

# HCC 2026 100% BUILD

## Team

Nathaniel Holguin

Karsten Jones

Anthony Nuzzo

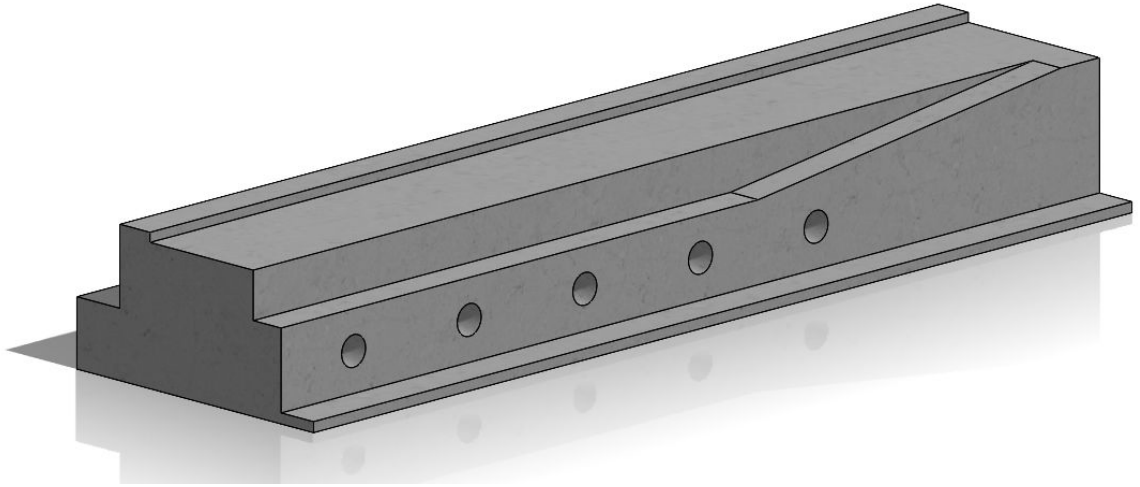
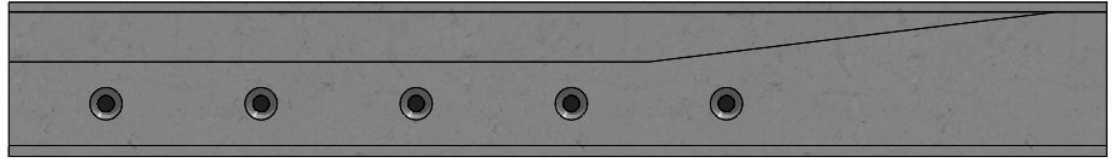
Dawson Stevens

# DESIGN EFFORTS

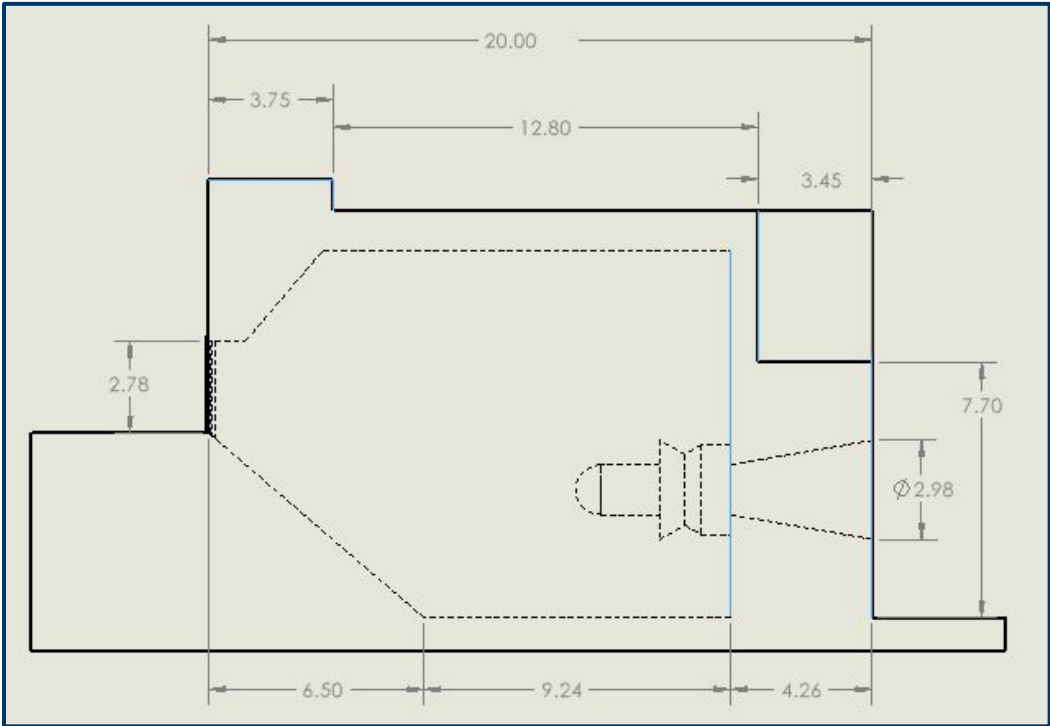
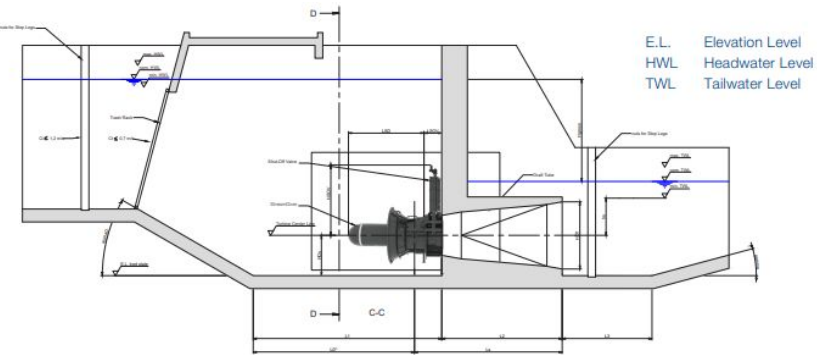


