SOLAR TURBINE

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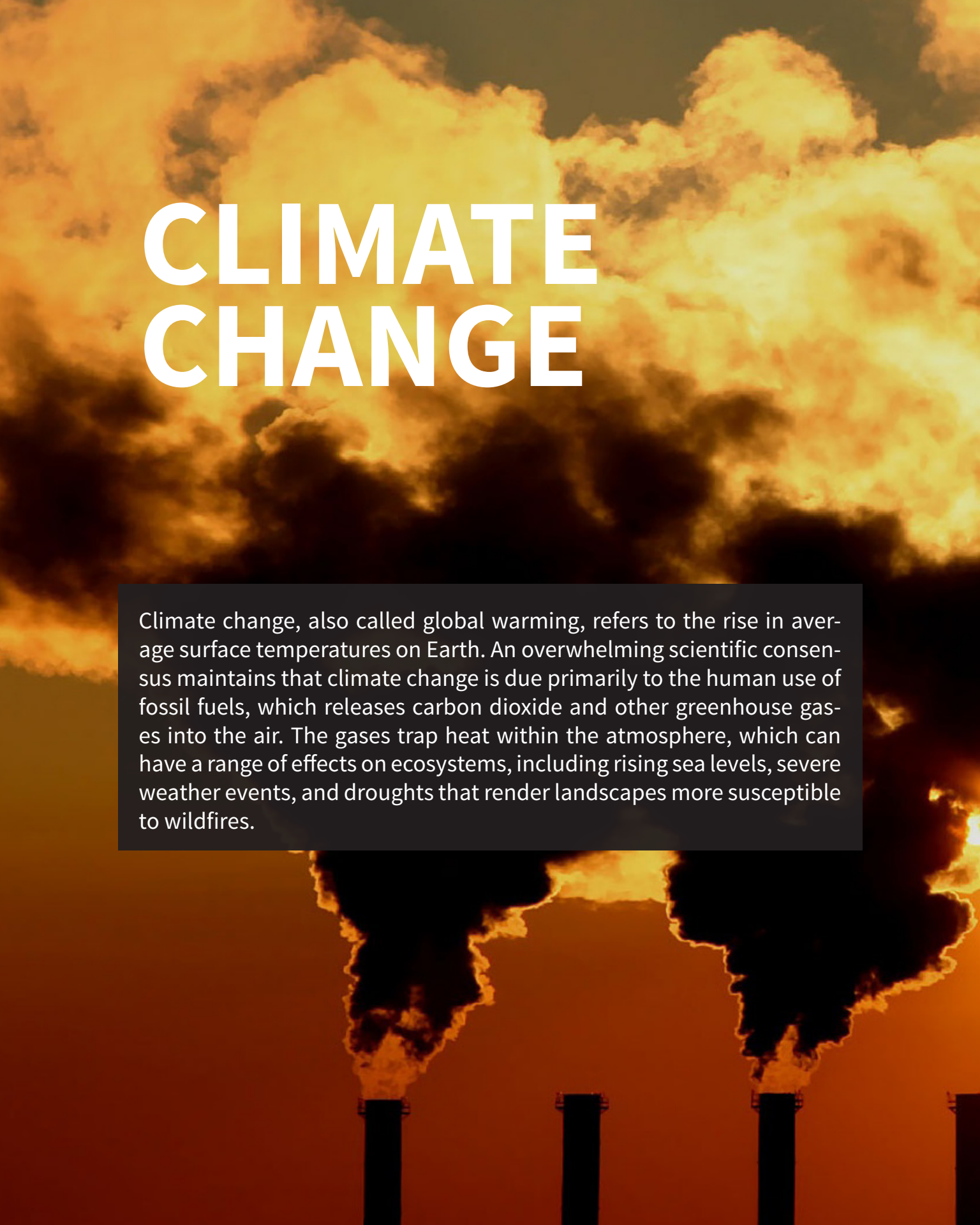
Contents



CLIMATE CHANGE

Climate change, also called global warming, refers to the rise in average surface temperatures on Earth. An overwhelming scientific consensus maintains that climate change is due primarily to the human use of fossil fuels, which releases carbon dioxide and other greenhouse gases into the air. The gases trap heat within the atmosphere, which can have a range of effects on ecosystems, including rising sea levels, severe weather events, and droughts that render landscapes more susceptible to wildfires.

