



Mahek Desai, Sarah Roomi, Krrish Gupta, Laveena Jain

# PROJECT PRESENTATION

**SECONDARY POLLUTANT ESTIMATION  
NEAR PHARMACEUTICAL INDUSTRIES**

INSTRUCTORS: Sachin Chaudhary and Sandeep Budde  
TA: Sasidhar Varada



AIR POLLUTION IN REGIONS WITH DENSE INDUSTRIAL AND PHARMACEUTICAL CLUSTERS HAS BECOME A MAJOR PUBLIC HEALTH CONCERN, WITH RISING CASES OF RESPIRATORY ILLNESSES, CARDIOVASCULAR DISEASES, AND CHRONIC CONDITIONS SUCH AS ASTHMA AND COPD LINKED TO PROLONGED EXPOSURE. A SIGNIFICANT PART OF THIS PROBLEM COMES NOT ONLY FROM THE DIRECT RELEASE OF PRIMARY POLLUTANTS BUT ALSO FROM THE FORMATION OF SECONDARY POLLUTANTS LIKE OZONE, WHICH ARE GENERATED THROUGH CHEMICAL REACTIONS IN THE PRESENCE OF UV RADIATION.

UNDERSTANDING WHEN AND UNDER WHAT CONDITIONS THESE SECONDARY POLLUTANTS ARE FORMED MOST ACTIVELY IS ESSENTIAL TO QUANTIFYING THE TRUE IMPACT OF INDUSTRIAL EMISSIONS. THIS PROJECT IS MOTIVATED BY THE NEED TO IDENTIFY THE DYNAMICS OF SECONDARY POLLUTANT FORMATION, EVALUATE THEIR PEAK FORMATION TIMES, AND PROVIDE A CLEARER PICTURE OF THE HIDDEN BURDEN OF POLLUTION ON HUMAN HEALTH IN VULNERABLE REGIONS SUCH AS PHARMA CLUSTERS.

# MOTIVATION

# INTRODUCTION

SECONDARY POLLUTANTS ARE FORMED WHEN PRIMARY POLLUTANTS FROM INDUSTRIAL EMISSIONS DURING LATE NIGHTS UNDERGO PHOTOCHEMICAL REACTIONS IN THE PRESENCE OF SUNLIGHT. THEIR CONCENTRATION CAN VARY WITH HEIGHT DUE TO CHANGES IN SOLAR RADIATION AND ATMOSPHERIC DISPERSION.

WE WISH TO QUANTIFY THE FORMATION OF SUCH SECONDARY POLLUTIONS WITH RESPECT TO THE TIME OF DAY, THE WEATHER ON A GIVEN DAY, AND THE CONCENTRATION OF CRITICAL PRIMARY POLLUTANTS



## PRIMARY POLLUTANTS:

- PM2.5 AND PM10
- CO<sub>2</sub>
- VOCs -
  - BENZENE
  - FORMALDEHYDE
  - XYLENE
  - ACETONE
- NOx - (NO<sub>2</sub>, NO)

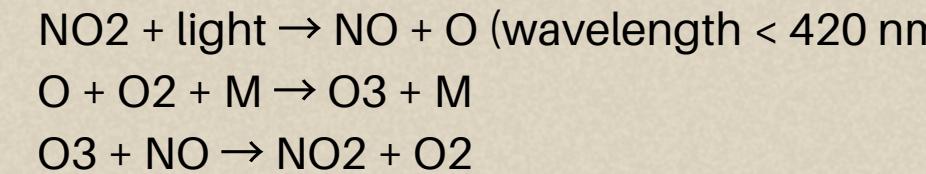
## SECONDARY POLLUTANTS:

- PM2.5 AND PM10
- OZONE
- SULPHURIC ACID
- NITRIC ACID
- PAN (PEROXYACETYL NITRATE)

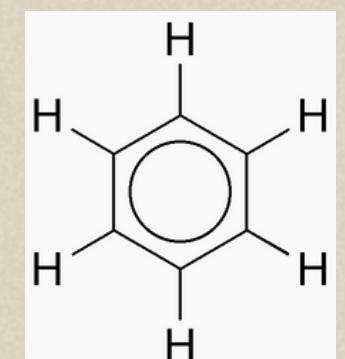
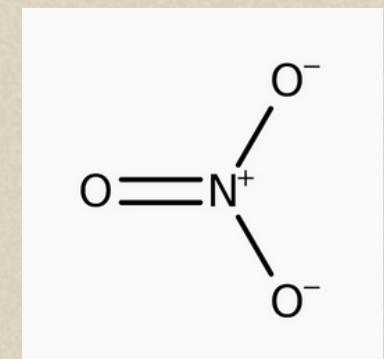
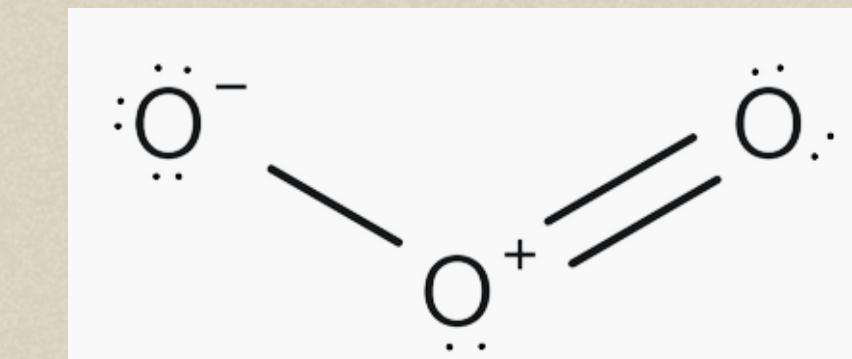
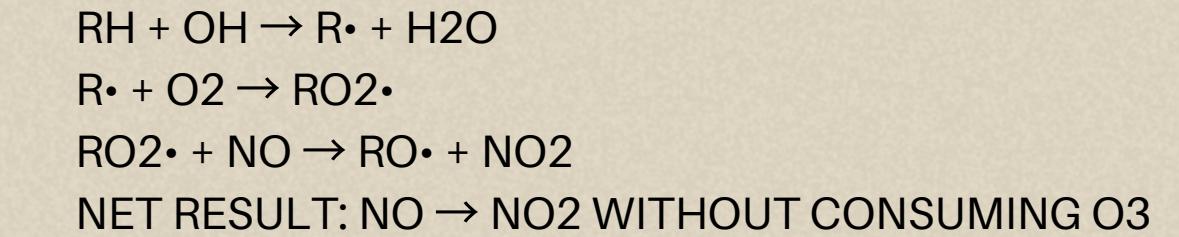
# KEY REACTIONS

