IoT Smart Meter with EV Charging Load Management Capability

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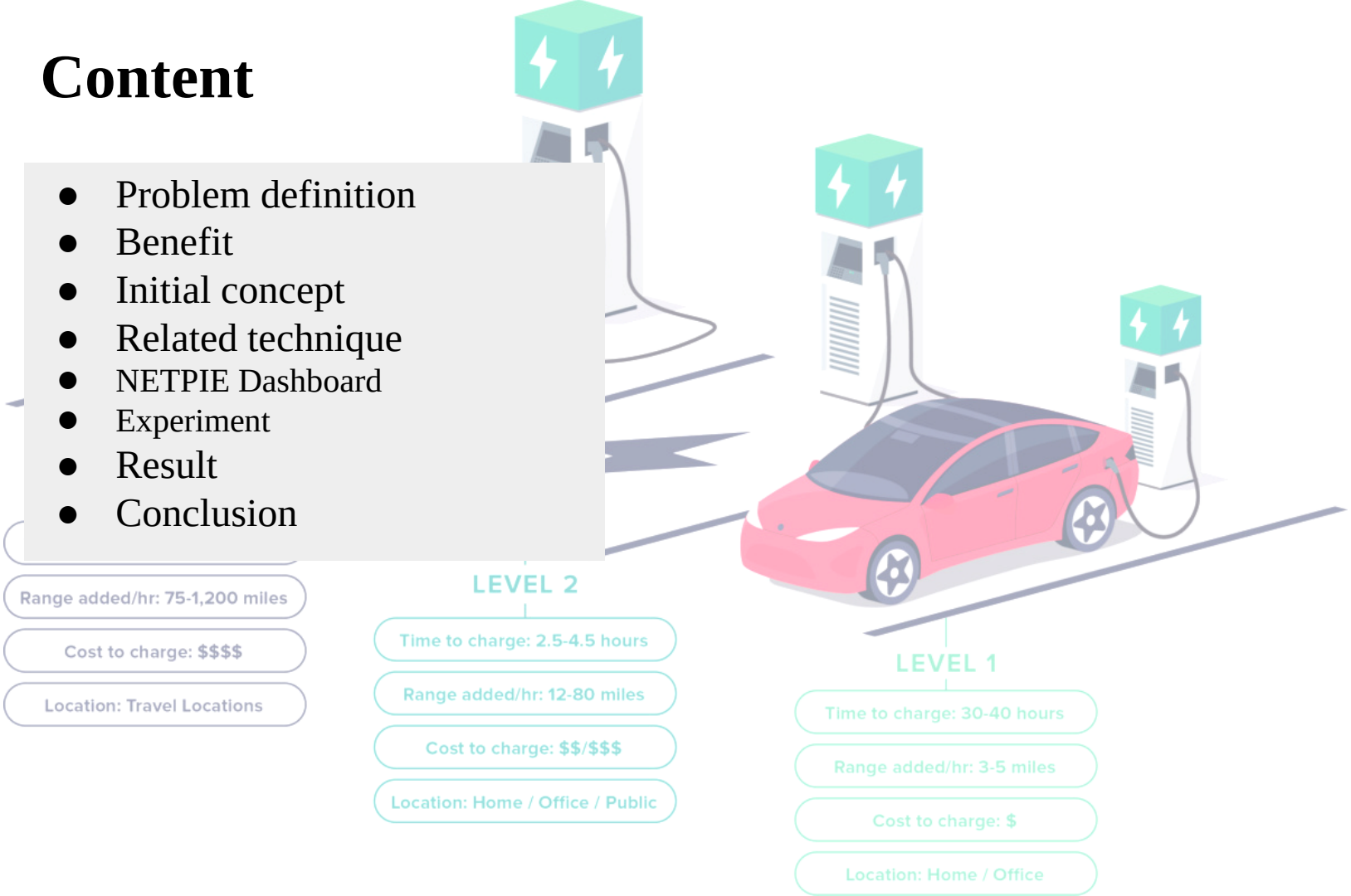
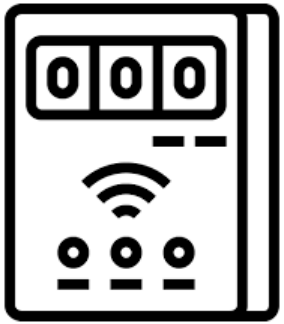


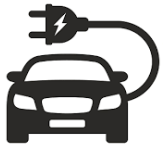
Problem Definition

The transformers in the distribution systems of the Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA) frequently experience problems due to overloading, which can cause fuses to cut off and result in power outages. As the use of electric vehicles is becoming more common, and usage patterns are becoming more synchronized, if smart meters can communicate with chargers in users' homes, it would help manage energy distribution for electric vehicles charging, allowing transformers to supply power continuously without overloading.



Benefits to EV Users

EV users will be notified when there is an increase in usage load in order to manage the charging time so that they will be able to manage Their time schedule.



Benefits to Electricity provider

Electricity provider can use the data on the dashboard to plan for budgeting for improvements to the distribution system (such as increasing the size of transformers).

Initial concept

Divided into three parts

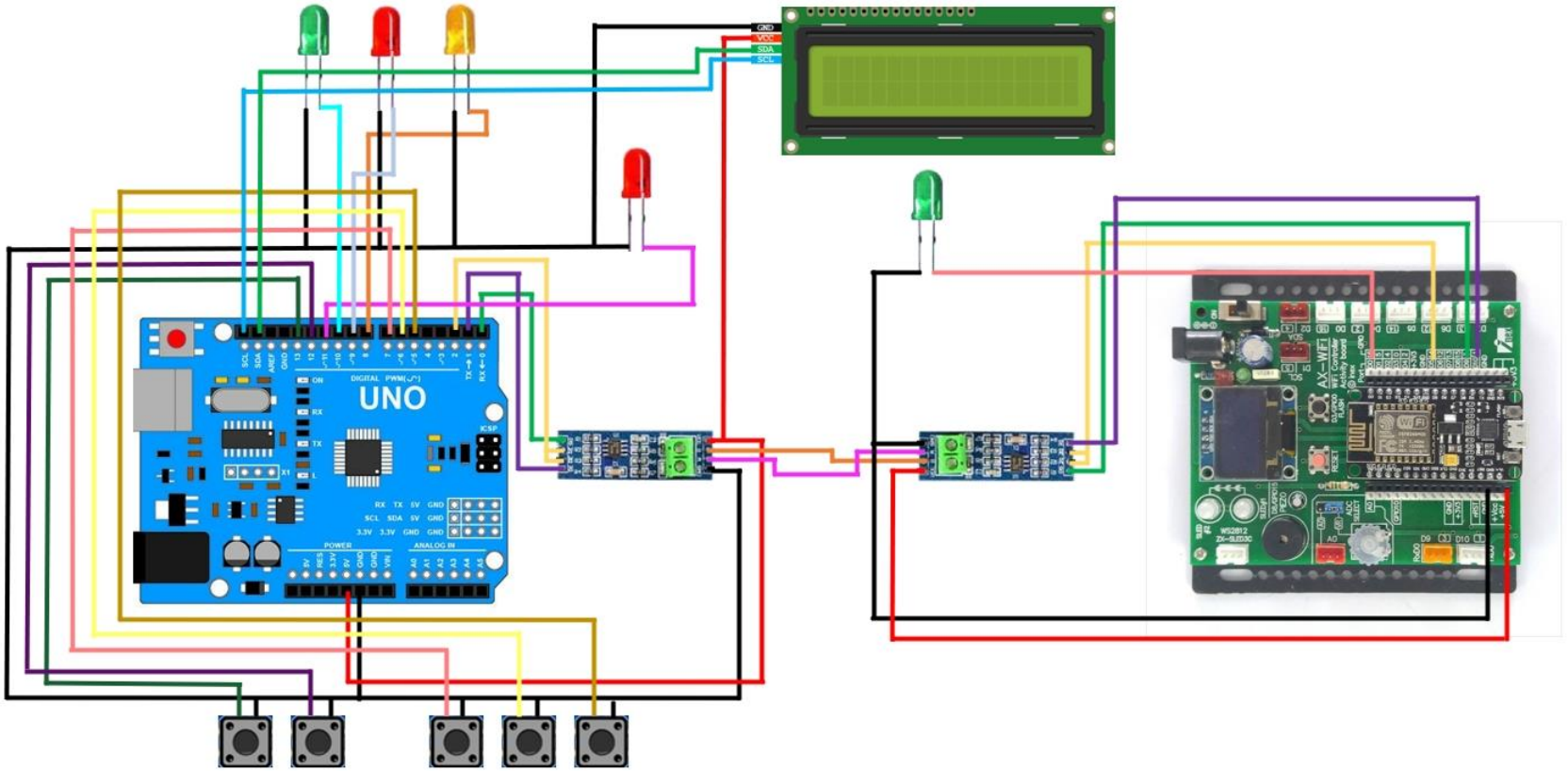
- Input - data (Simulation)
- Communication part
- Processing part

- **Simulation**
  - EV charger

- Modbus protocol (RS485)
- ESP8266 (Wifi Module)
- MQTT

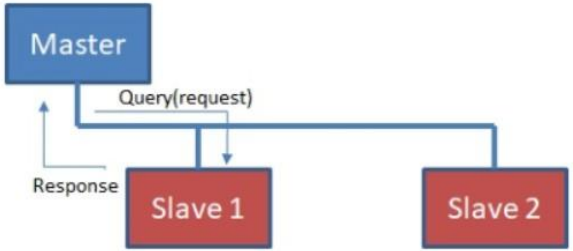
- **Calculation**
  - Power consumption
- **Operation**
  - Balance load
- **Notification**
- **Dashboard**

Wiring diagram



Related techniques

- **Modbus protocol**



It is an Open Protocol that can be used free of charge. The device that requires data is called Modbus Master (Client), while the device that provides data is called Modbus Slave (Server).

- **Type of Modbus**

  - **Modbus Serial**

    It is a communication by sending data along a serial cable between devices. The simplest communication method is to connect a serial cable between master and slave.

