Artificial Intelligence Managed Microgrid with Energy Storage (AI-MES)

(Pumped Hydroelectric & Ultra-Capacitor)

- PI Robert Nordahl NAVFAC EXWC PW, 530-300-3300, Robert.L.Nordahl.civ@us.navy.mil.
- PI Heros Nersesian NAVFAC EXWC PW, Heros.Nersesian@us.navy.mil

Problem Statement (Problem Curation)

Secure resilient power is required for critical circuits to support mission. Robust energy storage & technologies are needed to provide resilient power.

Stakeholders (Beneficiaries)

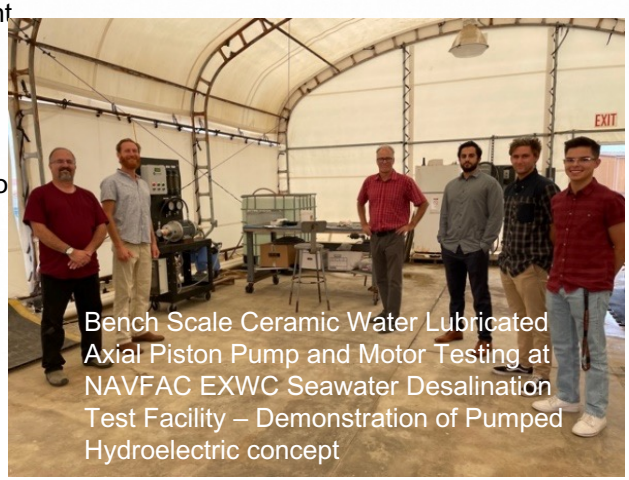
Beale & Vandenberg AFBs, NAVAIR Warfare Center, Weapons Division, China Lake & Point Mugu, San Nicolas & Clemente Islands, MCB Camp Pendleton & Kaneohe, Pacific Missile Range, Pearl Harbor Hickam

Metrics (Mission Achievement)

Peak Shavings ($), Power Quality Assurance (voltage, amperage, frequency, dips (sags) and swells in voltage values, power factor, harmonic currents, and the resulting distortion and crest factor, power and energy, voltage and current unbalance, inrush current values.

Proposal (Value Proposition)

AI-MES adapts to events and circumstances to provide continuous quality power.
Ultra-capacitors provide instantaneous power in the event of a grid down scenario and in the meantime regulate power quality
Pumped hydro (pumping water into tanks/reservoirs at elevation & releasing it to generate power when needed or when electricity prices surge) provides massive energy storage capacities and peak shaving opportunities as well as drinking and fire water.



Bench Scale Ceramic Water Lubricated Axial Piston Pump and Motor Testing at NAVFAC EXWC Seawater Desalination Test Facility – Demonstration of Pumped Hydroelectric concept

Buy-In & O&M: (Buy-In/Support)

Lt Robert Winter AOIC/APWO NBVC PW SNI asked for a super capacitor for the Test Range at SNI. Richard Mack NBVC IEM is actively looking for ways to increase energy resilience. Mick Wasco Marine Corps Air Station Miramar IEM is seeking alternate energy storage technology.

Objective (Deployment)

- Utilize SME expertise and Academia to develop and demonstrate an AI managed microgrid with robust energy storage technologies. Operate microgrid for 14 days, per DON Installation Energy Strategy 2025 Goal, using a mix of renewable & hydrocarbon generation & a mix of ultra-capacitor & pumped hydro energy storage and validate performance and resiliency.

Deliverables (Key Activities)

Q1- Milestone #1: Procure materials and assemble
Q2- Milestone #2: Programming and development
Q3- Milestone #3: Contract to build small scale unit
Q4- Milestone #4: Test and collect results

Commercial Partners (Key Partners)

- John MacHarg CEO Ocean Pacific Technologies
- Oceanus Power and Water LLC

Team Members (Key Resources)

- Kyle Lawrence NAVFAC EXWC EV
- Bill Varnava NAVFAC EXWC EX
- Maha N. Haji, PhD, Cornell U.
- Professor Sriram Narasimhan UCLA
- Eric Hahn, Naval Post Grad School (NPS)
- Anthony Gannon NPS

Pumped Hydroelectric

NEXTSTEP Details:

Initial funding has been used to survey several bases in California

All bases looked at indicate a possibility for Pumped Hydro Energy Storage

NextSTEP potable water leakage project targets saving 20 percent of base water

Flushing on many bases uses 30 percent of base water. Can flushed water be captured and used for pumped hydro energy storage?

