NEURAL NETWORK BASED ENERGY STORAGE CONTROL FOR WIND FARMS

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INTRODUCTION

Energy storage plays a crucial role in modern power systems, especially in renewable energy sources like wind and solar farms. Due to the intermittent nature of renewable generation, efficient energy storage management is necessary to balance supply and demand, optimize energy utilization, and improve grid stability. Traditional control strategies often struggle with the dynamic and uncertain nature of energy production and consumption. This project explores the use of Deep Q-Networks (DQN), a reinforcement learning technique, to develop an adaptive and intelligent approach to energy storage management.

OBJECTIVES

1. Implement Deep Q-Networks for Energy Storage Control
2. Compare with Traditional Methods
3. Optimize Model for Real-Time Decision-Making

WORKING PRINCIPLE

STEP 1: Observe the state

STEP 2: Predict the best action (Charge, Discharge, Idle) using DQN

STEP 3: Execute the action in the system.

STEP 4: Reward Calculation

STEP 5: Training the DQN Model

WORKING PRINCIPLE

THE ENERGY STORAGE MANAGEMENT SYSTEM CONSISTS OF THE FOLLOWING KEY COMPONENTS :

- LOAD DEMAND
- RENEWABLE ENERGY GENERATION
- ELECTRICITY PRICE
- BATTERY STATE OF CHARGE

THE GOAL IS TO OPTIMIZE THE CHARGING AND DISCHARGING DECISIONS TO MINIMIZE ELECTRICITY COSTS WHILE MAINTAINING BATTERY OPERATIONAL CONSTRAINTS.

