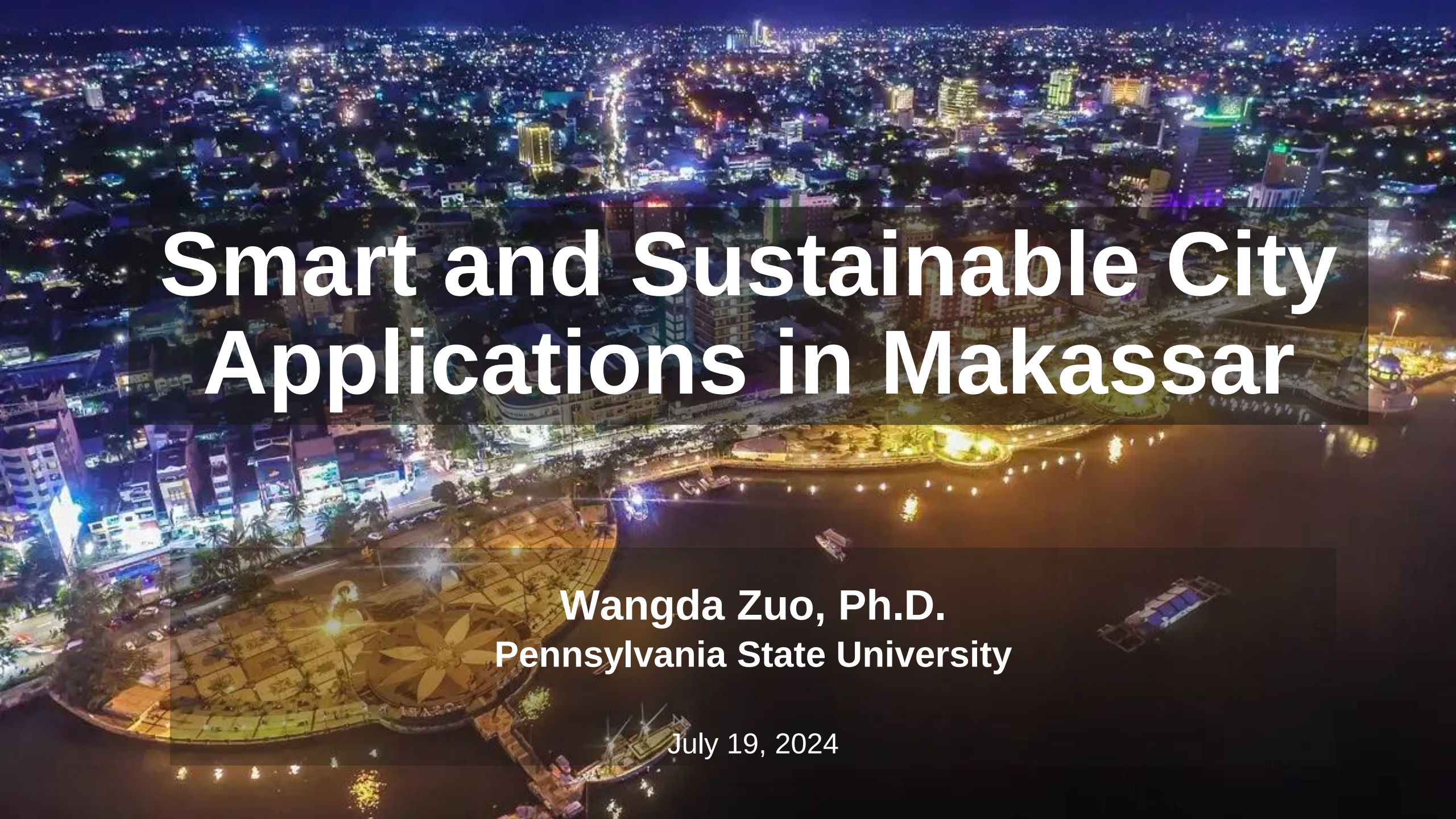


Smart and Sustainable City Applications in Makassar

Wangda Zuo, Ph.D.
Pennsylvania State University

July 19, 2024

Background

Makassar City is the 5th largest urban center in Indonesia (1.7 M population)
Makassar City's vision:

"To create Makassar as a livable world class city for all"

Makassar has converted 40+ alleys into garden alleys throughout the city

Smart Garden Alleys Inspired by Biomimicry Philosophy

Objective

This project will work to integrate innovations in **smart and connected communities to improve garden alleys** within the City of Makassar.

