# Power Generation through Recycled Materials



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# 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
- Constraints:
  - Must choose three different geographic locations.
    - 100 km away from the ocean, 500 km away from each other
  - Must generate 300 W*h at a rate of 12V direct current
  - Final product must cost under $50

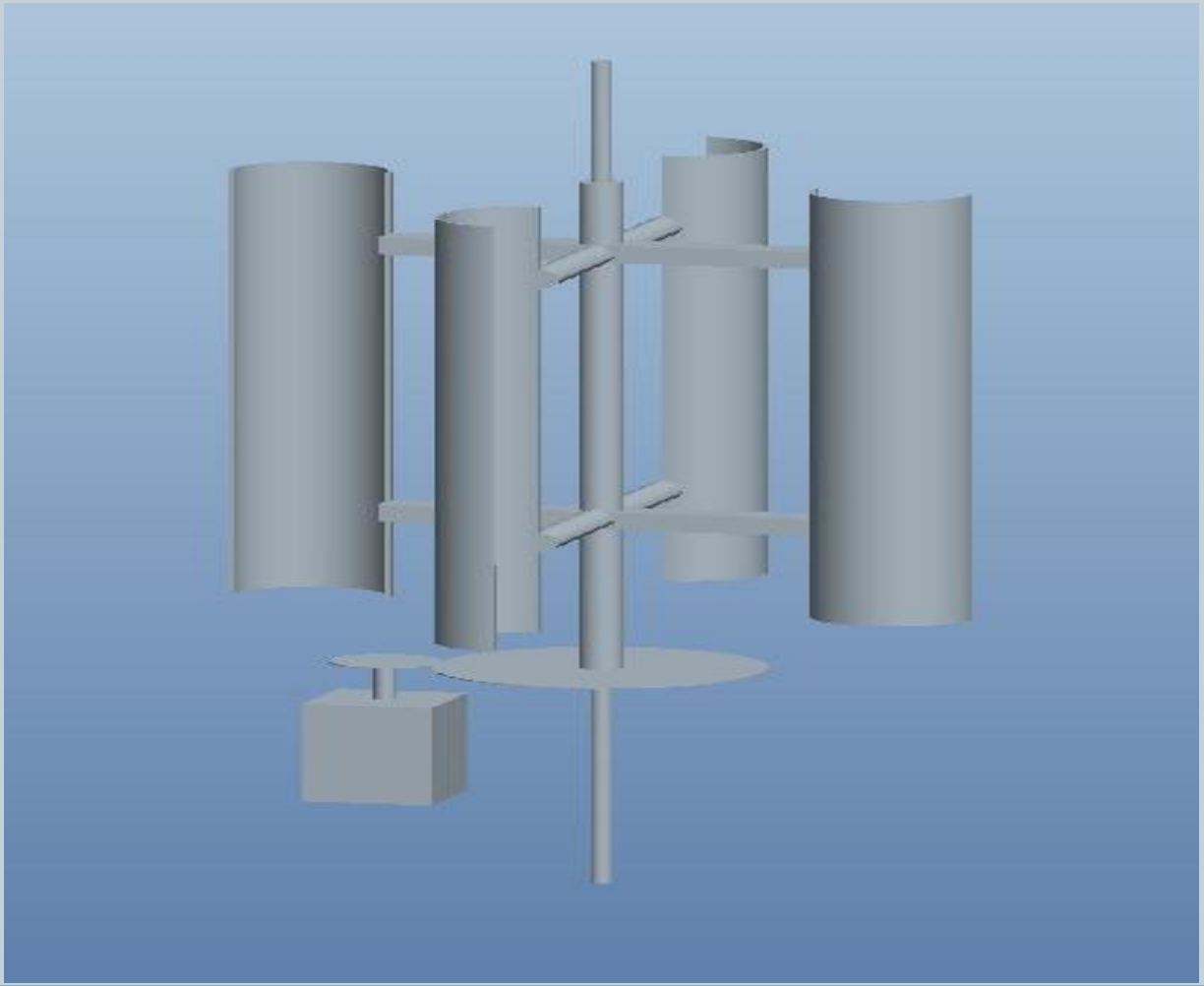
# Design Concept #1: Vertical-Axis Wind Turbine (VAWT)