Climate Change

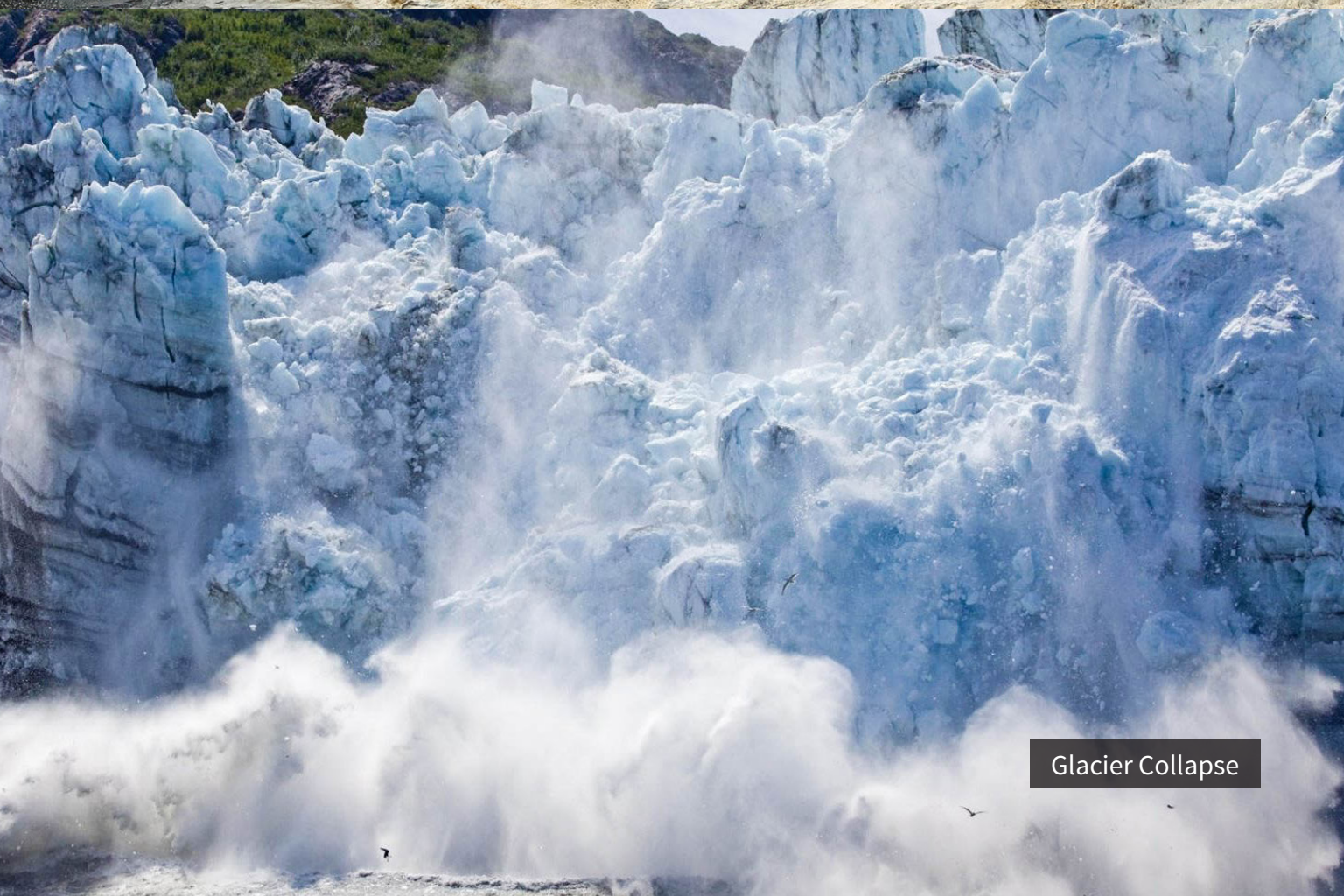
We are faced with the conservation of our planet. The consequences of our actions are more visible than ever before, manifesting themselves as the deterioration of our environment. In the past this deterioration did not affect our lives significantly, but the same cannot be said today. In some areas, soil moisture will decrease and along with drier conditions, will affect groundwater supply, which is critical in areas that completely rely on groundwater. As of 2016, Southern California has been suffering from drought for more than 4 years and more severe droughts are expected to occur in the future.

While the American Southwest is affected by drought, other parts of the nation will experience the exact opposite. In the Northeast and the Midwest, rainfall is expected to increase, increasing the chance of flooding. Colder areas will receive more rain instead of the usual snow as a result of higher atmospheric temperatures, which causes rivers to flood.

It is also speculated that tropical storms may become more frequent and intense, in any event, the damage inflicted by tropical storms is to increase due to rising sea levels caused by melting glaciers. This is only a portion of what is to come from our production of greenhouse gases, there are many more consequences and unfortunately for us, they will increase in severity.

Burning fossil fuels for the generation of electricity produces the largest amount of greenhouse gases, contributing 30% of all gases produced. These gases unleash a chain of events that comes to affect us all in a multitude of ways. Knowing this and having recognized the need to decrease carbon emissions, it makes sense to focus our efforts in this area. As renewable energy sources neither produces any of the greenhouse gases nor involves usage of hazardous materials; they do not pollute. This means that they are ideal for use in a time when we need to care for the condition of our environment and are an initial step in reversing climate change.