# DESIGN EFFORTS

Based off Voith Streamdiver template and fit into Coon Rapids cross-section



# DESIGN EFFORTS



# Feasibility & Engineering Awareness

## FERC (Federal)

Preliminary Permit / Exemption Screening  
Small Hydropower (1–10 MW) →  
Potential Conduit or Small Hydro  
Exemption  
Part 4 License (if not exempt)  
Coordination with:

- USACE (since this is a dam)
- Grid interconnection (Xcel / MISO)

Key risk: timeline + studies (2–5 years  
typical)

## MN DNR (State)

Public Waters Work Permit (REQUIRED)  
Dam Safety Review  
Fish passage & aquatic habitat protection  
Flow / bypass requirements ( modeled 15%)  
Construction impacts:

- Sediment control-maybe not
- Shoreline disturbance say why and  
how we mitigate

## NEPA (Environmental)

Environmental Assessment (EA) likely  
Full EIS if impacts escalate  
Required studies:

- Fish & wildlife
- Water quality
- Recreation impacts

Public + stakeholder engagement

## Project Alignment Design Decisions

- Run-of-river operation (no storage)
- Limited diversion (~15%) → minimizes ecological impact
- Modular StreamDiver units → reduced civil footprint
- Existing dam → avoids new impoundment

Modular capacity  
additions, have x  
amount, can add x  
more if money makes  
sense

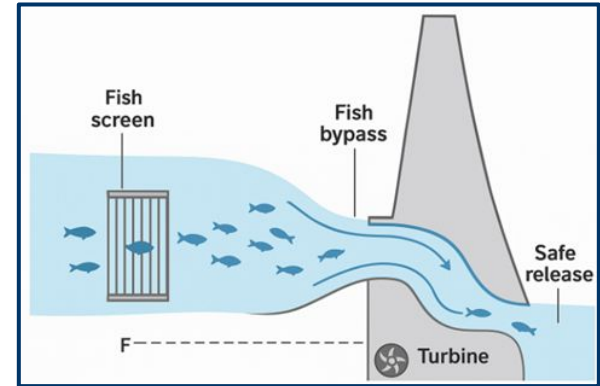
# Feasibility & Engineering Awareness

Used ORNL's Environmental Decision Toolkit

- Active Fishery - Fish screens prevent entry into turbine system
- Invasive Carp\* - Need to prevent upstream spread. Stoplogs prevent upstream travel during construction
- Water Oxygenation - Impact should be minimal or nonexistent-Justify, Ror wont have too much due to water height, transient flow, have problem with quars that just sit



\*Previously mentioned carp "DNA" was determined to not be indicative of a headwater population

