even though it was sometimes frustrating. But in the end, it was worth it and we succeeded in repeatedly taking a new look at the situation and we found the core problem that needed to be solved.

What really helped us as a team was the Lego Exercise. Through this exercise we managed to get to the heart of Titsa's situation and realised that we need to focus on improving the company's culture first. As all efforts to implement a circular economy plan will not be feasible with the current corporate culture.

Doing a project like this was very new for us. None of us had done a University project for a real company in a foreign country before. Moreover, most of us also have never worked together with people from other countries. However, for all of us, it was a wonderful experience to work with students of other nationalities and different fields of study. Our

diverse team led to a lot of creativity and helped us collect many different ideas. Things could be looked at from different perspectives through our different backgrounds.

We learned that although there can sometimes be small communication problems and decision-making processes take longer, we would never have been as successful without this diversity in our team.

As a team, it was also much easier for us to work together in Tenerife than in the preparation phase online via Zoom. For instance, Real-life communication was easier than in a Zoom meeting because it made it possible to see a person's body language and intentions.

However, the preparation via Zoom was of course necessary and important for us and we learnt a lot from it. We learnt for instance how to apply the business model canvas to visualise and structure the business model of Titsa. Moreover, before this innovation bootcamp most of us didn't know what a circular economy was. In Addition, the circular 9R model was new for most of us and it was very useful to work with in this project. Before participating in this bootcamp we thought that recycling would be enough to be sustainable. But now we know that there is more to it, for instance preventing, rethinking and reducing waste.

What we also benefited from was the merger at the end with team 4, so all the ideas could be worked out as one big group. By dividing the four approaches between the two teams, it was possible to work out the proposals for Titsa in more detail.

Review on learnings: Team 4

Over the last few weeks, individual personalities with different cultural and professional backgrounds have become a team, using each other's strengths and compensating for each other's weaknesses to develop an efficient and solution-oriented approach for the Titsa company.

In the first weeks we did not know exactly where this "journey" would take us and we had starting difficulties only in terms of the task we had to do, but not in terms of team building. Creating jamboards, papers and presentations together in preparation for the week in Tenerife helped us to find each other as a team and to get to know each other better in privately organised Zoom meetings. The fact that we were in different countries showed us how important it is to have open and honest communication with each other, but also how diversity in a team helps to generate creative and different ideas and approaches.

Our arrangements regarding the weekly assignments have always worked well. This was possible because everyone had the big picture in mind and approached it with the idea that this preparation and initial problem-solving suggestions could help us to make things easier later on and help the company better on site. We flew to Tenerife with different ideas and approaches in our "luggage". We were all happy to see each other live now and it made our teamwork even easier, better and more efficient.

Unfortunately, we had to realise that the company had already done our original task, which was to list the waste and separate it into hazardous and non-hazardous and to prepare a cost overview, in a very detailed and efficient way. This initially depressed the team mood, but did not stop us from getting to work on the newly revealed problem - the culture in the company. During this time we have learned that it is good and important to ask questions, even if they are unpleasant. However, this helps to get to the roots of a problem and to be able to address it effectively. In a very short time, we managed as a team to come up with new, more targeted proposals that, on the one hand, addressed the cultural problem but, on the other hand, did not lose sight of the goal of the circular economy.

We all think that this project has made us grow as individual personalities and people in society and that many tasks and problems can be solved better in a team than alone.

References (APA)

Front page images: erasmus.nl, ull.es, amsterdamuas.com, hs-kempten.de

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References

A

References

AE Solar. (2020). History and the Development of Photovoltaics. Retrieved November 29, 2022, from www.google.com website:

<https://www.google.com/url?q=https://ae-solar.com/history-of-solar-module/%23%3DThe%2520first%2520solar%2520panel%2520was>

ARBOLEDAS, J. L. (2018, April 17). Científicos ingleses crean una enzima capaz de alimentarse de plástico. Retrieved November 9, 2022, from Actualidad Gadget website:

<https://www.actualidadgadget.com/cientificos-ingleses-crean-una-enzima-capaz-de-alimentarse-de-plastico/>

Aurora. (2021, January 16). Comprehensive Guide to Solar Panel Types. Retrieved November 29, 2022, from Aurora Solar website:

https://www.google.com/url?q=https://aurorasolar.com/blog/solar-panel-types-guide/&sa=D&source=docs&ust=1669738067785386&usg=AOvVaw3eyHaPaQiXEICfG_oJuCJZ