## OZONE FORMATION CHEMISTRY

### PRIMARY REACTIONS

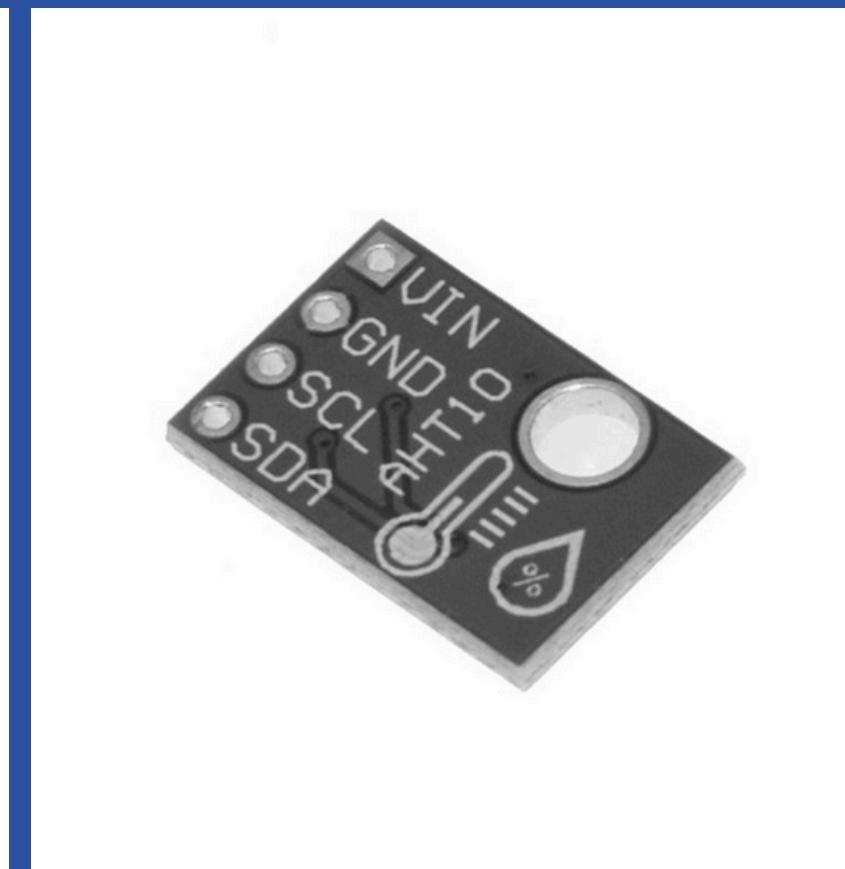


### VOC ENHANCED FORMATION



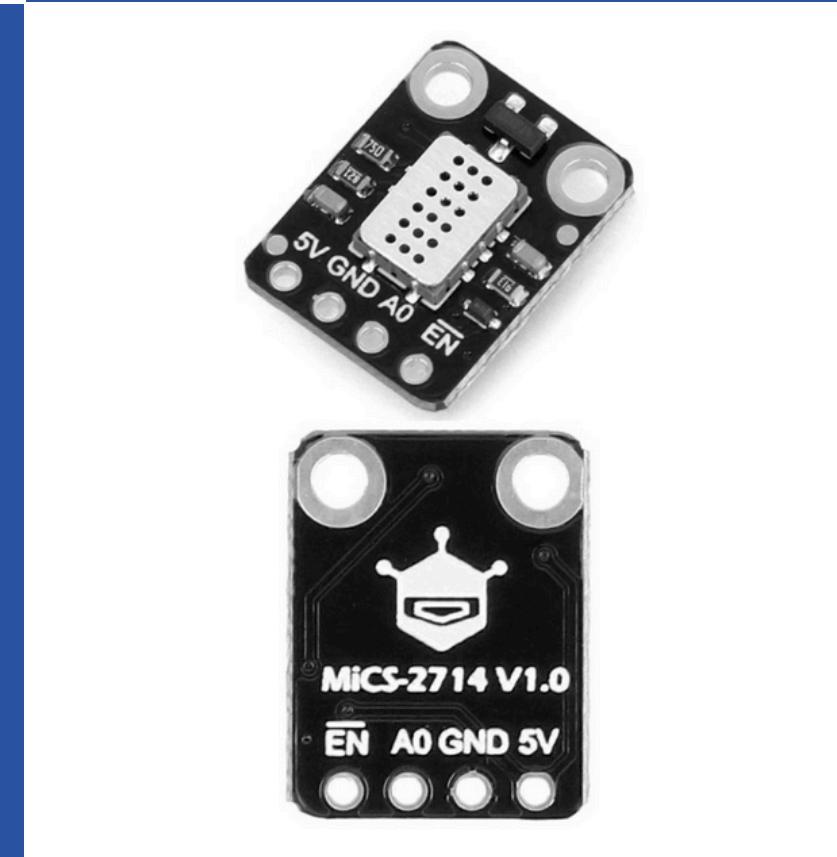
# SENSORS

OUR PRIMARY GOAL IS TO ANALYSE OZONE FORMATION AND THUS EVERY ASPECT OF THE CHEMICAL REACTION INVOLVED IN OZONE FORMATION IS IMPORTANT.



