Personal Hydroelectric Generator
Team 7

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Background

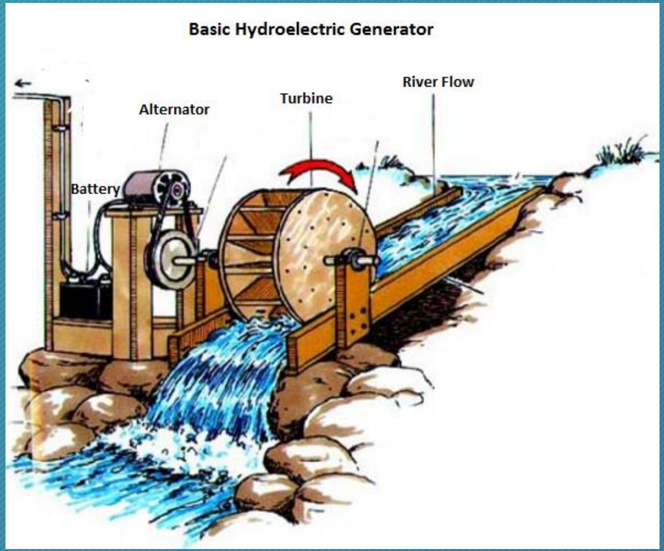


Fig. 1 – Basic Hydroelectric Generator

- Takes kinetic energy of flowing water and converts it to electrical energy
- Flowing water spins turbine which spins alternator which charges battery
- Process is more environmentally friendly than traditional methods
- Also better than building a hydroelectric dam which destroys the river below it
- Drawback is that not nearly as much electric potential is stored as in other methods

Presentation Overview

Mission

- Scope
- Need and Goal Statements
- Target Market
- Objectives
- Constraints
- HOQ

Design Method

- Decision Matrices
- Designs
- Mechanical component overview
- Electrical component overview

Future Plans and Entrepreneurial aspects

- Entrepreneurial senior design
- Business Model Canvas
- Potential Challenges
- Future Plans

Project Mission

Scope → Need and Goal Statement → Target Market → Objectives → Constraints → HOQ

Problem Scope

This project will consist of creating a marketable power generation system that not only harnesses power from flowing water but is also portable. These generators will create a realistic means of providing sustainable power to anywhere there is flowing water.

Needs Statement & Goal Statement

- Need Statement:

  "People in remote locations do not have access to electricity for powering their electrical devices."

- Goal Statement:

  "Develop a portable device that transforms organic kinetic energy into usable electricity."

Target Market

American Red Cross

Objectives

- Produce enough power to satisfy the need our target consumers.
  - Supplemental emergency power generation.
  - Environmentally conscious recreational camper.
  - Rurally indigenous communities.
- Minimize weight to ensure portability
  - Modular design
- Environmentally friendly
- Fast and simple assembly and disassembly

Project Constraints

- Weight
  - <100lb
- Noise Level
  - <50 dB
- Waterproof
  - Protect electrical components
- Safe and Reliable
  - Little environmental and human impact
- Generate Electricity
  - In order to charge a battery
- Budget
  - $1,500

River Flow Characteristics

The velocity used for all calculations concerning our design will be based off the average of these 5 velocities located in different geological coordinates around our initial target market.

V = 3.75ft/s

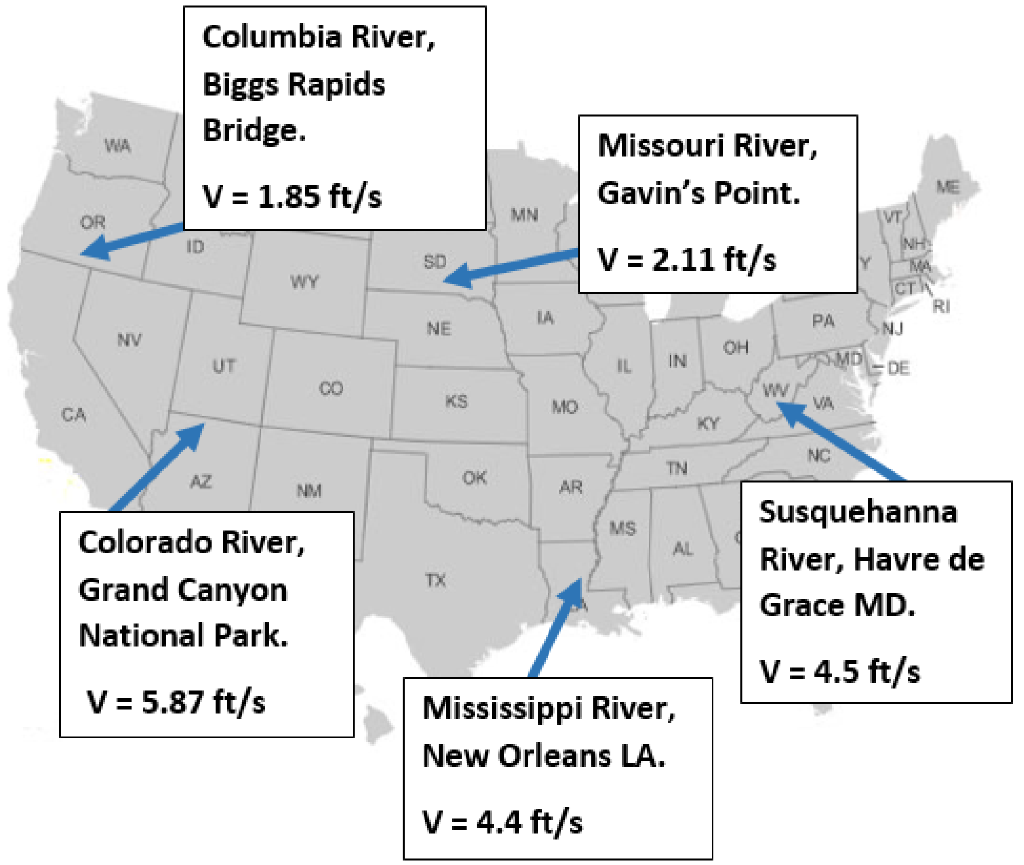


Fig. 2 – River Flow Across the Country

Sources: Reference 5, 6, & 7

Power of Water

- The amount of power available in flowing water is defined in the following equation:

$$P = 1/2 \xi \rho A v^3$$

- Turbine efficiency(ξ) is a measure of how much energy is transferred from the water to the blades
  - 100% efficiency means that all of the water's energy was transferred to the turbine (i.e. water velocity is zero after impacting turbine)
  - Actual values range from 10% – 30%

Radius of Turbine (m)	Power (10% Eff) (Watts)	Power (20% Eff) (Watts)	Power (30% Eff) (Watts)
0.10	2.344	4.688	7.032
0.20	9.377	18.753	28.130
0.30	21.097	42.194	63.292
0.40	37.506	75.012	112.518
0.50	58.603	117.207	175.810
0.60	84.389	168.777	253.166
0.70	114.862	229.725	344.587
0.80	150.024	300.049	450.073
0.90	189.875	379.749	569.624
1.00	234.413	468.826	703.239

Table 1 – Power of Flowing Water

Customer Discovery Survey

- If the generator could sustain all your lighting needs, run a small refrigerator, or power any TV, how much would you spend?
- Where would you mainly use this item?
- What is the most important from the following: Power Output, Price, Durability or Size?
- How likely are you to buy a hydroelectric generator if it meets your needs?