Farol de Felgueiras Lighthouse, Portugal



Glacier Collapse

MEGA

New York City - *Anthony Quintano*

CITIES

Megacities

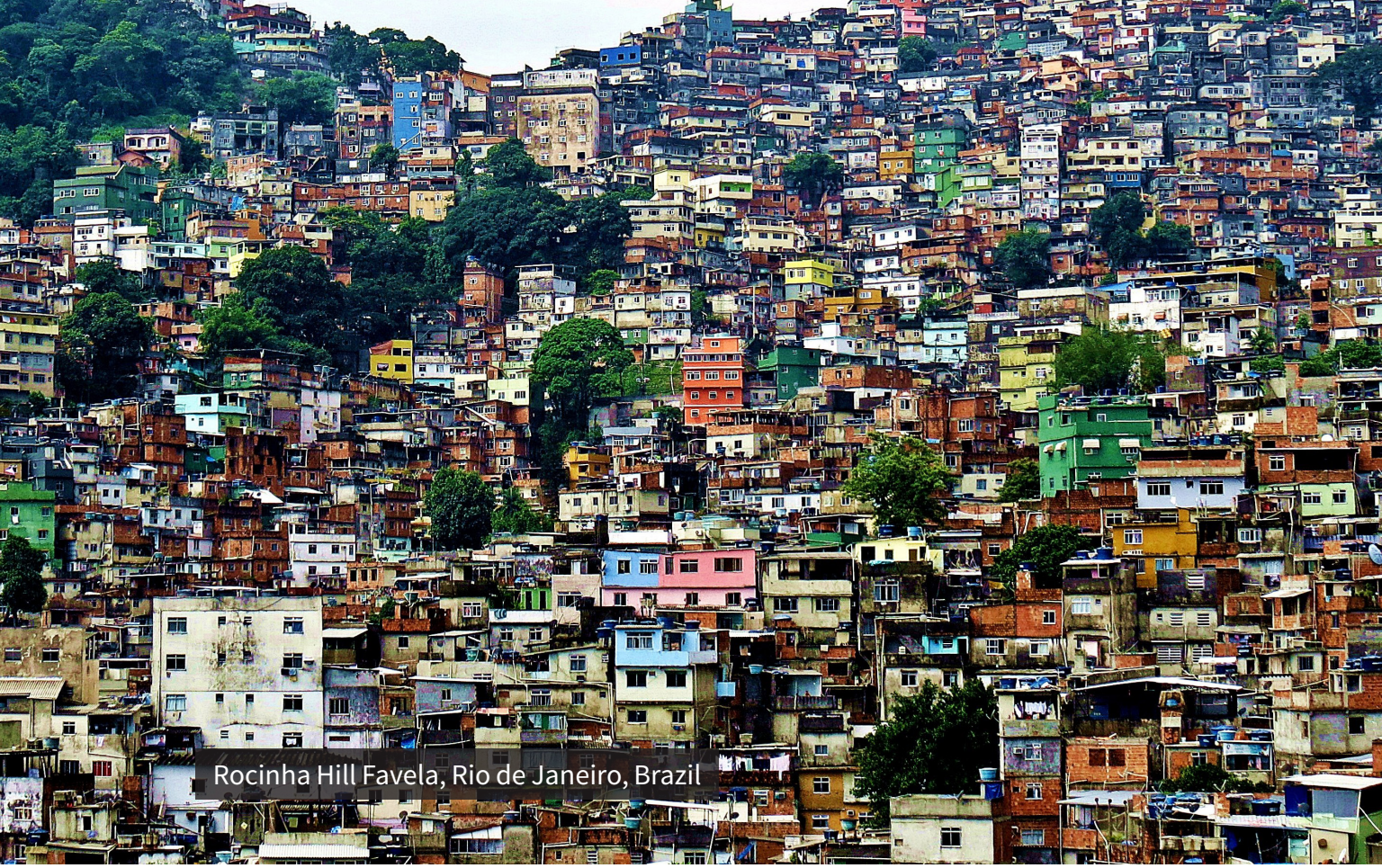
Cities are constantly growing in population and are the central hub for people to live in. During the 1950's, cities held around 30% of the population. Half a century later, over 50% of the world's population live in cities. By 2030, that number is expected to increase to 60%. This continuously growing number is the prime reason why more and more megacities are created.

What is a megacity? Megacities are usually defined as a city with a population over ten million people.

With the increase of population in cities and the reation of megacities in different places, there are issues that arise. Space is a primal concern. These megacities must expand continuously, out of which arises the issue of infrastructure. More buildings must be constructed, such as residential buildings, hospitals, schools, corporate buildings, police stations, etc. With all these additional buildings, roads must be made to connect the whole city together and accommodate the significant increase in population, which will create many traffic problems because there will be more and more vehicles on the roads.

There are also environmental challenges that come with megacities. Air pollution from the increase in vehicles can significantly affect the environment. According to the World Health Organization (WHO), air pollution kills approximately 130,0000 urbanites a year in industrializing countries. Another environmental challenge deals with energy. Existing energy sources such as natural gas and coal provide carbon emissions which heat our atmosphere (global warming). This leads to the concept of providing alternative energy, which comprises less than ten percent of the total energy mix in most countries. Renewable energy is a prime focus to help solve the energy issue in megacities.

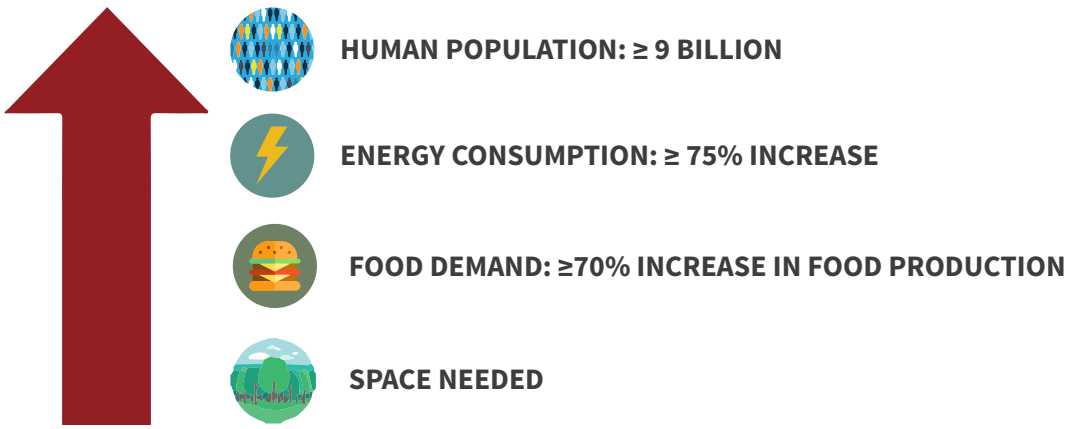
The quick urbanization of the world will create extreme demands for food. In previous years, agricultural productivity has been increasing around 2% per year, but recently it has decreased by half and will continue to decrease. However, our demand for food has been increasing to a point where consumption of food has surpassed production in the last eight years. Getting food for the ten million plus people in megacities will be a problem. With more and more land being used for these cities, less space is available to farm food. Food will have to be imported to these megacities which will increase the price of the product.