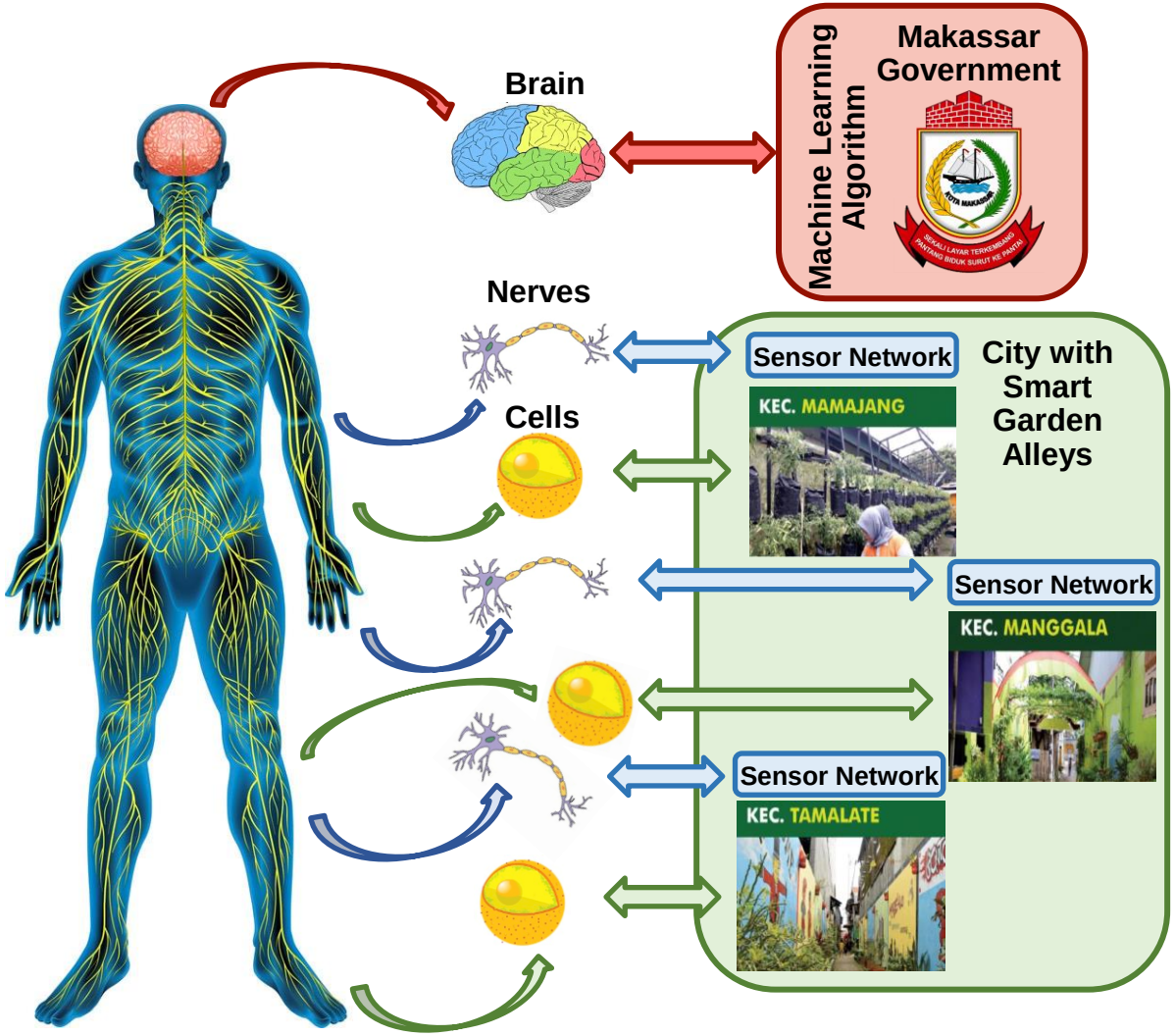
Existing

Cells: Garden alleys distributed throughout the city

Proposed

Nerves: Distributed sensor network provides feedback

Brain: City government leverages machine learning and optimization algorithms



Project Team

Project Website
https://sites.psu.edu/sbslab/research/city/smart-garden-alleys/

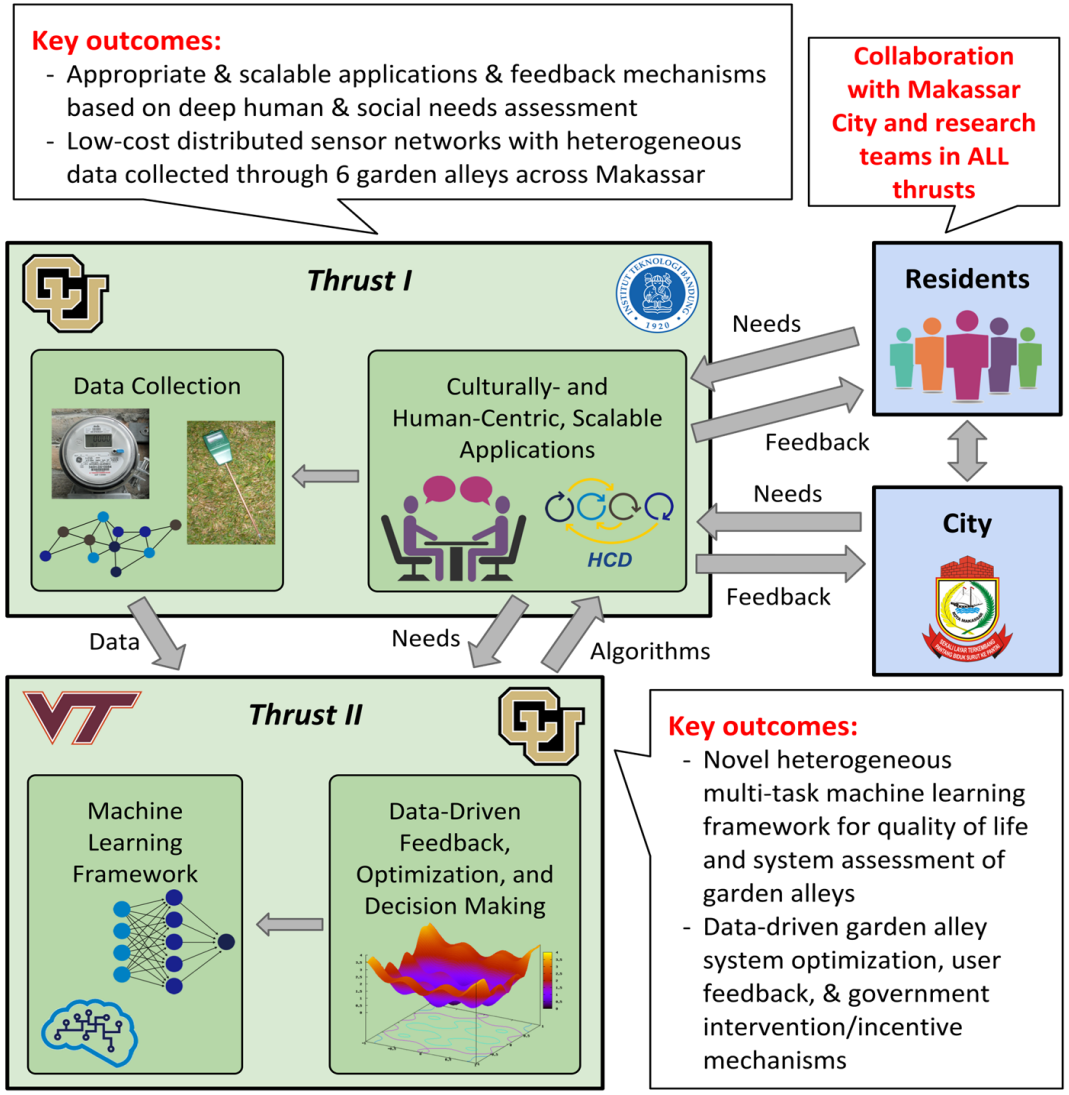
United States:

- Architectural Engineering, Pennsylvania State University
- Electrical and Computer Engineering, Virginia Tech
- Architectural Engineering, University of Colorado Boulder
- Fairview High School, Boulder, Colorado

Indonesia:

- Universitas Gadjah Mada
- Institut Teknologi Bandung
- Universitas Hasanuddin
- Makassar City