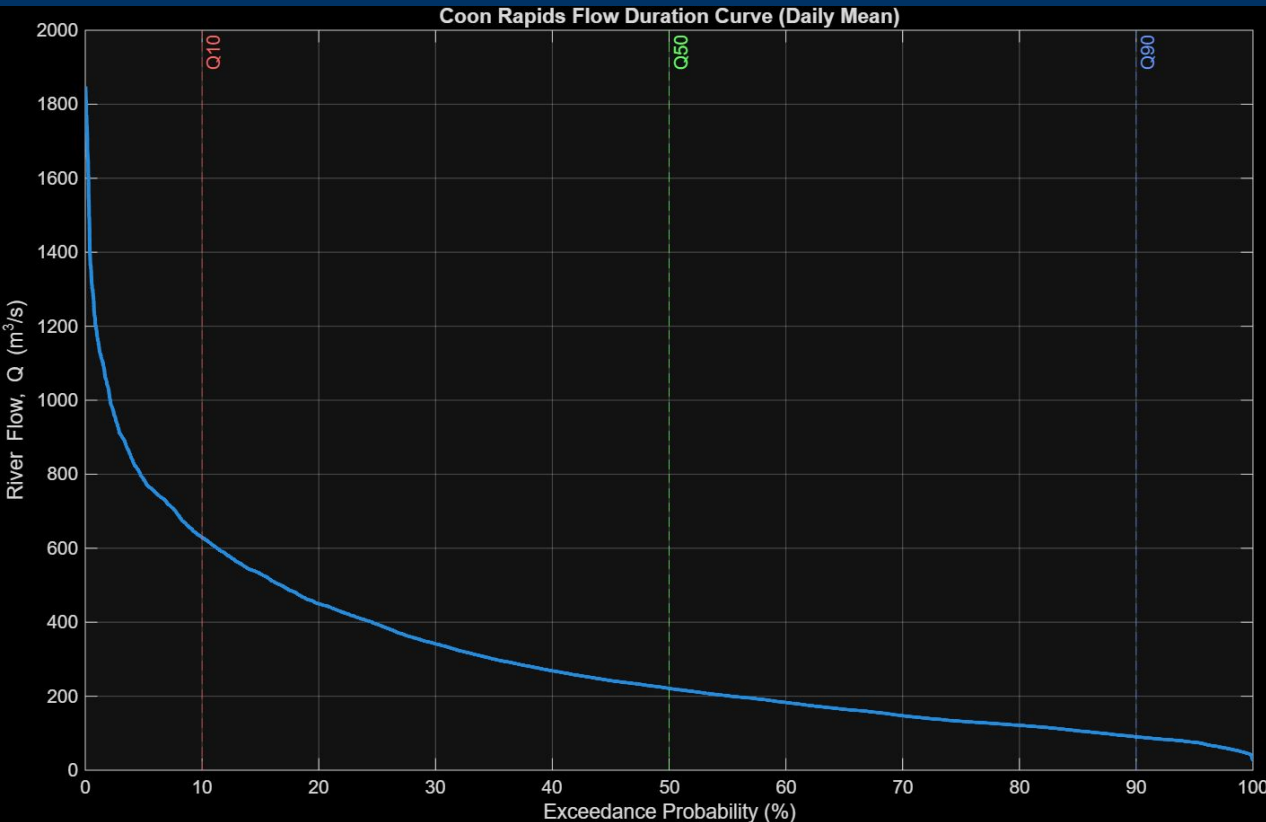


# RISK ASSESSMENT - COON RAPIDS DAM

Risk Category	Likelihood (1-5)	Impact (1-5)	Score (LxI)	Risk Level	Outcome
Flooding	5	5	25	High	Structural loading, downtime
Debris	4	4	16	High	Turbine damage, efficiency loss
Public Safety	3	5	15	High	Liability, injury risk
Sedimentation	3	3	9	Medium	Reduced performance
Supply Chain	2	3	6	Low	Cost/schedule delays

- **Flooding:** Seasonal Mississippi River peaks create extreme hydraulic loading (must handle these events)
- **Debris:** Upstream debris transport can damage turbines and reduce efficiency (debris mitigation)
- **Public Safety:** Low-head dam recirculation creates drowning hazard in a high-traffic park (safety measures)
- **Sedimentation:** Gradual sediment buildup reduced flow efficiency over time (routine maintenance)
- **Supply Chain:** Component sourcing variability may impact schedule (mitigate with standard components)

# Flow Duration Curve - Hydraulic Resource Assessment



## Key Flow Metrics

Q10  $\approx$  630 m<sup>3</sup>/s

Q50  $\approx$  220 m<sup>3</sup>/s

Q90  $\approx$  90 m<sup>3</sup>/s

## Design Implications

- High base flow  $\rightarrow$  strong run-of-river viability
- Low-flow reliability supports capacity factor
- Seasonal variability present but not limiting

