Tidal energy harvesting model

2021 – semester 1 – group: 18303

K a f r E l – S h e i k h S T E M H i g h S c h o o l

(Index)

I. Present and Justify a Problem and Solution Requirements

1.1 Egypt grand challenges

1.1.1. Increase the use of alternative and clean energy

Human civilization has started realizing how much harm they have already caused to the environment; and when it comes to take a stand against these environmental problems, the focus shifts to the use of alternative energy sources. The energy crisis is a growing problem for everyone in the world. It affects and will continue to affect all people, and it is a major issue. The energy crisis can be defined as the profound, negative effects that the energy industry has placed upon the global society. Scientists around the world are researching on developing and discovering new Alternative Energy Sources so that the growing energy needs of human population can be met more easily, safely, and efficiently.

Sources of alternative energies: -

Hydroelectric Energy:

The potential energy stored in the water held in dams by is made to drive a water turbine and generator which in turn produces electric power. This form of energy generation is called hydroelectric.

Advantages of hydroelectric power generation:

The source of hydroelectric power generation i.e., water is free of cost. Dams can provide virtually continuous electricity generation. The water used for power generation can be put to use again.

Solar Energy:

This is the energy which the earth receives from the Sun. This is one of the most promising alternative energy sources, which will be available to the mankind for centuries to come. The only challenge remains to tap the solar energy in the most efficient way. The solar power generation is done by using a series of photovoltaic cells where the solar rays are converted into

electricity. Apart from electricity production solar energy is also being used for heating water, cooking food etc.

Advantages of solar energy:

- Solar power generation is quite and clean. Solar energy is a renewable form of energy will not deplete until thousands of years. The source of energy is free

Wind energy:

The power of the wind is harnessed to propel the blades of wind turbine attached to an electric generator to generate wind energy, it is also an effective alternative source of energy in areas where the velocity of wind flow is high.

Advantages of wind energy:

- Wind energy is a clean form of energy.
- The source of power generation i.e., wind is free of cost.

1.1.2 Reduce Pollution

Pollution is the introduction of harmful materials into the environment. Pollutants can be natural, such as volcanic ash. They can also be created by human activity, such as trash or runoff produced by factories. Pollutants damage the quality of air, water, and land. Some types of pollution are illustrated here in some detail.

Water pollution

Water pollution is a major global problem that threatens human life and most other living things. Because People depend on water for most of their activities, such as industry and agriculture. and if they face any difficult in using it that would be major impediment to live on this planet. wasted (polluted) water is produced after any process and this water that contains toxic chemicals is thrown into the seas, oceans, and rivers. This leads to water pollution, fish poisoning, and a harmful effect on the water cycle, and this is known as water pollution. The water is exposed to pollution

because the water can dissolve more materials than any other liquid, and that is why it is called a "comprehensive solvent" and when you throw this waste into the water, it dissolves it. Then mixing, which leads to contamination.

Air pollution

Air pollution is defined as any contamination of the atmosphere that disturbs the natural composition and chemistry of the air. This can be in the form of articulate matter such as dust or excessive gases like carbon dioxide, sulfur dioxide and nitrogen oxides or other vapors that cannot be effectively removed through natural cycles, such as the carbon cycle or the nitrogen cycle. air is polluted due to many factors like: Vehicle or manufacturing exhaust Forest fires, volcanic eruptions, dry soil erosion, and other natural sources, building construction or demolition Burning of Fossil Fuels Agricultural activities exhaust from factories and industries. Inhaled polluted air leads to serious diseases such as pneumonia, lung cancer and others. Many countries have developed some technologies to avoid this problem to reduce the emissions from their factories and control the percentage of some pollutants like (so_2 – co_2 – NO_x). Our challenge is to develop a source of alternative energy that has no harmful emissions so that will reduce our need to burn fossil fuels to get energy consecutively reduce the air pollution.

Land pollution

The contamination of soil occurs by direct contamination such as using of pesticides for agricultural purposes or waste factories. Also, it may occur by indirect contamination when water mixed with chemical a material which leads to poor fertility and low crop production. Furthermore, some of harmful chemical materials will effect on plants and natural composition. This will reduce the amount of nutritional value.

1.2 Problem to be solved

‘‘Egypt has Africa’s second highest renewable energy capacity, but we are still not reaching our potential’’ that was the head of an article posted on (Enterprise Press) website; the article was about the global rank of Egypt in using the alternative energies as a sustainable and clean source of energy, the statistics in the article were based on the International Renewable Energy Association (IRENA) report that was published in October 2018 stated that we could “realistically and cost-effectively” supply 53% of our electricity mix using renewables by 2030 - a far more ambitious target than the government’s aim for renewables to make up 42% of our electricity mix by 2035. but until the present day we are depending mostly on natural gas and fossil fuel in supplying every day increasing demand on Energy which frame our life and not just us Egyptians and Egypt use non-renewable energy source, but the entire planet does in spite of its sextremely bad consequences on long term as stated by Daniel R. Fawst in his book Energy crisis: the future of fossil fuel. According to energypedia.info site figure 1 illustrates the current energy sources in Egypt. It’s obvious in the chart that Egypt like most countries depending greatly on oil and natural gas with a very small percentage on renewables.