- Renewable energy source:
  - Wind energy
- Energy conversion:
  - Wind rotates vertical turbine blades
  - Wind energy is converted to rotational mechanical energy
  - Alternator converts mechanical energy into electrical energy
- Power storage:
  - 12V DC output battery will be used for energy storage

# Design Concept #1: Vertical Axis Wind Turbine (VAWT)





# Design Concept #1: Vertical Axis Wind Turbine (VAWT)

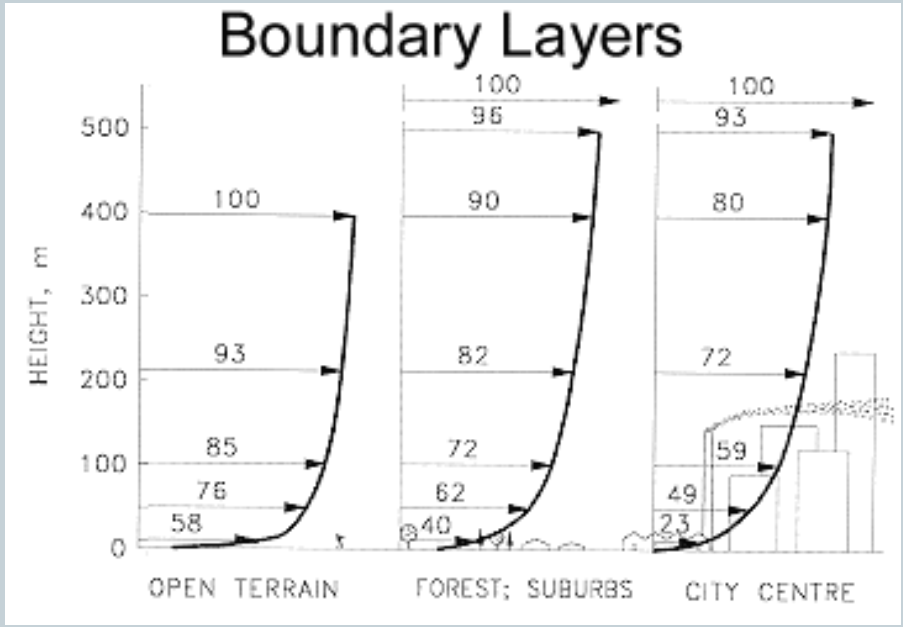


| Advantages | Disadvantages |
| --- | --- |
| • Omni-directional<br>• Low wind speeds<br>• Low elevation<br>• No active controls<br>• Widely available recycled materials can be used for parts | • Larger drag<br>• Less efficient than a horizontal axis wind turbine |

# Design Concept #1: Vertical Axis Wind Turbine (VAWT)



- Drag reduction
  - Control wind flow direction by implementing an external surface
  - 55 gallon drum
- Increase in height
  - Roof mounting on house/building
  - Decrease boundary layer effect - higher wind speeds