Research Approach



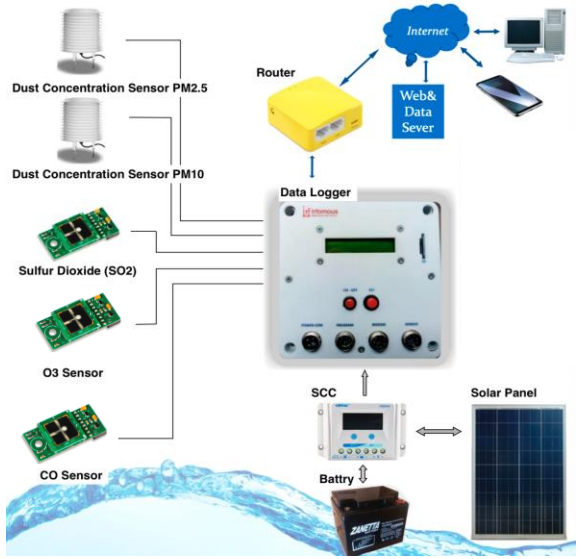
Research technology:

- Smart sensor networks
  - Real data collection
  - Quantitative method to evaluate the environment of garden alley
- Machine learning
  - Data driven model based on physical data (sensor network) and social data (survey and interview)
- Optimization theory
  - Cost saving
  - Human resources saving

Research Methods

1. Data Collection for Air Quality Data and Social Data

Custom designed air quality monitoring system for ASEAN Cities



Designed questionnaires

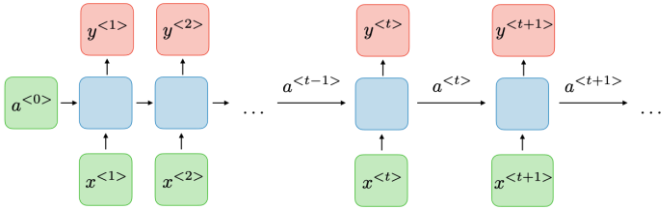
2. Design a Recommendation System for Urban Farming

Input

- Solar radiation
- Irrigation
- Fertilizer
- Precipitation
- Maintenance
- Air quality

