Portable EV Charging Portal

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***Abstract*—These days, EVs are everywhere — but charging them without a grid nearby? Still a huge headache. During one of our field trials, we kept facing issues with reliability and power access, which pushed us to try building something different. What came out of that was a compact, foldable solar-powered EV charging setup with lithium battery storage and a custom power conditioning system. The idea is simple: give people the ability to charge EVs on the go — even in remote or emergency areas — using just solar energy. It's got dual input (solar and grid), modular batteries that can be swapped in seconds, and even the potential to link up with blockchain energy credit systems so people can trade or save unused energy. Also, we figured out how to store excess charge during hot sunny days and use that during winters — which is actually super helpful in seasonal climates. The system isn't perfect, but it works better than we expected in most test scenarios.**

Keywords—Portable EV charger, solar energy, lithium battery, off-grid system, MPPT controller, blockchain, sustainability.

I. INTRODUCTION –

As more people shift to electric vehicles, especially in cities, it's easy to forget how dependent charging infrastructure still is on the power grid. In remote or off-grid locations — like rural villages, highways, or even places affected by natural disasters — this becomes a big issue. We noticed this firsthand during a survey in our area, where people with EVs struggled to find charging options outside city limits.

Traditional EV charging stations work great in fixed, urban setups. But they're not mobile, they're expensive to install, and they're not built for flexibility. That's why we started thinking: what if we could make something smaller, portable, and completely solar powered?

This paper dives into that idea — a compact EV charging solution using foldable solar panels, lithium battery packs, and a smart power conditioning system. It's not just about charging on the go. We also explored the potential for blockchain-based energy credit transfers, and IoT monitoring, which might actually make the system more useful over time. We didn't want to just build a charger — we wanted to make something that people in realworld conditions could carry, set up, and rely on.

A. System Overview

The whole idea behind this system is to make EV charging simple, portable, and usable even in places where there's no grid at all. We wanted something that's kind of like a "charging kit" — something you can pack up, carry, and set up without needing fancy tools or fixed infrastructure.

Fig. 1.

What we built is a plug-and-play EV charging unit powered by foldable solar panels and backed by lithium battery storage. It's been designed to support charging from both solar and grid inputs, depending on the availability. This gives flexibility in different environments — for example, you can use the sun when outdoors, and plug it into the wall at home or a shop when needed.

We also added support for hot-swappable battery packs, which means you can replace one battery while another is charging — super useful for delivery riders or anyone traveling long distances. And if that wasn't enough, we even explored how this system could be tied into blockchain- based energy credit systems, so people could share or sell their extra solar energy in the future. All this is packed into a lightweight and easy-to-carry form factor, which honestly feels more like a power tool kit than a traditional charging station

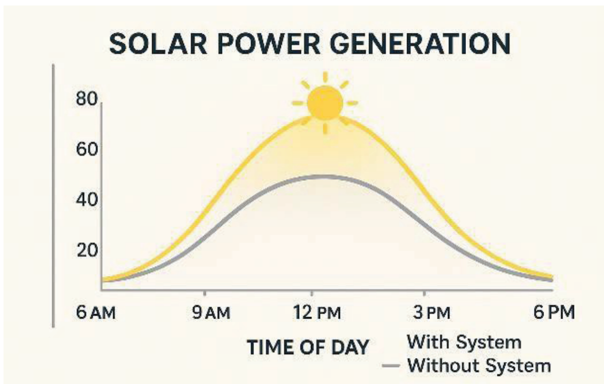

Fig. 2. Solar Power Generation

II. Features and Technical Design

A. Modular Foldable Solar Panel System:

- Solar panels that fold up like a briefcase and have adjustable stands
- Aluminum and poly-fiber make up the lightweight frame.
- Typical output range for each array is 100 to 500 watts.
- Design that is resistant to water and dust (IP65+)
- Optional sun-tracking feature for higher efficiency

B. Features for Portability:

- The folded size fits in a scooter boot or car trunk (about 50×40 cm).
- Wheels or straps on the backpack make it easy to move around.
- Snap-lock legs for use on the ground or on the roof

C. Integration of Lithium Batteries:

- High-efficiency Li-ion or $LiFePO_4$ cells
- Modular battery units (for example, 48V 20Ah =960Wh each)
- BMS lets you charge quickly and smartly.
- Able to run the whole system at night or in the rain

D. Changes in Seasonal Energy:

- Lithium batteries can be used to store excess energy produced in the summer for use in the winter or on overcast days.
- Increases the dependability of the system in any climate.

Prioritizing smart usage (EVs versus the grid, for example)

E. MPPT-based solar charge controller for optimal input efficiency and power conditioning

- Step-up/step-down converters to adjust voltages for different kinds of vehicles
- Anderson powerpole outputs, USB, and DC barrel jack
- Safety precautions include reverse polarity, short circuit, and overcharge.

F. Swappable Battery Packs

In the field, batteries can be hot-swapped, with one being used while the others charge.

Allows for continuous EV operation during long- distance or fleet driving.