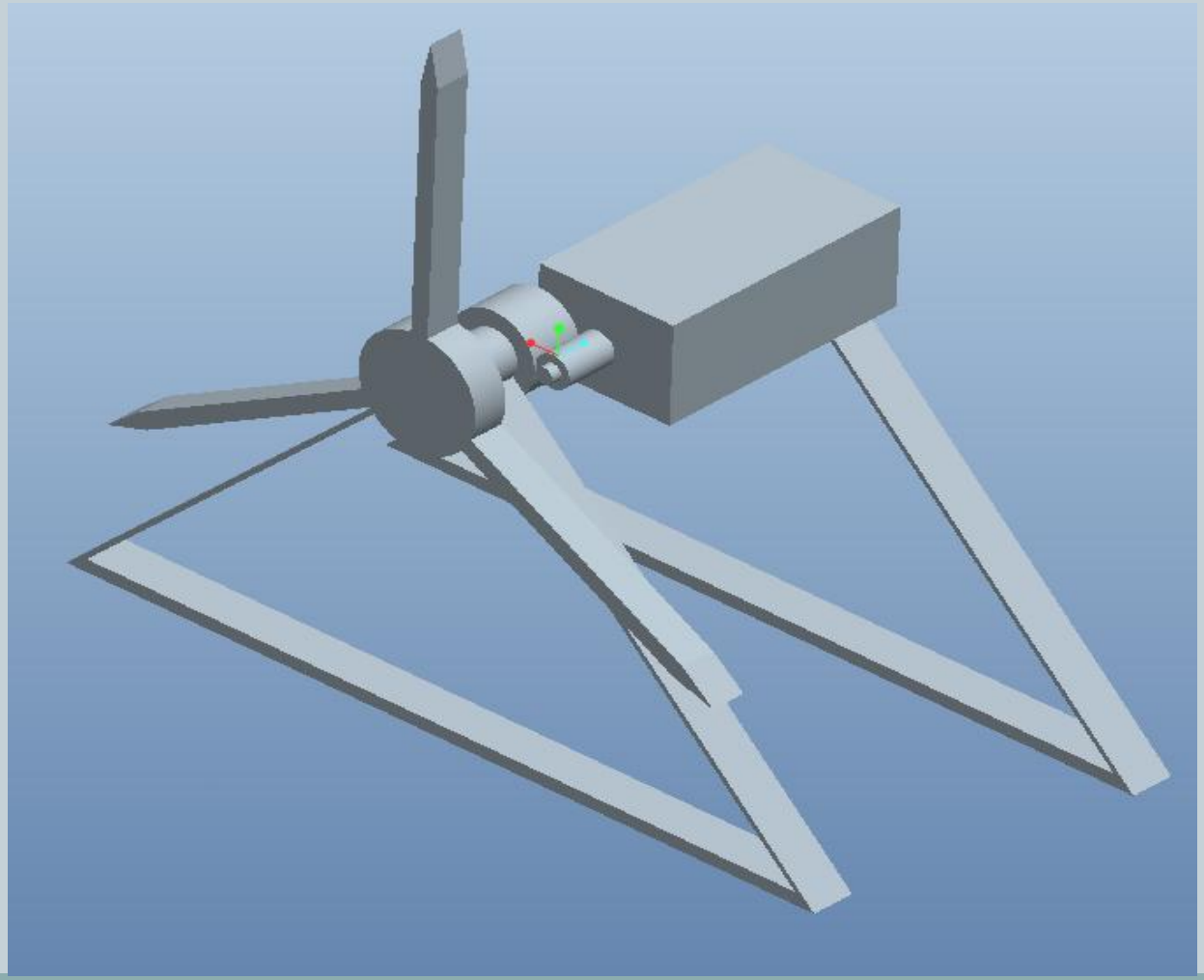
# Design Concept #2: Horizontal Axis Wind Turbine (HAWT)



- Renewable energy source:
  - Wind energy
- Energy conversion:
  - Wind rotates radial blades - standard wind turbine
  - Wind energy is converted to rotational mechanical energy
  - Alternator converts mechanical energy into electrical energy
- Power storage:
  - 12V DC output battery will be used for energy storage

# Design Concept #2: Horizontal Axis Wind Turbine (HAWT)





# Design Concept #2: Horizontal Axis Wind Turbine (HAWT)



## Advantages

- Higher efficiency than vertical axis wind turbine
  - Blades are perpendicular to flow
- Higher effectiveness at a small scale

## Disadvantages

- Directional
- More torque generated on supporting structure
- High disruption of wind flow field
  - Consideration when using multiple wind turbines

# Design Concept #2: Horizontal Axis Wind Turbine (HAWT)



- Directional consideration
  - Fixed by either stabilizing fin or an active control
- Increase in height
  - Same issue with boundary layer
  - Increase in turbine height will increase wind speed

