Power Generation through Recycled Materials

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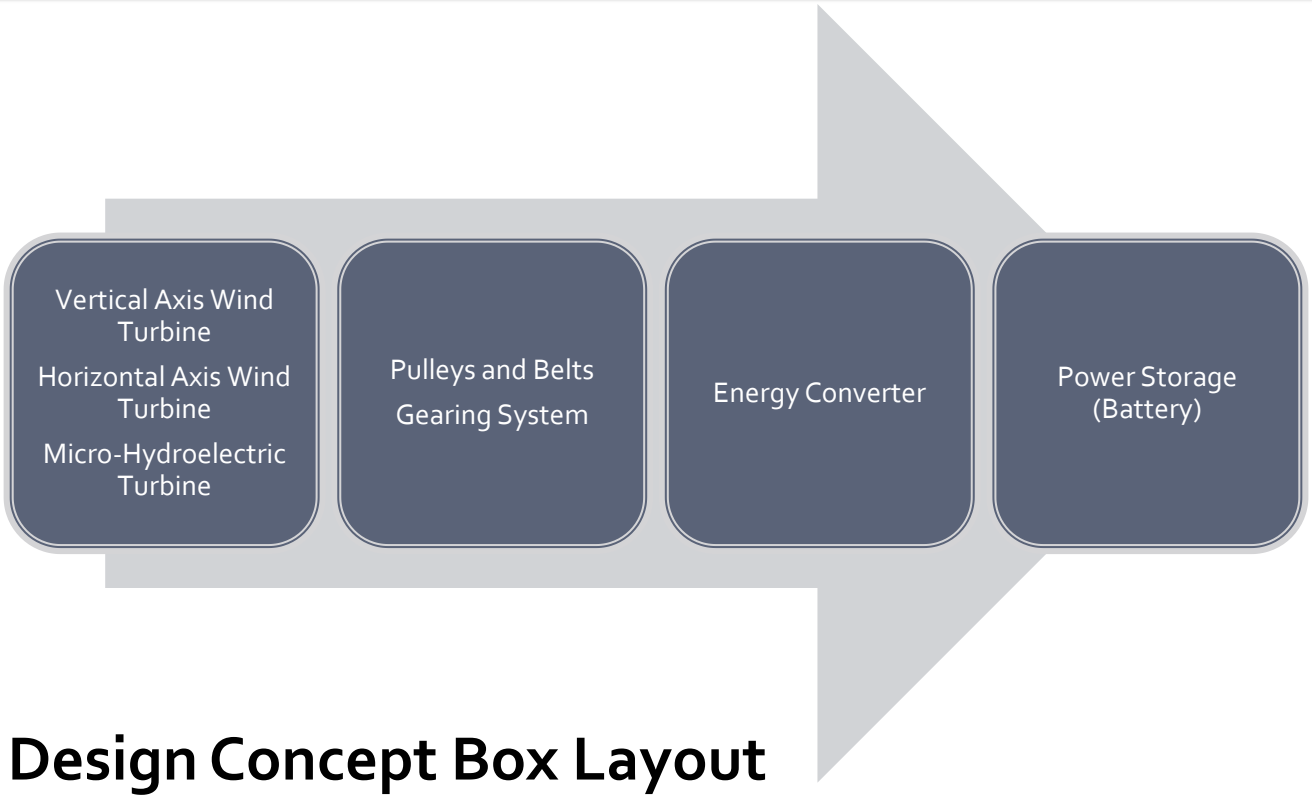
Sponsor: Cummins

Background Overview

- **Problem Statement:**
  - Design and construct a power generation device that implements the use of a renewable energy source and is composed entirely of recycled materials
- **Objectives:**
  - Must generate 100 W•h/day
  - Must store 300 W•h
  - Output must be 12 V DC
  - **Must sustain severe weather**
- **Constraints:**
  - Must choose three different geographic locations
    - 100 km away from the ocean, 500 km away from each other
  - Final product must cost under $50