## Design Constraints Applied

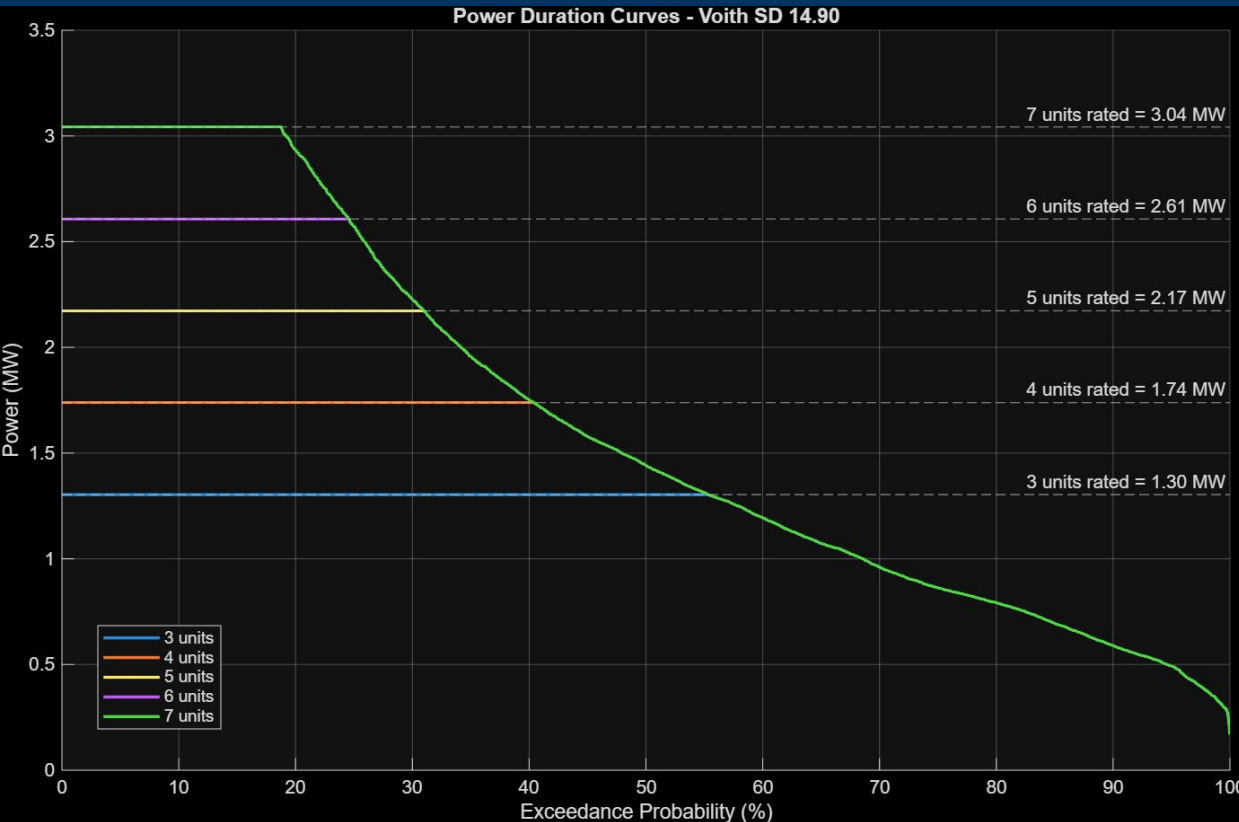
Max diversion: 15%

Environmental bypass: 15%

Turbine sizing based on usable flow envelope

Flow utilized capped by diversion & turbine capacity

# Power Duration Curve - System Performance & Capacity



## System Performance

- Power output limited by flow availability & turbine capacity
- High exceedance → reduced power due to flow constraints
- Flat regions → capacity-limited operation

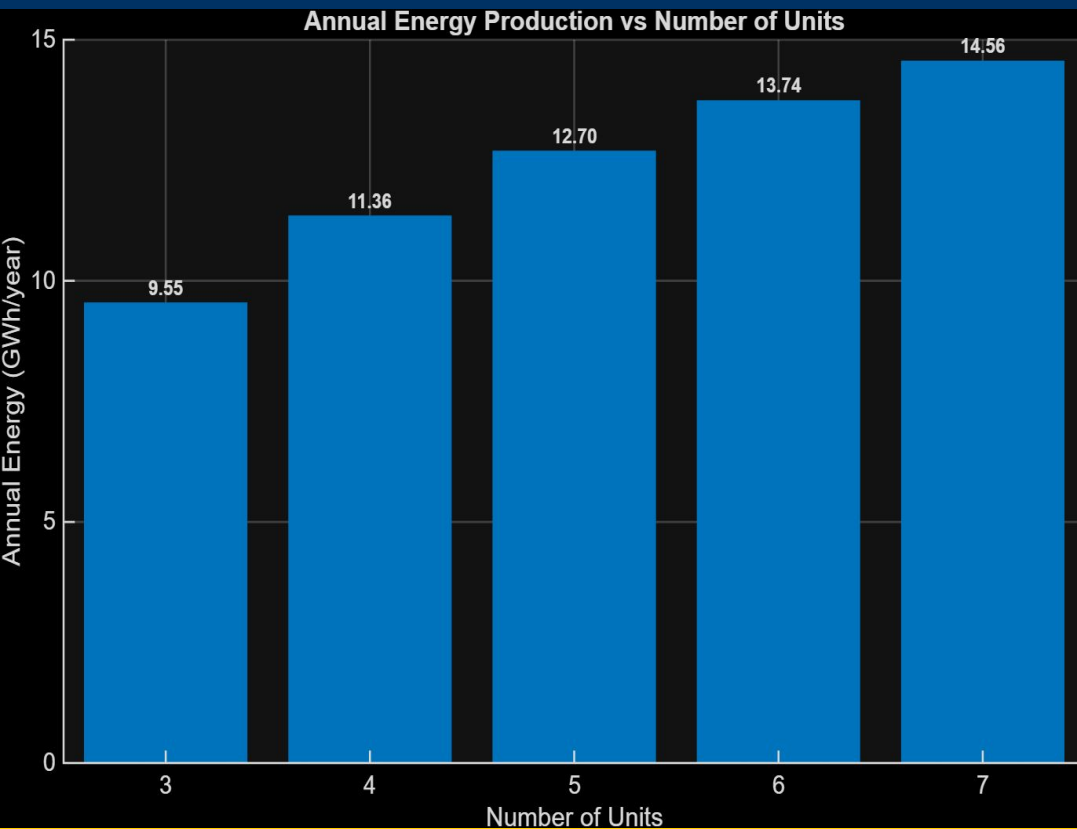
## Unit Configuration Comparison

- 3 units → high utilization, lower total output
- 5 units → balanced capacity vs utilization
- 7 units → higher peak power, increased underutilization risk

## Key Takeaways

- Increasing units → diminishing energy returns
- Optimal sizing driven by flow duration characteristics
- Supports LCOE based selection of 5 units

# Energy Scaling / Diminishing Returns



## Key Insight

- Energy increases with additional units
- Energy growth limited by available flow
- Indicates diminishing returns