B

Baum, Z. (2022, February 8). A greener future: Lithium-ion batteries and Hydrogen fuel cells. Retrieved November 22, 2022, from CAS website:

<https://www.cas.org/resources/cas-insights/sustainability/lithium-batteries-hydrogen-fuel-cells>

C

CanadianSolar. (2019). Redirecting. Retrieved November 29, 2022, from Google.com website:
https://www.google.com/url?q=https://static.csisolar.com/wp-content/uploads/2019/12/09091536/CS-Datasheet-HiKu_CS3W-MS_v6.0_EN.pdf&sa=D&source=docs&ust=1669738067783970&usg=AOvVaw0_5n3eXFWQEqq3pNXg1M_r

César Ramírez-Márquez, C., & Martín, M. (2022). Photovoltaics - an overview | ScienceDirect Topics. Retrieved November 29, 2022, from www.sciencedirect.com website:
<https://www.google.com/url?q=https://www.sciencedirect.com/topics/engineering/photovoltaics&sa=D&source=docs&ust=1669738067784640&usg=AOvVaw30pacITUzF9UY-0G2z1kVW>

E

Electronics notes. (2019). Li-Ion Battery Advantages / Disadvantages | Lithium Ion | Electronics Notes. Retrieved November 22, 2022, from [Electronics-notes.com](https://www.electronics-notes.com) website:
https://www.electronics-notes.com/articles/electronic_components/battery-technology/li-ion-lithium-ion-advantages-disadvantages.php

Ettah, E. B., & Obiefuna, J. (2012, January 11). The effect of relative humidity on the efficiency of solar panels in Calabar, Nigeria. Retrieved November 29, 2022, from Research Gate website:
https://www.researchgate.net/profile/Josiah-Obiefuna/publication/286185549_The_effect_of_relative_humidity_on_the_efficiency_of_solar_panels_in_Calabar_Nigeria/links/5d329a08299bf1995b398352/The-effect-of-relative-humidity-on-the-efficiency-of-solar-panels-in-Calabar-Nigeria.pdf

European Parliament. (2015, February 12). Circular economy: definition, importance and benefits | News | European Parliament. Retrieved November 29, 2022, from www.europarl.europa.eu website:
<https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits>

G

- GARGANTILLA, P. (2022, February 14). La esperanza de la bacteria que se come el plástico. Retrieved November 9, 2022, from ABC website:
https://www.abc.es/ciencia/abci-esperanza-bacteria-come-plastico-202202140250_noticia.html
- Gonzales, V. (2020). Tecnología de inversores en sistemas fotovoltaicos. CITE energía. Artículo Técnico. Ancón, Lima - Perú.
http://www.citeenergia.com.pe/wpcontent/uploads/2020/07/Ing.-Victor-Gonzales-Zamora_compressed.pdf, pp.1
- Gregus, N. (2021, December 13). 5 Key Differences Between Flow Batteries and Lithium Ion Batteries | EnergyLink. Retrieved December 20, 2022, from goenergylink.com website:
<https://goenergylink.com/blog/differences-between-flow-batteries-and-lithium-ion/>

L

- Lamigueiro, O. P. (2013). Energía solar fotovoltaica. Creative Commons ebook. España. 192 pp.
- Large.net. (2022, March 28). Saltwater Batteries How It Works - Disadvantages, Price And Comparison-battery-knowledge | Large Power. Retrieved November 20, 2022, from www.large.net website: <https://www.large.net/news/9au43mz.html>
- Longi. (n.d.). Redirect Notice. Retrieved November 29, 2022, from www.google.com website:
https://www.google.com/url?q=https://energy.economictimes.indiatimes.com/files/cp/755/cdoc-1625905724-Hi-MO4m%2520LR4-72HPH%2520430-460M.pdf&sa=D&source=docs&ust=1669738067783477&usg=AOvVaw0v1agInUDq2e0zF_tYYwXG

M

- Marsh, J. (2022, May 10). Lithium-ion vs. Lead Acid Batteries: How Do They Compare? | EnergySage. Retrieved November 23, 2022, from EnergySage Blog website: <https://news.energysage.com/lithium-ion-vs-lead-acid-batteries/#:~:text=What%20is%20the%20difference%20between%20lithium%20ion%20batteries%20and%20lead>
- Mejia, F., Kleissl, J., & Bosch, J. L. (2014). The Effect of Dust on Solar Photovoltaic Systems. *Energy Procedia*, 49, 2370–2376. <https://www.sciencedirect.com/>. <https://doi.org/10.1016/j.egypro.2014.03.251>