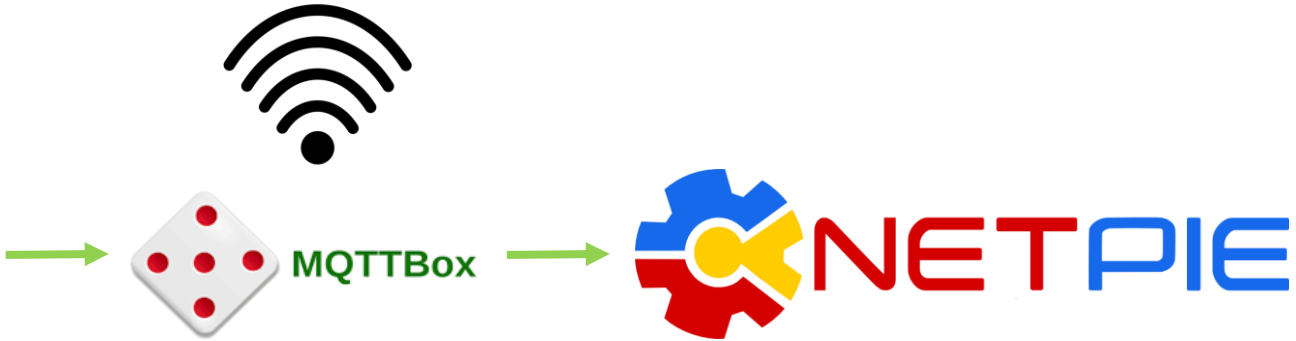
  - **Modbus TCP/IP**

    Ethernet communication is used with devices such as Ethernet Devices. A repeater can be connected to extend the distance without limits.

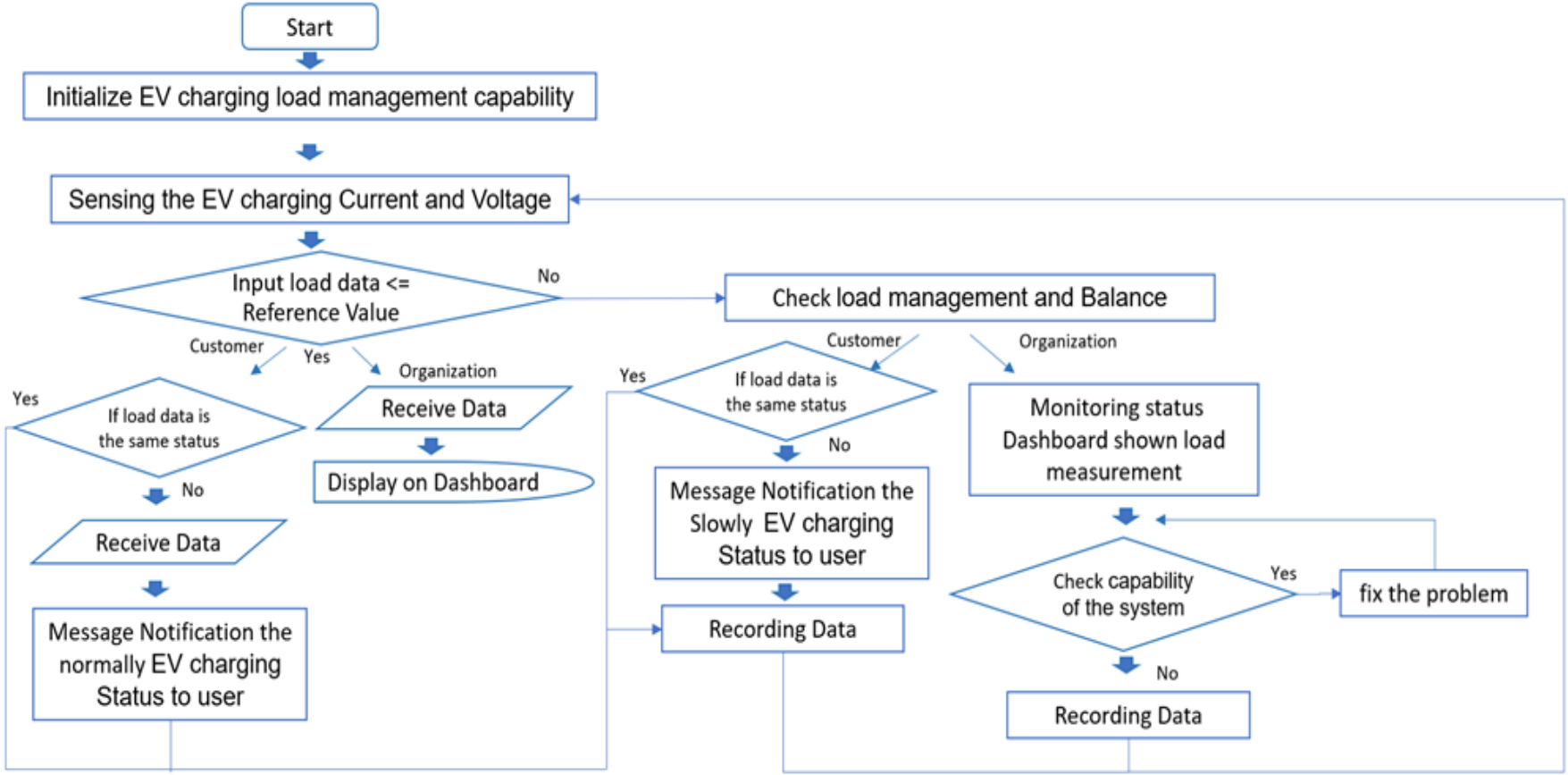
Related techniques

- **MQTT protocol**

MQTT is a standards-based messaging protocol. Or a set of rules used for machine-to-machine communication.

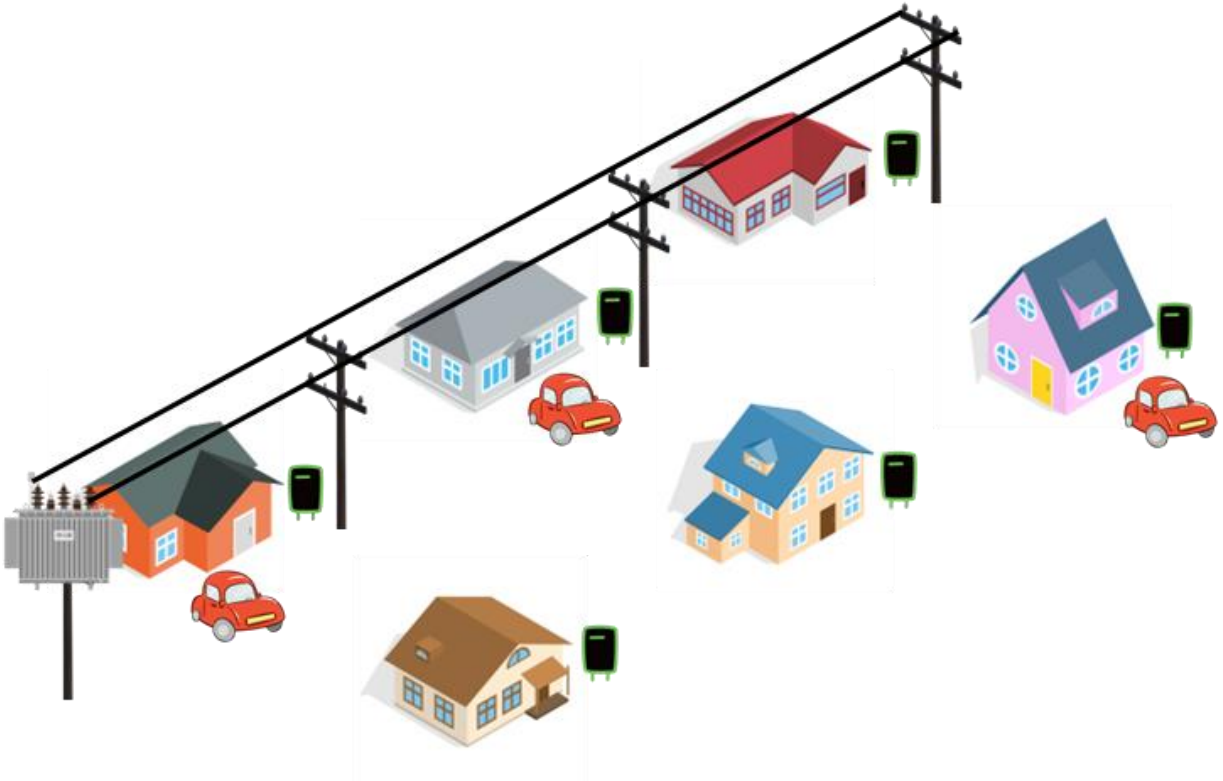


Flowchart of system



What about project

We simulate a village with 100 kVA transformers and 6 chargers.



