

Harvesting electricity from humidity of air

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Scientists have recently achieved a remarkable milestone in **renewable energy** by the generation of electricity **from moist air** (hygroelectricity).



[Ref - BBC]

About concept of Hygroelectricity:

- Hygroelectricity is a type of **static electricity** that **forms on water droplets** and can be transferred from droplets to small dust particles, just like in the earth's atmosphere.
- It is a **type of renewable energy** and unlike solar or wind, hygroelectric generators could work day and night, indoors and out, and in many places.
- The idea of hygroelectricity was generated by physicist **Nikola Tesla**, harnessing the processes that take place in clouds and produce lightning during thunderstorms.

About the research:

- The research is about discovering new ways of gleaning **electricity from water molecules** that naturally float in the air.
- It is possible because those **water molecules can transfer tiny electrical charges** between themselves.
- The challenge is picking up **enough electricity** to be usable.

Working of hygroelectricity:

- Scientists have made a tiny device made up of **two electrodes** and a thin layer of material filled with **nanopores**.
 - A nanopore is a pore of **nanometer size** (10^{-9} m).
 - It may be created by a **pore-forming protein** or as a hole in **synthetic materials such as silicon or graphene**.
- These nanopores, each **less than 100 nanometres in diameter**, allow water molecules from the air to pass through the device.
- As these molecules move from an upper chamber to a lower chamber, they interact with the **edges of the nanopores**, leading to a buildup of electric charge imbalances between the chambers.

- This process transforms the device into a **miniature battery**, which generates continuous electricity.
- It is possible to harvest enough to **power miniature computers or sensors**.

Researches around hygroelectricity:

- Research in 2020 described generation of **electricity from the air by tiny protein nanowires produced by a bacterium**.
- Tiny **pores can trap floating water molecules** and as they rub against the material, the water molecules lend it a charge.
- In this system, most **molecules stay near the surface** and deposit lots of electrical charge while a few others **penetrate more deeply**.
- This creates a **difference in charge** between the upper and lower parts of the material layer.
- This **charge separation** leads to generation of **small amounts of electricity**.
- This works on the principles of storm clouds which create opposite electrical charges that eventually **discharge in the form of lightning**.
- They created the same kind of structure, filled with **nanopores**, using a variety of different materials from **graphene oxide flakes** and polymers to **cellulose nanofibers derived from wood** and generated electricity.
- In another research, devices thinner than human hair generated very small amounts of electricity, equivalent to a **fraction of a volt**.
- In one study, scientists were able to harvest electricity by **passing humid air between two pieces of metal**, the moist air induced a charge in the metal as it flowed over it.
- **Project CATCHER**, which aims to harness humid air as a source of energy presented a video of a small LED light being turned on and off.
- A grey disc of about 4 cm, made up of Zirconium oxide was able to trap water molecules from humid air and force them to flow through tiny channels.
- This has generated an electrical charge, enough to **supply about 1.5 volts** from a single disc.

Limitations of these devices:

- Current **small-sized** devices can produce only a **few volts electricity**.
- **Cost of manufacturing** is very high.