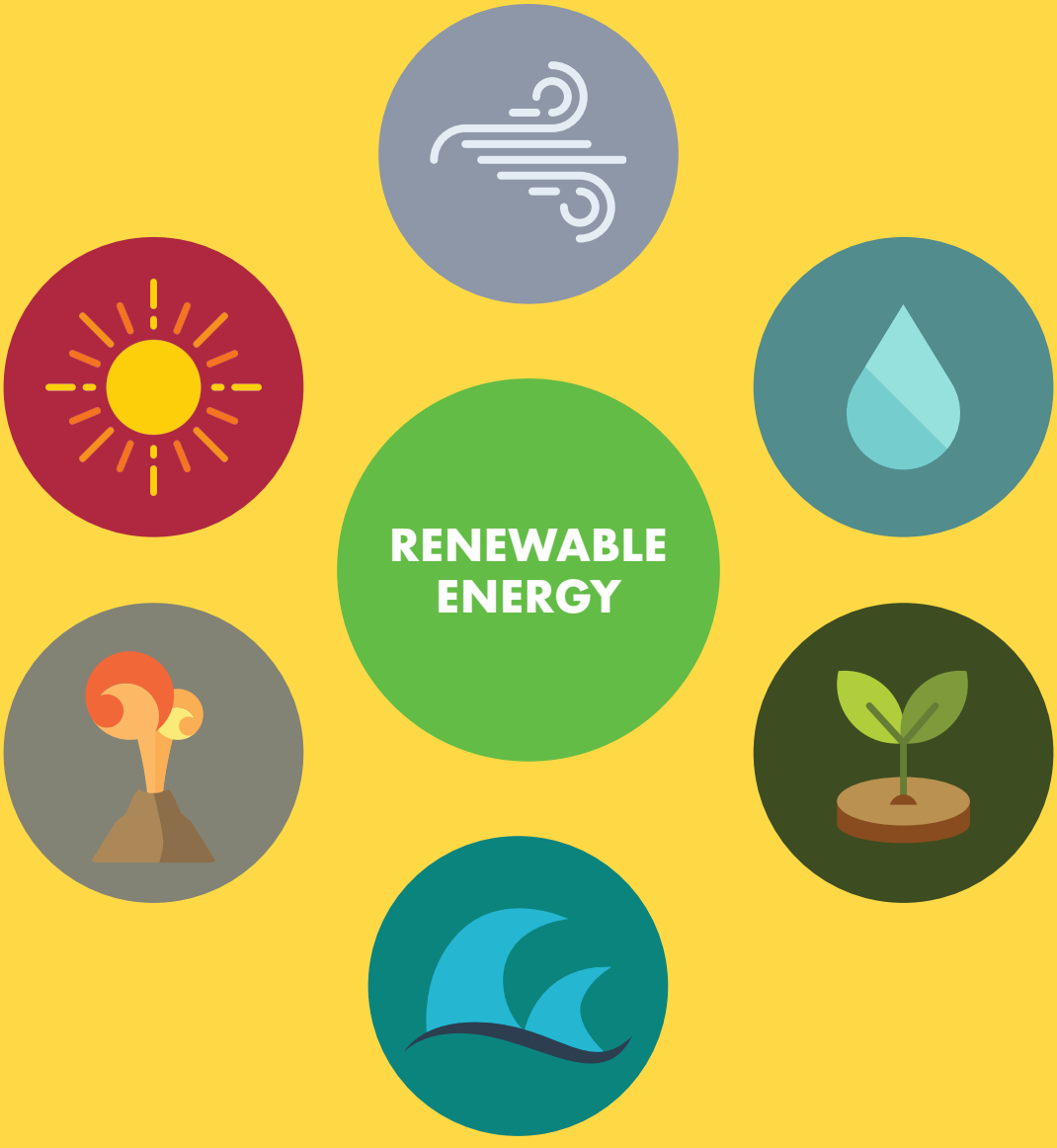


Rocinha Hill Favela, Rio de Janeiro, Brazil

Rocinha (little farm) is the largest favela in Brazil, and is located in Rio de Janeiro's South Zone. Most of the favela is on a very steep hill, with many trees surrounding it. Almost 70,000 (census 2010) people live in Rocinha, making it the most populous favela in Brazil.

by 2050...




RENEWABLE
ENERGY

Renewable Energy

what is renewable energy?

Renewable energy is energy that is generated from natural processes that are continuously replenished. This includes sunlight, geothermal heat, wind, tides, water, and various forms of biomass. This energy cannot be exhausted and is constantly renewed.