N

- NREL. (2022). *Cell Efficiency (%) 12 8 4*. Retrieved from <https://www.nrel.gov/pv/assets/pdfs/best-research-cell-efficiencies-rev220630.pdf>

R

- Relion. (n.d.). Lithium-ion Battery Advantages | RELiON. Retrieved November 22, 2022, from relionbattery.com website: <https://relionbattery.com/resource-center/technology/why-choose-lithium>
- Rimental. (n.d.). Retrieved November 7, 2022, from Rimetal website: <http://www.rimetal.es>
- ROMERO, S. (2021, May 18). Reciclaje de paneles solares: cuando una fuente de energía es “limpia” de verdad. Retrieved November 7, 2022, from elconfidencial.com website: https://www.elconfidencial.com/medioambiente/energia/2021-05-18/reciclaje-paneles-solares-vidrio-plastico_3084596/

S

- SÁNCHEZ MOLINA, P. (2021, November 9). Biomasa para sustituir el plástico y el cristal en células solares que son, además, más eficientes. Retrieved November 23, 2022, from PV Magazine España website: <https://www.pv-magazine.es/2021/11/09/biomasa-para-sustituir-el-plastico-y-el-cristal-en-celulas-solares-que-son-ademas-mas-eficientes/>
- Shahan, Z. (2014, September 4). Solar Panel Cost Trends (Tons of Charts). Retrieved November 29, 2022, from CleanTechnica website: <https://www.google.com/url?q=https://cleantechnica.com/2014/09/04/solar-panel-cost-trends-10-charts/&sa=D&source=docs&ust=1669738067780582&usg=AOvVaw1powu-nWmzJa-Vrbz3EmWU>

Sigfito Agroenvases. (n.d.). Retrieved November 7, 2022, from Sigfito Agroenvases website:

https://sigfito.es/puntos-de-recogida/donde-estan/?o_name=&city=&county=Santa+Cruz+de+Tenerife&filter=filter&Buscar=BUSCAR

Sodium-ion battery. (2022, November 22). Retrieved November 22, 2022, from Wikipedia website: https://en.wikipedia.org/wiki/Sodium-ion_battery#cite_note-:1-27

Solar Energy Technologies Office. (2022a). Concentrating Solar-Thermal Power. Retrieved November 29, 2022, from Energy.gov website:

<https://www.google.com/url?q=https://www.energy.gov/eere/solar/concentrating-solar-thermal-power&sa=D&source=docs&ust=1669738067781738&usg=AOvVaw3OMilIaIpWBBLpxtmdDR4s>

Solar Energy Technologies Office. (2022b). Concentrating Solar-Thermal Power Basics.

Retrieved November 29, 2022, from Energy.gov website:

https://www.google.com/url?q=https://www.energy.gov/eere/solar/concentrating-solar-thermal-power-basics&sa=D&source=docs&ust=1669738067781291&usg=AOvVaw0cBr_hC9SfV7kswRZ3wWDo

Solar Energy Technologies Office. (2022c). Photovoltaics - an overview | ScienceDirect

Topics. Retrieved November 29, 2022, from www.sciencedirect.com website:

<https://www.google.com/url?q=https://www.sciencedirect.com/topics/engineering/photovoltaics&sa=D&source=docs&ust=1669738067785013&usg=AOvVaw0thKAb7bkndDQHxCsg6sms>

Solar Energy Technologies Office. (2022d). Redirect Notice. Retrieved November 29, 2022, from www.google.com website:

https://www.google.com/url?q=https://www.energy.gov/eere/solar/how-does-solar-work%23cspbasics&sa=D&source=docs&ust=1669738067778851&usg=AOvVaw1lD_TIOuwEI8zFfnYfR0wu

Solar Energy Technologies Office. (2022e). Solar Radiation Basics. Retrieved November 29, 2022, from Energy.gov website:

<https://www.energy.gov/eere/solar/solar-radiation-basics>

Solucciona Energía. (n.d.). Reciclaje de módulos fotovoltaicos. Retrieved November 9, 2022, from Solucciona Energía website: <http://solucciona.com/solrecycle/>