Survey Results

If a generator could sustain all your lighting needs, run a small refrigerator, or power any TV, how much would you spend?	5	5	15	6
	Camping	Hunting	Cabin	Fishing Trip
Where would you mainly use this item?	13	16	4	10
	Power Output	Price	Durability	Size
What is the most important from the following: Power Output, Price, Durability or Size?	8	5	10	8
	Would buy	Might buy it	Wouldn't buy	I don't know
How likely are you to buy a hydroelectric generator if it meets your needs?	14	5	4	8

Table 2 – Survey Results

- $550 to $750
- Hunting
- Durability
- Would Buy

House of Quality

Engineering Characteristics →		Rate of Power Generation	Cost	Weight of Device	Stream Lined Profile	Power Output Efficiency	Mechanical Complexity	User Friendly	
Customer requirements	**Importance to Customer**								**Selling Points**
Functionality	**5**	10	5	2	9	10	5	4	225
Easy to Operate	**3**						6	10	64
Light Weight	**4**	7	7	10	4		3	8	117
Compact	**4**	6	2	8	6	2	6	8	114
Price	**2**	4	10	5		6	8	3	144
Durability	**3**		7	3	1	5	6	2	120
Aesthetically pleasing	**1**		4		8				48
Maintenance	**3**		3	5	2		5	8	92
Importance Weighting		110	115	116	102	85	128	150	

Fig. 3 – House of Quality

Design Overview

Decision Matrix → Designs → Mechanical Components Overview → Electrical Components Overview

Decision Matrices

Turbine (Hydrokinetic)

Criteria	Importance Rating	Francis	Kaplan	Hydrokinetic
Weight	3	2	3	5
Cost	2	3	2	3
Manufacturability	3	2	2	4
Durability	4	2	3	3
Efficiency	4	3	3	5
Total		38	43	65

Fig. 4 – Turbine Decision Matrix

Housing (PVC Duct)

Criteria	Importance Rating	Carbon Fiber	Polycarbonate	PVC Duct
Weight	4	4	4	3
Cost	3	1	2	4
Durability	2	4	4	3
Manufacturability	4	2	2	4
Total		35	38	46

Fig. 5 – Housing Decision Matrix

Alternator (AC)

Criteria	Importance Rating	DC Generator	AC Alternator
Weight	3	2	3
Cost	2	3	3
Safety	3	3	3
Durability	3	2	4
Efficiency	4	2	3
Total		35	48

Fig. 6 – Alternator Decision Matrix

Conceptual Design

- Turbine Selection:
  - Hydrokinetic Turbine
- Battery Selection:
  - Sold separately
- Alternator Selection:
  - Brushless permanent magnet alternator (PMA)
- Anchoring Selection:
  - Land-based cantilever system with possible upstream tension anchor point

