Evaluating Floating Solar PV Potential on Arizona Water Management Infrastructure

(A Drought Adaptation Technology)

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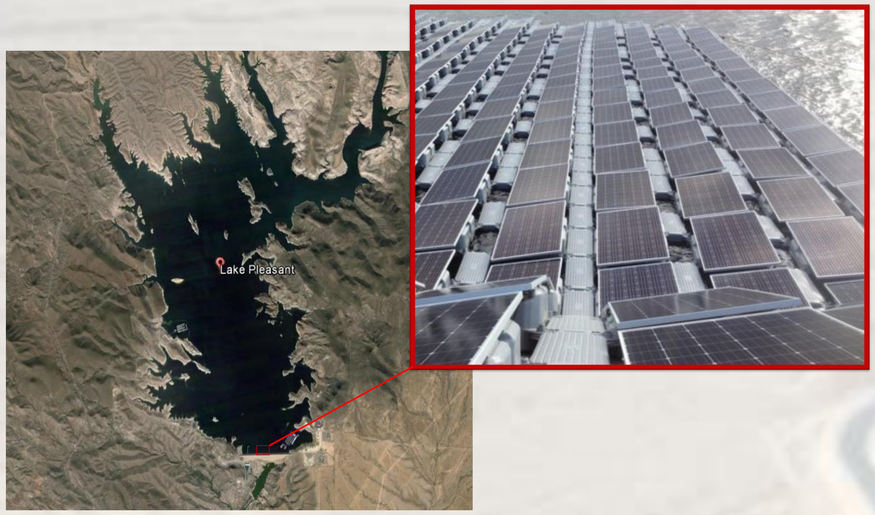
INTRODUCTION

- Floating solar photovoltaic installations are not yet well-known in the United States. The benefits include improved efficiency, improved lifetime of components, and reduction of evaporative water loss. Further, this opens up additional area for solar energy development.
- Arizona, with abundant sunlight, high evaporation rates, and limited water resources, has a lot to benefit from this technology.
- This Capstone evaluates the current state of floating solar technology, and provides recommendations for siting floating solar installations on Arizona reservoirs.



METHODOLOGY

- A review of the literature provides a background on sustainability challenges unique to Arizona
- Case studies on existing and planned floating solar installations provides info on technology such as cost, energy density, and construction methodology.
- National Renewable Energy Laboratory methodology used to calculate conservative technical potential of Lake Pleasant Reservoir
- Design concerns (proximity to electrical infrastructure, competing uses, economies of scale) are evaluated to design a pilot floating solar installation on Lake Pleasant Reservoir.

CASE STUDIES

Umenoki, Japan

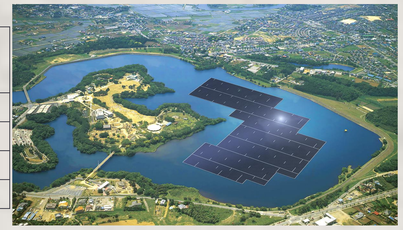
Surface Area	74,300 sq m
Total Modules	27,456 PV modules
Module Type	275 W Yingli
Peak Power Output	7.75 Megawatts Peak

Queen Elizabeth II Reservoir, Surrey, UK

Surface Area	**57,500 Sq m**
Total Modules	23,046 PV Modules
Module Type	275 W monocrystalline
Peak Power Output	6.33 Megawatts Peak
Projected Annual Output	5,800 MWh

Yamakura Dam, Chiba Prefecture, Japan

Total Surface Area	180,000 Sq m *
Total Modules	50,904 PV modules
Module Type	270W Kyocera
Peak Power Output	13.74 Megawatts Peak
Projected Annual Output	16,170 MWh



CAP AND THE NGS

- Total Power Use of CAP:
- **2,921,590 Megawatt hours (2014)**
- Evaporative Water Loss of CAP:
- **66,000 acre-feet per year (21,506,323,323 gallons)**
- CO_2 Emissions associated with the NGS
- **15.9 Million Metric Tons**

RESULTS

A Pilot on Lake Pleasant Reservoir

Surface Area:	120,000 m^2 (0.3% of Reservoir Area)
Total Modules:	43,637 modules – 275 W
Peak Power Output:	12MW Capacity
Annual Energy Production:	27,646.56 Megawatt hours
Lifetime Cost of Energy:	$40.51 per Megawatt hour
Estimated Water Savings:	166.89 Acre-feet / year

DATA

Energy Density of Combined Case Studies

Plant Name	Size	Energy Capacity	Energy Density
Sunflower	8,000 sq m	465 KWP	58.125 W/ m^2
Kawagoe	8,000 sq m	696.15 KWP	87 W/ m^2
Kato-Shi	31,300 sq m	2.87 MWP	91.7 W/ m^2
Umenoki	74,300 sq m	7.75 MWP	104.32 W/ m^2
QE II	57,500 sq m	6.33 MWP	110 W/ m^2
Combined:	**179,100 sq m**	**18.11 MWP**	**101 W/m^2**

Technical Capacity of Lake Pleasant Reservoir

Reservoir Openspace	Energy Density	State Capacity Factor (SAM)
17.118 Km^2	100 MW/ Km^2	0.263*

Technical Capacity:
1,711.8 MW

Technical Generation:
3,943,781.78 MWh/ Year

CONCLUSION + DISCUSSION

- The pilot project modeled to produce 12MW to power one 11.25MW pump unit on Lake Pleasant and utilize pumped storage
- Lake Powell and Lake Mead may be more important than Lake Pleasant for consideration of floating solar in order to replace NGS capacity
- Existing infrastructures associated with hydroelectric dams in Arizona provide ideal locations for the economical addition of renewable energy to Arizona's energy grid.