## SENSORS USED:

- MICS-2714 - USED TO MEASURE NOX CONCENTRATION, WHICH IS CRUCIAL FOR OZONE FORMATION
- SGP30 - USED TO MEASURE TOTAL VOC CONCENTRATION AND EQUIVALENT CO2
- SDS011 - USED TO MEASURE PM10 AND PM2.5 CONCENTRATION
- HW-837 - USED TO GET UV RAY INTENSITY TO ANALYSE FORMATION OF SECONDARY POLLUTANTS WITH RESPECT TO SUNLIGHT INTENSITY.



# DESIGN EXPLANATION

## NODE 1

- To track intensive emission hours - proportionate to CO<sub>2</sub> concentration
- Measuring secondary pollutant - PM
- Measuring primary pollutant - precursor gases for ozone & secondary aerosol formation

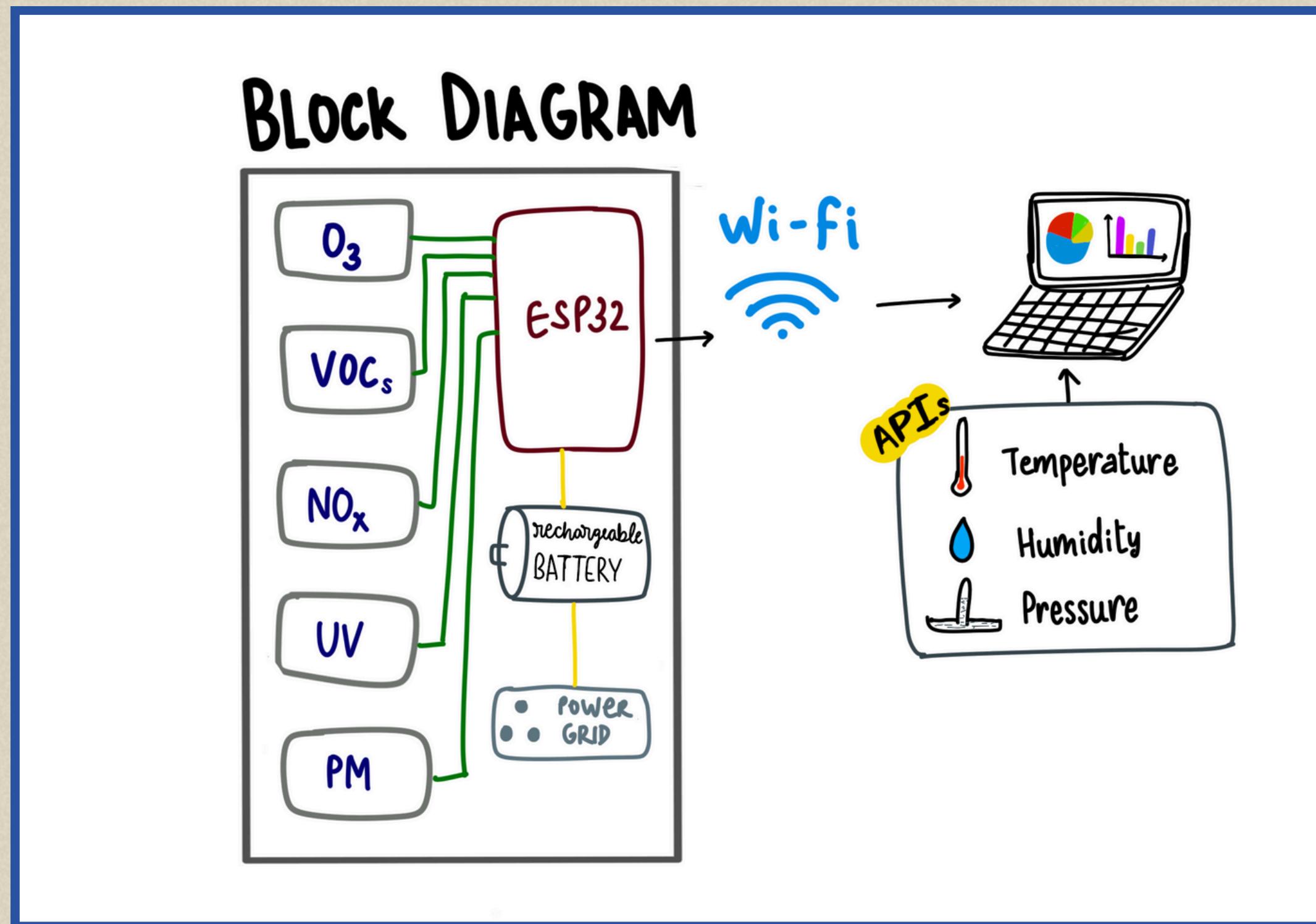
- **SGP30 (CO<sub>2</sub>, VOCs)**
- **SDS011 (PM2.5, PM 10)**
- **MiCS-2714 (NO, NO<sub>2</sub>, H<sub>2</sub>)**

## NODE 2

- To track ambient parameters
- To analyse formation of ozone with respect to sunlight intensity

