

# A prescriptive IoT solution to Detect & Mitigate fugitive methane gas in landfills via a Supervisory Control & Data Acquisition system

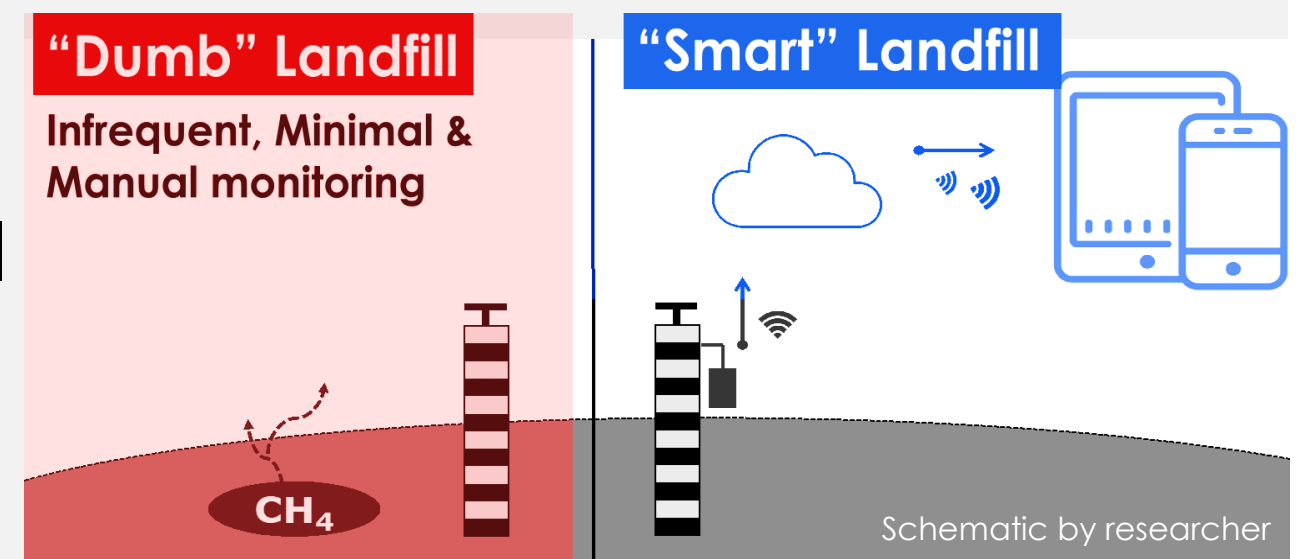
## Problem

- **Methane (CH<sub>4</sub>)** makes up only about 9% of total greenhouse gases (GHG) but has potency to **trap 80x more heat** vs. CO<sub>2</sub>
- **Landfills are the 3rd** largest sources of CH<sub>4</sub> emissions in the US. Landfill gas (LFG) wells capture some CH<sub>4</sub> | rest escape as **fugitive emissions**



