HCC 2026
33% Status Update

Team

Nathaniel Holguin

Karsten Jones

Anthony Nuzzo

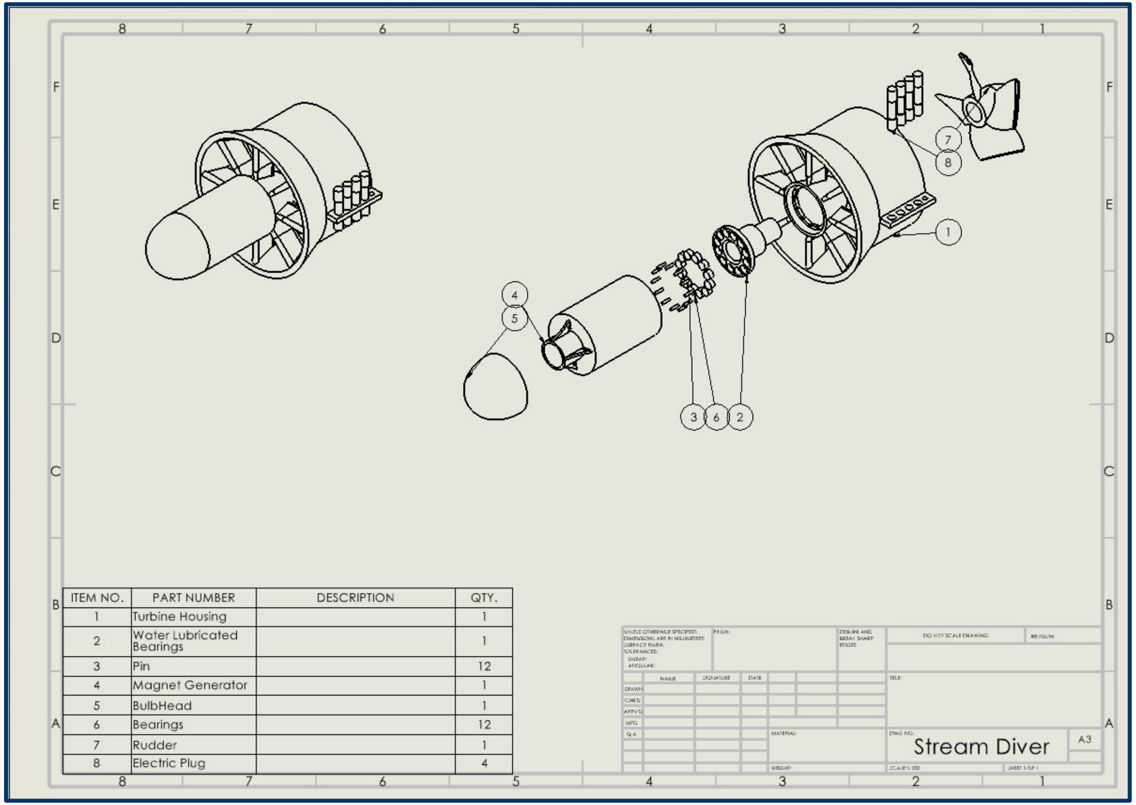
Dawson Stevens

Corbin Davis

PROJECT OVERVIEW

- **Competition**: DOE Hydropower Collegiate Competition
- **Scope**: Research driven feasibility, modeling, and prototype validation
- **Deliverables**: Siting & feasibility analysis
  Co-development opportunities
  Environmental and community impact evaluation
  Scaled physical testing and validation
- **Design Goal**: Develop competition ready hydropower system concepts

DESIGN EFFORTS



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Turbine Housing		1
2	Water Lubricated Bearings		1
3	Pin		12
4	Magnet Generator		1
5	BulbHead		1
6	Bearings		12
7	Rudder		1
8	Electric Plug		4

