Design And Fabrication of Solar Rechargeable Multipurpose Electric Cart for Small Scale Vegetable Vender

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Abstract*— The solar-operated cycle cart for small-scale vegetable transportation is an impersishable and innovative solution designed to address the problems faced by local farmers and vendors. This project integrates renewable energy technology with a conventional cycle cart, providing an eco-friendly alternative to traditional manual methods or fossil fuelpowered carts. The system incorporates a photovoltaic panel mounted on the cart's roof, harnessing solar energy to charge a high-capacity battery. This stored energy powers an electric motor that assists the rider in propelling the cart, reducing the physical exertion required for transporting vegetables. The design includes a lightweight and durable frame to optimize energy efficiency and enhance the cart's load-carrying capacity. The inclusion of a user interface allows the operator to monitor battery levels and system performance. Additionally, safety features such as efficient braking systems and reflective materials enhance visibility, especially during low-light conditions. This solar-operated cycle cart not only promotes sustainable transportation but also contributes to minimize carbon emissions corelated with conventional modes of vegetable transport. By converting sunlight into electricity, the project aims to enhance the livelihoods of small-scale farmers and vendors, offering an affordable and environmentally friendly solution for their daily transportation needs

1. INTRODUCTION

The solar-operated cycle cart for small-scale vegetable vendors represents a transformative solution to the pervasive problem of post-harvest losses in horticulture. With having a facility of capacity of up to 200 KG and the ability to increase the shelf life of produce by 10 to 20 days, be dependent on the crop, this innovation directly tackles the root causes of waste in the agricultural supply chain. What sets this cart apart is its efficiency with minimal resource inputs. Requiring only a liter of water per day and a modest 20 watts of electricity, the system operater asseamlessly whether connected to the grid or functioning off-grid. It will minimize operational expense and also makes it accessible to a many of farmers and traders, including those in remote areas. The self-adaptable and sustainable cart design is noteworthy. By taking off the need for cooling and chemical interventions, it will reduces environmental consequences and also ensures that the stored fruits and vegetables retain their natural freshness without compromising nutritional value. This will addresses the economic dimension of post-harvest losses and also aligns with green and eco-friendly principles. The high perishability of horticultural produce often results in a significant percentage not reaching the market, contributing to inflated prices. By directly intervening in the post-harvest phase, this solution empowers individual farmers, cooperatives, and traders to reduce waste, enhance product availability, and ultimately stabilize market prices. In doing so, it not only addresses economic concerns but contributes to sustainable agricultural practices, presenting a comprehensive and impactful solution to the challenges of the perishability of horticultural commodities. categorized by their generation, intelligence, structural, capabilities, application and operational capabilities.

2. HARDWARE DESCRIPTION

2.1 MOTOR

The motor specifications for a solar-powered vending vehicle for a physically challenged person will depend on a various of factors, which includes the size and weight of the vehicle, the kind of terrain it will be used on, and the maximum speed required. A DC motor with a power output of 250w and 13.6 amps is suitable for vehicle. This would allow for a top speed of around 15-20 kmph.

2.2 CHAIN DRIVE

The chain drive specification for a solar-powered vending vehicle for a physically challenged person will be depending on various of factors, including the size and weight of the vehicle, the kind of terrain it will be used on, and the top speed required, like chain sizes, sprocket sizes, chain tensioner, chain guard, chain lubrication.

2.3 BALL BEARING KIT

A ball bearing kit for a solar-powered vending vehicle for a physically challenged person can help reduce friction and improve the performance and efficiency of the vehicle. The ball bearing kit for a solar-powered vending vehicle for a physically challenged person will depend on the specific requirements of the vehicle and the needs of the user.

2.4 BATTERY

A lithium-ion battery is typically the best choice for a solar-powered vehicle due to its high energy density, long lifespan, and low self-discharge rate. The battery voltage will depend on the voltage of the motor and other electronics, we required a 4 batteries of specification 12V, 7 amps each.

2.5 SOLAR PANEL

Polycrystalline solar panels are typically the best choice for a solar-powered vehicle due to their high efficiency and durability. We require two solar panel each of having wattage around 10W and voltage of 18.5V.

2.6 MOTOR CONTROLLER

The motor controller should be designed to work with the specific type of motor used in the vehicle. The motor controller is rated as same wattage of motor that is 250W an voltage of 25V.

2.7 THROTTLER

The controller also has control interface such as throttle, with the use of throttle the vehicle can be accelerated and deaccelerated according to the user requirement.

2.8 PELTIER KIT

Peltier kit which contains a Peltier module which is sandwiched between two aluminum heat sinks. In Peltier module heat generation is high, so it is connected to a larger heat sink which is placed outside and colder surface is placed inside the compartment and above each of the heat sinks fan is mounted.

2.9 SOLAR CHARGE CONTROLLER

A solar charge controller is an essential component of a solar-powered vending vehicle for a physically challenged person, as it regulates the charging of the battery system from the solar panels. We will be using Maximum Power Point Tracking (MMPT) solar charge controller of specification 30A, 12V/24V for more efficiency. It also has clear and easy to read display that shows the current charging status of the battery systems.