In our capstone this semester the main grand challenge is to increase the use of renewable and clean energy sources in Egypt. So, we are asked to make a project that shall be a starting point for large scale applications in this field, moreover the idea of the project and the required design is completely different from the traditional previous projects in the same category. The project will integrate between three main elements which are: modern technology systems such as AI or smart sensors, the communication networks like (LPWAN) and alternative energy source applicable on a large scale and an example for that is tidal, solar energy, and geothermal energy etc.…

In conclusion our focus in this project is to reduce the use of non-renewable energy sources as much as possible with renewable ones with assistance of modern technology and communication networks.

What would happen If it solved?

This will be a very important step in our journey to overcome the current grand challenge by reducing the use of non-renewable energy sources with renewable ones. And increasing annual energy production in Egypt of alternative energy specifically.

Also, this shall contribute to reducing the global climate crisis as the entire globe direction now is to focus on investigation in the alternative energy as a main solution for the current climate change issues. Finally, we are looking forward to revealing the results of our work as great source of alternative energy that is available all day long which is the tidal energy, we shall be independent in producing our energy.

What will happen If it not solved?

The current situation in Egypt is disquieting; the pollution rates would continue to increase if we neglected this crucial grand challenge.

1.3 research: -

Increasing the use of alternative energy sources in Egypt is the primary grand challenge being addressed by this research through working on finding a new approach for solving the problem of the pollution and climate change crisis which is related to this challenge. The entire globe is now heading to a new chapter in generating, collecting, and distributing energy by investigating in alternative energy and the reasons for that is the current global climate issues, and by using modern communication networks and technologies which improves really fast every day. Indeed, now we are able to create extremely huge systems of alternative which shall supply us with sufficient energy needed for modern lifestyle. This will help us decrease the use of fossil fuel to achieve the desired grand challenge. Without research we are not able to get the information that we need to create the project, so research is the fundamental basis of any project.

Regarding the problem, it is related to a number of topics mentioned in the following: -

- Sources of Alternative energies.
- Generation of energy.
- Air Pollution.
- Types of communication networks.

Regarding the solution, the associated topics are mentioned in the following: -

- The prior attempts to solve the problem of supervised classification.
- Smart sensors.
- Mobile applications.

1.4 other solutions already tried

1.4.1 concentrated solar power(csp)

Researchers around the world have been investigating alternative materials that can support operation of concentrating solar power (CSP) systems at higher temperatures, and thus higher efficiencies, making concentrating solar electricity cost-competitive compared to photovoltaics and fossil fuel power. Cost reduction of CSP technology requires materials and components that will be stable and function above 700°C, a temperature that surpasses today's operating conditions by 150 degrees or more.

CSP systems capture solar energy as heat that can be converted directly to electricity or stored for later conversion when electricity is in greater demand. The flexibility provided by the ability to store the thermal energy as heat is a unique feature among renewable energy technologies.

CSP systems are comprised of sun-tracking mirrors that reflect sunbeams onto a solar receiver. The receiver can be in a number of configurations, including towers, troughs, or dishes. CSP towers have an installed capacity that is increasing worldwide. In a CSP tower plant, a field of mirrors known as heliostats surrounds the solar tower and concentrates the sunlight onto a receiver on the top of the tower. There, the concentrated solar energy heats a heat-transfer fluid (HTF) in the receiver. Through high-temperature liquid-phase pumps and valves, the HTF delivers the thermal energy either to a heat storage tank or transfers it, through a heat exchanger, to a working fluid, such as steam or supercritical CO_2, which powers turbines to generate electricity.

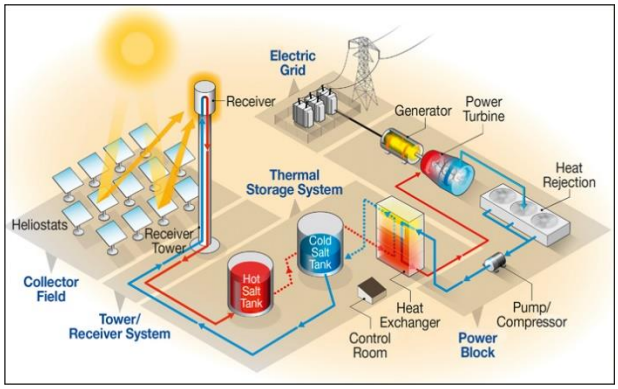


Figure 1: -csp system

Pros

- these systems rely on the sun which is a renewable resource
- produce no pollution while generating power
- can store heat energy that can be tapped for energy on demand

cons

- The main drawback is in the schedule and weather that do not allow a constant amount of electrical energy to be generated.
- Have high cost of the used materials