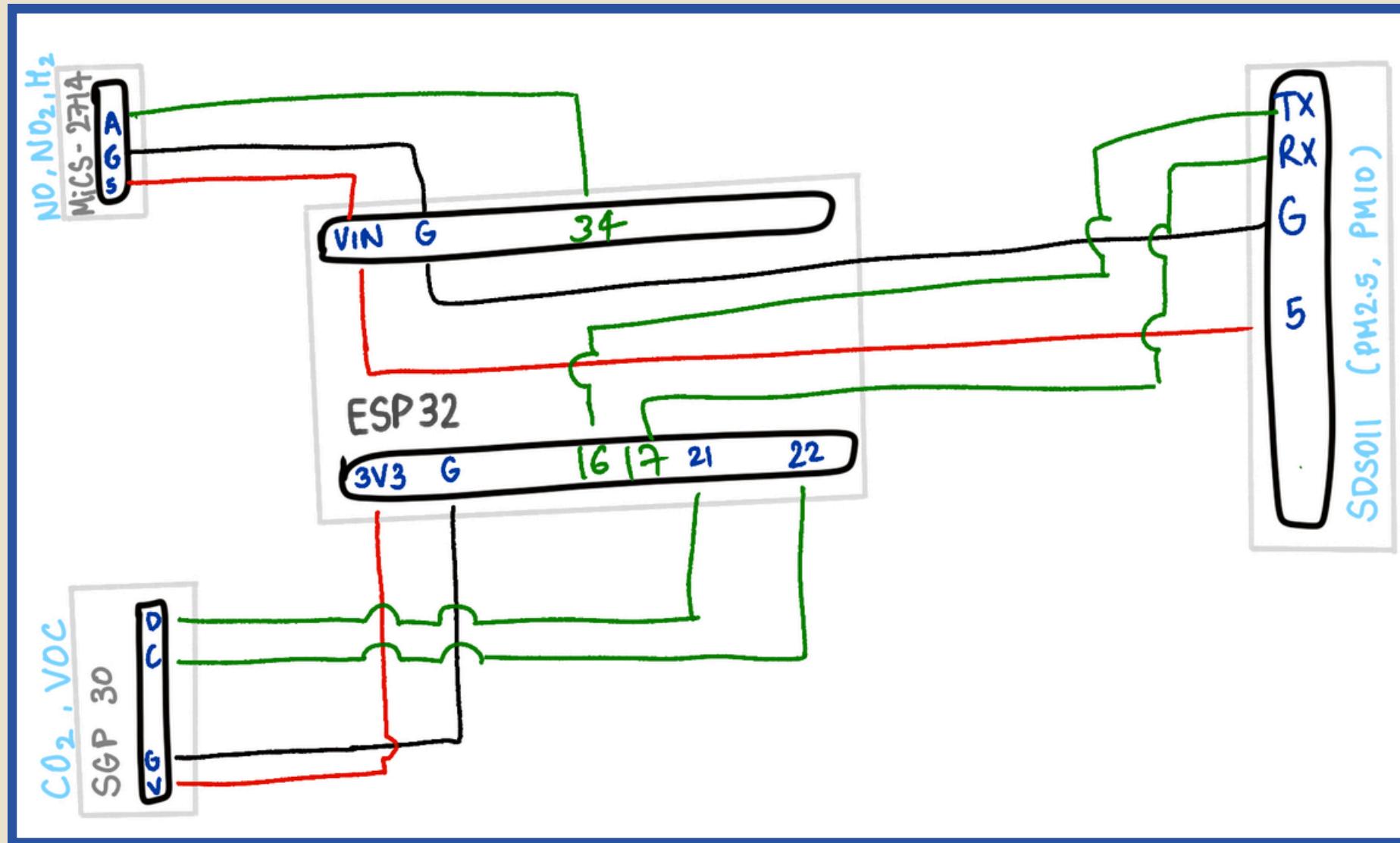
- **AHT10 (Temperature, Humidity)**
- **HW-837 (UV ray intensity)**