Charger 1 = 20 kW

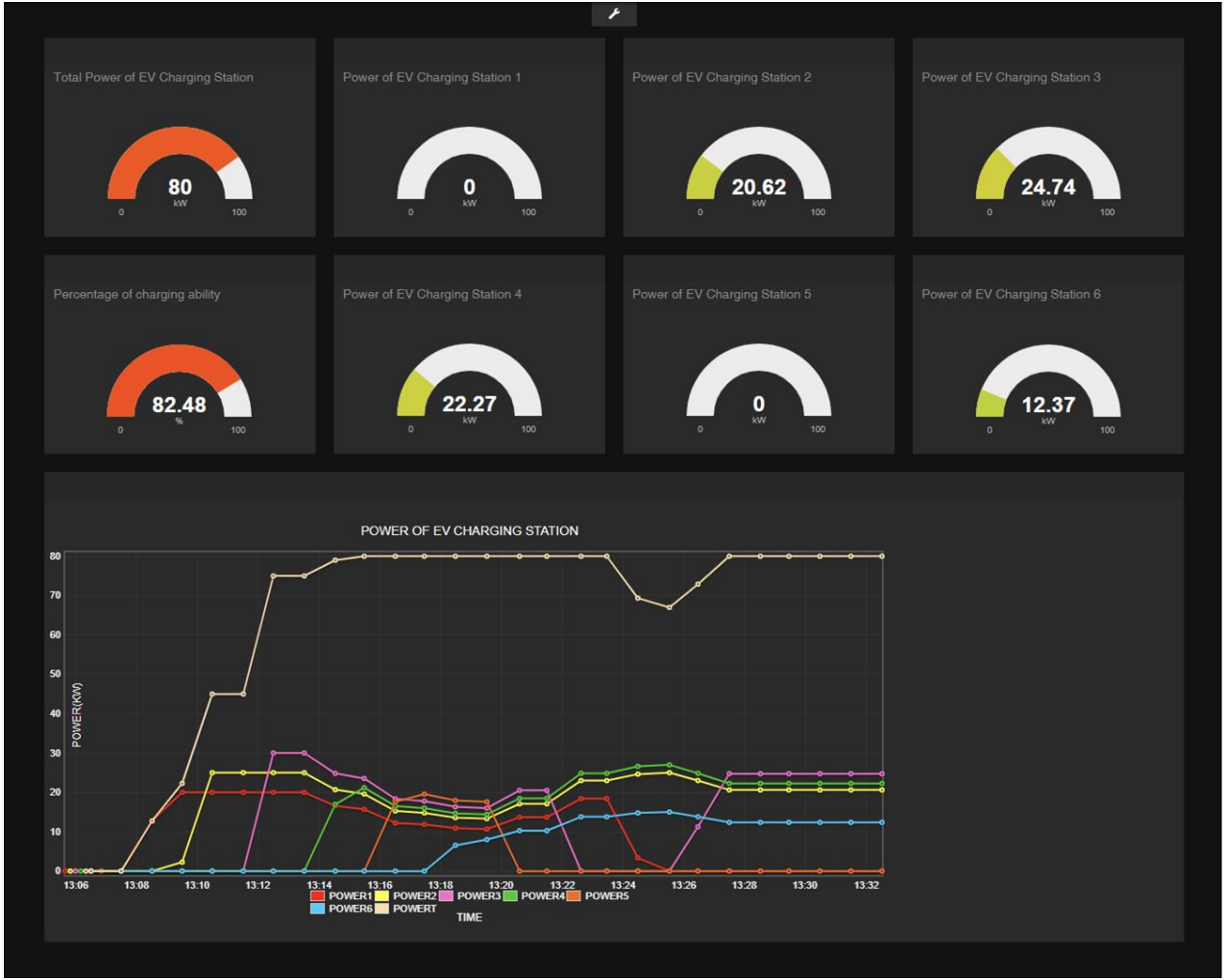
Charger 2 = 25 kW

Charger 3 = 30 kW

Charger 4 = 27 kW

Charger 5 = 23 kW

Charger 6 = 15 kW



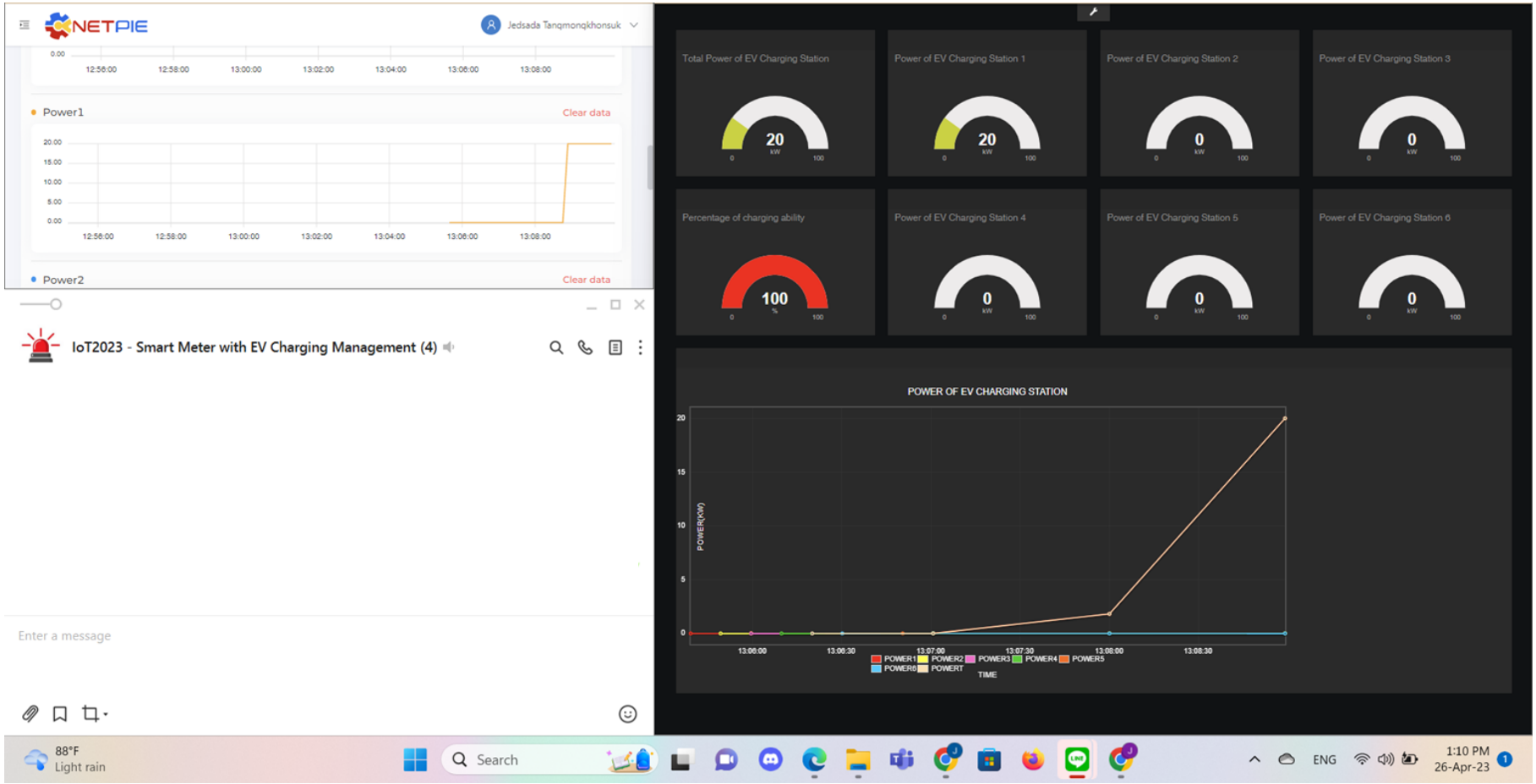
NETPIE Dashboard of Smart Meter with EV Charging Load Management Capability

Data Display Gauge Widget

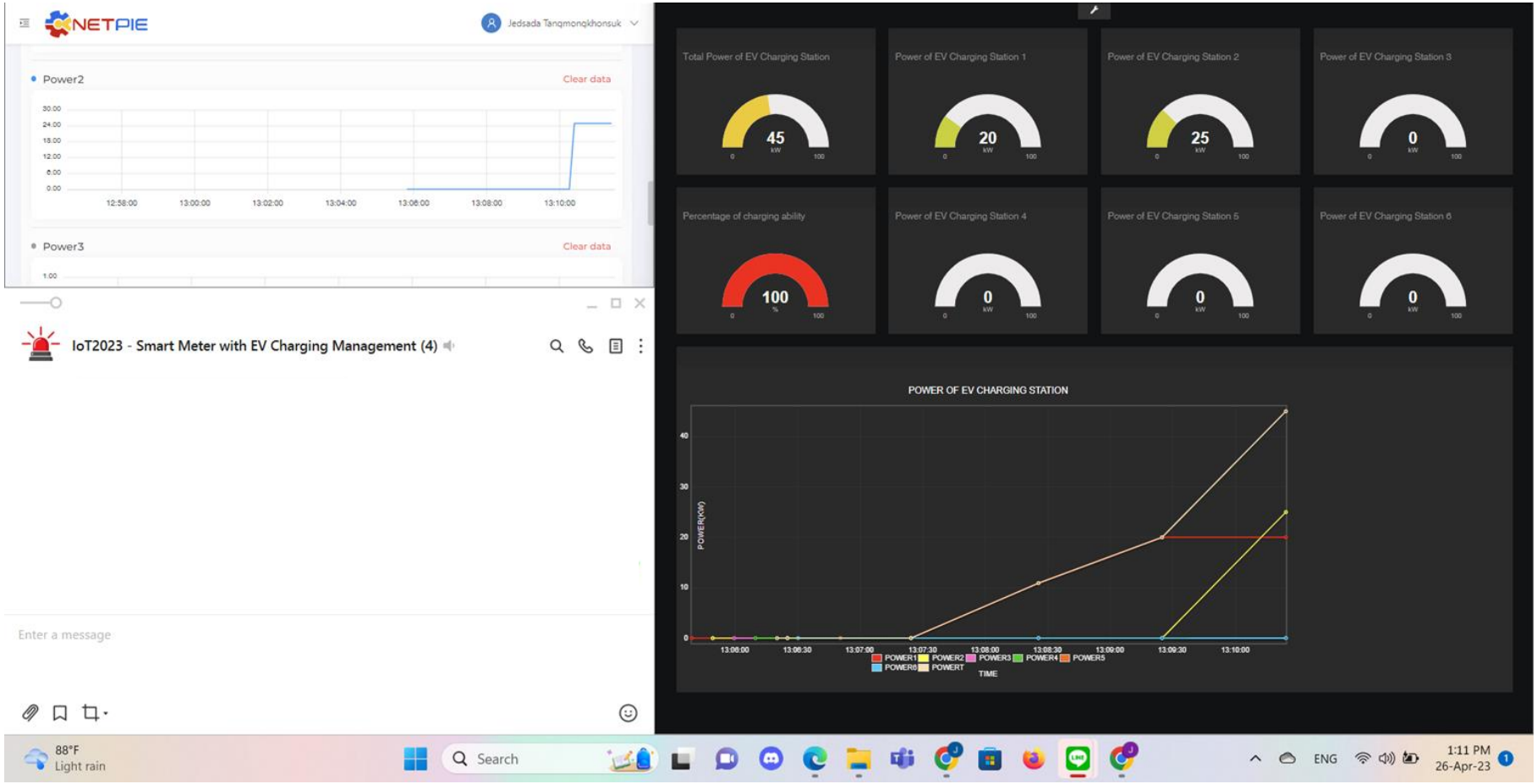
-Total Power of EV Charging Station
-Power of EV Charging Station 1,2,3,4,5 and 6
-Percentage of charging ability

