Names have been redacted for privacy at the request of the team. Further details may be disclosed upon formal request.

1. Team Information

- **Team Name: Half & Half**
- **School(s) / Organization(s):** Issaquah High School, Sedro-Woolley High School, Skagit Valley College, Pai Chai University, Jeju National University, Jeonju University
- **Team Members (Names and Emails):** [redacted]

2. Problem Statement

- **What community or city challenge are you solving?**
    - We aim to address the issues surrounding power outages in the Puget Sound area. Rather than focusing on the general public, our goal is to solve the challenges faced by vulnerable groups, such as seniors and travelers, who may experience barriers with mobile technology or language.
- **Who is affected?**
    - The most affected groups are those who face barriers in using mobile devices or have difficulty understanding text due to language differences. This includes seniors and international travelers.
- **Why does this problem matter *now*?**
    - A power outage is a critical emergency that can paralyze daily life. Therefore, prevention and early warning are paramount. While most people can immediately recognize a threat through mobile alerts, those unfamiliar with smartphones or facing language barriers are often left behind. Developing technology that ensures these vulnerable groups can intuitively perceive an upcoming outage is, therefore, essential.

3. Stakeholders & Impact

- **Who benefits from this solution? (e.g., residents, city staff, students, commuters)**
  The beneficiaries from this solution include all residents, city staff, students, commuters, all those who live in Puget Sound.
    - Vulnerable residents: Those reliant on life support equipment (oxygen, dialysis)/other medical devices or temperature-sensitive medication (insulin). This solution provides the 24-48 hour lead time needed to arrange medical transport or secure backup power.
    - City emergency staff: 911 dispatchers and first responders. Predictive data allows them to increase staffing levels before the storm hits and pre-identify high-risk intersections where traffic signals are likely to fail.
    - Infrastructure managers: Grocery stores and cold-storage warehouses can trigger "inventory protection" protocols, like moving perishables to refrigerated trucks or densifying freezer loads to hold temperature longer.

- Local businesses: Food preservation and other needs for preservation.

- **Which organizations or groups would be involved?**
  - Puget Sound Energy (PSE) & Seattle City Light: Primary utilities that provide the "Grid Asset Data" (age of poles, location of transformers).
  - Emergency Management Agencies: WA Emergency Management Division (EMD) and county-level offices (King, Pierce, Snohomish) to integrate predictions into public alert systems like ALERT King County.
  - Public Safety: Puget Sound Regional Fire Authority to coordinate response for downed lines.
  - NOAA / National Weather Service (Seattle): To provide high-resolution, hyperlocal wind and precipitation data.
  - WA Dept. of Commerce (Energy Office): To coordinate state-level resilience funding and policy support.
- **What positive impact would success create?**
  The positive impact that success would create is all residents in Puget Sound are prepared for upcoming weather-affected power outages.
  - Reliable power outage predictions
  - Faster restoration times : pre-stage crews in areas that would be most affected (more damaged)
  - Increase public safety
    - Allow residents to set-up pre-outage equipment safely (such as generators and lessen CO_2 admission)
    - Provide community spaces and resources to rely on

4. Proposed Solution

- **What is your solution?**

Our solution is an AI-driven predictive modeling system that forecasts power outage risks based on hyper-local storm data. Unlike standard weather apps that predict rain or wind, our model specifically predicts infrastructure failure probability in defined geographic zones. The interface is a streetlamp that changes the color of street lamps, and projects images to convey emergency situations. This is an infrastructure-based solution that overcomes language barriers and communication breakdowns.

- **How does it work?**
  - **Step 1: Data Analysis & Prediction**
    • The system aggregates past outage data and real-time weather forecasts.
    • AI algorithms calculate the probability of a power outage for each specific • city block.
  - **Step 2: Dynamic Projection (3 Phases)**
    Phase 1 (Normal / <30%): Projects aesthetic patterns (e.g., leaves, geometric shapes) for urban ambiance.
    Phase 2 (Warning /60%~80%): Projects caution lines or text ("High Load") to

alert pedestrians.

Phase 3 (Emergency / >80%): Projects **universal emergency pictograms** (e.g., fire icon, flood icon, running man) accompanied by **short explanatory text** (e.g., "Fire Nearby", "Do Not Enter") to instantly communicate the situation.

- **What makes it innovative or different?**
  - **1. From Static Light to Active Interface**

    Standard: Changing street signage or blocking roads requires physical personnel and time.

    Innovation: Utilizing IoT technology, administrators can instantly change the projection remotely. This allows for immediate traffic control or emergency guidance without dispatching personnel.
  - **2. Universal Visual Communication**

    Standard: Emergency texts depend on language.

    Innovation: The system projects universal pictograms (e.g., Fire, Stop) directly onto the road. This ensures intuitive understanding for everyone, regardless of language barriers.
  - **3. Hyper-Local Resilience**

    Standard: Broad Mobile Alerts & Anxiety

    Current mobile emergency alerts (CBS) are broadcasted over wide administrative districts. Citizens often receive warnings for distant accidents, causing confusion about the exact location and leading to "alert fatigue" (ignoring messages).

