UNIVERSITEIT TWENTE.

SMART ENVIRONMENTS PROJECT

DOCUMENTATION REPORT

“Ocean Energy”

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Introduction

The following is the documentation report *'Ocean energy'*. This report includes documentation on the processes undertaken by Huug Jansen, Stefan Kooy, Hyo Joon Kwon, Camilla Scholz, Maurits Spijker and Lilly Stelzer. We are all first year Creative Technology students studying at the university of twente. For this project we were assigned to find a solution for a widespread problem, and were tasked to identify and create a prototype for this.

We chose to take on the imminent problem involving the increasing demand for renewable energy as well as it's sources. We decided on this topic because we found that a lot of our world's current problems stem from climate change. Therefore we found it was necessary to tackle the energy generation problem we now face. As a group we saw that a lot of energy can be generated by renewable sources, but are not yet readily available and utilized in today's world, instead we still rely heavily on energy that comes from fossil fuels which will further damage our world.

A large portion of the modern world's energy needs could be satisfied if we found a good solution to harness the energy lost in the oceans every day. This energy would not have the problem of unpredictability that many other renewable energy sources like wind or solar energy have, as the ocean is in motion every second of every day.

With the population and as a result our energy needs growing rapidly, we require better, more reliable, more effective and more environmentally-friendly energy sources to meet this growing demand, while still protecting the world we live in to keep it habitable for many more generations.

We want to use the infinite motion of waves to utilize the massive unharnessed energy potential of the ocean. We decided to generate this electricity by harnessing the translational motion of the waves. We will achieve this with a floating platform that houses a generator. The axle of the generator is attached to a tooth wheel, which is locked with its teeth to a stationary vertical rod with a tooth rack. When moving along smoothly up and down with the waves this will result in the spinning of the tooth wheel along the vertical rod with a tooth rack.

We decided on this specific solution, as it is an innovative idea to harness the unused energy of waves in the ocean. It is a perfect gap between existing manners of harvesting energy and new prototypical methods. This makes it a simple, yet effective solution, that doesn't harm marine life in the oceans nor disturbing the surrounding habitat. It is a solution that fills the need for a new, renewable and environmentally friendly energy source to meet the growing energy demand of the world.

Chapter 1: Literature Review

	Idea / Summary	Citation
1.	**Forest fires:** The more prominent forest fires that are happening in the world as caused by the rapidly increasing temperatures and decreasing humidity levels in risk zones around the world. Regions such as California, East Australia, Greece and such are prone to such “heat waves” setting aflame the shrubbery and forests.	“Assessing Climate Change Impacts on Wildfire Risk in the United States”,15 September 2015,https://www.mdpi.com/1999-407/6/9/3197/pdf Accessed 20 Jan. 2021 "Forests | Free Full-Text | Effect of Climate Change ... - MDPI." https://www.mdpi.com/1999-4907/6/6/2214/notes. Accessed 20 Jan. 2021.
2.	**Schools and education ravaged by global disasters:** Problem : Destroyed schools and no education as a result of earthquakes and other devastating occurrences which ravage the school buildings and ways of accessing them. These regions are typically the poor ones, with limited funding and access already, leaving no alternative.	"Public School Earthquake Safety Program in Nepal." 21 Aug. 2014, https://www.tandfonline.com/doi/full/10.1080/19475705.2013.806363. Accessed 20 Jan. 2021.
3.	**Nitrogen (agriculture):** The increased precipitation of nitrogen has been damaging the Natura 2000 regions. However, it’s not nitrogen itself that harms nature, the substances that are harmful to nature are two types of nitrogen compounds: nitrogen oxides and ammonia. The biggest culprit right now is livestock farming.	"The Dutch Nitrogen Crisis - Greenfish." 19 Nov. 2019, https://www.greenfish.eu/the-dutch-nitrogen-crisis/. Accessed 20 Jan. 2021. "Nitrogen Cascade | BioScience | Oxford Academic." 1 Apr. 2003, https://academic.oup.com/bioscience/article/53/4/341/250178. Accessed 20 Jan. 2021.
4.	**Plastic soup:** There is plastic pollution in Mediterranean waters. The problem’s core is a social and behavioral problem. It can be traced back to the consumption chain.	"The Mediterranean Plastic Soup: synthetic polymers ... - Nature." 23 Nov. 2016, https://www.nature.com/articles/srep37551. Accessed 20 Jan. 2021.
5.	**Virus:** According to the resource, In Italy, the condition of Hospitals for Corona was becoming worse day by day so not every patient was getting proper and equal care which was the main cause of multi fold spread of Corona. Additionally , this research shows the age difference and gender difference of corona infection and how to prevent the infection.	"(PDF) Analysis on Coronavirus - ResearchGate." https://www.researchgate.net/publication/339933675_Analysis_on_Coronavirus. Accessed 20 Jan. 2021. "Coronavirus History: How did coronavirus start? - WebMD." 15 Apr. 2020, https://www.webmd.com/lung/coronavirus-history. Accessed 20 Jan. 2021.

6.	**Closed environments facilitate secondary transmission of coronavirus disease:** "It is plausible that closed environments contribute to secondary transmission of COVID-19 and promote superspreading events. Our finding is also consistent with the declining incidence of COVID-19 cases in China, as gathering in closed environments was prohibited in the wake of the rapid spread of the disease."	"Closed environments facilitate secondary ... - medRxiv." 16 Apr. 2020, https://www.medrxiv.org/content/10.1101/2020.02.28.20029272v2. Accessed 20 Jan. 2021.
7.	**Dealing with Corona:** keep informed, have a routine and so on to maintain your mental health safe during this covid-19 season// Eat a variety of food, cut back on salt and so on as what we eat can affect our body's ability to prevent and fight from infections.	#HealthyAtHome - Mental health, https://www.who.int/campaigns/connecting-the-world-to-combat-coronavirus/healthyathome/healthyathome---mental-health?gclid=Cj0KCQiA48j9BRC-ARIsAMQu3WQJgVvlOJZqUDTjMXMYaaTrCUaln9b25VIISL42WlqWYZ92WaBnhIIaAuzTEALw_wcB Accessed 20 Jan. 2021. "#HealthyAtHome - Healthy Diet - World Health Organization." https://www.who.int/campaigns/connecting-the-world-to-combat-coronavirus/healthyathome/healthyathome---healthy-diet. Accessed 20 Jan. 2021.
8.	**Droughts:** 2016 New York drought, because of the lack of rain,90% of the state was classified as "Abnormally Dry" or "Moderate Drought", ver two thirds of un-irrigated fields had losses between 30 and 90 percent, consequences especially big because the state was not prepared enough, may be a result of climate change	"Anatomy of the 2016 drought in the Northeastern United States." 15 Dec. 2017, https://www.sciencedirect.com/science/article/pii/S0168192317302800. Accessed 20 Jan. 2021.
9.	**Avalanches:** 1950-1951: 3 months with an extraordinary high amount of avalanches in the alps, 649 avalanches killed 265 people, probably a result of atypical weather conditions in the Alps, an abnormally high amount of snow was deposited in a small amount of time resulting in many buildings and people buried under snow	"The avalanche catastrophe in the Alps, 19-21 January 1951" Apr. 1951, https://rmets.onlinelibrary.wiley.com/doi/abs/10.1002/j.1477-8696.1951.tb01324.x Accessed 20 Jan. 2021
10.	**Floods:** 16/11/2020: The flood situation in the northern Philippines continues to worsen after torrential rainfall brought by Typhoon Vamco. Flooding has caused massive damage, including 236 sections of road and 98 bridges. 22,756 houses have been damaged and 3,096 totally destroyed. As many as 324,617 people have been displaced from their homes and moved to 2,991 evacuation centres.	"Disaster Resilience News – The latest in disaster management." https://disasterresiliencenews.com/. Accessed 20 Jan. 2021. "Flood risk and climate change: global and regional perspectives." 3 Mar. 2014, https://www.tandfonline.com/doi/full/10.1080/02626667.2013.857411. Accessed 20 Jan. 2021.

11.	**Famine (Food insecurity):** Over 20 million Yemenis are food insecure, of which nearly 10 million are acutely food insecure. The rate of child malnutrition is one of the highest in the world and the nutrition situation continues to deteriorate.100,000 children under the age of five are at risk of dying in Yemen as the country slides back into a hunger crisis. The coronavirus pandemic has worsened the food insecurity.	"Yemen on brink of losing entire generation of children to ...." 28 Oct. 2020, https://www.theguardian.com/global-development/2020/oct/28/yemen-on-brink-of-losing-entire-generation-of-children-to-hunger-un-warns. Accessed 20 Jan. 2021. "Malnutrition in Yemen: an invisible crisis - The Lancet." 20 Dec. 2016, https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(16)32592-2/fulltext. Accessed 20 Jan. 2021.
12.	**Food Waste:** Food waste is a major contributor to climate change and reducing it was ranked the third most useful action against climate change. Every year 1.6 billion tons of food is wasted, which is one third of the globally produced food annually. The first article is about the changes consumers can make, since consumers are responsible for 80% of the food wasted in the US. The second article focuses on companies, since they are involved in every part of the chain and can therefore influence every single step.	"People waste more food than they think—here's how to fix it." 24 Apr. 2019, https://www.nationalgeographic.com/environment/2019/04/people-waste-more-food-than-they-thin-psychology/. Accessed 20 Jan. 2021. "Tackling the 1.6-Billion-Ton Food Loss and Waste Crisis." 20 Aug. 2018, https://www.bcg.com/publications/2018/tackling-1.6-billion-ton-food-loss-and-waste-crisis. Accessed 20 Jan. 2021.
13.	**Mental Health after disasters:** Mental health issues often follow (natural) disasters and are often a forgotten factor when discussing disasters. A poll earlier this year found that the ongoing pandemic already affected the mental health of 56% of the adults questioned negatively. Especially depression, anxiety, PTSD, substance abuse, child abuse and domestic violence surge after (natural) disasters. (see the two articles above). Another study after the earthquake in Marmara, Turkey in 1999, showed that in the population assessed PTSD, depression and anxiety disorders surged, with over 60% getting a PTSD diagnosis.	"How Do Natural Disasters Affect Mental Health?." https://www.publichealthdegrees.org/resources/mental-health-natural-disasters/. Accessed 20 Jan. 2021. "The Coronavirus Is a Special Mental-Health Disaster - The ...." 7 Jul. 2020, https://www.theatlantic.com/health/archive/2020/07/coronavirus-special-mental-health-disaster/613510/. Accessed 20 Jan. 2021. "Disaster mental health care: the experience of Turkey." https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1489842/. Accessed 20 Jan. 2021.