Solucciona. (n.d.). Sol Recycle - Reciclaje de módulos fotovoltaicos. Retrieved November 29, 2022, from Solucciona Energía website: <http://solucciona.com/solrecycle/>

T

TedX. (2016). How do solar panels work? - Richard Komp. Retrieved November 29, 2022, from TED-Ed website:
https://www.google.com/url?q=https://ed.ted.com/lessons/how-do-solar-panels-work-richard-komp&sa=D&source=docs&ust=1669738067776102&usg=AOvVaw1LtWmV5vugWff6tuGA_SJW

V

Valencia, D. F. G., & Mora, V. S. S. (2022). Inversores inteligentes de energía solar fotovoltaica. Polo del Conocimiento: Revista científico-profesional, 7(4), 91.

STV

9R-strategies explained - Projectenportfolio. (n.d.).
https://projectenportfolio.nl/wiki/index.php/FACET_Tool_PR_00001

A

Air Source Heat Pumps (ASHPs). (n.d.).
<https://www.solarinspain.com/en/product/34/air-source-heat-pumps-ashps>

Amato, D. (2022, November 8). *Best reusable coffee cup 2022: Our pick of the best eco-friendly and sustainable coffee cups*. Expert Reviews.
<https://www.expertreviews.co.uk/kitchen/1406710/best-reusable-coffee-cups>

Ameren Missouri Savings. (n.d.).
<https://www.amerenmissourisavings.com/hvac-air-source-heat-pump-education-flyer/>

An Introduction to Green Roofs. (n.d.). Roofing Megastore. Retrieved November 21, 2022, from
<https://www.roofingmegastore.co.uk/blog/an-introduction-to-green-roofs.html#:~:text=Green%20roofs%20have%20a%20life,of%20alternative%20roofing%20options%20considerably.>

Attention Required! | Cloudflare. (n.d.).
<https://www.conserve-energy-future.com/benefits-of-green-walls.php>

B

Bilt, Z. C. van de. (2016, January 30). *Slideshow tekst*. Outdoor Shutters.
<https://www.debilt-zonwering.nl/producten/outdoor-shutters/categorie/outdoor-shutters.html>

Blueland. (n.d.). *The Clean Essentials - Effective, Biodegradable Cleaners*.
<https://www.blueland.com/products/the-clean-essentials>

Breen, L. (2022, November 11). *What is Solar Shading?* Gb&D Magazine.
<https://gbdmagazine.com/what-is-solar-shading/>

D

De levensduur van zonwering, hoe lang gaat het mee? (2022, March 31). SunCircle.
<https://www.suncircle.nl/de-levensduur-van-zonwering-hoe-lang-gaat-het-mee/>

Devos, G. (2017, January 23). *ELEKTRISCHE AUTO HUREN*. Tenerife Connect.
<https://tenerifeconnect.be/elektrische-auto-huren/>

Domotica Installatie laten aanleggen in huis? Wat is de prijs hiervan? (2022, September 6).
Electra - Gigant. <https://www.electra-gigant.nl/domotica-installatie-aanleggen/>

E

EAVE. (2022, September 29). *Paneles Solares | Venta e instalación | Eave Autoconsumo*.
Eave. <https://eave.es/>

eBike. (n.d.). *Trekking y Urbanas*. EBIKE.ES - Tienda Online No1 En Bicicleta Eléctrica.
<https://ebike.es/product-category/bicicletas-electricas/bicicletas-mixtas-urbanas/>

ecoffee cup | Nisbets Catering Equipment. (n.d.). Nisbets.
https://www.nisbets.co.uk/ecoffee-cup/_/a33-1

Ecoffee Cup: #stopthe100billion. (2022, September 10). Foodies Favorites.
<https://foodiesfavorites.com/meenemen/ecoffee-cup/>

Ecoforest 2022. (2022, October 14). Ecoforest. <https://ecoforest.com/en/>

Error 404 | ZinCo Green Roof Systems. (n.d.).

[https://zinco-greenroof.com/systems/sedum-carpet+++Ost,+I.+\(2022,+September+20\).+How+Much+Energy+Does+a+Solar+Panel+Produce?+Solar.com](https://zinco-greenroof.com/systems/sedum-carpet+++Ost,+I.+(2022,+September+20).+How+Much+Energy+Does+a+Solar+Panel+Produce?+Solar.com).

eVito Gesloten Bestelwagen | Mercedes-Benz Bedrijfswagens. (n.d.). Mercedes-Benz Vans.