Machine Learning Model

Recurrent Neural Network



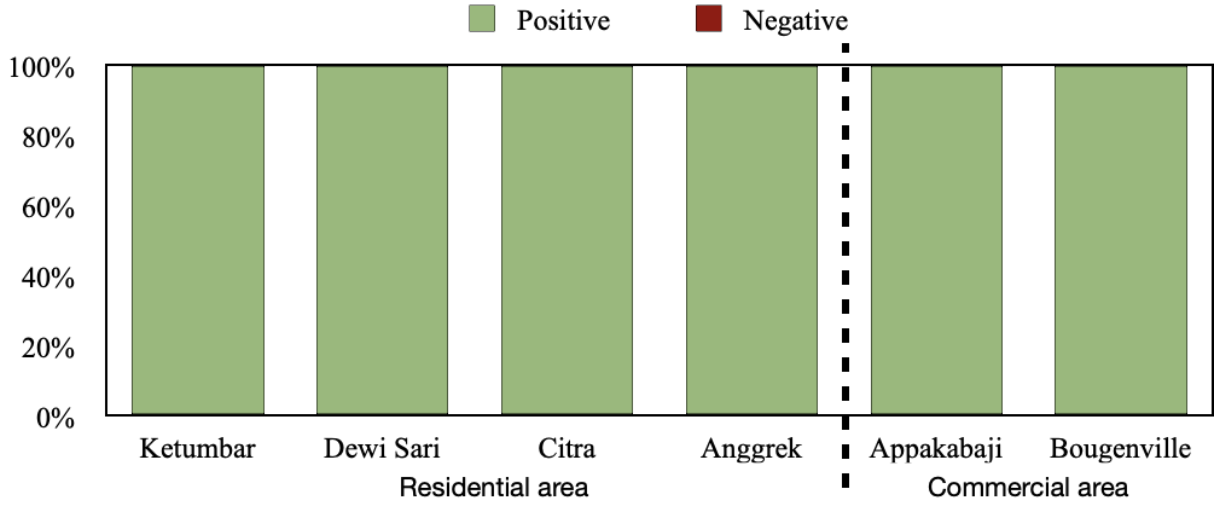
Output

Growth of edible plant

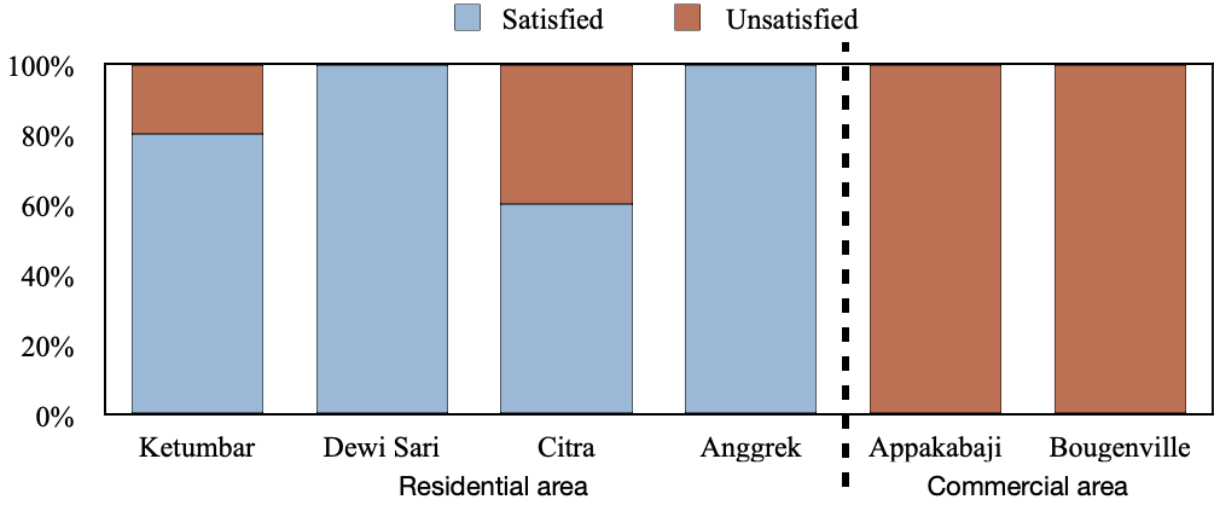
Growth of inedible plant