Initial Design

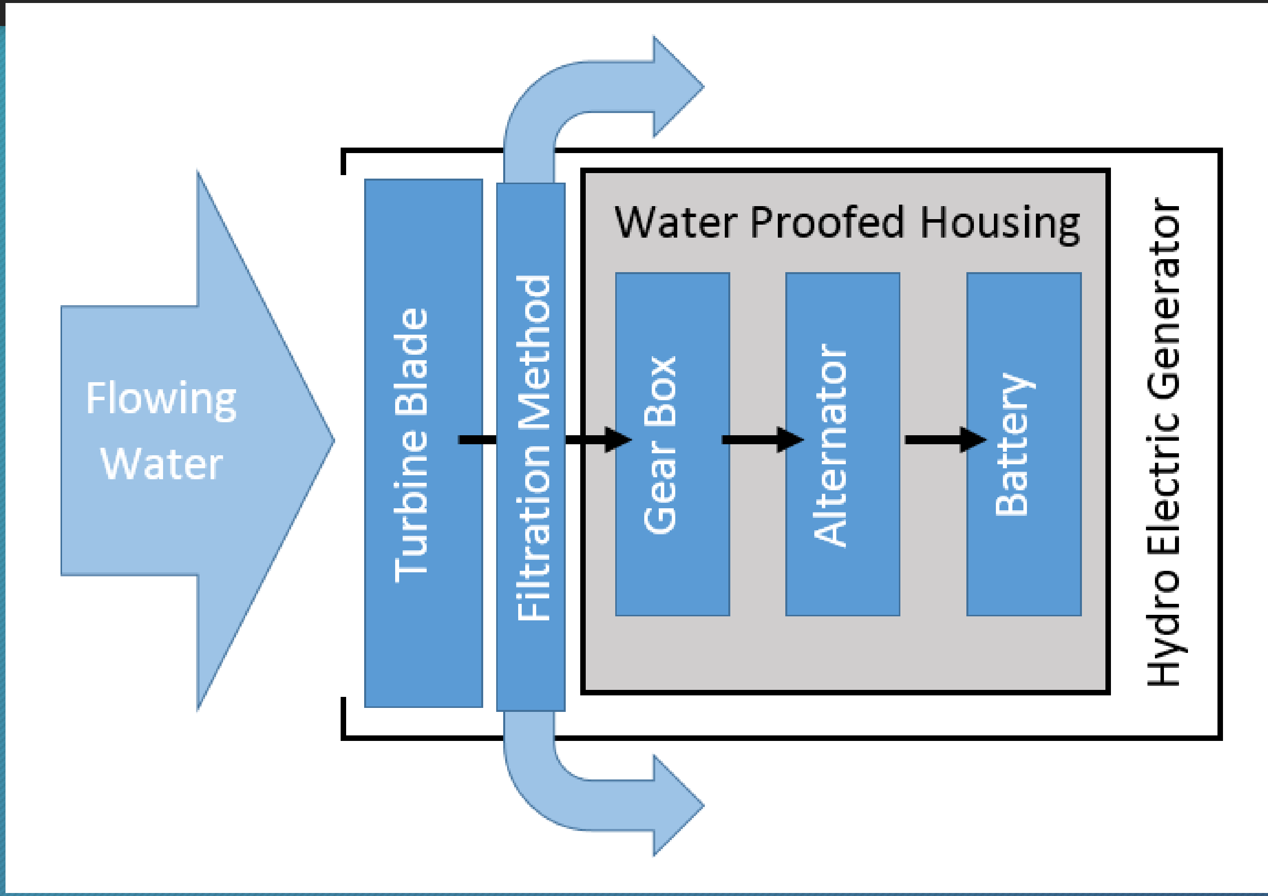


Fig. 7 – Design Flowchart

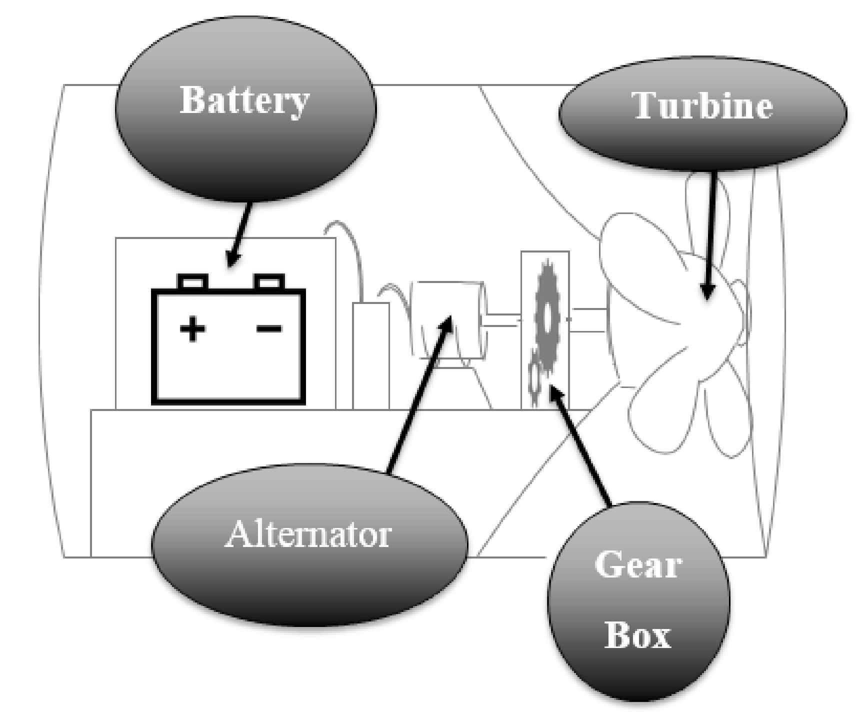


Fig. 8 – Design Overview

Revised Design

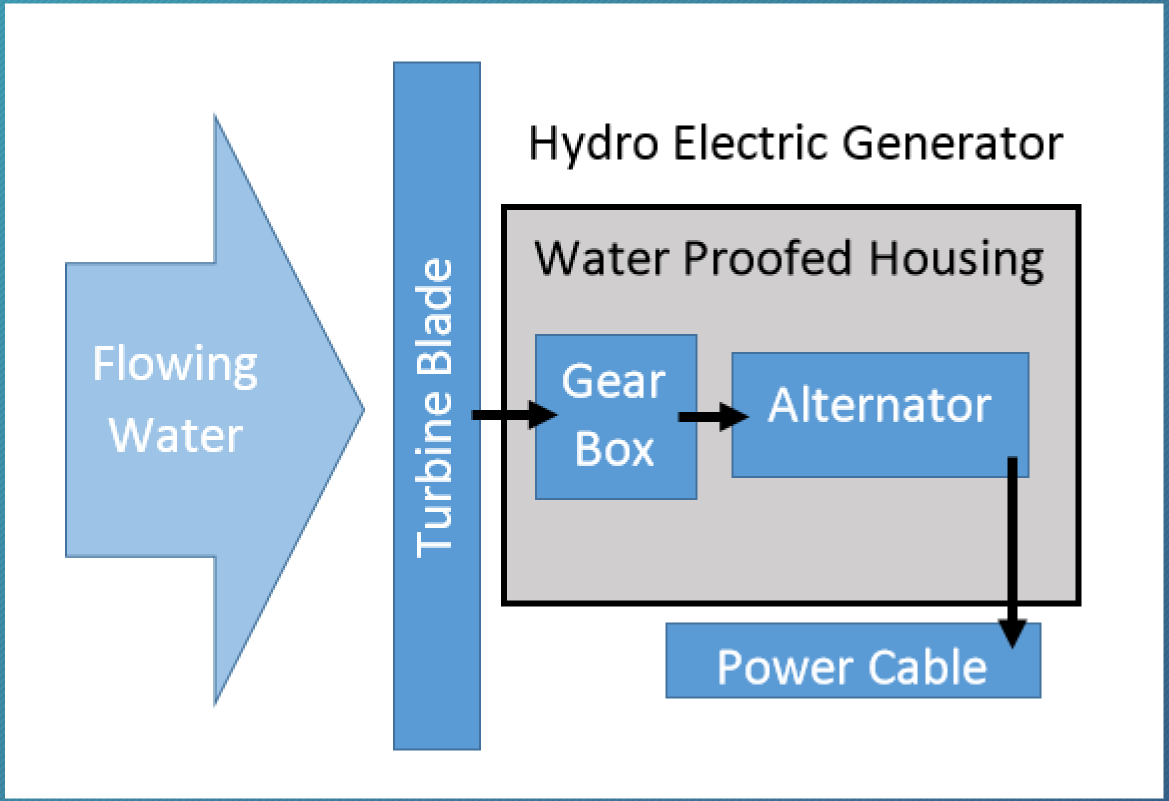


Fig. 9 – Revised Design Flowchart

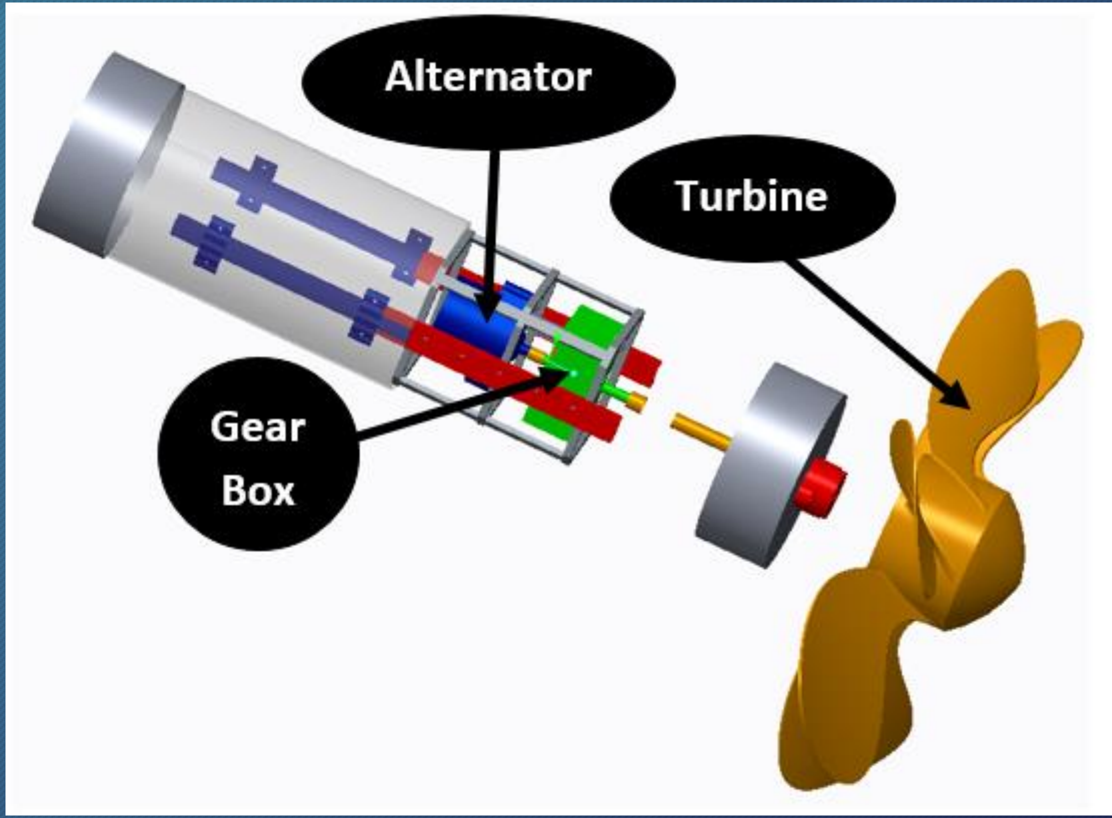


Fig. 10 – Revised Design Overview

