
GEO
LIGHT

CBI A^3 powered by

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CERN Ideas^s

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“ I believe in intuition and inspiration. Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution. It is, strictly speaking, a real factor in scientific research.”

Albert Einstein

MARIA RITA

Studying Corporate Communication at Politécnico do Porto, Rita joined the CBI program because she felt like she needed a new challenge in her life. And so far, it has been an amazing experience where she has been able to learn so much more, while meeting new people and working with them. Being part of Porto Design Factory also changed her perspective of life. Rita got the opportunity of discovering herself, and realizing that she wanted to be restless. And now, she swears that she will never settle and will always aim higher.

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Bárbara studies Industrial Design at Politécnico do Porto and she’s in her last year. She appreciates what’s different about the world, and is curious about the particularities implied in said difference. Bárbara is always asking questions, and believes she’s sensitive towards what is around her. She decided to join the CBI program because it was a great opportunity to meet new people and enroll in new challenges.

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EXECUTIVE SUMMARY

This paper has the purpose of presenting the Ipiranga's project for the Challenge Based Innovation A3 program - Geolight. We worked in collaboration with Design Factory Melbourne and IdeaSquare at CERN (the European Organization for Nuclear Research).
The CBI program intends to find problems in our region that are related to the UN Sustainable Development Goals, and use CERN technologies to create solutions to solve them. Those solutions are supposed to be implemented until 2030, which allows us to dream a little bigger. This year, the SDG chosen was the 12th – Responsible Consumption and Production.
We spent two weeks at CERN in November, developing multiple ideas and researching through the technologies to have a better understanding of how we could use them to create a real solution. At the end of this program, after some more research and development, we created the Geolight. This is a street light, implemented on the sides of the roads, that can detect when a wildfire starts and contain it, using CO2, while also having a more daily usage as lighting the roads.
The idea of making Geolight came from the massive wildfires Portugal suffers every year, but especially the one that occurred in 2017, in Pedrógrão Grande, where people got trapped by the fire and couldn't get out. Our main purpose is to create a safe passage, so when a fire occurs, roads don't get blocked. This way, people can get out, and firefighters can get in.

THE SOCIETAL CHALLENGE

This year, the CBI A3 program focused on the Sustainable Development Goal number 12 - Responsible Consumption and Production. Building on the context of the United Nations goals to change the world, the SDG 12 main point it to ensure responsible consumption and production patterns. It relates with resource management, efficient production and the moderate consumption of products and services. It requires a lot of cooperation among actors of the supply chain, from producers to final consumers.
We looked for problems related to this topic in our local context, and explored them deeper during the two weeks we spent at CERN. One of the problems was deforestation. This contributes to global warming, decrease in biodiversity, excessive loss of plants and animals, change in the Earth's crust, and several other issues. Previously, the causes of deforestation were the cut of trees for shipbuilding and houses' heating. Nowadays, the main causes are wildfires, acid rain and for the construction of infrastructures.
Referring more specifically to wildfires, Portugal has the biggest eucalyptus area compared to its size, and they are not a native tree. The lack of planning and regulation of eucalyptus plantation are factors that, along with climate change, increase the risk of having wildfires, turning forests into real ticking bombs. One of the major issues that wildfires cause is the increase of CO2 emissions.
Wildfires are becoming increasingly more expensive due to the proportions they're assuming every year, a consequence of global warming. But the problem is not only about the money – the shortage of water is not a thing so distance in the future. It is imperative that we find alternative means to fight fires, so that this resource is preserved.

GEOLIGHT

MAIN USERS

The firefighters are our Main Users. Geolight was made to allow firefighters to act faster in case of a wildfire, by detecting its location, as well as to contain it to prevent the spreading to roads and evacuation zones. Geolight sends a signal to warn firefighters that there is a fire starting. Nowadays, the call is given by civilians that notice a fire or by guards from the control tower. If the signal is given by Geolight, false alarms can be prevented. With the help of IPMA (Portuguese Institute of the Sea and Atmosphere), Geolight sends the safest directions for firefighters to follow in order to reach the location of the fire. Once they reach it, they proceed to its evacuation. The way out is also easily identified, avoiding incidents similiar to the one that happened on June 17, 2017, in which people tried to escape by alternative routes and ended up caught by the fire.