<https://www.mercedes-benz.nl/vans/nl/vito/e-vito-panel-van>

G

Global, B. (n.d.). *Building automation.* Bosch Energy and Building Solutions Global.

https://www.boschbuildingsolutions.com/xc/en/building-automation/?gclid=Cj0KCQiA99ybBhD9ARIsALvZavXGE6Cbs3eNvpY4zAPP3owCwjxOXqMrLSjqHmYy7wRLRDBtCc9oS nkaAqiLEALw_wcB

Green Roof Water Retention. (2019, March 19). Purple-Roof.

<https://www.purple-roof.com/post/green-roof-water-retention>

H

Houten jaloezieën: Voor- en nadelen. (2020, July 31). Interieurdesigner.

<https://www.interieurdesigner.nl/interieurtips/raamdecoratie/houten-jaloezieen-voor-en-nadel en>

Howell, B. (2022, November 2). *Types of Solar Panels: Which Is Best For You?* The Eco Experts. <https://www.theecoexperts.co.uk/solar-panels/solar-panels-types>

J

Jacobs Elektro Groep. (2022, July 6). *Domotica.* <https://jacobselektro.nl/diensten/domotica/>

Jardines verticales Sevilla, jardin vertical para empresas. (2022, July 19). Terapia Urbana. <https://www.terapiaurbana.es/>

Joyce, M. (2019, September 17). *Who Doesn't Love a Living Wall?* Work Design Magazine. <https://www.workdesign.com/2014/10/doesnt-love-living-wall/>

L

Lackey, S. (n.d.). *The True Cost of Green Walls*.

<https://www.bringnatureindoors.com/the-true-cost-of-green-walls/>

M

Mercedes-Benz eCitan | Mercedes-Benz Bedrijfswagens. (n.d.-a). Mercedes-Benz Vans.

https://www.mercedes-benz.nl/vans/nl/citan/ecitan?kpid=go_cmp-16627048549_adg-137772898234_ad-589009142099_kwd-873422788711_dev-c_ext-

Mercedes-Benz eCitan | Mercedes-Benz Bedrijfswagens. (n.d.-b). Mercedes-Benz Vans.

<https://www.mercedes-benz.nl/vans/nl/citan/ecitan>

Milieu Centraal. (n.d.). *E-bike of speed pedelec: snel en goedkoop*.

<https://www.milieucentraal.nl/duurzaam-vervoer/elektrische-fiets/>

Modernize. (2022, November 3). *How Much Does a Heat Pump Cost to Install?*

<https://modernize.com/hvac/heating-repair-installation/heat-pump>

O

Ost, I. (2022, September 20). *How Much Energy Does a Solar Panel Produce?* Solar.com.

<https://www.solar.com/learn/how-much-energy-does-a-solar-panel-produce/>

Our Editors. (2022, November 4). *10 Best Natural Cleaning Products For A Nontoxic Home*.

The Good Trade.

<https://www.thegoodtrade.com/features/natural-eco-friendly-cleaning-products-for-the-conscious-home>

P

Peacock, B. (2021, August 24). *Green roof improves solar panel efficiency by 3.6% on average*. Pv Magazine International.

<https://www.pv-magazine.com/2021/08/24/green-roof-improves-solar-panel-efficiency-by-3-6-on-average/>

Pure Energie. (2022, November 17). *De nieuwe salderingsregeling vanaf 2025*.

<https://pure-energie.nl/kennisbank/de-nieuwe-salderingsregeling-vanaf-2023/>

R

Rooij, D. de. (2022, June 2). *Solar charging stations for electric vehicles (EV's)*. Sinovoltaics (Hong Kong Office).

<https://sinovoltaics.com/learning-center/electric-vehicles/solar-charging-stations-electric-vehicles-evs/>

S

Sedum Carpet | ZinCo Green Roof Systems. (n.d.).

<https://zinco-greenroof.com/systems/sedum-carpet>

Sinovoltaics, J. (2022, April 21). *Solar Charging Station: types and applications*.

Sinovoltaics (Hong Kong Office).

<https://sinovoltaics.com/technology/solar-charging-station-types-and-applications/>

Sl, I. (n.d.). *INDOMOTIQ | Inmótica y Domótica*. <http://www.indomotiq.es>

Solar Shading Systems | Smartlouvre. (n.d.).