14.	**Homelessness after disasters:** Homelessness is a consequence for many people after disasters and a global disaster in itself as well. Around 20% of the population suffer from detrimental housing conditions, homelessness or the danger of becoming homeless. Homelessness can have a lot of different causes and its consequences are even more extensive. It is often a first step into a downward spiral, that is very hard to escape from and that affects every part of someone's life. The IDMC (internal displacement centre) estimated in the above report that every year 13.9 million people are displaced due to sudden disaster.	"Global Disaster Displacement Risk - A baseline for future work ...." https://www.internal-displacement.org/publications/global-disaster-displacement-risk-a-baseline-for-future-work Accessed 20 Jan. 2021.
15.	**Wildfires :** The wildfires in Australia starting last year were one of the worst in the last decades with an estimate of 10 million hectares of land getting burned. The Australian government responded by releasing water from helicopters or planes, bulldozing “firebreaks” into the ground and having thousands of firefighters fighting the bushfires. Climate change raises the annual temperatures, creating worse wildfires. And not only the fires itself, that destroy land are a consequence, also loss of biodiversity, air pollution due to smoke and an increase in CO2 in the atmosphere are some of the disastrous effects of wildfires.	"Wildfires have spread dramatically—and some forests may not ...." 30 Jan. 2020, https://www.nationalgeographic.com/science/2020/01/extreme-wildfires-reshaping-forests-worldwide-recovery-australia-climate/. Accessed 20 Jan. 2021. news articles: "Australia fires: What's being done to fight the flames? - BBC.com." 23 Jan. 2020, https://www.bbc.com/news/world-australia-51008051. Accessed 20 Jan. 2021.
16.	**Heat waves:** Global warming induces more heat waves, these can have a significant effect on our society and even cause death. Sadly, heat waves do not get enough attention because its effects are not always immediately obvious. Because of climate change the world is going to face more heat waves and therefore deserve more care and attention	"Heatwaves - World Health Organization." https://www.who.int/health-topics/heatwaves. Accessed 20 Jan. 2021.
17.	**Nuclear warfare:** Nuclear warfare is a form of warfare involving the use of nuclear weapons. The electromagnetic pulse created by a nuclear weapon travels at the speed of light and is capable of mass destruction. It causes radioactivity, climate change and problems to society and nature.	"Even a 'minor' nuclear war would be an ecological ... - Daily Mail." 11 Aug. 2017, https://www.dailymail.co.uk/sciencetech/article-4782438/Even-minor-nuclear-war-ecological-disaster.html. Accessed 20 Jan. 2021.
18.	**Melting ice:** Due to climate change the melting of icecaps and glaciers speeds up. This will result in an acceleration of climate change that will further destroy land and nature.	"Melting Glaciers: causes, effects and solutions - Iberdrola." https://www.iberdrola.com/environment/melting-glaciers-causes-effects-solutions. Accessed 20 Jan. 2021.

		"melting of floating ice raises the ocean level | Geophysical ...." https://academic.oup.com/gji/article/170/1/145/2019346. Accessed 20 Jan. 2021.
19.	**Biological warfare:** Biological warfare is another form of warfare where biological toxins or infectious agents such as bacteria, viruses, insects, and fungi are used with the intent to kill or incapacitate humans. These weapons can range from existing diseases to genetically engineered viruses.	Biological warfare: an emerging threat in the 21st century, 1/11/01 https://www.bmj.com/content/324/7333/336.short https://news.stanford.edu/pr/01/bioterror117.html Accessed 20 Jan. 2021.
20.	**New / better renewable energy:** In the future we are going to use more energy, but eventually the usual way of generating energy will no longer be possible since the resources will be depleted. This is why we have to look into renewable energy. As of today we cannot support our lifestyles on current renewable energy, therefore we need to improve the technology to increase efficiency and decrease cost.	"New directions in renewable energy education - ScienceDirect." https://www.sciencedirect.com/science/article/pii/S0960148108002115. Accessed 20 Jan. 2021.

Chapter 2: Identification of General Problems and Challenges

1. Fires

Fires are being caused by increasingly higher amounts of global warming in areas of the world. With this increase in temperature, and the higher uv radiation of the sun's rays on dry areas of the world, they are prone to be ignited into fast growing fires which suck up whole valleys of land. This is no exception to the recent fires in California, in both LA and San Francisco, as well as a large portion of south east Australia. These fires have caused both ecological and economic impact on our planet and the affected areas will require decades to recover its greenery. This is only prone to happen again, therefore we must implement a preventive solution to stop this from recurring as the temperatures become increasingly higher.

2. Pandemics

A pandemic is a really current problem. Viruses can be transmitted very easily and can cause health problems and even death on a large scale. To prevent a virus from being transmitted, measures must be taken which can be done in a technological way.

3. Plastic waste

Plastic waste is the biggest problem concerning the ocean environment. It threatens not only ocean wildlife health, but also human health, food safety and it affects climate change.

4. Avalanche

Avalanches are the result of too much snow and describe the rapid flow of snow down a mountain. Each year avalanches kill about 150 people and a lot are injured by avalanches. Avalanches can travel up to 90km/h and the probability of being rescued alive after one hour is ⅓. Most people who died because of an avalanche died of suffocation, wounds and hypothermia.

5. Floods

Floods are a harmful and disastrous global problem faced by many ocean-bordering countries. A flood occurs when the water levels are higher than the land surrounding it, or because of an explosion or shift in a large body of water which allows it to overrule the height of the bordering walls or land. This is common in countries like Japan, in which there are dams built to stop this, but yet it still occurs. The Netherlands is no exception to this either, as the water systems and canals as well as the dams set in the west oceans prevent the country from being engulfed in water. These solutions don't always work, but we must introduce new innovations upon these infrastructures in order to prevent floods from attacking our homes yet again.

6. Food Waste

Food Waste is one of the biggest contributors to climate change and we as consumers are responsible for almost 80% of the wasted food. Wasted food describes everything, from food that is produced but never sold to food that is thrown away in our homes. But we as one of the biggest participants in this can also make a big difference by changing our consumption and our overall behavior in relation to food.

7. Homelessness

Homelessness is the description for people who currently do not have a home, whether they live on the street, in a car or are staying at a friends home. It affects about 20% of the population and is often only the first step into a downward spiral. It is a global issue with every nation having its own strategies to cope with. But it is a pressing matter, because after disasters - which are happening more and more often- many more people are being displaced and face homelessness.

8. Mental Health

Mental Health is crucial for every person, because it affects every part of our lives. But after disasters many people's mental health suffers due to stress, anxiety and loss. Often they cannot cope healthily and in some cases even develop a mental illness. It is a very important matter, that is currently all around us as we are learning how to cope with a pandemic. Luckily in recent years the conversation about mental health has become more public and less stigmatized, but there is still a long way to go.

9. Renewable energy

In the future humans will use more energy as technology advances and becomes available to more people. With our current ways of generating energy from renewable resources we cannot support this. Therefore we have to look more into renewable energy. There are more ways to generate electricity with renewable energy than we use now, it is just a matter of making it accessible and cheap.

Chapter 3: Identification of Relevant Problems

Idea(s)	Solution(s)
Fires	
Idea 1: Fire suppression system Problem : The more prominent forest fires that are happening (Install the most cost effective efficient anti fire suppression systems in risk zones prone to forest or bush fires such as california and Australia) "Assessing Climate Change Impacts on Wildfire Risk in the United States",15 September 2015,https://www.mdpi.com/1999-407/6/9/3197/pdf Accessed 20 Jan. 2021 Forests | Free Full-Text | Effect of Climate Change ... - MDPI." https://www.mdpi.com/1999-4907/6/6/2214/notes. Accessed 20 Jan. 2021. **Addition 1:** The wildfires in Australia starting last year were one of the worst in the last decades with an estimate of 10 million hectares of land getting burned. The Australian government responded by releasing water from helicopters or planes, bulldozing "firebreaks" into the ground and having thousands of firefighters fighting the bushfires. Climate change raises the annual temperatures, creating worse wildfires. And not only the fires itself, that destroy land are a consequence, also loss of biodiversity, air pollution due to smoke and an increase in CO2 in the atmosphere are some of the disastrous effects of wildfires. Wildfires have spread dramatically—and some forests may not ...." 30 Jan. 2020, https://www.nationalgeographic.com/science/2020/01/extreme-wildfires-reshaping-forests-worldwide-recovery-australia-climate/ . Accessed 20 Jan. 2021. The Australian bushfires—why they are unprecedented ...." 3 Feb. 2020, https://www.science.org.au/news-and-events/news-and-media-r	Linking all of these together to the first idea of a fire suppression system. The drought could be sensed by sensors, and the fire suppression system could be primed for use beforehand so that they are ready for when the fire emmerges. Or, a built-in gps. When the sensor senses drought it sends a signal to the fire brigade so they can act quickly. Evacuation Plan for people to be saved from fires. *Can be linked to idea 1, with the drought sensors which tell people the estimated time they have to evacuate, and a live location of where it is exactly. Like the rain forecast and current cloud pattern.*

eleases/australian-bushfires-why-they-are-unprecedented. Accessed 20 Jan. 2021. news articles: "Australia fires: What's being done to fight the flames? - BBC.com." 23 Jan. 2020, https://www.bbc.com/news/world-australia-51008051. Accessed 20 Jan. 2021. **Addition 2:** 2016 New York drought, because of the lack of rain, 90% of the state was classified as "Abnormally Dry" or "Moderate Drought", ver two thirds of un-irrigated fields had losses between 30 and 90 percent, consequences especially big because the state was not prepared enough, may be a result of climate change Anatomy of the 2016 drought in the Northeastern United States." 15 Dec. 2017, https://www.sciencedirect.com/science/article/pii/S0168192317302800. Accessed 20 Jan. 2021. **Addition 3:** Global warming induces more heat waves, these can have a significant effect on our society and even cause death. Sadly, heat waves do not get enough attention because its effects are not always immediately obvious. Because of climate change the world is going to face more heat waves and therefore deserve more care and attention Heatwaves - World Health Organization." https://www.who.int/health-topics/heatwaves. Accessed 20 Jan. 2021.	
Corona	
Idea 2: **Anti corona system** Problem : A continuously impeding virus which has ruined many lives, and is vastly responsible for unrest and change in our world. (counter with sensors to know how many people entered a building and know the density of people in a	Hand sanitizer with UV-light that tells us how many germs are/were on our hands. Scanner that tells the building how many people have entered and are in a certain part of the building so that they can make sure that the area is still safe and not over crowded.