# BLOCK ARCHITECTURE

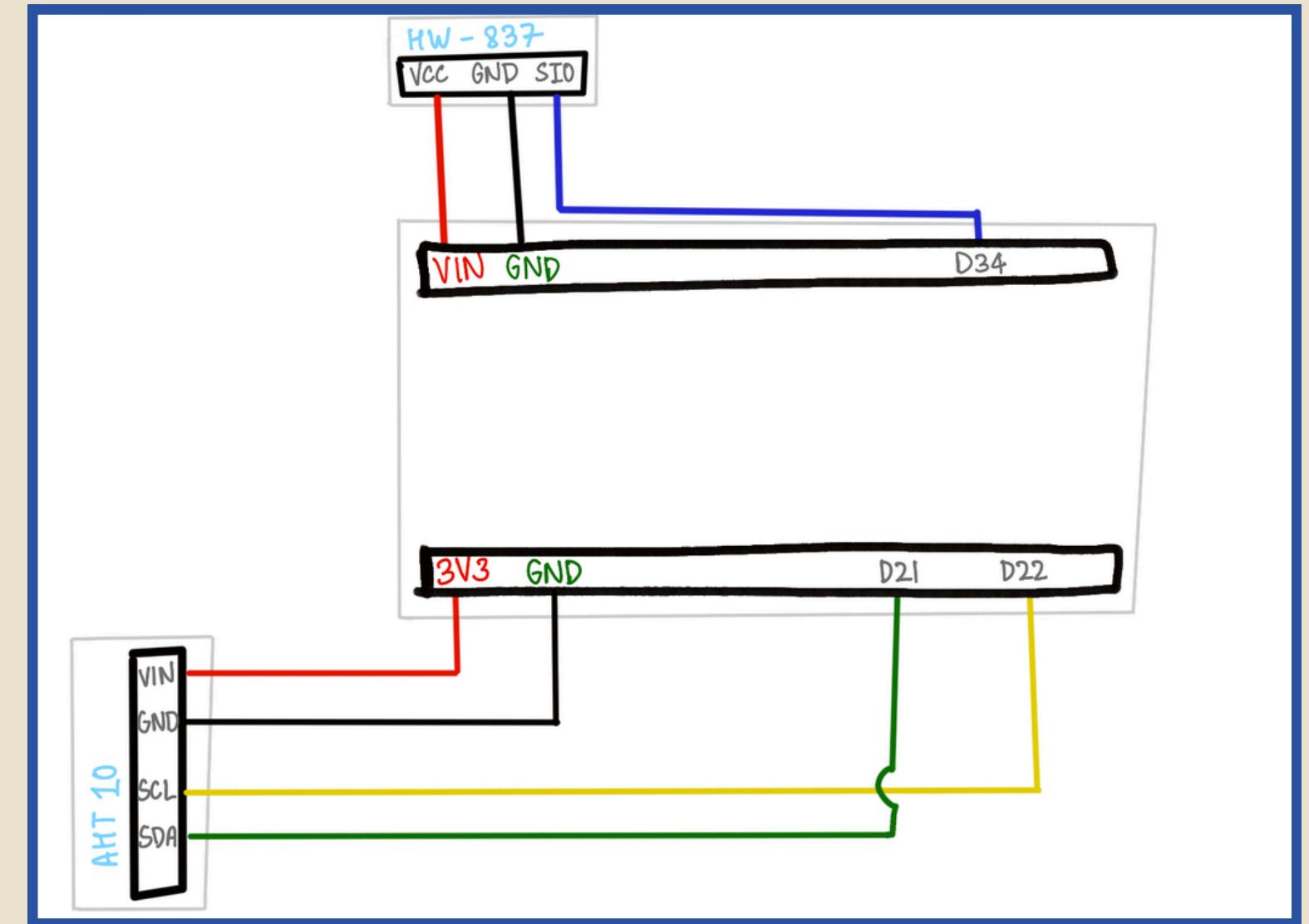


# CIRCUIT DIAGRAM

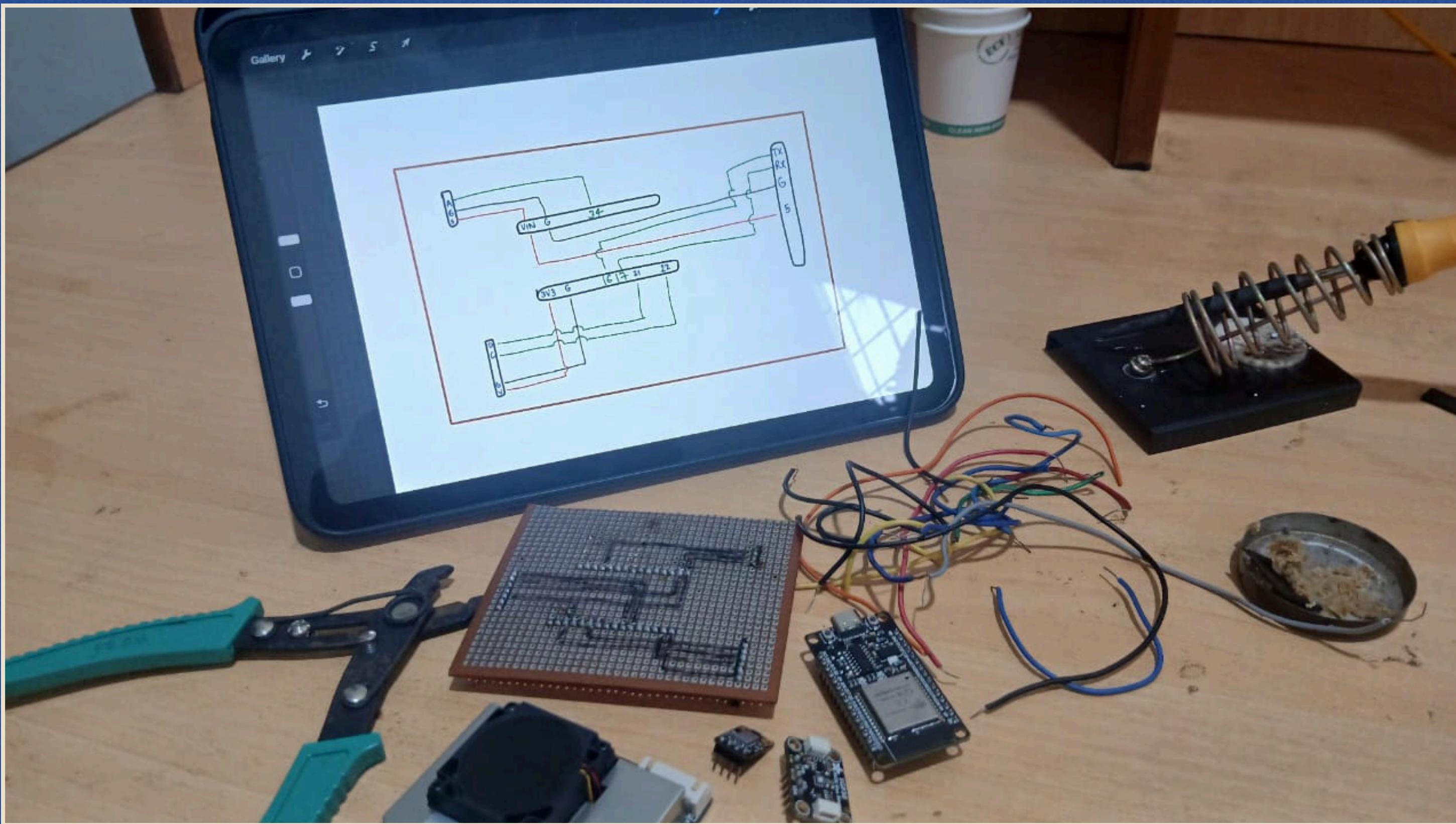