Flushing removes ground water sediments and removes water with little or no disinfectant. The Primary Standard of the Safe Drinking Water Act requires disinfectant to protect the public

Pumped Hydroelectric

Pendleton Details:

The fresh water lake at the south end of the base cannot be used for pumped hydro energy storage due to permit requirements

Pendleton has a potable water system that includes 5M gallon tanks at a 550 foot elevation. This could be used to support energy storage

The potable water system would need storage added at the bottom of the hill and piping to return the water to receive disinfectant

An alternative would be to add a pumped hydro energy system adjacent to the potable water system

Pumped Hydroelectric

Vandenberg Details:

Vandenberg Space Force flushes 30% of their potable water due to sediments and / or disinfectant requirements (Safe Drinking Water Act Primary Standard).

This water could be captured and pumped up hill to create an energy storage system. Installation Energy Manager is interested in pumped hydro energy storage

Long term base goal is a large lake, with hydro power

Could a small hydro plant be constructed at the current flushing location?

The coastal mountain range is present offering possible elevated storage locations

Pumped Hydroelectric

29 Palms Details:

29 Palms has reclaimed water from its wastewater treatment plant that is available to push up the hill near the base

The wastewater plant, base and hill with elevation are located very close together

The base installation energy manager is interested in pumped hydro energy storage

The base has excess solar power that could be used to push the water up the hill

MILCON Engineer in San Diego is currently working the 29 Palms energy storage project, with lithium ion batteries

Pumped Hydroelectric

Point Mugu Details:

NBVC, Point Mugu flushes water at Point Mugu, Port Hueneme and San Nicolas Island

This water could be captured and pumped up Laguna Peak or other elevations for energy storage.

The NBVC Production Manager is looking for a large amount of energy storage for the Point Mugu Flight Line

The existing potable water piping at San Nicolas Island has several sections that could support pumped hydro energy storage

There is a $5M current contract for a lithium ion battery at San Nicolas Island

Wind Turbine and diesel generator excess power will be used to recharge the battery

Pumped Hydroelectric

Point Loma Details:

Pumped hydro energy storage is possible a Point Loma. Their elevation is between 300’ and 400’

We are looking for the best way forward with the Point Loma Energy Manager

What water should they use, salt water, marginal water, reclaimed water or potable water?

Most water can be used for pumped hydro energy storage, including ocean water, treated waste water / reclaimed water, ground water and potable water.

Are there storage sites picked out, specifically high and low elevation?

Is there piping available between the two sites?

Is there storage tanks or equivalent at the two sites?

Pumped Hydroelectric

NEXTSTEP Details:

Ceramic Coated Pump and controls ($75,000 / $250,000):

90 percent efficient versus 70 to 80 percent for standard centrifugal pumps

The coating supports using saltwater or brackish water

(200 gpm) 100 KW system and add multiples to match site requirement

Pump testing will occur at the Seawater Desalination Test Facility at Port Hueneme in Fourth Quarter FY23

Field testing will occur in FY24, followed by full scale up of pumped hydroelectric system

Pumped Hydroelectric

Draft Microgrid UFC, Table 4-3, Energy Storage-based DER Details:

DER Type	Availability (COTS)	Hazardous Material Waste (EOL)	Energy Density	DoD History as Permanent Infrastructure	Lifecycle (Years)	Greenhouse Gas Emissions	Energy Time Provided Prior to Recharging
Fossil Fuel	Yes	State-Dependent	High	Yes	N/A	Yes	N/A
Iron Flow (BESS)	No	No	Low	No	25	No	Up to 12 Hours
Lead Acid	Yes	Yes	High	Yes	3-12	No	2 Hours
Lithium Ion	No	Yes	High	Yes	10	No	Up to 4 Hours
Compressed Air	No	No	Low	No	30	No	TBD
Fly Wheel (FESS)	No	No	Low	Yes	20	No	30 Minutes
Pumped Hydro	No	No	Low	Yes	>40	No	Up to 12 Hours
Super Capacitor	No	TBD	High	No	10-20	No	TBD
Hydrogen	No	No	TBD	No	N/A	No	N/A

Pumped Hydroelectric

Power Review for multiple bases

Higher elevation provides greater power versus cost

The system cost is similar for most bases but higher elevation produces greater power.