Detailed CAD Schematic

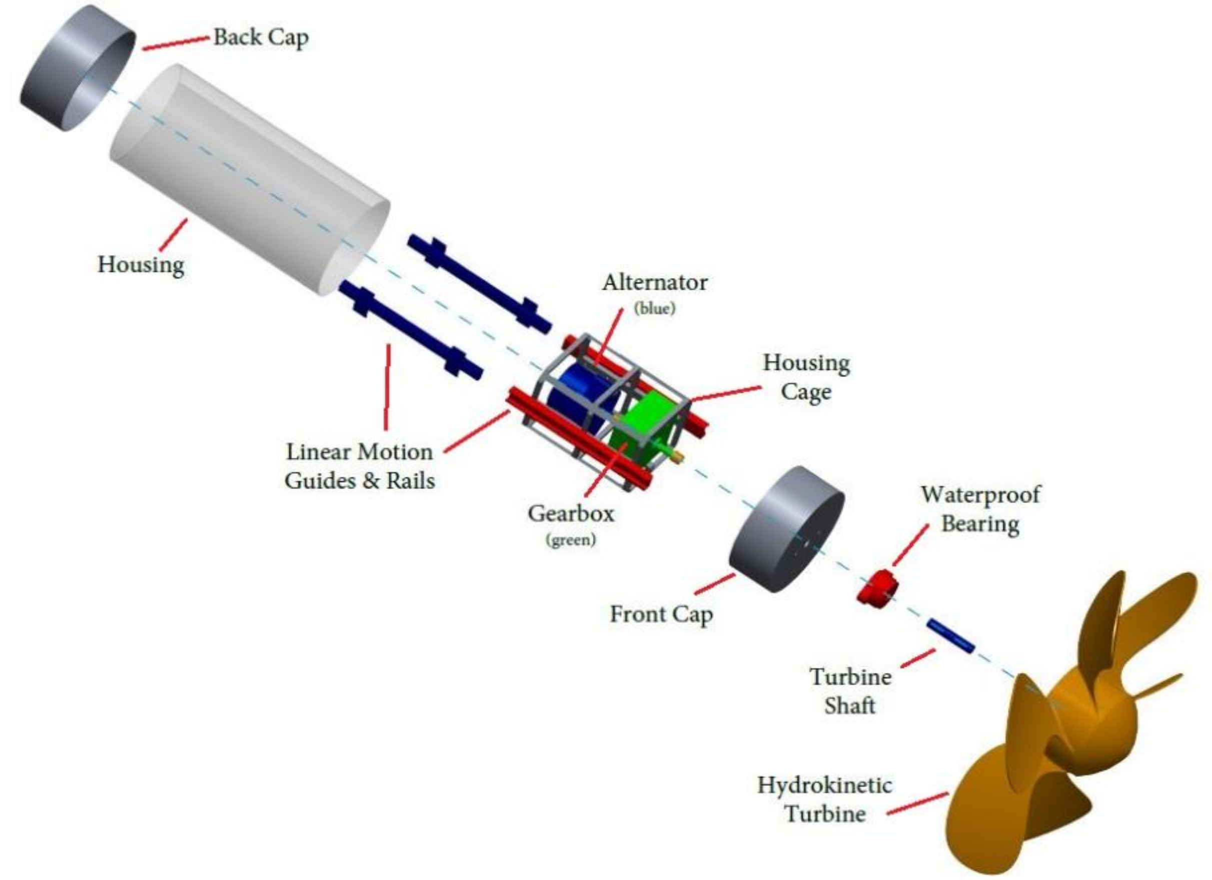


Fig. 11 – Hydroelectric Generator CAD

Detailed CAD Schematic

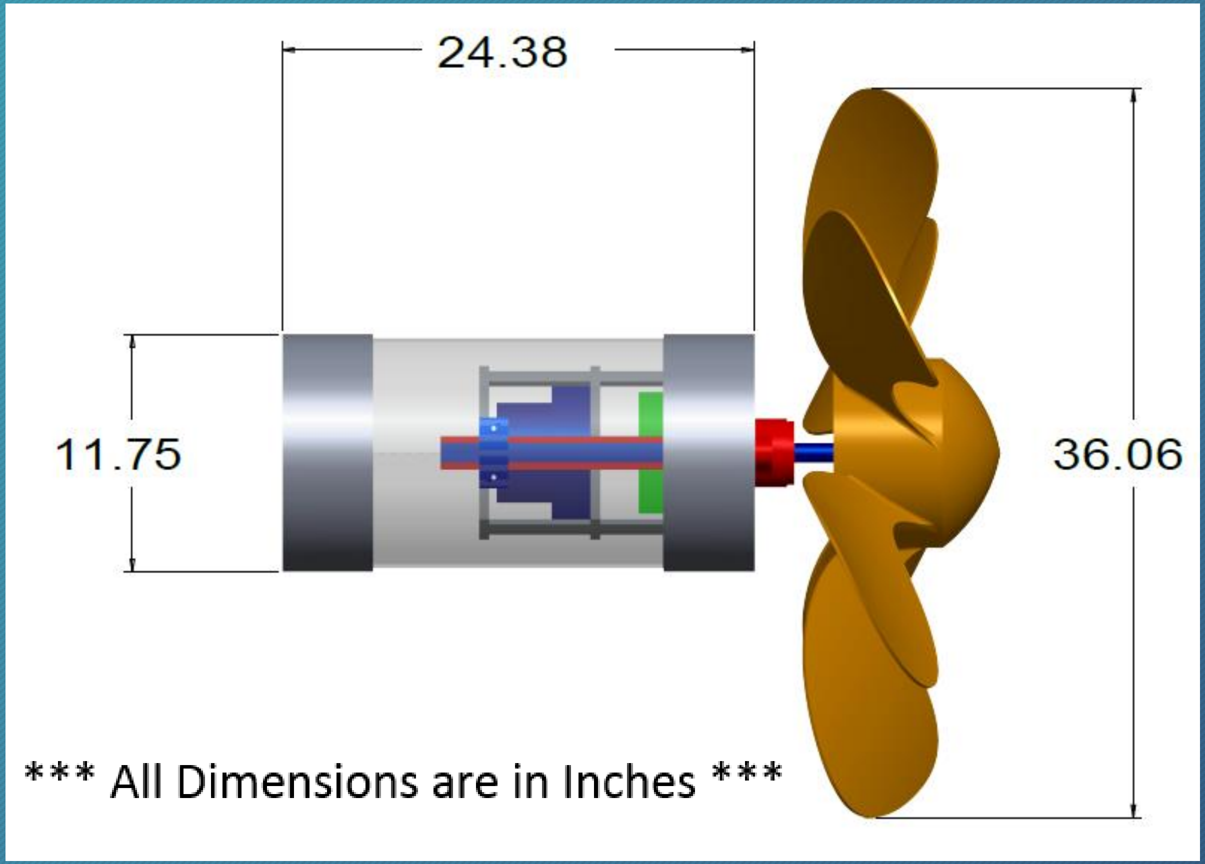


Fig. 12 – Hydroelectric Generator CAD with Dimensions Side - View

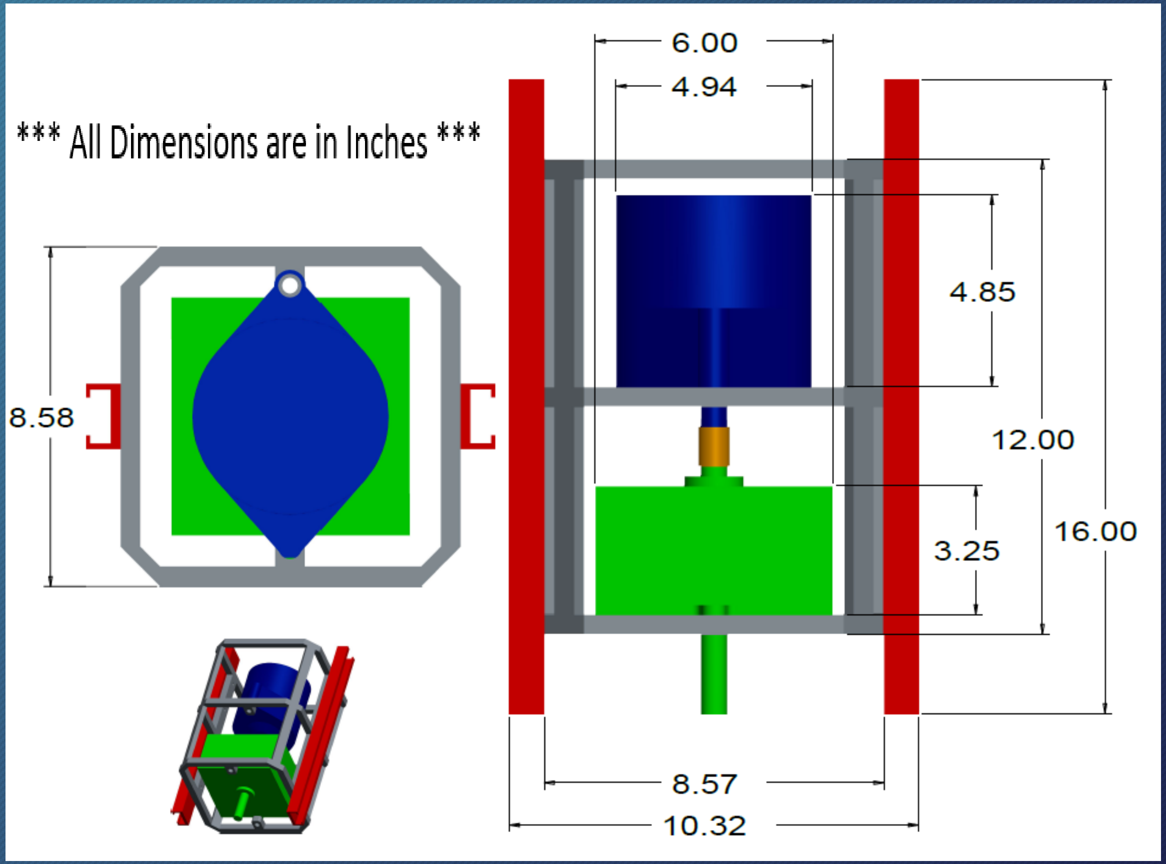
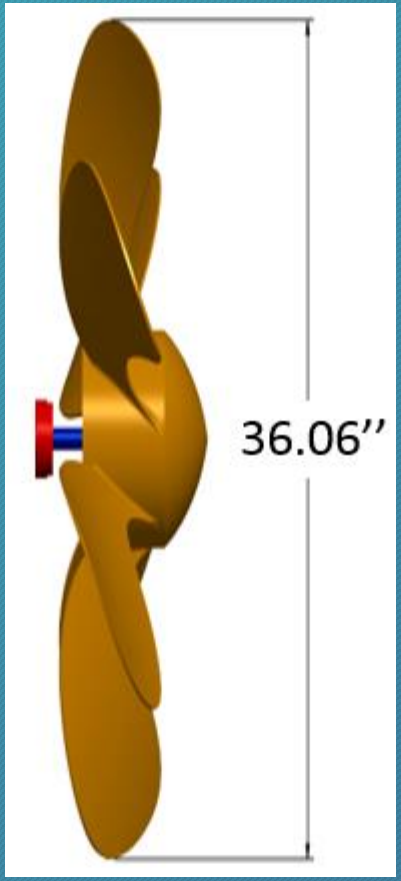