building and calculate the risks and implications of such a thing) Covid-19 Automated Occupancy Control System | FootfallCam." https://www.footfallcam.com/en/Industries/Covid-19-Automated-Occupancy-Control-System. Accessed 20 Jan. 2021. **Addition:** **Closed environments facilitate secondary transmission of coronavirus disease 2019 (COVID-19).** Summary: "It is plausible that closed environments contribute to secondary transmission of COVID-19 and promote superspreading events. Our finding is also consistent with the declining incidence of COVID-19 cases in China, as gathering in closed environments was prohibited in the wake of the rapid spread of the disease. Closed environments facilitate secondary ... - medRxiv." 16 Apr. 2020, https://www.medrxiv.org/content/10.1101/2020.02.28.20029272v2. Accessed 20 Jan. 2021.	Can be combined with idea 1 into one system Far-UVC light: A new tool to control the spread of ... - Nature." 9 Feb. 2018, https://www.nature.com/articles/s41598-018-21058-w. Accessed 20 Jan. 2021. → far UVC light against airborne influenza
New / better renewable energy	
Idea 3: In the future we are going to use more energy, but eventually the usual way of generating energy will no longer be possible since the resources will be depleted. This is why we have to look into renewable energy. As of today we cannot support our lifestyles on current renewable energy, therefore we need to improve the technology to increase efficiency and decrease cost. New directions in renewable energy education - ScienceDirect." https://www.sciencedirect.com/science/article/pii/S0960148108002115. Accessed 20 Jan. 2021.	A new or better way of producing energy. A new creative way of Wind-, Hydro or Solar energy that can support society. For example a new machine that uses tidal energy and converts it to electric energy.
Floods	
Idea 4: **Floods**	Make a water pumping system which pumps water that is overful on one end of a river, lake whatever to another part that is

16/11/2020: The flood situation in the northern Philippines continues to worsen after torrential rainfall brought by Typhoon Vamco. Flooding has caused massive damage, including 236 sections of road and 98 bridges. 22,756 houses have been damaged and 3,096 totally destroyed. As many as 324,617 people have been displaced from their homes and moved to 2,991 evacuation centres. Disaster Resilience News – The latest in disaster management." https://disasterresiliencenews.com/. Accessed 20 Jan. 2021. -> very recent disaster so no research article can be found, only news articles Flood risk and climate change: global and regional perspectives." 3 Mar. 2014, https://www.tandfonline.com/doi/full/10.1080/02626667.2013.857411. Accessed 20 Jan. 2021.	stable and receives less rain etc. This could be smaller scaled than a full fledged waging flood, but rather smaller river systems which are common in the Netherlands. Adaptive of anti flood systems in place in the Netherlands like canals and small dams, a man made concrete solution which does not allow the water past and forces it to stream through somewhere else.
Food waste	
Idea 5: **Food Waste** Food waste is a major contributor to climate change and reducing it was ranked the third most useful action against climate change. Every year 1.6 billion tons of food is wasted, which is one third of the globally produced food annually. The first article is about the changes consumers can make, since consumers are responsible for 80% of the food wasted in the US. The second article focuses on companies, since they are involved in every part of the chain and can therefore influence every single step. People waste more food than they think—here's how to fix it." 24 Apr. 2019, https://www.nationalgeographic.com/environment/2019/04/people-waste-more-food-than-they-think-psychology/. Accessed 20 Jan. 2021. Tackling the 1.6-Billion-Ton Food Loss and Waste Crisis." 20 Aug. 2018, https://www.bcg.com/publications/2018/tackling-1.6-billion-ton-food-loss-and-waste-crisis. Accessed 20 Jan. 2021.	A scanner in the fridge that scans the expiry date and the product itself, so that you know what you have and when you have to eat it, to reduce food wasted caused by unmindful grocery shopping and forgetting what you have already bought. It could also show you recipes based on what is in your fridge.

Chapter 4: Identification of 1 Problem

Renewable Energy Problem

We, as a group, decided to choose the idea regarding renewable energy problems in the world. We did this through a democratic system from the original 9 ideas from chapter 2. This was done through a ranking system in which your top choice counted for 5 points, second for 4 and your third, fourth and fifth for 3, 2 and 1 points respectively. This resulted in the following totals below. Renewable energy was number 1 with 22 points, food waste in second with 17 points and fires & corona in tied third place with 16 points each. So thereafter we discussed the first place and collectively agreed to take on this problem.

Idea No.	Idea Name
1.	Fires
2.	Corona
3.	Plastic Waste
4.	Avalanches
5.	Floods
6.	Food Waste
7.	Homelessness
8.	Mental Health
9.	Renewable Energy

Idea No.	Points
1	16
2	16
3	4
4	0
5	6
6	17
7	1
8	5
9	22

Figure 1: result for which problem we would like to work on.

Motivation:

This problem is more and more relevant as we move away from fossil fuels and aim to make a more environmentally friendly and sustainable energy consumption and production path possible for future generations. These include solar, wind and hydro to name a few. These “new” methods of harvesting energy do solve the problems that fossil fuels posed, but they also introduce new problems, like noise pollution from wind turbines, added buildings and less greenery around solar panel farms, and the apparent damaging of the local environment from dam systems harvesting hydroelectric energy. So we see in these new problems a possibility to further improve renewable energy sources and keep our planet habitable and life enjoyable for many more generations to come.

We as a team also believe that we can innovate new ideas to advance the development and allow these new ways of harvesting energy to progress in order to overtake the fossil fuel systems in place in the world. It intrigued all of us, and with the destruction of the environment being an issue that is especially eminent to us as the younger generation, we were led to believe that it was a wise decision for the team.

Chapter 5: Potential Solutions

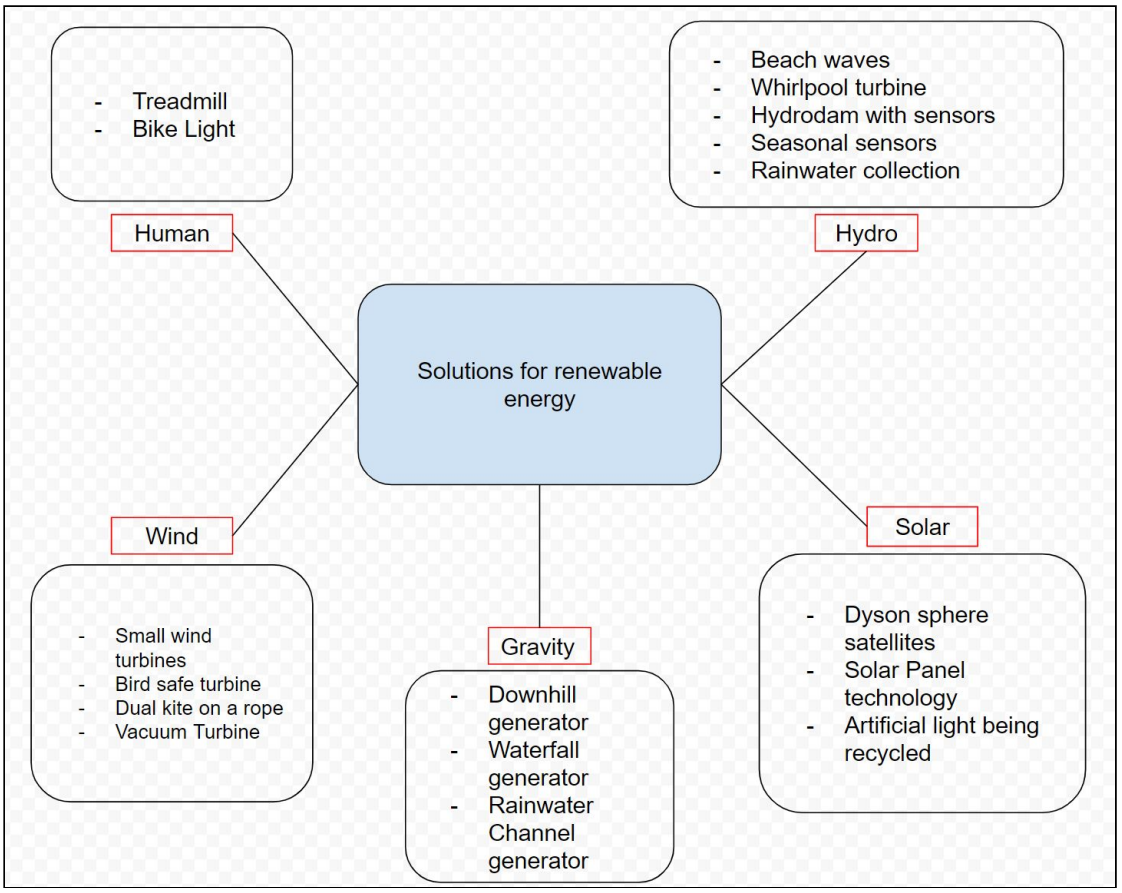


Figure 2: a map for the solutions for renewable energy.

1. Streetlight turbine
2. Rainwater pipe generator
3. Small / optimized turbines
4. Hydrodam
5. Artificial light panel
6. Kite energy
7. Beach waves
8. Treadmill

1. Highway wind generator (on a streetlight)

In this century highways and roads are some of the most complex systems we as humans have implemented into our world. They allow us to travel to places with ICE or Electric vehicles. This could be a motorbike, bike, scooter, car etc… The roads as a result of freeing our ability to drive vehicles quickly to point B give us an allowance of speed. With speed in a vehicle comes the resulting wind as we pass by.

This wind is simply wasted at this point in time. This is why a wind turbine, which would be placed in close proximity to the cars on a highway, along the fence could catch these otherwise wasted gusts of wind and in turn rotate the rotor. This rotation of the rotor would generate electricity.

Placing these turbines near busy highways would be the most efficient method of capturing this energy. The rotors would be efficiently placed, without being too close to the passing vehicles.

An added implementation to this design could be a multifunctional way of harvesting energy to the most efficient manner. Our thought with this implementation was to add a solar panel to the top of the system of these wind capturing poles along the side of highways.