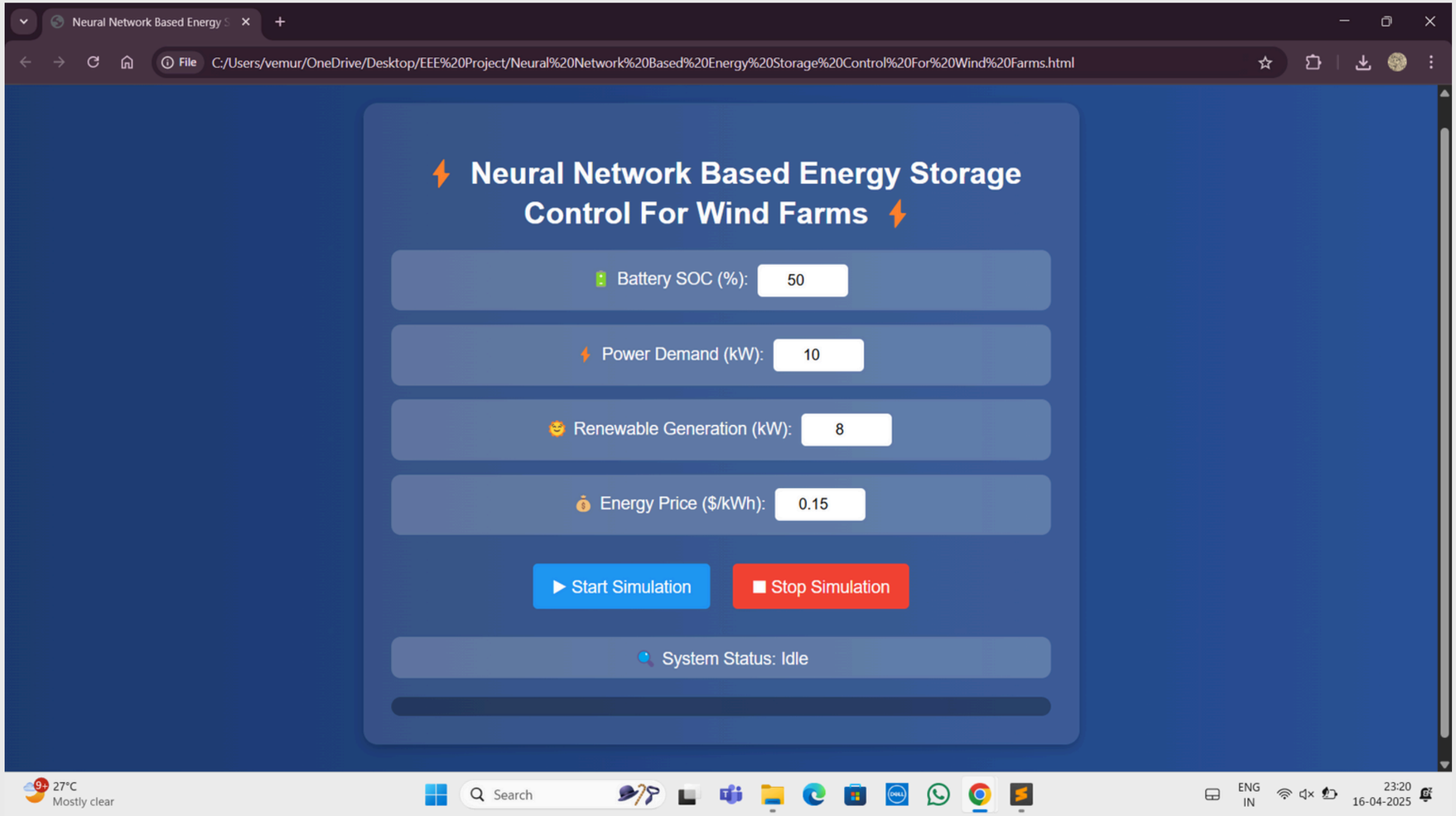
METHODOLOGY

1. PROBLEM IDENTIFICATION & DATA COLLECTION

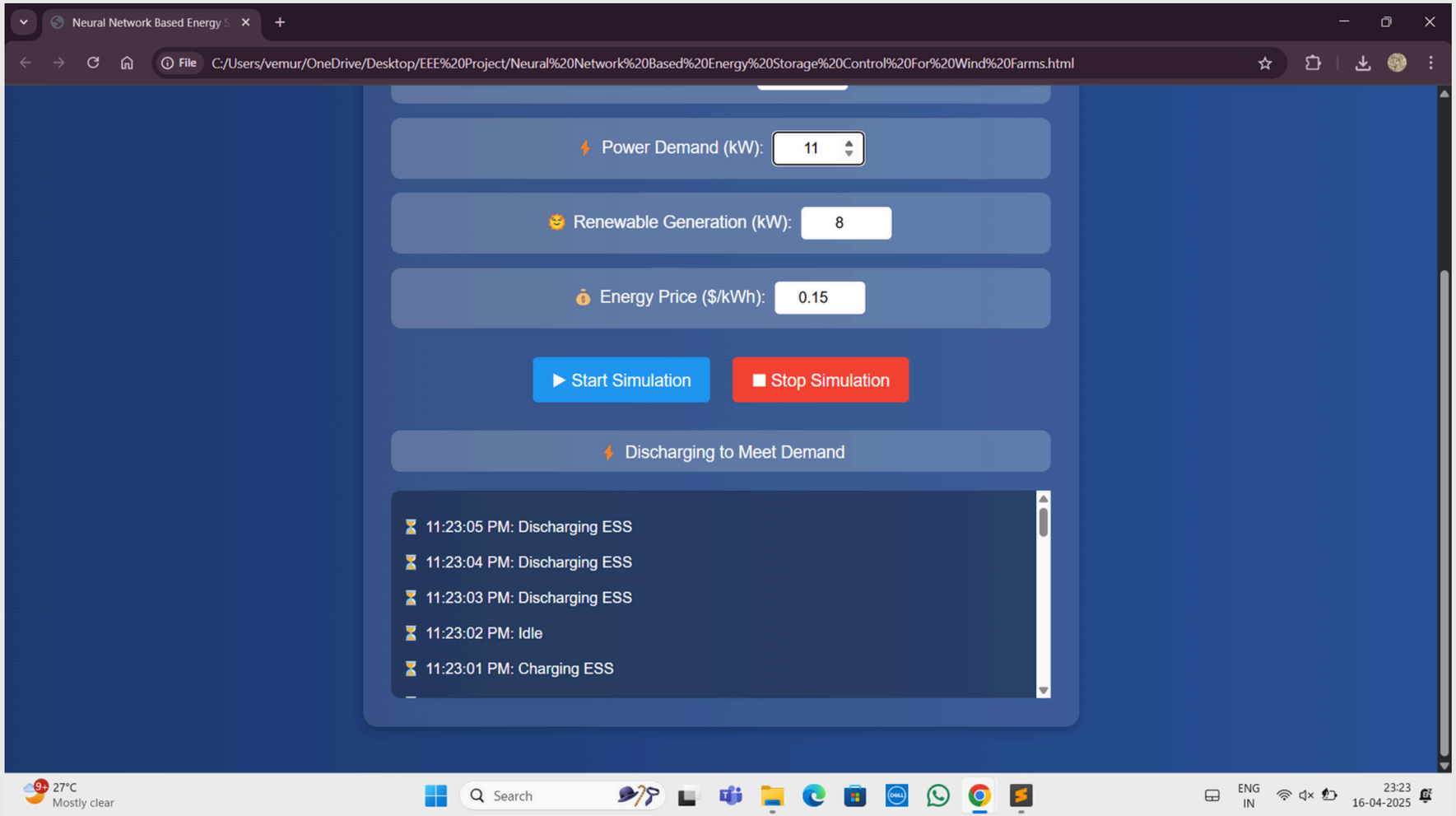
2. IMPLEMENT DEEP Q-NETWORKS (DQN)