USER INTERFACE

With Geolight, people's safety is reinforced. The authorities, as well as the firefighters, will receive an alert through a signal sent by the device once it detects the starting of a fire. People that might be passing by will have a radio station that will tell them the safest way out, through a system connected to IPMA. Geolight, that also works as a street light, will change colors so that it's understood if it is safe to drive through certain roads. It will also be possible to know when the flame detector is activated, thanks to the light that Geolight transmits, allowing the monitoring by air of the areas where it is necessary to intervene.

ENSURING A GREENER FUTURE

FUNCTIONALITIES

On a daily basis, Geolight works as a street light that is capable of capturing CO2 from the air. Once the flame detector is activated, Geolight launches the CO2 (that has been previously pressurized and turned into liquid) to contain the fire and avoid its spreading until the firefighters arrive. The CO2 captured is stored inside the device and in an underground storage. Once it reaches its full capacity, the underground deposit is possible to be removed, so that the CO2 can be used for other purposes, such as producing carbon nanofibers or concrete. Geolight is 14 meters tall and the storage inside of it is capable of storing 1300L of CO2 (not including the underground deposit), and is able to launch it at a distance of approximately 1km.

MAIN MATERIALS

DEVICE

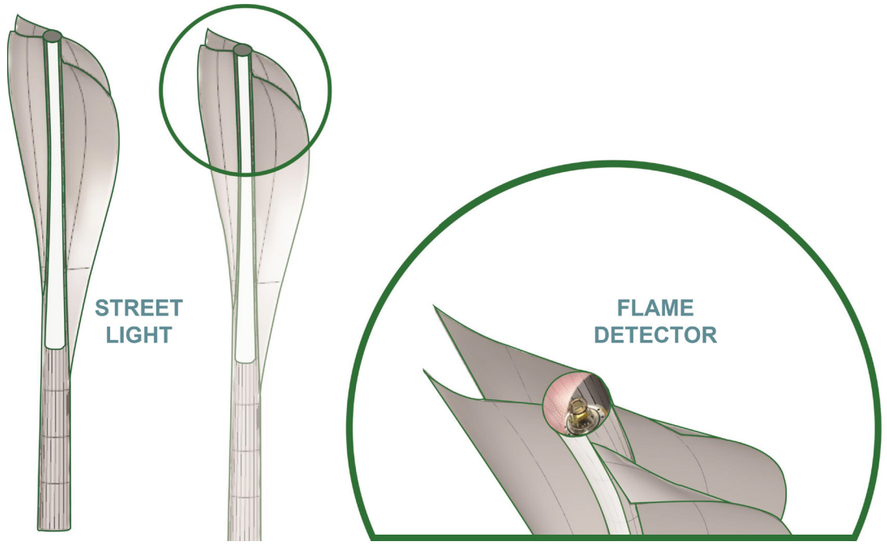
The material chosen for the for the outer coating was the Austenitic Stainless Steel 310S (AISI 310S) because it's very resistant. This material has about 25% of chromium, 0,6% of silicon and 20% of nickel. This combination is known for its behavior of corrosion resistance at high temperature. The addition of carbon is optimized in order to improve its creep deformation resistance, and the steel can easily be welded. AISI 310S is projected for high temperature applications, up to 1100°C, in oxidating atmospheres.