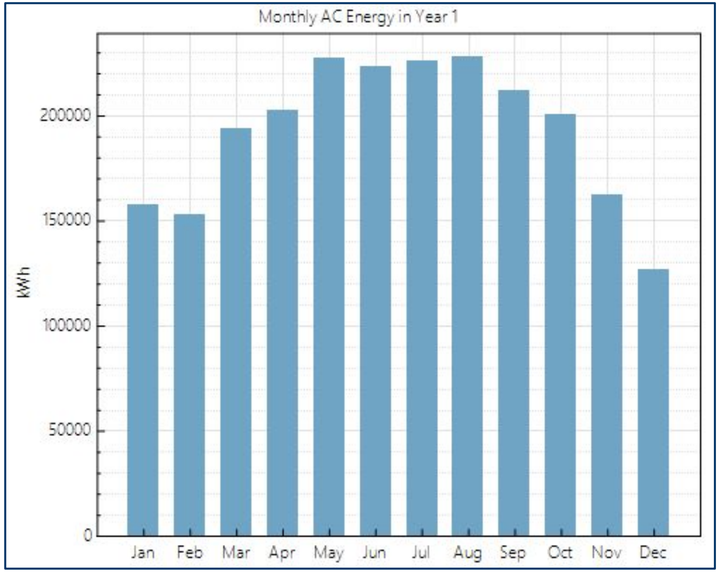
Hydropower Turbine Model

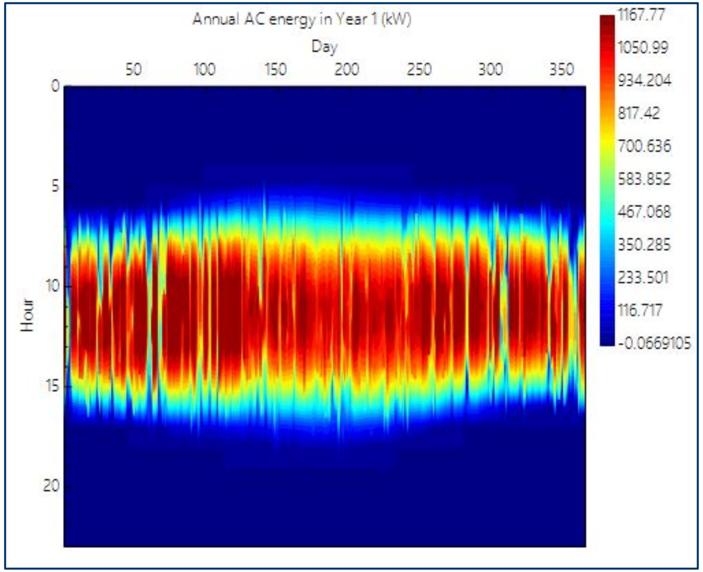
- Requirement: Full scale design produces 1-10 MW
- Fixed Blade Runner - A simple, low-maintenance design
- Fish Safe Blades - Rounded stainless-steel blades reduce strike risk
- Magnet Generator - Direct drive permanent magnet generator; eliminates need for a gearbox

Engineering calculations have not changed since preliminary design

SOLAR PROTOTYPE 1

- Question: Is a solar power plant beneficial to the John C. Stennis L&D project?





