Energy Optimization

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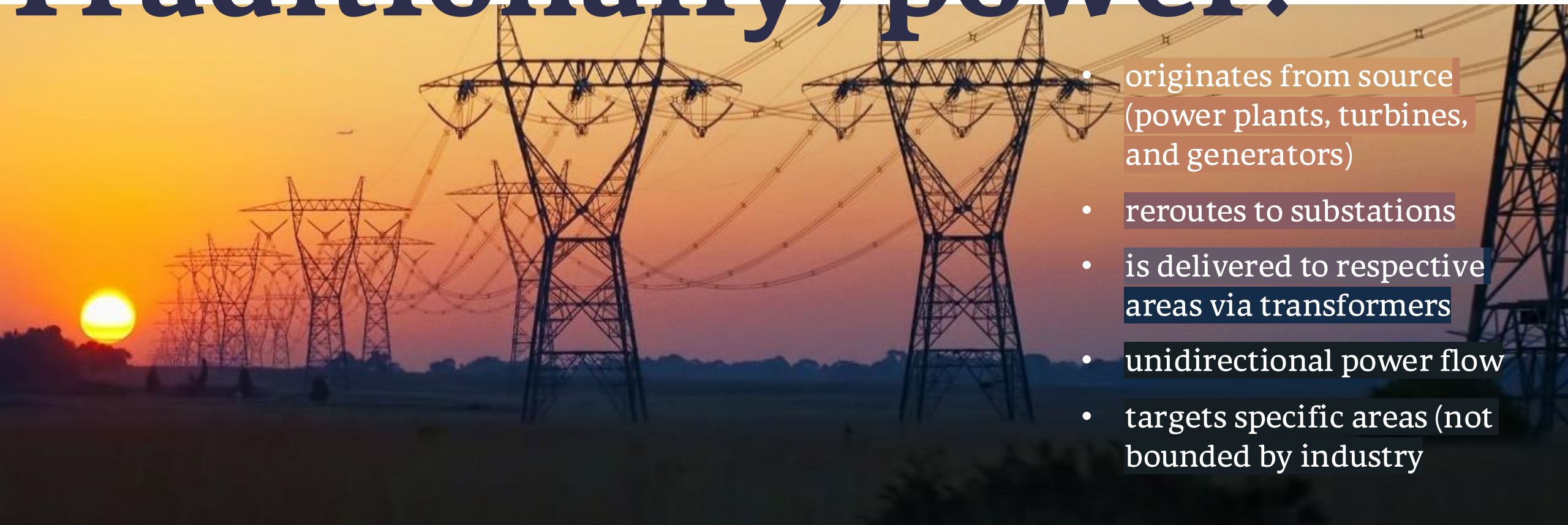
power is out.

what happens next?

blackout.

Traditionally, power:



- originates from source (power plants, turbines, and generators)
- reroutes to substations
- is delivered to respective areas via transformers
- unidirectional power flow
- targets specific areas (not bounded by industry

hence,

smart grids.

Intelligent power grids with:

- Bidirectional power flow
- Self-monitoring energy distribution
- Sensors which can automatically troubleshoot in case of an outage (as opposed to manual restoration)
- **Can be optimized using AI**