Residents Survey

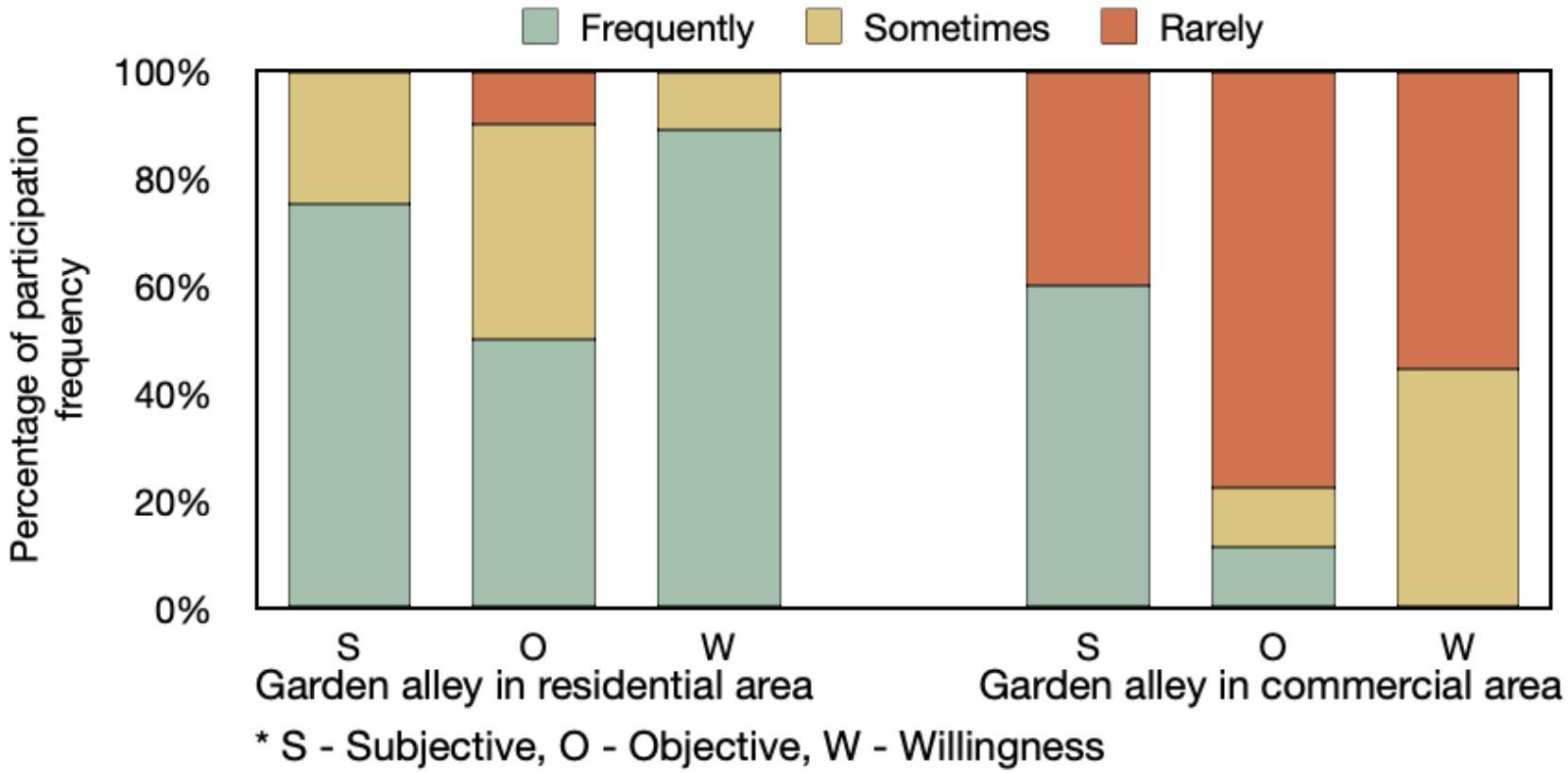
Attitude to garden alley project



Satisfaction of current garden alleys

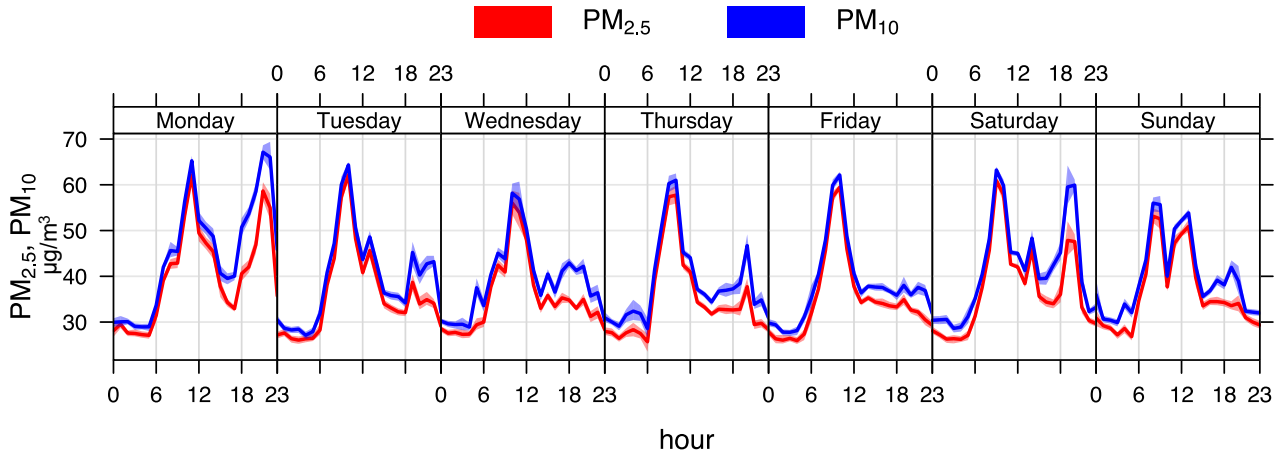