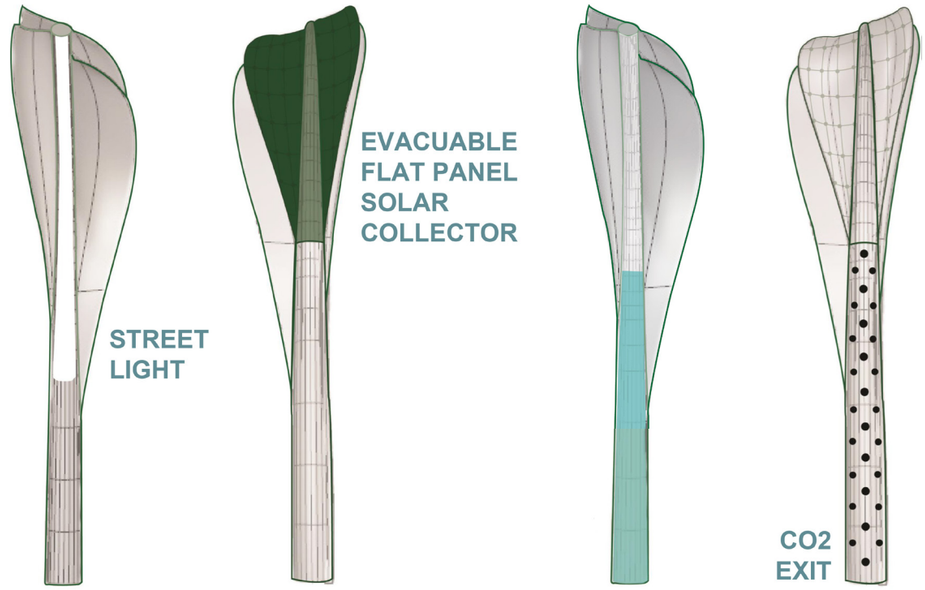
INTERIOR MEMBRANE

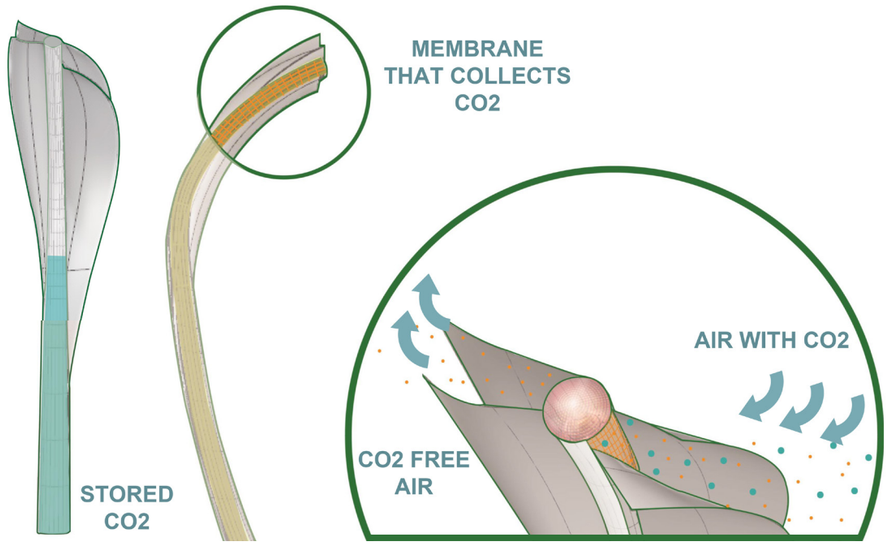
The material for the fiber membranes could be polypropylene (PP) or Polyvinylidene fluoride (PVDF). A study, made in 2014, showed that CO2 membrane stripping in PVDF has a faster CO2 desorption (phenomenon where a substance is released from a surface) rate than in PP membrane, but PP membrane presented a better stability on long-term running.

HOW DOES IT OPERATE?