Design Layout



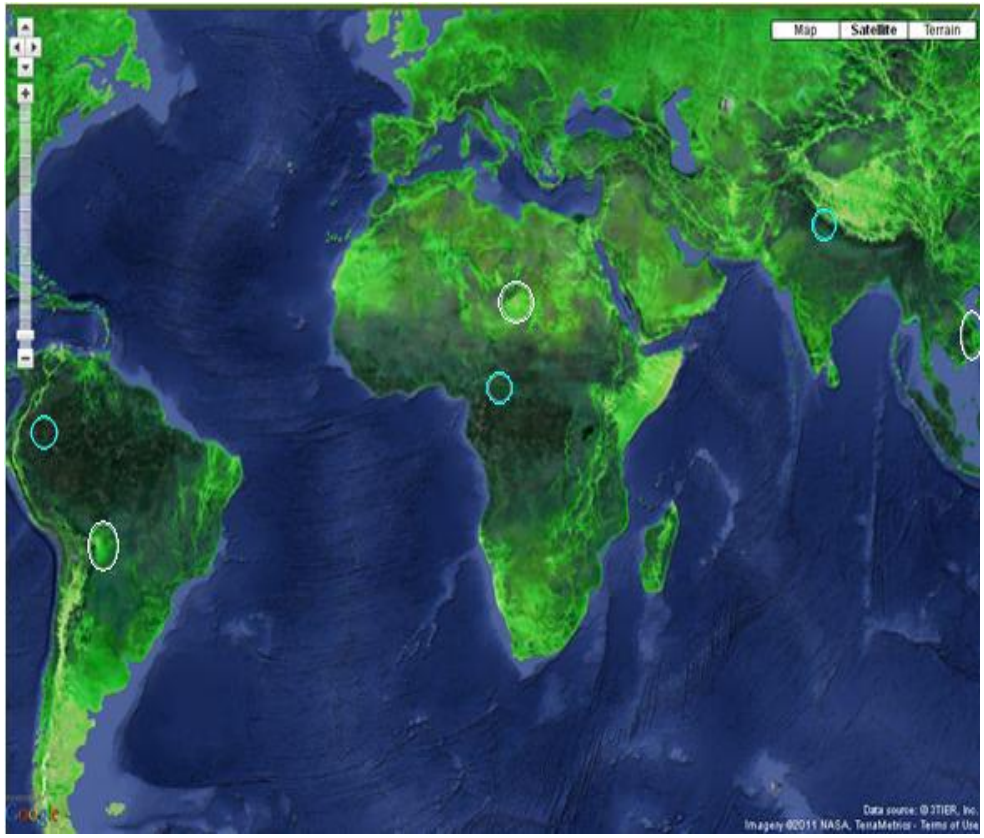
- **Design Concept Box Layout**
  - Energy Capture→ Speed Change→ Energy Conversion→ Battery Storage
  - Simplicity with 4 component layout

Geographical Locations

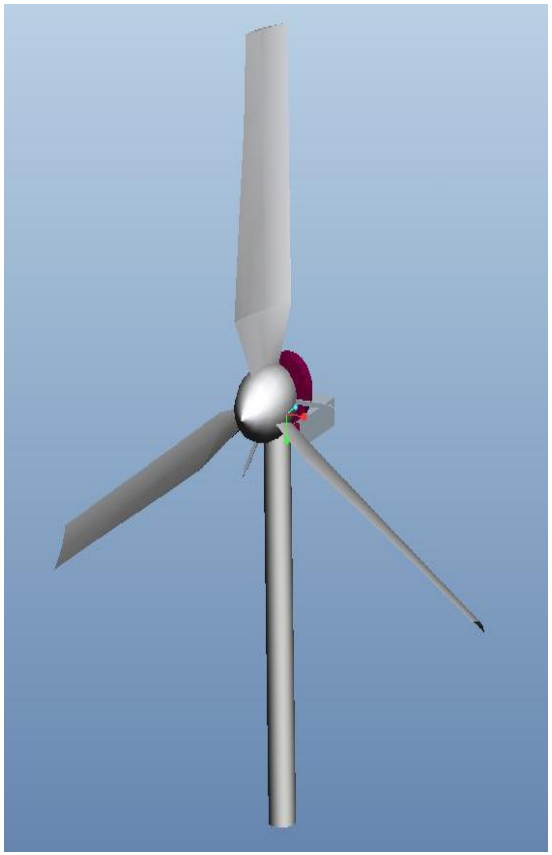
- **Wind Energy Locations**
  - **Faya-Largeau, Chad**
    - Average wind speed = 4.6 m/s ~ 10 m height
  - **Santa Cruz, Bolivia**
    - Average Wind = 3.9 m/s ~ 10 m height
  - **Sen Monorom, Cambodia**
    - Average Wind = 5.1 m/s ~ 10 m height

(An average of 4 m/s was used for calculations)