<https://www.smartlouvre.com/applications/solar-shading>

Stormwater Management Roof | ZinCo Green Roof Systems. (n.d.).

<https://zinco-greenroof.com/systems/stormwater-management-roof>

T

The spectacular steep pitched green roofs define the appearance of the GF Victoria Hotel in Tenerife. (n.d.). Zinco. https://zinco.se/news/press_releases/press_release_details.php?id=112

Toepassingen van domotica in de zorg | Beyer Installatie. (n.d.).

<https://www.beyerinstallatie.nl/toepassingen-domotica-zorg>

TripAdvisor, 7. (2022, November 19). *Electric Mountain Bike Rental Tenerife | Spain*.

Tripadvisor.

https://www.tripadvisor.com/AttractionProductReview-g187479-d20078290-Electric_Mountain_Bike_Rental_Tenerife-Tenerife_Canary_Islands.html

U

Using Green Roofs to Reduce Heat Islands. (2022, July 13). US EPA.

<https://www.epa.gov/heatislands/using-green-roofs-reduce-heat-islands>

V

Velez, A. (2022, March 30). *How Much Do Plantation Shutters Cost, and How Do They Pay Off?* Real Estate News & Insights | realtor.com®.

<https://www.realtor.com/advice/home-improvement/how-much-do-plantation-shutters-cost/>

W

What Is Solar Shading? | Fixed and Dynamic. (2020, January 24). Enviroscreen.

<https://www.enviroscreen.org.uk/what-is-solar-shading/>

Writer, P. C. (2020, May 6). *14 - Environmentally friendly office products for your eco-office*. Eco Friend.

<https://ecofriend.org/14-environmentally-friendly-office-products-for-your-eco-office/>

(2022, January 13). *Are green walls ecologically sustainable?* SRS Group.

<https://www.srsgroup.co.nz/blog/are-green-walls-ecologically-sustainable/>

TITSA

B

Ball, A., & Grubnic, S. (2007). Sustainability accounting and accountability in the public sector. In *Sustainability accounting and accountability* (pp. 176–195). Routledge.
<https://doi.org/10.4324/9780203815281>

Baumgartner, R. J. (2009). Organizational culture and leadership: Preconditions for the development of a sustainable corporation. *Sustainable Development*, 17(2), 102–113.
<https://doi.org/10.1002/sd.405>

Bögel, P., Pereverza, K., Upham, P., & Kordas, O. (2019). Linking socio-technical transition studies and organisational change management: Steps towards an integrative, multi-scale heuristic. *Journal of Cleaner Production*, 232, 359–368.
<https://doi.org/10.1016/j.jclepro.2019.05.286>

D

Domingues, A. R., Lozano, R., Ceulemans, K., & Ramos, T. B. (2017). Sustainability reporting in public sector organisations: Exploring the relation between the reporting process and organisational change management for sustainability. *Journal of Environmental Management*, 192, 292–301. <https://doi.org/10.1016/j.jenvman.2017.01.074>

Domingues, A. R., Moreno Pires, S., Caeiro, S., & Ramos, T. B. (2015). Defining criteria and indicators for a sustainability label of local public services. *Ecological Indicators*, 57, 452–464. <https://doi.org/10.1016/j.ecolind.2015.05.016>

Doppelt, B. (2003). *Leading change toward sustainability: A change-management guide for business, Government, and Civil Society*. Greenleaf Publishing Sheffield.

Droege, H., Raggi, A., & Ramos, T. B. (2021a). A systematic literature review on circular economy performance assessment in public sector organizations. In *The Role of Law in*

Governing Sustainability (pp. 203–221). Routledge, Taylor and Francis Group.

<https://doi.org/10.4324/9781003158837-17>

Droege, H., Raggi, A., & Ramos, T. B. (2021c). Overcoming current challenges for circular economy assessment implementation in public sector organisations. *Sustainability* (Switzerland), 13(1182), 22. <https://doi.org/10.3390/su13031182>

E

Europa Press. (2022, March 18). The Government of the Canary Islands approves the preliminary draft of the Circular Economy Law. *Tenerife Weekly*. Retrieved November 28, 2022, from <https://tenerifeweekly.com/2022/03/18/the-government-of-the-canary-islands-approves-the-preliminary-draft-of-the-circular-economy-law/>

Environmental Protection Agency.gov. (2022, September 29). What is a Circular Economy? | US EPA. EPA. Retrieved November 28, 2022, from <https://www.epa.gov/recyclingstrategy/what-circular-economy>

