Smart Power for Tomorrow:
AI and Microgrids in Action

- **Presented by the Electro Wizards: Zachary Hershberger, Carter Smith and Oscar Rubio-Flores**

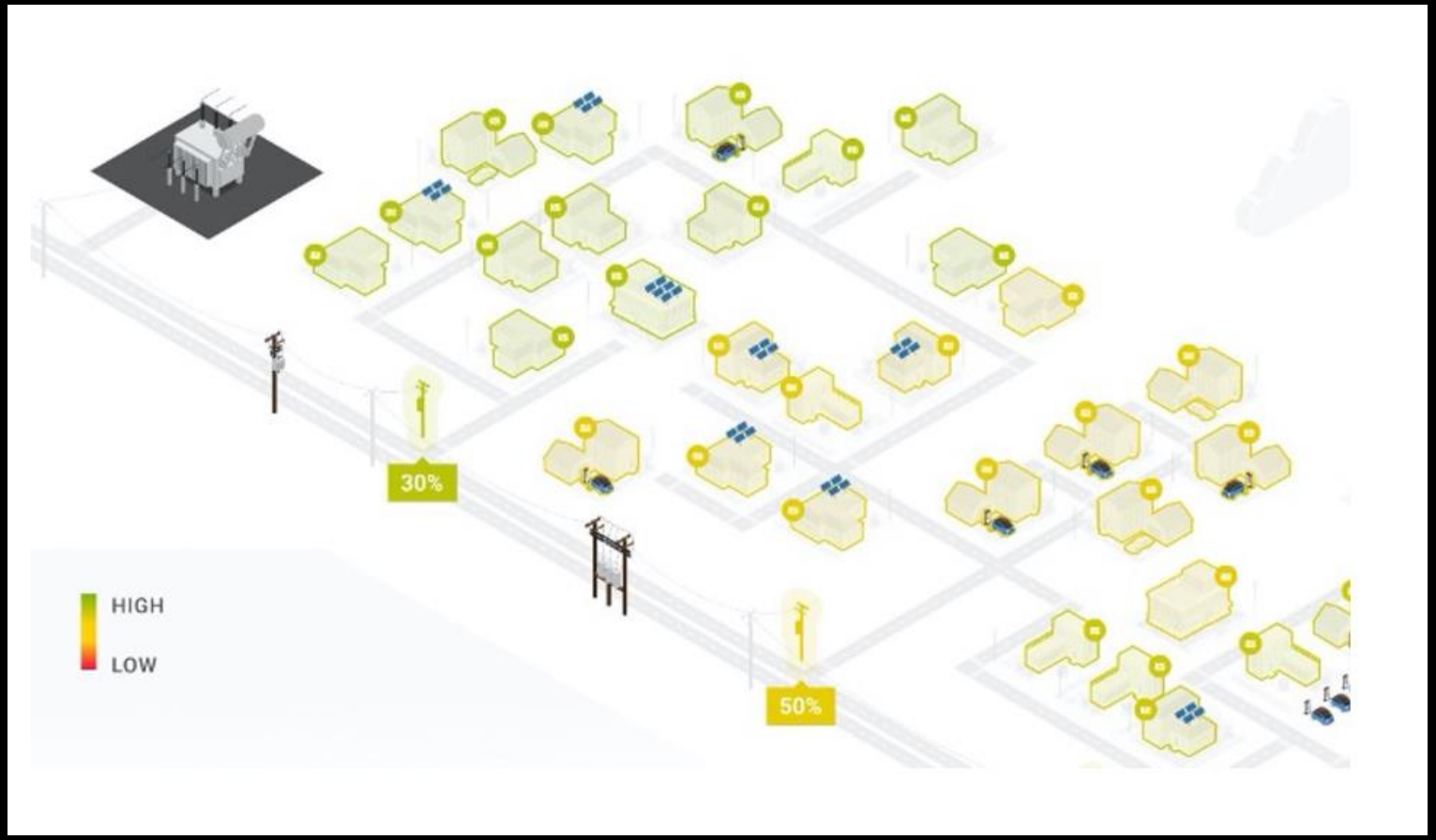
Presentation Overview:

Throughout this presentation, we will cover:

- What the smart grid is and how it can improve our lives
- Our specific mission and priorities in our design
- The importance of this project in the modern day
- The 10 user types we identified as most vital to our communities
- Why we chose our specific designs and microgrids and what this means for power distribution

The Smart Grid:

A smart grid is a better way of managing energy throughout a community and effectively transporting it from the generation site to the users by utilizing AI and other strategies to prepare for outages before they happen.