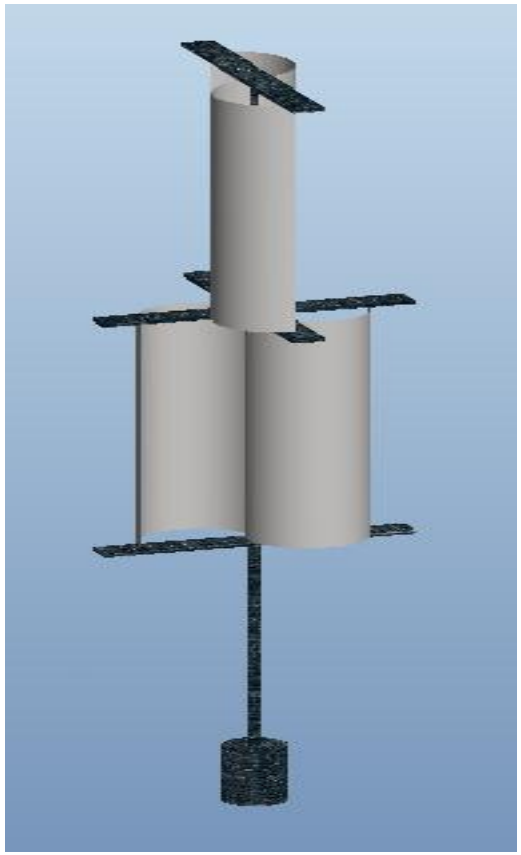
- **Water Energy Locations**
  - **Atrato River, Colombia**
    - Average Flow = $2.0 \cdot 10^6$ L/s
  - **Indus River, Pakistan**
    - Average Flow = $6.5 \cdot 10^6$ L/s
  - **Benue River, Cameroon**
    - Average Flow = $1.75 \cdot 10^5$ L/s



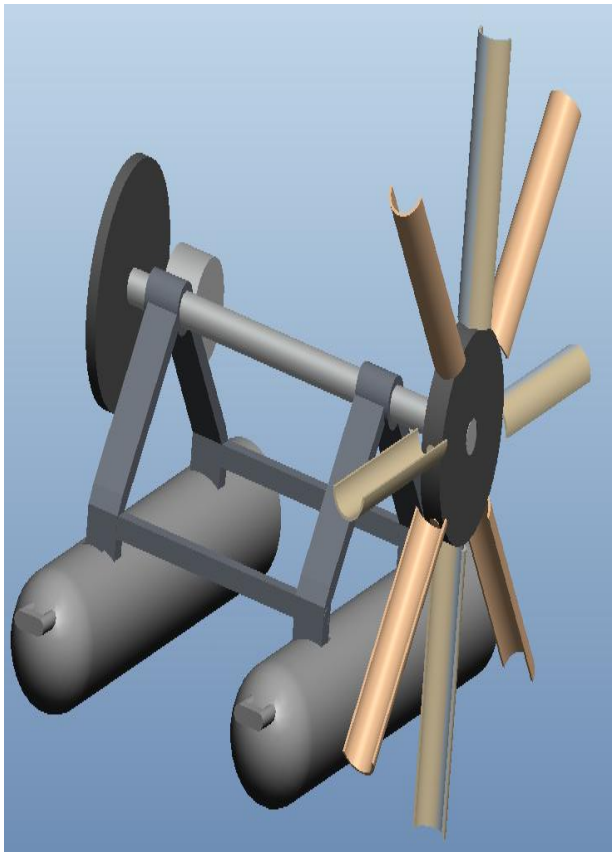
Building the HAWT, VAWT, Micro-Hydro



HAWT-Horizontal Axis Wind Turbine



VAWT- Vertical Axis Wind Turbine



Micro-Hydro Electric

Wind Design Specifications

VAWT

- **Drag based Savonius turbine**
- **Power coefficient**
  - **0.24**
- **2-Savonius blades**
  - 90° offset
- **Area of turbine (10W output)**
  - Minimum area: 1.563 m^2
  - Minimum cylinder diameter: 0.375 m
  - Minimum cylinder height: 2.5 m
- **Bicycle dynamo assembly**
- **Supporting structure**

HAWT

- **Lift based turbine**
- **Power coefficient**
  - **0.114**
- **3 – blade design**
  - 120° offset
- **Area of turbine (10W output)**
  - Minimum area: 3.29 m^2
  - Actual area: 4.6 m^2
  - Diameter of blade: 2.14 m
- **Bicycle dynamo assembly**
- **Supporting structure**