## Performance Comparison

### 3 Units

- 9.55 GWh/year
- CF  $\approx$  0.84 (high utilization)

### 5 Units

- 12.70 GWh/year
- CF  $\approx$  0.67 (balanced performance)

### 7 Units

- 14.56 GWh/year
- CF  $\approx$  0.55 (lower utilization)

Optimal configuration selected based on performance-cost tradeoff

# ANALYSIS - ECONOMIC RESULTS

## Inputs

TECHNICAL INPUTS	
Selected Case	5 units
Number of Units	5.00
Per-Unit Design Flow (m <sup>3</sup> /s)	10.00
Net Head (m)	5.21
Efficiency	0.85
Rated Power (MW)	217.0%
Average Power (MW)	1
Capacity Factor	67.0%
Annual Energy (MWh/yr)	12699
ECONOMIC INPUTS	
Project Life (years)	4000.0%
Discount Rate	6.0%
Engineering / Permitting Fraction	12.0%
Contingency Fraction	20.0%
Annual O&M Fraction	3.0%
SCREENING-LEVEL COST INPUTS	
Installed Cost (\$/kW)	\$3,500
Display Installed Cost Assumption (\$/kW)	\$3,500
JEDI Project Cost Reference (\$)	\$10,567,019
JEDI Direct O&M Reference (\$/yr)	318651.8347

- Key Assumptions
  - Installed Cost: \$3,500/kW
  - Project Life: 40 Years
  - Discount Rate: 6%
- Economic Results (Based on 5 units)
  - Total CAPEX: \$7.6M
  - Annual OPEX: \$228k/yr
  - Installed Capacity: 2.17 MW
  - Annual Energy: 12,699 MWh
  - Lifetime Cost: about \$16.7M

# ANALYSIS - LCOE

Sensitivity - 3 to 7 Units									
Units	Rated MW	Avg MW	CF	P90 MW	Annual MWh	Installed Cost (\$/kW)	Total CAPEX (\$)	Annual OPEX (\$/yr)	LCOE (\$/MWh)
3	1.30	1.09	84.0%	0.59	9,553	\$3,500	\$4,550,000	\$136,500	\$45.94
4	1.74	1.30	75.0%	0.59	11,355	\$3,500	\$6,090,000	\$182,700	\$51.73
5	2.17	1.45	67.0%	0.59	12,699	\$3,500	\$7,595,000	\$227,850	\$57.69
6	2.61	1.57	60.0%	0.59	13,745	\$3,500	\$9,135,000	\$274,050	\$64.11
7	3.04	1.66	55.0%	0.59	14,565	\$3,500	\$10,640,000	\$319,200	\$70.47

- Key Findings:
  - Minimum LCOE occurs at 3 units, but limits total energy output
  - Selected design: 5 units for optimal design
  - Increasing units increases CAPEX disproportionately
  - Diminishing energy gains beyond 5 units
- Design Decision
- 5 units selected for:
  - Higher total energy output
  - Better system reliability
  - Optimized balance between cost and energy production

# ANALYSIS - JEDI MODEL

JEDI ECONOMIC IMPACT SUMMARY	
JEDI Project Cost (\$)	\$10,567,019
JEDI Direct O&M (\$/yr)	\$318,652
Construction Jobs (FTE)	90.0
Construction Output (\$)	\$12,100,000
Operating Jobs	3.8
Operating Output (\$/yr)	\$588,124

- **Key Impacts**

- \$12.1M in construction output
- 90 jobs supported during construction (Engineers, construction workers, suppliers)
- Significant local economic activity generated (Local business, contractors, supply chains, etc.)

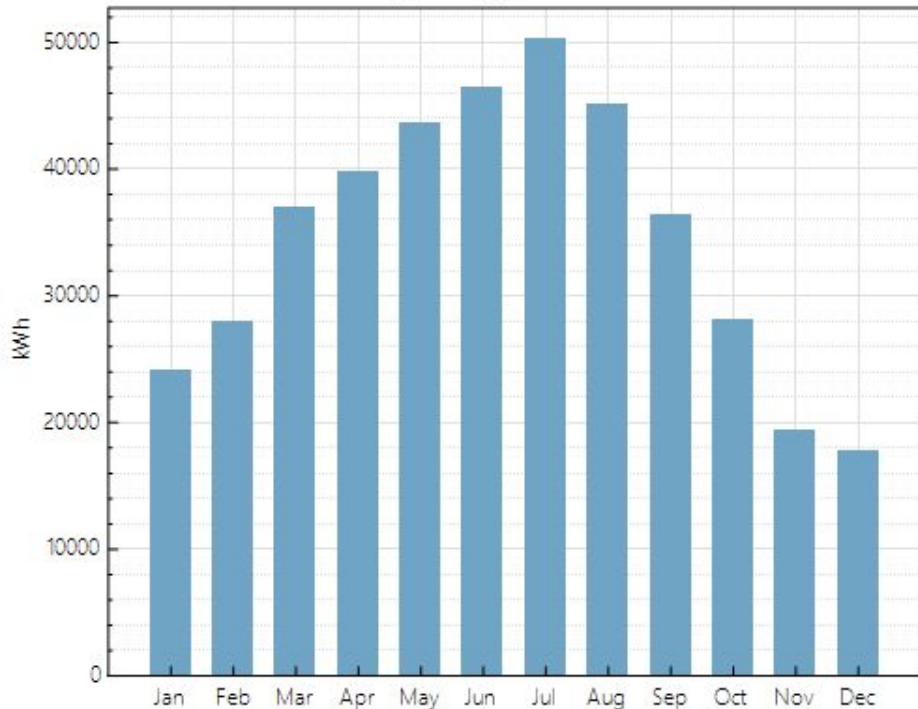
- **Long-Term Benefits**

- 3.8 operating jobs (about 4 full-time)
- \$588k/year in economic output
- Continued regional economic contribution