3. TRAIN & OPTIMIZE THE MODEL

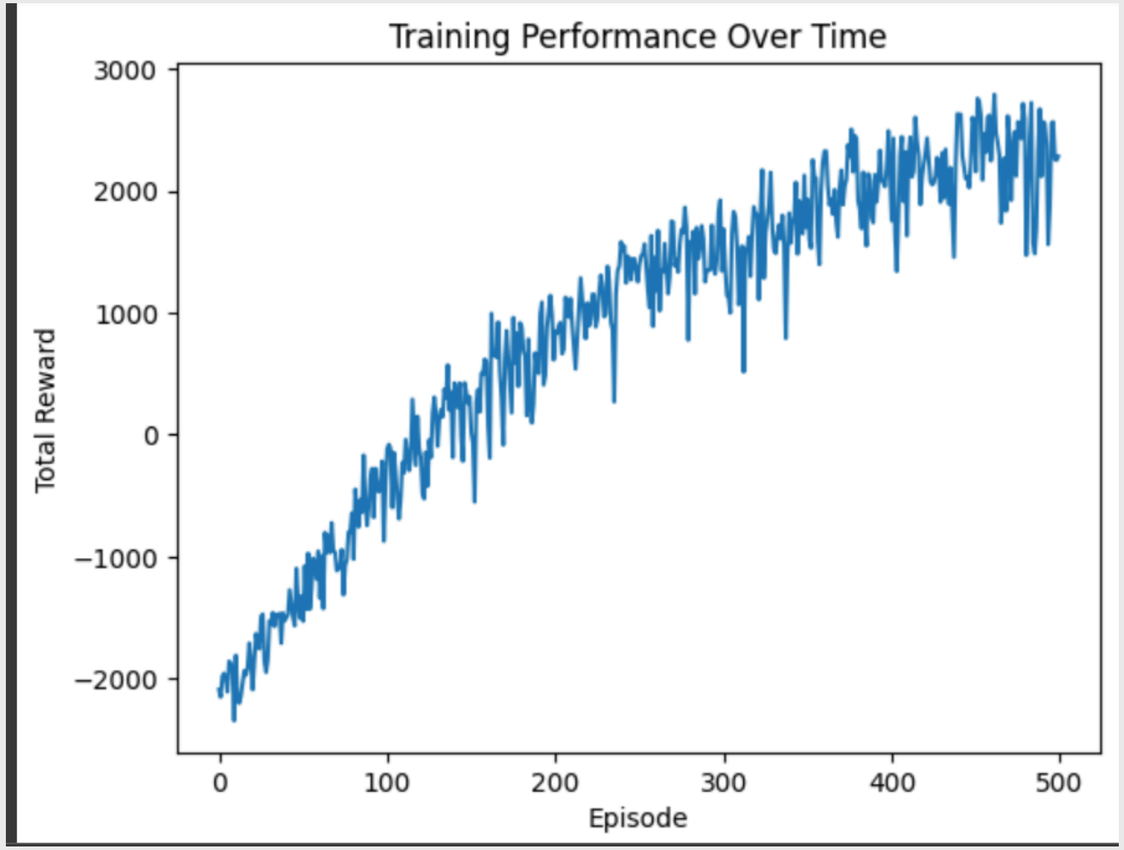
UID


Neural Network Based Energy
File C:/Users/vemur/OneDrive/Desktop/EEE%20Project/Neural%20Network%20Based%20Energy%20Storage%20Control%20For%20Wind%20Farms.html
Neural Network Based Energy Storage Control For Wind Farms
Battery SOC (%): 50
Power Demand (kW): 10
Renewable Generation (kW): 8
Energy Price ($/kWh): 0.15
▶ Start Simulation
■ Stop Simulation
System Status: Idle
27°C
Mostly clear
Search
ENG
IN
23:20
16-04-2025

