Reign of Reliability

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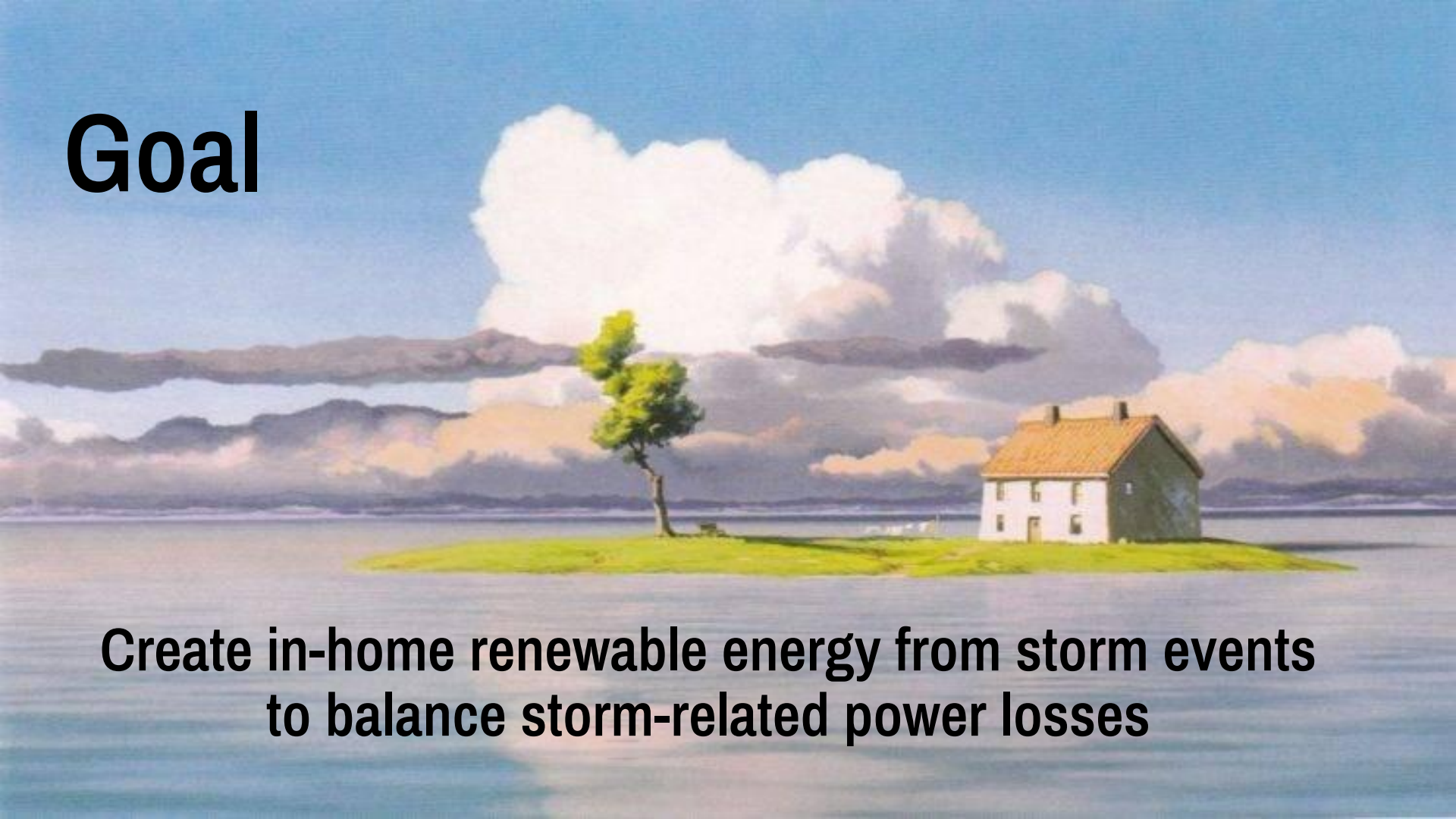