Data Display FeedView Widget

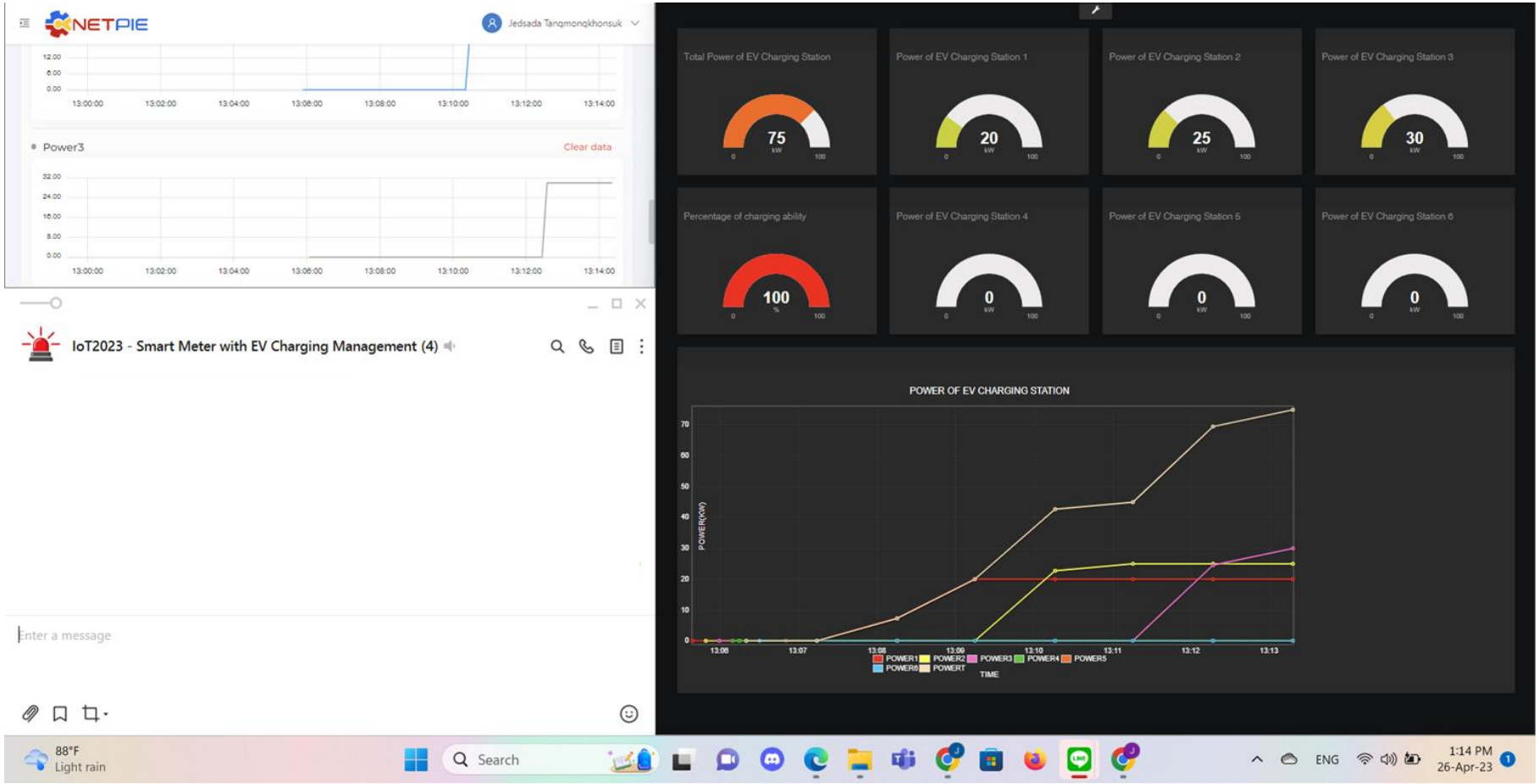
-Feed data of Total Power of EV Charging Station
-Feed data of Power of EV Charging Station 1,2,3,4,5 and 6


NETPIE
Jedsada Tangmongkhonsuk
Power1
Clear data
Power2
Clear data
IoT2023 - Smart Meter with EV Charging Management (4)
Enter a message
Total Power of EV Charging Station
Power of EV Charging Station 1
Power of EV Charging Station 2
Power of EV Charging Station 3
Percentage of charging ability
Power of EV Charging Station 4
Power of EV Charging Station 5
Power of EV Charging Station 6
POWER OF EV CHARGING STATION
POWER(KW)
TIME
POWER1 POWER2 POWER3 POWER4 POWER5
POWER6 POWERT
88°F
Light rain
Search
ENG
1:10 PM
26-Apr-23

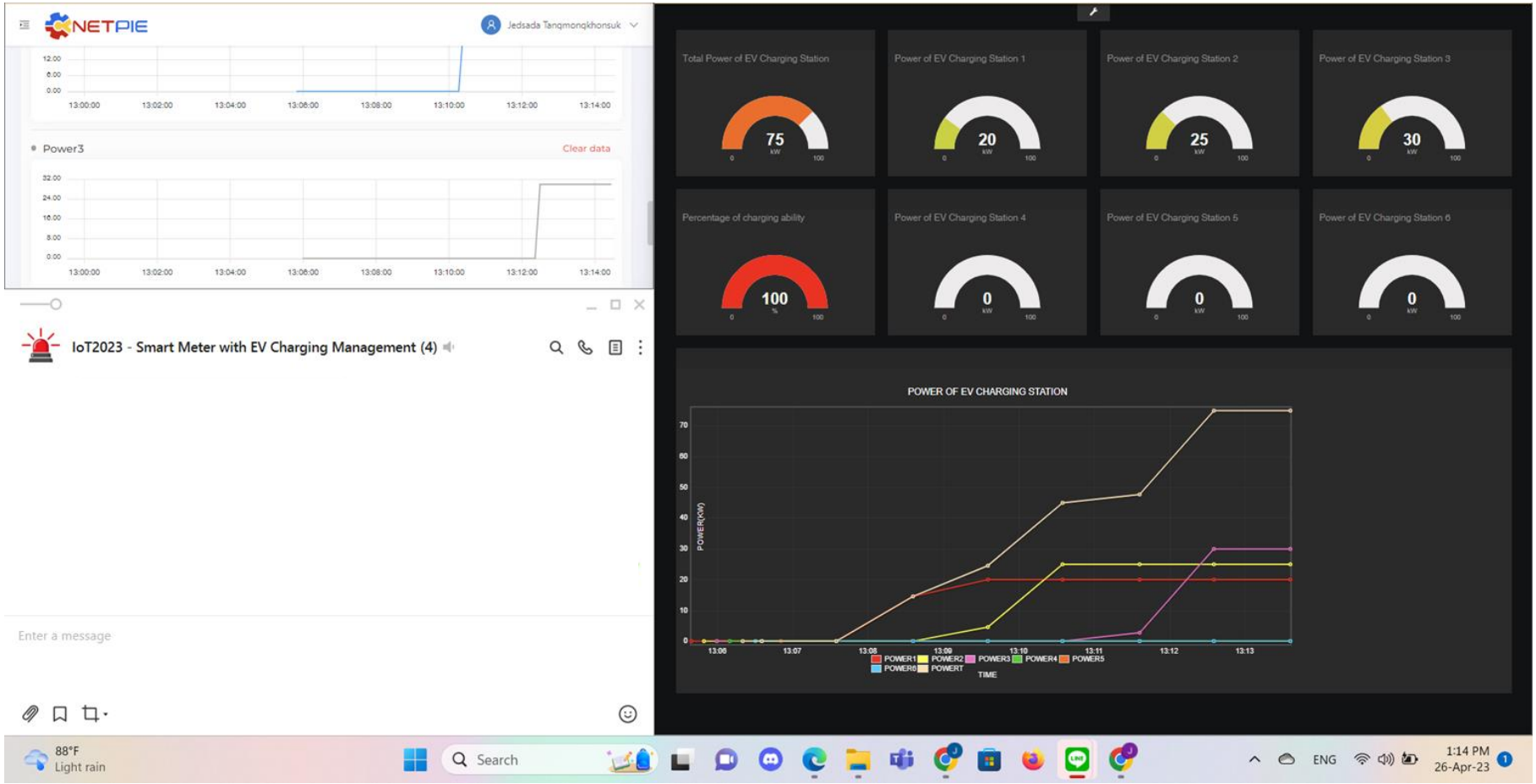
EV1 ON


NETPIE
Jedsada Tangmongkhonsuk
Power2
Clear data
30.00
24.00
18.00
12.00
6.00
0.00
12:58:00
13:00:00
13:02:00
13:04:00
13:06:00
13:08:00
13:10:00
Power3
Clear data
1.00
IoT2023 - Smart Meter with EV Charging Management (4)
Enter a message
Total Power of EV Charging Station
45
kW
Power of EV Charging Station 1
20
kW
Power of EV Charging Station 2
25
kW
Power of EV Charging Station 3
0
kW
Percentage of charging ability
100
%
Power of EV Charging Station 4
0
kW
Power of EV Charging Station 5
0
kW
Power of EV Charging Station 6
0
kW
POWER OF EV CHARGING STATION
POWER(KW)
40
30
20
10
0
13:06:00
13:06:30
13:07:00
13:07:30
13:08:00
13:08:30
13:09:00
13:09:30
13:10:00
POWER1 POWER2 POWER3 POWER4 POWER5
POWER6 POWERT
TIME
88°F
Light rain
Search
ENG
1:11 PM
26-Apr-23

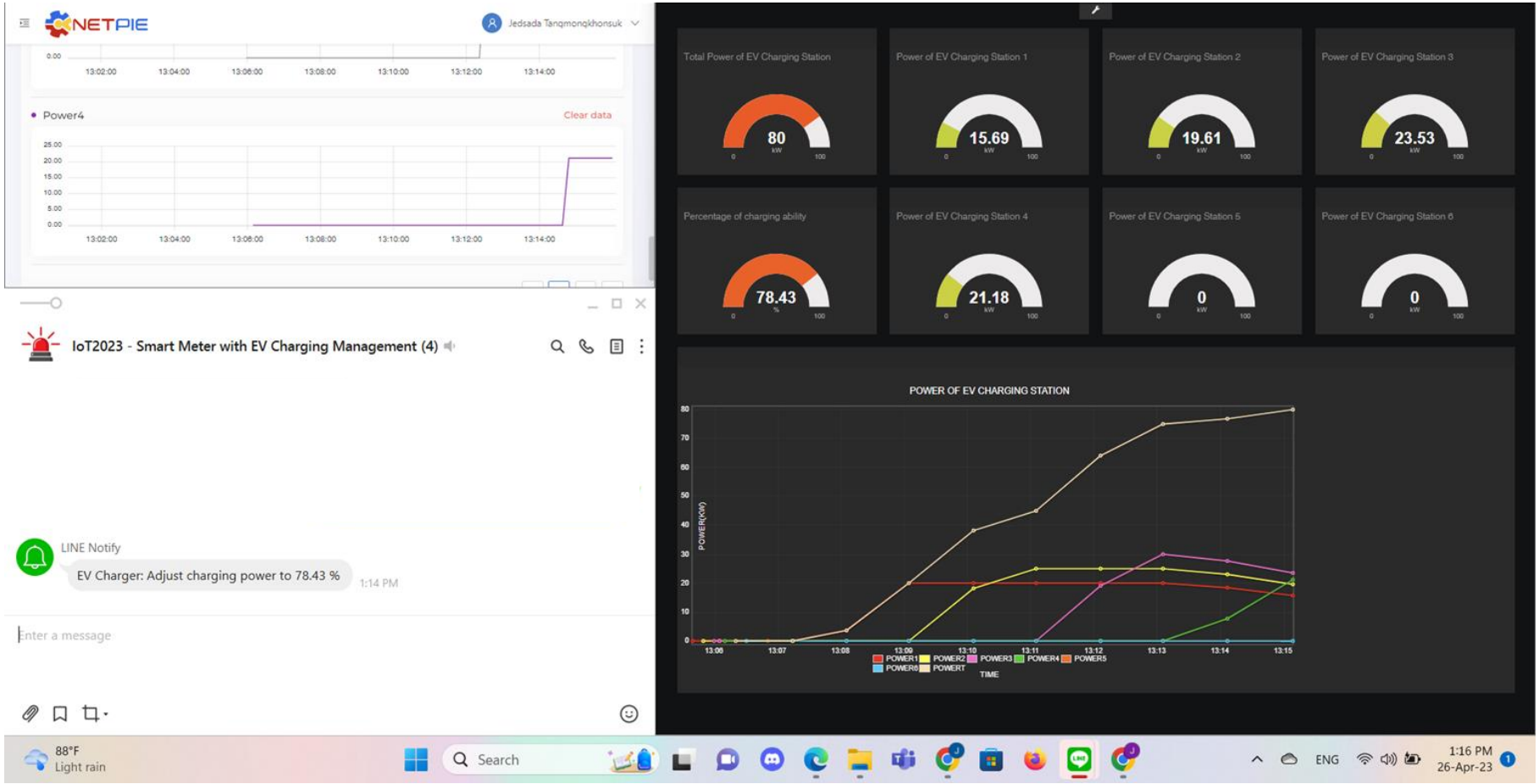
EV1 and 2 ON


NETPIE
Jedsada Tangmongkhonsuk
Power3
Clear data
IoT2023 - Smart Meter with EV Charging Management (4)
Enter a message
Total Power of EV Charging Station
75
Power of EV Charging Station 1
20
Power of EV Charging Station 2
25
Power of EV Charging Station 3
30
Percentage of charging ability
100
Power of EV Charging Station 4
0
Power of EV Charging Station 5
0
Power of EV Charging Station 6
0
POWER OF EV CHARGING STATION
POWER(KW)
TIME
POWER1 POWER2 POWER3 POWER4 POWER5
POWER6 POWERT
88°F
Light rain
Search
ENG
1:14 PM
26-Apr-23