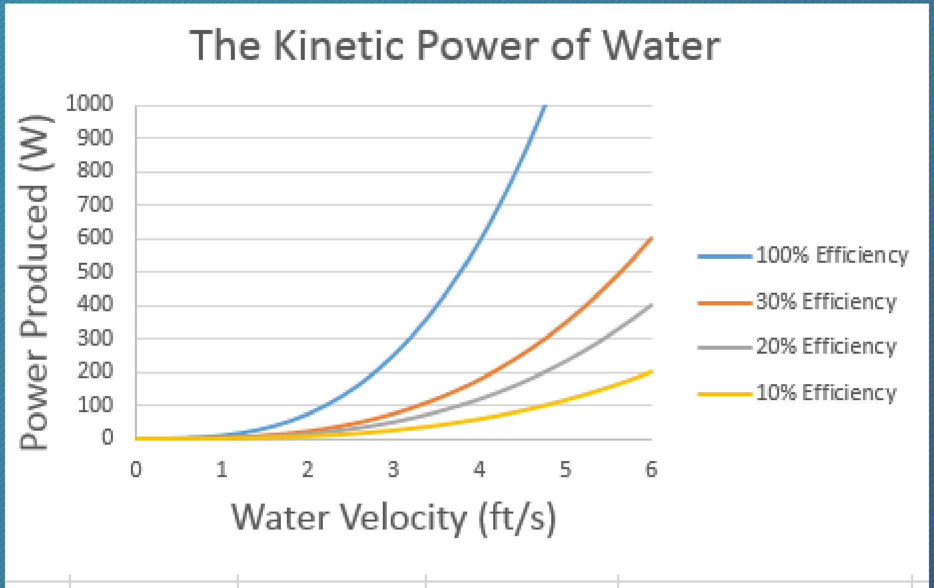
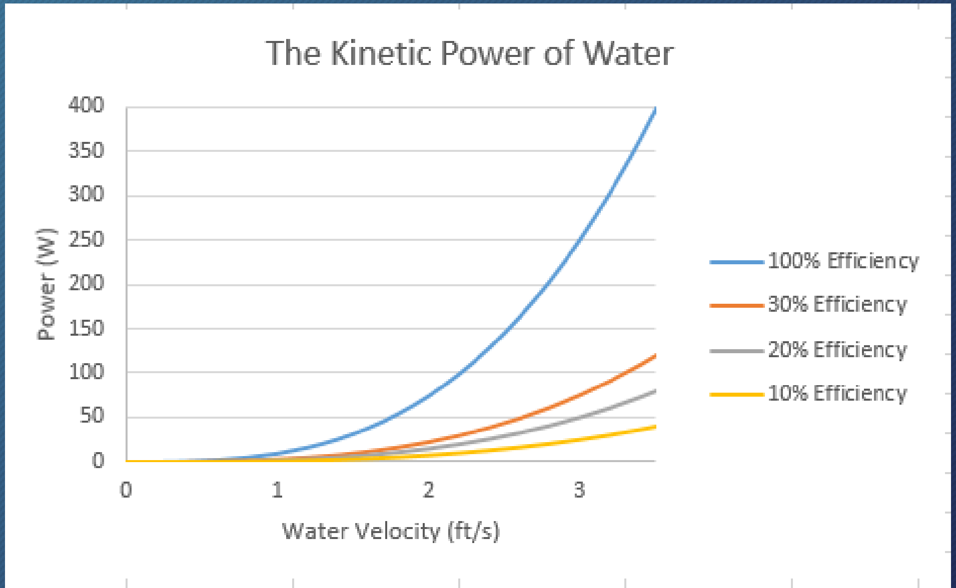


Fig. 13 – Hydroelectric Generator Cross-Sectional View with Dimensions

Hydrokinetic Turbine







Gearbox/Anchoring System

- Cannot move forward with gearbox design until turbine selection is complete. Will use a metal reduction gearbox to increase RPM of a shaft and decrease torque.