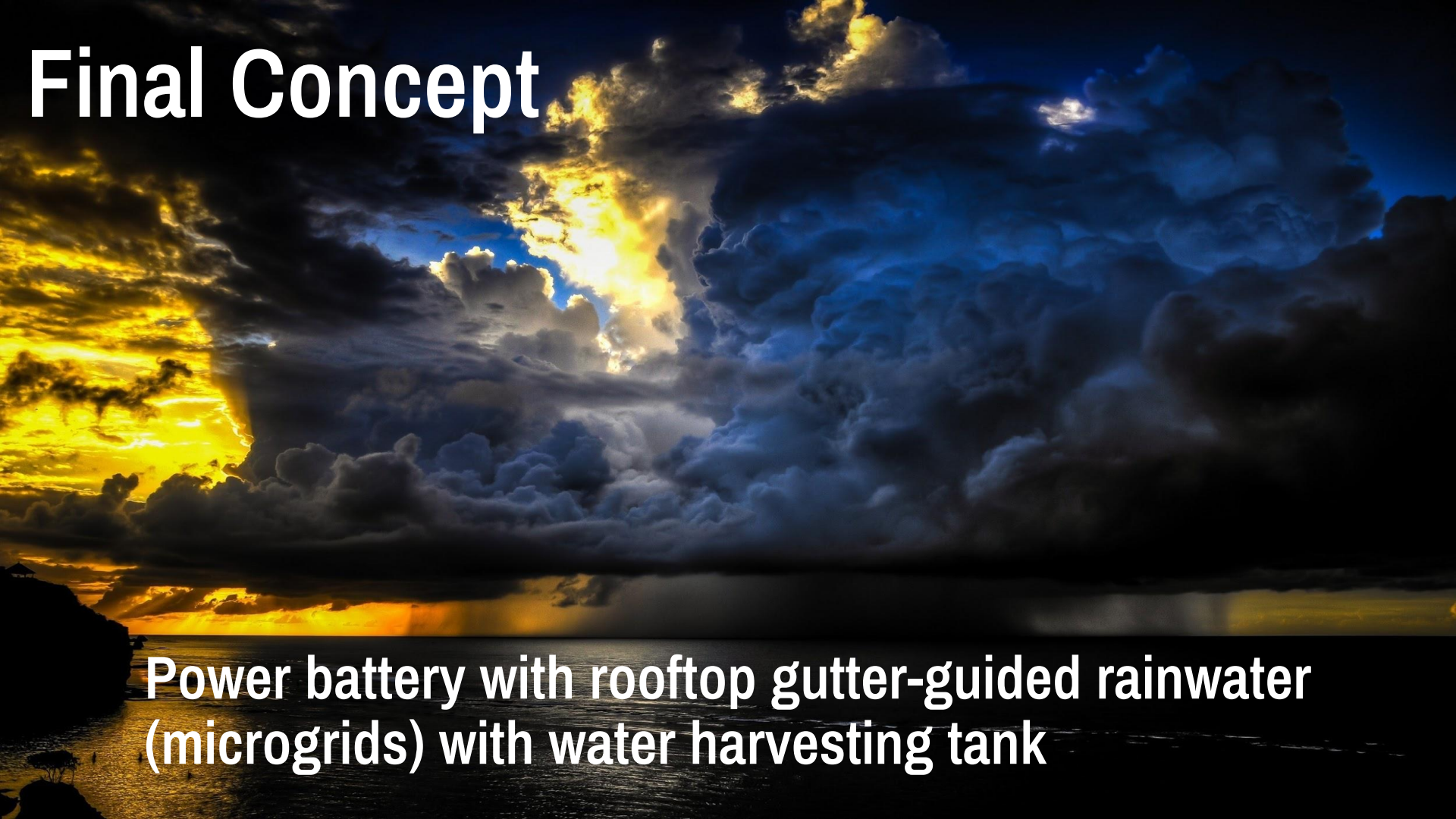
Address growing need for renewable and reliable power in storm-related power outages
Motivation