There are so many other wasted sources of harvestable energy in our world today, based off of inventions and innovations that we as humans have already implemented, and this is only one of them. This idea is both feasible in smaller scale, and also could be quite successfully implemented in more places in the world as it is a generally applicable innovation.

2. Rainwater pipe generator

At this moment rainwater can be used way more efficiently. People are already catching rainwater so fresh water is not wasted, but there are other things you can do with rainwater such as generating electricity. The idea is simple. When it starts raining the water falls down through the pipe. Because the water falls fast, a wheel can generate electricity by means of a dynamo being powered by the rain water. The generated electricity can be stored and used for all kinds of things, e.g. the washing machine, the electric stove or the lights in the living room. And on top of that your monthly charges will go down as well!

3. Small and optimized wind turbines

Wind is a great source of energy, but with traditional turbines the used area, as well as the noise and overall impression are factors that could be improved. With smaller vertical wind turbines that could be attached to walls most of these factors wouldn't be an issue anymore. These small wind turbines would be the new facade of buildings to use available surfaces more efficiently. They would not only convert wind into energy, but could also be expanded to feature solar panels as well as being a design feature. Added sensors could inform about temperature, wind speed or air quality.

4. Hydro Dams

One of the biggest problems at the moment with Hydro Dams is the destruction of the ecosystem around the dam. The dam prevents the natural water flow and as a result destroys the habitat of animals living in the river. A solution for that would be a dam that reacts to the season and the weather to regulate the water accordingly. Sensors could track the water levels and water quality, react to its environment and let through more or less water according to what the sensors detect to as much as possible mimic the natural flow of the river.

5. Artificial light panels

We all know the modern solar panel. It is a great technology to capture the energy from the sun. However, as soon as the sun is under we switch on our own lights. One city can be brighter than the moon just by artificial lighting. We want to capture and recycle that energy, by modifying the technology of the solar panel. With an artificial light panel we can be more power efficient as we reuse part of the energy emitted.

6. Kite energy
Two kites that are connected to a generator by a tether. One kite will catch wind and pull the tether. The tether will unwind on the generator and therefore generate electricity. Once the kite has reached its maximum length on the tether, the kite will fold up and the second kite will open up. The second kite will now start to unwind its tether on the generator, and with that reset / wind up the tether of the first kite. This process can be repeated and optimized based on wind conditions.

7. Beach waves
The ocean and sea store a lot of energy. You can see this energy in the form of tides and waves. If we manage to capture the energy of the water we can generate electricity. Our solution is to use floaters or specialised propellers to capture the energy and transfer it to cities.

8. Treadmill
Working out while generating energy is almost an ideal solution, and with more than 4 million people working out in gyms there is a lot of energy being wasted. We want to incorporate generators in gym machines. Instead of just lifting weights, you can work out and keep the lights on.
Long term cost efficient and beneficial to gym owners. Short term less so because of the cost of implementation.

Chapter 6: Solution Selection

1. Selected solution

The solution we selected to elaborate is wave energy. Wave energy stems from kinetic energy from the wind that is being transferred onto the surface of the ocean.[1]

2. Motivation

This is a good choice for an innovative system within the unused energy that we could harness from the waters. The waves that form in the ocean at all times, could be used in order to move any number of different systems to harvest energy. According to experts, wave and tidal energy are currently the most mature technologies for renewable energy sources[1]. And in comparison to other renewable energies the energy in the ocean is more dense than for example solar energy, so there is less space needed for harvesting the same amount of energy[2], which is another important aspect we have to consider when thinking about products for the future. Because as the population grows, more and more space will be used otherwise and we have to be very mindful of how we use the limited space on earth. We found that this was a perfect gap between the existing manners of harvesting energy and this new method which has rarely been experimented with and is still in its prototypical stage. The methods used to harvest this type of energy from waves is also broad, in that there are many simplified methods of doing so. This allows us to fall back on another method of physically generating the electricity, while still implementing it within the same general idea and prototypical concept idea and / or product.

3. Why we picked this one (ranking system and Feasibility)

We finally picked this, along with other factors as discussed in this chapter through a ranking system in which we also aimed to satisfy everyone in the group in order to get an idea we all felt interested in making for the project and was do-able for our team.

4. Why we selected this solution over others

We picked this over our other ideas because this one has a lot of potential.
There is a lot of energy stored in the ocean and seas. Wave energy is estimated to have a potential of 29500 TWh per year, according to OES[1]. We also believe there are not a lot of existing solutions that could block our ideas. We have a lot of freedom to brainstorm and believe we can find a new, creative and exciting solution.

[1] "Ocean Energy: Information Sheet" 20.May 2013. Technology_Information_Sheet_Ocean_Energy.pdf (europa.eu) Accessed 20 Jan. 2021

[2] "Ocean energy could be the wave of the future" 30. May 2019. https://www.sciencenewsforstudents.org/article/ocean-energy-could-be-wave-future Accessed 20 Jan. 2021.

Chapter 7: Methodology

1. **Our production methodology: equipment, data collection, data use/analysis**

We are going to make detailed 2d and then 3d sketches to visualise our idea. Based on that we can predict how we should build our device. When we build the device we take careful steps and check if our methodology could break parts of the system. When the device is built, we can adjust some parameters to improve the efficiency, and carefully document these changes.

To make the building of the prototype possible in a socially distanced world, we split up the tasks and distributed them equally among the team members.

We split the tasks in management, hardware, research, documentation, data analysis and programming, visualization, and practical tests. These we distributed, so that each one of us got one main task, but we all helped each other and supported each other during difficult subtasks.

Huug was our main manager, which includes reading through the feedback and the documentation and handling all communication between the team and professors, student assistants and Alfred. He also constructed the laser-cut pieces and 3d printed parts we needed for our prototype.

Stefan was tasked with the hardware purchase and the involved research into the needed parts. He looked into the specific needs of our dynamo for example. He also was tasked with documentation and formatting.

Hyo Joon handled the research necessary for our project. This included finding out how suitable wave energy is for our planned solution and gathering further knowledge about energy harvesting from the ocean.

Lilly was tasked with the documentation, which included writing and revising the final report. Additionally she was writing the small summary for our project as well as aiding in the structure for the different chaptered sections of the report.

Camilla handled the data analysis and programming, involving the programming of the motor and the review of the gathered data. She also made most of the sketches in order to visualise our ideas for the product.

Maurits was responsible for the practical tests and the planning of the prototype and its functioning. Within this task he discovered new ways to design construction of the prototype in 3D modelling of others through 2d designs he brought to light to the team.

Task list

Huug	- Management (MAIN)	Documentation (Secondary)
Stefan	- Hardware (MAIN)	Programming (Secondary)
Hyo Joon	- Research (MAIN)	Programming (Secondary)
Lilly	- Documentation (MAIN)	Research (Secondary)
Camilla	- Programming (MAIN)	Research (Secondary)
Maurits	- Practical test (MAIN)	Research (Secondary)

First prototype:
A floating platform which uses a generator attached to a reel of rope which spools, in turn generating electricity. This would then light up an LED.

Materials needed:
- platform (wood)
- guide rail = metal / wooden rod
- Generator / (bike) dynamo
- rope
- Motor and power
- Cam
- Wires
- multimeter
- resistor
- LED

2. First Basic Scenario Solution

We as a group decided to choose, as our basic scenario solution which we will move forwards with a Floating device that moves up and down with the waves. There will be an attached string tied to the floating device which will allow the generator to remain stable, and in a controlled position in the water enclosure to ensure effective and accurate testing and energy harvesting. It reacts to different water / wave strengths in that the electricity generated is differing and allows us to see when the generator is optimally producing energy. The generator will adjust to allow more or less of the reel of string to be extended depending on these wave / water strengths. This idea would be beneficial to new renewable energy harvesting and would allow our group to make a functioning product.

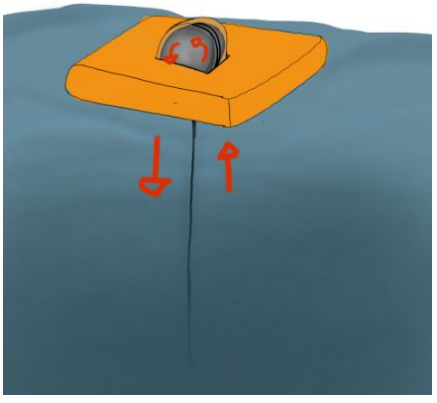


Figure 3: A thumbnail sketch of the First Basic Scenario Solution.

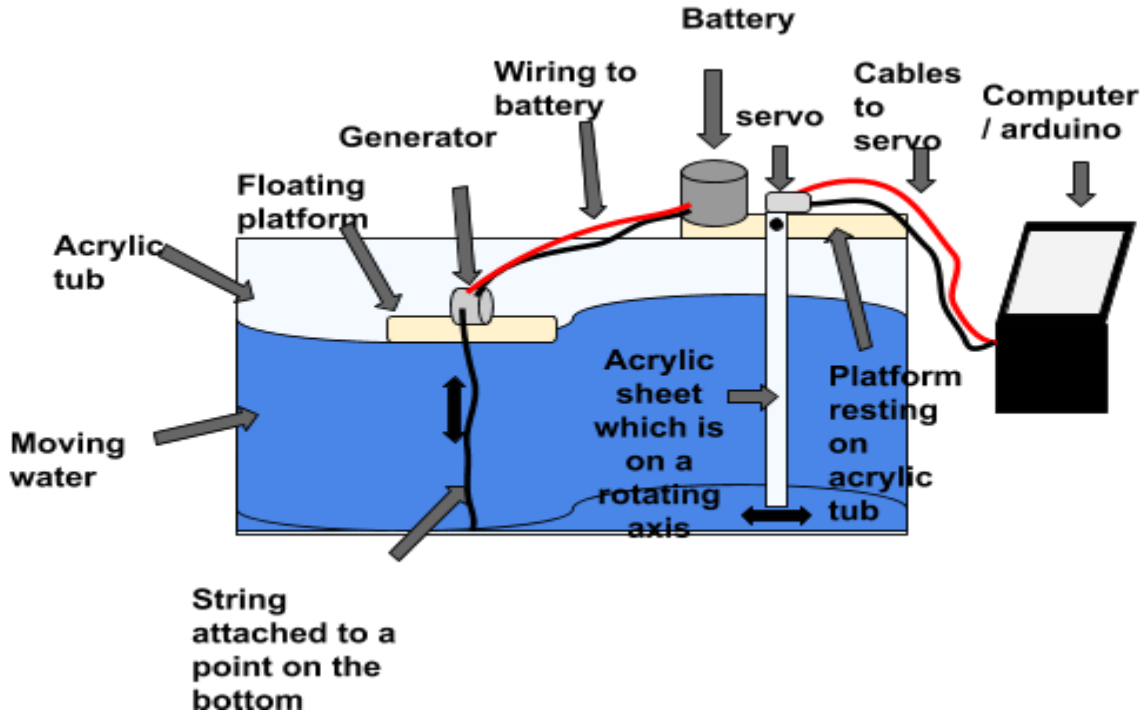


Figure 4: A more in depth 2D vision of the product.