## Current work

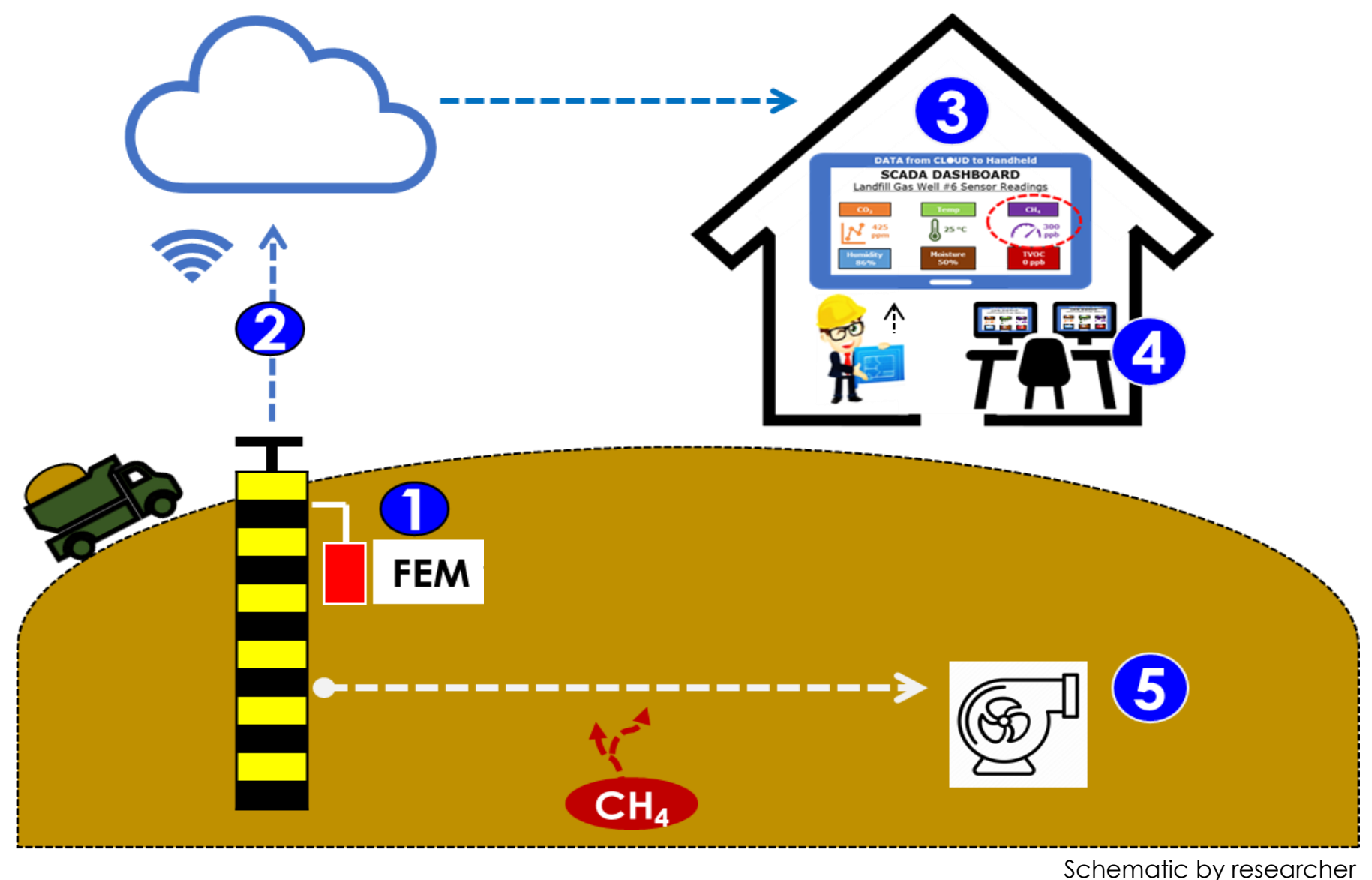
- **Monitoring:** Minimal batch measurements to detect fugitive CH<sub>4</sub> emissions lacks information for timely decisions
- **CH<sub>4</sub> Extraction:** Improper LFG extraction also resulting in sub-surface O<sub>2</sub> intrusion & landfill fires + GHG's
- **Need:** "Smart" monitoring to mitigate LFGs | Consequently **lower GHG emissions**



