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Solar Based Power Banks Supporting Affordable and Clean Energy

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ABSTRACT

Today, we all use things like smartphones, smartwatches, and other small gadgets that need power. But sometimes, it's hard to find electricity, especially in villages or places far from cities. So, we need a way to charge our devices even without electricity.

That's why we made a **solar power bank**. It's a small and easy-to-carry device that uses sunlight to make electricity. This electricity gets stored in a battery inside the power bank, and later we can use it to charge our phones or other devices.

We used parts like:

- A **solar panel** to collect sunlight
- A **TP4056 module** to safely charge the battery
- **USB ports** to connect phones
- And some **safety parts** to protect the battery

This power bank is good for the environment because it uses sunlight instead of electricity from the grid. It also helps people who don't always have power at home.

Our project supports two big global goals:

- **Clean Energy (SDG 7)** – so everyone can have safe and modern energy
- **Climate Action (SDG 13)** – so we can fight pollution and protect the Earth

We built the power bank, tested it, and it worked! We learned a lot about how solar energy works. It shows how we can use the sun to power our everyday devices. This is a small step to help the planet and use clean energy in the future.

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INTRODUCTION

Having electricity that is cheap, clean, and always available is very important. It helps people live better and have a brighter future. But even today, many people—especially in villages or faraway places—still don't have power all the time.

At the same time, more and more people are using phones, tablets, and other electronic devices. So, we need a better and eco-friendly way to charge them.

One great idea is a **solar power bank**. It's a small device that takes energy from the sun and stores it. You don't need to plug it into the wall. That means it's very useful in places where there are power cuts or no electricity at all.

Solar power banks are also better for the Earth because they use **sunlight** instead of burning fuels. This helps reduce **pollution** and helps fight **climate change**.

These devices also support **Goal 7 of the United Nations**, which says that everyone should get clean and affordable energy by the year 2030. Solar power banks give people more control and help them use energy that's safe and good for the planet.

In this report, we will explain how solar power banks work, how we made one, why they are useful, and where they can be used. We will also show how they help make the world a cleaner and better place.

I. LITERATURE REVIEW

As the Earth gets warmer and some people still don't have good access to electricity, it's really important to use clean and safe energy. This review collects

information from books, reports, and real-life examples. It talks about how **solar energy** is being used in small things like **solar power banks**.

These solar gadgets can help us reach big world goals like:

- **SDG 7** – clean and cheap energy for everyone
- **SDG 13** – fighting climate change

By looking at what scientists and experts have found, this review shows that solar power can help make the world better, fairer, and cleaner for all people.

Solar Energy as a Renewable Resource

Solar energy is one of the best and cleanest types of energy we have. Unlike fuels like coal or gas, it doesn't pollute the air and it never runs out. Big energy groups like the **International Energy Agency (IEA)** say that in many places, **solar power is now the cheapest way to make electricity** - even cheaper than coal or gas!

One really cool fact from studies is that **the sun gives the Earth more energy in just one hour than the whole world uses in a whole year!** If we can use even a little of that sunlight with solar panels, we won't need to burn so many fossil fuels. That means cleaner air and more people can get electricity.

Solar panels (also called **PV systems**) are very useful. They can be used in big cities or faraway villages where there is no electricity. They also work in different kinds of weather and don't break easily. When we add batteries, they can store power for later, which is great for places that have power cuts.

This makes solar energy perfect for helping people in countries where electricity isn't always easy to get.

Power Banks and the Importance of Energy Storage

Power banks are super useful these days because we use our phones and gadgets a lot. But most normal power banks still need to be charged using electricity from the wall. That electricity often comes from **coal or gas**, which is not good for the Earth.

To fix this, scientists are working on power banks that have **solar panels**. These can charge using **sunlight**, so they don't need regular electricity. This is better for the environment and helps save energy.

Inside these solar power banks, there are **batteries**. Most of them use **lithium-ion (Li-ion) batteries** because they can hold a lot of energy, last a long time, and you can charge them again and again. Scientists are also testing other cool battery types like:

- **Lithium-polymer batteries**
- **Supercapacitors**
- **Solid-state batteries** (they're still new but look promising)

Another important thing is the **Battery Management System (BMS)**. This is like the brain of the battery. It keeps the battery safe and helps it work better by controlling how it charges and how fast it gives power. This is super helpful when the power bank is used outside, where the weather and sunlight can keep changing.