Residents Survey

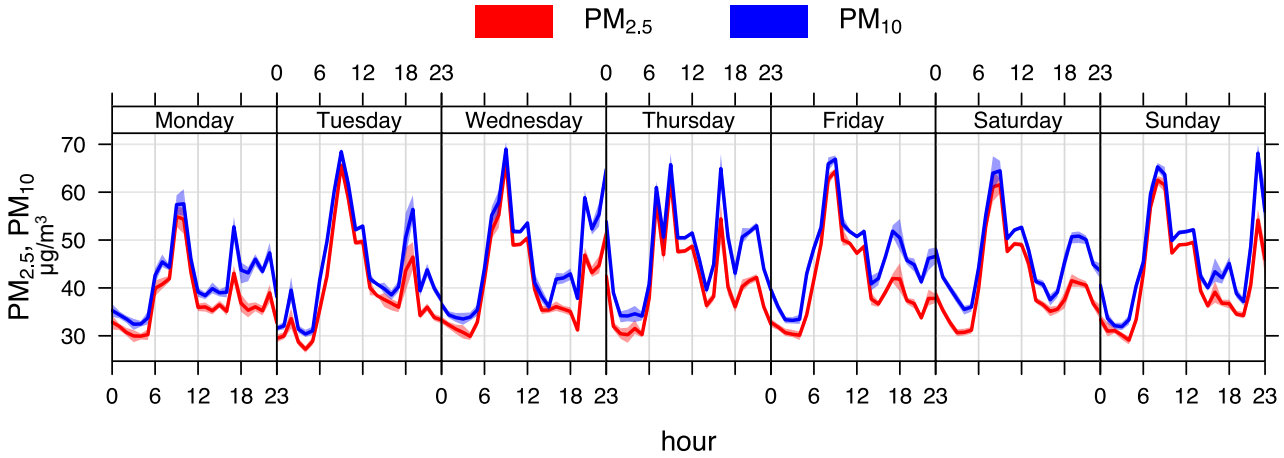


PM2.5 and PM10

Alley Dewi Sari (Residential)

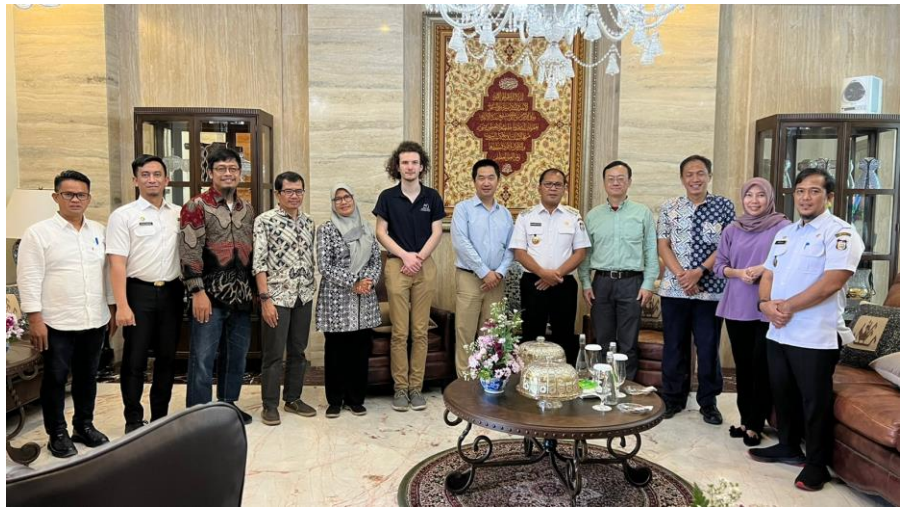


Alley Appakabaji (Commercial)