Goal



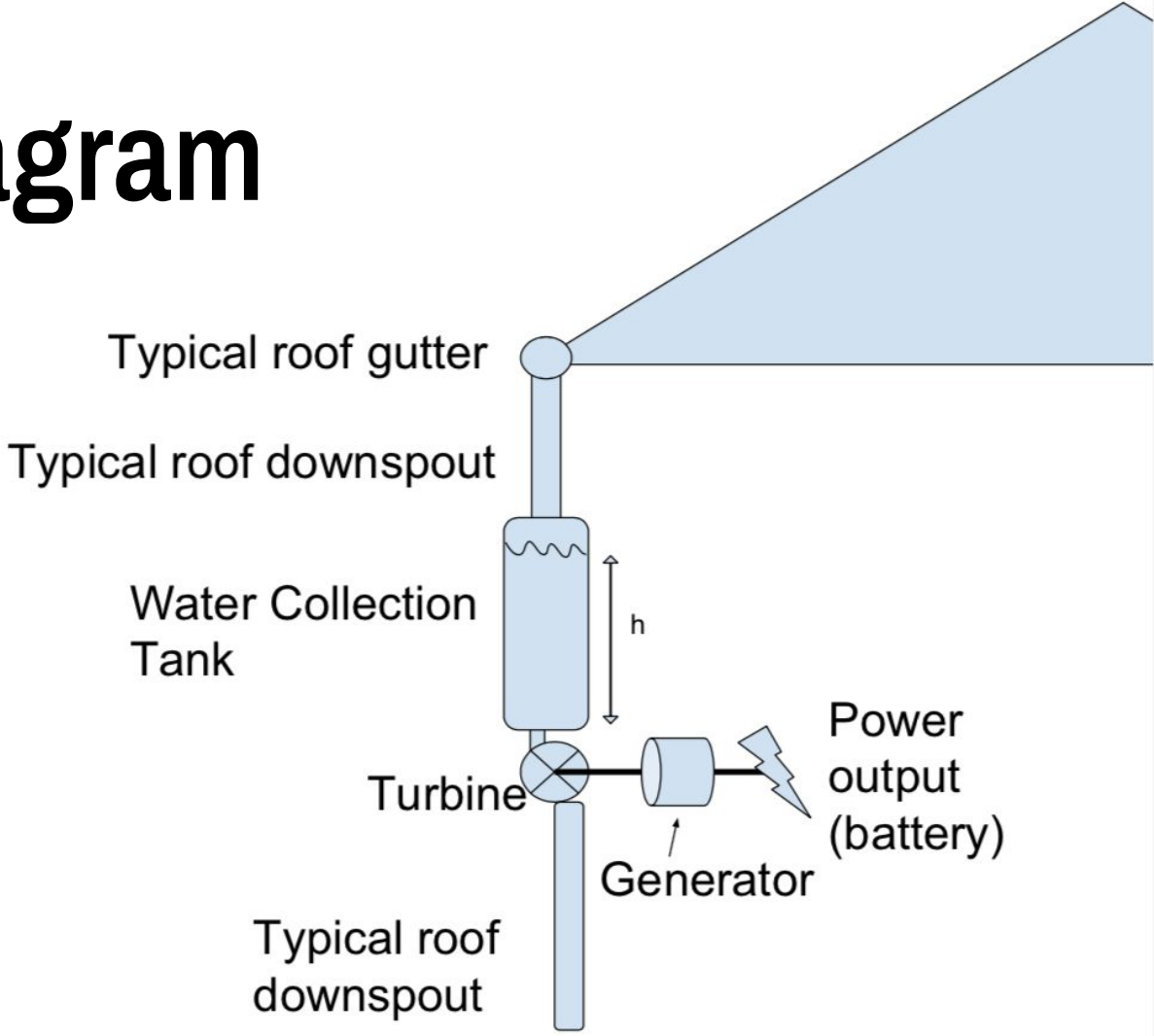
Create in-home renewable energy from storm events
to balance storm-related power losses