1.4.2 Tidal barrage

Tidal barrages are low-walled dams, usually installed at tidal inlets or estuaries. Similar to traditional hydroelectric dams, sluice gates are used to create a reservoir on one side of the barrage. The barrage is secured to the sea floor, while the top of the barrage is just slightly above where the water level hits during the highest tide. Tidal turbines are located towards the bottom of the barrage, inside a tunnel, which allow water to flow through. Tidal barrages look like traditional hydropower dams. Turbines located along the bottom of the barrage are turned with the incoming and outgoing tides. During an incoming high tide, water flows over the turbines as the water rises. Then, the water flows back through the turbines as it becomes low tide. The turbines are connected to

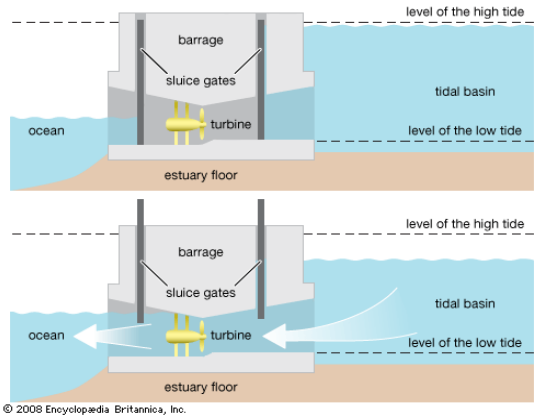


Figure 2: - tidal barrage mechanism

a generator which produces the electricity. Tidal barrages are the most efficient way to harness tidal energy, but they're also the most costly. They require an entire concrete structure to be built, which can cost a pretty penny. Barrages also have a larger environmental impact on the surrounding ecosystem than tidal fences or turbines. Because they are essentially an underwater wall, fish and other sea creatures can't pass through, causing a myriad of effects on the local ecosystem. The water then rushes back through the turbines when the tide falls. The turbines are linked to a generator, which generates energy. Tidal barrages are the most efficient method of capturing tidal energy, but they are also the most expensive. They necessitate the construction of an entire concrete structure, which can be quite costly. Barrages have a greater environmental influence on the surrounding ecology than tidal gates or wind turbines. Because they are effectively an underwater wall, fish and other marine species are unable to travel through, generating a slew of consequences for the surrounding environment.

Pros: -

- Predictable and Reliable
- Long-lasting Equipment
- Effective at Low Speeds

Cons: -

- Environmental Impact
- High Construction Costs
- Scarcity of Suitable Locations

1.4.3 Impulse turbine

Impulse turbine alters the velocity of a water jet. The jet is positioned on the turbine's winding blade, which alters the flow direction. A change in impulse exerts a force on the turbine blade. As the turbine spins, the force operates over a longer distance (work), and the oblique water flow is discharged with less energy. Newton's second law addresses the flow of energy to impulse turbines. The impulse turbine is most commonly employed in very high head applications. The Operating Principle of an Impulse Turbine: This turbine's runners have constant static pressure, and the turbine runner is at atmospheric pressure. The runner spins in the air, and the blade is sprayed via the nozzle to exchange energy with it. To exchange energy with the turbine, the runner revolves in the air, and the blade is sprayed via the nozzle. High-speed flow is directed to the blades by jet nozzles or a set of nozzles, which are often in the shape of a bucket or cup. As a result, just the pressure in the nozzle varies. Curved blades are used to alter the flow velocity. Based on the law of energy interaction, this strike causes a change in speed and a force to be imparted to the turbine blades. Forces obtained by fluid motion are dependent on two parameters, according to Newton's second equation of motion: the mass of the fluid entering the turbine and the change in velocity of the fluid between the turbine intake and output. There is no change in fluid mass in this scenario; only the change in velocity is taken into account in the computation of the force applied to the runner. As a result, the following steps are used in the power generation process in impulse turbines:

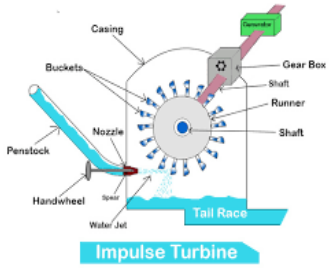


Figure 3: -impulse turbine

• The stored water flows upstream from a source through the penstock to reach the nozzle.

• The potential energy of water inside the nozzle is converted into kinetic energy and injected into the blade or bucket; thus, the runner rotates.

• The runner has a mechanism to control the flow of injected water. The spear usually plays an important role in this process.

• The generator connected to the shaft converts mechanical energy into electrical energy

Pros: -

- Has high efficiency
- This turbine can work easily at low discharge.
- easy to assemble.