(Nvidia.com)

Our Mission

- Our smart grid design focusses almost entirely on medical centers and urgent care facilities. After healthcare facilities have their power restored, we focus on buildings within our community which tend to help people in need the most.
- Most users who are not either first responders or health professionals were resources for those people and thus users like gas stations are also ranked highly.

Why PTC?

This project develops a smart, resilient power system tailored to our community’s unique needs.

Using AI and microgrids, we target improved energy efficiency, reduced outage impacts, and environmental sustainability.

By introducing AI into a large part of so many lives, the fear of AI may lesson.

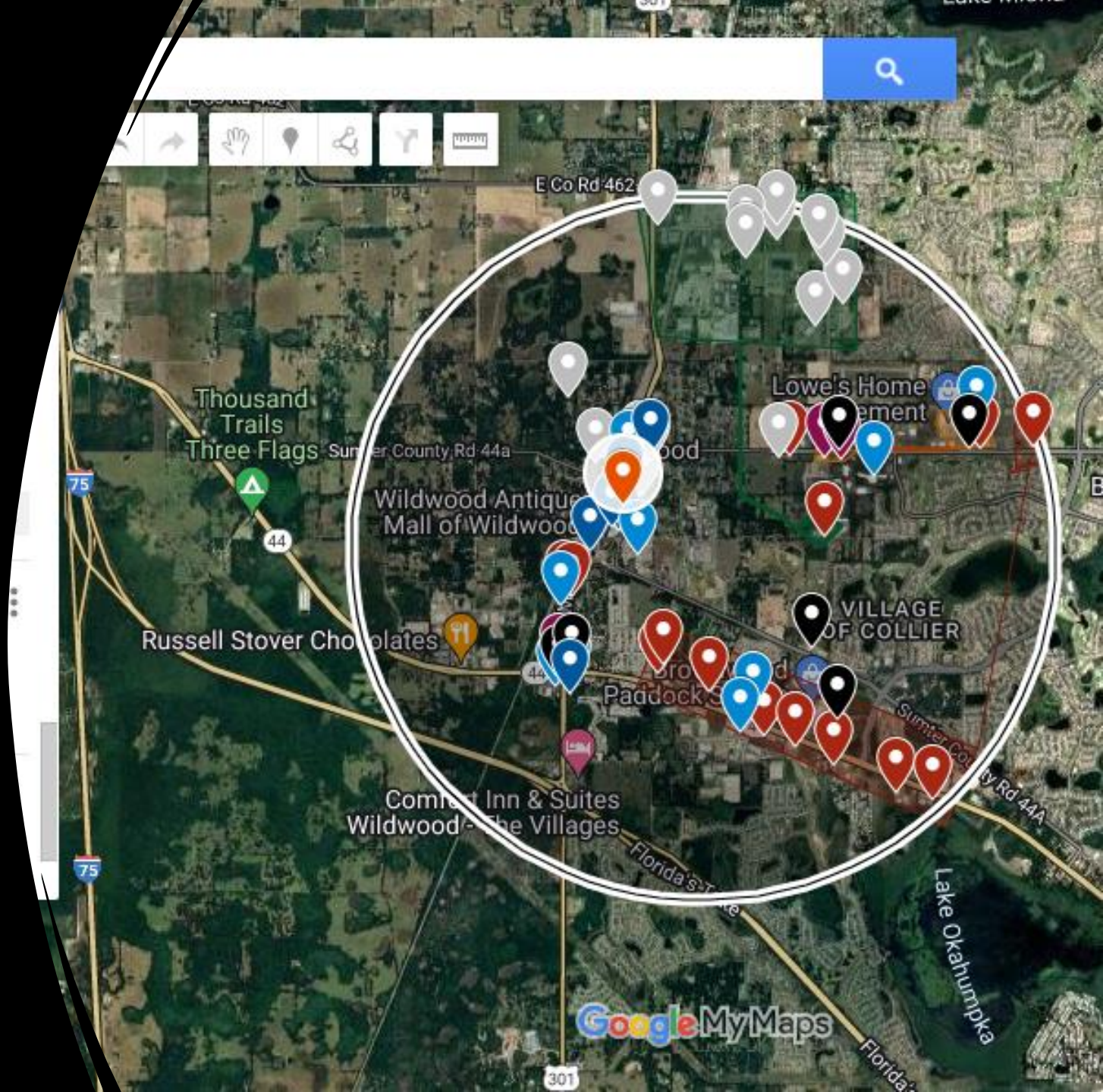
Community Power Users:

We had 2 main criteria for ranking the users of our grid; population impacted and the importance of the impact.