Final Concept



Power battery with rooftop gutter-guided rainwater (microgrids) with water harvesting tank

Concept Diagram



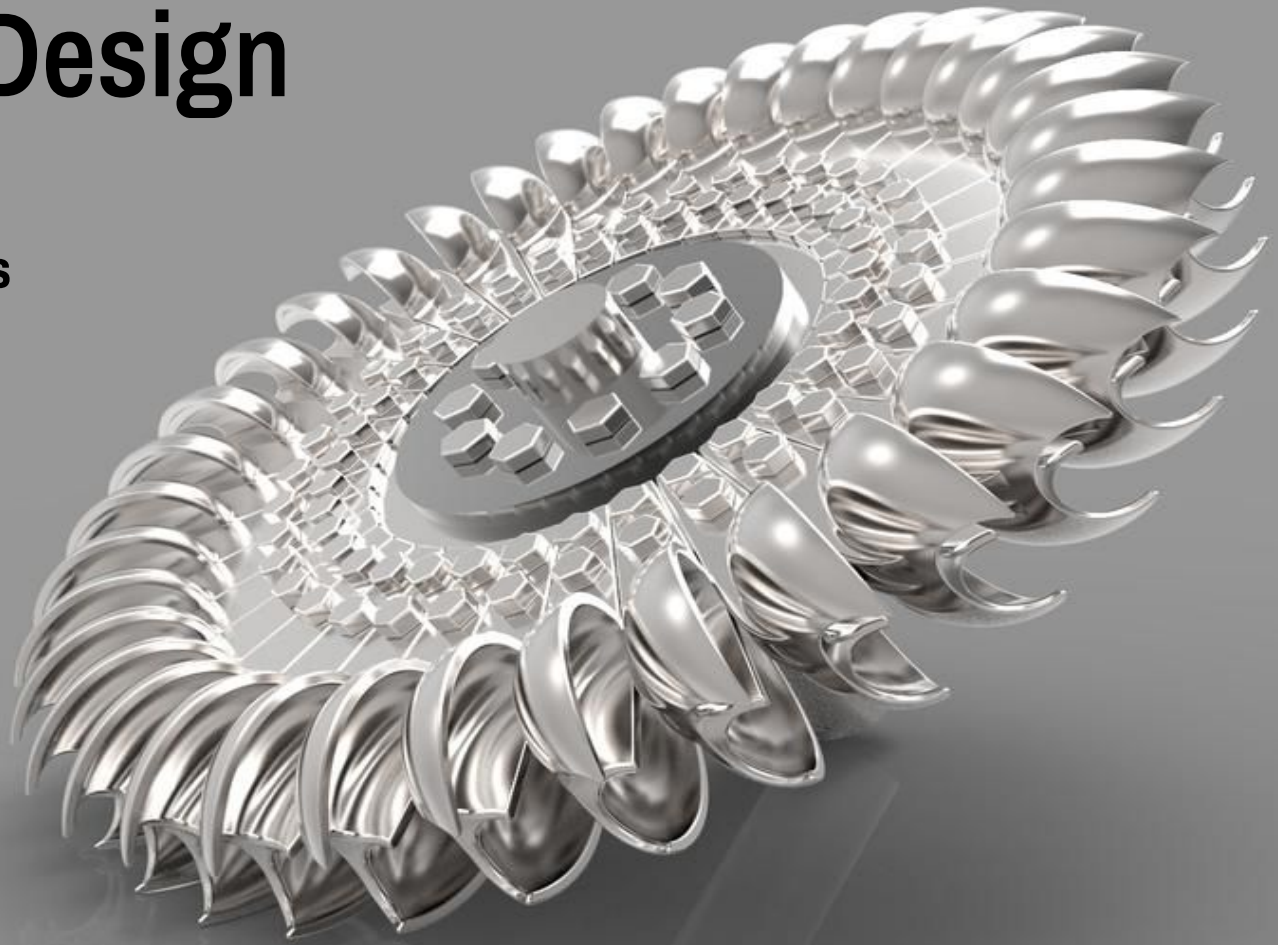
Technical Design

Pelton Wheel

Outsourced solidworks design with edits

Generator

Permanent magnet commutator motor mounted to turbine



Technical Design

Motor Calculation

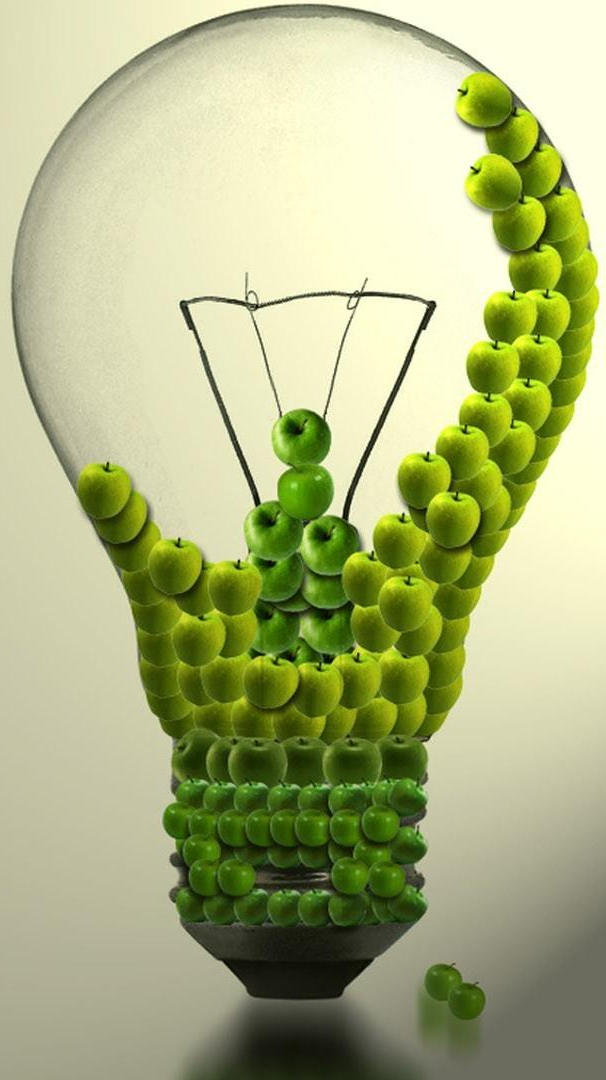
$$v_t = k\omega - iR_A$$

R_A = Armature Resistance