- Anchoring system planned to be cantilever design attached through spikes to shore.

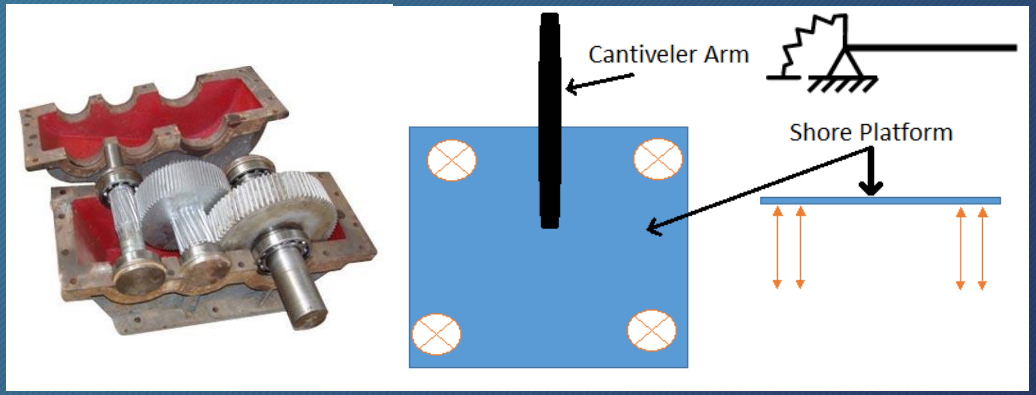


Figure 16 – Gearbox and Anchoring System Possibilities

Housing

Housing	
Material	PVC Duct
Outer Diameter	11.375”
Inner Diameter	11”
Wall Thickness	0.187”
Length	2’
Weight/Foot	3.944 lbs