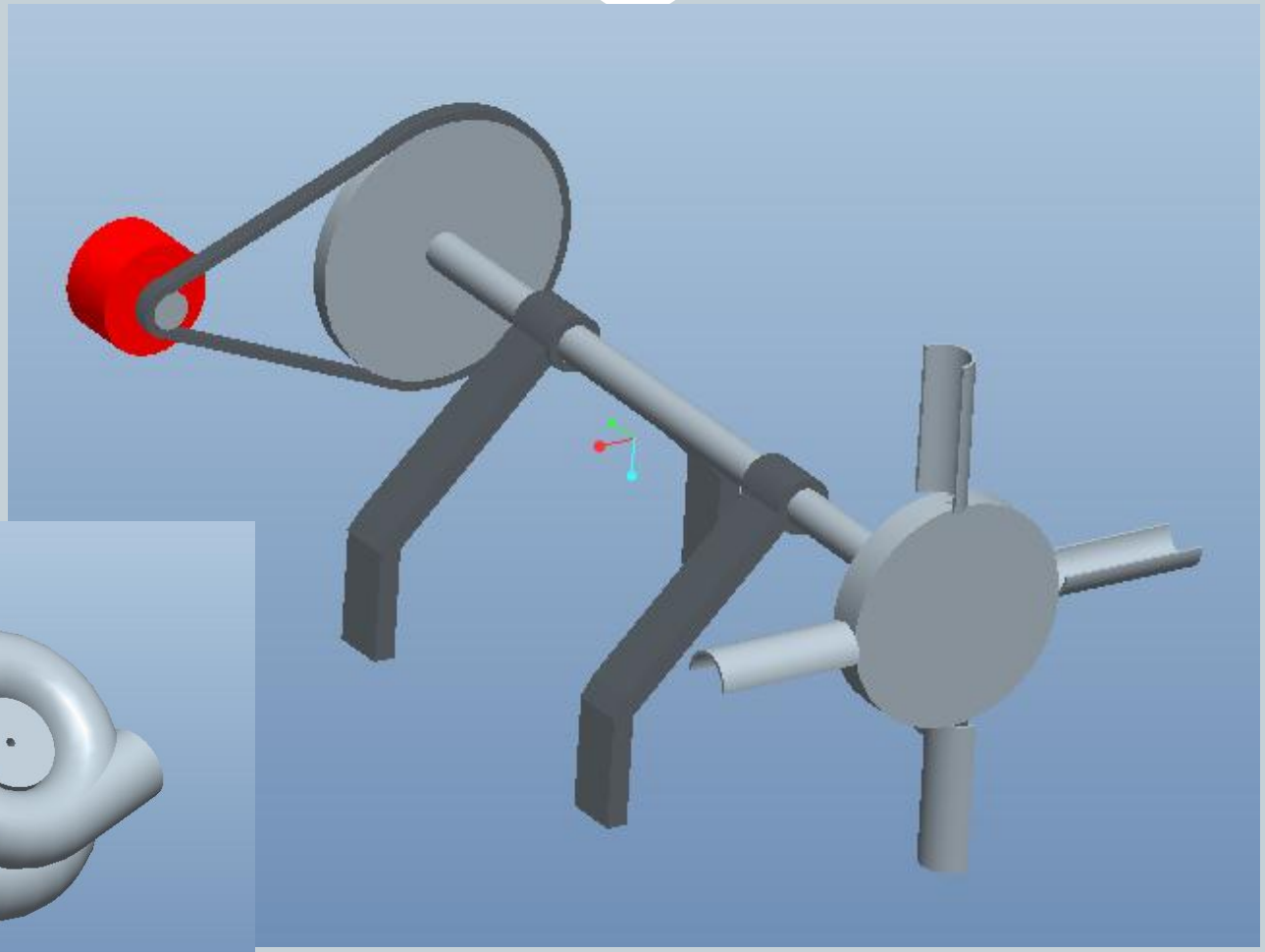
# Design Concept #3: Hydro-Power Wheel

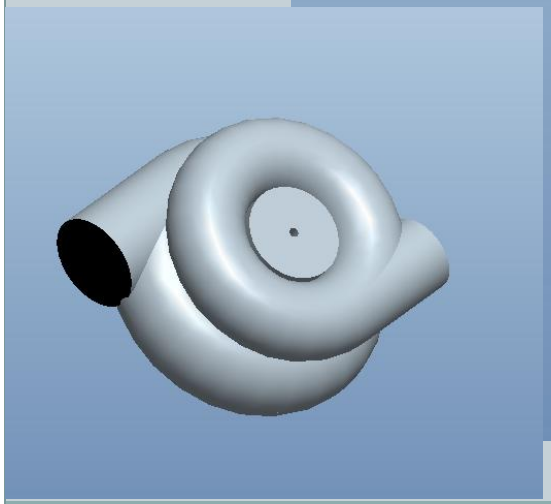


- Renewable energy source:
  - Water power
- Energy conversion:
  - Elevated water contains potential energy
  - Falling water contains kinetic energy
  - Water rotates wheel - conversion from linear to rotational energy
  - Wheel rotates alternator - conversion form mechanical energy to electrical energy
- Power storage:
  - 12V DC output battery will be used for energy storage

# Design Concept #3: Hydro-Electric Generator







# Design Concept #3: Hydro-Electric Generator

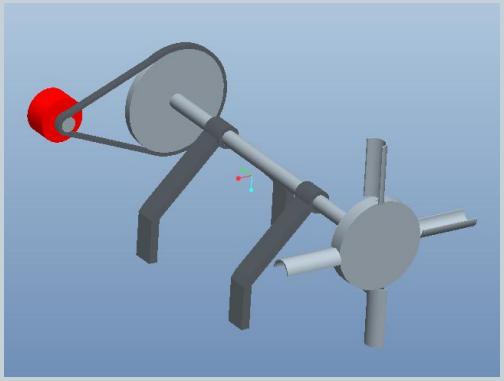


| Advantages | Disadvantages |
| --- | --- |
| • Greater output capacity when compared to wind energy<br>• Capable of sustained output<br>• All components are readily available in most scrapyards | • Requires a certain amount of falling or moving water to run the system<br>• Additional measures required to insure electrical components remain dry |

# Design Concept #3: Hydro-Electric Generator



- Fin Geometry and Quantity
  - Cupped or Flat
  - Optimal number of fins depends on flow rate of water and geometry
- Consider incorporating automotive turbo preceding the turbine
  - Couple shafts of turbine with turbo to maximize energy extracted from flow