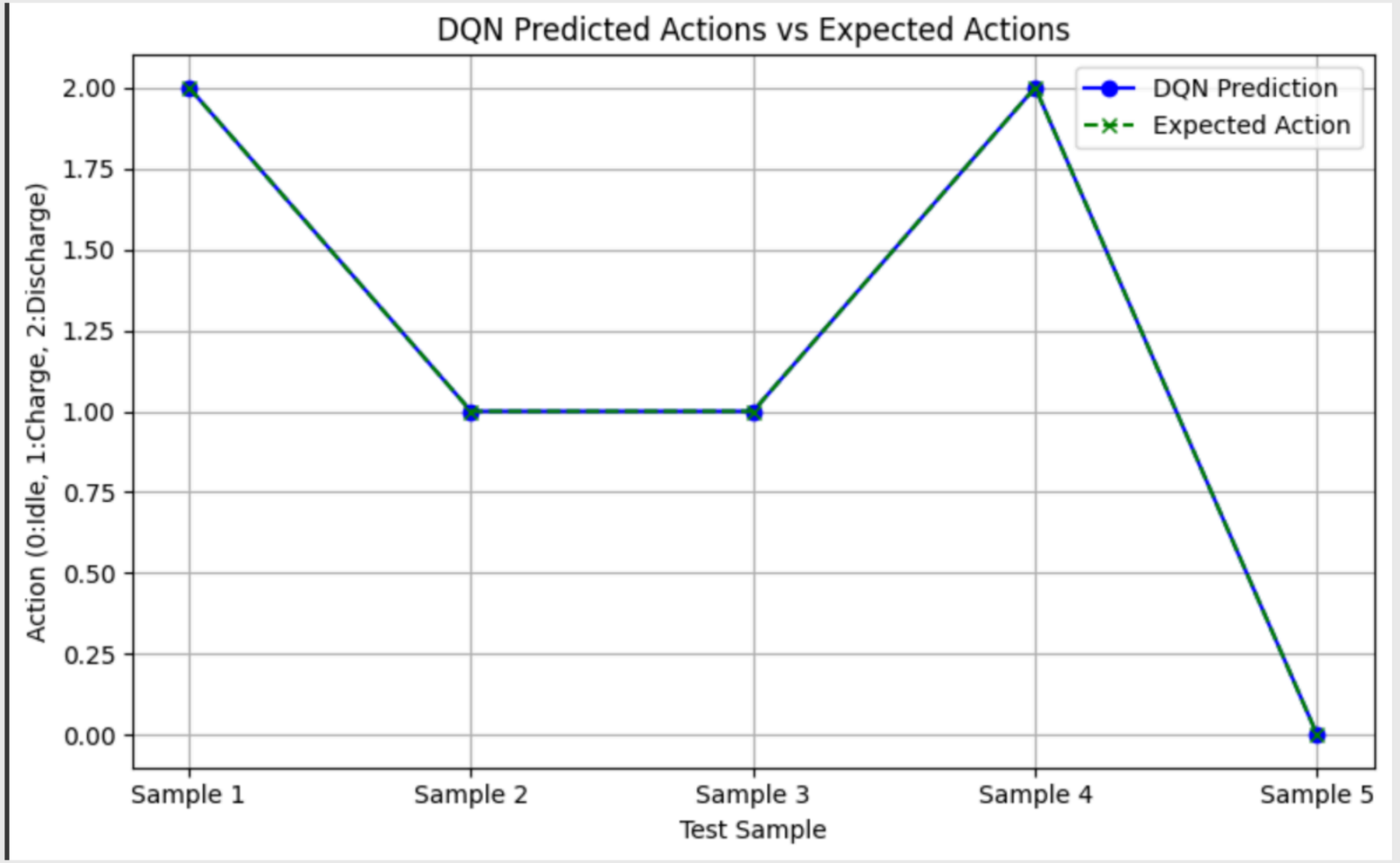
UID


Neural Network Based Energy S
File C:/Users/vemur/OneDrive/Desktop/EEE%20Project/Neural%20Network%20Based%20Energy%20Storage%20Control%20For%20Wind%20Farms.html
Power Demand (kW): 11
Renewable Generation (kW): 8
Energy Price ($/kWh): 0.15
▶ Start Simulation
■ Stop Simulation
Discharging to Meet Demand
11:23:05 PM: Discharging ESS
11:23:04 PM: Discharging ESS
11:23:03 PM: Discharging ESS
11:23:02 PM: Idle
11:23:01 PM: Charging ESS
27°C
Mostly clear
Search
ENG
IN
23:23
16-04-2025