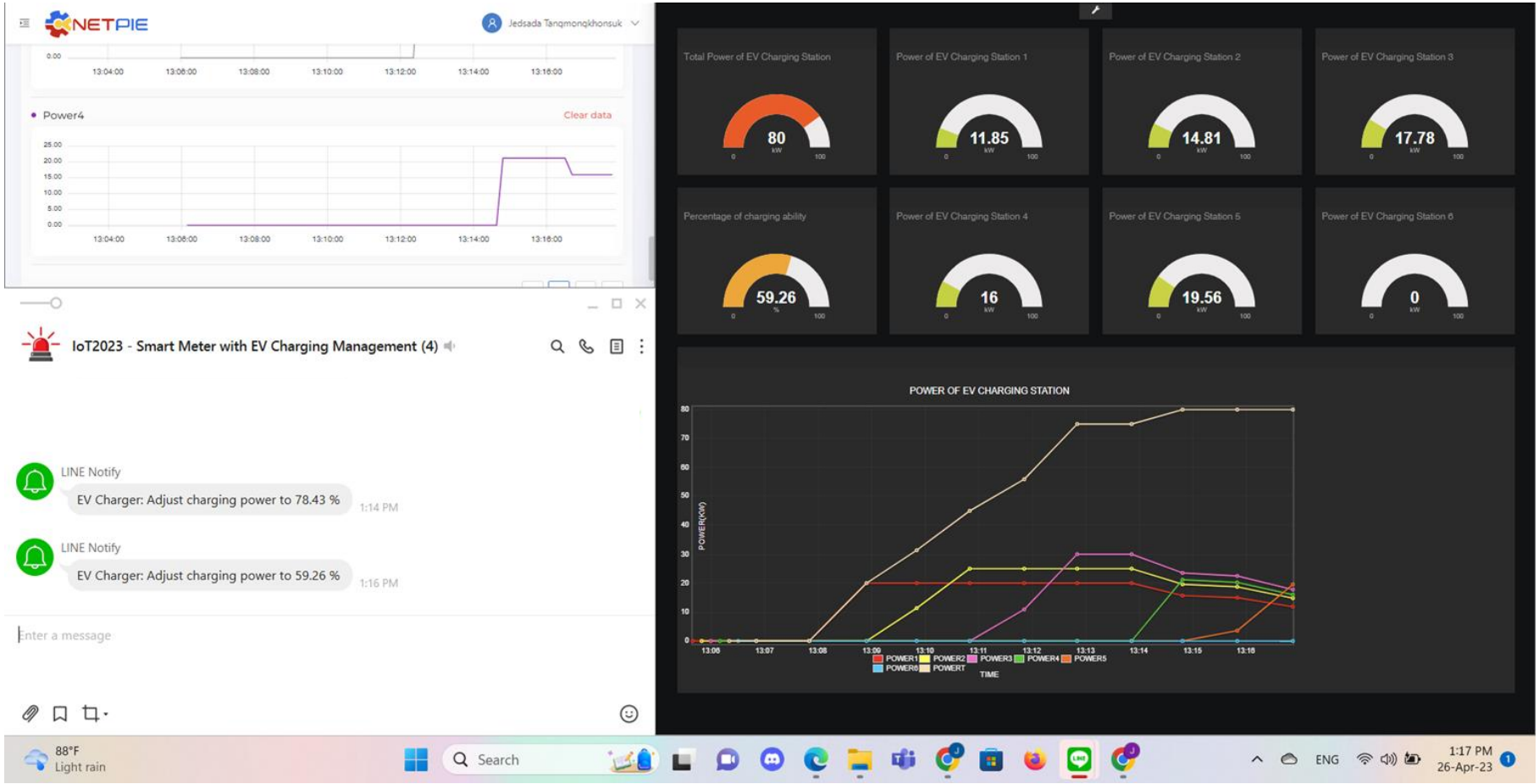
EV1,2 and 3 ON



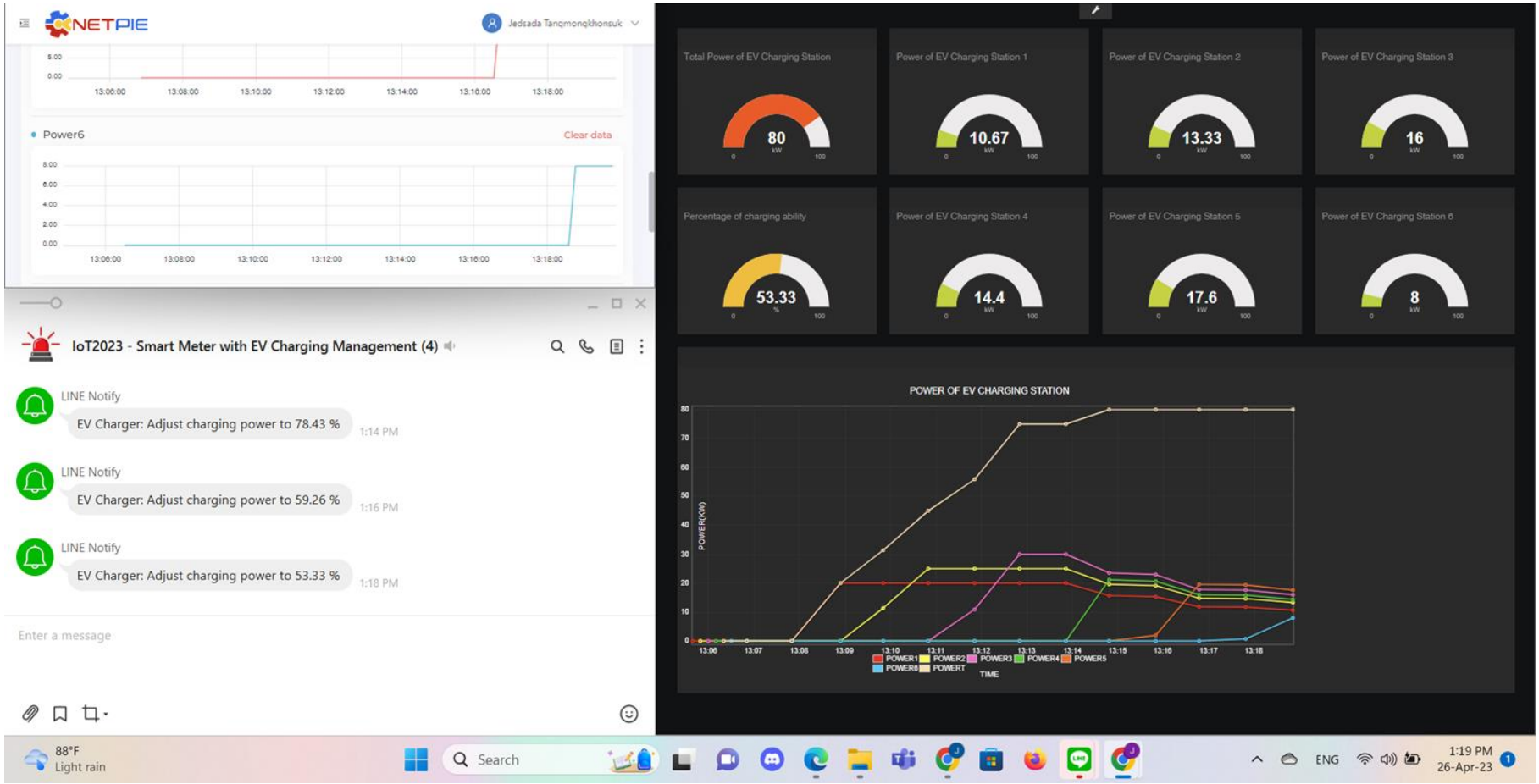
EV1,2 and 3 ON continually



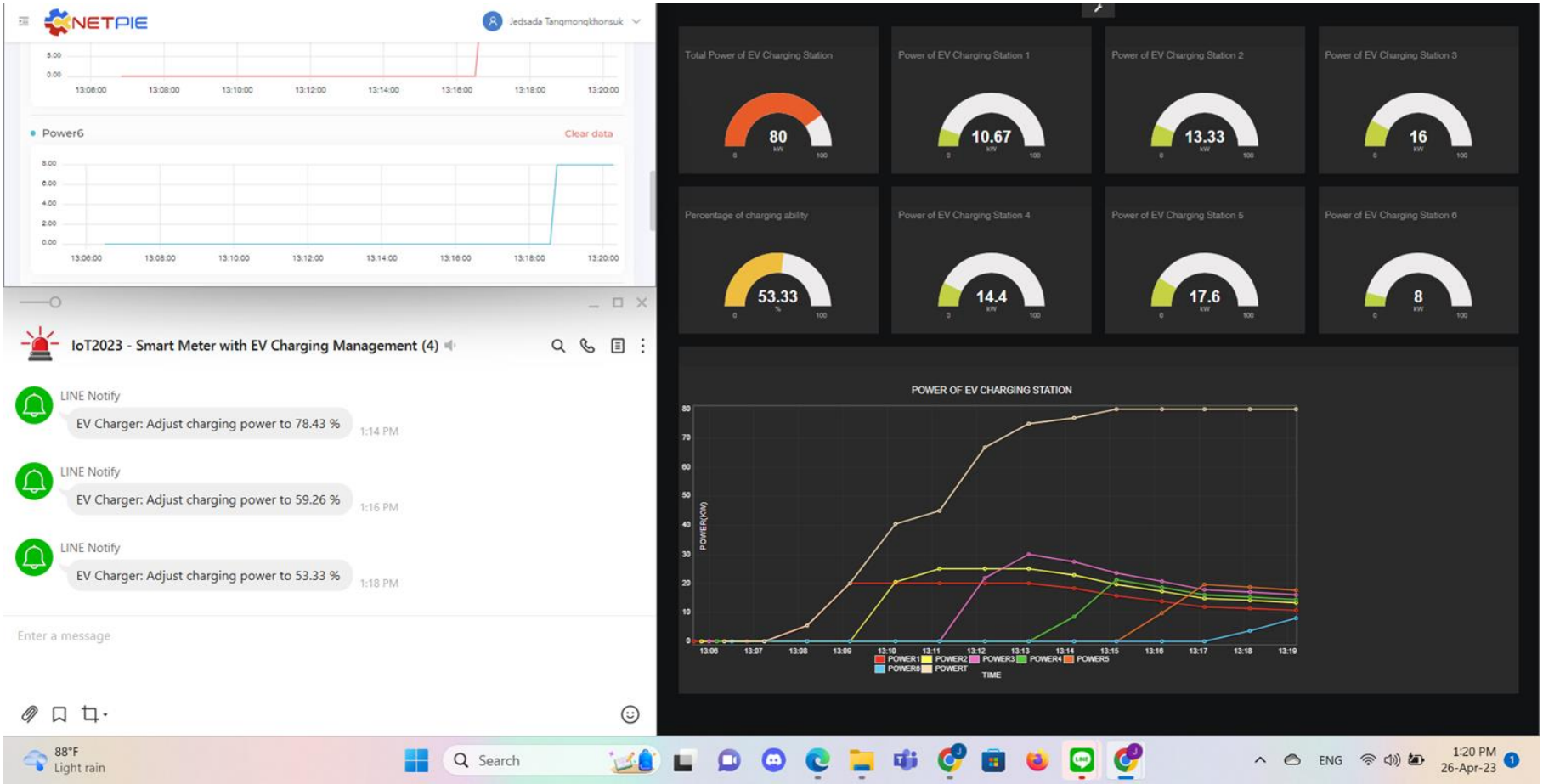
EV1,2,3 and 4 ON - Limit Maximum Power 80 kW, Charging ability of Power 78.43%



