

SUSTAINABLE CAPSTONE PROJECTS (SCAP) FALL 2023-2024

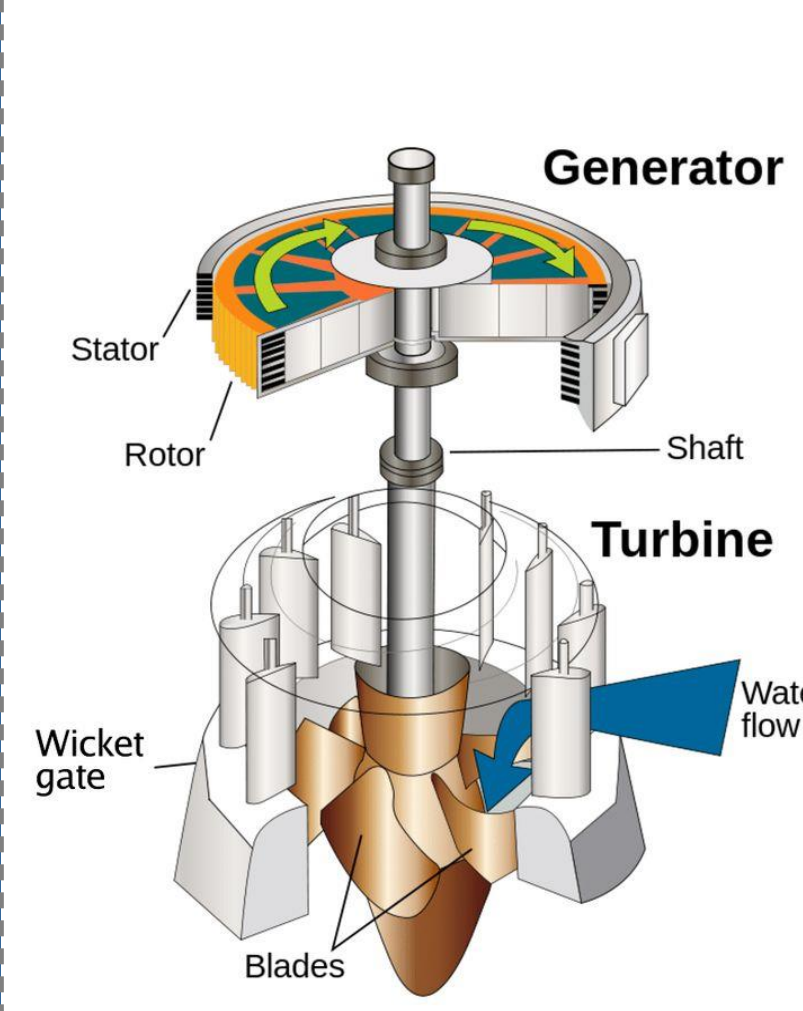
Mini Hydroelectric generator

GROUP MEMBERS

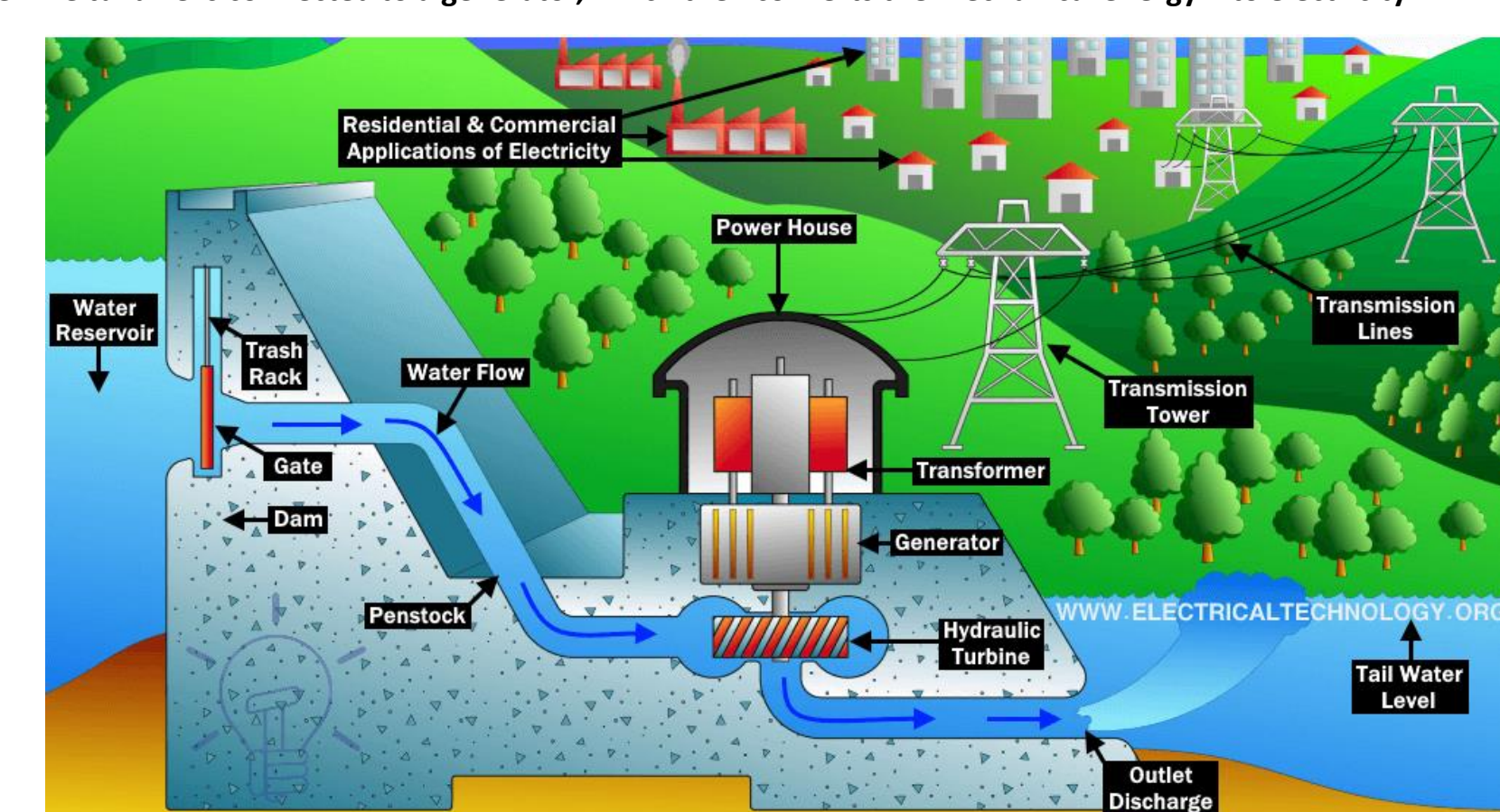
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INTRODUCTION


Concept




A hydroelectric generator converts mechanical energy from moving water into electricity. Hydroelectric power is electricity produced from generators driven by turbines. These turbines convert the potential energy of falling or fast-flowing water into mechanical energy. Water is released from a reservoir located at a high elevation and the falling water causes the turbine to rotate. The turbine is connected to a generator, which then converts the mechanical energy into electricity.