Cons: -

- The size of this turbine is large as compared to other types
- This turbine works only in high heads, which is difficult to control

1.4.4 geothermal energy

Surface phenomena such as lava flows, geysers, fumaroles, hot springs, and mud pots are caused by heat from the Earth's core. The heat is created mostly by the radioactive decay of potassium, thorium, and uranium in the Earth's crust and mantle, as well as friction caused along continental plate borders. Geothermal heat energy may be collected and used for human purposes, and it can be found everywhere on the Earth's surface. The projected amount of energy that can be recovered and used on the surface is 4.5 106 exajoules, or around 1.4 106 terawatt-years, which is almost three times the world's yearly use of all sources of energy. Geothermal energy may be

utilized to create power depending on the temperature and fluid (steam) flow. Electricity may be generated by geothermal power plants in three ways. Despite its structural differences, all three regulate the behavior of steam and utilize it to power electrical generators. Geothermal power is considered a kind of renewable energy since the extra water vapor at the conclusion of each operation is condensed and returned to the earth, where it is warmed for later use. Some geothermal power facilities merely collect rising ground steam. The heated water vapor is sent straight into a turbine, which operates an electrical generator in such "dry steam" operations. Other power plants, based on the flash steam and binary cycle designs, begin the electrical generating process with a mixture of steam and warm water ("wet steam") retrieved from the ground. In flash steam power plants, pressurized high-temperature water is taken from under the surface into flash tanks, where the abrupt drop in pressure causes the liquid water to "flash," or evaporate, into steam. After that, the steam is used to power the turbine-generator set. Binary-cycle power plants, on the other hand, utilize steam generated by a secondary working fluid (such as ammonia or hydrocarbons) confined within a closed loop of pipes to power the turbine-generator set. Geothermally heated water is pulled up through a distinct set of pipes in this process, and most of the energy contained in the heated water is transferred to the working fluid via a heat exchanger. After then, the working fluid vaporizes. The working fluid vapor is recondensed and routed back to the heat exchanger after passing through the turbine. For electrical power to be affordable, water must be heated above 175 °C (347 °F). Water

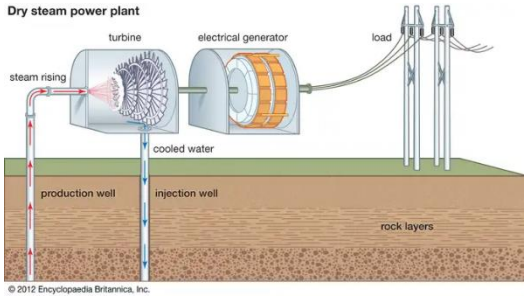


Figure 4: -dry team power plant

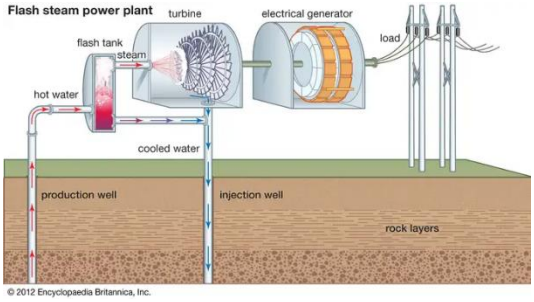


Figure 5: - flash steam power plant

temperatures as low as 85–90 °C (185–194 °F) can be employed in geothermal plants that use the Organic Rankine Cycle (ORC), a form of binary-cycle technology that uses lower-temperature heat sources (such as biomass combustion and industrial waste heat).

Pros: -

- Environmentally Friendly
- Renewable
- Sustainable / Stable

Cons: -

- Location Restricted
- Could damage by earthquakes
- High Costs

II. Generating and Defending a Solution

2.1. Solution and Design requirements

Any project is designed to achieve specific goals (design requirements). The most two important design requirement that a lot of projects focus on them are:

- The project should achieve a high efficiency
- The project is cost effective

Therefore, cost and efficiency have been chosen as a design requirement to improve in the selected solution.

Efficiency:

The term efficiency refers to the peak level of performance that uses the least number of inputs to achieve the highest amount of output. Efficiency requires reducing the number of unnecessary resources used to produce a given output, including personal time and energy. It is a measurable concept that can be determined using the ratio of useful output to total input. It minimizes the waste of resources such as physical materials, energy, and time while accomplishing the desired output.

Cost:

Project management is a critical component of every project. Cost is seen as a crucial component in project management. If a project is ideal yet expensive, it will offer little benefit. A project is said to be cost effective when it produces good results without costing a lot of money. our project is cost effective due to changing is some materials used that have lower cost and provide the same service, another reason is the increase of efficiency, as the efficiency increased the power produced increased with the same cost of the project. therefore, the project is cost effective.

2.2. Select of Solution

By studying the previous solutions and comparing them with each other, the selected solution was chosen because it is the most solution that meets our design requirements (cost and efficiency) and also solves many grand challenges like reducing pollution and increasing resources of renewable energy. The solution focus on harvesting the tidal potential energy in the sea through a mechanism known as tidal barrage. A tidal barrage is a dam-like structure that captures the energy from water masses moving in and out of a bay or river due to tidal forces.