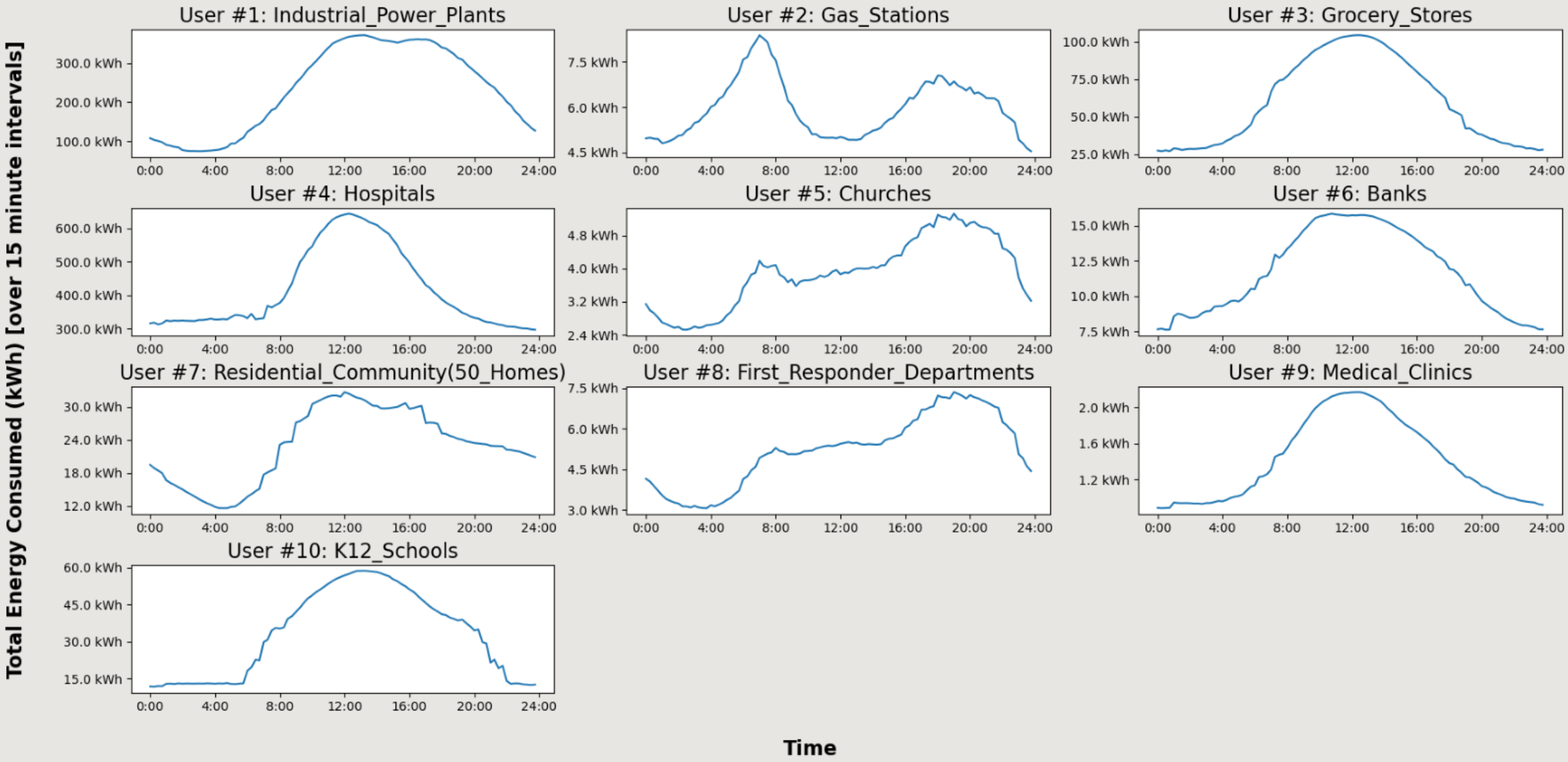
User Rank	User Type	User Count
1.	Industrial (Power Plant)	1
2.	Gas Stations	10
3.	Grocery Stores	9
4.	Hospitals	2
5.	Churches	30
6.	Banks	9
7.	Residential Communities	7
8.	First Responder Departments	4
9.	Medical Clinics	7
10.	K12 Schools	12

Belleview User Types

Main takeaways:

- Diverse collection of services
- Different characteristics
- **Different energy consumption peak times.**

Daily Energy Consumption for 10 Selected User Types



Initial Ranking:

<u>FLAWED</u>: Does not account for variable factors (e.g., generators).

Loss of power at hospital---->major impact

- Generators take 10-120 seconds to power on
- Lasts for 96 hours minimum *(OSHA regulations)*

Similar situation with banks, power plants, and first responder departments.

User Rank	User Type	User Count
1.	Industrial / Power Plants / Utility	1
2.	Gas Stations	10
3.	Grocery Stores	9
4.	Hospitals	2
5.	Churches	30
6.	Banks	9
7.	Residential Communities	7
8.	First Responder Departments	4
9.	Medical Clinics	7
10.	K12 Schools	12

Operationalizing Priorities:

our methodology.

Aim:

1. Create a system that can actively reorder a priority list when given various factors to consider.
2. Use statistics to quantify the importance of power restoration for each user type.

Methodology I

Determined by three **factors:**

NECESSITY FOR COMMUNITY *(50%)*

ENERGY CONSUMPTION *(15%)*

- *Single unit consumption (25%)*
- *Total unit consumption (75%)*

FINANCIAL IMPACT *(35%)*

- *On businesses (20%)*
- *On community (80%)*

Necessity for Community:

1. NECESSITY	
Type	**Points**
Industrial Power Plant	10
Hospitals	9
First Responder Departments	8
Banks	7
Gas Stations	6
K12 Schools	5
Grocery Stores	4
Residential Communities	3
Churches	2
Medical Clinics	1

- Weighted 50% of total **functional value.**
- **Priority based on imminent need** (Excludes generators)
- Ranked 1-10
  - User type 1 awarded ten points
  - User type 10 awarded one point

Methodology II

Two main **variables:**

TIME: As days progress, certain industries become more essential to prevent economic fallout.

GUARANTEED REFUEL FOR GENERATORS: during natural disasters, refueling is a logistical nightmare, leaving essential industries in dire need.

Instituting these variables institutes an active change in priority list throughout time.