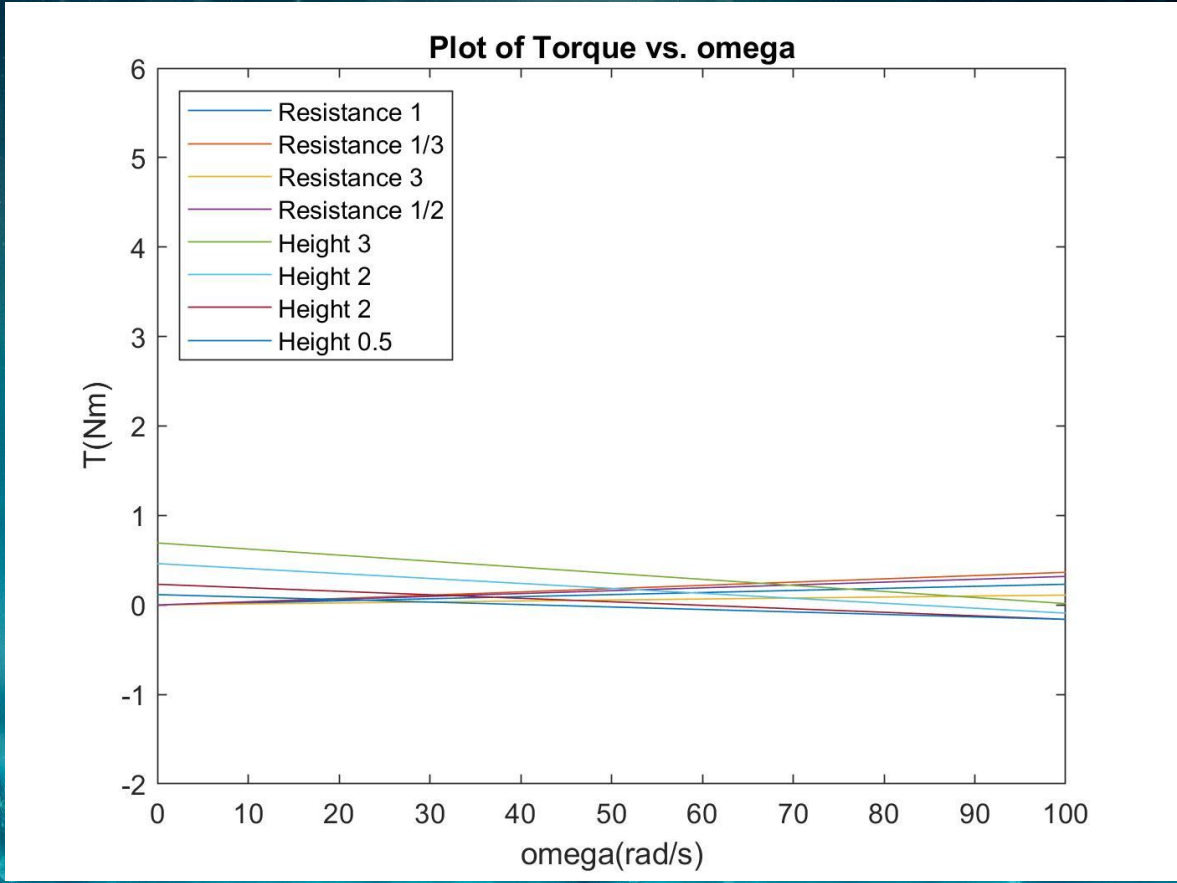
Fluid Calculation

$$\tau = \frac{\rho g h Q}{\omega}$$

Q = water flow rate



Technical Design: Theoretical Data



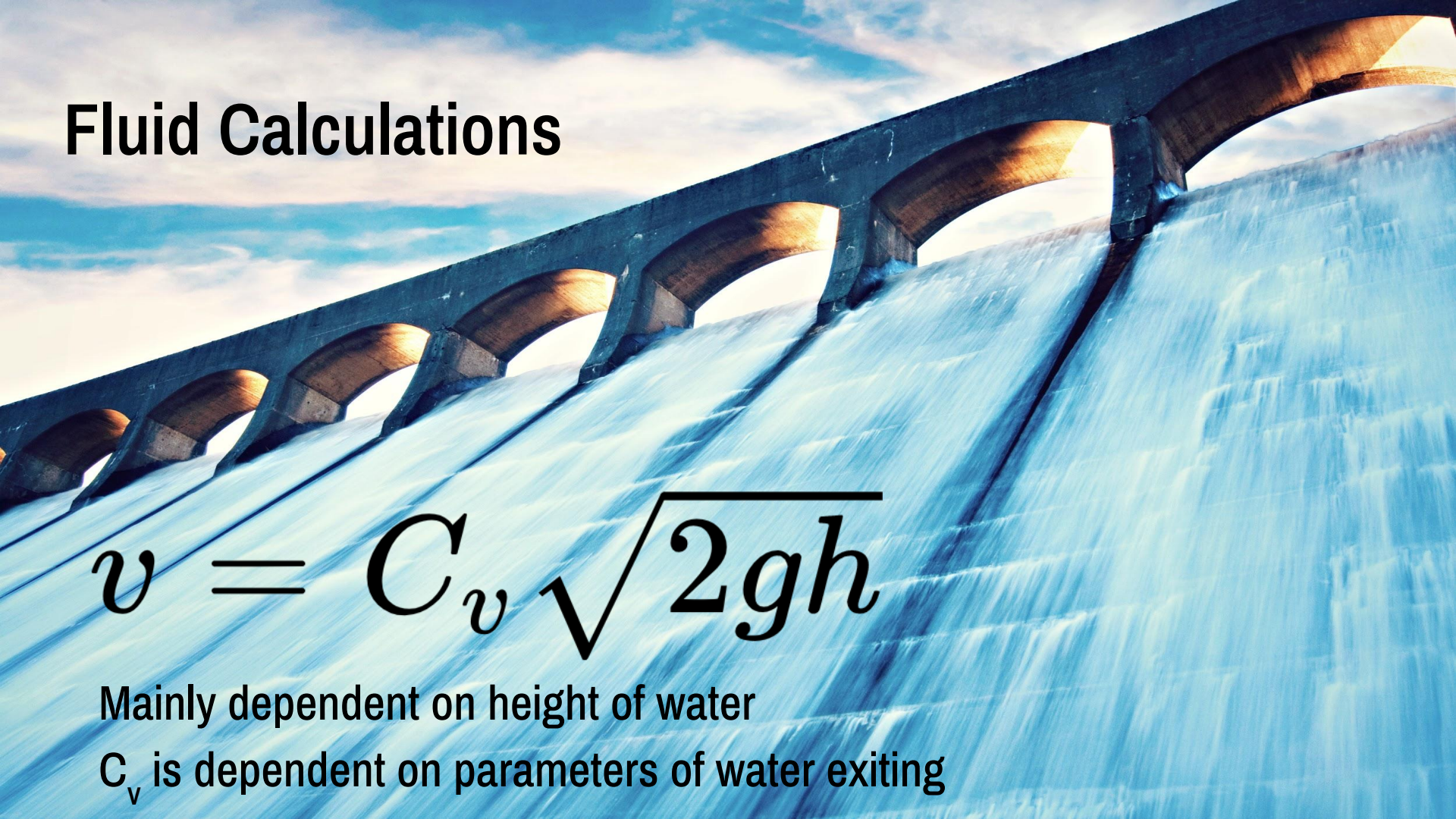
Catchment System

Wall mounted tank

Pressure gauge for mechanical metering

Potential app for smart home control

Fluid Calculations



$$v = C_v \sqrt{2gh}$$

Mainly dependent on height of water

C_v is dependent on parameters of water exiting

Fluids Proof of Concept