In order to work, Geolight combines CERN technologies and Non-CERN technologies. But how do they all work? First, let's analyse CERN tech. The ones we chose are the Flame Detector and the Evacuable Flat Panel Solar Collector.
The Flame Detector can detect when a fire starts, immediately sending a signal to the system so the CO2 can be released.
The Evacuable Flat Panel Solar Collector captures the sunlight and turns it into energy, while also being able to store it. Geolight runs on solar and electric energy. By having two types of energy, we ensure that the device will still be functional even during a fire, when electric energy has a tendency to fail.
When it comes to non-CERN technologies, we have a membrane and a refrigeration compressor. The main function of the membrane is to fixate CO2. This technology is based on projects made by Climeworks and Global Thermostat, which capture the CO2 present in the atmosphere and give it another utility. In this project, the CO2 captured and subsequently pressurized will have a function similar to a large fire extinguisher.
After capturing the maximum amount allowed by the membrane, CO2 is heated to at least 100ºC to enable its desorption. After this process, the CO2 is pressurized by the compressor, which has a minimum capacity of 100 bar. In order for this to happen, the compressor's valve is opened so the CO2 can fill the deposit. Once filled, it's ready to start releasing carbon dioxide, and this happens when a signal is sent by the flame detector to the device's sprinklers.







CERN TECHNOLOGIES

FLAME DETECTOR

The Flame Detector is a sensor much more sensitive than those selled on the market. It is ideal for open spaces and it can detect flames and smoke, as well as some dangerous gases. It has a technology that allows it to locate exaclty the position of the fire based on UV flame and smoke detectors. It was originally designed to be used in an early emergency detection of forest fires.

EVACUABLE FLAT PANEL SOLAR COLLECTOR

The Evacuable Flat Panel Solar Collector was originally designed for the solar cells to retain the thermal properties of direct sunlight and transform that energy into electricity. This technology is used in the Geneva's airport, and it is the largest solar roof in Europe.