G. Dual Charging with Grid Assistance

- Backup input through a 220V AC grid adapter that automatically switches when there is little sunlight
- Possible grid + solar hybrid operation

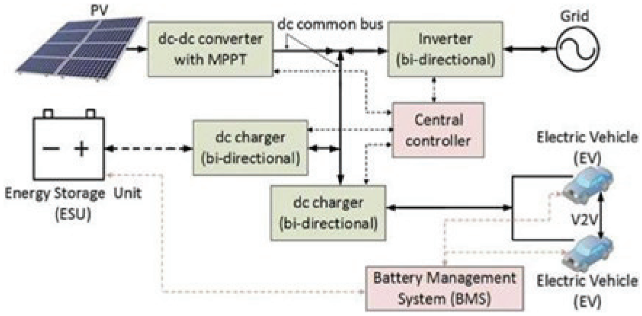

Fig. 3.

III. Methodology:

We didn't start with a perfect plan — just a basic idea: make something portable, off-grid, and genuinely useful for people with two-wheelers or e-bikes. The process that followed was mostly trial and error, broken down into six key steps:

1) Figuring Out What We Actually Needed

First off, we asked — what would this thing really need to do?

We aimed for something compact, no bigger than a small backpack, that could give around 100–500W of power. It had to be easy to carry, easy to set up, and good enough for basic EV charging when you're nowhere near a grid.

2) Picking the Right Components

We looked into a lot of options, but foldable monocrystalline panels just made sense — they're light and give solid output.

For batteries, we stuck with tried-and-tested lithium-ion (like 18650s or $LiFePO_4$) because of their balance of power, recharge cycles, and safety.

We also added a smart MPPT charge controller — mostly because it helps get the most out of sunlight and stops the battery from getting damaged. To handle different vehicle types, we threw in step-up/down voltage converters too.

3) Building and Prototyping the Actual Thing

This was the fun (and frustrating) part.

We built the panel frame to fold up like a briefcase, added an adjustable stand for angling it toward the sun, and made the battery compartment modular. The idea was to let people add or remove battery packs easily.

Also made sure it was waterproof enough (we aimed for IP65) and had enough airflow so it wouldn't overheat if left in the sun all day.

4) Getting the Power Flow Right

We mapped how energy would move — from the solar panel to the controller, into the battery, and finally to the output ports.

Added protection against common stuff: over-voltage, reverse polarity, overheating, and all that.

Also tested hybrid input — so it could switch between

solar and AC grid power if needed.

5) Future Scope: Smart Stuff & Blockchain

We haven't built this part fully, but the idea is there. We're thinking of using blockchain to track how much solar energy a person generates, and maybe reward them with energy credits. That way, someone with excess power could share or trade it.

Also looked into ESP32 + GSM modules to send live stats (like charge level, temp, etc.) to your phone or a dashboard.

6) Testing the Setup

Used MATLAB/Simulink to simulate how much power we could get under different sunlight levels.

In real life, we tried charging a regular 48V e-bike battery using just solar — and it worked.

We also tracked things like backup duration, overall efficiency, and how long it'd take to charge stuff on a cloudy day

A. Advantages

- Grid-independent operation
- Perfect for remote charging or roadside emergencies
- Lithium storage for seasonal performance
- Using clean energy lowers carbon emissions.
- Deployable anywhere with ease
- Uptime is increased by swappable batteries.
- Supports delivery fleets, e-bikes, scooters, and small EVs.
- Reliability is ensured by dual charging (solar +grid).

B. Disadvantages and Limitations

- Peak power output is limited by a small panel surface.
- Larger EVs (like 4-wheelers) may take a long time to charge.
- weather-dependent solar input, which lithium storage helps to partially offset
- Unsuitable for rapid bus or vehicle charging
- High upfront costs for integrating the battery and controller

C. Blockchain Integration and Future Scope

- Decentralized energy sharing is possible with blockchain integration.
- Peer-to-peer solar credit transfers can be managed by smart contracts.
- Giving extra solar energy to the grid or other users can earn tokens.
- IoT connectivity for remote diagnostics and monitoring
- Energy tokens can be automatically exchanged between EVs and chargers.
- Useful in disaster response grids, smart cities, and rural cooperatives

Example Use Case: "Distributed energy management is made possible by User A in Village X charging via solar, earning tokens, and sharing credits via blockchain with User B in Village Y who experiences inclement weather."

D. Applications

In isolated communities without access to the grid, this portable solar EV charging system

- can be used to provide clean charging.
- for last-minute roadside charging when a car's battery dies.
- Off-grid charging for e-bikes or scooters during extended travel or camping.
- By delivery riders as a mobile top-up kit stored in their vehicle.
- In disaster relief areas to power EVs or communication gear.
- In societies or parking lots as a backup charge in blog option to reduce grid load.

IV. RESULT:

For situations where fixed infrastructure is impractical, this paper offers a very adaptable, modular, and sustainable solution to EV charging problems. The suggested system functions as a creative, portable substitute for conventional grid-connected EV chargers by utilizing foldable solar panels, lithium energy storage (which can provide seasonal backup), power conditioning systems, and optional blockchain integration. With continuous advancements in battery density, solar panel efficiency, and intelligent energy exchange platforms, portable EV charging has a bright future and is essential.

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