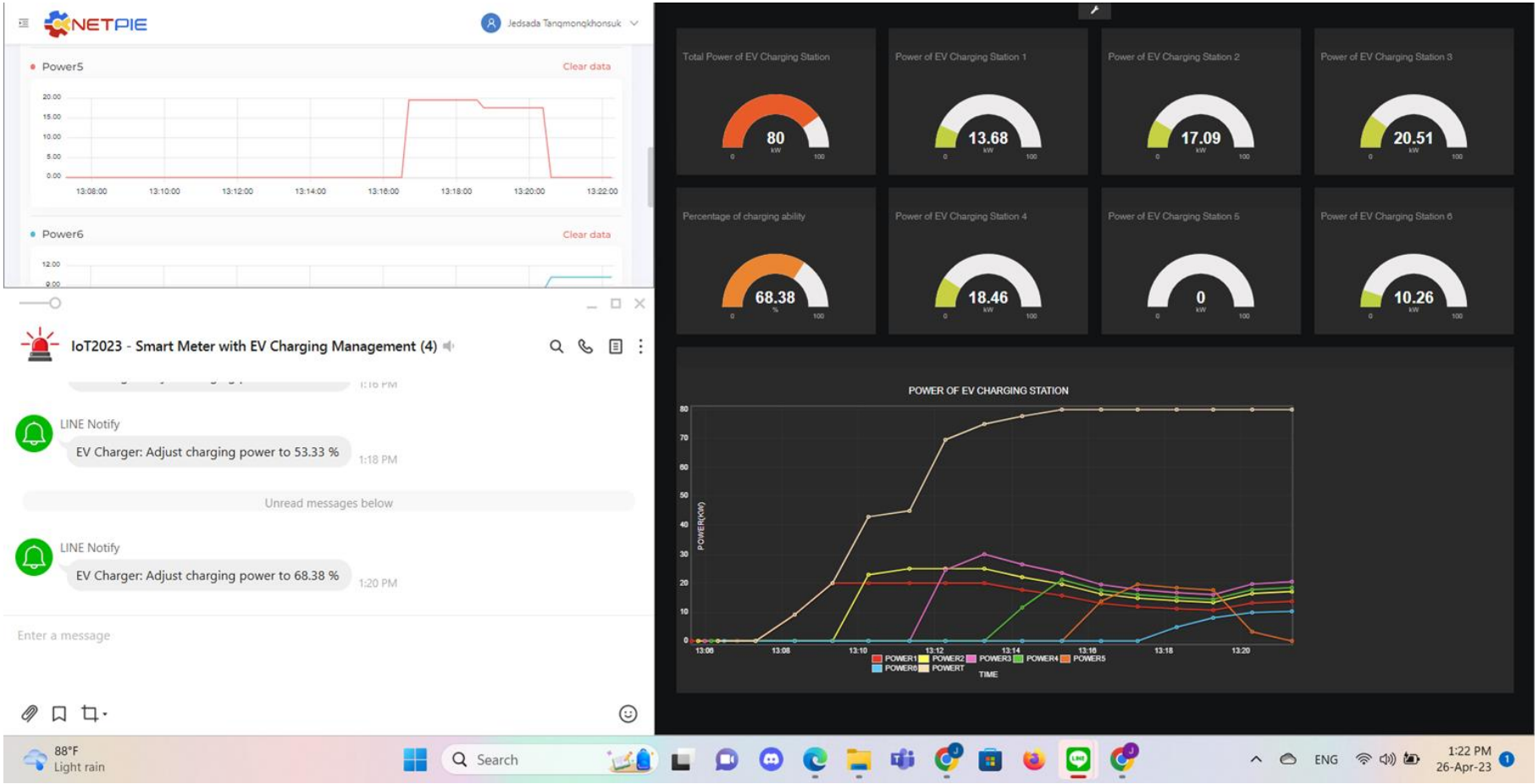
EV1,2,3,4 and 5 ON - Limit Maximum Power 80 kW, Charging ability of Power 59.26%



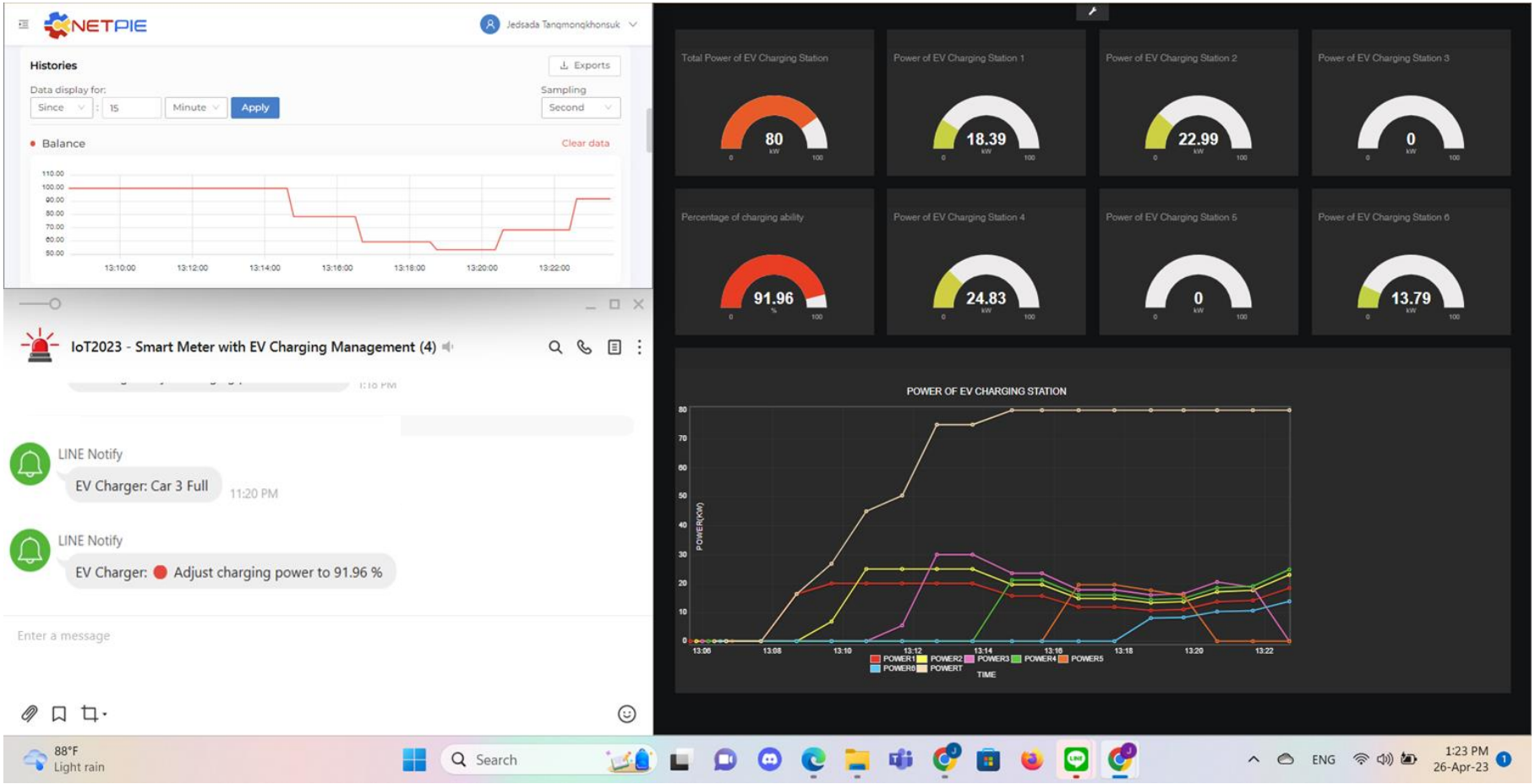
EV1,2,3,4,5 and 6 ON - Limit Maximum Power 80 kW, Charging ability of Power 53.33%