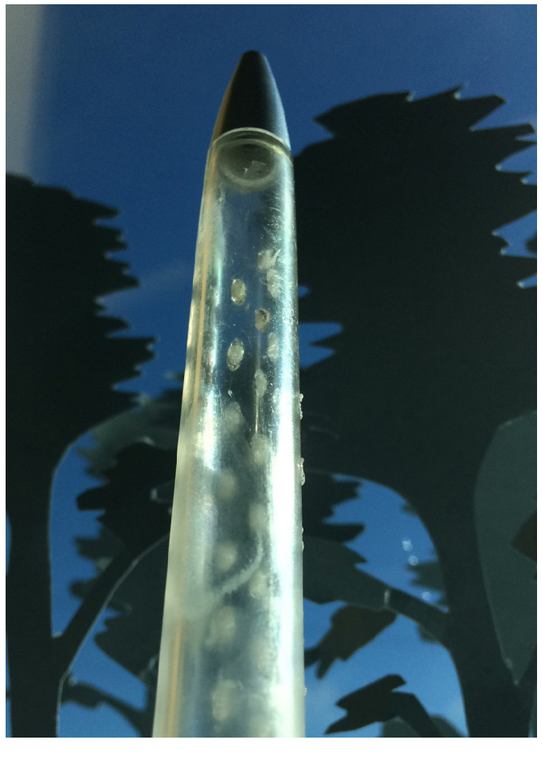
VALUE PROPOSITION

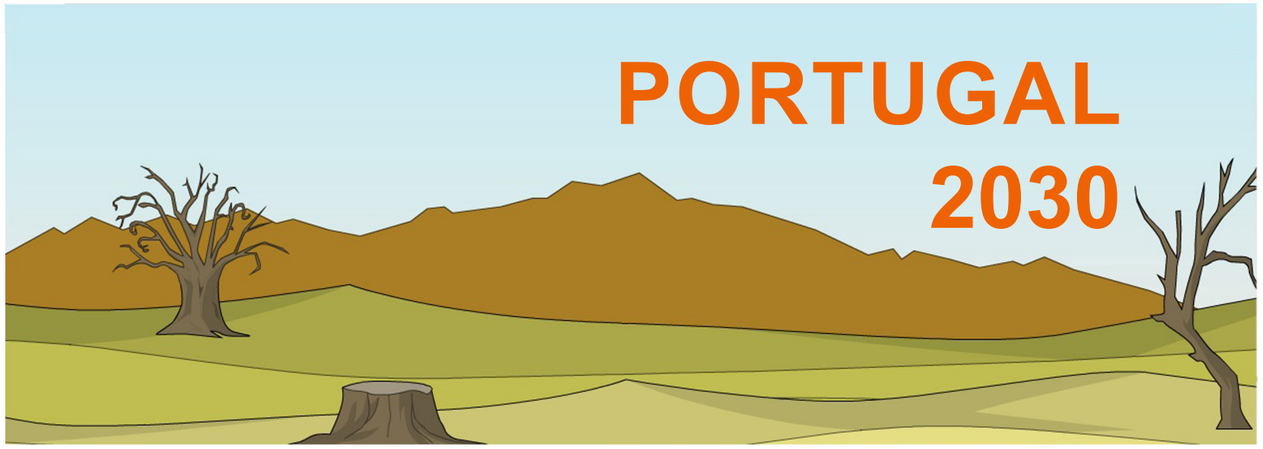
As constantly referred, wildfires are a problem that devastates the country every year. And the future doesn't look so promising. However, with Geolight, this future can be avoided, or at least its impacts can be minimized.
The time it takes for firefighters to reach the location of a fire is long enough for it to assume bigger proportions and become uncontrollable. By having a device that works 24/7, implemented in strategic places, people would feel safer, and it would give the firefighters some time to get there and control the fire in a much easier and faster way.
Geolight would also ensure that there's always a safe passage for people to escape, avoiding them to be caught by the flames. This also helps the firefighters evacuate people more rapidly, enabling them to focus on putting out the fire. In order to get some feedback on our project, we visited Valongo – a city that suffers from wildfires every year. We decided to talk to locals and to firefighters, and we got some really different responses. The population didn't really believe we could do anything, showing signs that they stopped believing the Government would do anything, or let us do anything. However, firefighters said the idea would be really useful. Going to the firestation helped us see some of the main problems firefighters face when they are working – for example, the lack of updated information on the direction and proportions the fire is assuming, making it harder for them to know the best way to reach the place. Realising this allowed us to improve our idea and include characteristics that could be beneficial for them on our device. Geolight will not only save lives; it will also prevent the destruction of the natural landscape, decrease the CO2 emissions caused by wildfires and prevent deforestation.

PROTOTYPES

Our first prototype was developed in CERN. This was when we first started building the idea of a device that could put out fires while also being environmentally friendly. It was an artificial tree spread around the forest. But soon we realized that this wasn't viable, because trees don't grow with a specific location pattern, so there wouldn't be a specific place to install them (besides, its size wouldn't allow a proper functioning) and a lot more devices would be needed. At the same time, we became aware that, to completely put out a fire, Geolight would have to launch a huge amount of CO2. This would bring more problems, because with big amounts of carbon dioxide, the air would lack oxygen, making it harder for people and animals that could be nearby to breathe, and at the same time, we would be launching big amounts of this gas back into the atmosphere.

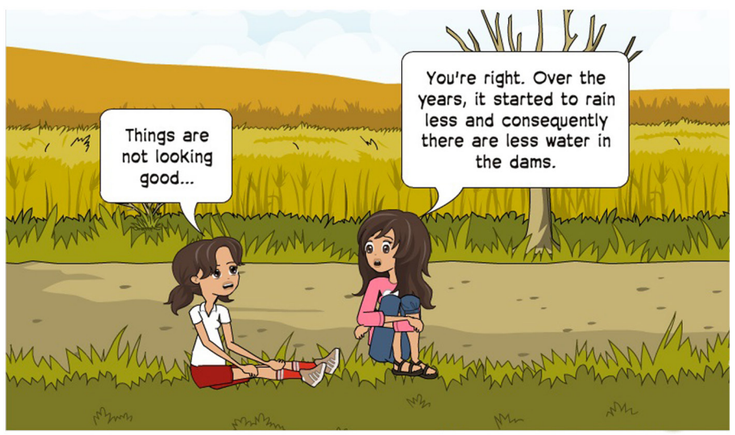
This takes us to our second prototype, and here is where the big changes happened. We decided that the device should be implemented on the sides of the roads, making it easier to save people that might be passing by. Also, instead of putting out a fire, Geolight will only contain it until the firefighters arrive – this way, the amount of CO2 launched is not enough to suffocate.




