HydroPower Solutions
FULL AND BY FARMS
Essex County, NY

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1 Upper Spring
455ft Elevation
Piped to lower spring 600ft
1¼" PE pipe
Open dry joint cistern
Valve to lower spring

2 Lower Spring
335ft Elevation
Piped to barn for 1000ft
2in PV pipe
600 gallon concrete box

3 Barn
225ft Elevation
300 feet to grid connection
50psi

4 River
Average 320 cfs
100 ft wide
3.5 ft deep

Upper Spring

Lower Spring

Lower Spring

Abstract

As part of the Path to Zero Net Energy (PZNE) class, our team was networked via Kurt Kornbluth (course coordinator) with the owners of Full and By Farm, James Graves and Sara Kurak, to conduct a feasibility study on the possibility of implementing hydropower on the farm. The scope of the project involved analyzing the two spring wells to the west of the barn as well as the Boquet River to the east, and legal and economic ramifications. It was found installing a diversion spillway on the river which diverts the water, had the most potential for generating energy whilst satisfying the legal requirements. Hydropower from the wells was not feasible. The average power consumption, accounting for propane usage totaled 3000 kWh. A diversion spillway has the potential to cover that load with a calculated 3500 kWh per month (4.5 kW).

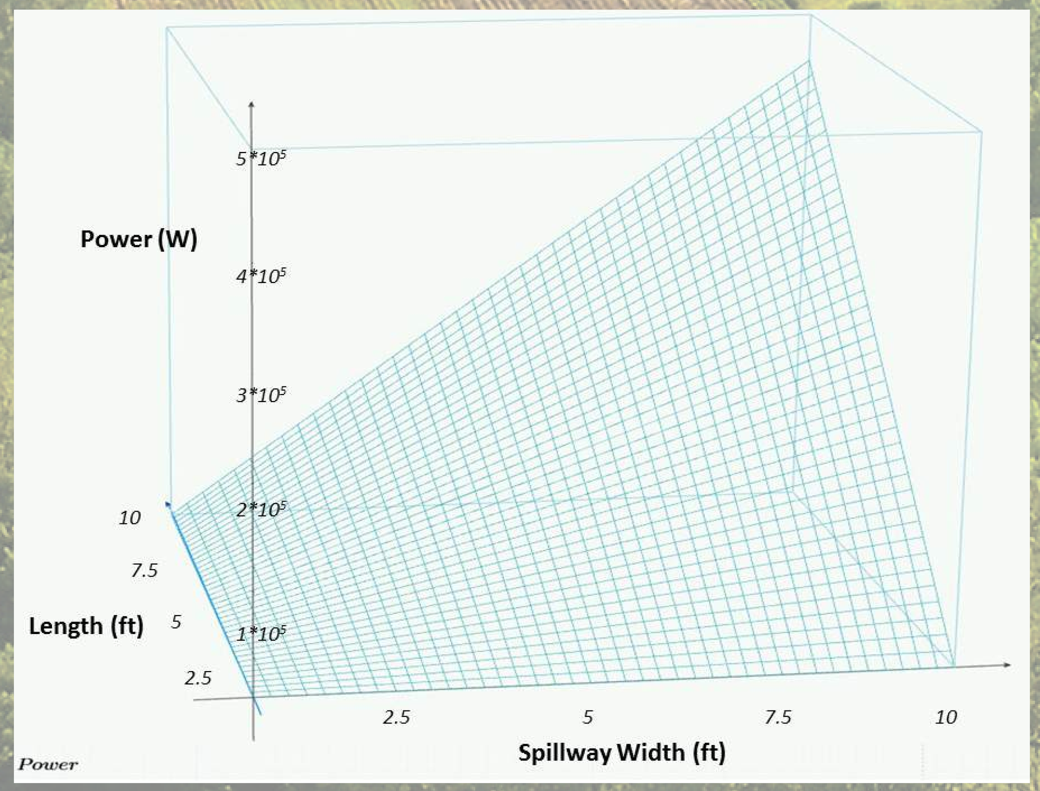
Hydropower Unit	Maximum Power	Energy per Month	LCOE
Monthly Demand	4000 W	3000 kWh	$0.12/kWh
Lower Spring	100 W	70 kWh	$0.51/kWh
Upper & Lower Spring	200 W	140 kWh	$0.24/kWh
In-Stream Turbine	250 W	180 kWh	$0.40/kWh
Diversion Spillway	4800 W	3500 kWh	$0.11/kWh

A table summary of the energy generation and the Levelized Cost of Electricity (LCOE) to show the feasibility of implementing each of the hydropower units.

Kaplan Turbine Pelton Turbine

Methodology

The options of on-site hydropower include the Upper Spring, the Lower Spring, or the Bouquet River by utilizing either a Diversion Spillway or an In-stream Turbine. Preliminary calculations were conducted to find the potential power generating capacity of the various hydropower units.
There are two ways of extracting hydropower:
Potential Energy: $Power = \eta \rho g Q H$
Kinetic Energy: $Power = \frac{1}{2} \eta \rho A v^3$
The two springs and the diversion spillway utilizes the potential energy while the in-stream turbine utilizes the kinetic energy of the river flow.



Power generated for the diversion spillway as a function of spillway height and width.

Results

The elevated springs were found to provide little power and energy, totaling only 4.8% of average annual energy demand at a levelized cost of $0.24/kWh. The in-stream turbine was restricted by the slow flow velocity and the shallowness of the river resulting in little potential of being a stepping stone toward self sufficiency. The exact quantity of extractable power was found to be dependent upon the turbine model. Utilizing a diverged spillway showed a potential to supply up to 3500kWh per month, at a levelized cost of $0.12/kWh. This is larger than the estimated average monthly energy usage of electricity and propane totaling approximately 3000kWh. Electricity is $0.11/kWh, inferring that hydropower is not a feasible option.

Image References: USGS Topological Maps, Google Earth, Google Map, James Graves