Construction of Horizontal Axis Wind Turbine Design

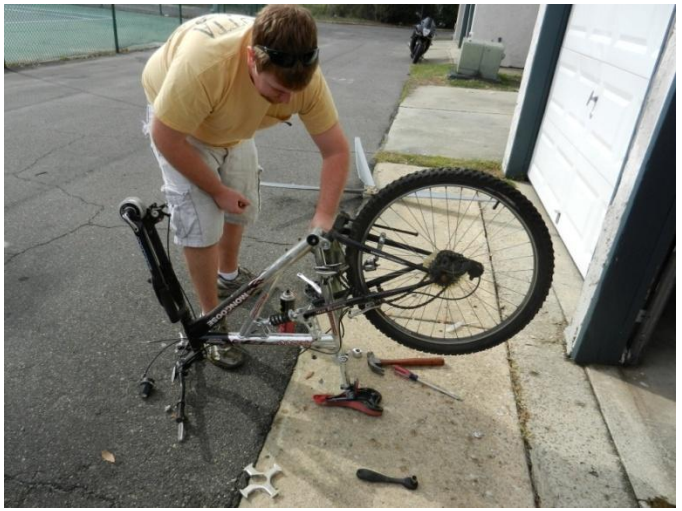
COMPLETED TASKS

- Constructed turbine blades
- Assembled turbine
  - Working area = 4.59m^2
- Disassembled bicycle
  - Collected and cleaned ball bearings

REMAINING TASKS

- Grease bearing assemblies
  - Chain, sprockets, hubs
- Reconstruct bicycle
  - Remove front of bicycle
- Attach turbine to pedal axis
  - Fabricate a 4-inch extension rod
- Construct PVC mount for assembly
  - Use existing seat mount
- Begin testing

Pictures of Horizontal Axis Wind Turbine Design



Construction of Vertical Axis Wind Turbine Design

COMPLETED TASKS

- Axis for rotation
  - Computer chair seat swivel
- Turbine blade
  - 55-gallon drum
- Bicycle wheel assembly will be used for speed change system

REMAINING TASKS

- Assemble the rotating axis
- Construct turbine blades
  - Mount turbine structure
- Construct PVC supporting structure

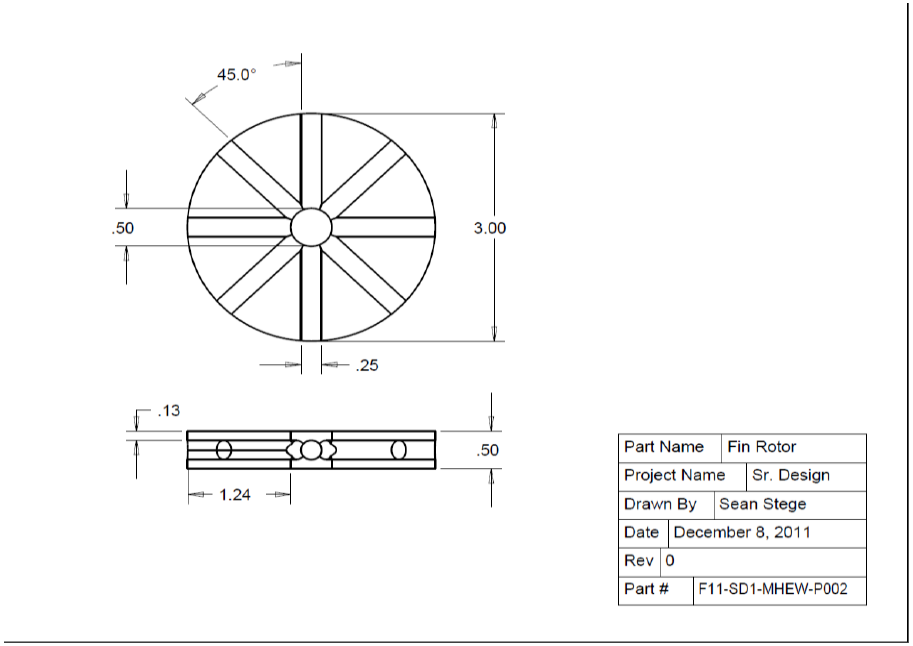
Pictures of Vertical Axis Wind Turbine Design

Construction of Micro-Hydro Turbine

- **Paddle-Wheel**
  - Use indigenous bamboo to reduce cost and utilize locally abundant resources
  - Lightweight and holds up well in water
- 8 fins so at least two are in contact with the water at all times

Prototype Considerations

- *Utilize 4" PVC in place of timber bamboo*



Future Plans

- Finish construction of wind turbine assemblies
- Test each and meet required objectives
  - Compare competencies
- Incorporate a safety for severe weather
  - Flyball governor
  - Bicycle brake pad
- Biweekly teleconferences with Cummins representative Terry Shaw

Questions?