Project goal

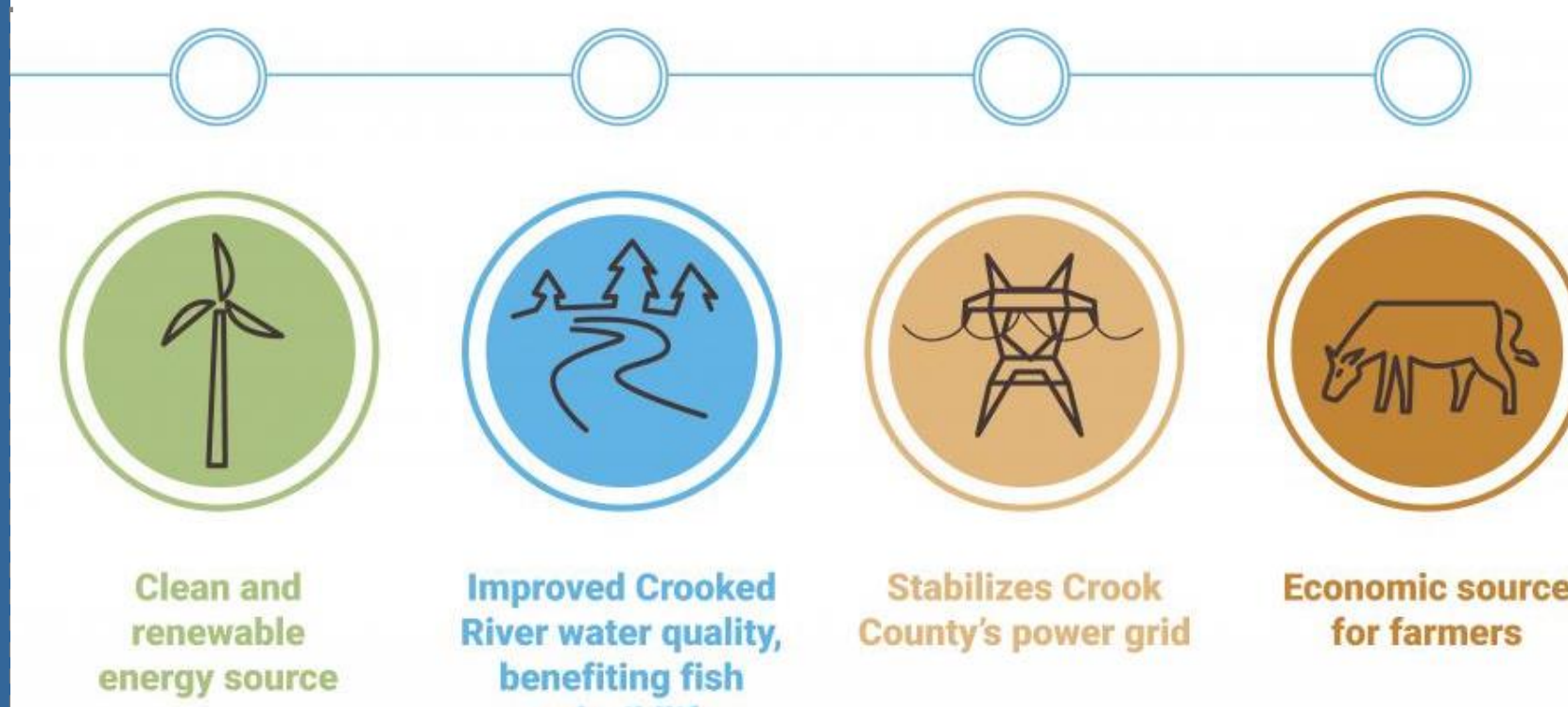


More than 30v produced



Enough power to charge some electronic devices

benefits of hydroelectricity



Hydroelectric generators offer a multitude of benefits, making them a valuable choice for energy production. Let's explore these advantages: Hydropower relies on the water cycle, which is driven by the sun, making it renewable. Unlike fossil fuels, water is abundant and naturally replenished. During major electricity outages or disruptions, hydropower plants can generate power to the grid immediately, providing essential backup power.