User Rank	User Type	User Count
1.	Hospital	13
2.	First responders	1
3.	Gas stations	6
4.	Pharmacies	3
5.	Senior Homes	1
6.	stores	8
7.	City Hall	1
8.	Schools	2
9.	Churches	15
10.	restaurants	6

Visual Understanding

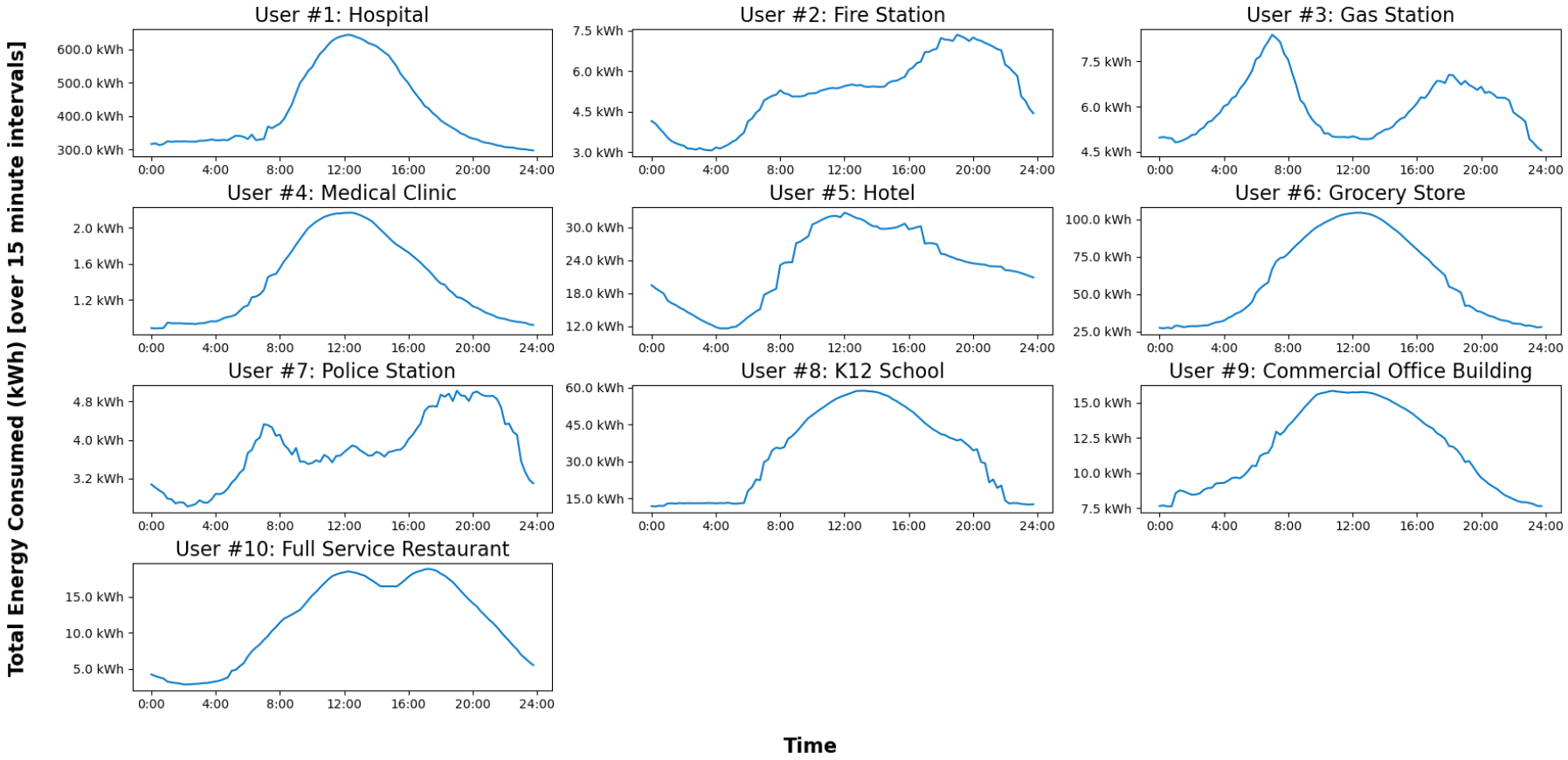
- Adding a visual aspect to the power grid is extremely important as it helps outline how users are interconnected and how priorities might depend on location as well as importance.



