# e - Saniso

## Energy and sanitation solution for social inclusion

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Brazilian team

# Team

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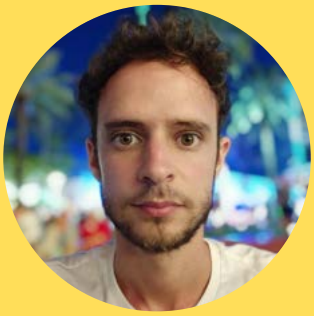

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# Team

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# Abstract

Brazil is the 5th largest country in the world, with a territorial extension of 8.5 million km². With such territorial extension, people's lives are very different, mainly when we compare the population's income and access to services. The lack of money and access to services can cause serious damage to the population, socially, environmentally and economically. Besides, energy has a fundamental relationship with human history, delimiting our own welfare, interactions with the environment, public services, and other people. In short, improving energy and sanitation access are strictly related with lifes quality and well being. The main goal of this project is to develop and implement technologies that is better suited to Brazil's southeastern coast, more specifically Baixada Santista, promoting social inclusion for remote and traditional communities.

Watch the presentation video of the project:

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# Summary

# 1 - Current situation

## *1.1 - Water-Energy-Food Nexus*

Water, energy and food are essential items for the survival of humanity, for poverty reduction and for sustainable development, as stated by [1] apud [2]. Despite this importance, there is a risk of shortage, as several studies indicate that the demand for these items will grow a lot in the coming decades [3], as can be seen at Figure 1.

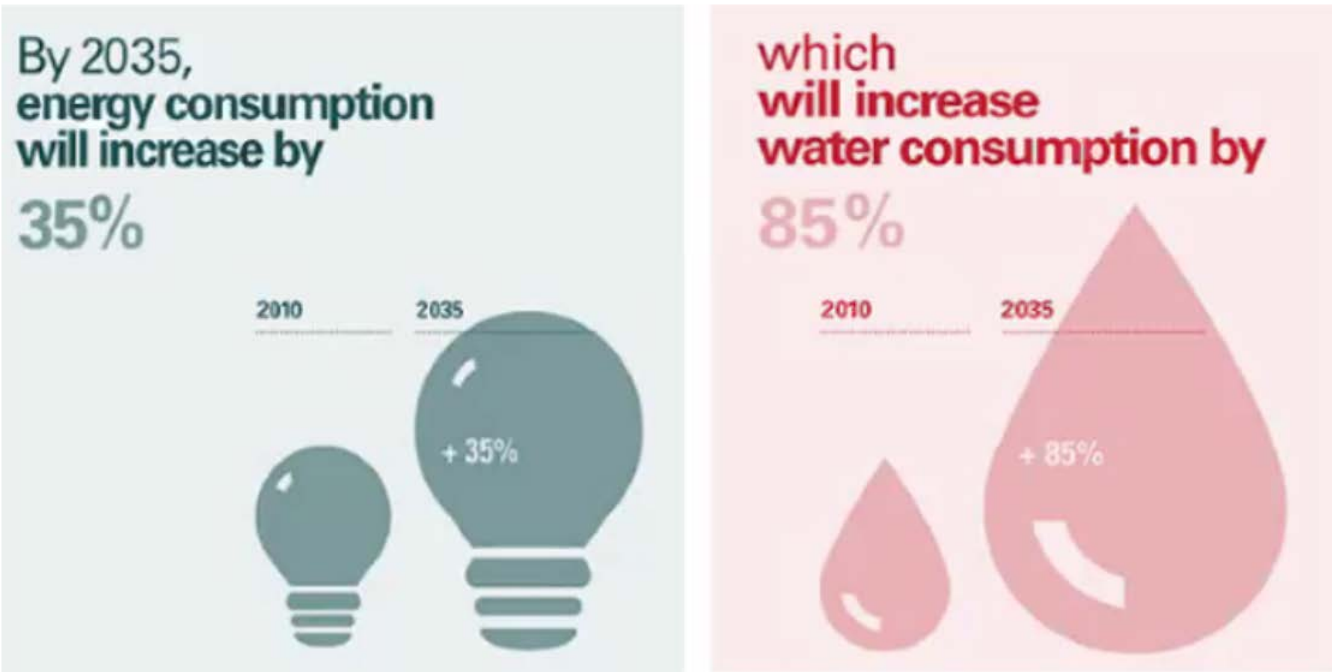


Figure 1: Increase of energy and water consumption by 2035.
Source:[4] apud [5].

Besides the demand growth forecasts by 2030, [6] apud [7] predicted, for the 2000 to2050 period, the growth of world demand for water, energy and food by 55%, 80% and 60%,respectively (Fig. 2).

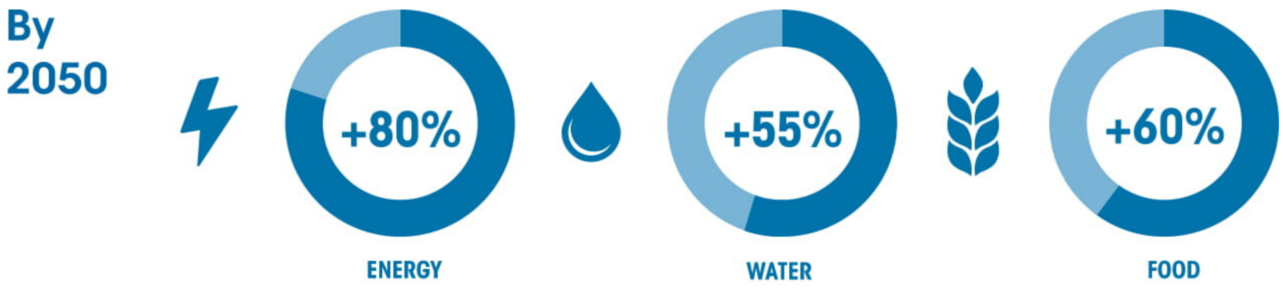


Figure 2: Estimated increase in water, energy and food demand by 2050.
Source: [6] apud [7].

Some of the reasons cited by [1] apud [2] are:

- population growth and migration;
- economic development;
- international trade;
- urbanization;
- diversification of diets;
- cultural and technological changes;
- climate change.