Program Demonstration.

```
#Defining Workbook
wb = openpyxl.load_workbook(path, data_only=True)

#Defining Sheet
ws = wb["Sheet1"]

Generator_List = []
Generator_Dic = {}

User_Type_Count = ws.cell(row=1, column=13).value
UserTypes_Function = {}
for i in range(int(User_Type_Count)):
    x = 9
    y = (   + 2)
    a = 1
    b = y
    z = 13
    d = b
    nth_user = ws.cell(row=y,column=x).value
    Adj_Function = format(float(round(ws.cell(row=b, column=a).value, 2)), '.2f')
    Out_Function = format(float(round(ws.cell(row=d, column=z).value, 2)), '.2f')
    UserTypes_Function[nth_user] = str(Adj_Function) + "|" + str(Out_Function)

print("Your Current User List: " + str(UserTypes_Function))
print("")

Time = float(input("Input Simulation Duration (In Days of quarter increments): "))
Quarters = int(Time * 4)

Gen_Status = str.upper(input("Do you wish for the simulation to account for functioning generators? [Y/N] "))

print("")

if Gen_Status == "Y":
    Refuel_Days = int(input("How Many days of refuel are expected? "))
```

Results.

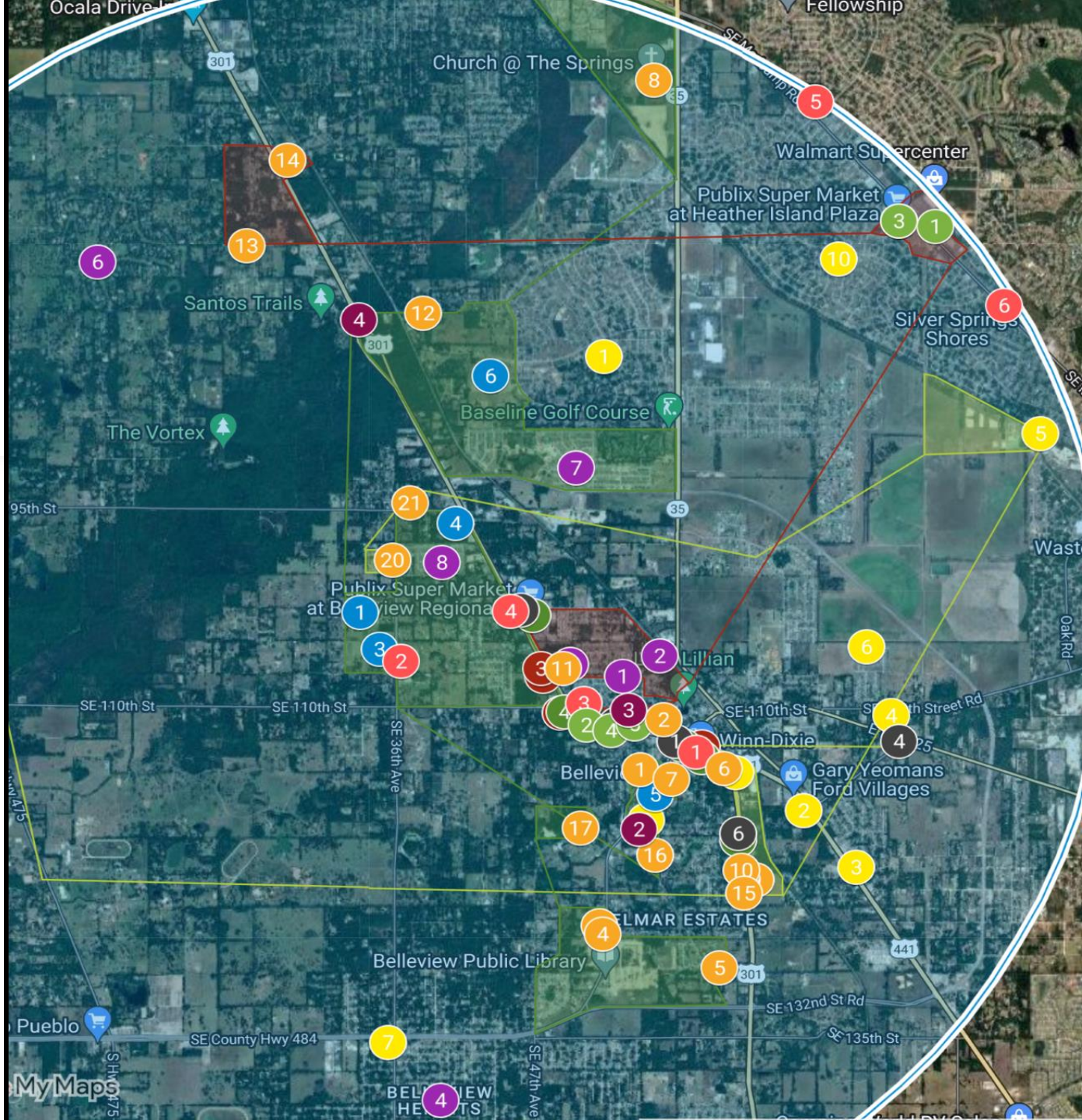
12:00 AM - 5:59 AM - Adjustment				
User	Disaster Power Distribution (% Max)	Distributed Power (kW)	Normal Max Power Demand (kW) from 12A-6A	Power Allocation Difference (kW) from 12A-6A
1	**7.19**	683.8	433.8	250.0
2	**5.65**	537.7	287.7	250.0
3	**19.59**	1864.1	1614.1	250.0
4	**31.31**	2979.2	2729.2	250.0
5	**6.69**	636.8	386.8	250.0
6	**6.61**	628.8	378.8	250.0
7	**8.37**	796.0	546.0	250.0
8	**3.33**	316.4	66.4	250.0
9	**2.50**	237.9	31.4	206.5
10	**8.76**	833.8	633.8	200.0
	100.00	9514.48	7107.99	