Power Distribution Needs

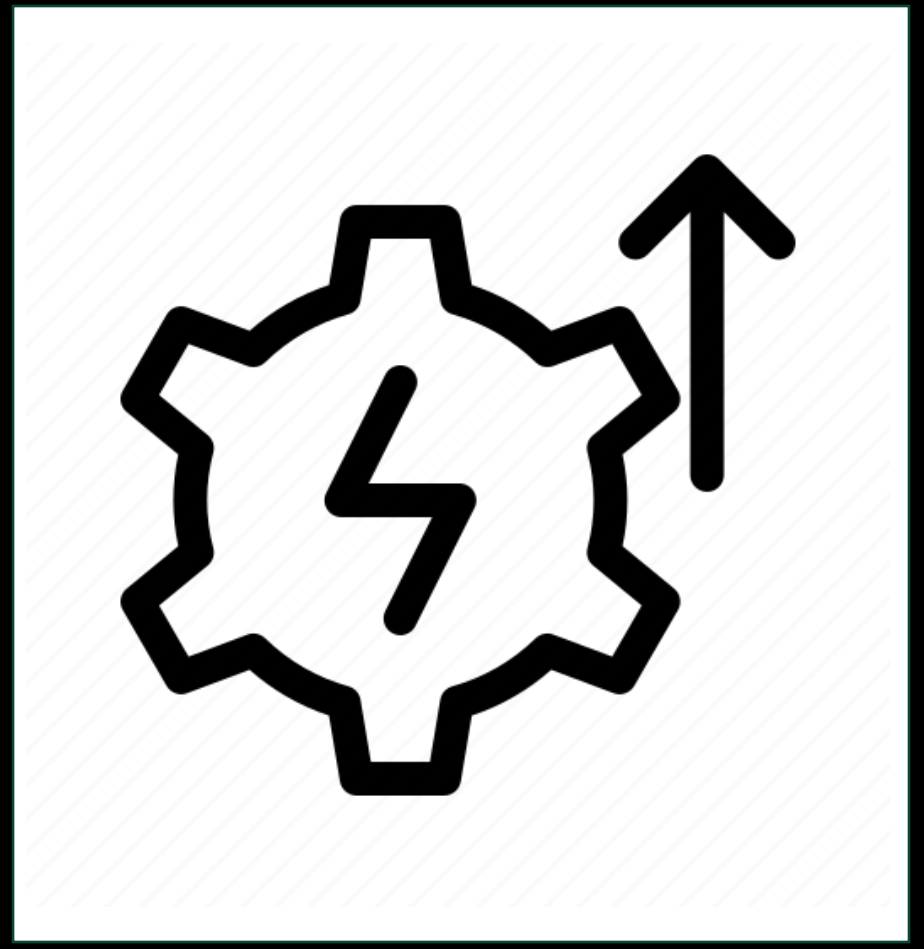
This table we made in activity 3 outlines the average power consumption and peak hours for various user types, highlighting their diverse energy needs.

User	Highest Energy Consumption (Time & kWh)	Why do you think it is highest then?
1	12:00pm 800kWh Hospitals	Many people are out at noon and thus there is more car crashes, working accidents, or other medical problems. AC also costs more during this time.
2	8:00pm 7.5kWh First Responders	Most people are cooking dinner at this time causing more fires.
3	7:00am 8kWh Gas Stations	Many people stop to get breakfast or coffee in the morning.
4	12:00pm 2kWh Pharmacies	Most offices have more customers at this time because people are more often available and this is also the hottest part of the day.
5	12:00pm 30kWh Senior homes	Amenities are usually open, and many people are checking in and out as well as heat.
6	12:00pm 100kWh Stores	The cooling of frozen items as well as fresh meat or dairy products takes a lot of energy especially at noon.
7	9:00pm 3kWh City Hall	More people are intoxicated during this time and many people are driving.
8	1:00pm 60kWh School	This is lunch time for the kids and it is also one of the hottest times of the day.
9	12:00pm 15kWh Churches	Many employees are heating their lunches near this time.
10	12:00pm 10kWh Restaurants	This is the time when the most customers come to the restaurant and also when it needs more cooling.