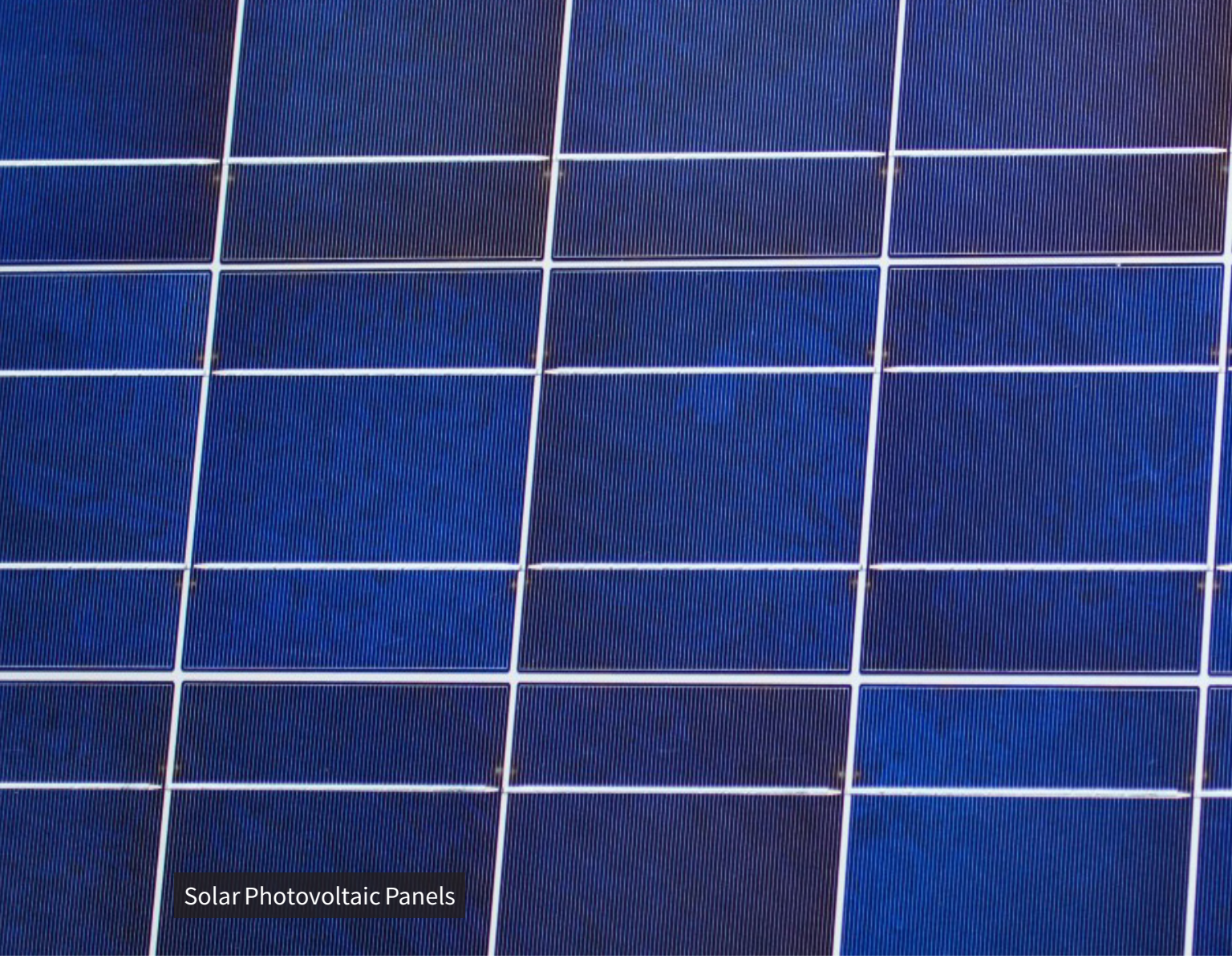
types of renewable energy

- Solar
- Wind
- Hydroelectric
- Biofuel
- Wave
- Geothermal

why renewable energy?

The total electricity production of the U.S. accounts for more than one-third of global warming emissions, with the majority generated by coal-fired power plants, which produce about 25 percent of total U.S. emissions; natural gas-fired power plants produce 6 percent of total emissions. In contrast, these renewable energy sources do not produce any of the harmful emissions into our environment. They are the leading clean energy sources which are effectively infinite. The energy from wind, solar, geothermal, hydroelectric sources forms the major components of renewable industry.

However, the wind and solar energy do have a tremendous potential to meet with the enormous increase in the total energy demand throughout the world. The United States has some of the best wind resources when compared with the other countries. The wind energy has become one of the most cost effective ways of producing energy since the installation cost has dropped significantly.



Solar Photovoltaic Panels

Solar Energy

Solar energy is the energy source that has seen a high increase in usage in the last twenty years. We can place the solar panels anywhere the sunlight is available and it will produce energy. The solar panels are flexible to be designed to fix in the location we want them to be.

Solar panels are designed to absorb the sun's rays as a source of energy for generating electricity or heating. It uses photovoltaic (PV) modules, which is a packaged, connected assembly of typically 6×10 solar cells. Solar photovoltaic panels constitute the solar array of a photovoltaic system that generates and supplies

solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions. They typically range from 100 to 365 watts.

The efficiency of a module determines the area of a module given the same rated output – an 8% efficient 230 watt module will have twice the area of a 16% efficient 230 watt module. There are also a few commercially available solar panels available that exceed 22% efficiency[1] and reportedly also exceeding 24%.