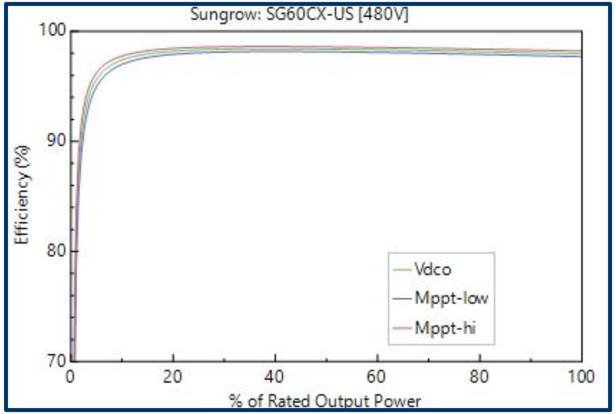
SOLAR PROTOTYPE 1

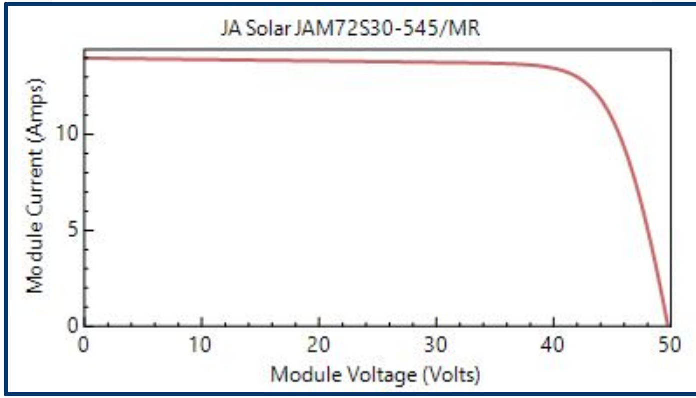
- Answer: Utilizing an preliminary System Advisory Model(S.A.M.) we estimate:
  - 2,272 Modules
    - 1.5MWdc
    - 1.2MWac
  - JA Solar JAM72S30-450/MR Module(updated)
  - Sungrow: SG60CX-US Inverter

Metric	Value
Annual AC energy in Year 1	2,311,302 kWh
DC capacity factor in Year 1	17.6%
Energy yield in Year 1	1,541 kWh/kW
Performance ratio in Year 1	0.81
LCOE Levelized cost of energy	8.24 ¢/kWh

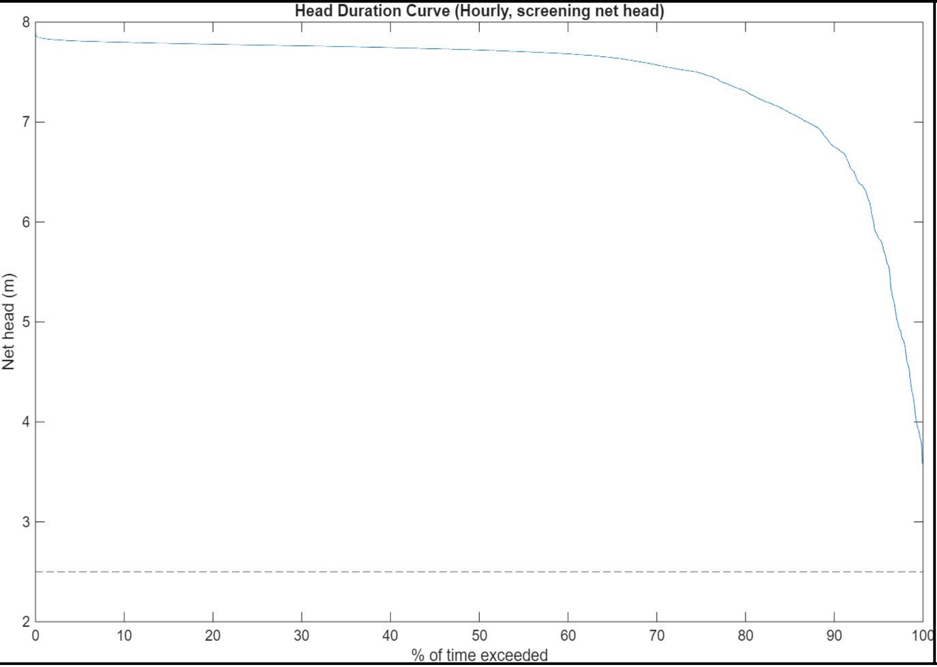
HOW WILL THIS INFORM OUR DESIGN?