The barrage method of tidal energy extraction entails constructing a barrage across a tidal-flowing bay or river. Unlike a conventional dam, which dams water on one side, a tidal barrage allows water to flow into a basin or river during high tide and releases it during low tide. This is accomplished by measuring the tidal flow and controlling the sluice gates at critical tidal cycle times.

Turbines are installed at these sluices to capture the energy generated by the water as it flows in and out. Turbines installed in the barrage wall produce electricity as water flows into and out of the estuary basin, bay, or river. These systems are similar to hydro dams in that they generate a static head or pressure head (a height of water pressure). The turbines can generate power when the water level outside the basin or lagoon changes relative to the water level inside.

Caissons, dams, sluices, turbines, and ship locks are the essential components of a barrage: caissons house sluices, turbines, and ship locks (huge concrete blocks). Embankments are used to seal a basin that is not filled by caissons. The flap gate, vertical rising gate, radial gate, and rising sector are the sluice gates used for tidal power.

2.3 Selection of prototype

Based on the design requirements and the selected solution the final design of the prototype was created as a model to demonstrate the idea (mechanism) of the large-scale solution. But on a small scale(prototype), the prototype consists of two parts:

First of all, is the power generation system that will be as follows: the barrage is fixed in a container to simulate the tidal power plant. Inside the barrage the turbine will be fixed to spin and drive the generator that is connected with the turbine through gears to increase the efficiency of the system as the water flows through it and generate electrical power. On the two sides of the barrage there is a sluice gates that will control the flow rate of water according to the water level (tide level) to maintain the difference in water levels between the two sides of the barrage. The second part of the prototype is the technology and communication system.to employ technology in the project, smart sensors will be used to do specific function which measure the parameters such as voltage and water level and transfer it in the form of data after it is being processed by the microcontroller unit (Arduino UNO) and then transfer these data to the mobile app by the Bluetooth module. A specific type of sensors will be used to determine the height of the water level in the container to control the sluice gates with motors that allows water to flow through the barrage and spins the turbine according to a specific code programmed in the microcontroller. Then the collected data will transfer to a mobile application to monitor it by the previous mechanism.

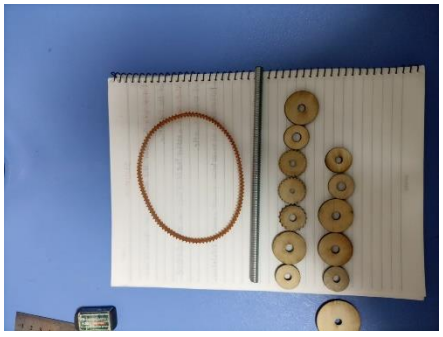
Figure 6: -prototype design

Finally, is the mobile application that will be designed to receive data from the smart sensors system to monitor and analyze it.

III. Constructing and Testing a Prototype

3.1 Materials

Item	picture	quantity	usage	source	cost
Arduino Uno		1	control the electronic components and the communication system.	Online store	155
Ultra-sonic sensor		1	Measure the height of the water using a sound wave.	Online store	35
Servo motor		4	Controlling the sluice gates.	Electronics shop	160
Bluetooth module		1	Sending data from the sensor to the mobile application.	Online shop	110
Voltage and current sensor		1	Measuring the output voltage and current.	Online shop	70
Multi meter		1	Measuring the output voltage and current.	Fab lab	-
Jumpers		60	Connecting Arduino components.	Online shop	45

Turbine		1	Absorb energy from water to rotate and drive the generator.	Fab lab	-
Plastic container		1	Used to simulate tidal barrage power plant.	Plastic containers shop	55
Generator		1	Converts the mechanical energy from the turbine into electrical energy.	Electronics shop	50
Gears system		1	Gears used to increase the torque on the generator to rotate faster and generate more electricity.	Fab lab	-

Wooden plates		2	Making the barrage to separate the water in the sea from water in the basin to create difference in height between water levels.	Fab lab	-
Mobile app creator	MIT APP INVENTOR		Used to create the mobile application that receives data collected from the sensors.	Google play store	-
Total cost	680 L.E				

All safety precautions were followed in constructing the prototype as follows:

- Following the fab lab safety instruction in dealing with sharp and heavy equipment.
- Wearing protective instruments like glasses and gloves.
- Following all covid-19 safety guidelines to avoid infections

3.2 Methods and Test Plan

3.2.1 methods

Preconstruction: -

First, the turbine was built at the fab lab using a 3D printer. Second, all electronic parts (Arduino and intelligent sensors) were purchased from an online store. Then Software applications were installed to set up the intelligent sensors and create a mobile application that will track and monitor the data. Finally, A plastic container, PVC tube, generator, and two wooden plates were purchased to create the main structure of the prototype.

Construction I: -

The prototype's construction proceeded through numerous stages, as follows:

First, Make two holes in the wooden plates with a definite area according to the area of the PVC tube. The turbine is inserted into the PVC tube. Second Connecting the two wooden plates holes with the tube's ends. Then Adding a small rod to the turbine to be like an axis that transfer the movement of the turbine through gears and rubber string to a generator which is vertical upward with the axis of the turbine. And putting the previous system (barrage)in the middle of the container.