In this scenario, the BRIICS group countries (Brazil, Russia, India, Indonesia, China and South Africa) account for approximately 60% of global water demand, as it is expected to it highlight growth savings compared to other countries by 2050 [3]. Brazil is part of this group and it has abudancy of natural resources, as a result it has to combine economic growth with sustainable development goal (SDGs)

For these countries, electricity generation and the industrial sector needed or increased demand for water. The water consumption by production of each energy source can be exemplified by the case of 2014. Besides of the fact of water and energy consumption increasing, the emerging and developing countries have shown an important role in energy production - differently of the countries considered more developed, which consume most of the energy produced worldwide [3].

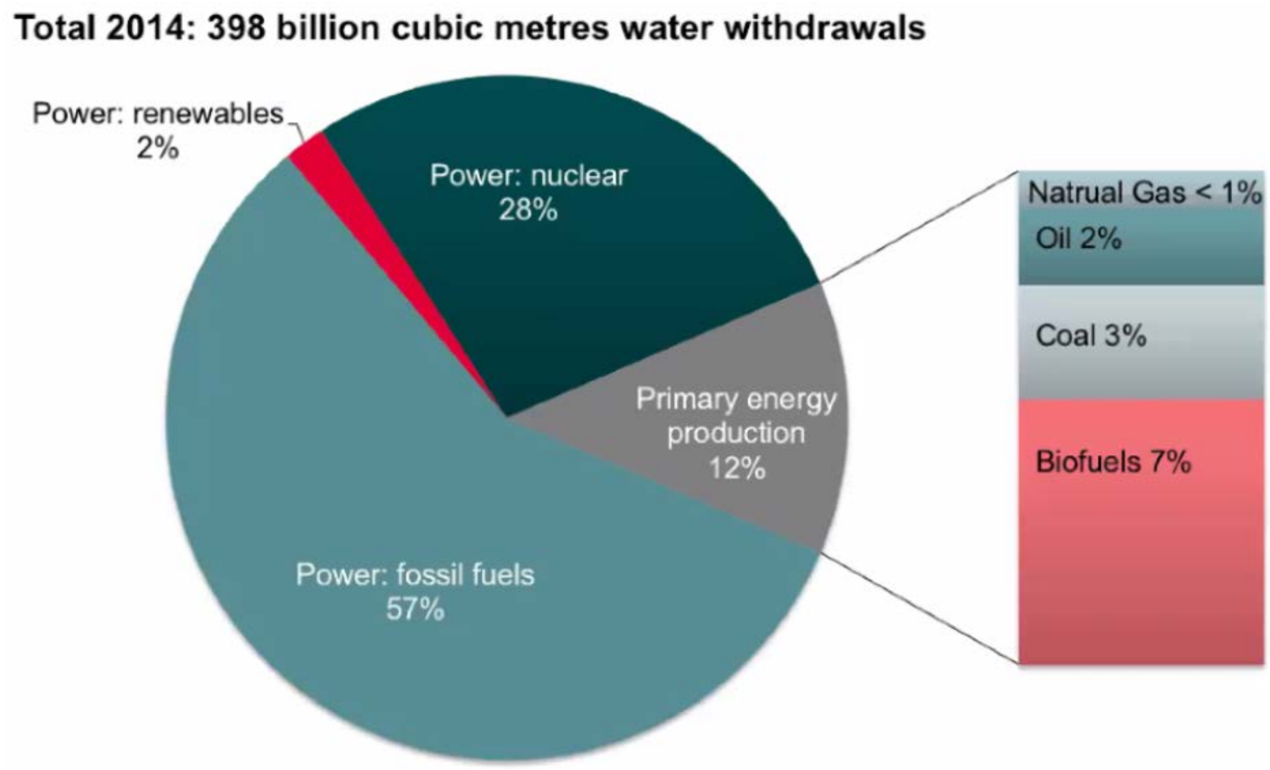


Figure 3: Water consumption by production of each energy source[1].
Source: [4].

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In the scenario projected for 2050, as well as water, the BRIICS will make a major contribution to world energy production (around 45%), while OECD countries and the rest of the world will contribute about 29% and 26%, respectively. Among the expected energy sources, coal, oil and gas will represent a greater participation in the global energy matrix, but non-fossil energies, such as nuclear, biomass and other renewable energies, will also have their production increased [6]. These cited facts show how water and energy is an essential item for human beings and has a strong relationship with economic activities and technological development.

1- Renewables include solar photovoltaic (PV), Concentrating Solar Power (CSP), wind, geothermal and bioenergy. Water requirements are quantified for "source-to-carrier" primary energy production (oil, gas, coal), a definition which includes extraction, processing and transport. Water withdrawals and consumption for biofuels account for the irrigation of dedicated feedstock and water use for processing. For electricity generation, freshwater requirements are for the operational phase, including cleaning, cooling and other process related needs [4]

However, it is necessarily to highlight that — although historically the themes of energy and water or energy, water and food were analyzed and planned separately —, with the increase of human interference in the environment in the last decades, and consequent impacts, many studies have started to be done to demonstrate the strong interrelation between these themes and the risks related to the pressure of one on the other [3]. Therefore, it is extremely important to visualize the relationship of the water-energy-food nexus as something integrated, as can be seen in Figure 4.