3. First Ambitious Scenario Solution

The ambitious idea is to add sensors to the device that can report on the water quality and rate of motion of the water. This way you could use the device also as an analysis system and the data can be sent to a computer. Based on the results you can choose to change the position of the buoy. We could also use the knowledge of the tides to adjust our device. When the tide is getting high the waves become larger, therefore the pull on the cable will be longer. With that we could use different gearing to extract as much energy as possible from the difference in height.

4. Final Basic Scenario Solution

Since our first prototype idea, we have changed how our solution is going to look like. We have decided to use a toothed rod and a gear instead of a rope, since a rope is much more high maintenance. And since we want our product to be as low maintenance as possible, we have decided to replace the cable. But the basic idea of our solution has not changed, we still want to make a floating device that moves up and down with the waves, it changed now into a guided movement, as the toothed rod will allow the platform to smoothly move up and down, while still staying at the same place.

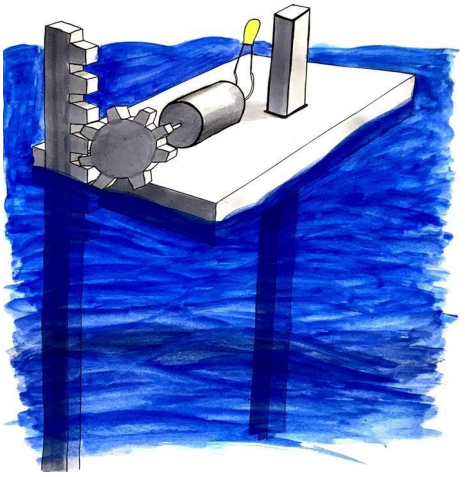


Figure 5: A sketch of the Final basic Scenario Solution.

There are a few main technologies being used for wave energy extraction and our solution falls under a point-absorber. This is a floating structure which absorbs energy (from all directions) through its movement at or near the water surface[1]. To test the amount of energy harvested we will connect a LED and additionally we will measure the voltage to show the difference in energy harvested between differently sized gears.

The layout of our device:

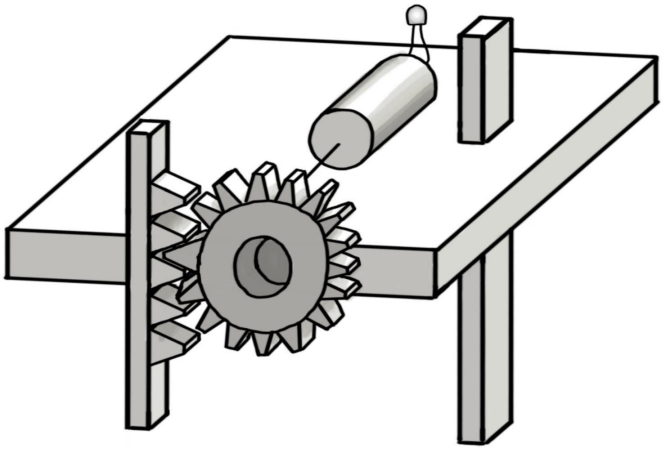


Figure 6: Visualization of the device.

In the prototype we plan on making, the water will be left out for now and thus we decided to simulate the waves with a camshaft, so our prototype will look like the sketch below.

The second design of the prototype:

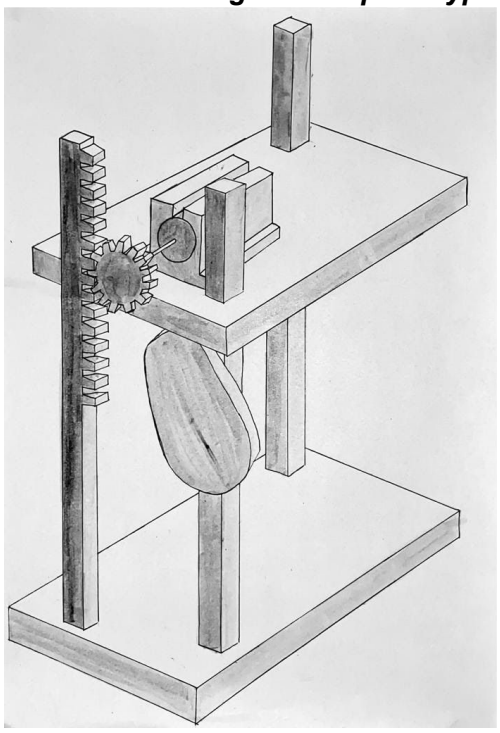


Figure 7: A sketch of the second design of the prototype.

We are going to use some laser cut parts, as well as 3d printed parts which we designed ourselves on fusion 360.

The top floating platform which houses the dynamo:

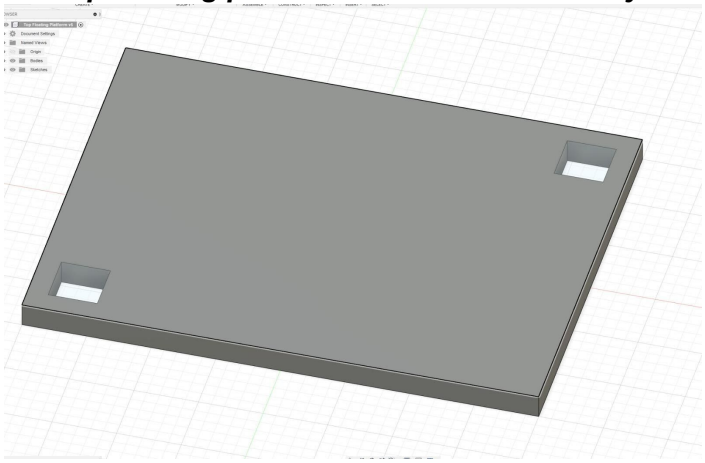


Figure 8: An image of the design of the top floating platform on fusion 360.

This platform will be available in two different sizes, for the differently sized gear. The only difference between them is the third hole on the left which is for the different tooth racked pole which is adjusted for the gear sizing.

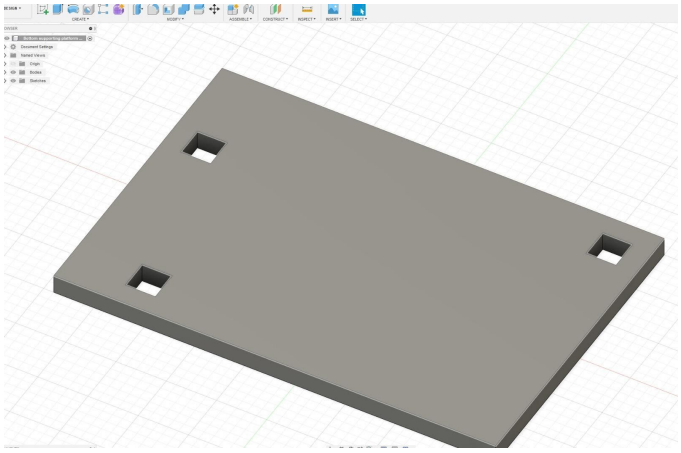


Figure 9: An image of the design of the bottom platform on fusion 360.

This will be our camshaft that will simulate the movement of the waves, which will also be available in two different sizes to document and compare the harvested energy from different sized waves.

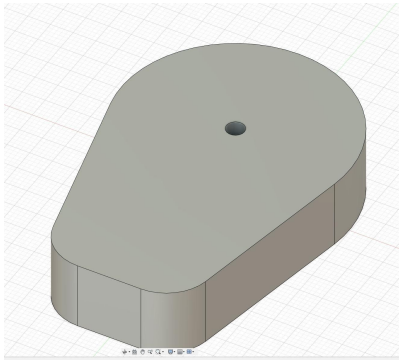


Figure 10: An image of the design of the camshaft on fusion 360.

These are the “slides” which are simply two 20cm poles which stabilize the platform in the water, not allowing much free movement from side to side which may cause damage to the equipment housed on top of the floating platform.

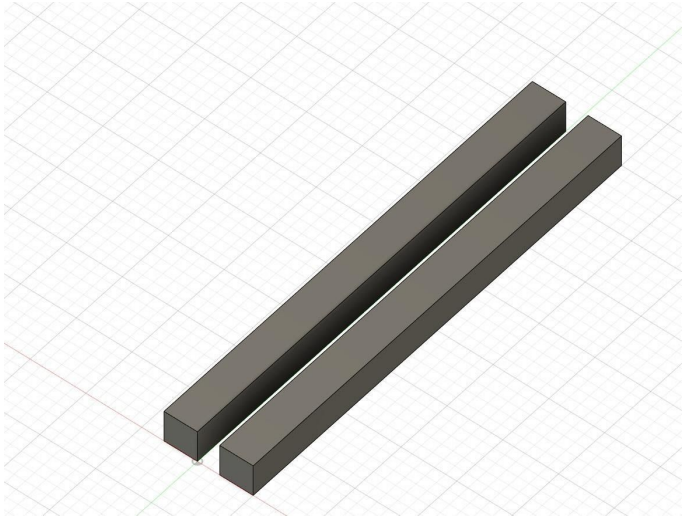


Figure 11: An image of the design of the rods on fusion 360.

This is going to be the gear that translates the vertical movement of the waves into rotational movement, which then can be easily translated into energy.

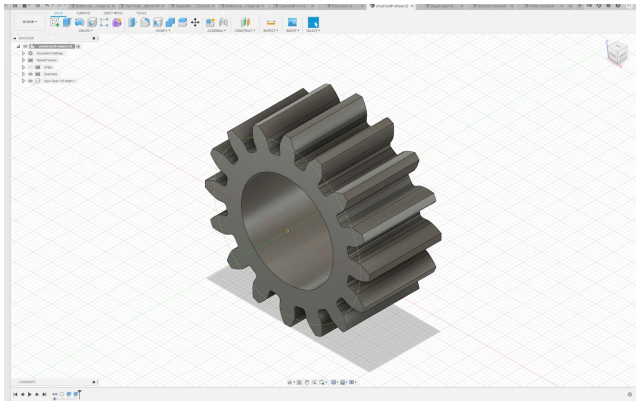


Figure 12: An image of the design of the Gear on fusion 360.