Analysis of Existing Solar Power Bank Models

After checking the solar power banks that people can buy today and reading what users say, we found some problems:

- **Too Expensive:** Many solar power banks cost too much. People in poor or village areas, who really need them, can't always afford them.
- **Slow Charging:** The solar panels don't turn sunlight into energy very well. Most only use 10–15% of the sunlight. So, charging takes a long time if you're using only the sun.
- **Big and Heavy:** Some are too big and heavy to carry easily. If they are small and light, then the solar panel is also small and doesn't work well. If the panel is big and strong, the power bank becomes hard to carry.
- **Not Strong Enough:** A lot of solar power banks are not protected from **rain**, **dust**, or **falling down**. This is a big problem in villages or outdoor places.

Scientists and experts say we really need better solar power banks that are:

- **Cheap**
- **Charge faster**
- **Easy to carry**
- **Strong and weather-proof**

These better power banks can help people who live without regular electricity, in villages, during emergencies, or while traveling.

Role in Achieving Sustainable Development Goals (SDGs)

The **United Nations** made some big goals called **SDGs (Sustainable Development Goals)** to help make the world a better, fairer, and greener place. **Solar power banks** can help reach some of these goals. Here's how:

- **SDG 7 – Affordable and Clean Energy:** Solar power banks give people power even if they don't have regular electricity. This is really helpful in villages or faraway places. People can charge their **phones, lights, or radios**, which helps them stay connected and get important information.
- **SDG 13 – Climate Action:** Solar power banks use **sunlight**, not fuels like coal or gas. This

means **less pollution** and **cleaner air**, which helps in fighting **climate change**.

Also, if we add smart features like **IoT (Internet of Things)** or **AI (Artificial Intelligence)**, these power banks can work even better. They can save energy and give power when it's really needed.

So, solar power banks are a smart and green choice for a better future!

Technological Trends and Research Gaps

Scientists are now trying new materials like **perovskite solar cells**, **organic PV**, and **thin-film technology**. These can make solar power banks **work better** and be **lighter or bendy** in design.

They are also adding **smart tools** like:

- **MPPT** (a controller that helps get the most power from sunlight)
- **IoT** (so the power bank can connect to the internet and work smartly in real-time)

All these things can make future solar power banks smarter and more useful.

But even with these cool ideas, there are still some problems:

- We **don't know how well** these power banks work in different weather or places over a long time.
- There is **no proper way** to test all devices the same way, so it's hard to compare them fairly.
- We **don't have enough feedback** from people who live in villages or off-grid areas.
- Most power banks are **hard to fix or recycle**, which causes waste.

That's why scientists and companies are now being asked to make solar power banks that are:

- **Easy to use**
- **Eco-friendly**
- **Can be fixed or recycled**
- And good for people in all kinds of places

This helps build a **circular economy** - where things are made to last, can be repaired, and not thrown away quickly.

II. GAP ANALYSIS

When we read about solar power banks in research, we can see some big problems - especially when we think about how people use them in real life.

One big problem is the **cost**. Even though solar power is getting better, many solar power banks are still **too expensive**. This is sad because **people in poor or far-away places** - who really need them - often **can't afford** them.

Another big problem is efficiency. Most solar panels in these power banks don't turn sunlight into energy very well. So, they take a long time to charge. This makes it hard to use them in places where there isn't strong or regular sunlight.

The design of solar power banks also has some problems. Some are too big and heavy to carry around easily. Others are too small, so they don't store enough power. This makes it hard for people like students, nurses, or travelers who move around a lot.

Many power banks also don't work well in dust, rain, or heat, so we can't say if they are strong enough for villages or outdoor places.

Another problem is the lack of smart features. Most power banks don't have things like energy-saving systems or IoT (which helps track charging and use). These smart tools could make them work better.

Also, we don't hear much from real users, especially from poor or village areas. We don't know how they use the devices, what problems they face, or what features they really need. If we listened to them, we could make better and more useful designs.

One more big worry is about the environment. Many power banks are not made from eco-friendly materials and are hard to recycle. This adds to the problem of e-waste (electronic waste). And because there's no common way to test the devices, it's hard to know which ones are actually good and strong.

All these problems show that future solar power banks should not only be smart - they should also be:

- Affordable
- Easy to carry
- Strong and long-lasting
- Good for the environment

And most importantly, they should really help the people who need them the most.