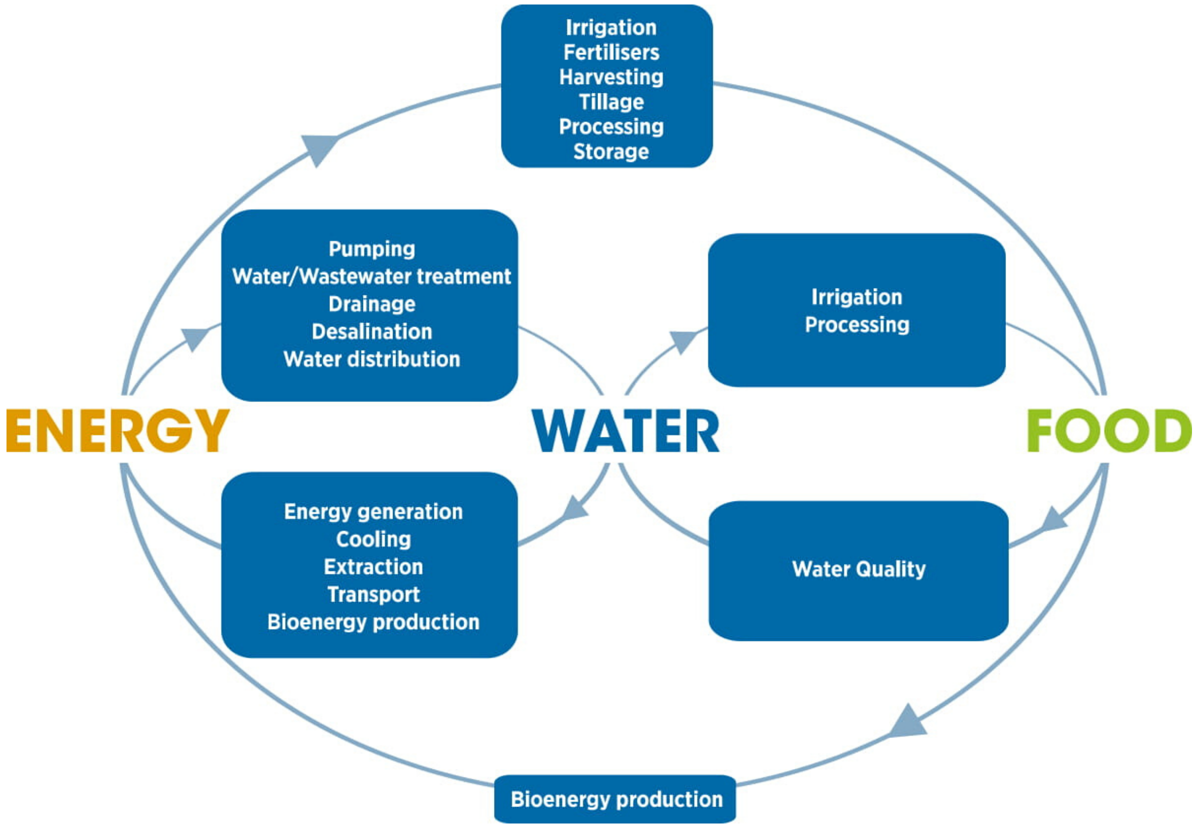


Figure 4: Schematic illustration of various elements of the water–energy–food nexus.
Source: [7].

# 1 . 2 - Disconnected communities and social inclusion

Disconnected communities located in shorelines, mountains, islands and other areas have very particular natural, cultural and socioeconomic characteristics [9]. These communities either being of traditional population, or being result of pressures that have caused migrations to the places where it exists. In a large amount of cases occur incorrect occupation and use of land, and management aspects of public policies are neglected for a long time, causing disturbance of different orders for society, being reality to different regions of the world [10].

These places often do not even have basic infrastructure for the resident population and must be priority places for interventions arising from government actions. Another important aspect to be taken into account is the vulnerability and high sensitivity that these communities have in relation to the rapid external changes that occur in the economy, social and environment [9]. Social inclusion in this case may be through the use of non-grid solutions and technologies that would serve to improve the quality of life for residents and also the environmental quality [11].

The Water-Energy-Food Nexus becomes an important tool for the creation of public policies aimed at integrating disconnected locations, for example, by providing water treatment solutions we can prevent more than 577 thousand deaths around the world caused by precarious conditions of access to water, sanitation and hygiene (WaSH) [12]. Providing renewable sources of energy to these communities, we can improve their economic/subsistence activities that can result in making gains in food security.

Coastal areas in Brazil lack public impact policies, in addition to the need to improve many socio-environmental aspects, among them climate change is sensitive point to be prioritized. As researchers, we have a great responsibility in addressing the problems arising from climate change. It is important that it presents itself in a proud way and with strategic management to face the problems now and in the future, acting as a promoter and implementer of public policies of impact for the community management of this problem and not just as a “disaster manager” as seen most of the time [13].

Energy access is considered to be a fundamental factor responsible for societal development throughout human history. In this scenario, it is well understood that the degree of access and quality of energy sources delimit our interactions with the environment, other people, public services and our own welfare. During the last few decades, society has been discussing over the necessity of transitioning our energy sources from fossil fuel to renewable, evaluating the feasibility of the latter over the enormous amount of incoming energy flux from the Sun. In one hand, it is correct to consider energy to be abundant and present its manifestation everywhere we look at. On the other hand, does abundance mean easy access to high quality energy to everyone in our society? Definitely not.

Energy access is one of the UN`s Sustainable Development goal since 2015, reinforcing the importance of this subject specially in developing countries and rural communities without access to sanitary and energy infrastructure. One indicator of energy poverty is the reliance on the traditional use of biomass for cooking. Over the World there are 2.7 billion people depending on traditional biomass for cooking [14]. Energy poverty can also be understood as the dependence on biomass (crop residues, wood and animal dung for example), muscular energy (either human or animal), kerosene, candles, batteries and coal [15].

In this scenario, energy poverty means the requirement of manually gathering fuel and resources in the environment, sometimes leading to long distances carrying loads and a considerable time investment. The time requirement for these tasks may vary between communities and environment. [15] has evaluated papers presenting time investments ranging from one to six hours on a daily basis. Considering how time consuming and how physically demanding it is to perform all tasks related to preparing a meal (including gathering fuel, water, preparing and processing ingredients), energy poverty is closely related to scholar evasion, as children often need to help their family on home labor.

Another alarming consequence of lacking improved energy sources is the impact on human health. The usage of biomass (and other traditional fuels as previously stated) is responsible to cause Indoor Air Pollution (IAP), which has been responsible for over 4 million deaths around the world [16]. Burning traditional biomass also lead to food contamination, which may lead to food poisoning among other illnesses. [17] has studied the action of toxic element emissions (for example particulate materials, aromatic hydrocarbons, nitrogen compounds and benzene) through burning traditional biomass that causes health problems ranging from damage on respiratory system to cancer.