G

Green, S. (2021, 29 september). How and How Much Should I Charge as a Consultant? *hubspot.com*. <https://blog.hubspot.com/sales/consulting-fees>

H

Hodgson, P., Potter, S., Warren, J., & Gillingwater, D. (2013). Can bus really be the new tram? *Research in Transportation Economics*, 39(1), 158-166. <https://doi.org/10.1016/j.retrec.2012.06.009>

Hans-Henrik Jorgensen, Oliver Bruehl und Neele Franke (2014); Executive Report, Making change work, IBM Global Business Services. <https://www.ibm.com/downloads/cas/WA3NR3NM>

Hill, C.W.L., Schilling, M.A. and Jones, G.R. (2017). *Strategic Management : an Integrated Approach : Theory & Cases*. Boston, Ma: Cengage Learning.

K

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127, 221-232.
<https://doi.org/10.1016/j.resconrec.2017.09.005>

Kanter, R. M. (1999). *The change masters*. International Thomson Business Press.

Kiesnere, A. L., & Baumgartner, R. J. (2019). Sustainability management in practice: Organizational change for sustainability in smaller large-sized companies in Austria. *Sustainability (Switzerland)*, 11(3), 40. <https://doi.org/10.3390/su11030572>

Kotter, J. (1995). *Leading change: Why transformation efforts fail*. Harvard Business Review

L

Linnenluecke, M. K., & Griffiths, A. (2010). Corporate sustainability and organizational culture. *Journal of World Business*, 45(4), 357–366.
<https://doi.org/10.1016/j.jwb.2009.08.006>

Lozano, R. (2009). *Orchestrating organisational change for corporate sustainability: Strategies to overcome resistance to change and to facilitate institutionalization*. Cardiff University.

M

Mendoza, J. M. F., Gallego-Schmid, A., & Azapagic, A. (2019a). A methodological framework for the implementation of circular economy thinking in higher education institutions: Towards sustainable campus management. *Journal of Cleaner Production*, 226, 831–844. <https://doi.org/10.1016/j.jclepro.2019.04.060>

Mendoza, J. M. F., Gallego-Schmid, A., & Azapagic, A. (2019b). Building a business case for implementation of circular economy in higher education institutions. *Journal of Cleaner Production*, 220, 553–567. <https://doi.org/10.1016/j.jclepro.2019.02.045>

Millar, C., Hind, P., & Magala, S. (2012). Sustainability and the need for change: Organisational change and transformational vision. *Journal of Organizational Change Management*, 25(4), 489–500. <https://doi.org/10.1108/09534811211239272>

O

Orechwa, J. (2022, 19 november). How Much Does It Cost To Hire a Management Consultant? Projectionsinc. <https://projectionsinc.com/cost-to-hire-a-management-consultant/>

R

Ramos, T. B., & Moreno Pires, S. (2013). Sustainability assessment: The role of indicators. In *Sustainability assessment tools in higher education institutions: Mapping trends and good practices around the world* (pp. 1–417). Springer, Cham. <https://doi.org/10.1007/978-3-319-02375-5>

S

Salvioni, D.M. and Almici, A. (2020). Transitioning Toward a Circular Economy: The Impact of Stakeholder Engagement on Sustainability Culture. *Sustainability*, 12(20), p.8641. doi:10.3390/su12208641.

Siebenhüner, B., & Arnold, M. (2007). Organizational learning to manage sustainable development. *Business Strategy and the Environment*, 16(5), 339–353. <https://doi.org/10.1002/bse.579>

T

The International Association Public Transport, U. (2022). Sustainable Development. UITP - the International Association Public Transport.
<https://www UITP.org/topics/sustainable-development/>

U

UITP. (2020). MEMBERSHIP SERVICES. cms UITP.org.
https://cms UITP.org/wp/wp-content/uploads/2020/09/Services-List_2020.pdf

UNECE (2021). Promoting Circular Economy and sustainable use of natural resources in the UNECE region.

<https://unece.org/sessions-commission/events/sixty-ninth-session-commission-20-21-april-2021>

W

Werle, M., & Laumer, S. (2022). Competitor identification: A review of use cases, data sources, and algorithms. *International Journal of Information Management*, 65, 102507.
<https://doi.org/10.1016/j.ijinfomgt.2022.102507>