III. PROPOSED METHOD

We made a simple **solar power bank** using easy-to-find parts. Here's what we used:

- **Solar Panel** – to collect sunlight
- **Lithium-Ion Battery** – to store the power
- **TP4056 Module** – to charge the battery safely
- **IN4007 Diode** – to protect the battery
- **Voltage Booster** – to make the power strong enough
- **USB Ports** – to charge phones and other things

How It Works

1. **Solar Panel – Making Power**

- Sunlight falls on the solar panel
- It makes around **5 to 6 volts** of electricity
- This power goes into the charging module

2. Diode – Safety Helper
- We put a diode between the solar panel and charging module
- It lets power go **only one way** (from panel to battery)
- It stops power from flowing backward and **saving the battery**

3. Charging Module – Charging the Battery
- The **TP4056** takes power from the panel
- It sends power to the battery safely
- It has **safety features** like:
- Stops overcharging
- Protects from short-circuits

4. Battery – Storing the Power
- The battery keeps the power made by the sun
- Later, we use this power to charge phones and devices

5. Voltage Booster – Making Power Stronger
- The battery gives only **3.7 volts**
- But phones need **5 volts** to charge
- The booster changes 3.7V to 5V

6. USB Ports – Charging Our Devices
- The USB ports are connected after the booster
- Each port gives **5V power**
- We used them to charge things like:
- Phones
- LED lights
- Smartwatches

How We Tested It

Indoor Testing
- We used lamp light or a DC charger to test charging inside

Outdoor Solar Testing
- We placed it under real sunlight
- Tested at different times – morning, afternoon, evening

Load Testing
- We connected devices like a phone, light, and fan
- Checked how well they charge

Safety Testing
- We checked if the diode and charging module were working
- Made sure the battery was safe from damage

What Data We Collected

1. Solar Charging Performance
- How long it takes to charge the battery in sunlight
- How the panel works in different lighting

2. Battery Output & Storage
- How much power the battery gives
- How many times it can charge and recharge

3. Charging Devices
- What types of gadgets it can charge
- How many devices can be charged at the same time

4. Weather & Environment
- Collected info like sun and temperature
- Compared results in **city vs village** areas

Flowchart and Circuit Diagram

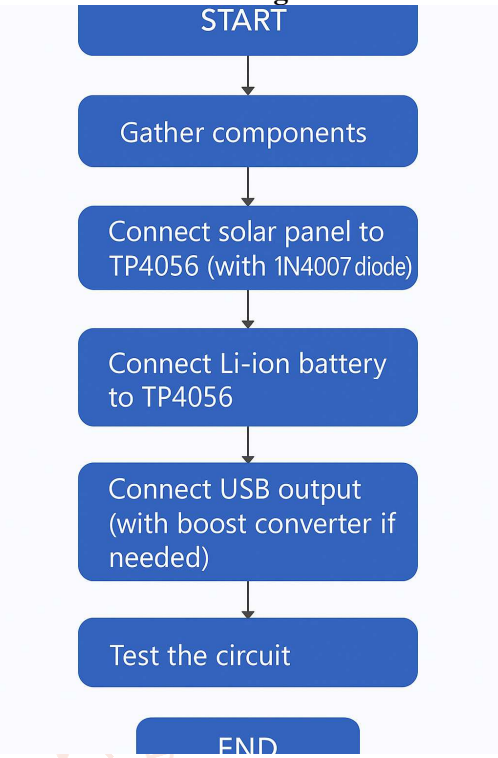

Figure1: Flowchart

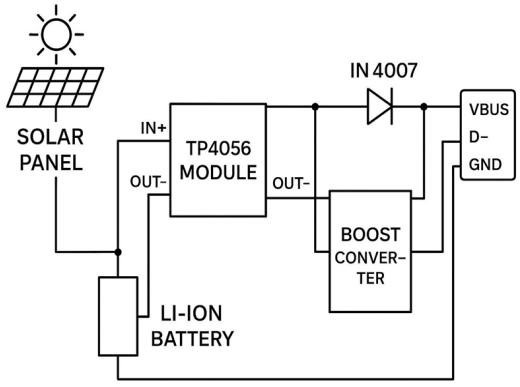

Figure 2: Circuit diagram

IV. CONCLUSION

Making and testing our solar power bank was a big success! We saw that this small and simple device can really help people, especially in places where there is no electricity or where power cuts happen often.

- It worked really well!
  The solar panel collected sunlight, charged the battery, and the battery gave power to things like **phones and LED lights**.

- This supports **Goal 7 of the United Nations** - giving clean, cheap, and reliable energy to everyone.

One of the best things is that this solar power bank is **easy to make** and **not expensive**. The parts are cheap and easy to find. You don't need any special tools, so people in villages or far places can build it too.

Using this solar power bank means:

- You don't need to rely on electricity from the grid.
- You use **sunlight** instead of **coal or gas**, which is better for the Earth.
- More people can charge their things anytime, anywhere.

We also found other good things:

- People can have their **own power**, even during blackouts.
- It doesn't need much fixing and can last for many years.
- Yes, it charges slower on **cloudy days**, and the battery is not very big - but the good parts are more than the bad ones!

In the end, this project taught us that even a small solar device can help a lot. It's good for the planet, and it gives people more control over their energy.

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