Therefore, our understanding is that the access to an improved energy source does not only affect the availability of energy per se, but also improve the overall life quality of individuals. We strongly believe that an effort toward providing a traditional community with improved energy, even though in a limited scale, may lead to a significant improvement on the community members welfare.

# 1.3 -Public Health and Sanitation

Safe sanitation is essential for health, from preventing infectious diseases, waterborne disease and to improving and maintaining good aspects of mental and social well-being [18]. The lack of sanitation is one of the direct causes of countless losses for the individual who does not have access to it, and thus, it generates enormous problems to the entire social context to which this individual is inserted. Most of them are lost in social well-being and productivity, because when an individual contracts some disease caused by pathological agents present when there is no sanitation, he is physically affected by the symptoms of the disease and is unable to work or study, the expenses of HUS (Health Unic System) and NISS (National Institute of Social Security) also suffer significant impacts due to illness and absence from work, increasing the so-called “avoidable expenses” for public coffers [19].

The 20th century was marked by the consolidation of sanitary practices throughout world, and in Brazil it was not different, at this time, the government and industry work on collective buildings to promote water supply and provide basic infrastructure for sanitary sewage. It is from the 1970s that the first approaches to creating a unified regulatory model for sanitation in the country, being 2007 the most important year so far with the enactment of the Law Federal No. 11,445 / 2007 which establishes national guidelines for the basic sanitation [20].

According to the World Health Organization , “Environmental Health is all those aspects of human health, including quality of life, which are determined by physical, chemical, biological, social and psychological factors in the environment, in order to control, correct and avoid these factors that could potentially harm the health of current and future generations” [18]. Issues related to environmental health have a global theme, and need multiple efforts in addition to new institutional arrangements and sectoral agreements to achieve their main objective, which is the prevention of environmental risks that negatively affect people’s lives [21].

In Baixada Santista (region we chose to implement our project), the biggest challenge for the universalization of the water supply service will be the coverage of the public network in subnormal agglomerates and disconnected communities, places where it is not possible to install basic sanitation equipment . It will demand a large contribution of resources, of a financial and human resources, from the Municipal Government, which hold the title to the service, these resources will be applied in land regularization, in the housing program and in the implementation of specific technologies for the needs each location [22].

Public health problems caused by the Sars-Cov-2 virus are even worse when added to the country’s health reality, moreover, they show as demands for search for alternatives that see ensuring universal sanitation. Alongside social distancing, case isolation and contract tracing, regular hand-washing with water and soap is recognized as one of the most important measures to prevent transmission of COVID-19 [23].

# 2 - Implementation area

## 2. 1 - Brazil

Brazil is the fifth largest country in the world, with a territorial extension of 8.5 million km2. This amounts to more than 205 Switzerlands or 13 Frances (see Figure 5), with such territorial extension, people's lives are very different, in the many corners of the country. This difference is clear when we compare the population's income and access to services (see Table 1) [24].


Figure 5: Brazil's extension.
Source: Authors.

According to Maria Lúcia Vieira, representative of "PNAD Contínua", from the Brazilian Institute of Geography and Statistics — IBGE —, a public institution of the Brazilian federal administration [25]:

> "Historically, Brazil is a country where inequality is one of the worst. We know that it is one of the countries with the highest concentration of income, perhaps among the 10 largest."

Let’s remember that these numbers speak of people. In short, 43% of the money is in the hands of 10% of the population; 60% of the population, survives on a monthly income of up to R$ 1500.00 (approximately 385 dollars. Table 1, makes clear the Brazilian social discrepancy when accessing basic services, such as water, sewage and garbage collection. It is clear that, even with government financial aid programs, this part of the population is always below the access of those with better social conditions.

Table 1: Average real monthly household income per capita and possession or access to goods or services, by receiving social programs from the Federal Government. Source: [24].

| Ownership or access to goods or services | Does receive federal government social programs? | | | |
|---|---|---|---|---|
| | Bolsa Família | | BPC-LOAS | |
| | Receives | Does not receive | Receives | Does not receive |
| Average real monthly household income per capita (R$) | 352 | 1 641 | 755 | 1 433 |
| | Access to services (%) | | | |
| Water supply | 71,6 | 87,7 | 80,2 | 85,7 |
| Sewerage with general network, rain network or sewer connected to the network | 39,5 | 72,2 | 55,5 | 68,3 |
| Garbage collection | 76,1 | 93,7 | 87,6 | 91,5 |
| Electric lighting | 99,2 | 99,8 | 99,7 | 99,8 |
| | Ownership of goods (%) | | | |
| Fridge | 95,3 | 98,6 | 96,5 | 98,2 |
| Washing Machine | 32,0 | 71,4 | 45,8 | 66,9 |
| Television | 94,0 | 96,5 | 94,5 | 96,3 |
| Computer | 12,6 | 45,6 | 17,0 | 42,1 |

# 2. 2 - Baixada Santista - São Paulo

The Baixada Santista Metropolitan Region (RMBS) was established in 1996, and has an area of 2,420.5 km² , where nine municipalities are located: Bertioga, Cubatão, Guarujá, Itanhaém, Mongaguá, Peruíbe, Praia Grande, Santos and São Vicente, housing 1,765,431 inhabitants.