Stakeholder Engagement

Makassar delegation visited Washington D.C. in July, 2022

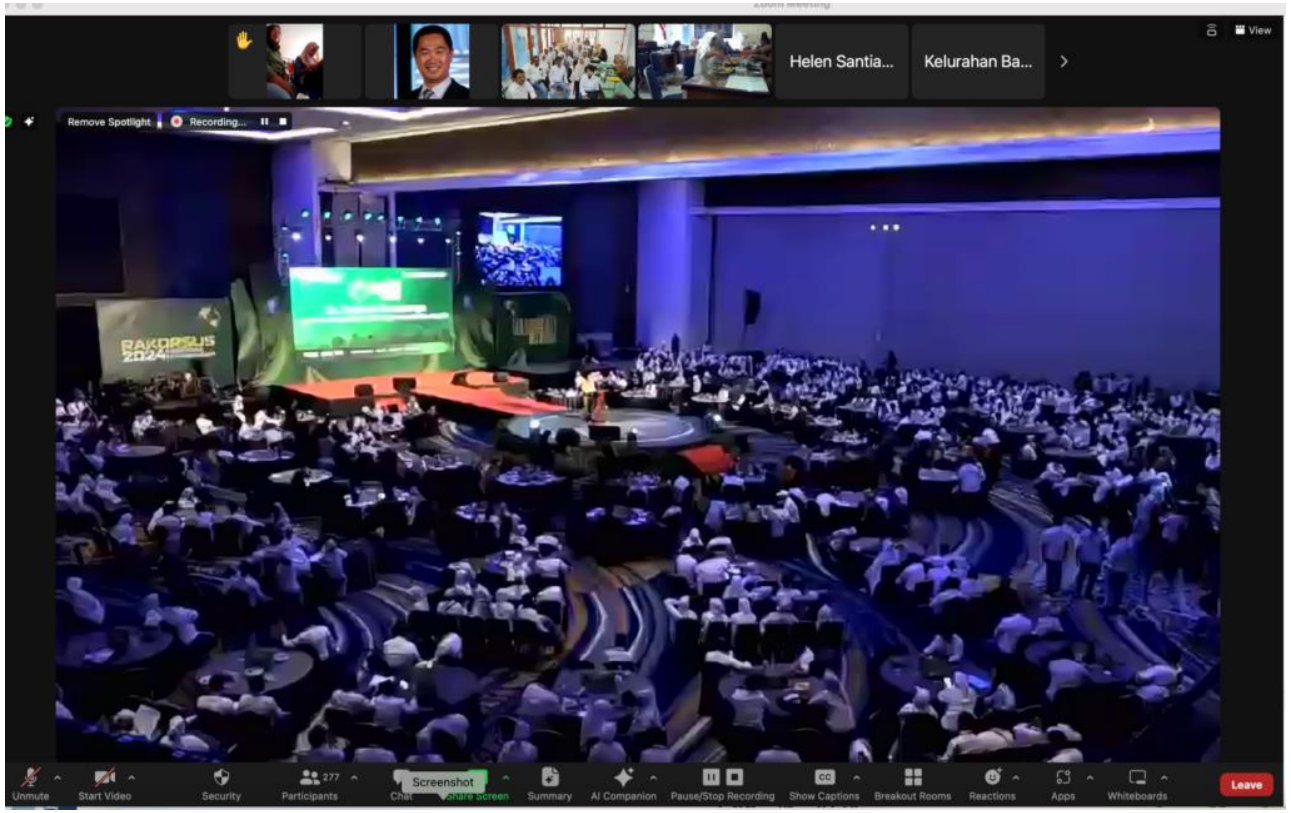


US delegation visited Makassar in December 2022

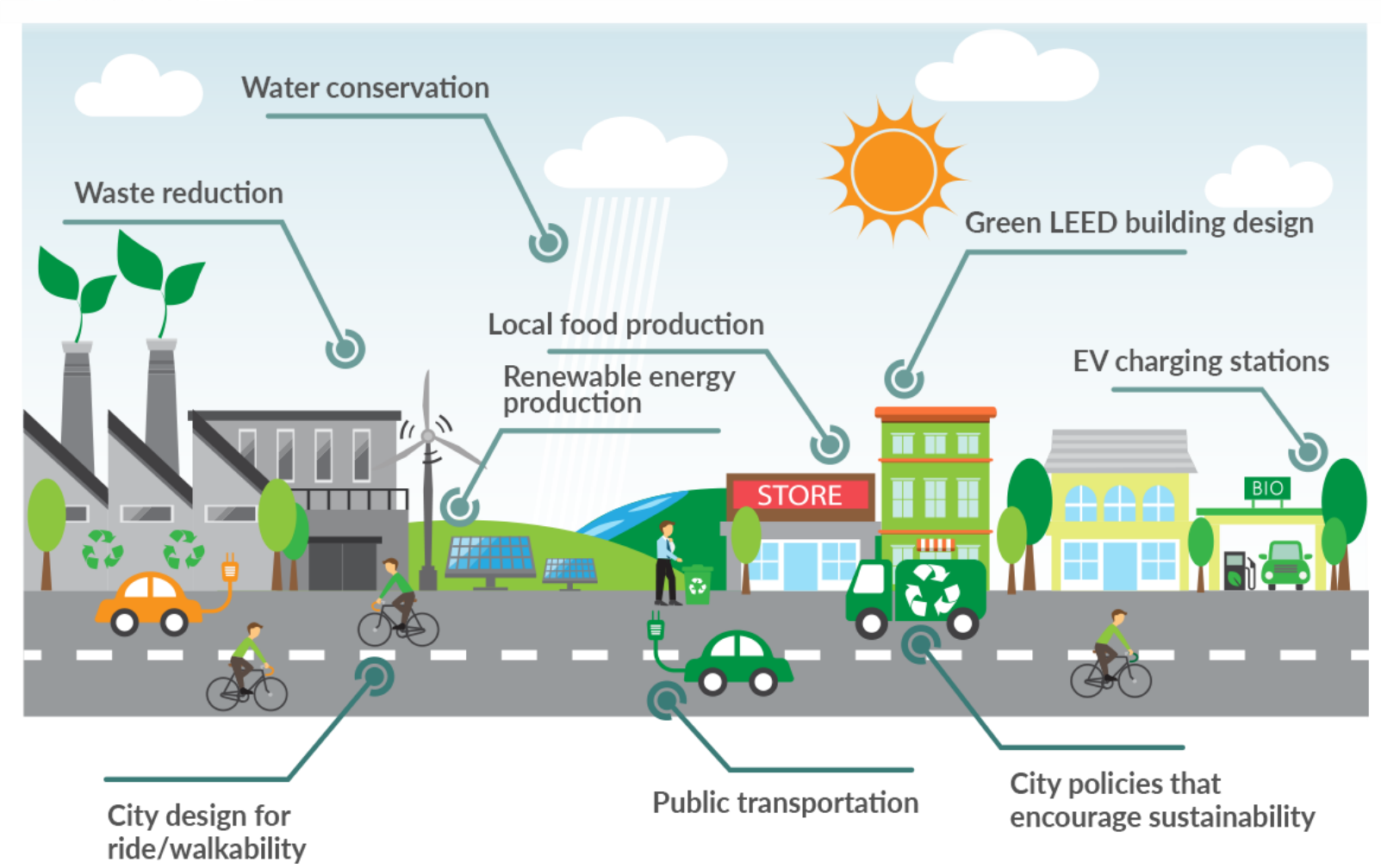
INTERVIEW WITH MAYOR POMANTO FROM MAKASSAR, INDONESIA

USASCP

Makassar Low-Carbon City with Metaverse

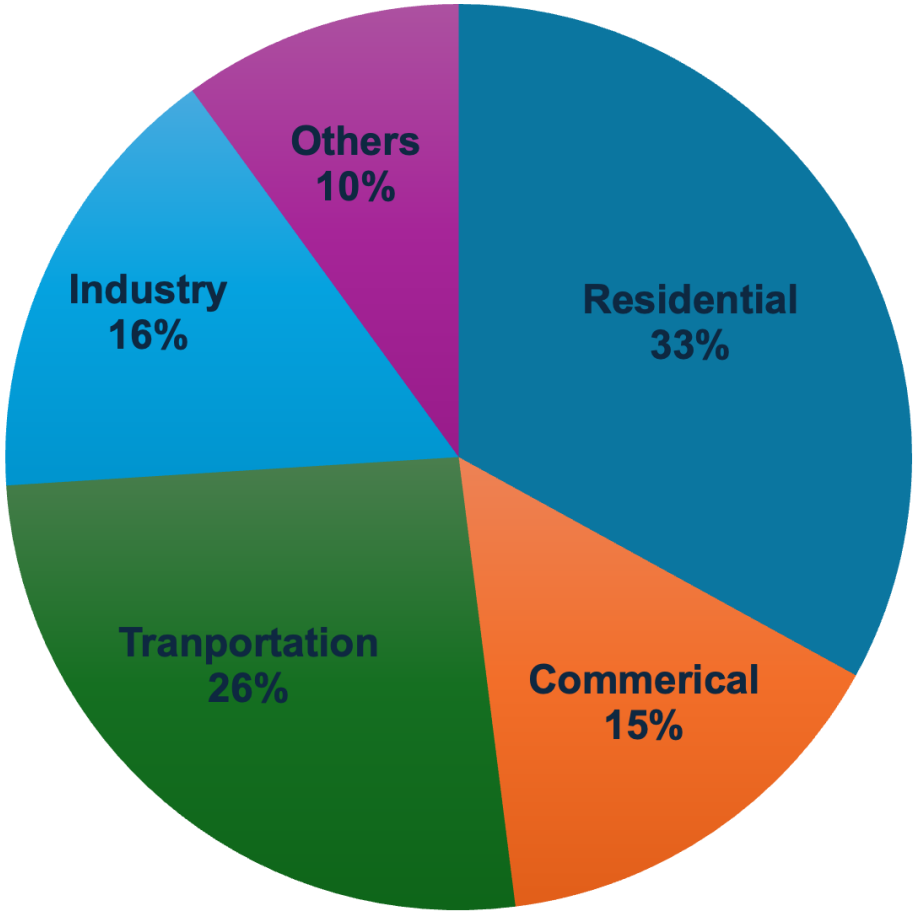


Pathway to Net Zero Carbon City in Makassar



https://www.letsgosolar.com/consumer-education/sustainable-cities/

Makassar City Carbon Emission Profile



Makassar Carbon Emission by Sector in 2019

https://www.asean-mayors.eu/2020/10/indonesia-review-on-makassars-ghg-inventory/

Energy consumption due to direct emission (use of fossil fuel) and indirect emission (electricity from grid) dominates Makassar's GHG emissions.

It will reach the level of 1.4 million tCO_2e by 2030.

Makassar's Pathway to Net Zero Carbon City: Renewable Energy

Name	Rooftop PV in Makassar	Mega solar in Makassar	Mega solar outside Makassar
Aveilabe area (km^2)	13.8	19.3	231.3
Capacity (MW)	2,044	850.9	10,179
Annual power generation (MWh)	3.4 million	1.44 million	17.21 million
Cost of energy ($/MWh)	91.5	106.2	93.6
Economic viability (10 years inverter PV system)	Feasible (IRR = 6.8%)	Feasible (IRR = 4.6%)	Feasible (IRR = 6.4%)
CO_2 annual reduction relatively to power demand emission (%)	124	52	629

Sihotang, M.A. and Okajima, K. (2017) Photovoltaic Power Potential Analysis in Equator Territorial: Case Study of Makassar City, Indonesia. Journal of Power and Energy Engineering, 5, 15-29.

Smart Garden Alley and Community Renewable Energy

Sustainability

Resilience

Energy

Water

Food

Pilot Project Site Survey

Vision for Makassar: Net Zero Carbon Alley

Image generated by OpenAI DALL·E 3

Vision for Makassar: Net Zero Carbon City

Image generated by OpenAI DALL-E 3

Acknowledgment

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