



Paper-based Supercapacitor for Rapid Device Charging

For Prelims: [Supercapacitor](#), [Lithium-Ion batteries](#), [Seaweeds](#), [Exclusive Economic Zone](#), [Algal blooming](#), [Bio-ethanol](#)

For Mains: Significance of Seaweeds

Why in News?

Scientists at the **Gujarat Energy Research and Management Institute (GERMI)** have achieved a breakthrough in [energy storage technology](#) with the development of a **paper-based supercapacitor**.

- This cutting-edge supercapacitor, **derived from seaweed**, boasts remarkable attributes such as **being lightweight**, [biodegradable](#), and **capable of fully charging a device within a mere 10 seconds**.

What is a Paper-based Supercapacitor?

- **About:**
 - The paper-based supercapacitor developed by GERMI researchers is the **thinnest and most lightweight of its kind**.
 - **By leveraging cellulose nanofibers derived from seaweed, the team successfully created an anodic paper [supercapacitor](#)** that exhibits exceptional tensile strength, performance, and cost-effectiveness.
- **Applications and Business Prospects:**
 - The applications of **this innovative supercapacitor are vast, spanning electronics, memory backup systems, airbags, heavy machinery, and electric vehicles**.
 - Consequently, it presents a **lucrative business prospect for industries seeking high-performance energy storage solutions**.
 - The technology's versatility and eco-friendly nature make it an attractive option for both manufacturers and consumers.
- **The Potential of Marine Cellulose:**
 - The paper supercapacitor owes its remarkable properties to the **marine cellulose-based material derived from seaweed**.
 - This **material holds immense potential for integration into various smart electronic devices**.
 - Additionally, the **cultivation of seaweed can serve as a source of revenue for coastal communities**, creating economic opportunities and sustainable development.

What is a Supercapacitor?

- A supercapacitor is an electrochemical charge storage device. They are also known as ultracapacitors.
 - It has significant advantages such as high-power density, long durability, and ultrafast

charging characteristics as compared to conventional capacitors and [Lithium-Ion batteries \(LIB\)](#).

- Main components of supercapacitors include **electrode, electrolyte, separator, and the current collector**.

What are Seaweeds?

▪ About:

- [Seaweeds](#) are macroalgae attached to rock or other substrata and are found in coastal areas.
- They are classified as **chlorophyta (green), rhodophyta (red) and phaeophyta (brown) on the basis of their pigmentation**.
 - Among them, chlorophyta holds more potential components — **carbohydrates, lipids, proteins and bioactive compounds**.

▪ Significance:

- **Nutritional Value:** Seaweeds are rich in essential **nutrients, including [vitamins](#), minerals and dietary fibre**.
- **For Medicinal Purpose:** Many seaweeds contain [anti-inflammatory](#) and **anti-microbial agents**. Certain seaweeds possess powerful [cancer-fighting agents](#).
- **Bioindicator:** When waste from agriculture, industries, aquaculture and households are let into the ocean, **it causes nutrient imbalance leading to [algal blooming](#)**, the sign of marine chemical damage.
 - **Seaweeds absorb the excess nutrients and balance out the ecosystem.**
- **Oxygen Production:** Seaweeds, as [photosynthetic](#) organisms, play a vital role in marine ecosystems by producing oxygen through photosynthesis, sustaining the respiration and survival of marine life.
- **Cellulose Content:** Green seaweed that is **collected from the Porbandar coast of Gujarat** has a **high amount of a particular type of cellulose in its cell wall**.
 - Cellulose is found to be the **most suitable biopolymer material for manufacturing paper-based electrode materials** such as batteries for energy storage applications.
 - **Cellulose itself is an insulating material that requires to be coated with conductive material** to make a paper-based energy storage device.

▪ Seaweed Cultivation:

- Out of the global seaweed production of **around 32 million tons of fresh weight valued around USD 12 billion**.
 - China produces approximately 57%, Indonesia 28% followed by South Korea, whereas India has a mere share of ~0.01-0.02%.
- By an estimate, **if cultivation is done in ~10 million hectares or 5% of the [Exclusive Economic Zone](#) area of India**, it can provide employment to ~ **50 million people**, **contribute** to national GDP, lead to ocean productivity, abates algal blooms, **sequesters millions of tons CO₂**, and could produce **bio-ethanol of 6.6 billion litres**.

[Source: DTE](#)