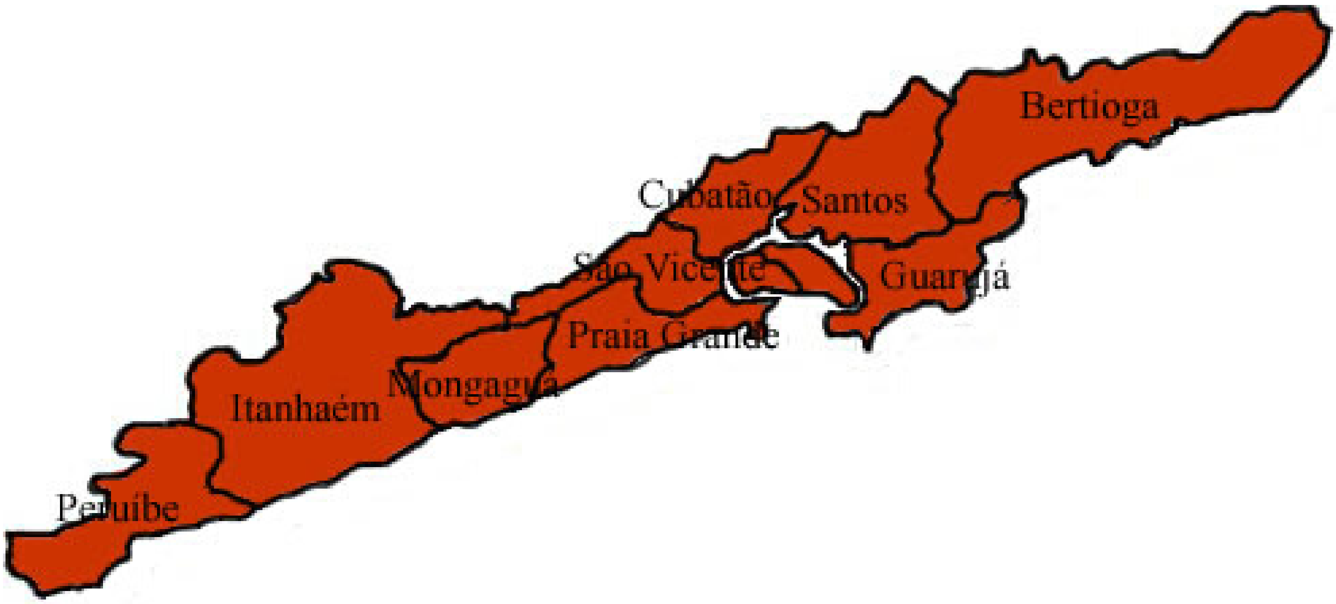


Figure 6: 9 cities of the Baixada Santista Metropolitan Region (RMBS). Source: [26].

This region is characterized by 65 continuous kilometers of coastline, in an elongated and narrow strip, limited by the escarpments of the Serra do Mar, with its remnants of Atlantic Forest, and the Atlantic Ocean. It presents a great diversity of ecosystems, such as mangrove, estuary, islands, sandbank, coves, dunes, beaches and rocky shores. Much of these ecosystems are protected through Conservation Units or other types of areas protected by law.

The physiographic and socioeconomic characteristics of RMBS condition the frequent occurrence of physical processes (landslides, floods and floods, linear and coastal erosion), which affect the population at different intensities, which can be aggravated in the face of the prospects of climate change, since a greater occurrence of extreme events is estimated due to the rise in sea level with the increase in average temperature.

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# 3 - Solution

## 3.1 - Biodigester

### 3.1.1 - Biological degradation of organic matter

Biodigester is a alternative technology for treatment of solid waste, it works to digest organic matter turning it into gas and bio fertilizer. Basically, the degradation of organic matter is a result of anaerobic digestion (AD) made by bacteria, that grow up from organic waste itself. This process initiate with a hydrolysis process, initiating a chain of reaction illustrated by Figure 7. This is a natural process that occurs, generating some sub products that can be reintroduced on the natural system or be used by local population to improve their life quality.

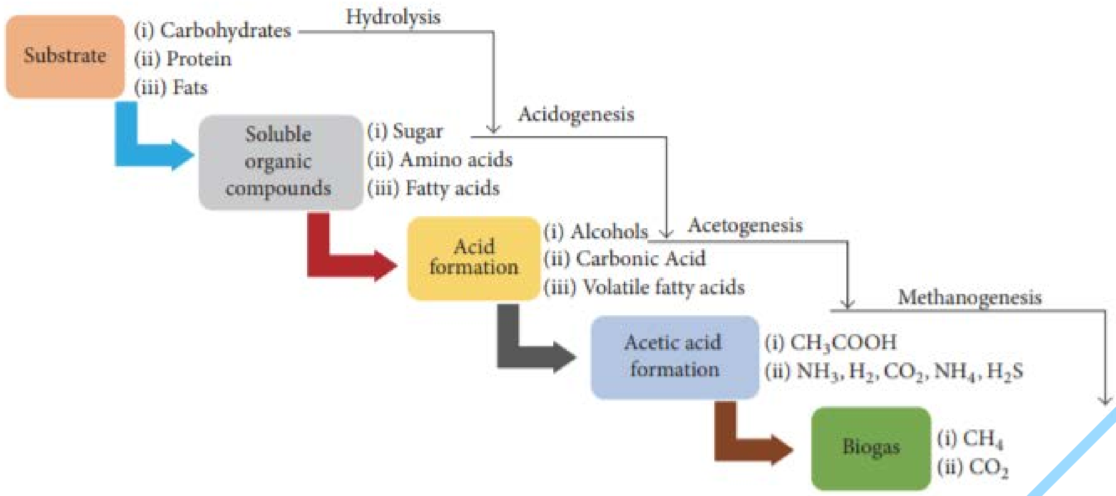



Figure 7: Anaerobic digestion phase.
Source: [27].

It can be made in different setups and with a variety of materials, depending on the desired application and scale of the project. Nowadays, this technology is getting more and more common and it is being used from manure management on big farms to decentralized solutions for small communities or permaculture's villages. On both situations the environmental and social benefits are significantly higher than traditional technology.

One of the products of biodigester, more specifically, anaerobic digestion is the biogas, it contains around to 50-70 percent of methane and 30-50 percent of carbon dioxide [27], depending on the composition of the biowaste or operational methods. In biogas, the amount. of methane (CH4) because it can be used to generate different types of energy,such as heat or electricity. Some times, it is needed a filter to remove most part of the others undesired compounds.

## 3.1.2 - Perfect choice for small communities

Focusing on the benefits of biodigesters for small communities, we have to look for their main products, gas and fertilizer. Biogas can be used for cooking or even as light source on those places without electric energy. When we think in the world, around 1.4 billion people will not have access to modern energy [28]. This reality can be modified with policies, investment, science and innovation that increase the viability and access to biodigesters for traditional and remote communities. Implementing this solution contribute directly for enhancement of life quality and health.