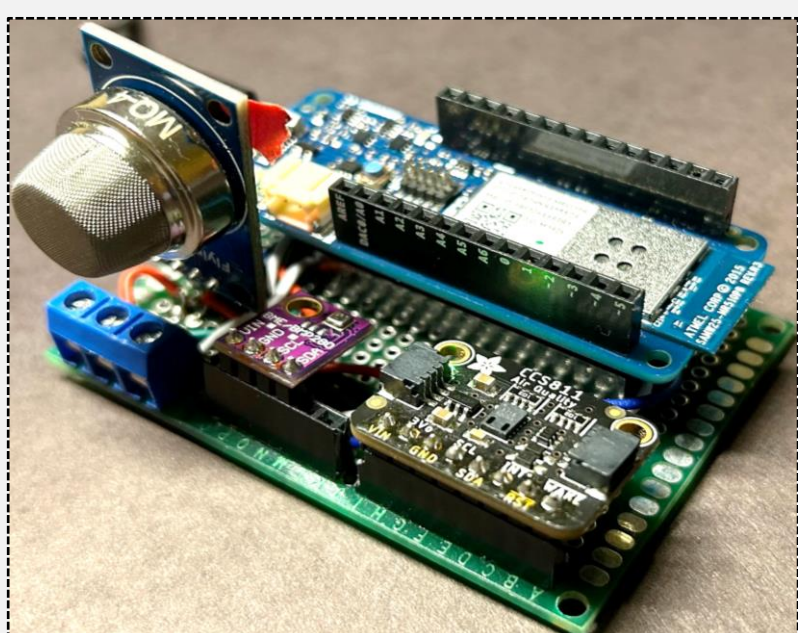
## Engineering Goal

### Develop a Supervisory Control & Data Acquisition system for CH<sub>4</sub> detection & mitigation

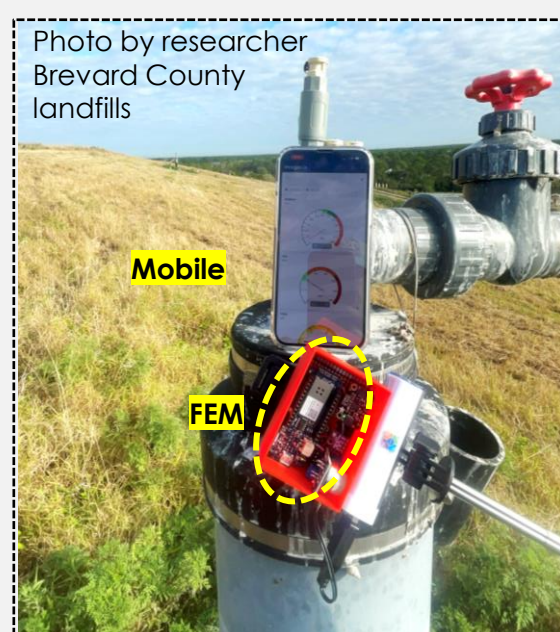
- 1 **Fugitive Emissions Monitor (FEM)** with microcontroller + ambient sensors
- 2 **Real time data transmission** to cloud
- 3 **Descriptive & Diagnostic analysis** in visualization platform
- 4 **Predictive analytics** to achieve specific outcomes through ML
- 5 **LFG CH<sub>4</sub> Mitigation** component