This is going to be the toothed rod that will allow the platform to smoothly move up and down with the simulated waves or present waves.

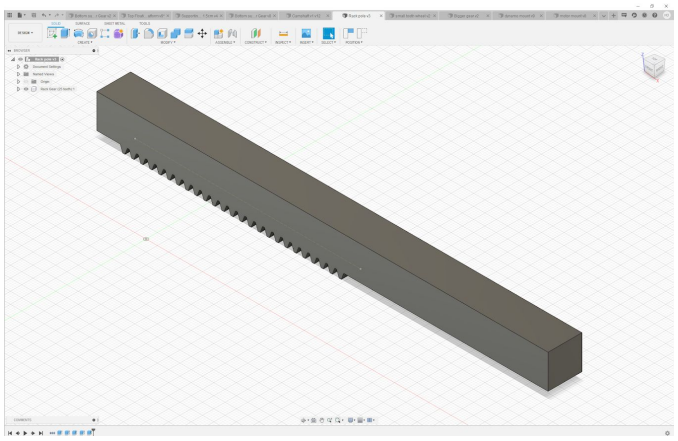


Figure 13: *An image of the design of the toothed rack pole on fusion 360.*

This is going to be the housing of the small motor, to protect it from possible surrounding disturbances as well as allowing it to be mounted to the supporting poles.

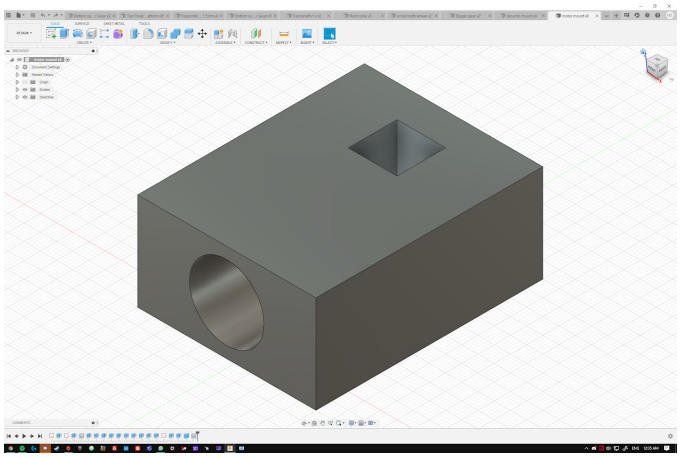


Figure 14: An image of the design of the motor housing on fusion 360.

This will be the piece that holds the generator and connects it to the platform with a simple sliding in of the dynamo, and screws to the base platform.

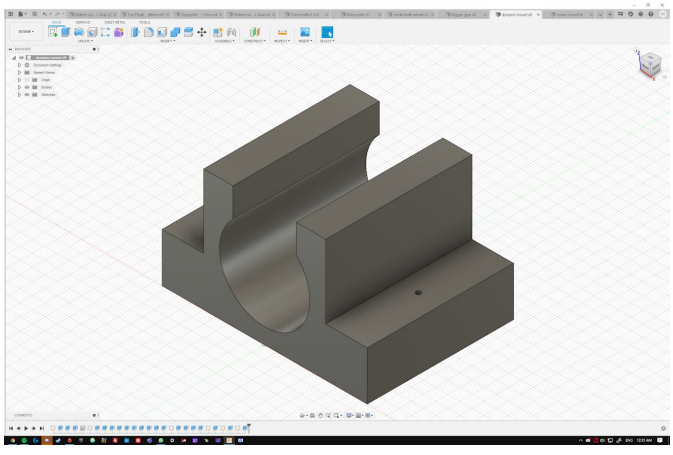


Figure 15: An image of the design of the generator holder on fusion 360.

This is the side view of the dynamo mount on the top platform of the prototype.

Dynamo mount side view:

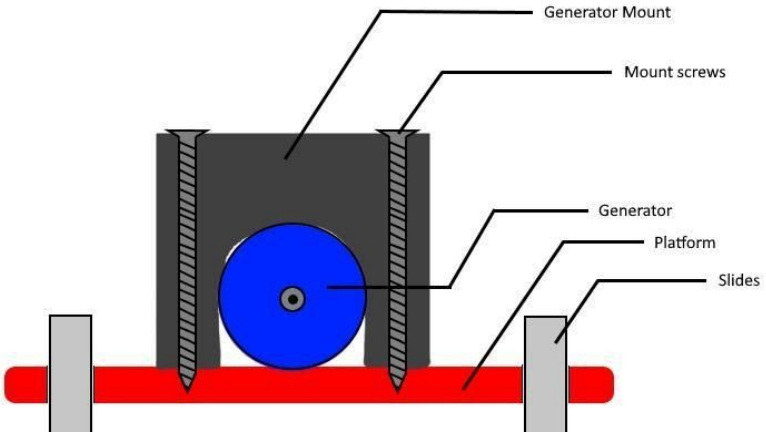


Figure 16: A sketch of the dynamo mount side view.

The cost of production of the prototype

When calculating the cost of production of the product it is important to take into account costs of prototyped products as well. Our prototype was not fully bought or accounted for, however predictions of its cost have been given educated estimates. The equipment costs of the laser cutter and 3D printer have not been accounted for.

Part Name	**Cost (EUR)**
Dynamo ***6V***	8.50
Small Motor For Oscillating ***5V***	1.50
Arduino Uno	9.00
Resistors / Wires / LED	1.00
Wooden Platform(s) ***0.16m^2***	2.00
3D printed Parts: Beams x4 + Dynamo mount + Motor mount + camshaft + Gear ***350g***	7.00
Total Cost Of Prototype	

5. Final Ambitious Scenario Solution

The ambitious idea is to have multiple different sized gears, so we can translate the motion of the waves into a higher rotational speed for the generator, to increase the harvested energy. Next to that, we would like to add a casing for the platform that encloses the generator so we can test our solution in a water environment. Also an additional feature for the ambitious scenario is to add sensors to the device that can report on the water quality and rate of motion of the water. This way you could use the device also as an analysis system and the data can be sent to a computer. Based on the results you can choose to change the position of the buoy. To reduce the maintenance level of our ambitious scenario solution, we decided to make it a near-shoreline device. This means that it is at moderate water depths between 20 and 25 metres and up to 500 metres away from the shore, which results in a perfect compromise between maximum energy potential with offshore devices and easier maintenance with shoreline devices.

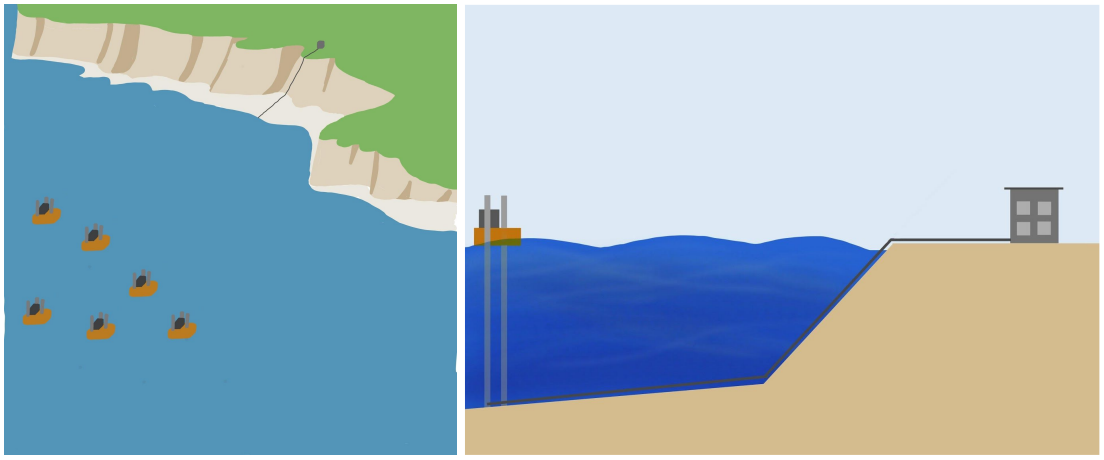


Figure 17 & 18: Sketches of the final ambitious scenario solution.

Hardware Needed For The Ambitious Plan:

- Generator
- Wiring
- Battery
- Voltage / Current meter
- Toothed rod rack
- Toothed Gear
- “Slides” supporting rods
- Waterproof housing
    - Silicone / Flex Seal (waterproof)
    - Acrylic sheets (3mm thick)
- Floating platform made of buoyant material
- Access to 3d printer / laser cutter
- Access and skills to 3D model
- Body of water
- Waterproof enclosure / box
    - Silicone / Flex Seal (waterproof)
    - Acrylic sheets (5mm thick)
    - Stainless steel
    - Or as an alternative solution a pre-built enclosure such as a fish tank
- Servo’s / small motors (wave maker)
- Water resistant tape

The cost of production in real world application
We cannot get a good estimate of an industrial sized generator. Apparently they tend to keep that information to serious buyers only.

Because this is a new innovation all of the production would have to be newly created for the product, making it highly expensive for the first units.

We estimate the costs for a single module to be 2 million to 5 million euros. This estimation is based on the cost of windmills at sea. Although windmills are very different from ocean generators, we argue that the production process is very similar and therefore the cost is too.

The production process in real world application
The production process of the Ocean Energy generator when implemented in the real world would be very different to our small-scaled production of the prototype. The most notable changes would be the scale of the parts, and the materials used, as well as the power that is able to be generated by the generator.

For our prototype we used simple PLA plastic, and Thick plywood for the parts. This is very different to what would be used. For the platform, a series of different materials could be used in order to simulate a pontoon. In production projects of similar caliber and scale to a real life iteration of our prototype, many use air-filled cavities in the volumes of thick-walled plastic platforms. This, along with the change in material from the rods from PLA to stainless steel poles which are planted in the sea bed.