Another product of biodigesters is fertilizer. This product is particularly important to rural and remote communities, because they usually have crops to provide their food. Wherefore, it helps to increase food security, and also, it can value their products, being able to receive organic products certificate. Moreover, people are looking for these products that are organic and local made. A result of the covid-19 pandemic on the consumption pattern of society.

The biodigester can be related with the nexus of energy-water-food, because it is connected with all of these subjects. In the energy access problem, it is able to produce biogas that has all the benefits listed above. For the food security, the fertilizer can help to increase productivity of their crops. In addition, a solution that solve any basic sanitation problem, as solid waste management, affects directly, and indirectly, the water quality and, consequently, clean water access.

Figure 8: Applications of biogas
Source: [28]

In Brazil, most of the solid waste generated is organic matter, around 50-60 percent [29]. Small communities have even higher percentage of organic waste than urban areas. When we look through this scenario, biodigester are a effective and sustainable path to solve the solid waste management problem, as the same time improving access to clean energy. In the southeast coast of Brazil, there are some arising initiatives for the public government to install incinerators to burn solid waste with foreign technology that it is not the best alternative for the kind of solid waste generated by brazilian population.

In this region resides the major area of the tropical rainforest, know as Atlantic Forest that is pointed out as one of the biodiversity's hotspots for conservation of the world, being a sensible zone to implement incinerators and new landfills [30]. Landfills are traditional solutions for solid waste disposal are landfills, it has a high demand of new location were native forests reside. This scenarios, make portable biodigesters even more attractive as the most suitable solution.

# 3.1.3 - Biodigester design

Low income communities in developing countries most of the time do not have financial resources to pay for a technological solution. Therefore, we can propose a technology that they cannot buy. In addition, coastal area suffer the effect of the tide movement and river flow, a fixed construction is not the best option to implement on these locations, because can be underwater when the tide is high.

Our solution (see Figure 9) is a portable biodigester of small scale that people can have on their backyard or even inside their home. Moreover, it is made with low cost materials that can be recycled or reused material.

These features are important to the project, because people need to be able to build and manage their own biodigester, whenever it is required. In other hand, by reusing gallons of water, the solution provides a great alternative destination for them.

Figure 9: Developed biodigester
Source: Authors

To assemble the developed biodigester, you only need some basic parts and tools that you can easily find in local . In total, it costs around R$170 (around US$31). The process is very simple. It goes like this: You take the processed organic material mixed with water and put in the gallon. Bacterias of the organic waste start the anaerobic digestion, generating gas. It is conducted by the hose to the glass jar, which will remove the steam from the gas, making the gas more efficient. Besides, if the jar contains a mix of water with caustic soda, it will also remove Carbon Dioxide, avoiding black stains on the bottom of the pan.

After that, the gas goes through a piece of steel wool, which removes Sulphuric acid from the gas, preventing corrosion and bad odor. Finally, the concentrated gas is fed to the air chamber, where it can be collected and used to power to a gas stove, spin a turbine or simply as light source.

Apart from all that, the biodigester generates fertilizer, which can be collected in the bottom part of the gallon. It can be used on gardens to produce food and, therefore, more organic material, which can be further used in the biodigester. If used properly, the only part that requires maintenance is the piece of steel mesh of the gas filter, which must be changed roughly every 3 month.

# 3.2 - Water purifier

## 3.2.1 - Developed technology

The water purifier, while not as simple as the biodigester, is projected to be as economically accessible as possible, costing around R$500 (around US$100). It is also projected to last as long as possible. The proposed filter works in two phases:

First we remove solid and organic material through conventional activated carbon candles.

Second, we use an UV-C lamp, which has proven efficiency in removal of pathogens in the treatment of drinking water.

The system has a water pump that makes it possible to raise the water up to 5 meters from any source, such as a river or raining water, and store 20 liters of water for treatment.The UV lamp we chose allows sterilization of 10 liters of water per minute. To power the pump and the UV lamp, we use a solar panel with 20 W of power and a stationary 7 Ah battery, which allows the use of energy even at night. The filter works automatically, when the tap is turned on, it activates the UV lamp. However, if the battery level is critical, the lamp would not work. To ensure correct operation, in this case the water flow will be cut off by a solenoid valve until the charge is restored.

There is no need for regular maintenance of filter components, the battery must be changed every 5 years, and the lamp every 80,000 (eighty thousand) liters of treated water, being an essential feature to stay long time witihout maintenance.

Figure 10: Water purifier design.
Source: Authors

## 3.2.2 - Local solutions for local communities

The solution proposed is based on the QLuz project, developed by Rolland Vetter, a Dutch researcher, funding by National Institute of Amazonic Research. It is being used on the native communities to collect and treat contaminated water from rivers. The sterilization of biological pathogen and bacteria occurs by UV radiation.

The solution is well suited for tropical climates with different water sources. For the success of the proposal it is important to have solar power availability to feed up the UV lamp and the water pump system. In the coastal area of Brazil, more specifically, the estuarine areas have limited water rivers and salt water intrusion in the groundwater.

Another well know brazilian technology is *Aqualuz*, recognized globally. It was developed by a undergraduation student to clean up rain water in the semi arid region of Brazil using solar radiation. It has the same principle than our technology, nut it uses UV radiation from the sun instead of light source. The main application is to be used on cisterns systems, focusing on biological contamination of water, with bacterias and viruses.

This is a contradictory scenario because some the urban areas have the infrastructure to collect and treat water from distant sources. However, the traditional and remote communities, most of them placed on environmental protected areas are unable to access water resources.

As a result, decentralized solution for water access, solid waste management and sanitation are the most suitable proposal to be implemented and promoted for these communities. This is the objective of our integrated solution presented here.

# 4 - Implementation

## *4.1 - Limitations*

The main limitation for the biodigester is the acceptance of the technology by the population of small communities, because it demand some time and effort to operate properly. The method is not complex but it is a habit that they do not have before the implementation of the solution.

These technical limitations of the biodigester need to be solve in new developments of the technology. It is important have a good communication that it is able to listen the claims of the stakeholders and translate it on new innovations.

A way to solve that is giving support and, explain, what are the environmental, social and economical benefits for them, a rule that environmental education can help to solve. As a result, we developed booklets for the biodigester and water purified to be used as guidelines that help than to build and operate these technologies.