    Innovation: Pinpoint Physical Alerts

    The Smart Gobo System operates on a strictly hyper-local basis (block-by-block). Unlike phones that ring everywhere, only the streetlights in the actual danger zone turn red. If the light is normal, you know you are safe.

5. Technology & Approach

- **Tools or technologies used or proposed**
  - **Core Logic:** Python (pandas, numpy) for data manipulation.
  - **Machine Learning:** Scikit-Learn for training predictive models (Logistic Regression).
  - **Development Environment:** Google Colab for model training and iteration.
  - **AI Integration:** Google Gemini API to parse risk metrics into user-friendly summaries
- **How technology supports the solution (if applicable)**
  - Machine learning allows us to process vast datasets of historical weather and grid performance that would be impossible for humans to analyze manually. The AI component ensures that the output isn't just raw data, but actionable intelligence (e.g., "High Risk: Charge medical devices immediately").
    - The implementation of the model through smart streetlights will ensure accessibility of outage information to all populations

- **Training model features:** wind speed (wind_gust_max), rainfall (rain_sum) The correlation matrix shows that the two features that are most related to outage count are wind_gust_max (wind speed) and rain_sum (rainfall amount). Therefore, these are the two main features that the ML model will be evaluating to predict power outages.

6. Feasibility & Implementation

- **How could this realistically be implemented?**
  To begin, projectors could only be placed in critical areas such as hospitals, civil service jobs, and industries before being placed in neighborhoods. Smaller, budget friendly projectors can also be used at first rather than switching streetlamp systems entirely.
- **What resources would be needed?**
  Puget Sound Energy (PSE) & Seattle City Light (Puget Sound Data & Streetlight Access), ML Model trained on weather and outage data, Weather forecast API, Streetlight projectors, Google Gemini
- **Who could own or maintain this solution?**
  Emergency Management Agencies, WA Dept. of Commerce (Energy Office), PSE & Seattle City Light

7. Equity, Accessibility & Ethics

- **How does your solution ensure inclusivity?**
  - Reducing language barriers: Instead of text, the system uses pictograms (visual symbols) and color codes. (Ex: a red lightning icon indicates a power outage warning, while a green arrow shows the direction to an evacuation shelter.) This allows information to be delivered clearly and equally to travelers with limited English proficiency and to children with low literacy levels.
  - Bridging the digital divide: Smartphone apps can be useless when batteries run out or for elderly people who are less familiar with digital technology. By leveraging physical infrastructure such as streetlights, the system ensures that even people without smart devices can access the same critical information.
- **Are there accessibility, privacy, or ethical considerations?**
  - For accessibility, we use distinct flashing patterns alongside colors to support individuals with color vision deficiency. Regarding privacy, our system analyzes environmental and grid data only, collecting zero personal identifiable information.
- **How are unintended consequences addressed?**
  - **1. Preventing False Alarms:** To avoid public panic from AI errors, we use a "Human-in-the-Loop" system. All AI-generated alerts must be verified by a city official via a dashboard before the streetlights change color.
  - **2. Ensuring Road Safety:** To prevent driver distraction or confusion with traffic signals, we utilize Projection Mapping technology. The visuals are projected at a

sharp downward angle strictly onto pedestrian sidewalks, not the roadway, and use distinct flashing patterns to avoid confusion with red lights.
    - **3. Fail-safe for Total Blackouts:** Each unit includes a local backup battery and Edge-AI. If both the grid and communication networks fail, the streetlight can independently detect the voltage drop and activate emergency projections for up to 3 hours.

8. Sustainability & Scalability

- **Could this solution grow or adapt to other cities or communities?**
    - An official image key and system can be made and implemented in other communities, cities, states, and countries–just with their own weather and energy data. Open APIs (publically available application programming interfaces) could be one way to spread this idea.
    - This could evolve to smart streetlights being used for other public safety announcements, and risk images can be localized depending on the region's specific weather and energy patterns.
    - Later updates can be installed as regions get used to this implementation, and it takes on a more permanent role in the area.
- **How does it support long-term impact?**
    - Provides instant understandable texts and images for all, ensuring effectiveness and increased safety. Arrows pointing to nearest shelters adds to this.
    - Could promote smart energy use and energy stewardship, creating overall sustainability.
    - With advanced warning, businesses, hospitals, and those reliant on medical devices can prepare accordingly, preventing waste and boosting the economy.

9. Reflection (Short)

- **What did your team learn?**
    - How to collaborate, split work effectively, and work past challenges.
- **What would you improve with more time?**
    - If we had more time, I would’ve liked to look more into the app and web development. Having a website where it talks about the impact of our projector streetlights, then the website and app being accessible to those who are able to receive the necessary alerts (smart device users, etc).