Design a Building Electrification Demonstration Vehicle

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1. Building Electrification Vehicle

- The project purpose is to show electrification in residential and commercial buildings through a demonstration vehicle
- This vehicle will implement: 2 heat pumps, water heater, and dashboards that will all be powered using electricity
- We have implemented a solar panel system on the roof of the vehicle to recharge the batteries
- By building a demonstration electrification vehicle we will be able to show the feasibility of electrification that can be scaled up for commercial and residential buildings
- About 80% of the direct fossil fuel CO2 emissions come from residential and commercial sector(epa.gov)

4. Vehicle Features

- 2 Heat pumps (window unit & mini split)
- Induction stove
- Sink and faucet
- Water heater
- 2 Water Storage Tanks
- Smart light bulbs
- Smart breakers and Panel
- Transfer switch and Plug
- 4 Batteries (12V/ 200ah)
- 10,000W Inverter
- Display for dashboard

Energy			
Component	Voltage (V)	Wattage(per hour)(W)	Amperage (A)
Heat Pump 1	220	1080	4.90909090
Heat Pump 2	120	1000	12
Water Heater	240	4500	18.75
Water Pump	115	345	3
Solar Panel	20	-2100	15
Stove	240	2000	45
Dashboard 1	120	60	5
TOTAL	240	6885	45

Fig. 4.1: Components table with energy specifications

6. Energy Calculations

- Energy calculations done for the whole system based on the spec sheet provided for each appliance on their website
- Power consumed calculated is for an entire day, with each appliance turning on at different points in time
- Different scenarios taken into consideration, with different appliances operating for variable duration

Scenario 2	Time (Hr)
Heat Pump 1	3
Heat Pump 2	3
Water Heater	0
Water Pump	1
Solar Panel	2
Stove	1
Dashboard 1	5
Total energy used:	4885
The number of batteries	**~3 (2.04)**

Fig. 6.1: Load calculation on basis of time of operation

2. Simulation and Data

- We simulated the circuit on MATLAB/Simulink, and got results, which we compared with the Home assistant data
- Fig. 2.1 shows the circuit diagram for the system, Fig. 2.2 depicts the graph resulting from the simulation

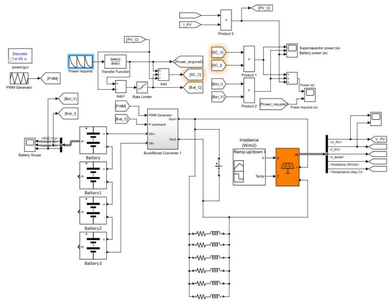

Fig. 2.1: MATLAB/Simulink circuit diagram

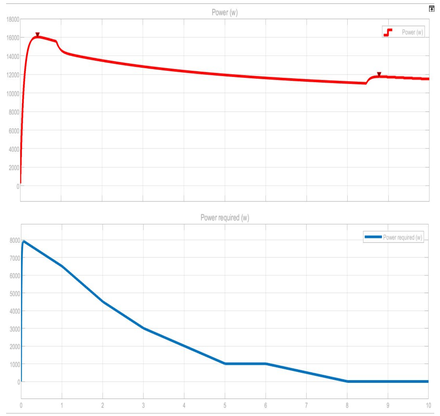

Fig. 2.2: MATLAB/Simulink simulation graph results

5. Operating System and Sensors

- One of the goal for this project is to create an interactive dashboard for users to monitor the total energy consumption, energy production by solar panels, battery level and temperature
- Dashboard also serves as a control panel to turn on/off the appliances
- Home Assistant (HA) is a open source home automation system that we use as our operating system
- Sensors include: Temperature, humidity, current sensor
- A smart breaker panel system is used which reads in the power consumption of each appliance and send data via WIFI

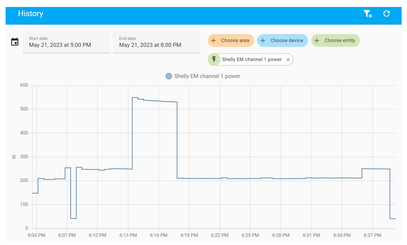

Fig. 5.1: Energy consumption graph

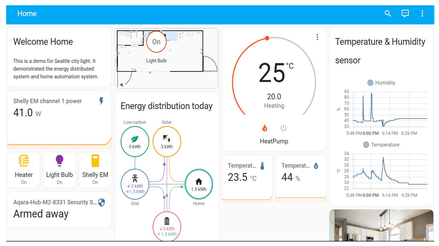

Fig. 5.2: HA dashboard

3. 3D Sketch and One Line Diagrams

- The batteries are connected to switches, which can control how many batteries we need at that particular time
- Below is a drawing of the power distribution among loads, to show how the transfer switch is implemented into our system
- Fig 3.3 shows the payload and their placement in the electric truck (K270E)
- The body size is 18’ x 8’6” x 8’6” (l x w x h)

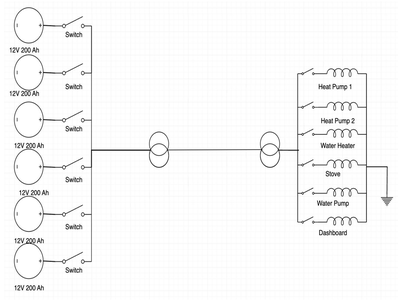

Fig. 3.1: One Line Diagram

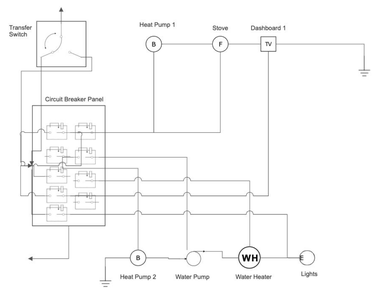

Fig. 3.2: Power distribution among loads

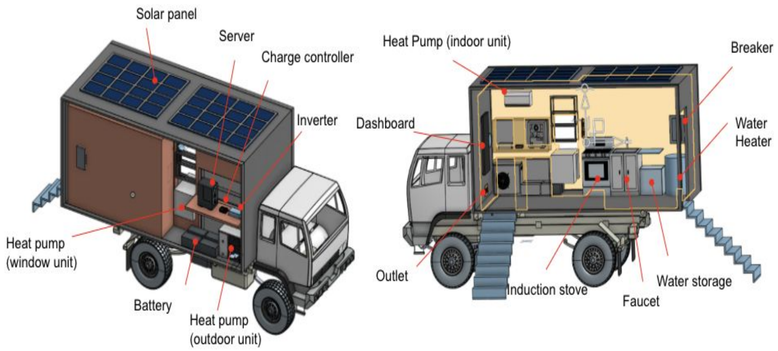

Fig. 3.3: 3D Model of vehicle and components

6. Future Work

- Further improvements to electrical drawings
- Finish implementing the circuit breaker system to demo
- Start planning the building process of the vehicle itself and the components inside
- Hand it over to a contractor

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