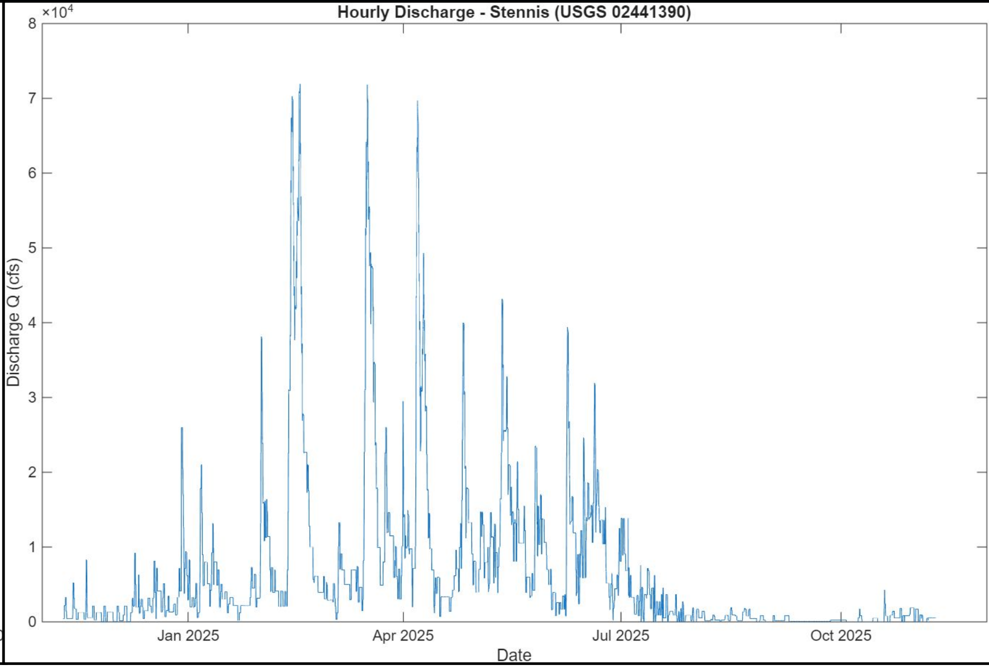
- Utilizing county specific weather data, we believe to generate between 1.2-2.2 GWh per year
- Fits within the plan to add solar integration at John C. Stennis L&D, requiring about 4 acres of land readily available in vacated sections of the dam.
- Estimated capital cost is around $1.7M, which is within the scope of the project.