## NODE 1



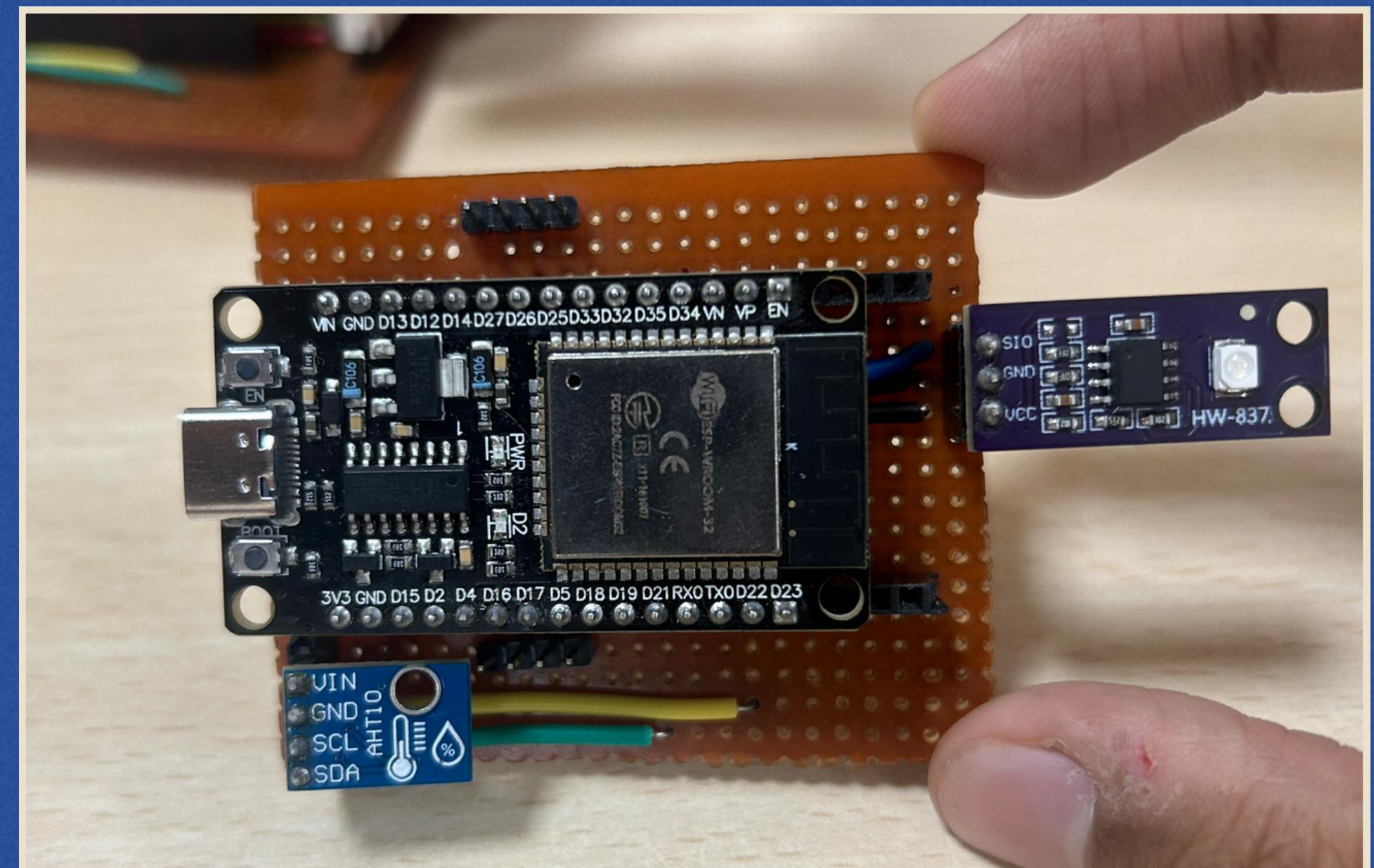
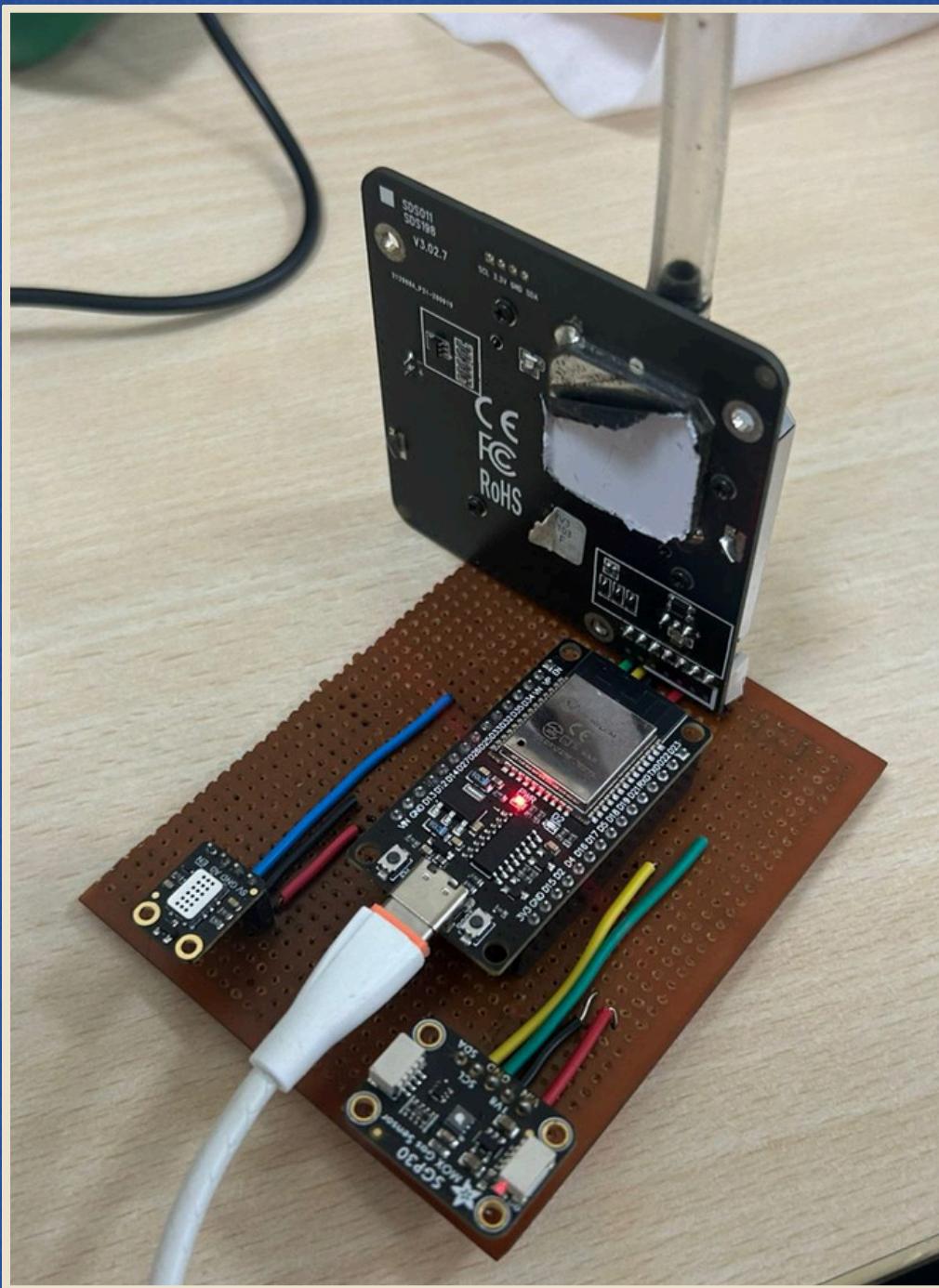
## NODE 2