Table 3 – PVC Pipe Attributes

Figure 17 – PVC Piping

Ends Caps	
Material	PVC Duct
Outer Diameter	11.75”
Inner Diameter	11.375”
Wall Thickness	0.187”

Table 4 – PVC End-cap Attributes

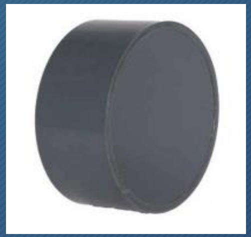


Figure 18 – PVC End Cap

Rail System: No specific information because one has not been selected

Figure 19 – Rail System

Water Proofing

Waterproof Spherical Flange Bearing

- Lubrication using grease inserted by a zerc fitting
- Heat Tolerance ranges from -22 to +212 °F
- Designed for a 1” shaft diameter

Figure 20 – Spherical Flange Bearing

Rubber Sleeve with Screw Bands

- Rubber sleeve allows for better contact each band with the PVC duct
- The band can screw tight enough to secure the cap to the housing tube for a perfect seal

Figure 21 – Rubber Sleeve

Electronic Components - Alternator

Figure 22 – DC – 540 PMA

Wind Blue Power	DC - 540 PMA
Voltage Production	14V @ 250rpm
Amperage Production	5A @ 250rpm
Charge Time to 500W	7 Hours @ 250rpm
Startup Torque no Load	0.17 Nm
Diameter	<7 inches
Depth	6.5 inches
Wire Gauge	10-12 AWG (0-20)A
Weight	11 lbs.
Price	$249.00

Figure 23 – Alternator Specifications

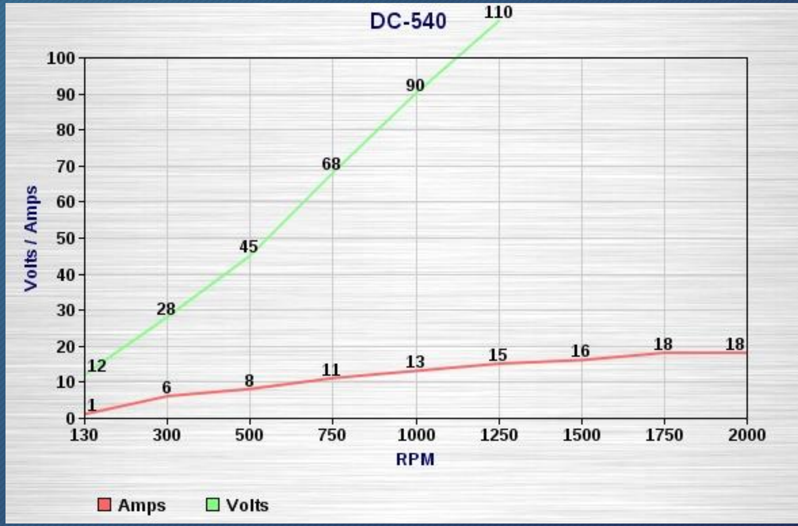


Figure 24 – Production Based on RPM
(Based on OC and SC)

Electronic Components – Charge Controller

Figure 25 – 12 Volt 25 Amp Charge Controller From Wind Blue Power

- Takes in 3 – phase from the alternator
- Beneficial for longer distances
- Includes heat sink fins to dissipate heat
- Simple to set up to battery
- Built in switch to prevent overcharging of battery
- Switch enables automatic generator braking
- Price - $44.00

Electronic Components – Watt Meter

Figure 26 – Watt Meter Provided by Wind Blue Power

- Wattmeter allows end user to see all stats in one place
- Simple to hook up
- Will be placed at the battery terminals for easy access
- Measure charge(ah), power(w),current(A), and voltage(V)
- Price - $24.00

Electronic Components – Circuit Schematic

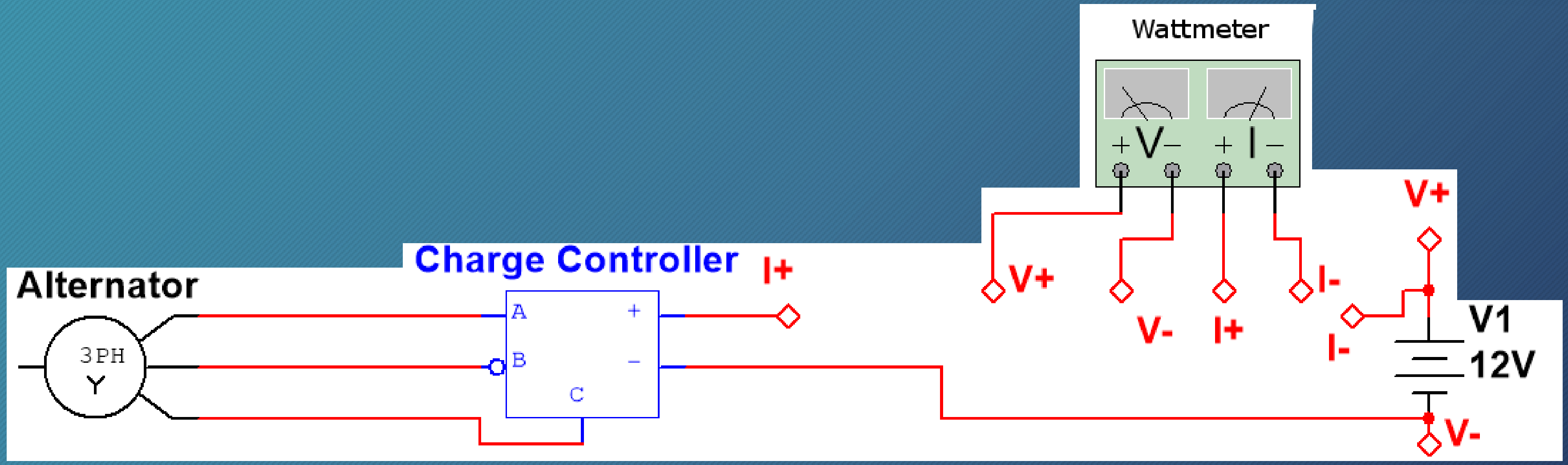


Figure 27 – Circuit Schematic

Future Progress and Entrepreneurial Aspects

Entrepreneurial Senior Design → Business Modal Canvas → Potential Challenges → Future Plans

Entrepreneurial Senior Design

- Requires us to evaluate the business potential and marketability of our product

- InNolevation Challenge - $10,000 for 1st place & Domi Venture entry
  - Business Model Canvas
  - Stage 1 – Value Proposition
  - Stage 2 – Rest of canvas except for financials
  - Stage 3 – (Nov 20) work with a representative to improve the canvas