MATERIALS USED IN CONSTRUCTION

Re-Used/Recycled Materials:

- DC motor (reused)
- Stepper or stepping motor (reused)
- Centrifugal fan from a Combustion Fan Radial Gas Blower (recycled)
- 10L water bottle (1),(Recycled)

Other Materials:

- 1000uf 50 V Capacitor (2)
- 1n4007 diode (8)

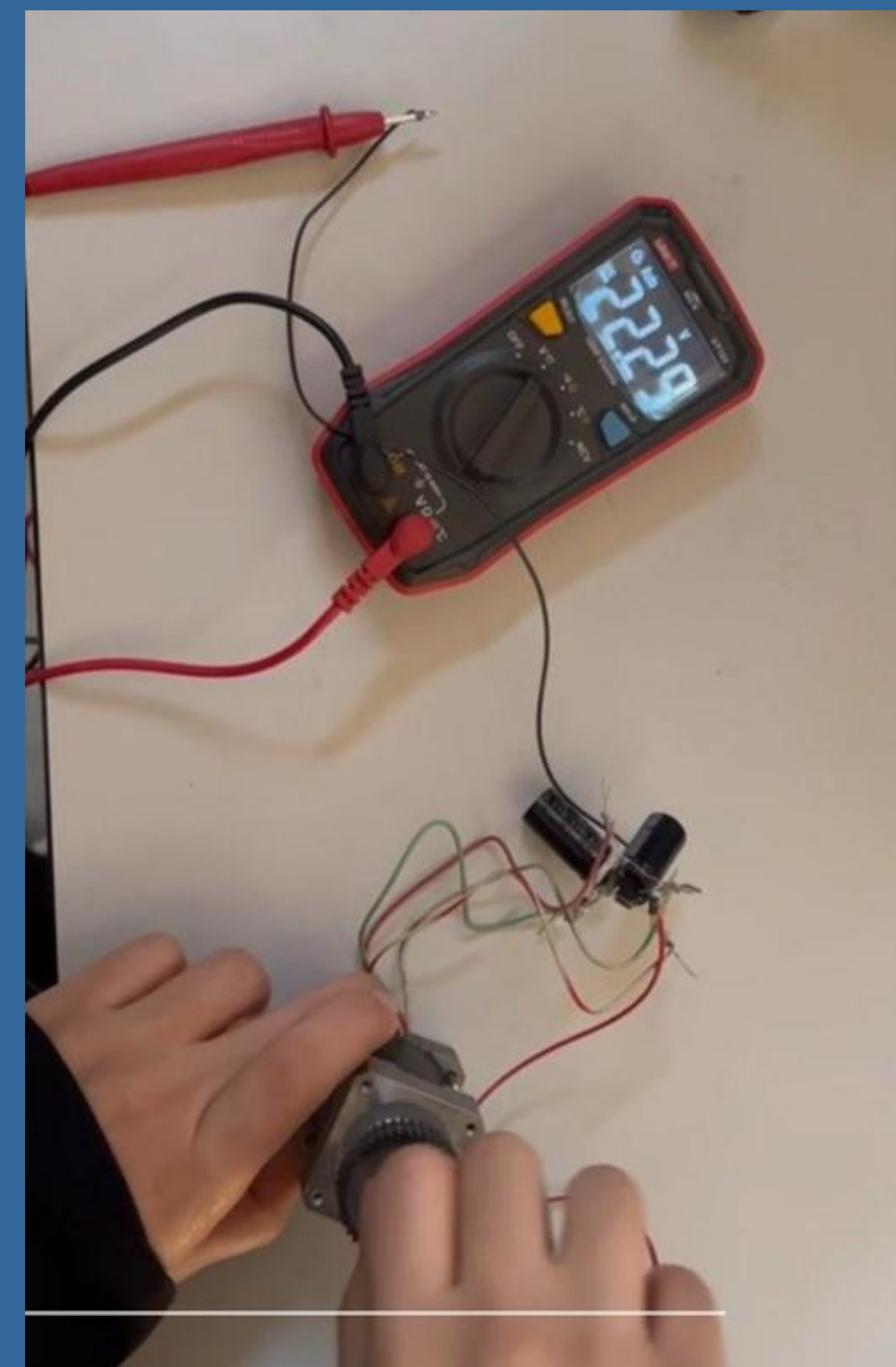
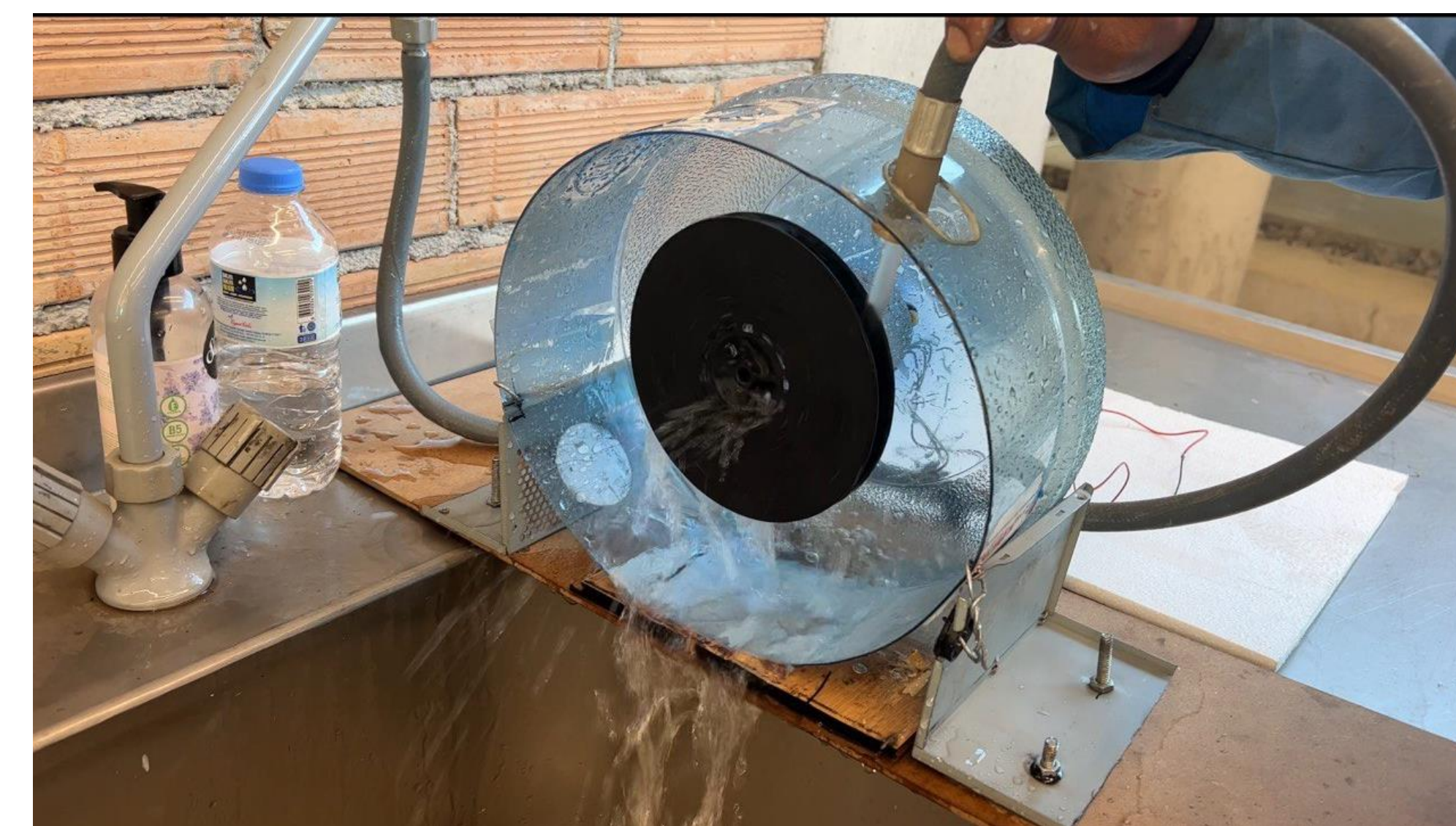


Figure 1. More than 20V simply by turning the shaft by hand.