Impacts estimated using NREL's JEDI hydropower model for regional economic activity.

# Solar Integration - Coon Rapids Site

Monthly AC Energy in Year 1



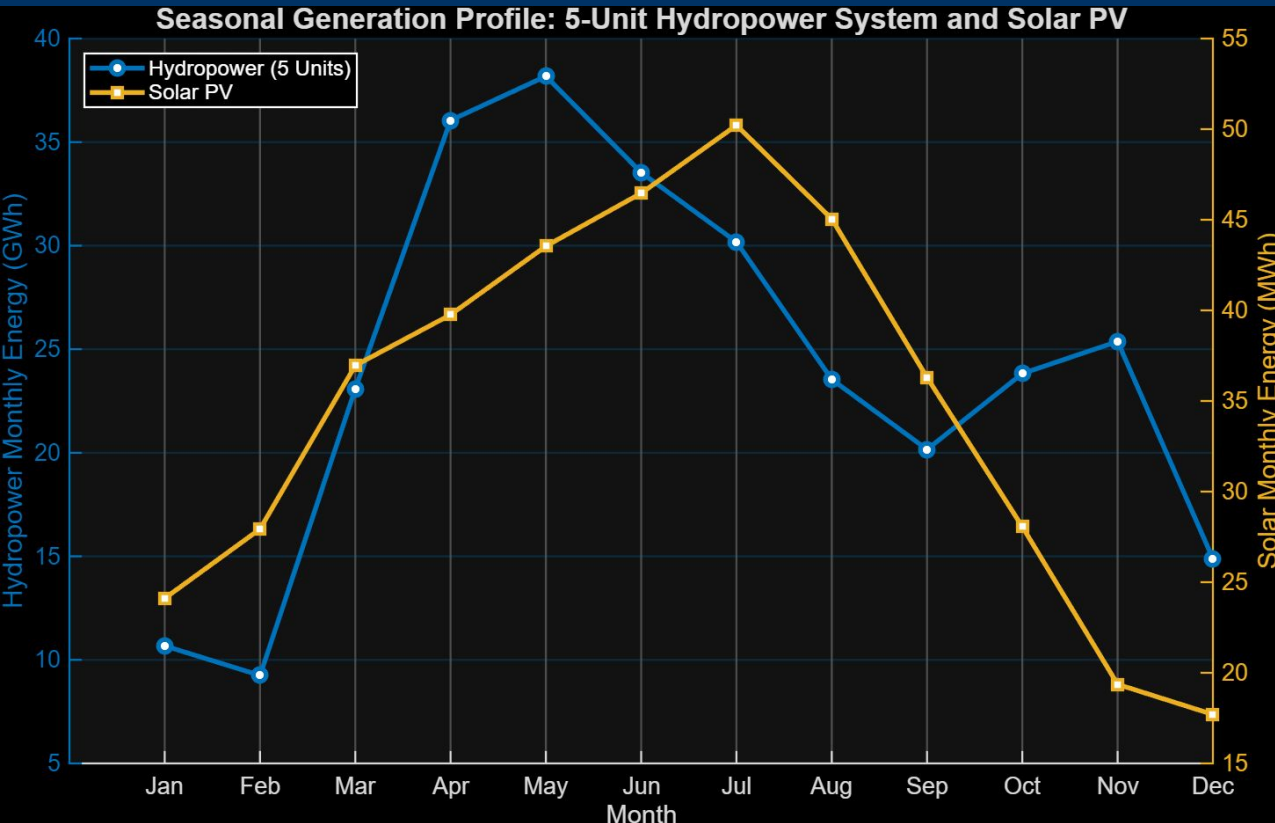
Proposed Site installation  
Area (~0.9 acres), 575  
modules



- Installed capacity: 305 kWdc / 250 kWac
- Annual generation: 415 MWh/year
- Capacity factor: 15.5%
- Specific yield: 1,361 kWh/kW-yr
- LCOE: ~ 12.2 ¢/kWh
- Installed cost: ~ \$560k

Peak solar productivity aligns with summer recreational demand and complements hydropower variability.