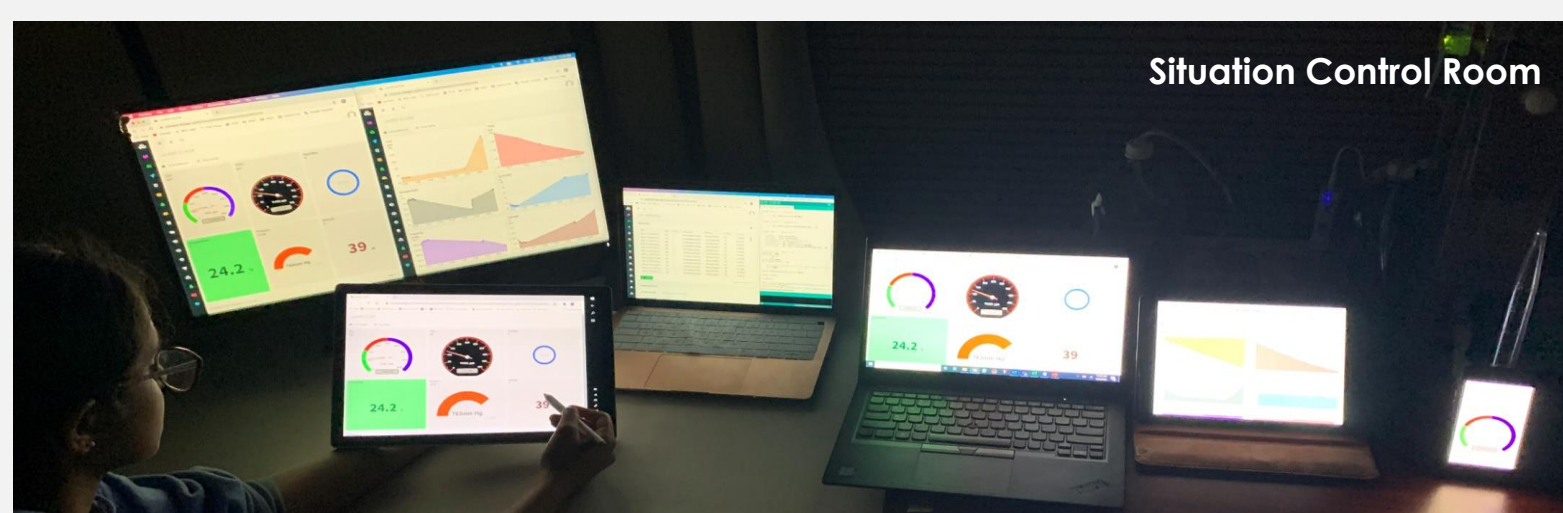
## Project Execution | System development



Fugitive Emissions Monitor (FEM)



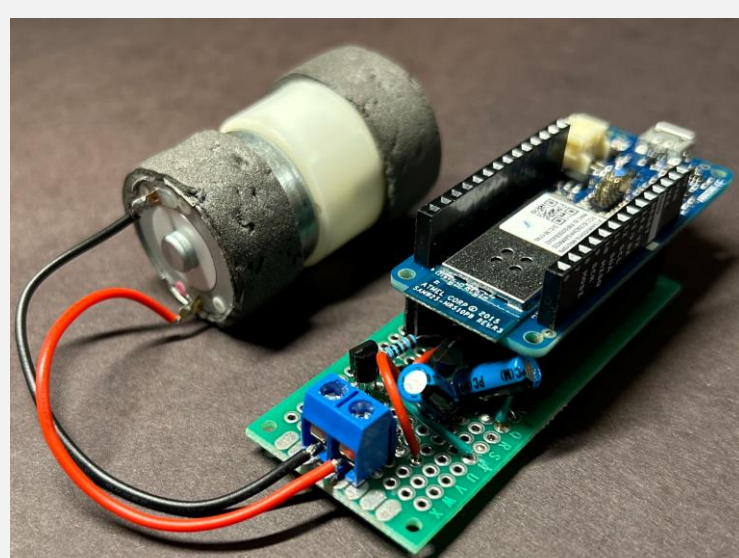
FEM in field



Situation Control Room

↑ Real-time data transmission on Cloud visualization platform

CH<sub>4</sub> Mitigation component →



All photos by researcher

## Conclusions

- **End-to-end informed analytics solution** provided CH<sub>4</sub> fugitive emissions detection, real-time data transmission, visualization, analytics & mitigation
- **FEM with microcontroller & sensors programmed** to measure LFG metrics in real-time
- **Descriptive & diagnostic analytics** visualized in cloud IoT platform.
- **Predictive analytics** executed using trained ML algorithms due to complex behavior of CH<sub>4</sub> generation-to-moisture. A **5<sup>th</sup> order Polynomial equation** provided best curve-fit to explain relationship between datasets.
- **LFG CH<sub>4</sub> mitigation** executed based on separate circuitry & remote extraction via a digital switch.
- This **"Smart" field-tested solution** can help engineers monitor LFG CH<sub>4</sub> real-time, harvest more CH<sub>4</sub>, minimize CH<sub>4</sub> fugitive emissions, & put US on a path to achieve **45% GHG reduction by 2030**