FINAL PRODUCT

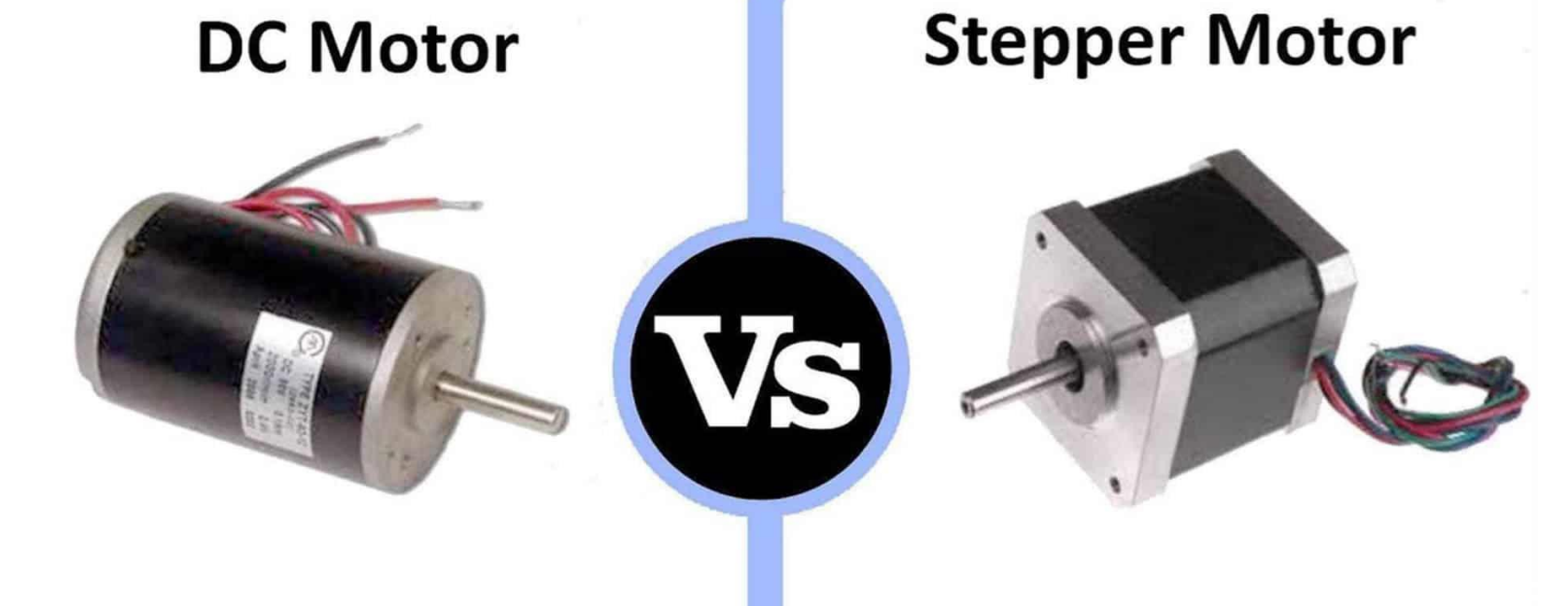
The hydroelectric generator was built using a stepper motor to which a centrifugal fan was attached to its shaft to act as a turbine. A 10-liter water bottle was cut off 1/3 from the bottoms and the bottom part was used as a housing to prevent the water from splashing and wetting everything around while the turbine was rotating. The housing was bolted to a piece of wood to provide a solid structure for the entire system.