# Hybrid Energy Integration - Coon Rapids Site



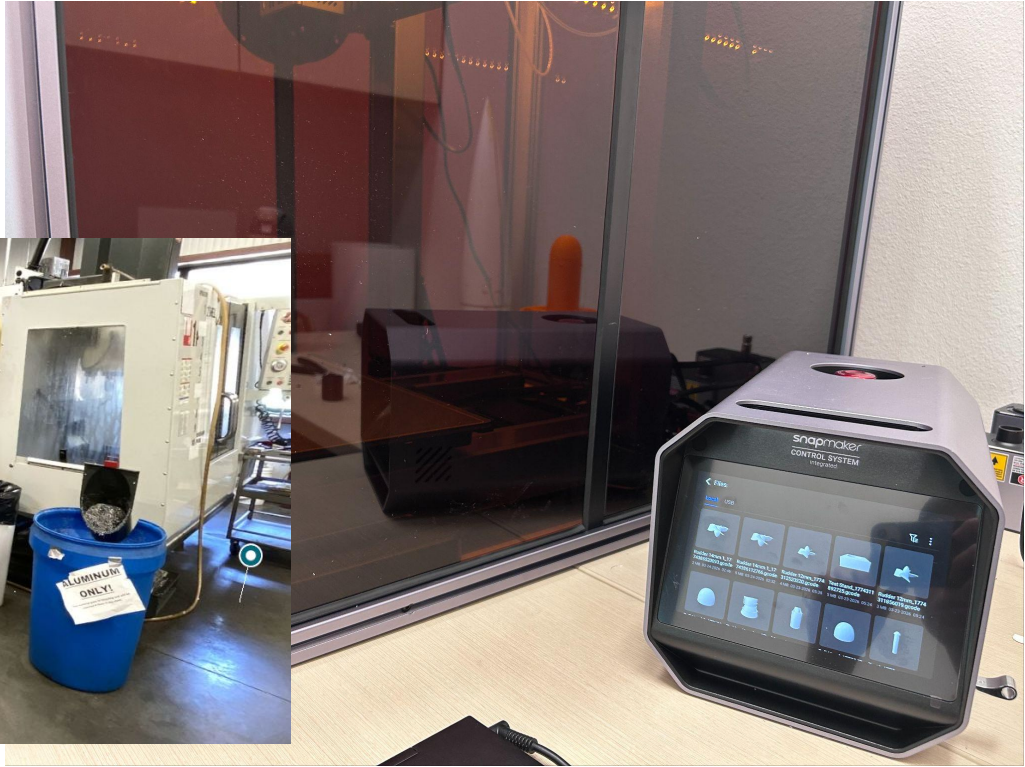
## System Performance Insights

- Hydropower provides primary baseload generation, peaking during spring snowmelt
- Solar PV contributes seasonal augmentation, with peak output in summer
- Hybrid system improves seasonal energy balance, reducing variability

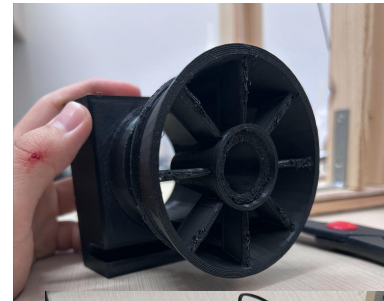
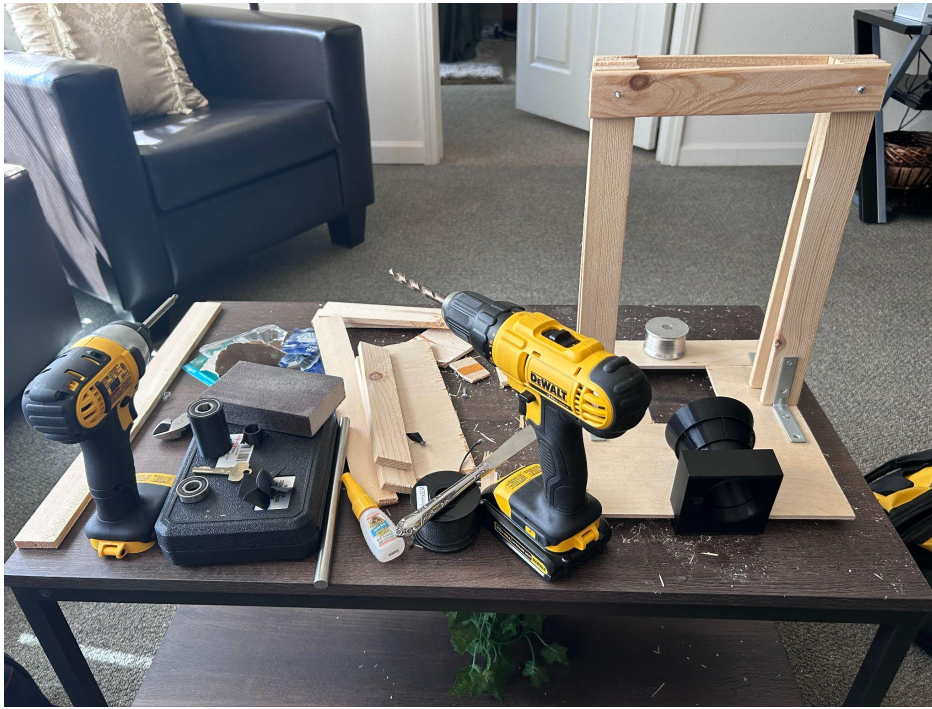
## Capacity Context

- Hydropower: ~1–10 MW scale (primary generation)
- Solar PV: ~0.25 MW scale (supplemental)
- Solar contributes <5% of total annual energy
- Hybrid Total ~ 2.4 MW