The Business Model Canvas

Team or Company Name: Personal Hydroelectric Generator

Date: 11/18/2015

[X] Primary Canvas

[ ] Alternative Canvas

Key Partners

- Payment service such as *paypal*
- Distribution partners –USPS, FedEx, etc.
- Suppliers – generators, alternators, and turbine components
- FSU – (senior design) supplies initial funding for the project
- Kickstarter – entry level fundraising
- Grants from competitions such as InNolevation Challenge

Key Activities

- R&D –improve on hydroelectric generator design
- effective sales team
- establish premium models with added features

Key Resources

- Brand name
- Product design
- Sales and support teams
- Sales of parts and expanded features

Value Proposition

- Provide a constant, clean energy source with enough power to supply a small home or cabin with electricity
- Utilize the power of flowing water in order to generate electricity
- Significantly quieter than its gasoline counterpart
- Portability

Customer Relationships

- Dedicated sales for large purchase accounts
- Support staff
- Automation (where possible)
- Periodic newsletter

Channels

- Global sales and support team
- Online website with product information
- Social media accounts

Customer Segments

- Developing countries – specifically villages and homes near bodies of water
- Humanitarian organizations
- Outdoorsmen – riverside camp sites
- Military

Figure 28 – Business Model Canvas

Potential Challenges

- Heat dispersion inside the housing
- Water contacting electrical components
- Achieving proper gear ratio for desired output
- Submerging the apparatus to desired depth
- Anchoring the system to withstand the necessary forces
- Keeping the design compact and easy to assemble

Gantt Chart

Task Name	Duration
General Research	15 days
Initial Website Desig	47 days
Develop Conceptual	10 days
Subsection Compone	**17 days**
Turbine Selection	10 days
Generator Selecti	10 days
Charging System S	10 days
Mounting System	10 days
Housing Selection	10 days
Finalize Premlinary D	8 days
Design Analysis	**13 days**
Electrical Analysis	13 days
Mechanical Analy	13 days
Thermodynamic A	13 days
Modeling and Sim	**13 days**
Turbine Flow Si	13 days
CAD Drawings (	13 days
Order Components	14 days

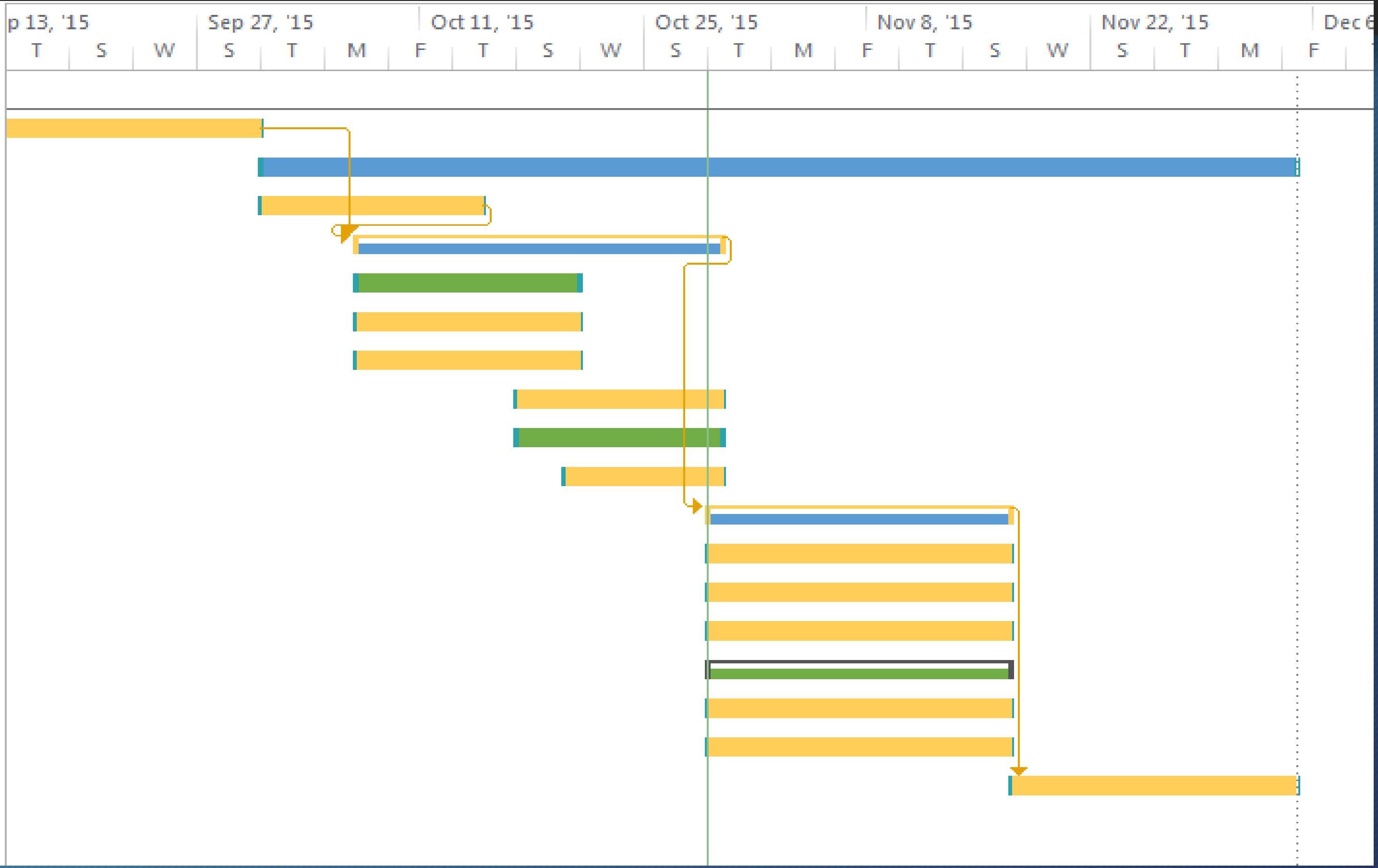


Figure 29 – Gantt Chart

Future Plans

- Finalize Following Component Designs and Selections:
  - Turbine Blade
  - Anchoring System
  - Gear Box
  - Electrical Displays
- Complete Commercialization business plan and next stages of InNOLEvation challenge
- Investigate measures to protect turbine and turbine user during operation
- Test alternator for heat dissipation issues
- Order Components
- Machine and construct base and mounting for components in housing

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QUESTIONS?