Daily Energy Consumption for 10 Selected User Types
Total Energy Consumed (kWh) [over 15 minute intervals]
User #1: Hospital
600.0 kWh
500.0 kWh
400.0 kWh
300.0 kWh
User #2: Fire Station
7.5 kWh
6.0 kWh
4.5 kWh
3.0 kWh
User #3: Gas Station
7.5 kWh
6.0 kWh
4.5 kWh
User #4: Medical Clinic
2.0 kWh
1.6 kWh
1.2 kWh
User #5: Hotel
30.0 kWh
24.0 kWh
18.0 kWh
12.0 kWh
User #6: Grocery Store
100.0 kWh
75.0 kWh
50.0 kWh
25.0 kWh
User #7: Police Station
4.8 kWh
4.0 kWh
3.2 kWh
User #8: K12 School
60.0 kWh
45.0 kWh
30.0 kWh
15.0 kWh
User #9: Commercial Office Building
15.0 kWh
12.5 kWh
10.0 kWh
7.5 kWh
User #10: Full Service Restaurant
15.0 kWh
10.0 kWh
5.0 kWh
0:00
4:00
8:00
12:00
16:00
20:00
24:00
Time

AI-Driven Power Optimization

- Utilizing power consumption data can help us know when a outage may occur and will help us alert users of these risks.
- Knowing how much power each user needs during different hours can also help us decide how to manage our priorities as the energy required to run users at full capacity will affect their power efficiency or the amount of help to the community per kw of power.



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
User 1	**76.0**	17829.2	17739.9	89.3
User 2	**3.0**	703.8	16.6	687.2
User 3	**2.5**	586.5	172.6	413.9
User 4	**2.5**	586.5	13.4	573.0
User 5	**1.0**	234.6	78.0	156.6
User 6	**7.5**	1759.5	1434.7	324.7
User 7	**2.5**	586.5	13.6	572.9
User 8	**1.0**	234.6	105.6	129.0
User 9	**3.0**	703.8	631.3	72.5
User 10	**1.0**	234.6	138.8	95.8
	100.00	23459.43		

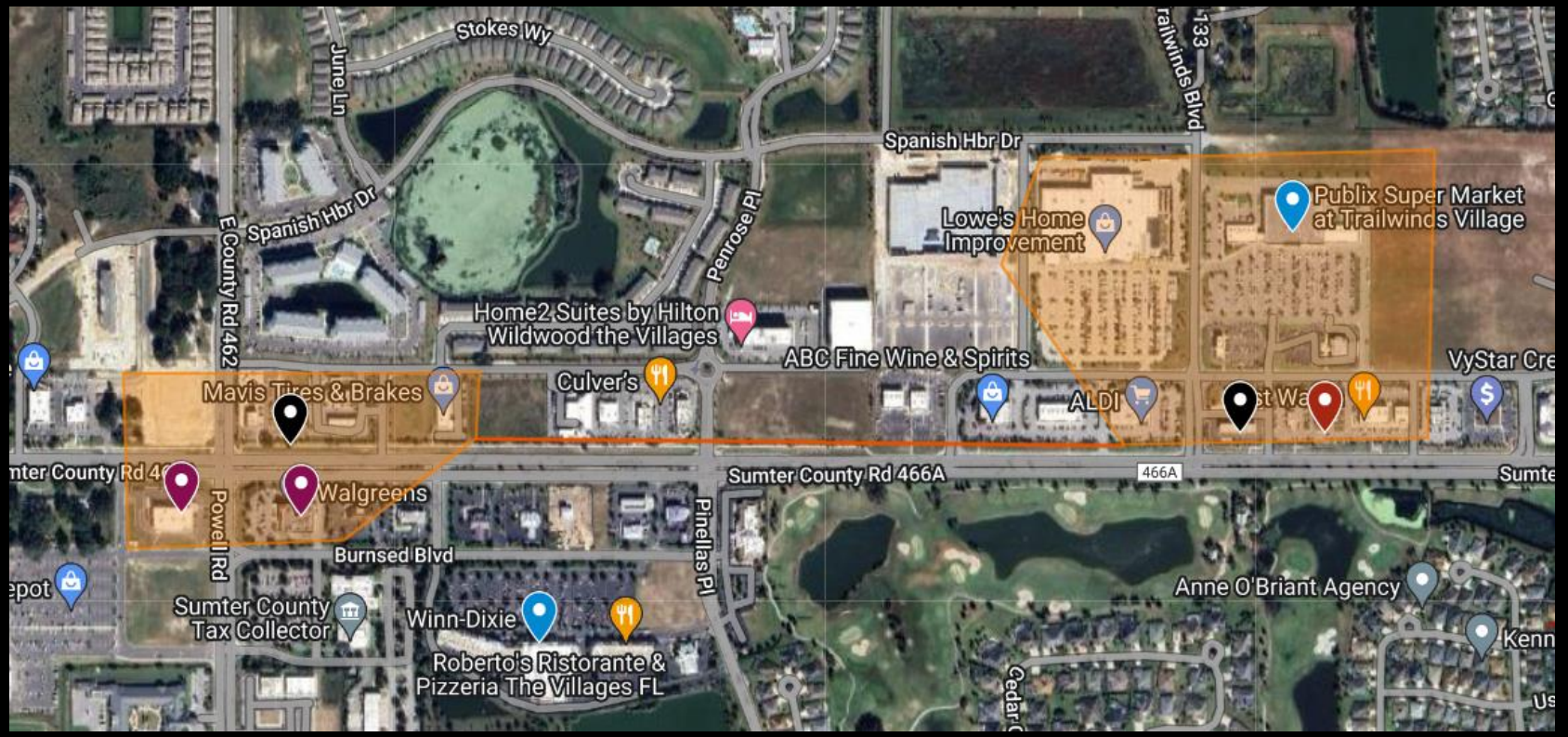
Perfect power distribution to all users during this time