PORTUGAL
2030

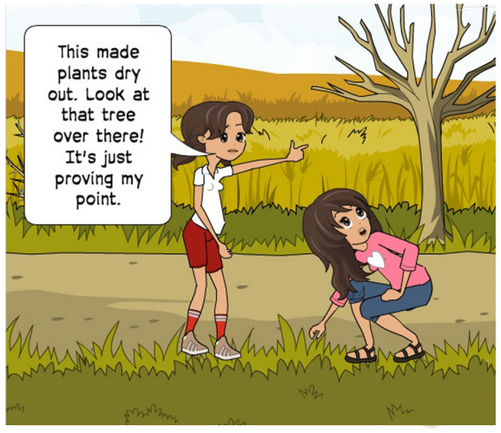

And you know what that means: an increase in CO2 emissions.


Also, wildfires lead to deforestation. All of this stands completely against the SDG12.

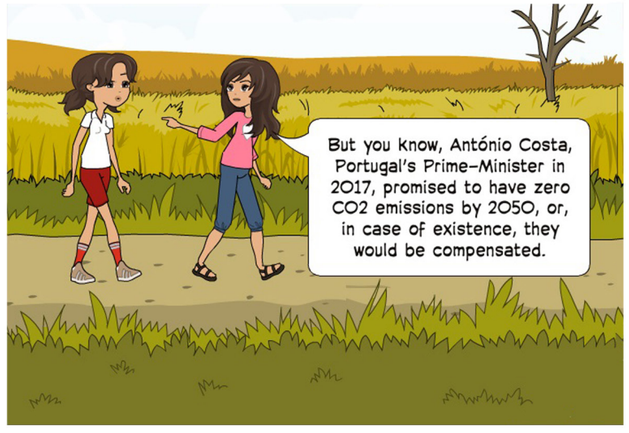

Things are not looking good...
You're right. Over the years, it started to rain less and consequently there are less water in the dams.

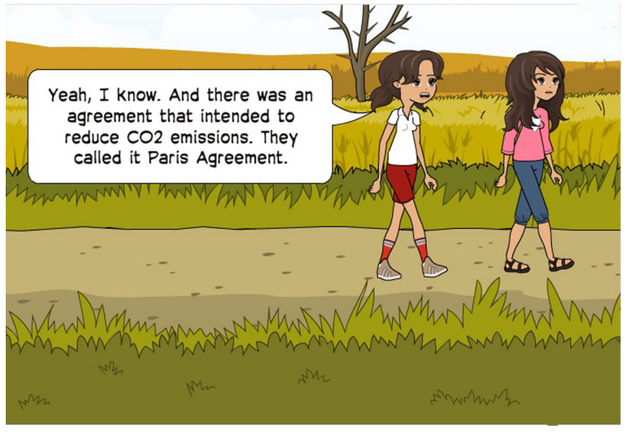

Yes! And with less water, we started suffering from drought!
You're right. It's so hot today and we're still in February. Global warming is showing its signs more and more every year.


Urgh, I know! And that only contributes more to global warming... It's a vicious cycle!


This made plants dry out. Look at that tree over there! It's just proving my point.


It was one of the few native trees we still had here. Did you know that, in terms of territorial area level, Portugal is the country with the biggest eucalyptus planted area?


But you know, António Costa, Portugal's Prime-Minister in 2017, promised to have zero CO2 emissions by 2050, or, in case of existence, they would be compensated.


Yeah, I know. And there was an agreement that intended to reduce CO2 emissions. They called it Paris Agreement.


The worst part is, all of these problems increase the risk of having wildfires.


But I heard there's a new device that can capture CO2 and use it in case of a wildfire to contain it until the firefighters arrive!
Yes, I've heard of it! It's called Geolight!