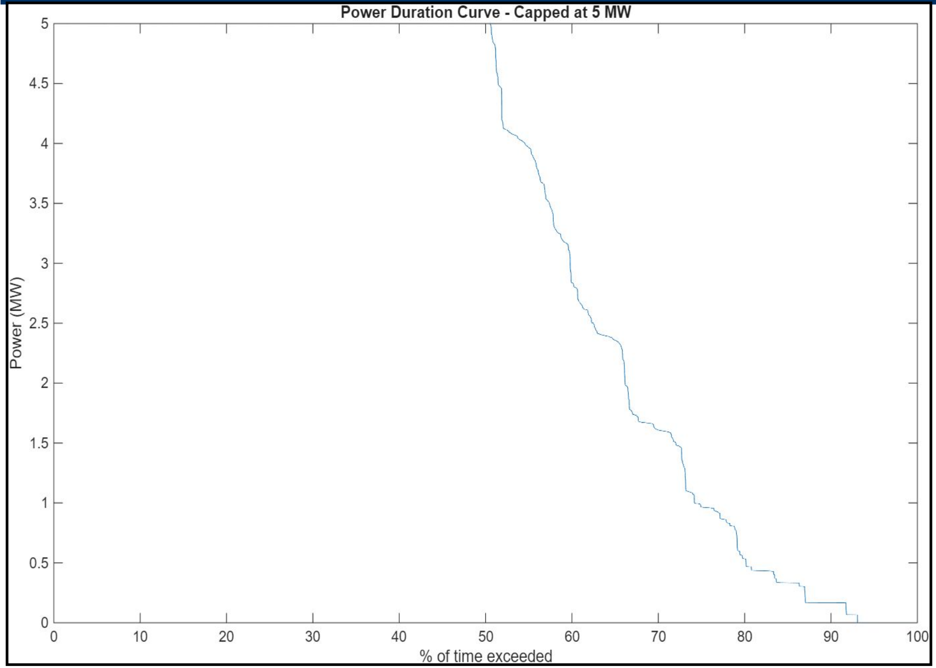
SITE OPERATIONS ANALYSIS

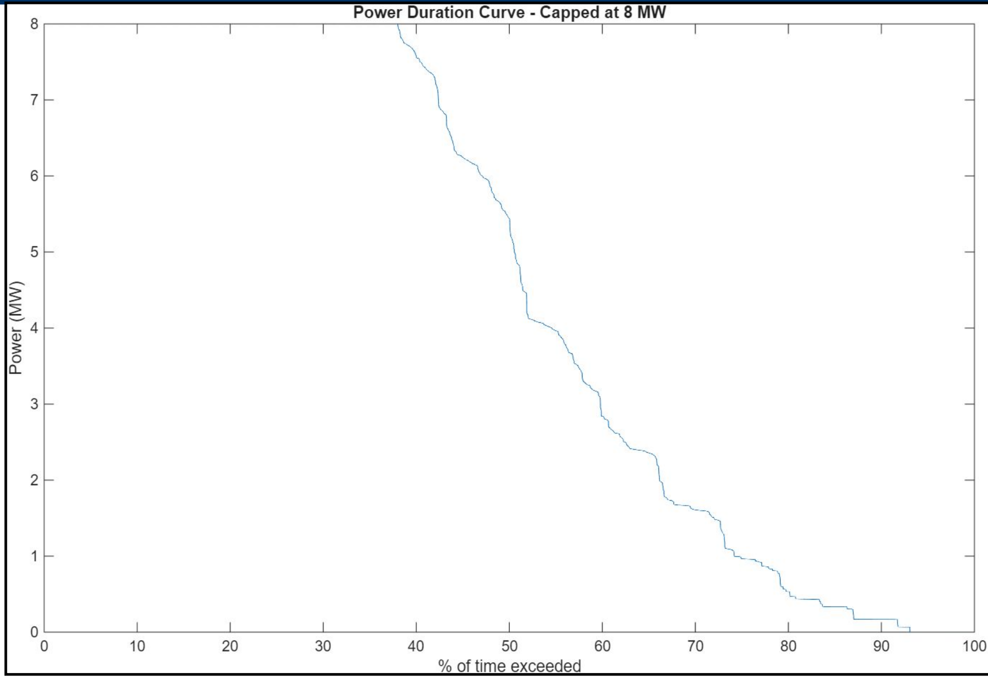




- Not governed by head availability, Flow constraints the design with irregularities. USGS data.

SITE OPERATIONS ANALYSIS



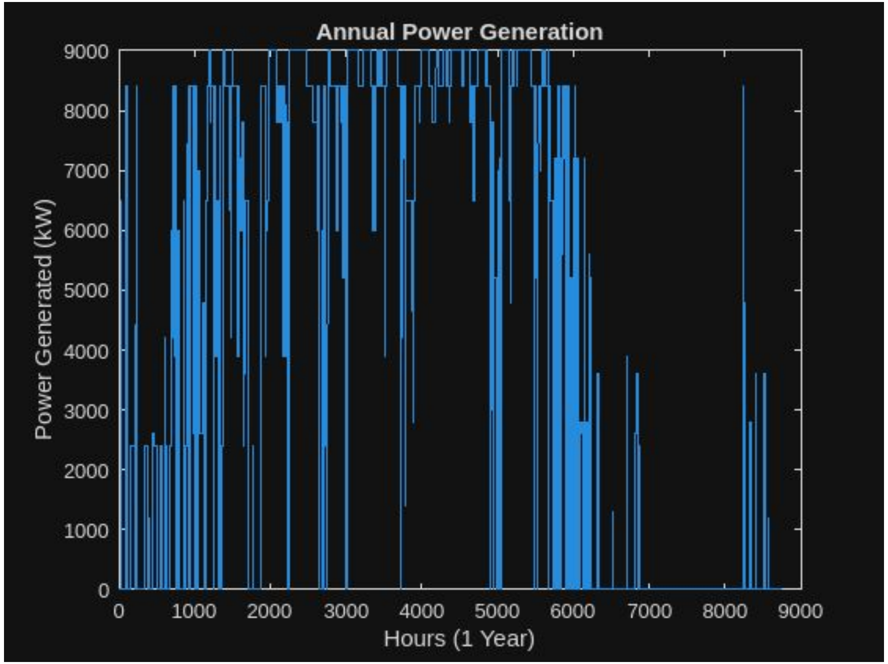


- Increasing installed capacity beyond approximately 5 MW results in diminishing returns due to flow variability rather than head limitations.

Digital Prototype 2

- Uses Voith Streamdiver 14-90 power curve and real world data from John C Stennis
- Assumes 6 turbines

Measure	Value
Mean	3.042 MW
Max	9.000 MW
Min	0 MW
Annual MWh	38,963 MWh



Digital Prototype 2

How does this inform our design?

- Gives us numerical data that shows the potential of the dam

- Allows us to determine how many turbines can be used while staying within the 1-10 MW range.