The lack of financial and materials resources are one of the problems that affect all communities in Brazil. As a result, our implementation process requires governmental funding or other financial support sources to apply the solution without any cost for those communities interested to implement.

For the water purifier, the limitation is the cost and installation of the system. It is a robust solution that need skilled workers to build it properly. This would not be easily replicable by local communities themselves. This process need to have a responsible and honest dialog with communities' leaders and residents.

For any social initiatives that have the primary goal to increase social inclusion, all cultural and local aspects need to be considered in the implementation process. Therefore, Saniso-e is going to be a social enterprise that will fight to give free access for basic sanitation and water access for those local communities, respecting their way of life and their cultural identities..

# 4.2 - Business plan

The initial idea for implementing the solutions proposed by our group is in line with the concept of social entrepreneurship and results in the creation of a social company. Social impact businesses aim to develop products and services that serve vulnerable communities, bringing benefits to these locations and contributing to the transformation and social inclusion of these locations. An important point to be taken into account is that a social enterprise differs from philanthropy, as it is self-sustaining without being dependent on donations or the sale of its products as a source of revenue, a social enterprise has its product as a reason for social impact and not the actions that follow from the sale of products or services.

To implement the proposed solutions, we will start from the application of a pilot business model to create a social company, going through the prototyping processes where we seek to develop the product, understand the value proposal and identify the potential solution to the problem that the solution can provide. After prototyping, we will go on to validate the product and implement the company, where we will study the economic feasibility, ways of accessing credit (notices, agreements with government entities, development agencies, incubators and business accelerators) and tests with the target audience to validate the solution.

After product validation, with the tests carried out and the product adherence consolidated, we will carry out the market validation where we will seek to take the first sales of the product, study the market, the customers, better understand and refine the company's business model so that can achieve its goals of being sustainable in a niche market and can achieve the expected social impact. With the consolidated business, the last phase of the company is the search for scale, to impact the largest number of people and prepare for the growth phase. With this methodology we believe that we can make the social impact of the proposed solutions viable.

# 5 - Final considerations

Global warming, pandemics, social inequalities, and many other ills that exist on the planet are reflections of generations acting inappropriately. Young students from our generation who have committed themselves to participate in this important initiative called "The Geneva Challenge" have a great challenge ahead. As we see it, the challenge is not based on the assumption of just creating solutions and technologies to reduce social problems and readjust natural environments on our planet. Instead, we believe in democratizing access to technologies that already exist and are yet to come.

The reality of communities that are isolated and disconnected from the usual sanitation network is very difficultin Baixada Santista, region of application of our proposal, we have this reallity very acentuated. These places have little voice in the discussion of public policies, for long being neglected by the public authorities. During circumstances, such as the COVID-19 pandemic, the problems caused by the lack of sanitation are even more evident. Along with creating and promoting access to technologies, new institutional arrangements and new public policies must guarantee for these communities to be effectively included in society, not leaving these ideas only on paper.As students and researchers, we are used to the methodologies, reviews, protocols, and much more which academic life brings.

However, in this project we aim to impact people, applying our studies and research to really make the difference, by looking for practical solutions which bring a positive impact on the life of people who often live forgotten and so close to us. Through these technological solutions presented in this proposal – which we understand as functional, compact, and easy to operate that doesn't require major changes to local infrastructure –, we believe that our solution will help to advance the spectrum of social inclusion in these locations while respecting culture, customs, and local particularities.

# 6 - Booklets

This section is going to show our booklets developed to help and guide people who want to build or more information about both technologies presented.
See the results int he next pages:

# BIODIGESTER

# BIODIGESTER

*Assembly and usage instruction manual*

## You will need

1

1m30cm of PVC Pipe

2

2 PVC Elbows

3

4 PVC Caps

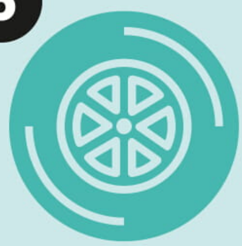
4

Steel Wool

5

2 20l water gallons

6



16” diameter tire air chamber

7

5m of 10mm Hose

8

Epoxy resin

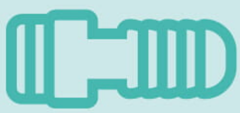
9

Glass jar

10

Black Spray Paint

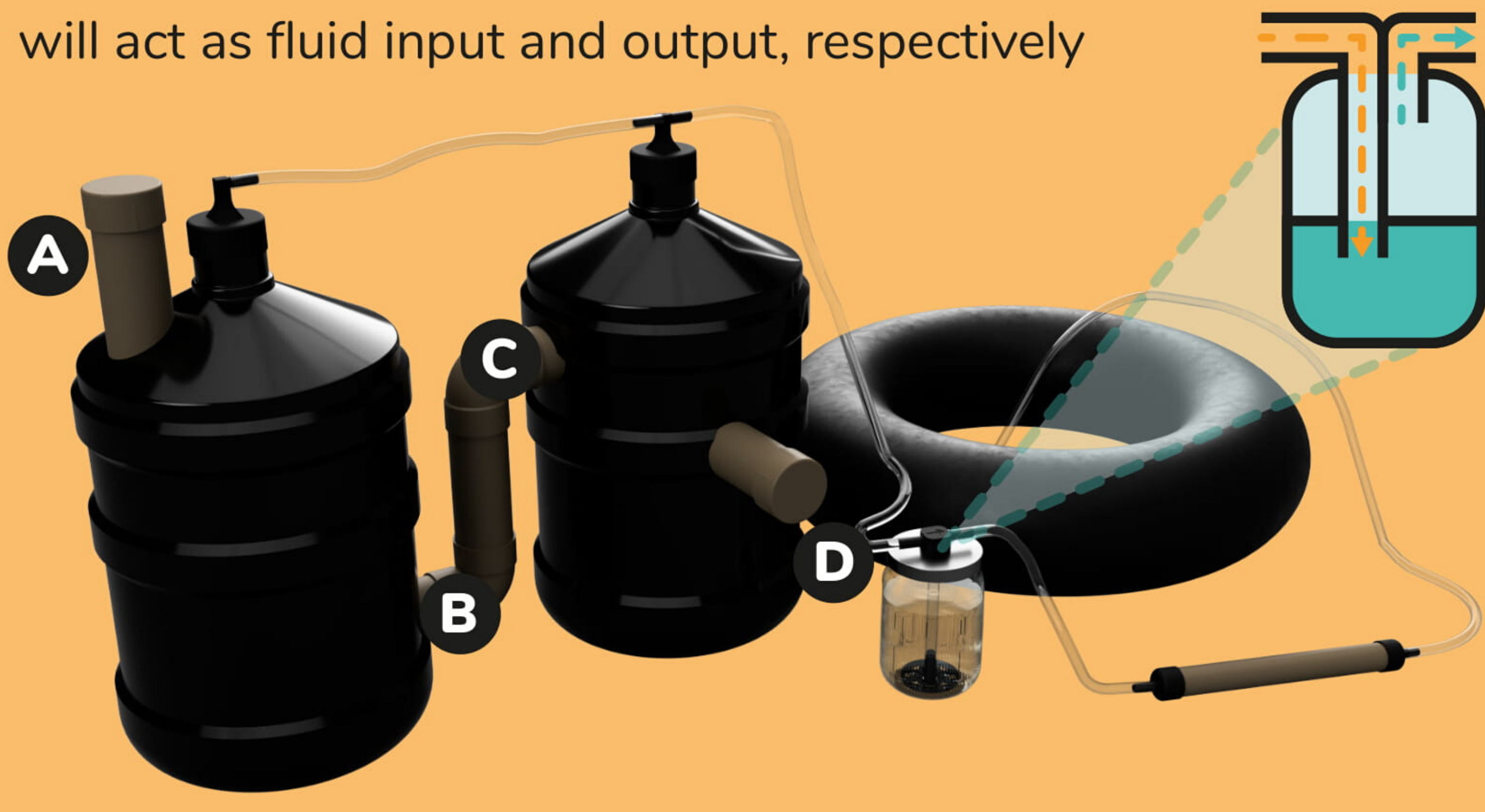
11



7 Hose Adapters

# How to assemble

- Cut the PVC 1 in 4 parts (1x50cm, 1x30cm and 2x25cm)
- Poke 2 pipe-sized holes in each water gallon (letters A to D)
- Paint 10 the gallons 5 and let it dry
- Stick the 2 shorter pipes on A and D
- Join the elbows 2 on both sides of the longer pipe 1 to connect them to holes B and C
- Fill 2/3 of the glass jar 9 with water and cover it
- Using the hose adapters 11 on the caps and the lid, connect the hose 7 to the gallons, 5 then to the glass jar 9 as the figure shows
- Stick the piece of steel wool 4 into the remaining pipe 1 and use it to connect the glass jar to the air chamber 6
- Apply epoxy resin 8 around the B and C holes and around all caps to prevent air leaks
- Use the caps 3 to cover the A and D pipes. These pipes will act as fluid input and output, respectively



# How to use

## Gather organic material

Leftovers of fruits, vegetables and eggs; used coffee powder, organics in general.
**Don't gather:** meat leftovers and animal excrement.

## Grind it and add water

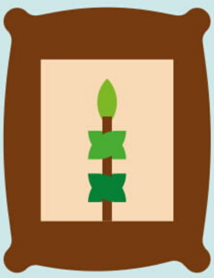
You may simply use a pestle, or some fancy food processor, to grind the organic material. After grinding, add half the volume of water to get a uniform mix, grinding it further if needed.

## Fill the biodigester over the days

Gently pour the uniform mixture over the days on A, until it gets full.

## Collect the produced biogas

The concentrated biogas in the air chamber can be used* to power to a gas stove, spin a turbine or simply as fuel.



## Collect the produced fertilizer

The liquid outputted by D is a powerful fertilizer and can be used on gardens to produce food and, therefore, more organic material, which can be further used in the biodigester.

**! *Children should not try this without a responsible adult supervision***

# WATER PURIFIER

# WATER PURIFIER

*Assembly and usage instruction manual*

# You will need

4.5m of PVC Pipe

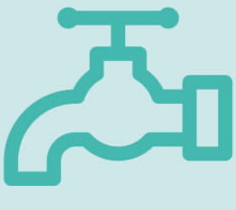
9 PVC Elbows

1 PVC Cap

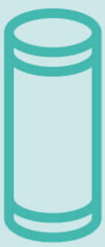
Reducing T

8 PVC Ts

20l water gallon



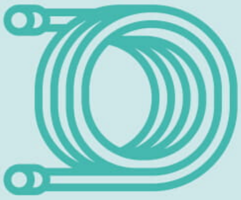
Tap



Activated Carbon Filter

20W Solar Panel

# You will also need



15m of 10mm Water Hose

20m of 1.5mm Electric Cable

9W UV Lamp

Solenoid Valve

Quartz Dome

Water Pump

PVC Waterproof Box

Charge Controller

Battery

Lamp Ballast

# What does it do?

The proposed filter has two phases of purification: one of filtration to remove solid and organic material through conventional activated carbon candles; and a second step, for sterilization using UV-C light — “UV-C lamps” are known as “germicidal lamps” —, which has proven efficiency in removal of pathogens in the treatment of drinking water.

This system has a water pump that makes it possible to raise the water up to 5 meters from any source, such as a river, and store 20 liters of water for treatment. To power the pump and the UV lamp, a solar panel with 20 W of power and a stationary 7 Ah battery was chosen, which allows the use of energy even at night. The UV lamp we chose allows sterilization of 10 liters of water per minute.

The filter works automatically: when the tap is turned on, an internal pressure change occurs in the filter that activates the UV lamp. To ensure correct operation, if the battery level is critical — which would make the lamp not work — the water flow will be cut off by a solenoid valve until the charge is restored.

Thanks to the pumping system, the filter can be shared or installed at homes, allowing access to drinking water.

For maintenance, the filter requires changing the battery every 5 years and changing the lamp every 80,000 liters treated. The panel has a 25-year warranty, operating above 80% of efficiency.

**! WARNING: do not look directly into UV-C light; it is extremely dangerous and can cause blindness and severe skin burns.**

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