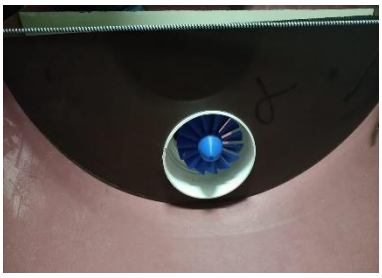


Figure 7: -Tidal barrage

Construction II: -

The second part of the project is the communication system's construction and connection:

First, Connecting the programmed ultrasonic sensor with Arduino to detect and measure the water level (tide level) till It reaches a certain height then the sensor sends a signal to the Arduino, which translates to a command directed to the servo-motor to open the sluice gate that allows the passage of water.

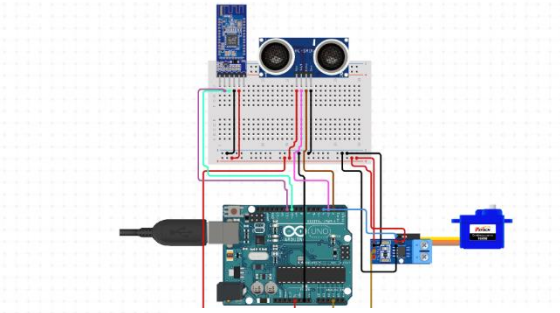


Figure 8: -electronics connection

Also, connecting the voltage sensor to measure the output voltage is used to calculate the power. Finally, the Bluetooth module is connected to the Arduino and receives the sensor's output data and then directs it to a mobile application for analysis and processing.

3.2.2 test plan

To meet the design requirements (efficiency and cost), the following test plan was developed to determine the exact percent of efficiency of the chosen solution: To simulate the movement of natural tides, 20 liters of water were added to one side of a separate container to mimic the natural sea level. More water was added until the ultrasonic sensor gave an alarm (red light), indicating that the water level had reached the desired maximum height and sending a signal to the Arduino. The Arduino then sends a command to the servo – motors, which open the sluice gates, allowing water to flow to the opposite side of the barrage and powering the turbine. To increase the project's efficiency, gears were added to connect the turbine and generator, making the project as efficient as feasible at low speeds. The average efficiency of the project rose from 81 percent to 87.5 percent with the addition of gears. Because of the increased efficiency, the project has met another design objective, which is cost, as the project generates more power at the same cost as the previous large-scale solution. The output power is monitored and calculated by passing it via (voltage and current sensor). Finally, a mobile application linked to the Bluetooth module gathered all sensor data and displayed it on graphs. The efficiency of the project is estimated by dividing the average electrical power produced by over the average water passed through the turbine's tube.

3.3 Data Collection

3.3.1 The Measuring tools which had been used

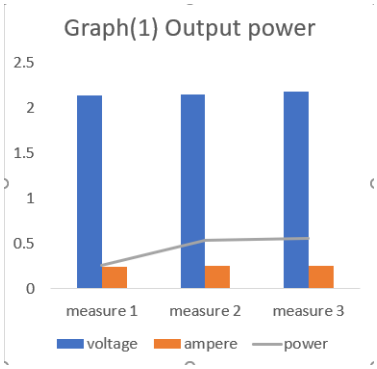
After testing the prototype, the following tools were used in data collecting:

- MAX471 voltage and current sensor
- HC-SR04 ultra-sonic sensor
- Digital multimeter

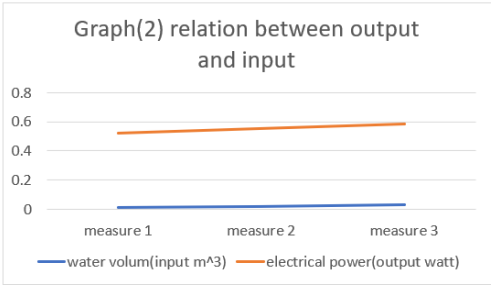
To increase level of accuracy in measurements many measurements were taken and then calculating the average value of them.

3.3.2 results

To get an accurate result, the prototype testing was repeated 3 times with 3 measurements then calculating the average power to reduce errors in measurements as much as possible. As graph (1) shows, the prototype has produced an average power of 0.7 Watt.



To ensure that the project addresses the design requirements (efficiency and cost), the project efficiency was calculated by dividing the output (electric power) by the input (water mechanical energy). Graph (2) shows that the relation between the amount of water and generated power is a directly proportion relation means that as the amount of water increases the amount of potential energy increase and increasing the pressure on the turbine driving it more producing more power verifying the equation of the tidal energy $E=\frac{1}{2}APgh^2$.