FUTURE SCENARIO

This is the future we face. And we can already feel the symptoms starting. Less rain, higher temperatures, frequent heat waves, hotter summers and freezing winters (although the average temperature will rise). Droughts will be a reality in Portugal. Plants will dry out and water in dams will evaporate faster.
The only way to solve this is to have more sustainable forests. But to do so is a really tough challenge, The generalized decreased of precipitation, the increase of temperatures, which leads to evapotranspiration (loss of water from the soil, plants, and water courses), that will make forests become drier, the increase of soil erosion - all of this will exponentially increase the risks of having wildfires.
Filipe Duarte Santos, professor of physics and environmental sciences at the University of Lisbon, said that there is greater uncertainty about whether man-kind will be able to reduce CO2 emissions than what will happen to the weather. He added that, to fulfill the Paris Agreement (an International pact that set out a global action plan to limit global warming to below 2ºC), We would have to reduce the emissions of greenhouse gases to 80% of 1980 levels, which is a very difficult task.

“ We are called to be architects of the future, not its victims.”

R. Buckminster Fuller

IMPLEMENTATION PLAN

RESOURCES

The project would be funded through Public-Private Partnerships (PPP) – the Government informs the location to conduct the pilot experience and launches a contest for private companies that might be interested in investing.

WHAT ARE THE BENEFITS FOR COMPANIES AND WHY SHOULD THEY INVEST IN THIS PROJECT?

Besides receiving something in return from the Government, they would also be producing their own energy or CO2, benefiting from cheaper prices. By turning this into a business, we address people's needs, while funding it. This partnership also benefits the Government, by addressing the wildfires' problem without it wasting too much money.
The implementation of Geolight would be executed by steps. In 2020, the idea would be presented to the Government, in order for it to initiate the contest for the Public-Private Partnership. The next step is the implementation, carried out from 2025 to 2030. During the implementation part, the Research and Development steps in, to study the best location for the pilot experience, the critical places to where it can expand and how some technologies work in real time.

STAKEHOLDER ENGAGEMENT

The Government will play a huge role in this – hence the big influence and why it's in the Meet their Needs quadrant - because it will allow the project to go forward by creating a Public-Private Partnership. Furthermore, the energy and CO2 companies also have a big influence and power, because they're the ones that are going to finance the project.
When it comes to Key Players, firefighters are obviously the first ones that cross our minds – they are the ones that are going to benefit the most from Geolight, and thus their interest is really high. Besides them, Quercus and ICNF (Portuguese environmental organizations) are also included in this part, because they play a big role in the implementation of the device by pressuring the authorities. These organizations' interest is also elevated, thinking that their main concern is the protection of the environment.
The media stands in the Low Priority quadrant, for the fact that, while the device is not implemented, their knowledge about it is still very low, and so is their interest. However, after the companies invest in Geolight, the media may increase it's influence, due to the fact that it might increase the interest of other companies.
The last quadrant – keep informed – is occupied by the people. People are the stakeholder that suffer the most from wildfires. Their houses get destroyed, they lose years worth of hard work, and, in the end, help always comes in too late. This means their interest is pretty high. However, their influence is still low, because of their lack of resources to change anything.

CONCLUSION

While developing Geolight, we encountered several obstacles that made us think if the whole idea was viable, and we danced with ambiguity several times.
Na exemple of a problema we faced, and probably the hardest one because it could destroy the whole project, was knowing if we could capture CO2 from the atmosphere. The answer we needed came from two companies – Climeworks and Global Thermostat – that do exactly this.
We started this project by using three CERN technologies, but later on realized that one of them was unecessary, and that we could save a lot of energy if we took it out.
All these obstacles only made us see the impact and importance of research.
In conclusion, Geolight is a device that can contain fires using CO2 captured from the air, and by doing so, it can save a lot of lives, as well as preserve natural landscape.

Geolight could have prevented the death of many people. We can't bring those lives back, but we can save a lot more in the future.

IPIRANGA

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