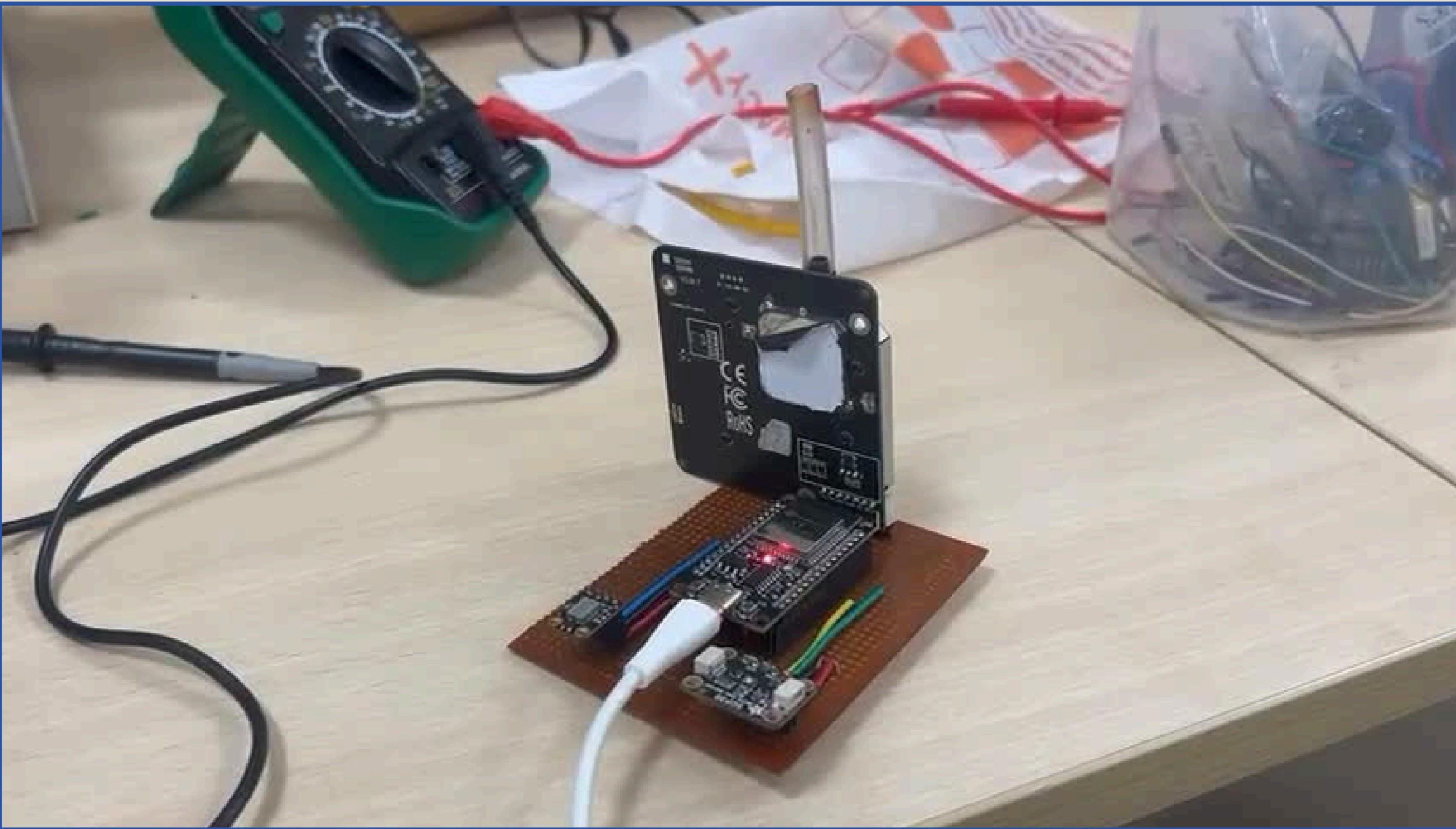
# PROCESS



# FINAL CIRCUITS

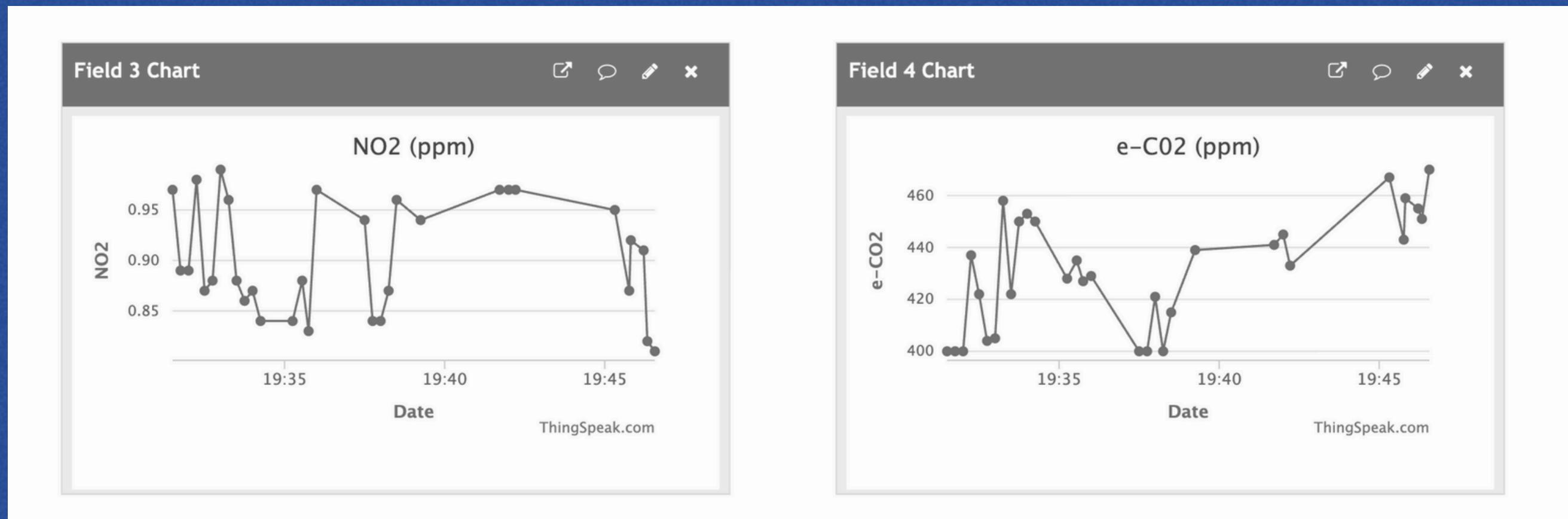


# DEMONSTRATION



# DATA COLLECTION

CURRENTLY DATA IS BEING SENT FOR ONLY NODE 1  
DATA IS BEING COLLECTED EVERY 5 SECONDS AND IS BEING SENT TO  
THINGSPEAK VIA MQTT EVERY 15 SECONDS



# DATA COLLECTION

Timestamp: 2025-09-27 12:40:19  
Sensor Readings:  
PM2.5: 4.90 µg/m³  
PM10 : 9.70 µg/m³  
NOx : 1.46 ppm  
eCO2 : 470 ppm  
TVOC : 43 ppb

Timestamp: 2025-09-27 12:40:24  
Sensor Readings:  
PM2.5: 4.80 µg/m³  
PM10 : 9.60 µg/m³  
NOx : 1.63 ppm  
eCO2 : 465 ppm  
TVOC : 67 ppb

Timestamp: 2025-09-27 12:40:29  
Sensor Readings:  
PM2.5: 4.80 µg/m³  
PM10 : 10.10 µg/m³  
NOx : 1.63 ppm  
eCO2 : 488 ppm  
TVOC : 83 ppb

Timestamp: 2025-09-27 12:40:34  
Sensor Readings:  
PM2.5: 4.90 µg/m³  
PM10 : 10.10 µg/m³  
NOx : 1.60 ppm  
eCO2 : 491 ppm  
TVOC : 92 ppb

15:32:16.950 -> UV voltage: 0.35  
15:32:16.950 -> UV Analog Value: 289  
15:32:16.950 -> UV Index: 3.53  
15:32:16.950 ->  
15:32:18.020 -> Temperature: 29.00 °C  
15:32:18.020 -> Humidity: 64.61 %rH  
15:32:18.020 -> UV voltage: 0.65  
15:32:18.020 -> UV Analog Value: 531  
15:32:18.020 -> UV Index: 6.48  
15:32:18.020 ->  
15:32:19.052 -> Temperature: 28.94 °C  
15:32:19.052 -> Humidity: 64.68 %rH  
15:32:19.052 -> UV voltage: 1.15  
15:32:19.052 -> UV Analog Value: 942  
15:32:19.052 -> UV Index: 11.50  
15:32:19.052 ->  
15:32:20.084 -> Temperature: 28.91 °C  
15:32:20.084 -> Humidity: 64.84 %rH  
15:32:20.084 -> UV voltage: 1.60  
15:32:20.084 -> UV Analog Value: 1309  
15:32:20.084 -> UV Index: 15.98  
15:32:20.084 ->  
15:32:21.147 -> Temperature: 28.89 °C  
15:32:21.147 -> Humidity: 65.09 %rH  
15:32:21.147 -> UV voltage: 1.80  
15:32:21.147 -> UV Analog Value: 1475  