Graph (2) also indicates that the project has a total average efficiency of 87.5%

Table (1) shows all data collected from the prototype testing, with an average power of 0.7 Watts

Table (1)

Voltage	2.163	2.22	2.23
Current	0.292	0.318	0.332
Power	0.631	0.707	0.743
Average power	0.7		

IV. Evaluation, Reflection, Recommendations

4.1 Analysis and Discussion

4.1.1 Analysis

Given the environmental damage caused by nonrenewable energy sources, we must ensure that increasing reliance on renewable energy sources represents a significant step as a challenge that contributes to resolving many other problems such as pollution and climate change. This is especially important now that climate change has become a visible problem, causing global warming and melting ice at the poles. In light of this difficulty, Egypt has the opportunity to strengthen its reliance on renewable energy sources (tidal energy) that assist in reducing pollution and, as a result, will help to make progress in solving the great challenge of global warming. As the results shows, investigation in tidal energy harvesting is a promising investigation. Despite its tiny environmental impact compared with other sources of renewable energy, it provides an effective solution that will be a solid addition to renewable energy sources in Egypt with the aid of contemporary technologies. Tides are the rise and fall of sea levels produced by the combined influence of the Moon's and Sun's gravitational forces, as well as the rotation of the Earth. As the moon circles around the Earth, its gravitational force pulls the water sector facing it, creating a high tide. In contrast, the sun's gravitational force pulls the water, generating another high tide. The low tide area is the gap between these two tides. So, because we have two high and two low tide area there are two tides every 24 hours. A tidal barrage is a dam-like structure that captures the energy from volumes of water going in and out of a bay or river as a result of tidal pressures. Unlike a typical dam, which dams water on one side, a tidal barrage enables water to flow into a bay or river during high tide and releases it during low tide.

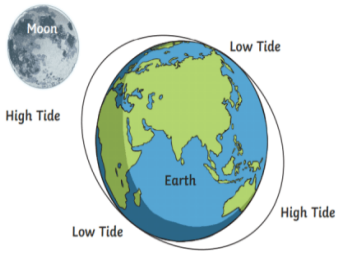


Figure 8: tides mechanism

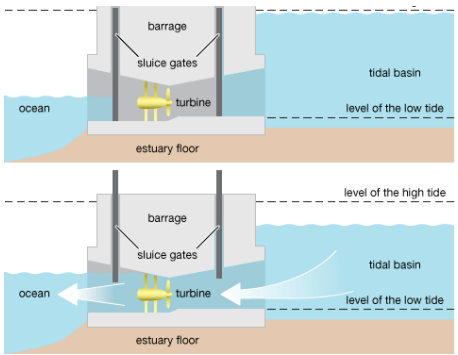
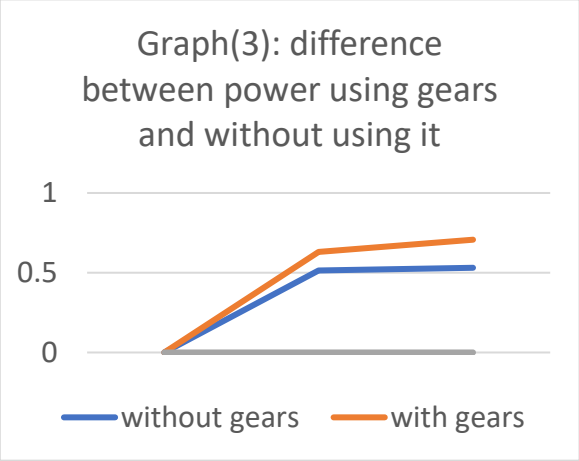


Figure 9: Tidal barrage

This is accomplished by sensing the tidal flow and operating the sluice gates during critical tidal cycle periods. Turbines are installed at these sluices to capture the energy generated by the water as it flows in and out.

The model: -

Tidal power output can be estimated using the equation $E=\frac{1}{2}APgh^2$ in which the main factors that affects the power generation progress is the area and height (volume of water). Tides are predictable but are not constant as the mons movement around the earth in not in uniform circular path which affects the tide height and consequently affects output power. to solve this challenge gears were added on the turbine and generator axis instead of connecting them directly which is the method that could be affected by the nonconstant tides range. The working idea of the gears is to transfer the kinetic energy between two terminals with a low torque input force into high output torque. the scientific base of this theory is that gears are not in the same size.by applying the law of conservation of energy, to rotate the biggest gear you need a high energy, when gears are connected the energy transmit from the large gear into the smallest one with the same ratio(with negligible friction energy waste) so when a high energy drives a small gear it is observed in the high torque output from the small gear and vice versa. Graph (3) shows the difference in output power when using gears, The ratio between these torques is called the gear ratio which is the number of teeth of the output gear to the number of teeth of the input gear. Suppose that the input gear teeth is30 teeth and the output gear is 105 the gear ratio is 105/30=3.5:1 which indicates that as the input gear completes one rotate it drive the output gear 3.5 rotates. Incorporating a communication system



with a smart sensor network and developing a mobile application with a data base has improves the overall project's efficiency and accuracy. This is accomplished not only through the sensors and the application, but also by supporting the entire system with artificial intelligence (AI) programs.