3. WORKING

3.1 Working principle

The Solar Rechargeable Multipurpose Electric Cart for Small Scale Vegetable Vendors operates on a sustainable and efficient working principle, combining solar energy harvesting with versatile electric propulsion.

The primary feature is the integration of solar panels on the roof of the cart, which harness sunlight and convert it into electrical energy through photovoltaic cells. This solar energy is stored in rechargeable batteries, serving as a clean and renewable power source for the cart. The use of solar power aligns with the objective of reducing environmental impact and providing an eco-friendly solution for small-scale vegetable vendors.

The electric propulsion system consists of a motor connected to the wheels of the cart. When the cart is in operation, the electric motor is powered by the stored solar energy in the batteries, enabling smooth and quiet movement. This electric propulsion eliminates the need for conventional fuel, reducing operating costs and environmental pollution.

The cart is equipped with a multipurpose design to cater to the specific needs of small-scale vegetable vendors. It includes storage compartments, display shelves, and a refrigeration unit to maintain the freshness of perishable goods. The electric cart enhances mobility for vendors, allowing them to easily navigate through crowded marketplaces or reach various locations without the constraints of traditional manual carts.

To enhance user convenience, the cart incorporates a simple control interface that allows the vendor to manage speed, direction, and other operational features. Additionally, safety features such as brakes and lights contribute to a secure and efficient operation.

3.2 Working procedure

1. PV Solar panel absorbs radiation from sun collects the charge.
2. The charge controller is kept to maintain the flow of charge. This provides path for charging the battery as well direct running of vehicle.
3. Charge flows to motor which in turn connected to the throttle which runs the vehicle on acceleration.
4. Even the temperature-controlled compartments will get the supply directly to maintain the specified temperature.
5. When there is need of vehicle during unavailability of sun the vehicle can be run through charged battery
6. The peltier effect is the reverse phenomenon of the see beck effect; the electrical current flowing through the junction connecting two materials will emit or absorb heat

per unit time at the junction to balance the difference in the chemical potential of the two materials

7. When electricity is passed through the module, electrons move in one element and positive holes move in the other element, this is called peltier effect.

3.3 Calculations:

- First, let's calculate the power required by the motor to maintain a speed of 15 km/h: Velocity

$= \frac{15 \times 1000}{3600}$

= 4.17 m/s

- Total weight = 200 kg

vehicle weight = 80kg

passenger weight = 70kg

vegetable weight = 50kg

- Time(t) = 10 sec
- Acceleration :

a = $\frac{v}{t} = \frac{4.17}{10}$ = 0.41 m/s^2

- Force for acceleration :

F =200 x 0.41 = 82 N

- Torque on the wheels (wheels diameter =200)

Mt = F x R = 82 x 200 =16400 N mm

=16.4 N m

- Speed of Wheel in rpm :

$V= \frac{\pi \times d \times n}{60000}$

$4.17 = \frac{\pi \times 400 \times n}{60000}$

n = $\cong 200\ rpm$

- Power :

$P = \frac{2\,\mu\, n\, T}{60000} = \frac{2 \times \pi \times 200 \times 16.4}{60000}$ = 0.34 kW

- Battery:

Total 5 batteries of 12V and 8Ah are used

Total battery power = 8 x 12 x 5 = 480 W

Assuming battery power Efficiency = 80%

actual battery power output = 480 x 0.8 =384 W

We are using Two motors of 250 W

Assuming efficiency of motor = 80%

Motor output = 0.8X x 250

= 0.8 x 2 x 250 = 400 W

0.4 kW

- To charge a 48V, 8Amps battery from a 10W solar panel with an output voltage of 37V, we would need a charge controller to regulate the voltage and current to the battery. The time required to charge the battery will depend on several factors such as the efficiency of the solar panel, the amount of sunlight available, and the charging circuit used.
- When two solar panels are connected in series, the voltage adds up while the wattage remains the same. Therefore, if you connect a 10-watt solar panel with an 18.5-volt solar panel in series, the resulting configuration will have a combined voltage of 18.5+ 18.5 = 37 volts. The wattage will remain the same at 10 watts
- To calculate the time required to charge a battery, we need to consider the charging efficiency and the available power from the solar panel.
- Available Power = Solar panel output voltage x Solar panel output current

= 37V x 10W / 48V

= 7.708W

To calculate the charging time:

Charging Time =Ah/A

Here A= Charging current

As we know that charging current should be min 10% of the Ah rating this is because a higher rate may cause the battery acid to boil.

We are using 8Ah battery of quantity 5

So,

Ah= 8Ah x 5= 40Ah

A= 40 x (10/100) = 4A i.e. charge current should be 10%

We can use 5A

Using 5A has charging current

Substituting the values:

Charging Time = Ah/A

=40/5

Charging time= **8 hours**

5. REFERENCES

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