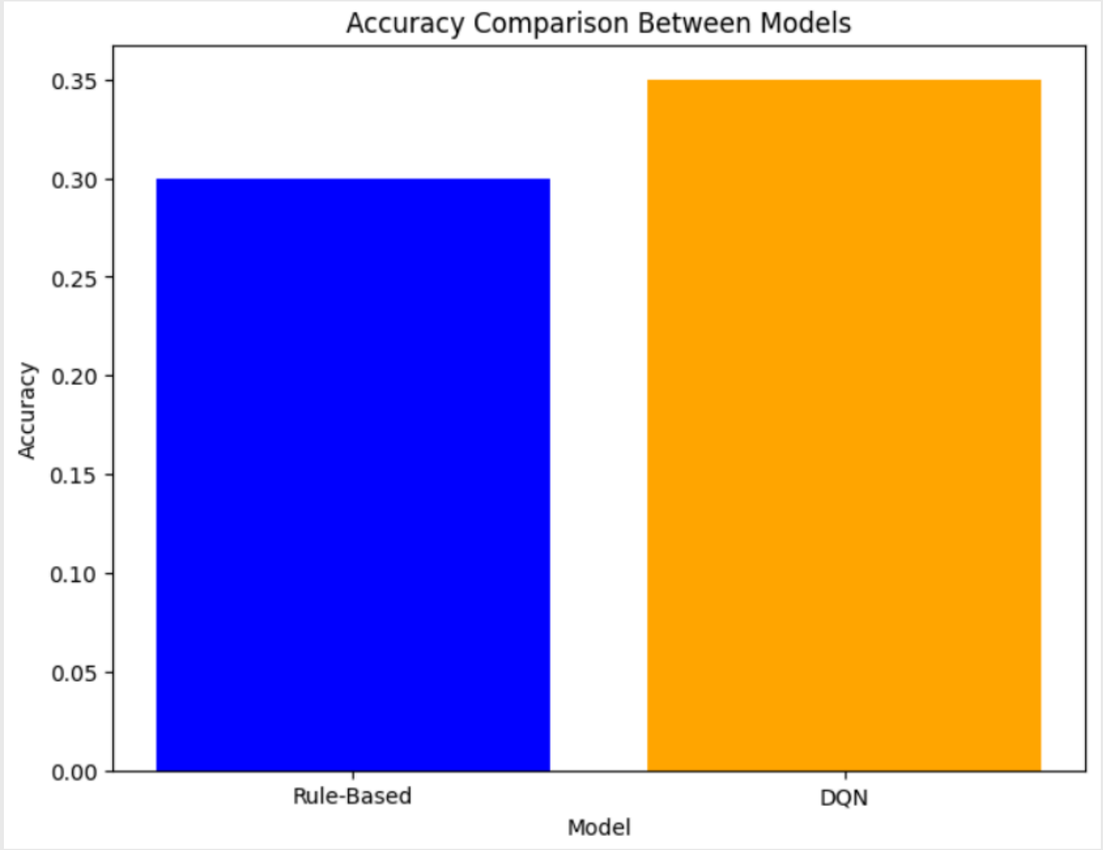
RESULT


Training Performance Over Time
Total Reward
3000
2000
1000
0
−1000
−2000
0
100
200
300
400
500
Episode

RESULT


DQN Predicted Actions vs Expected Actions
DQN Prediction
Expected Action
Action (0:Idle, 1:Charge, 2:Discharge)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Sample 1
Sample 2
Sample 3
Sample 4
Sample 5
Test Sample

RESULT


Accuracy Comparison Between Models
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Accuracy
Rule-Based
DQN
Model

THANK YOU