6:00 AM - 11:59 AM - Adjustment				
User	Disaster Power Distribution (% Max)	Distributed Power (kW)	Normal Max Power Demand from 12A-6A	Power Allocation Difference (kW) from 12A-6A
1	**15.32**	1457.6	1441.0	16.6
2	**3.63**	345.6	335.6	10.0
3	**39.34**	3742.9	3737.9	5.0
4	**0.00**	0.0	5103.1	-5103.1
5	**5.39**	512.5	502.5	10.0
6	**6.10**	580.1	570.1	10.0
7	**0.00**	0.0	897.8	-897.8
8	**1.01**	96.2	86.2	10.0
9	**0.74**	70.5	60.5	10.0
10	**28.47**	2708.8	2698.8	10.0
	100.00	9514.18	15433.56	

6:00 PM - 11:59 PM - Adjustment				
User	Disaster Power Distribution (% Max)	Distributed Power (kW)	Normal Max Power Demand from 12A-6A	Power Allocation Difference (kW) from 12A-6A
1	**14.424**	1372.3	1362.3	10.0
2	**3.074**	292.5	282.3	10.2
3	**20.954**	1993.6	1983.6	10.0
4	**19.910**	1894.3	3096.5	-1202.2
5	**6.818**	648.7	638.7	10.0
6	**4.616**	439.2	429.2	10.0
7	**7.517**	715.2	705.2	10.0
8	**1.340**	127.5	117.5	10.0
9	**0.511**	48.7	38.7	10.0
10	**20.836**	1982.3	1972.3	10.0
	100.000	9514.19	10626.20	

12:00 PM - 5:59 PM - Adjustment				
User	Disaster Power Distribution (% Max)	Distributed Power (kW)	Normal Max Power Demand from 12A-6A	Power Allocation Difference (kW) from 12A-6A
1	**33.45**	3182.5	1489.4	1693.1
2	**2.93**	279.0	274.0	5.0
3	**39.60**	3767.6	3761.4	6.2
4	**0.00**	0.0	5149.8	-5149.8
5	**6.46**	614.3	609.3	5.0
6	**6.01**	571.8	566.8	5.0
7	**9.66**	919.5	914.5	5.0
8	**1.20**	114.2	109.2	5.0
9	**0.69**	65.7	60.7	5.0
10	**0.00**	0.0	2819.3	-2819.3
	100.00	9514.62	15754.43	

Distribution of Microgrids.



Conclusion.

Using smart grids, we prioritized out user type priority list by

- Creating a numerical methodological system to **operationalize** and **quantify** imminent need
- Using AI to prioritize diverting power to local industries not only dependent on the day, but also the time of day.
- Optimizing smart grids to prevent power overload.

References

[1] “Hospital Backup Generator Requirements,” Woodstock Power Company, https://woodstockpower.com/blog/what-are-the-requirements-for-hospital-backup-generators/#:~:text=In%20general%2C%20hospitals%20must%20have,generator%20for%20powering%20necessary%20equipment. (accessed Nov. 8, 2024).

[2] “Brownouts and blackouts: Causes, effects, and best solutions,” California Commercial Generator Sales, Rental, Maintenance & Service, https://www.gotpower.com/brownouts-and-blackouts/ (accessed Oct. 21, 2024).

[3] “Power grid: What is it and how does it work?,” Just Energy, https://justenergy.com/blog/power-grid-what-is-it-and-how-does-it-work/ (accessed Oct. 21, 2024).

[4] M. Brain and D. Roos, “How Power Grids Work,” HowStuffWorks Science, https://science.howstuffworks.com/environmental/energy/power5.htm (accessed Oct. 16, 2024).