We used many 3D printed parts as well as laser cut parts. These would be different to those used in real life application as the production would either use casting or plasma cutting in order to cut the thicker metal parts. The other parts such as the platform would be too large to be created as one part, and would therefore be cut with a form of laser cutter in order to create a modular design

Because of the scale of the parts, as well as the materials used, the methods of fastening the parts to one another would be very different as well. In production, the industry standard epoxy / resin would be used in order to connect all non-metal parts together. All metal parts would be welded together. The fastening that is non-permanent would be done with nuts and bolts with appropriate torque ratings met.

Chapter 8: Results and Conclusion

We as a team designed and prototyped possibilities for the parts of the newly dubbed “Ocean Energy Prototype” which is the name of our prototyped product. After creating renders in the autodesk environment and sending them to Alfred in the smart XP labs to have them printed and laser cut we were ready to reserve a space to work there.

Our experience at the smart XP labs with construction of all of the parts went relatively well although we encountered a number of unforeseen problems including fitment and also simply the hardware we had acquired being differing to our expectations. This is also of course due to lack of contact between us, and the dispersion of parts amongst us also. Among these things we still managed to create a functioning prototype which displays the main concept that we wished to achieve with our project.

Problems we encountered:

- Poles didn’t perfectly fit the platform
    - The motion of the platform was not as smooth as expected due to instability in the center,
    - due to variation in the cuts of the laser cutter and the extra filament from the 3D printer.
    - This was also as a result of giving the parts too much clearance in some cases.
    - We also needed to sand some of the supporting poles down slightly because of variations in the print due to the height of the pole making it sway during printing
- In hindsight we had some unsuitable gear, such as the dynamo which has a present clicking as it is turned which takes away from the fluidity of the platform’s motion and the amount of energy which is able to be generated.
- The motor of the arduino kit was not fully strong enough to lift the platform without running at a high speed which only bumped it and didn’t move the platform much.

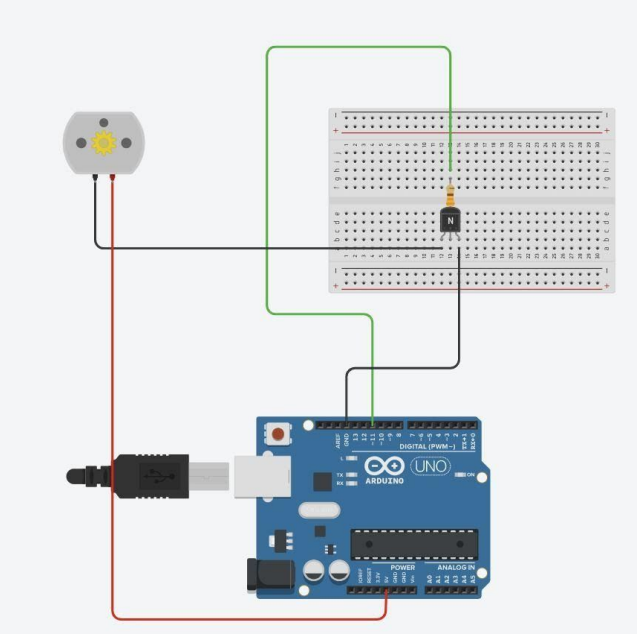


Figure 19: Schematic of the connection between the Arduino and the generator.

Building Process

To get started with our first version of the prototype we had to put all the laser cut and 3D printed parts together. We had to fix the thickness of the rods slightly in order to get them exactly the size we wanted, but they were still unstable at the top.

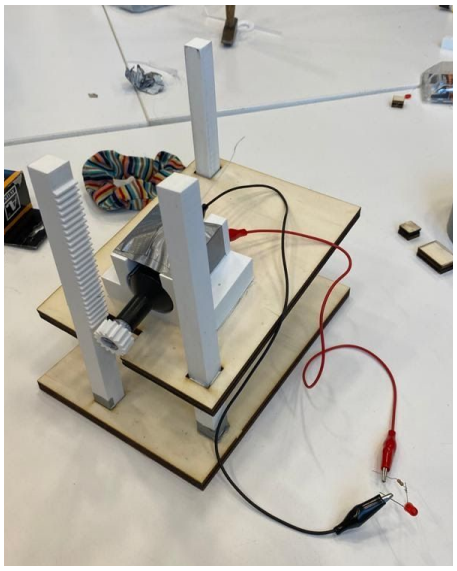


Figure 20: A photo of the Ocean Energy Prototype V1.

In the second version of the prototype we added a piece of laser cutted wood that connected two essential parts. The toothed rod and the front platform pillar are now stabilized. The gear was able to move up and down without getting out of place.

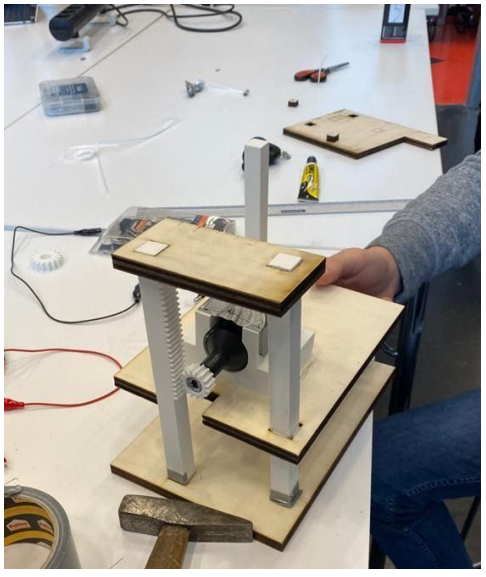


Figure 21: A photo of the Ocean Energy Prototype V2.

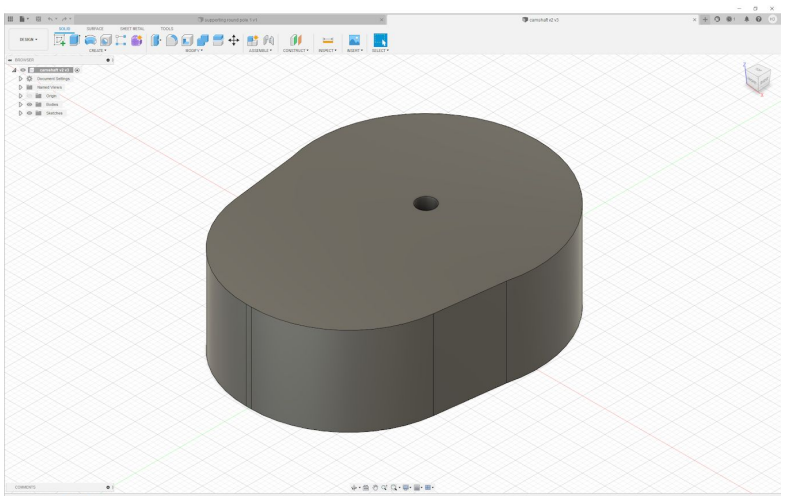


Figure 22: Camshaft version 2

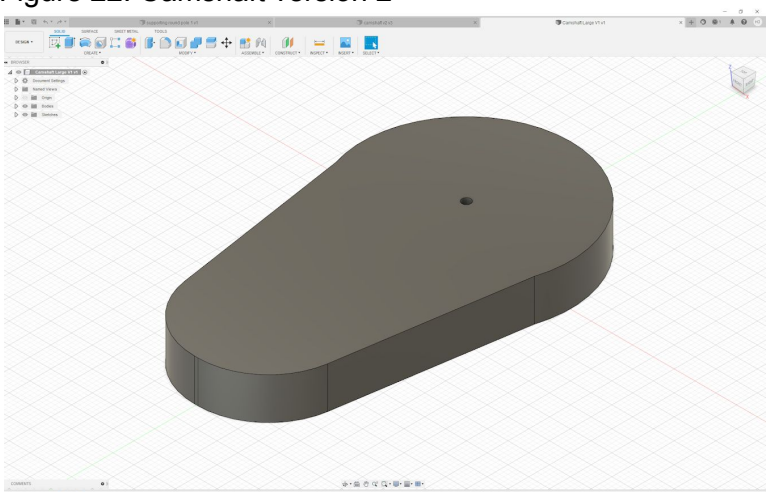
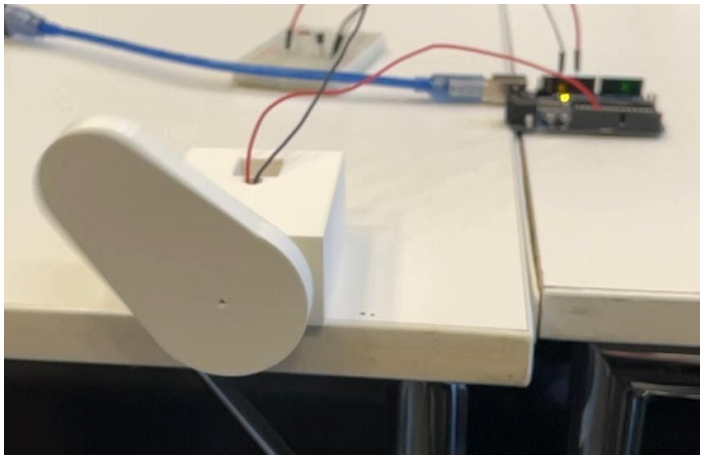


Figure 23: Camshaft version 3

After the base of the prototype was built we connected the motor with camshaft to the Arduino. We printed a housing for the motor which we put around the pillar at the back. The camshaft was meant to simulate the waves that move the platform up and down, but unfortunately the motor was not strong enough.



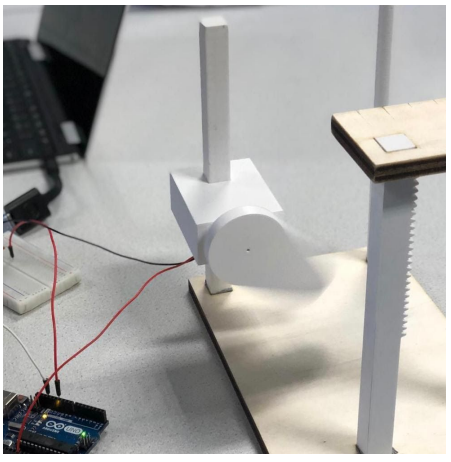


Figure 24 & 25: Photos of the Ocean Energy Prototype V3.