Prony Brake Design Analysis

$P = (2\pi * N * r * F_{net}) / 60$

- N = Rotational Speed (RPM)
- r = Radius of the Aluminum Drum (Meters)
- F_{net} = Force difference in reading from the Digital Scale and the hanging dead weight (Newtons)
- P = theoretical power generated (Watts)

T. Wildi, "The Prony Brake," in *Electrical Machines, Drives, and Power Systems*, 6th ed. Upper Saddle River, NJ, USA: Pearson Prentice Hall, 2006, pp. 75–77.

Prony Brake: 2x4 Wooden Frame (~$10)

- Two 50 lb (23 kg) digital fish scales
- Paracord line connected to tower (~$5)
- Lathed Drum (~$15)
- Dead weight on the bottom end
- Neiko 20713A Digital Laser Tachometer (~$30)
- Digital Push Pull Force Gauge AMF-50N for Precision Measurement (~$50)

Total Cost: $160

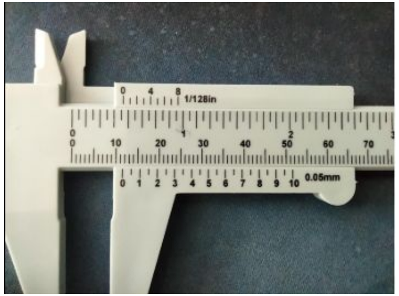
Turbine: Scaled Down Stream Diver (1:16)

- 8mm Ground Stainless Steel Shaft (~$12)
- 3D printed fins, 100% infill, 10 - 15 cm ($25)
- Center hole of 8.1 mm
- Two 608-2RS Ball Bearings (~$8)

Experiment: 495/Thermal Fluids Lab

- Water shot out 1 cm tube
- Water flow 0.4 - 0.8 L/s
- Gives speed 500 - 1000 RPM
- Net force up to 5 Newtons
- Generates 20 - 80 Watts

Prony Brake Uncertainty Analysis



Standard Caliper:

± 0.05 mm

U_r = 0.25%

Digital 50N Fish Scale:

± 0.5 Newtons

U_F = 9.8%

Neiko 20713A Digital Laser Tachometer:

± 1.5 RPM

U_N = 0.15%

Digital Push Pull Force Gauge AMF-50N for Precision Measurement:

± 0.01 Newtons

U_F = 0.2%

$$U_T = \sqrt{[(U_N * \partial P/\partial N)^2 + (U_r * \partial P/\partial r)^2 + (U_F * \partial P/\partial F)^2]}$$

$$U_T = \sqrt{[(U_N * N)^2 + (U_r * r)^2 + (U_F * F)^2]}$$

First total Uncertainty: 9.8%

New total Uncertainty: 0.3536%

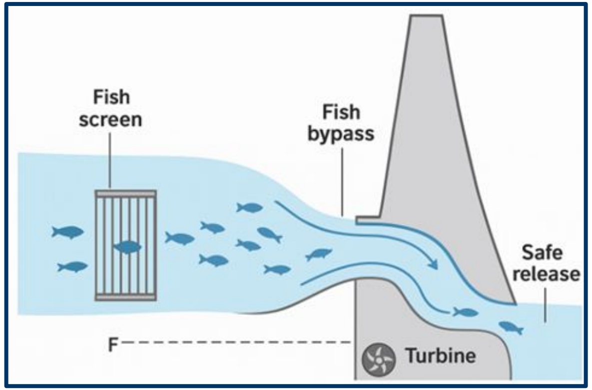
S. J. Kline and F. A. McClintock, "Describing Uncertainties in Single-Sample Experiments," *Mechanical Engineering*, vol. 75, no. 1, pp. 3–8, Jan. 1953.

J. P. Holman, *Experimental Methods for Engineers*, 8th ed. New York, NY, USA: McGraw-Hill, 2012, pp. 48–60.

ENVIRONMENTAL ANALYSIS

Used ORNL's Environmental Decision Toolkit

- Active Fishery - Fish screens can prevent entry into turbine system
- Giant Salvinia - Construction equipment can be cleaned to prevent spread
- Water Oxygenation - Impact should be minimal or nonexistent



Non-Dimensional Analysis

- Based on the Hydropower Equation to compare results
- Equations to scale down our project so that we accurately test our prototype
- Modified to be able to work with a garden hose or similar flow

$$D_p = D_m \sqrt{\frac{Q_p}{Q_m}\sqrt{\frac{H_m}{H_p}}} \quad (4)$$

Plugging in the variables to solve for D_p.