# MANUFACTURING/BUILD

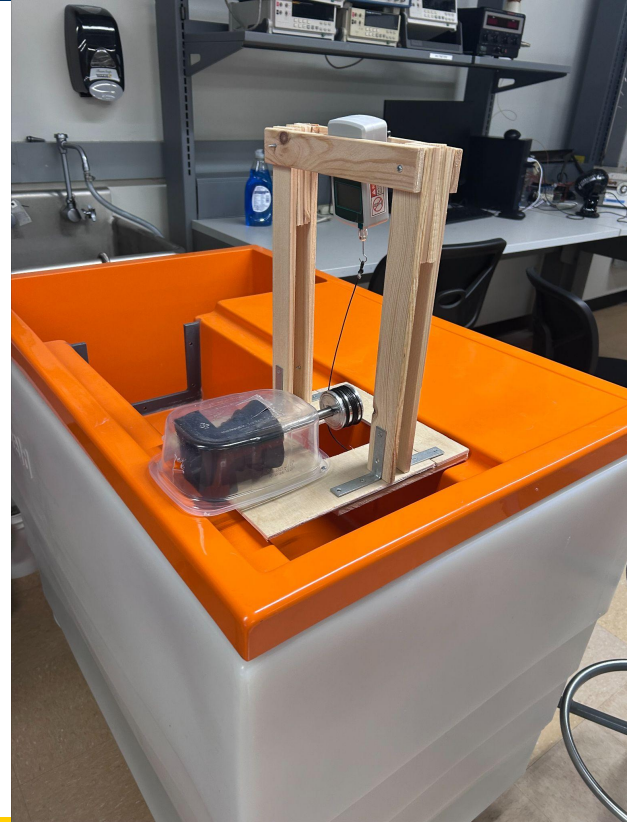
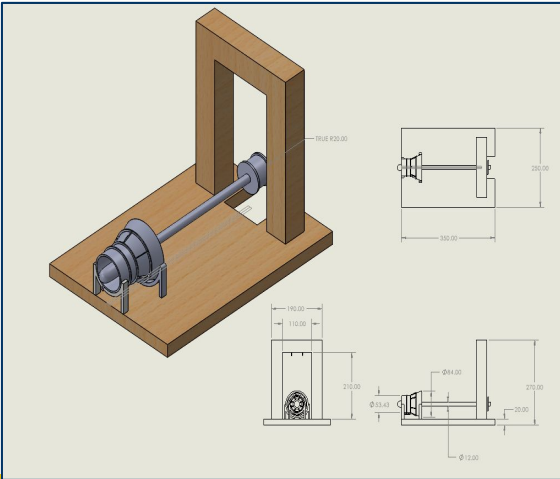


# MANUFACTURING/BUILD



# MANUFACTURING/BUILD

- What data we are getting
  - Torque: 0.01 - 0.13 Nm
  - Rpm: 100 - 3000 RPM
  - Power: 1 - 6 W
  - Efficiency: 10 - 75 %
- From
  - Water output: 0.1 - 1 L/s



# Purchasing & Manufacturing Plan

No.	Date	Department	Purposes	Demand detail				Procurement details			Handler	State
				Product	Model	Unit	Quantity	Date	Price	Amount		
1	2026/02/25	Mechanical	Prony Brake	PGN Bearings	12x28x8 mm	***	2	2026/03/10	\$7.00	14.00	PNGBearings	Complete
2	2026/02/25	Mechanical	Prony Brake	Neiko 20713A Digital Laser Tachomet	Neiko 20713A	***	1	2026/03/10	\$30.00	30.00	Autozone	Complete
3	2026/02/25	Mechanical	Prony Brake	Digital Push Pull Force Gauge	AMF-50N	***	1	2026/03/10	\$50.00	50.00	Friday Parts	Complete
4	2026/02/25	Mechanical	Prony Brake	Dyneema cord	UHMWPE Braided Cord	***	1	2026/03/10	\$18.00	18.00	Amazon	Complete
5	2026/02/25	Mechanical	Prony Brake	Stainless Steel shaft	12mm, 303 stainless steel, corrosion resistant, 1ft/300mm length	***	1	2026/03/10	\$32.00	32.00	McMaster	Complete

What are our expenses to date?		
Description	Expense amount	
3d Printer	Artizan snapmaker 3D 3in1 printer	\$2,882.94
Machined metal shaft	7 inch metal shaft	\$10.00
Team Shirts	Team shirts x8	\$125.00
PGN Bearings	12x28x8 mm bearings x2	\$14.00
Neiko 20713A Digital Laser Tachometer	Neiko 20713A	\$40.00
Digital Push Pull Force Gauge	AMF-50N	\$50.00
Dyneema cord	UHMWPE Braided Cord	\$18.00
Stainless Steel shaft	12mm, 303 stainless steel, corrosion resistant, 1ft/300mm length	\$32.00
<b>Total Expenses</b>		<b>\$3,171.94</b>
<b>True remaining balance</b>		<b>\$14,828.06</b>

State	Amount	Ratio
In Process	-	0%
Complete	144.00	100%



**THANK YOU!**