1. Ulanoff, Lance. "Elon Musk and SolarCity Unveil the 'World's Most Efficient' Solar Panel." Mashable. N.p., 02 Oct. 2015. Web. 01 Nov. 2016.

112 ft. Wind Turbine

Wind Energy

With the help of those gigantically tall turbines, the energy produced by wind has been proven to be very efficient. In the past, it was usually used to produce energy for the ships, pumping water and grinding the grains. As time passes by, with the increasing number of wind farms, people are considering it as the primary reliable source to produce energy for whole world.

how does it work?

The wind turbine captures the wind's energy. The blowing wind across both the sides of the blades creates an uneven pressure distribution due to its shape, which makes them spin. The number of revolution per minutes varies according to the location and the wind speed. The number revolutions can be increased with the help of the gear box attached to the rotor. Hence the blades are kept at higher height as greater they are above the ground more wind-speed can be found.

The huge rotor blades on the front of a wind turbine are the "turbine" part. The blades have a special curved shape, similar to the airfoil wings on a plane. When wind blows past a plane's wings, it moves them upward with a force we call lift; when it blows past a turbine's blades, it spins them around instead. The wind loses some of its kinetic energy (energy of movement) and the turbine gains just as much. As you might expect, the amount of energy that a turbine makes is proportional to the area that its rotor blades sweep out; in other words, the longer the rotor blades, the more energy a turbine will generate. Obviously, faster winds help too: if the wind blows twice as quickly, there's potentially eight times more energy available for a turbine to harvest. That's because the energy in wind is proportional to the cube of its speed.

Wind varies all the time so the electricity produced by a single wind turbine varies as well. Linking many wind turbines together into a large farm, and linking many wind farms in different areas into a national power grid, produces a much more steady supply overall.

existing hybrid solution

what is a hybrid solution?

hy·brid
/ˈhīˌbrid/
Anything derived from heterogeneous sources, or composed of elements of different or incongruous kinds.

existing solutions

Existing hybrid solution that focuses on solar and wind energy mainly exists in small-scale form in targeting residential areas. The small-scale electric system combine the home wind electric and home solar electric energy which as lot of benefits over either one system by themselves. One of the reasons why this idea has proven to be effective, is due to different peak operating times of wind and solar energy systems. In the winter, there is less sunlight available when the wind is strong; In the summer, the sunlight intensity and daylight duration lasts longer. Hence, the system complements one another.

Implementation by industrial sector

Traffic Monitoring System

Many of these hybrid systems are not connected to the electricity distribution lines, but they function as “off-grid”. They are commonly used for the small houses and street lamps. There are also applications to some industrial sector too, though limited. However, these systems must be provided with backup batteries to set a continuous energy production. The storage capacities of need to adjusted per the size of the hybrid system; generally, the battery tanks can supply the electric load for one to three days.