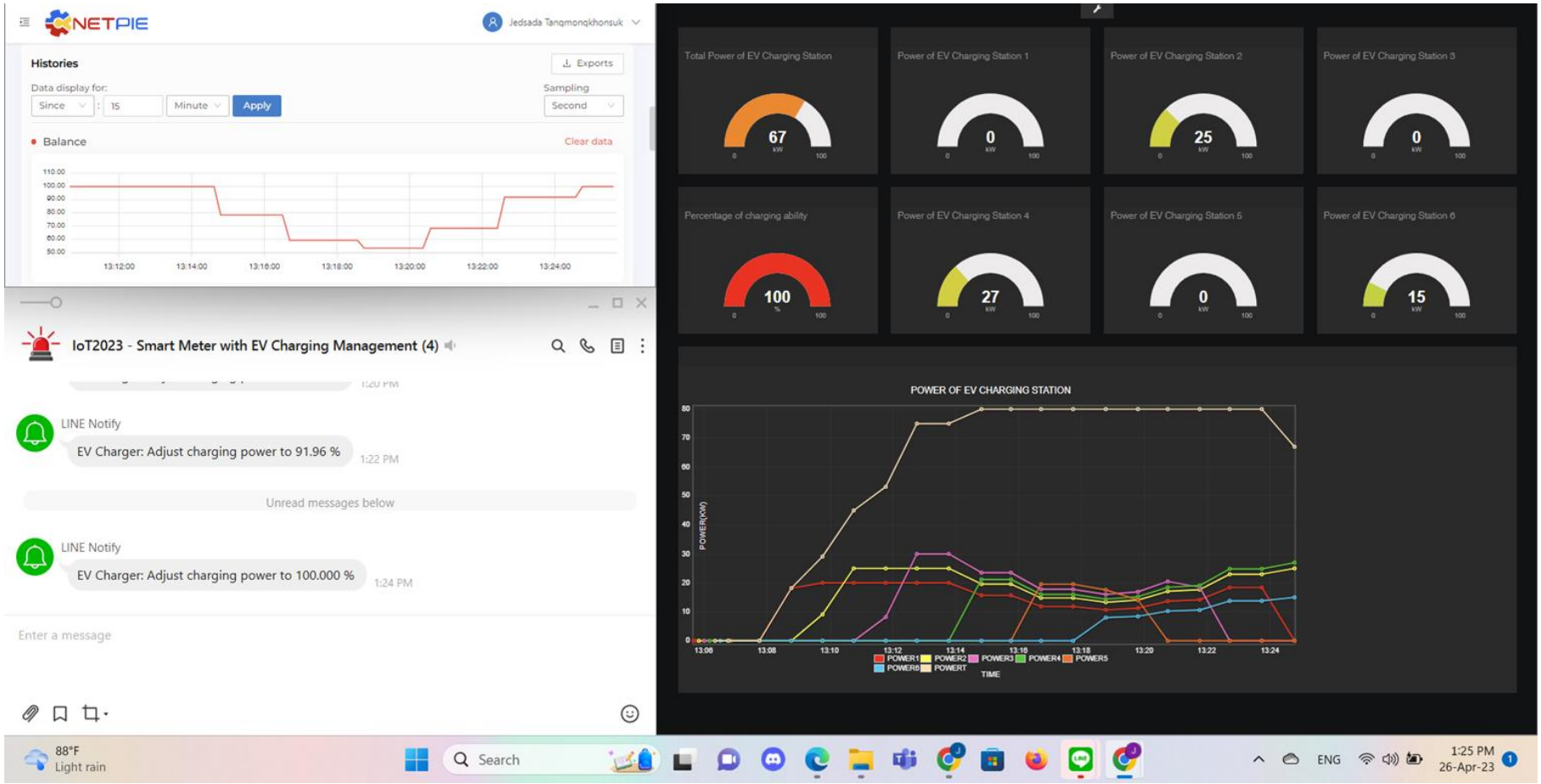
EV1,2,3,4,5 and 6 ON continually - Limit Maximum Power 80 kW, Charging ability of Power 53.33%



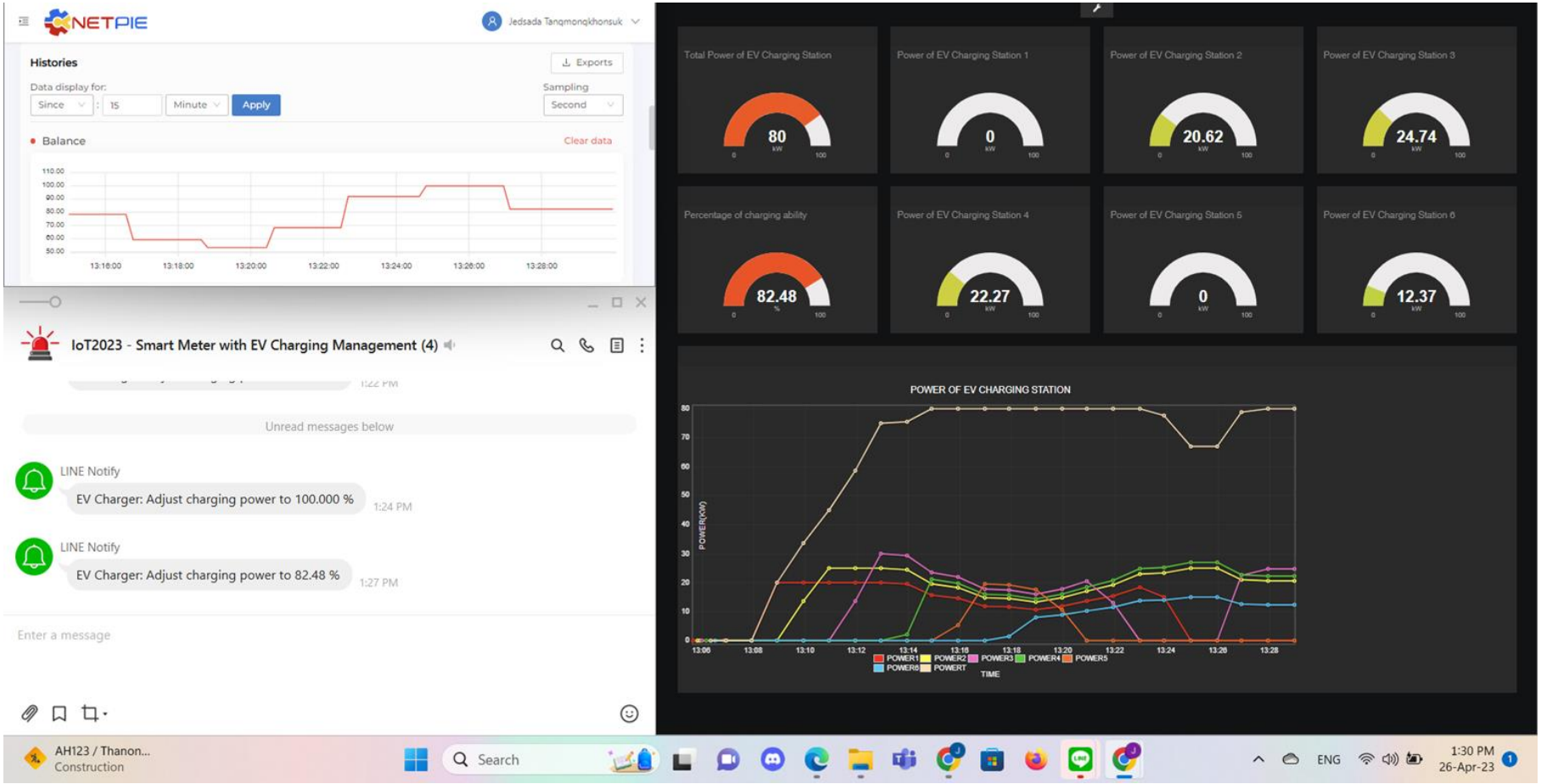
EV1,2,3,4 and 6 ON, EV5 OFF - Limit Maximum Power 80 kW, Charging ability of Power 68.38%



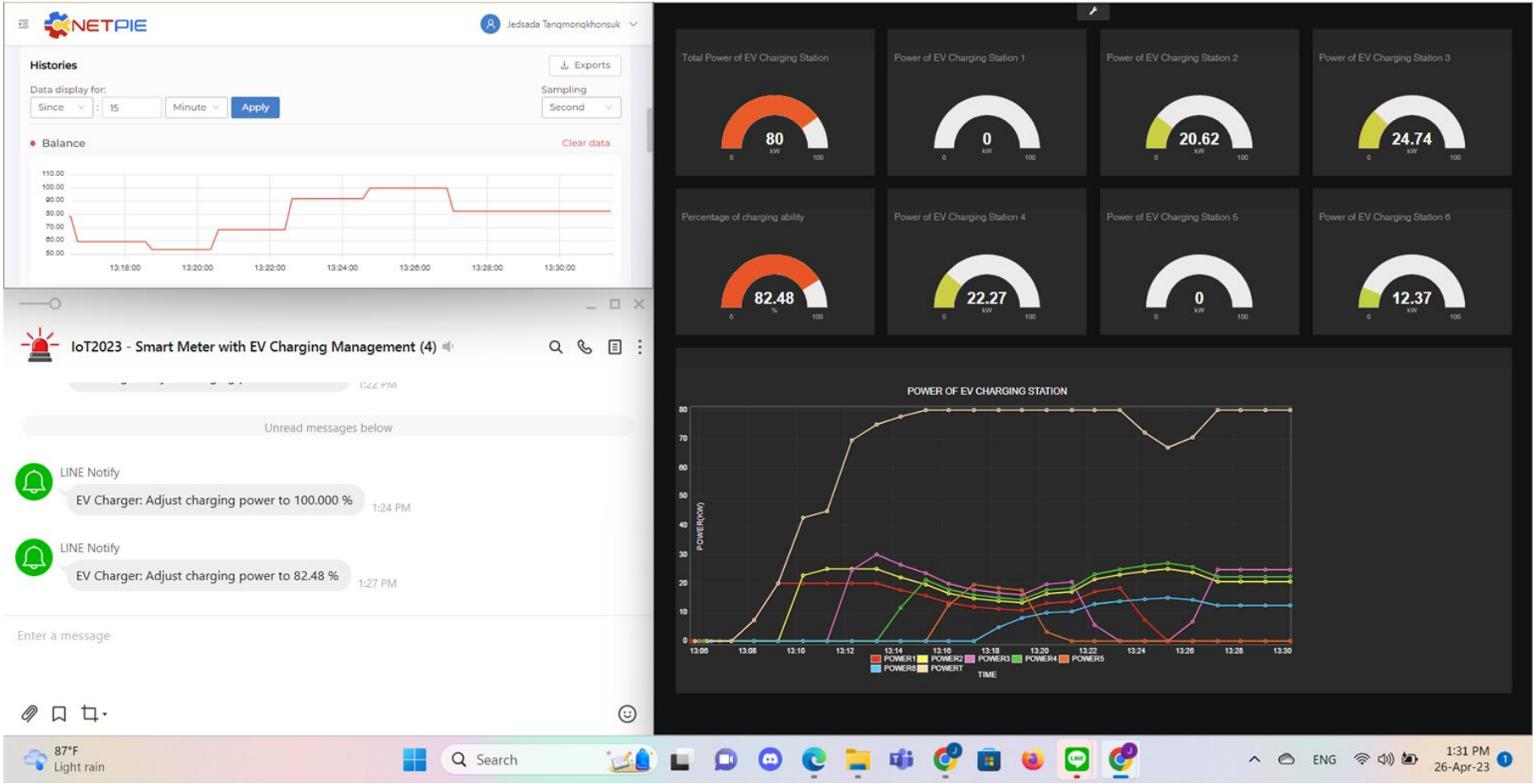
EV1,2,4 and 6 ON, EV3 and 5 OFF - Limit Maximum Power 80 kW, Charging ability of Power 91.96%