Technology: -

Incorporating a communication system with a smart sensor network and developing a mobile application with a data base has improves the overall project's efficiency and accuracy. This is accomplished not only through the sensors and the application, but also by supporting the entire system with artificial intelligence (AI) programs.

Scientific laws: -

The energy available from a barrage is dependent on the volume of water. The potential energy contained in a volume of water is $E=\frac{1}{2}APgh^2$ where h is the vertical tidal range, A is the horizontal area of the barrage basin, ρ is the density of water = 1025 kg per cubic meter (seawater varies between 1021 and 1030 kg per cubic meter) and g is the acceleration due to the Earth's gravity = 9.81 meters per second squared.in the real-life project A=90 km^2, h=2.3 meter.so, by substituting in the previous formula then: $\frac{1}{2} * 90 * 1025 * 9.8 * (2.3)^2$=2391212.25 J

Then divide the energy by time to get power: 2391212.25 /86400=27.67606771MW for one turbine, so by using 10 turbines the total power will reach 276.06771MW.

The output power is calculated using this formula: P=IV, I is the electric current in ampere and V is the voltage. The SI unit for power is Watt.

Water flow rate is calculated by $F = \frac{V}{T}$ where F is the flow rate, V is the volume and T is the time.

The efficiency formula is $\frac{output}{input}$ output which is the electrical power, and the input is the amount of water.

4.1.2. Conclusions

According to reviewing the collected data and analysis, exact conclusions have existed. The prototype price is 680L.E, and the real-life project price is estimated to be 560,000,000$ compared to the real project in France which have a total cost of 620,000,000$. The tidal energy industry must develop a new generation of efficient, low cost and environmentally friendly apparatus for power extraction from free or ultra-low head water flow.

- The negative environmental impacts of tidal barrages are probably much smaller than those of other sources of electricity but are not well understood at this time. It is essential to consider the influence of energy extraction while estimating the available energy from a potential tidal energy site.
- The future costs of other sources of electricity, and concern over their environmental impacts, will ultimately determine whether humankind extensively harnesses the gravitational power of the moon.
- Yet most of this tidal energy resource is under-utilized; however, if effectively captured using suitably engineered systems, it could be capable of making a significant contribution to our future energy needs.

It is proved that the amount of power generated is strongly related to the size of the tidal range. The output varies with the square of the tidal range. Next, the output power is directly related to the area of the impoundment structure that indicates the amount of water passing through the

turbine during each generated phase. This model and new renewable energy (Tidal energy) must be used mainly for remote locations after an opportunity to build small tidal generators

(1-10 MW). The optimal solution is essential to design the tidal station depending on the critical values of parameters to generate the optimal electrical energy. This is a preferable, friendly, environment clean and healthy renewable energy source.

4.2 Recommendations

There is no project that is entirely perfect or done. Because science is cumulative, there are several recommendations that should be noted for future research on this study: Places with a minimum tidal level of 3 meters are strongly suggested for maximum performance and efficiency. Extending study into the project's targeted region for development to minimize the environmental impact on marine life. Finally, increase reliance on modern technology such as AI and machine learning to more accurately predict tides and enhance overall system control, particularly control of water flow from the two sides of the barrage.

4.3 Learning Outcomes

CH.3.01: relates to scientific methodology with the quantitative and qualitative analysis with explanation.

CH.3.02: relate to any project the uncertainty in measurement, accuracy and precision that relates to the errors in any work because there isn’t any work absolute. There is difference between voltage sensor reading and voltameter reading (about ±0.35 to ±0.45 volt).

PH.3.04: relates to ground communication helped in understanding the mechanism of how data is sent from the Bluetooth module to the mobile application.

PH.3.05: relates understanding the difference between analog and digital data that helped in improve the accuracy of the results through using analog data transmission.

ST.3.01: concept the sample distribution and central limit theorem that convert the sample distribution into normal distribution by confirm 2 conditions $n \geq 30$ and $10\%N > n$ where n is number of sample and N is the number of populations.

CS.1.02

Understand what an operating system is and what it can accomplish. In this learning outcome, we learned about the binary system and how to start apps, as well as standard hardware and software management tools. The concept of employing several computers to deal with computer commands in the form of a code that can be typed into the computer machine language is a sort of language that a computer can comprehend. Using either an interpreter or a compiler.

Cs.3.02

In this L.O., we learnt about the conditions for building a network, which helped us create a network between the website and the prototype.

Cs.2.03

To assist us create the app for our project, we needed a basic grasp of how to design and build a website using a programming language.

English

Persuasive essays are essential for expressing ideas or opinions in English. It is a piece of academic writing in which logic and reasoning are used to support a point of view. Learning

about this style of essay aided us in explaining the project's concept in the suitable manner in the poster.

ME 2.04

We used the concept conservation of mechanical energy to calculate the loses of energy in transmission of the energy from hydro to mechanical and finally to electrical power.

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