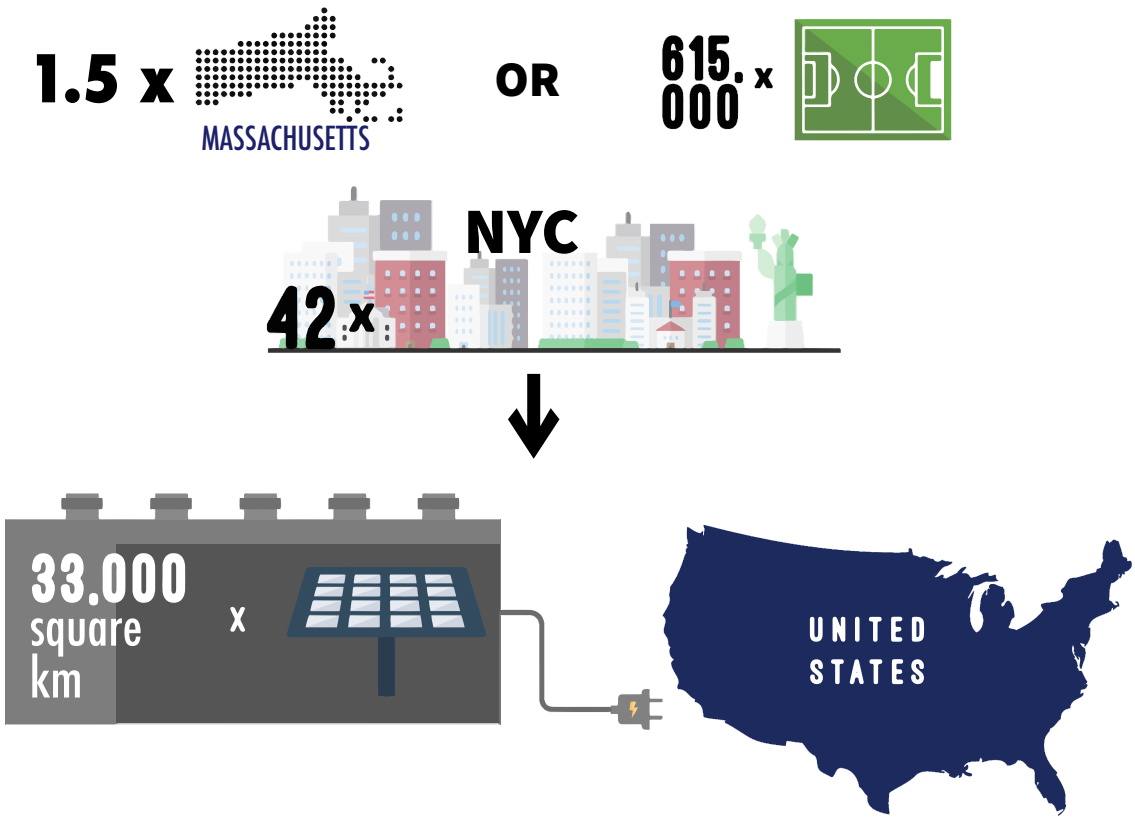
Wind Farm in Scotland

Occupied Space

"I'm all 'bout that space (bass), 'bout that space (bass)" — All About That Bass

According to the MIT authors, if we want to power 100 percent of estimated U.S. electricity demand in 2050 completely with solar energy, that would require up to 33,000 square kilometers (sq.-km) of land. What that means is we must spread the solar panels across the whole area of the country. That's if we spread solar panels evenly across the entire country only then we can generate enough electricity to meet the estimate energy consumption demand. However, it is impossible to reliable fully on the solar energy as we receive sunlight for four to five hours per day, which might not be able to produce energy for the whole twenty-four hours.

On the other hand, an Australian environmental scientist and Energy Collective contributor Barry Book demonstrated to meet with the projected electricity demand of United States in 2050 fully with using the wind energy, it will require us to install wind turbines across 66,000 sq.-km of land area; still produce only one-third of the demand. The wind farms do take up lot of land to produce the energy as the wind turbine requires the land up to ten times the rotor diameter between two turbines to work with maximum efficiency.



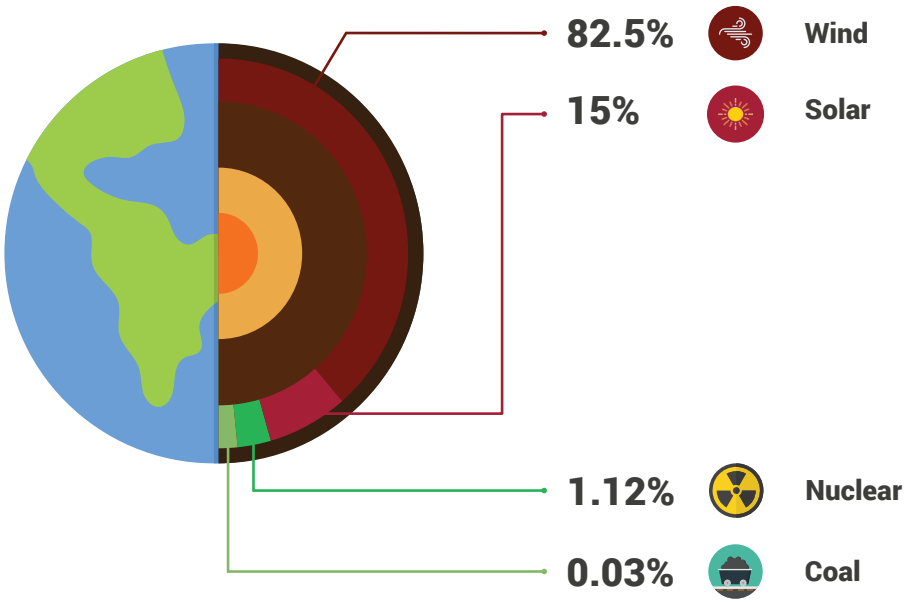
33,000 square kilometers of solar panels to power the entire Uniterd States

Conclusion

- **renewable sources are space intensive**

Through extensive investigations and researches on renewable energy and its effects on nature and mankind, we come to the realization that albeit clean energy ultimately benefits mankind, in order to accomodate with the rising demands and ever-increasing human population, every available space is essential for development.