15:32:21.147 -> UV Index: 18.01  
15:32:21.147 ->  
15:32:22.177 -> Temperature: 28.85 °C  
15:32:22.177 -> Humidity: 65.27 %rH  
15:32:22.177 -> UV voltage: 1.76  
15:32:22.177 -> UV Analog Value: 1442

# CHALLENGES

- HW-137 (ultraviolet intensity sensor) is not working, likely due to the sensor being faulty.
- Haven't been able to figure out the issue with ACD10 (CO2 sensor)
- MQ131 (Ozone sensor) which is crucial to the project was out of stock for a long time; is available now and needs to be ordered.
- Learning how to solder

# FUTURE PLANS

- Combining both the nodes and calibrating the sensors.
- We will be using a UV intensity sensor to analyze the sunlight intensity and its correlation with production of secondary pollutants.
- We will also be using a regression model to estimate ozone levels.
- We will be creating a dashboard that consists of various analytical graphs, (Eg: Ozone levels throughout the day).
- Using a thermal camera sensor to figure out when emmisions take place
- Trying to estimate PAN concentration with given sensors

# RESEARCH INSPIRATIONS

- Secondary pollutants, RM Harrison
- Potential Estimation of Secondary Pollutant Formation of BVOC from Peltophorum pterocarpum in Urban Area
- Hyderabad's pharmaceutical pollution crisis: Heavy metal and solvent contamination at factories in a major Indian drug manufacturing hub

**THANK YOU**

A black and white photograph of a large industrial facility, likely a cement or steel plant. The scene is filled with various industrial structures, including several tall, thin smokestacks and a complex network of pipes and scaffolding. The perspective is from ground level, looking towards the background where more of the facility's extent is visible under a clear sky.