

Ocean Renewable Energy Storage (ORES)

*Energy storage for renewable integration
and grid management*

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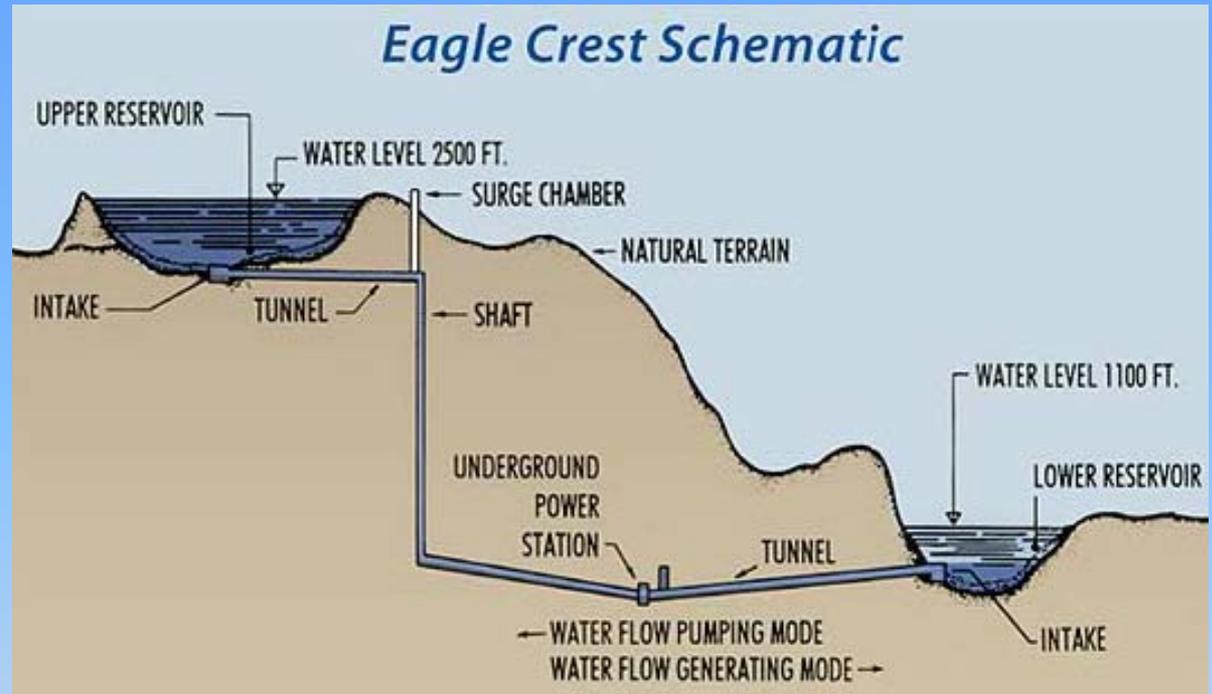
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Introduction

- Research Project
- Talking early informs more decisions
- Store energy *and* anchor energy harvesters
- Variant of Pumped Storage Hydro (PSH)

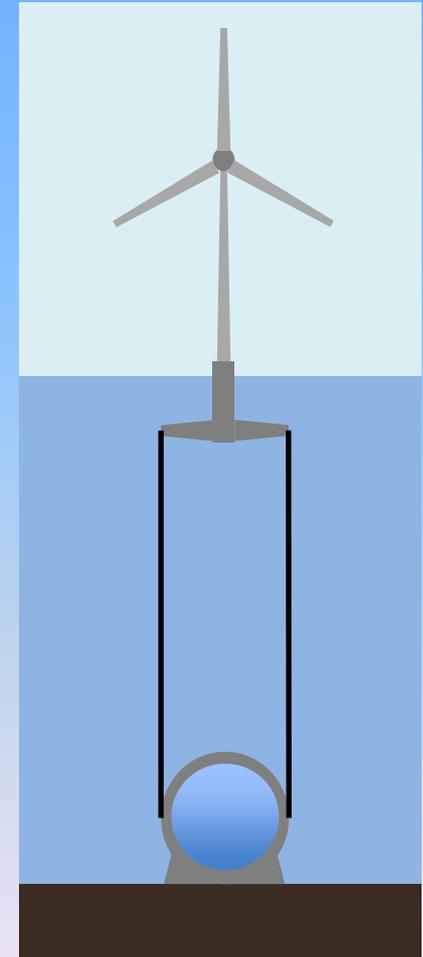
Conventional Pumped Storage Hydro (PSH)