25.6 Square-Kilometers of 550-Megawatt Photovoltaic Power Station



Land Usage Per Energy Source

solar turbine

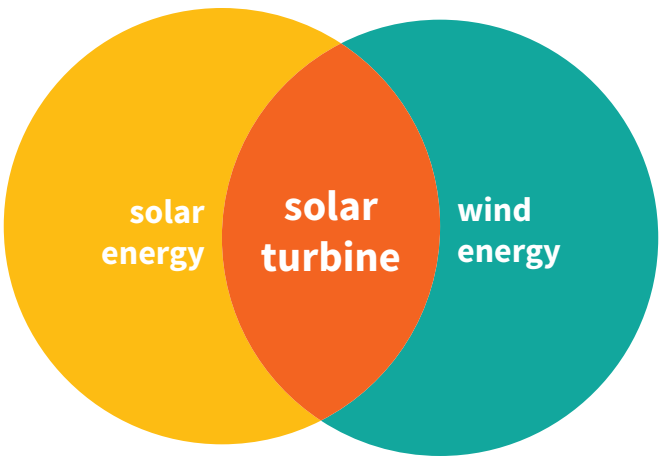
Our Solution

introduction

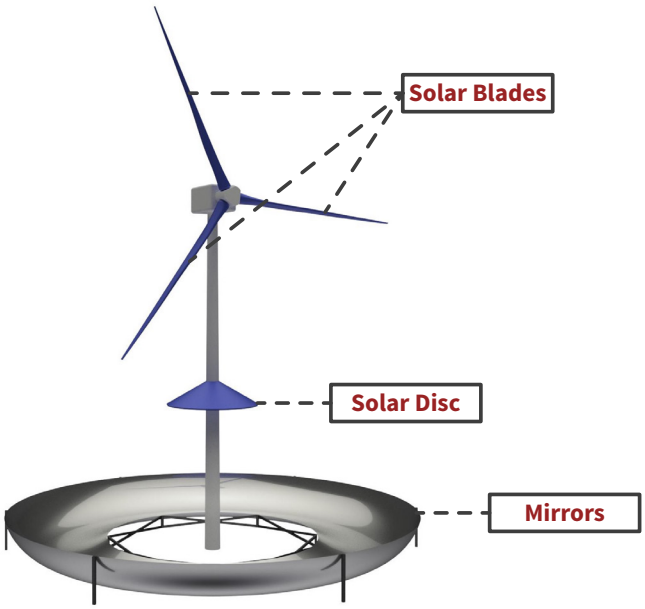
Faced with climate change and shrinking resources, we investigated possible solutions to our problems. We needed a way to make clean energy while taking up the least amount of space in order to address both dilemmas at the same time. The most apparent solution is to take the clean energy solutions that are currently in use and improve them. The existing solutions we chose to focus on were photovoltaic solar cells and wind turbines due to the fact that they are the most easily avaiable renewable sources.

There is space for improvement for both of these solutions, as they both suffer from major shortcomings. Current solar panels are incredibly inefficient, with an average efficiency ranging from 15 to 25 percent and a maximum effIciency of 40%. Given the amount of time and effort that has gone into developing and improving this technology, it was unlikely that we would be able to improve solar cells in the short timeframe that we were given.

Wind turbines rely on smooth airflow in order to produce energy most efficiently and thus, their blades are designed to utilize this type of wind currents and are made to be aerodynamic as to not excessively disrupt this airflow in order to continue relying on the same current. Our lack of knowledge on the subject of fluid dynamics and aerodynamic design prevented us from venturing into the subject of turbine design. What we were then left with was coming up with some sort of hybrid solution that would utilize both of these technologies.



the design



Solar Turbine

With the goal of making renewable energy more space efficient and focusing our efforts on a hybrid solution, the idea of a wind turbine with solar panels mounted onto it surfaced. The initial idea consisted of somehow mounting solar panels on the faces of the turbine blades, this way, the panels could be mounted without disrupting the airflow that was to power the turbine.

To account for the different locations of the sun throughout the day, solar panels would be wrapped around the whole blade. This would allow the panels to capture sunlight whenever the sun would be anywhere but straight above. To account for the sun being straight above the turbine, we decided to mount a disc shaped solar panel below the blades of the turbine around the tower. This solar disc would allow the capture of sunlight throughout the whole day and fix our issue of the blades not receiving direct sunlight through the middle of the day. Finally, we decided to use the powers of mirrors and its reflective nature to harness more sunlight . We would optimize the mirrors at a certain angle to reflect sunlight onto the blades. This will allow for sunlight to hit the other side of the blades when the sun is facing horizontally to the turbine. It also will allow the panels to capture a little more solar energy.

Wind turbines rotate to take advantage of changing wind currents, so our mirror design would have to account for this in order to receive adequate sunlight. The mirror would have to positioned in a way so that it would not disrupt airflow to the blades. This meant that the mirror could not be directly in front of the blades and would be preferably placed close to the ground. It was decided to use an array of mirrors that would encircle the entire turbine to keep the design simple. The mirrors would be angled at different positions on the array to ensure that the blades would have sunlight reflected at them no matter what position the sun is in.

impact

The main issue with renewable energy is its efficiency and the amount of space it needs in order to produce the same amount of energy as fossil fuel sources. While turbines can capture great amount of energy, they must be spread out in order to achieve maximum efficiency. This space between turbines is the major reason why wind turbines require some of the most space out of the numerous renewable energy sources. Placing solar panels on the wind turbine itself is saving space instead of placing them on the ground.

Using a turbine blade of 35.35m, the additions of solar panels on these blades (solar blades) would have a surface area of 53.9m^2. Given that the diameter of the tower is 3.5m, 11m of diameter for the solar disc would have an area of 340m^2.

A total of 665m^2 of solar panels would be on each wind turbine. This amount of added solar paneled area would generate around 640kWh everyday in the Illinois area. Comparing it to the average amount of wind energy of Illinois (9000kWh) the addition of solar panels on the turbine could increase the amount of energy captured by over 7%. If the solar turbine is placed in a more sunny region (Arizona), the solar output would be near 10% more.

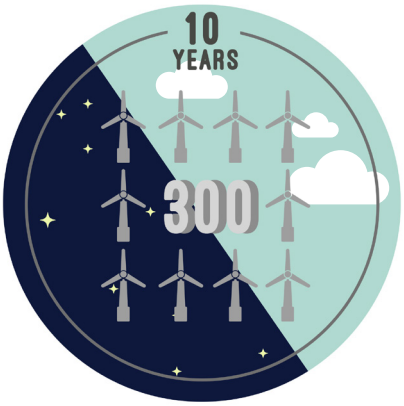
In terms of space saved, 665 square meters of solar panels would save about 650m^2 from the actual land. Installation of 100 solar turbines would save about 16 acres of land that would have been used on a solar farm.

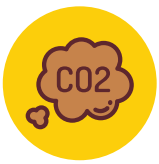
what can 1 billion kWh renewable energy save?

▶ 300 solar turbines over 10 years produce 1 billion kWh energy.

2,442,140
pounds of CO_2 by burning coal

255,412
gallons of gasoline consumed





5,004,150
pounds of CO_2 being released into the atmosphere

195,000
square meters of land

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