CHARGE YOUR CAR IN HARVARD YARD

EV Charger/Parking Meter Powered by Renewable Energy

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Engineering Problem

- Electric vehicle charging stations utilize electricity that emits billions of tons of CO_2 every year by power plants.

Engineering Goal

- The goal of this project is to engineer a level 2 electric vehicle charging station paired with a parking meter that is powered through renewable energy to make it both eco-friendly and convenient.

Purpose

- Integrating charging stations into existing parking meters can help cities save space from its simplistic and a dual purpose design.
- Due to the use of renewable energy as an energy source, this parking meter/EV charging station duo will be environmentally friendly.
- Electric vehicle users in urban areas to have easy access to these charging stations if they were placed in parking areas. This invention will further encourage the use of electric vehicles.

Background

- Air Pollution
  - Decreases a person's life expectancy by 1-2 years
  - Major Greenhouse gases affecting the Ozone layer:
    - Nitrogen oxide (NO), Carbon Dioxide (CO_2), Methane (CH_4), Water Vapor (H_2O)
- CO_2 emitted by electric vehicle chargers in the US
  - Up to 10 lbs. of CO_2 is produced per every 1 kWh from commercial charging stations
  - Overall, commercial charging stations with high carbon intensity produce high carbon emission per mileage
  - Home/Level 1 chargers have a 92% gas penetration which results in a higher carbon intensity and is not superior compared to commercial charging stations

- Electric car chargers
  - Level 1
    - Works with household outlets
    - Can deliver 1.6 kW – Approx. 9 hours to charge empty battery
  - Level 2
    - Works with household outlets as well
    - Can deliver 19.6 kW – Approx. 2-3 hours to charge empty battery
    - Cost - $2,500
  - DC Fast Chargers
    - Not for household usage
    - Can deliver 90-120 kW – Approx. 10-30 minutes to charge empty battery
    - Cost - $100,000

- Wind Turbines
  - Horizontal Axis Wind Turbines (HAWT)
    - Turbines that rotate around a horizontal axis
    - Work best with wind speeds higher than 5 m/s
  - Vertical Axis Wind Turbines (VAWT)
    - Turbines that rotate around a vertical axis
    - Savonius – High torque machines that rotate around a shaft
    - Darrieus – Generators and motors placed at the bottom of the turbine for stability
      - Can withstand wind speeds up to 61 m/s
        - Darrieus H
        - Hélicoïdale

- Parking Meters
  - Single space Meter
    - Used to cover one parking space
    - Easy installation; requires little or no wiring
  - Multi-space Meter
    - Used to cover more area across a sidewalk or parking space
    - Less meters required
  - Collects money for the right to park a vehicle in a certain area for a limited time

Decision Matrix

Criteria	Weight (1-5)
Environmentally Friendly Will it be harmful or produce CO_2 while charging the cars or producing the energy	5
High Cost Efficiency Less money per kW of energy being produced	4
Feasibility Easy to install on sidewalks; shouldn't take much place	4
Low Levels of Danger Will it spontaneously combust	2
User performance Will it be easy for people (convenient) to use on a daily basis	2