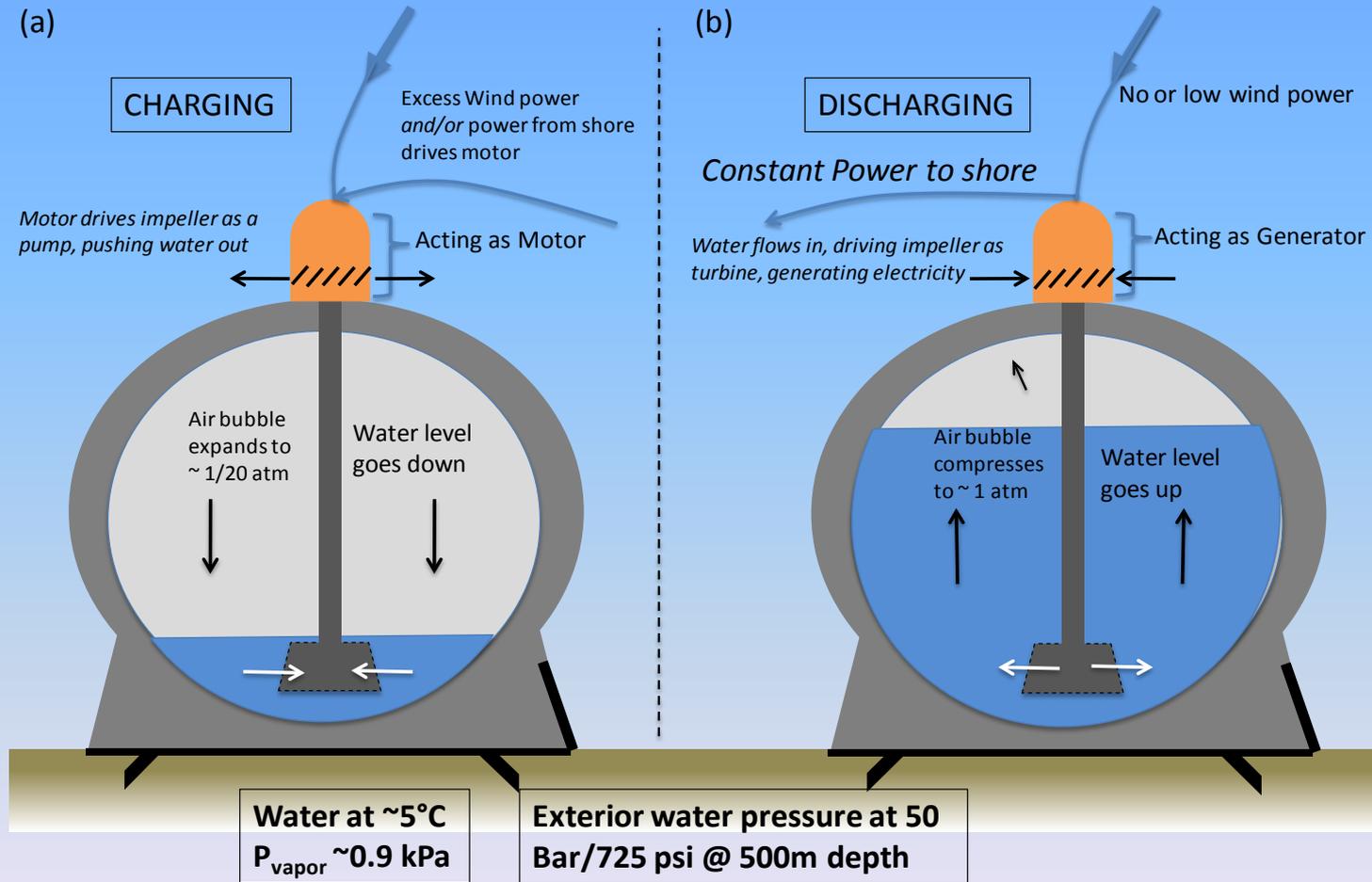
- Pump from low to high to store energy
- Run from high to low through turbine to release

ORES Concept

- FWT on TLP anchored by ORES
- ORES on ocean floor as low reservoir
- Tension lines
 - Support transmission lines
 - Guide ROVs
- Transmission to shore (not shown)



ORES Operating Concept



Modular – add spheres to achieve desired storage capacity

ORES

- Capacity depends on depth and size
- Working on “widgetizing”

Depth (m)	C_{\max} (MWh)		
	25m Di	27m Di	30m Di
150	2.30	2.90	3.97
200	3.06	3.86	5.30
250	3.83	4.83	6.62
300	4.60	5.79	7.94
320	4.90	6.18	8.47
350	5.36	6.76	9.27
400	6.13	7.72	10.59
450	6.89	8.69	11.91
500	7.66	9.65	13.24
550	8.43	10.62	14.56
600	9.19	11.58	15.89
650	9.96	12.55	17.21
700	10.73	13.51	18.53
725	11.11	13.99	19.19
750	11.49	14.48	19.86

Assumes 95% usable volume and 70% round-trip efficiency.

Synergistic Benefit – Fly Ash Usage

- Replace 30-50% of cement
- Encapsulation of fly ash
- 650-1,100mt/sphere
- Desirable properties for concrete



*Kingston Fly Ash Retention Pond Failure,
~9.3 million tonnes coal fly ash released
into Emory River, Tennessee, 22 Dec 2008
Current clean-up estimate \$850+M*

Synergistic Benefit – Artificial Reefs

- Potential benefits to fish stocks
- Preformed attachments?
- Need more information

Conclusion

- Many potential benefits
- Local projects, local economic stimulus