Assumptions

- 1 in/hr rainfall
- 2700 ft^2 roof area
- 35 ft roof
- 0.8 efficiency

$$P_{th} = \rho q p h$$

Water Collected

6.4 m^3

Output Power

15.1 Wh

Experimental Setup

Goal

Determine actual performance of turbine

Measured

Water velocity (height, distance, flow rate), resistance

Voltage

Problems

Motor Protection

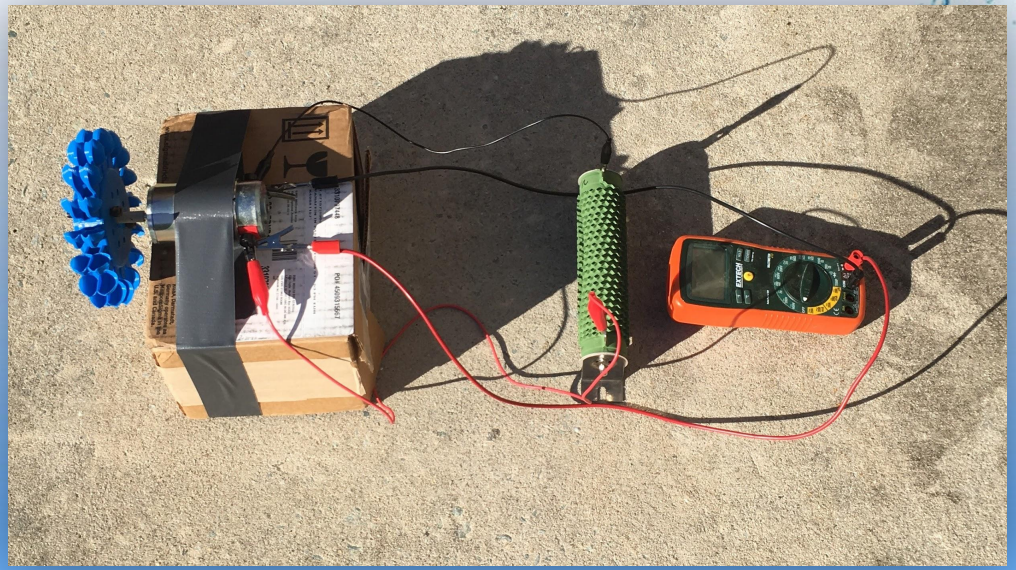
Varying conditions (wind)

Experimental Results

Max Power output recorded:

0.82 W

Proof of concept; scaled up



Results

Height

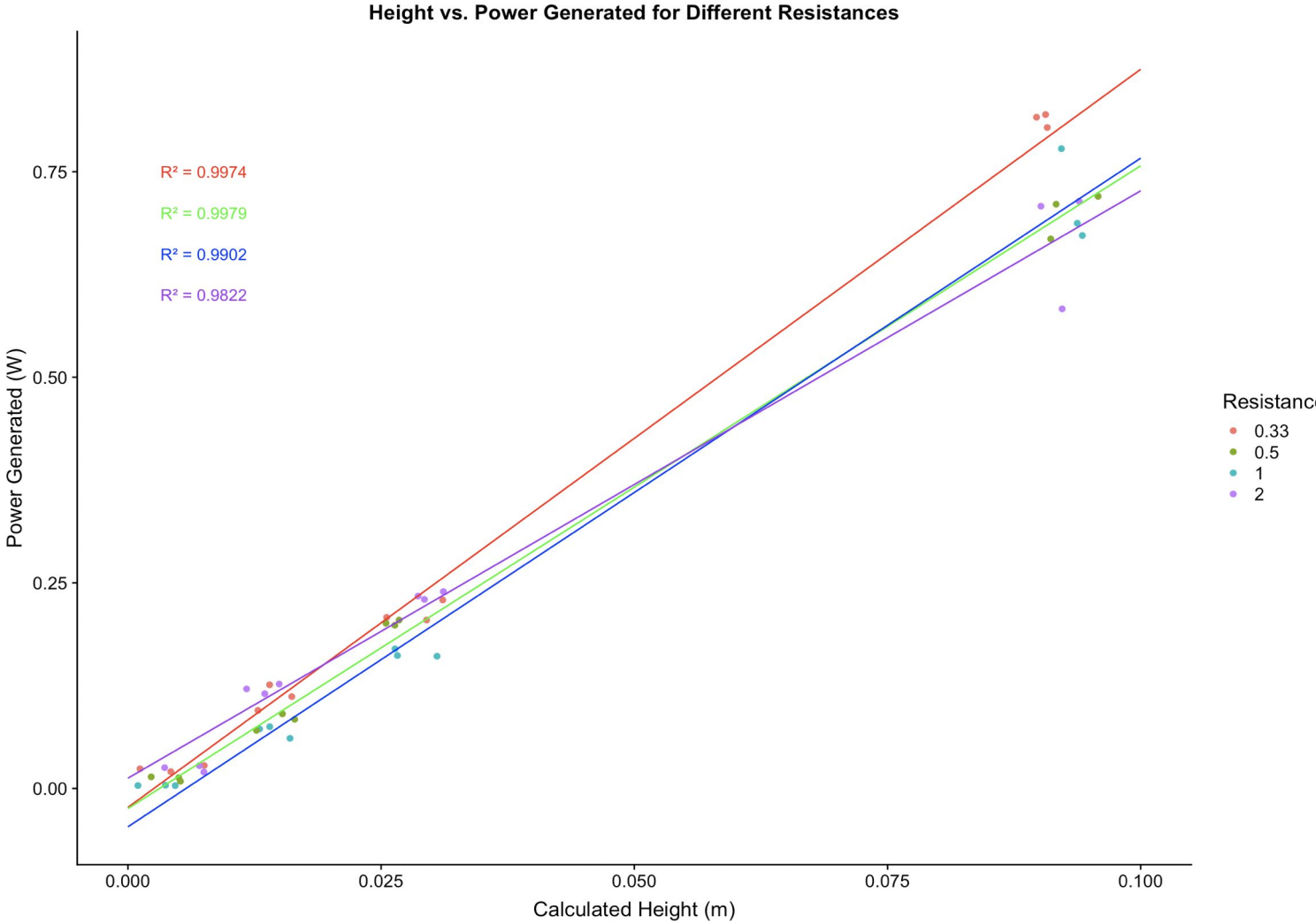
1 meter

Resistance

0.33 Ohms

Power

8.95 W



Environmental Benefits

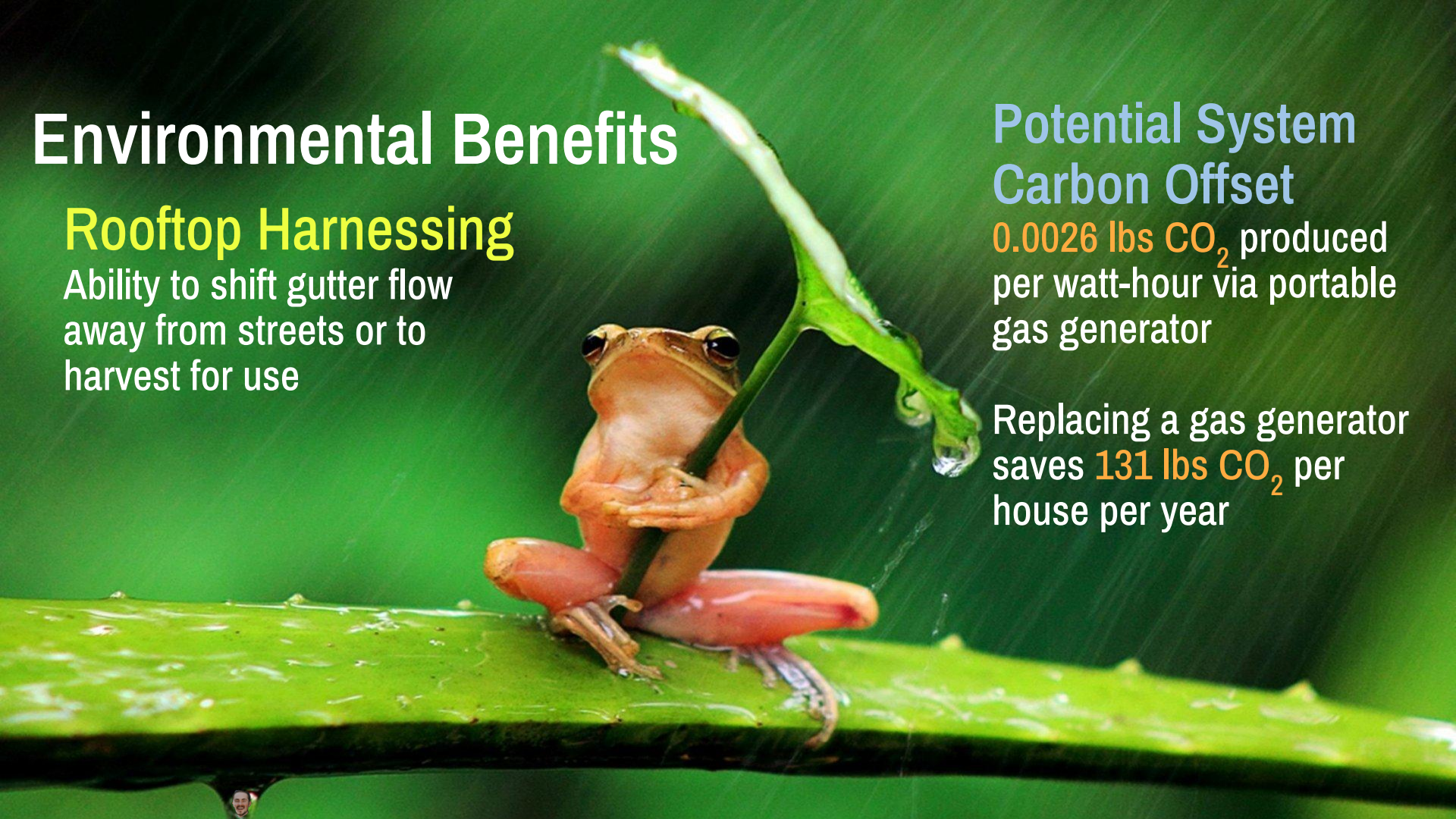
Rooftop Harnessing

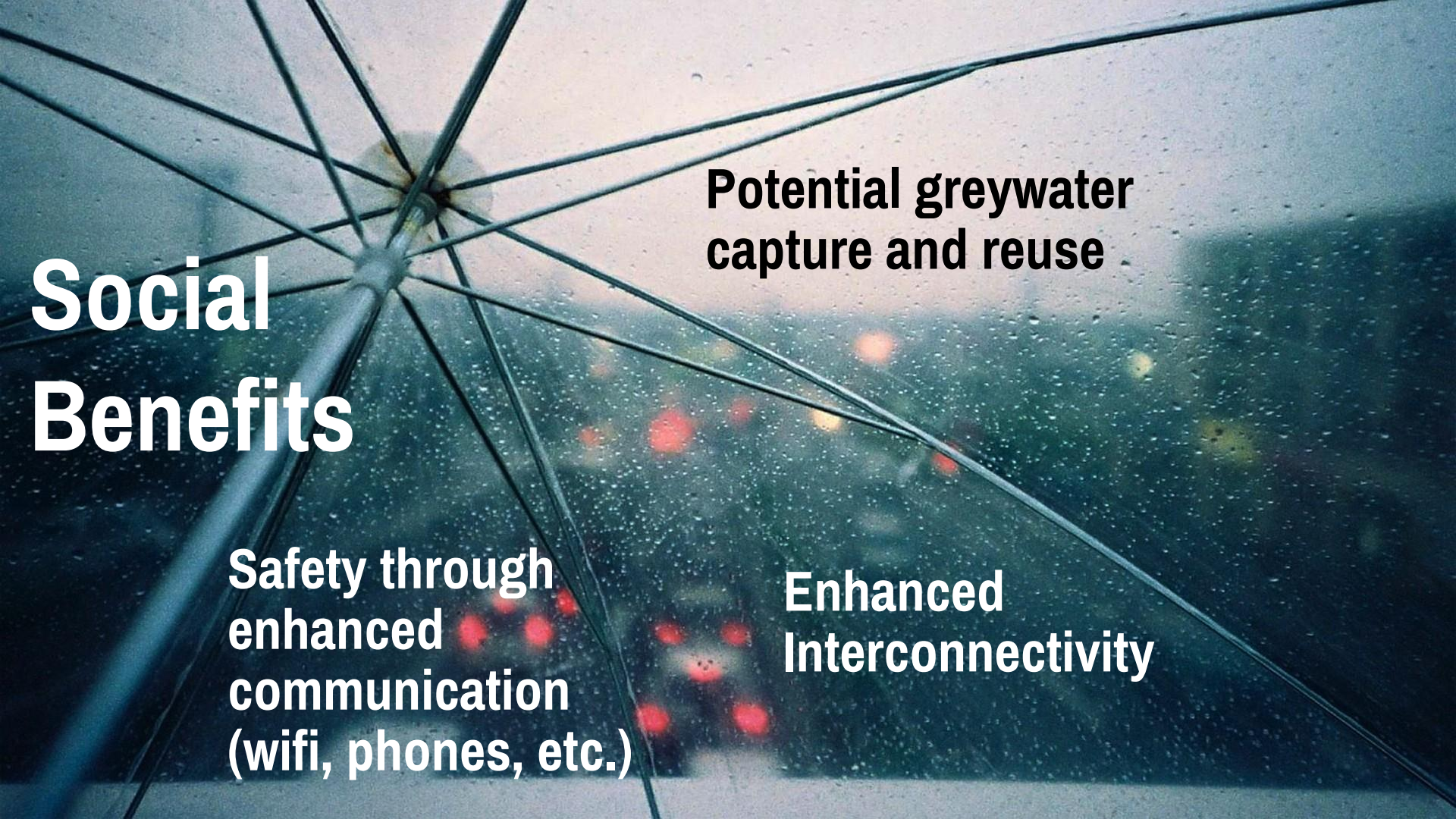
Ability to shift gutter flow away from streets or to harvest for use

Potential System Carbon Offset

0.0026 lbs CO_2 produced per watt-hour via portable gas generator

Replacing a gas generator saves 131 lbs CO_2 per house per year




Social Benefits
Potential greywater capture and reuse
Safety through enhanced communication (wifi, phones, etc.)
Enhanced Interconnectivity

Target Market

Rural areas

Developing Countries--PAYGO

Individual Homeowners

Data from Parents of Duke Students:

91.5% in owned home

74.6% willing to mount system

Expanded Market

Developing Countries

- Renewable and reliable
- Located at home - no need to travel long distances for small amounts of power
- Better than solar
  - Easier to fix
  - PAYGO
  - Cheaper

Business Plan

- Costs <$50 (61%)

  - Observe rain data from other parts of the world

    - Frequency of blackouts

      - Subsidized by Duke Energy

      - Modular design

Updated Prototype Costs

Purchased

$95 motor (provided)

$10 plastic mounting piece

$3 15/64” drill bit

$20 plastic rod

Predicted

$5 cover for turbine

$15 tank

$5 PVC outlet

Conclusions

Larger scale

Cheaper bill of materials

Electrical control of catchment system

Financial Support