$$D_p = 1.3\sqrt{\frac{0.0024}{13}\sqrt{\frac{8}{1}}} = 0.0297\text{m} \cong 3\text{cm}$$

The result isn't limited by the 3D Printing area which is 400mm x 400mm x 400mm. Using equation (1) we can predict the power output to be 0.87 MW or 870,000 W. Setting Pm= 870,000W in equation (3) results in Pp= 20.5W.

$$P_p = 870,000\left(\frac{.03}{1.3}\right)^2\left(\frac{1}{8}\right)^{3/2} = 20.5\text{W}$$

To verify the calculations, we can check the new flow rate with equation (1), and see if the results are consistent.

$$P = 1000\, kg/m^3 \times 9.81\, m/s^2 \times 1\, m \times 0.0024\, m^3/s \times 0.85 = 20\text{W}$$

The difference is 0.5W or a 2.5% margin of error. This is less than 5%, this is an acceptable result.

Corbin Davis- Non-dimensional Analysis

COMMUNITY CONNECTIONS

- Event: Willow Bend community outreach event
- Audience: Local families and students
- Purpose: Introduce hydropower and renewable energy concepts

FIRST OUTREACH MODEL

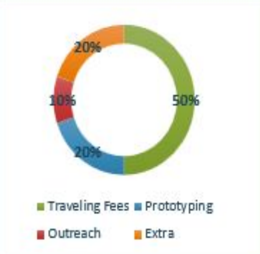
SCHEDULE

ME486C - HCC26 Gantt

Task name	Stard date	End date	Assigned	Status	12-Jan	13-Jan	14-Jan	15-Jan	16-Jan	17-Jan	18-Jan	19-Jan	20-Jan	21-Jan	22-Jan	23-Jan	24-Jan	25-Jan	26-Jan	27-Jan	28-Jan	29-Jan	30-Jan	31-Jan	1-Feb	2-Feb	3-Feb	4-Feb	5-Feb	6-Feb	7-Feb	8-Feb	9-Feb	10-Feb	11-Feb	12-Feb	13-Feb	14-Feb	15-Feb	16-Feb	17-Feb	18-Feb	19-Feb	20-Feb	21-Feb	22-Feb	23-Feb	24-Feb	25-Feb	26-Feb
Project Management	12-Jan	18-Jan	ME Team	Done																																														
Engineering Calculations	12-Jan	23-Jan	ME Team	Done																																														
Individual Analysis	18-Jan	30-Jan	ME Team	Open																																														
Cultural and Social Analysis	20-Jan	30-Jan	Dawson	In process																																														
Site Operation Analysis	20-Jan	30-Jan	Karsten	Done																																														
Prony Brake Uncertainty Analysis	20-Jan	30-Jan	Nathaniel	In process																																														
Solar Power Analysis	20-Jan	30-Jan	Anthony	Done																																														
33% Build	12-Jan	3-Feb	ME Team	Open																																														
Engineering Model Summary	12-Jan	18-Jan	Corbin	Done																																														
Final CAD and Fabrication Files	12-Jan	20-Jan	Corbin	Done																																														
Manufacturing Confirmation	12-Jan	20-Jan	ME Team	Done																																														
EE Architecture Development	12-Jan	22-Jan	EE Team	Done																																														
Testing Plan	12-Jan	24-Jan	Karsten	Done																																														
Manufacture and Fabrication	12-Jan	24-Jan	ME Team	Done																																														
EE Build and Integration	12-Jan	25-Jan	EE Team	Done																																														
Prototype Dry Assembly	12-Jan	26-Jan	ME Team	In process																																														
Community Connections	12-Jan	3-Feb	Nathaniel	In process																																														
Website Check #1	12-Jan	20-Feb	Nathaniel	In process																																														
February Competition Submissions	12-Jan	23-Feb	ME Team	In process																																														
Siting Challenge	13-Jan	23-Feb	ME Team	In process																																														
Design Challenge	14-Jan	23-Feb	ME Team	In process																																														
Community Connections	15-Jan	23-Feb	ME Team	In process																																														
67% Build	4-Feb	26-Feb	ME Team	Open																																														
Validating Manufactured Components	4-Feb	26-Feb	ME Team	Open																																														
Validating Subsystem Integration	4-Feb	26-Feb	ME Team	Open																																														
Cost Models Refined using as-built	4-Feb	26-Feb	ME Team	Open																																														
Environmental and Operational Check	4-Feb	26-Feb	ME Team	Open																																														
Prony Brake Build and Test	4-Feb	26-Feb	ME Team	Open																																														
Prototype Testing	4-Feb	26-Feb	ME Team	Open																																														