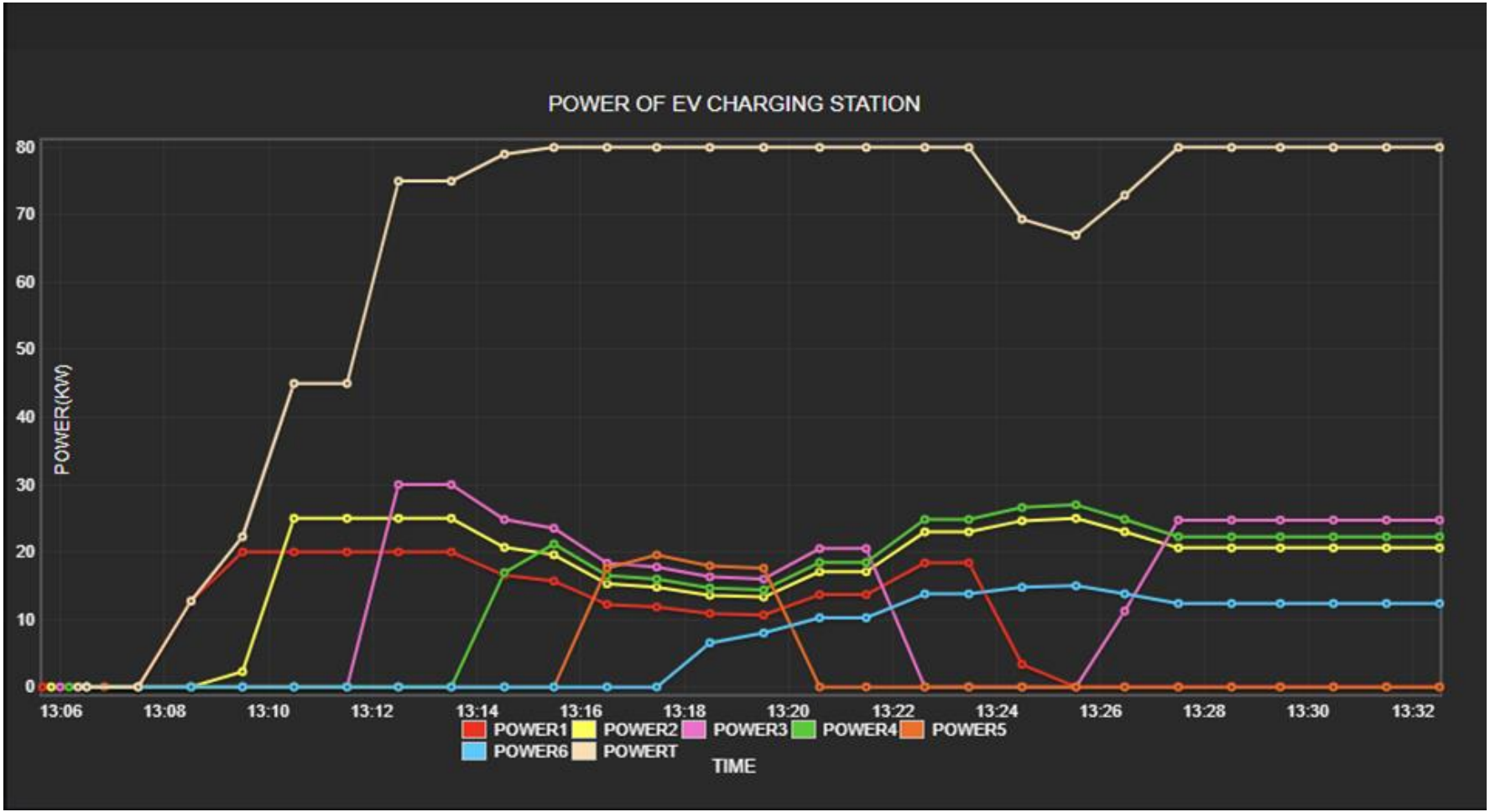
EV2,4 and 6 ON, EV1,3 and 5 OFF - Charging ability of Power 100 %



EV2,3,4 and 6 ON, EV1and 5 OFF -Limit Maximum Power 80 kW, Charging ability of Power 82.48 %



EV2,3,4 and 6 ON, EV1and 5 OFF <u>continually</u> -Limit Maximum Power 80 kW, Charging ability of Power 82.48 %



Feed data of Total Power of EV Charging Station and Power of EV Charging Station 1,2,3,4,5 and 6

Result

No	Power (kW)							charging ability	Notification
	EV 1	EV 2	EV 3	EV 4	EV 5	EV 6	EV Total	%	
	20	25	30	27	25	15	Max 80	Max 100	
1	ON	OFF	OFF	OFF	OFF	OFF	20	100	-
	20	0	0	0	0	0			
2	ON	ON	OFF	OFF	OFF	OFF	45	100	-
	20	25	0	0	0	0			
3	ON	ON	ON	OFF	OFF	OFF	75	100	-
	20	25	30	0	0	0			
4	ON	ON	ON	ON	OFF	OFF	80	78.43	notify
	15.69	19.61	23.53	21.18	0	0			
5	ON	ON	ON	ON	ON	OFF	80	59.26	notify
	11.85	14.81	17.78	16	19.56	0			
6	ON	ON	ON	ON	ON	ON	80	53.33	notify
	10.67	13.33	16	14.4	17.6	8			
7	ON	ON	ON	ON	OFF	ON	80	68.38	notify
	13.68	17.09	20.51	18.46	0	10.26			
8	ON	ON	OFF	ON	OFF	ON	80	91.96	notify
	18.39	22.99	0	24.83	0	13.79			
9	OFF	ON	OFF	ON	OFF	ON	67	100	notify
	0	25	0	27	0	15			
10	OFF	ON	ON	ON	OFF	ON	80	82.48	notify
	0	20.62	24.74	22.27	0	12.37			

Table1. Power, charging ability and Notifications in different cases.

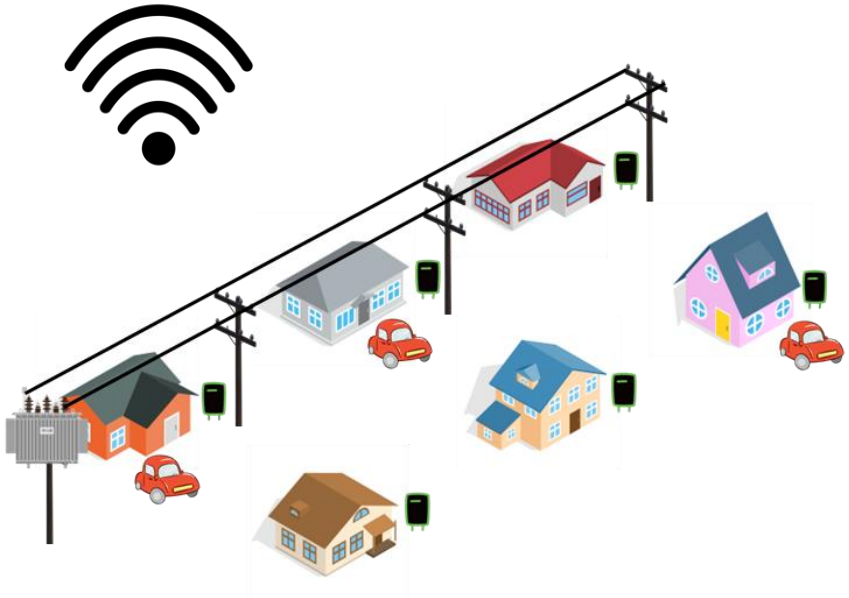
	A	B	C	D	E	F	G	H	I
1	time	Balance	Power1	Power2	Power3	Power4	Power5	Power6	PowerT
2	26-04-23 13:10	100	20	16.66667	0	0	0	0	36.66667
3	26-04-23 13:11	100	20	25	0	0	0	0	45
4	26-04-23 13:12	100	20	25	16.36364	0	0	0	61.36364
5	26-04-23 13:13	100	20	25	30	0	0	0	75
6	26-04-23 13:14	94.11727	18.82455	23.53	28.23545	5.776364	0	0	76.36364
7	26-04-23 13:15	78.43	15.69	19.61	23.53	21.18	0	0	80
8	26-04-23 13:16	70.762	14.154	17.69	21.23	19.108	7.824	0	80
9	26-04-23 13:17	59.26	11.85	14.81	17.78	16	19.56	0	80
10	26-04-23 13:18	57.481	11.496	14.366	17.246	15.52	18.972	2.4	80
11	26-04-23 13:19	53.33	10.67	13.33	16	14.4	17.6	8	80
12	26-04-23 13:20	61.53909	12.31182	15.38091	18.46	16.61455	8	9.232727	80
13	26-04-23 13:21	68.38	13.68	17.09	20.51	18.46	0	10.26	80
14	26-04-23 13:22	79.09818	15.82091	19.77182	11.18727	21.35545	0	11.86455	80
15	26-04-23 13:23	91.96	18.39	22.99	0	24.83	0	13.79	80
16	26-04-23 13:24	94.372	12.873	23.593	0	25.481	0	14.153	76.1
17	26-04-23 13:25	100	0	25	0	27	0	15	67
18	26-04-23 13:26	100	0	25	0	27	0	15	67
19	26-04-23 13:27	82.48	0	20.62	24.74	22.27	0	12.37	80
20	26-04-23 13:28	82.48	0	20.62	24.74	22.27	0	12.37	80
21	26-04-23 13:29	82.48	0	20.62	24.74	22.27	0	12.37	80

Data Feed Histories (Sampling in Minute)

Conclusion

- Input and communication
  - Add and remove EV from the system including power adjustment for each EV user
  - Transmit and receive input and processing parts working on Modbus with load balancing function
  - The power consumption will be displays on LCD screen to check the correct information between the data sent from Modbus and shown on the dashboard
- Dashboard
  - Devices connects via Netpie,which stores their information
  - Display the required data like power consumption which will be able to export data to excel
- Notification
  - Users receive information about the percentage of charging when power load has fallen below 100% and goes back to a normal state
  - Immediately, the charger is full this data will be transmitted to the user via line notification

IoT Smart Meter with EV Charging Load Management Capability



THANK YOU

Let’s join our line notification group.