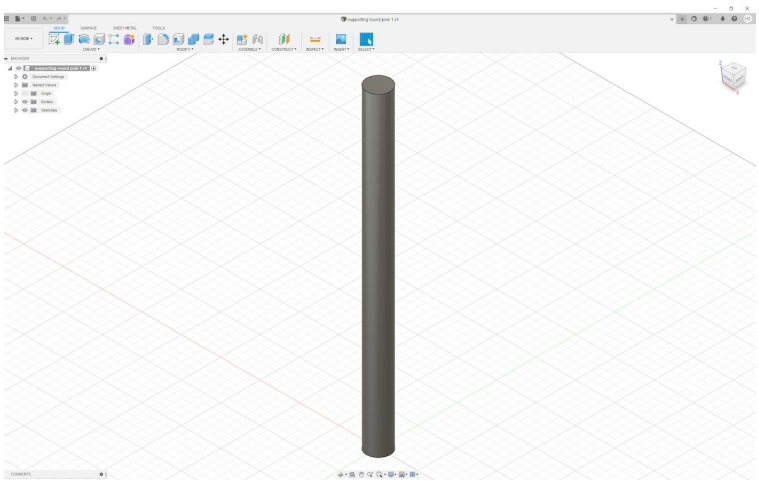


Figure 26: Cylinder stabilizer pillar

Our final design included one more cylinder stabilizer pillar.

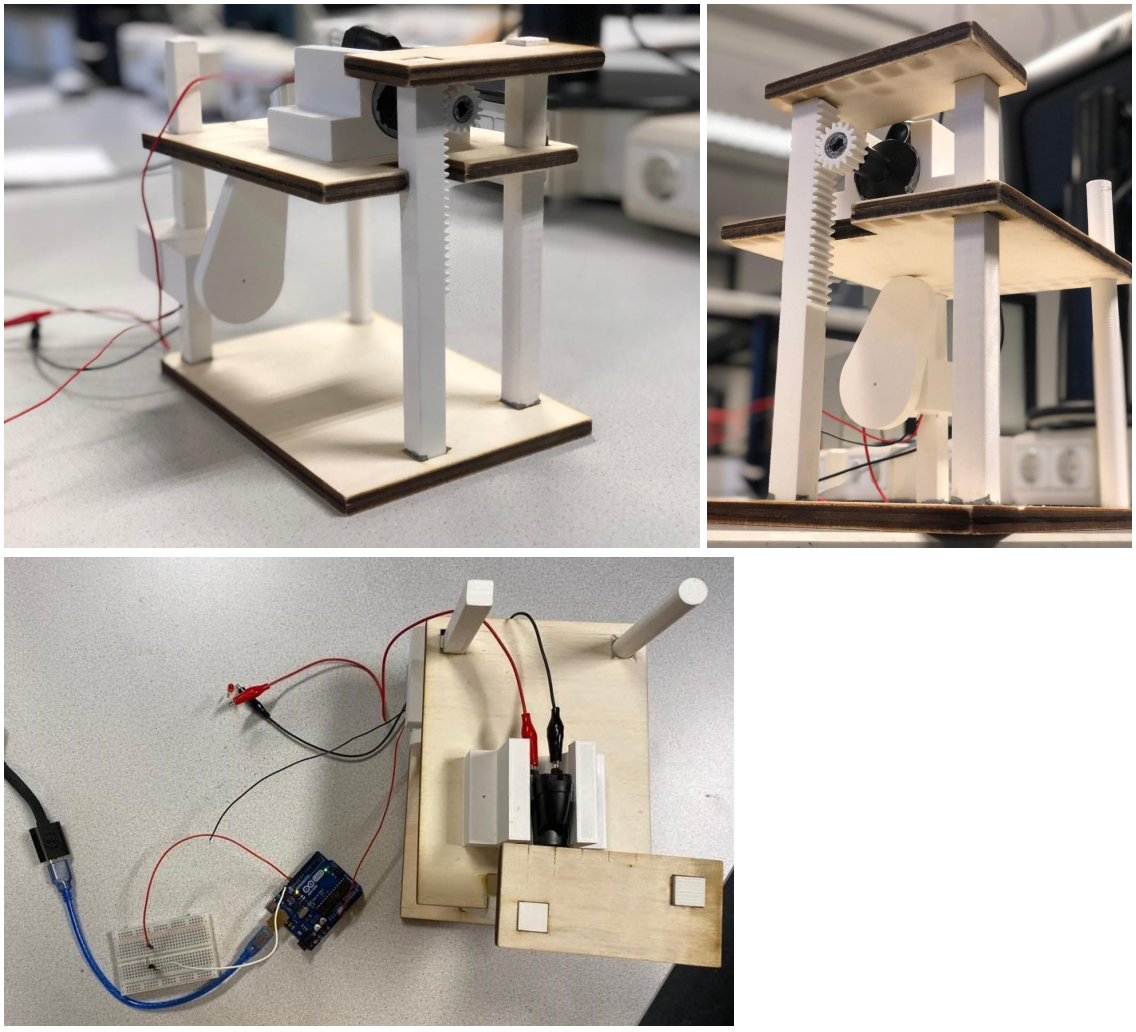


Figure 27 & 28 & 29: Photos of the Final Ocean Energy Prototype.

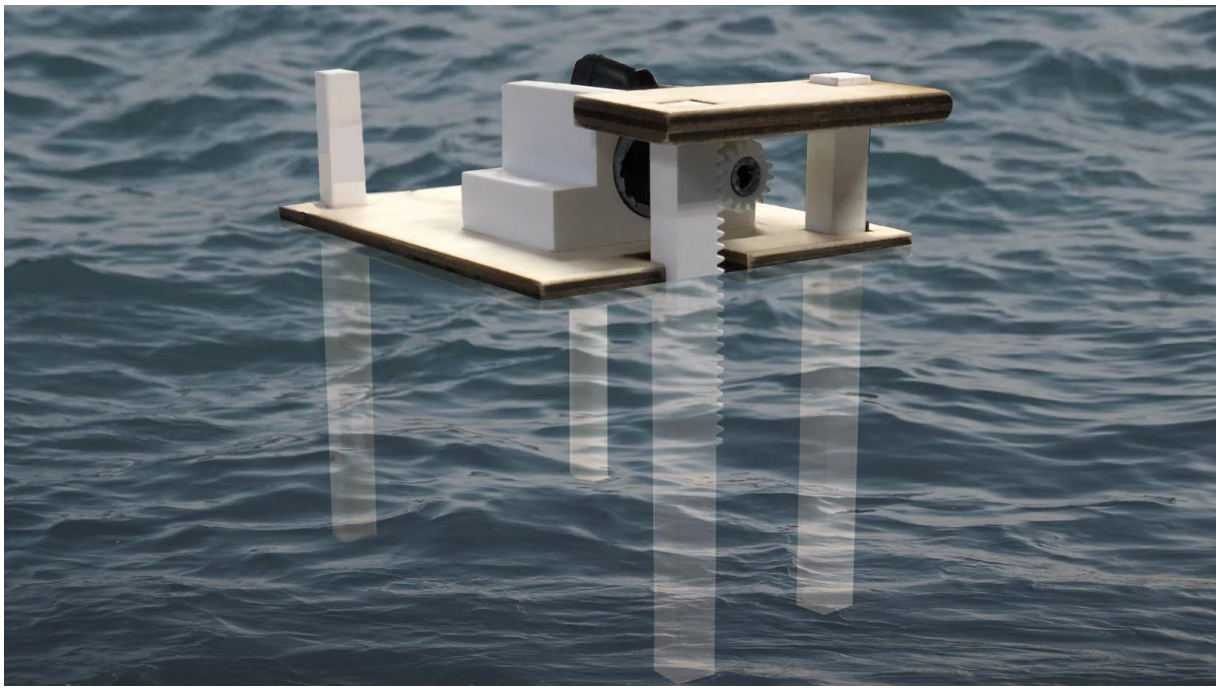


Figure 30: A photo of the final Ocean Energy Prototype in water.

Changes we would make in future versions:
During the testing of our prototype we found that the dynamo we bought did not rotate smoothly. In future versions we would like to add a different one which allows an easier and smoother movement. Another issue we encountered was that the platforms and the poles that stabilize the prototype did not exactly fit each other due to small errors and inaccuracies during the laser cutting and 3d printing. This could be easily remedied by metal poles and more precisely fitted cutouts for the poles.
Furthermore metal poles would be a smoother material then the PLA plastic pillars, so the platform would move up and down more easily. The gear which did match the toothed rod perfectly already had some wear off after the tests we made. Changing this gear from a 3d printed one to a metal gear would solve this problem. Additionally the platform which holds the dynamo had more weight than anticipated and thus the motor that is in our arduino kit was not strong enough to turn the camshaft and lift up the platform, so switching to a stronger motor would be necessary for the prototype to work properly. As the prototype got quite tall we realized that more poles were needed to stabilize the construction. Luckily we were able to print additional cylindrical poles which made the prototype much more stable.

How much energy the prototype generates
The dynamo used was a standard 3W Bike dynamo that requires quite a lot of force in order to allow it to turn. On a larger spinning surface with much more mass, such as the bike wheel it would be propped against this would result in a smooth power delivery. Unfortunately this was not the case for us as there was simply not enough force to have a smooth rotation of the dynamo. When testing the amount of power generated from the system we used our hands to simulate the realistic testing conditions of the prototype. When doing so we found that peak output was 1.5W and the lowest wattage was 0W, as at the top and bottom of the toothed rack the mechanism stops and returns the direction it came from, coming to a standstill. When testing the system we used an LED to indicate when the system was outputting any energy, and the points at which the platform had to come to a stop and return the way it came from there was clearly no light illuminated, which confirms our findings on the

energy output. Our dynamo, in hindsight, was not efficient for our application due to it being limited to a maximum output of 3W and not having fluid rotation.

Yields prognosis
Given that the dynamo we used for the prototype delivers only 3 watts of power, the estimated yield of this on an annual bases can be calculated as follows:

3W	= 0,003kWh
0.003W * 8.760h	= 26,28 kWh (annually)
1 kWh	= €0,22 *[3]
26,28 kWh (annually)	= €5,78 (annually)

As shown in the calculations above, which are based on full efficiency, our prototype hardly yields anything. In addition, we indicated earlier that the peak of the power output was at 1,5W, which means that in practice the yields would be nil. However, our final design would contain a way larger generator and therefore would be way more efficient. In this case the yield would depend on the power of the generator.

[3] "Wat kost een kilowattuur (kWh) elektriciteit? | Consumentenbond." 23 Sep. 2020, https://www.consumentenbond.nl/energie-vergelijken/kwh-prijs. Accessed 25 Jan. 2021.

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