BUDGET & PURCHASING PLAN

How much do we have?	Where Do We Want To Allocate Money?		
Initial Amount			
$15,000.00	Traveling Fees	50%	$7,500
Total Expenses	Prototyping	20%	$3,000
$10,500.00	Outreach	10%	$1,500
Potential Savings	Extra	20%	$3,000
$4,500.00	Total	100%	$15,000



What is our income?

What is our Income?		
Description	Date	Amount
Project Application	9/18/2025	$5,000.00
January Submission	1/26/2026	$5,000.00
Febuary Submission	2/23/2026	
Build & Test Submission	2/23/2026	$3,000.00
Build & Test Presentation	2/23/2026	$2,000.00
Final Event	4/24/2026	$5,000.00
	Total Income	$20,000.00

What are our expenses?

Description	Expense amount	Distribution	
In Person Workshops	$1,000.00		
In person Conferences	$7,500.00	Prototype 1	$200
Prototyping Materials	$1,000.00	prototype 2	$200
Mapping Software	$500.00	Final Prototype	$500
Community Outreach	$500.00	Outreach Model	$100
Total Expenses	$10,500.00		$1,000.00

What are our expenses to date?		
Description		Expense amount
3d Printer	Artisan snapmaker 3d 3 in 1 printer	$2,882.94
Machined metal	7 inch metal shaft	$10.00
Team Shirts	Team shirts x8	$125.00
Total Expenses		$3,017.94
True remaining balance		$14,982.06

Prony brake materials will be added after finalization of design.

Purchasing plan	Percentage
Purchased	80%
On Hand	80%
Yet to be purchased	20% unknowns

B.O.M

Theoretical B.O.M			
Total Project Cost Estimate			$24,600,000.00
Civil Works	Cofferdams & Dewatering		$1,600,000.00
	Intake Structure,Trash Rack, Stoplogs,		$1,200,000.00
	Powerhouse bay, crane,rails (Vendor)		$2,500,000.00
	Bulb Pit, Draft Tube Concrete (Vendor)		$1,400,000.00
	Vertical Fish Ladder (Manufacture)		$2,700,000.00
Electromechanical	Kaplan Bulb Turbine Generator Package,		$6,900,000.00
	Wicket Gates & Servos (Manufacture)		$800,000.00
	Overhead Crane (Purchase)		$350,000.00
	Automated Trashrack Cleaner (Purchase)		$250,000.00
Electrical and Balance	Generator Switchgear, Protection/SCADA		$900,000.00
	Unit Transformer (Purchase)		$800,000.00
	13.8kV Feeder/POI connections & Intertie		$600,000.00
	Cables, Ductbank, Grounding (Purchase)		$300,000.00
Soft Costs & Contenginc	Permitting, Envirmoantal Studies,CM		$1,800,000.00
	Utility, Legal, Financing (Purchase)		$400,000.00
	Contengincy Construction (Purchase)		$2,100,000.00
Total Price Point			$24,600,000.00

Rough estimate of a potential Stennis Conversion.

Moving Forward

- Met with Industry Mentor, requests an alternate site selection process using a different method of analyzing cash value. Likes what we have but the area brings in no value.

- Met with John C. Stennis, the current state of the dam is critical, most components are outdated and head height regulations are too tight. From an energy and utilization perspective, the area itself would not generate the money of a traditional NPD conversion and would soon become obsolete due to the nature of this navigational lock system.

- Using Locational Marginal Pricing and Energy Informative Agency data, we will reevaluate our site selection process to fit our clients needs. Looking at dispatchable needs, and grid stress to find high output areas.

THANK YOU!

NORTHERN ARIZONA UNIVERSITY