Working principle

As water flows through the housing inlet, the impeller rotates with the stepper motor shaft attached to it. Normally a stepper motor generates alternating current AC when used as a generator. This current is unsuitable for powering some electronic devices as they may be damaged. To prevent this, a bridge rectifier was built to convert alternating current into direct current DC suitable for electronic devices. The rectifier bridge was built with 8 diodes (1n4007) and 2 capacitors (1000uf 50v). When the impeller turns, electricity is first stored in the two capacitors, and when a load is connected to the circuit, the capacitors deliver their energy to the load. A load here is any electronic device that consumes power or electricity.

RESULTS AND DISCUSSION



It has been found that DC motors are not very efficient when used as generators because they require high RPM to produce electricity, due to their construction. Various DC motors have been tested to convert them into generators, but the best of them only produced a maximum voltage of around 3V, despite high shaft rotation and maximum power from water pressure.

On the other hand, stepper motors have proven to be more efficient. They can spin well without a gearbox and produce enough power. By rotating the motor shaft by hand, a voltage of 20V was produced after adding two bridge rectifiers to the motor, Figure 1.

For a good understanding of the efficiency of DC and stepper motors, consider checking out the videos in the reference section. (Testing the efficiency of a DC motor as a generator and Which motor Type is the best Generator?).

How can the system be improved?

To improve the system, a pump that can be powered by solar panels could be added to recirculate the water instead of using tap water. Additionally, a means to continuously read or regulate the voltage while the system is running should be implemented to prevent overloading, overheating, or damaging electronic devices.

CONCLUSIONS

It has been found that stepper motors are more efficient than DC motors when used as generators. However, stepper motors produce alternating current, which is unsuitable for most electronic devices. To make the generated power usable, a bridge rectifier can be used to convert alternating current to direct current, which is suitable for most electronic devices. Conversely, DC motors can generate direct current voltages directly, but they require high RPM to produce electricity. This is a crucial discovery that can assist us in selecting the appropriate motors for upcoming projects. In case an alternating current is generated, a bridge rectifier can be used to convert it to a direct current. The hydroelectric generator that was built has many benefits. First, it produces sufficient voltage to power various electronic devices. Moreover, it can function as a backup power source in the event of a power outage. Additionally, the bridge rectifier circuit's capacitors possess a high enough capacitance value to store a significant amount of energy. Some drawbacks of the developed hydroelectric generator are that it uses tap water to rotate the wheel or impeller of the generator. Additionally, there is no way to monitor the voltage or current produced when the system is functioning. To prevent damage to the capacitors used in the bridge rectifier circuit, the wheel should not run continuously, as the increasing energy produced may exceed the amount of energy the capacitors can hold, despite having a high capacitance. Furthermore, since the voltage produced is relatively high, there are some risks of shock or electrocution. When building the hydroelectric generator, several challenges were encountered. One of the biggest challenges was dealing with the insufficient water pressure of tap water, especially when using DC motors as a generator. The water tank was placed at a high altitude to increase the potential energy of the water and thus its pressure, however, this approach failed due to friction losses throughout the piping. Another challenge was attaching the turbine to the shaft of the motor. As they did not have mating diameters. It's hard to imagine gaining such a vast amount of knowledge about different types of motors in such a short period of time without participating in the SCAP program and working on this project.

REFERENCES

Benefits of Hydropower

<https://www.energy.gov/eere/water/benefits-hydropower>

Testing the efficiency of a DC motor as a generator

<https://www.youtube.com/watch?v=U3U0tNRQfZA&list=PLnRUH9FUzCxsW5aun08KhGDtEc-dVvsl&index=19>

Which motor Type is the best Generator?

https://www.youtube.com/watch?v=cJ_vDA7xsGs&list=PLnRUH9FUzCxsW5aun08KhGDtEc-dVvsl&index=14

All About Converting Stepper Motors to Generators and how to make a bridge rectifier.

<https://www.youtube.com/watch?v=zCTggoh994&list=PLnRUH9FUzCxsW5aun08KhGDtEc-dVvsl&index=17>