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
User 1	**68.0**	15952.4	33170.5	-17218.1
User 2	**1.0**	234.6	21.5	213.0
User 3	**1.0**	234.6	201.4	33.2
User 4	**1.0**	234.6	25.9	208.7
User 5	**1.0**	234.6	128.3	106.3
User 6	**15.0**	3518.9	3322.6	196.4
User 7	**1.0**	234.6	17.3	217.3
User 8	**5.0**	1173.0	449.8	723.2
User 9	**5.0**	1173.0	950.2	222.8
User 10	**2.0**	469.2	439.7	29.5
	100.00	23459.43		

Lesser energy distributed to hospitals later in the day.

Microgrids for Resilience!!!

- Microgrids provide backup power and flexibility, reducing grid strain during high demand or outages.
- Map-based layout groups users efficiently, ensuring priority to essential services.
- AI optimizes microgrid management to align supply with demand in real-time, supporting reliable energy distribution.
- Microgrids also can help simplify data for the AI to be able to work quicker and more efficient as they compact users into a group and we can see them as one conglomerate user.



Microgrid 1				
Grid Color: Orange		**Total Load (kW):** 3,068.7		
User Type	**Initial Priority Rank (Act 2)**	**User Count**	***Power Supplied (kW)***	**Local User's Names**
Gas Station	2	2	67.2	7-Eleven
Pharmacy	3	2	8.7	CVS, Walgreens
Grocery Store	4	1	417.9	Publix
Hospital	1	1	*2,574.9*	ER

Microgrid elaboration:

The most vital microgrid to our community was our first one (the orange one) this is why it is the only one included in this presentation. This grid is important because it holds both the ER and 2 of our communities' pharmacies as well as having 2 gas stations within this limited space.

Some things we incorporated in our decisions include:

- How these users function together
- E.X: The gas station could be vital for first responder vehicles

- The power these users consume
- E.X: Hospitals take vast amounts of power while gas stations take a small amount.

Impact and Future Benefits

- Our design provides reliable and consistent access to power, reduces outage impacts, and creates a grid that adapts to future growth in the community.
- For power providers, this system offers efficient management, reduced maintenance costs, and the ability to conduct predictive maintenance using AI.
- Our design has the potential to incorporate renewable resources, making it environmentally sustainable and adaptable for future needs.

References and Data Sources

1. IEEE. IEEE Reference Guide. [Online]. Available: IEEE Reference Guide
2. Smart Grid Coordination Group. "Introduction to the Smart Grid."
3. Nvidia Tech blog. "Building Software-Defined Smart Grid Technology"

Questions?