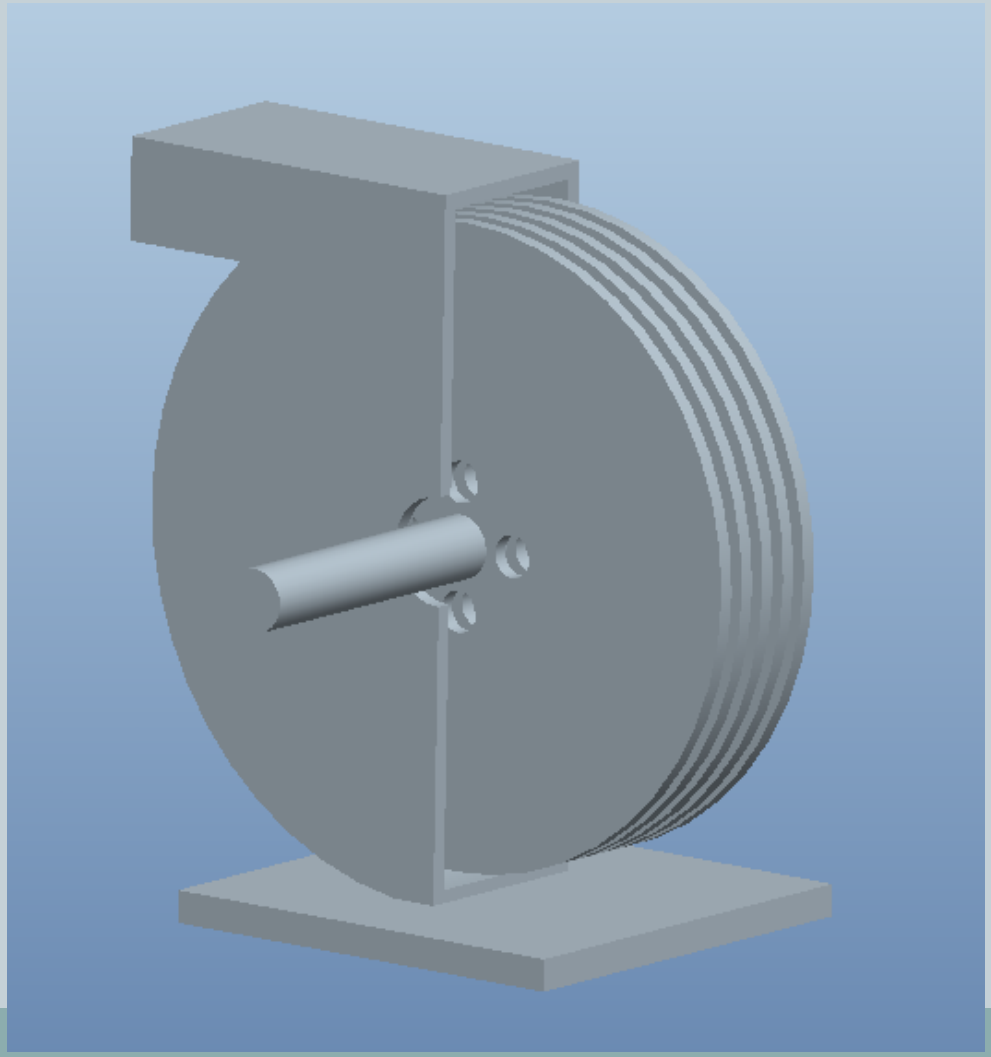
# Design Concept #4: Tesla Turbine



- Renewable energy source:
  - Water power
- Energy conversion:
  - Elevated water contains potential energy
  - Falling water contains kinetic energy
  - Water rotates turbine - conversion from linear to rotational kinetic energy
  - Turbine rotates alternator - conversion form mechanical energy to electrical energy
- Power storage:
  - 12V DC output battery will be used for energy storage

# Design Concept #4: Tesla Turbine





# Design Concept #4: Tesla Turbine



## Advantages

- Readily available materials
- Water creates adequate friction between CDs
- Parts can be easily replaced
- Can be implemented in conjunction with wheel in place of pulleys or gears
  - Increase rpm of system to alternator specification

## Disadvantages

- CD material strength may not be sufficient
  - Require reduction in rotational speed
- Additional parts added make design much more complex

# Decision Matrix



| | | Concepts | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **VAWT** | | **HAWT** | | **Hydro-electric** | | **Tesla** | |
| Specifications | Importance Weight | Rating | Weighted Scores | Rating | Weighted Scores | Rating | Weighted Scores | Rating | Weighted Scores |
| Durability | 15% | 3 | 0.45 | 4 | 0.6 | 3 | 0.45 | 1 | 0.15 |
| Efficiency | 20% | 3 | 0.6 | 4 | 0.8 | 4 | 0.8 | 3 | 0.6 |
| Ease of Assembly | 15% | 4 | 0.6 | 4 | 0.6 | 2 | 0.3 | 4 | 0.6 |
| Low Cost | 30% | 4 | 1.2 | 3 | 0.9 | 2 | 0.6 | 4 | 1.2 |
| Low Maintenance | 15% | 4 | 0.6 | 4 | 0.6 | 4 | 0.6 | 2 | 0.3 |
| Innovative | 5% | 2 | 0.1 | 2 | 0.1 | 4 | 0.2 | 5 | 0.25 |
| | Score | **20** | **3.55** | **21** | **3.6** | **19** | **2.95** | **19** | **3.1** |

# Future Plans



- Teleconference with Cummins
  - Starting October 26 and repeating every two weeks
- Material exploration
  - Junkyard visitation
  - Background research on parts
  - Alter design based on availability
- Concept Selection
- Contruction, Testing and Iteration
- Finalize project

# References




- http://www.kaper.us/basics/BASICS_040502_hunt_windflow.html
- http://www.victordanilochkin.org/research/turbine/papers/HAWT%20versus.pdf

# Questions?