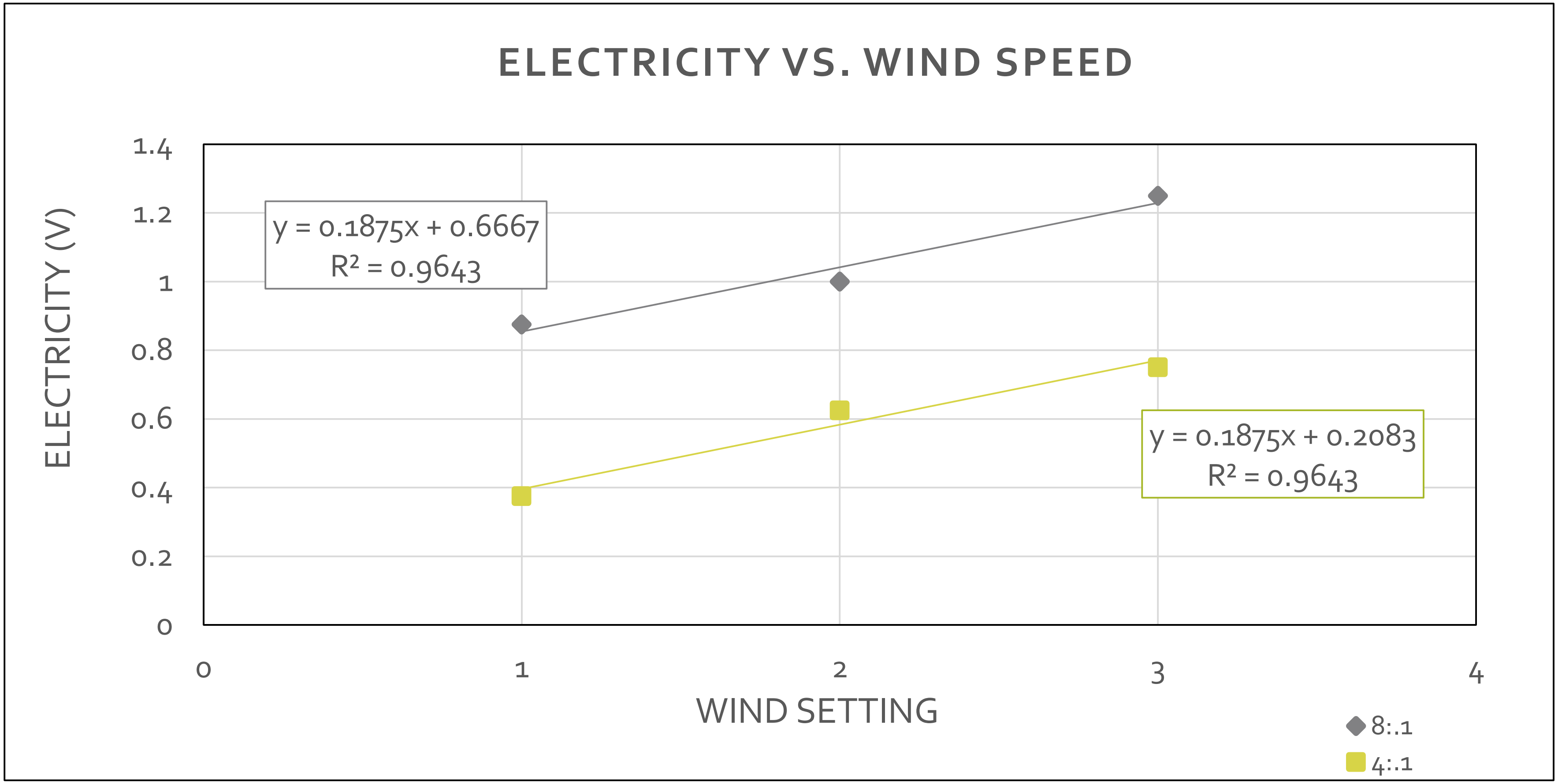
Procedure

- Find data and statistics on the uses of EV chargers and about vertical wind turbines and batteries
  - Use existing data and wind maps on cities in Massachusetts, particularly Boston
    - Depending on the city, which altitudes result in a higher wind speed?
    - Wind turbines have to have more than 9 m/s wind speed in order to function and produce copious amounts of electricity
- Gather materials needed for a potential prototype
  - Electric box, wiring, Arduino, voltmeter, contractor/relay, control board
- Build a prototype of an EV charger using a wind turbine and an Arduino

- Add in the inverter component onto the charger
  - Once the charger is built, there needs to be an inverter that will convert the direct current into alternating current
- Test this prototype to determine:
  - The time it takes to charge a EV battery from 0-100 % charge
  - The amount of kW being produced from this prototype
  - The amount of electricity the battery inside the prototype can store
- Analyze the data
  - Test the prototype in a real-life scenario
    - Test to see if it is not only user friendly, but also functional
  - If not working as expected, "debug" the prototype, find ways to improve upon it/make it functional
  - Re-test and analyze the prototype after fixing

- Add the parking meter component on top of the electric charging station
  - The parking meter will be a device that can keep track of time and electrical output of the EV charger into the car
  - It should also be able to monitor the amount of electrical output
- Test the full prototype in conditions similar to everyday usages of parking meters
- Analyze/produce a report on data collected

Results



Graph of data collected from the wind turbine prototype.

Data Analysis

- The data collected from the wind turbine prototype will be compared to commercial vertical wind turbines.
- The data measured will be scaled by a factor of how much electricity the prototype is able to produce compared to standard VAWTs.
- The data recorded from the final prototype will be analyzed by matching them to standard electric vehicle chargers to determine whether the data accurately addresses the engineering statement.

Future Directions

- The next step of this process will be to build another prototype with the electric vehicle charger that is being powered by wind energy.