further offshore and into deeper water. Interconnecting electricity transmission from offshore wind to the onshore electricity grid has become a significant challenge because of the intermittency of wind and the large capacities of wind power generation requiring interconnection. One potential solution is long duration electricity storage. Most prior art electricity storage technologies are not suitable for the marine environment. For example, the corrosivity of the marine environment and the ability for lithium burn in water, even without the presence of air or oxygen, has deemed lithium ion batteries unsuitable or undesirable for marine environments. There is a significant need for a low cost, scalable, environmentally friendly, low land or water use, long lasting, high round trip energy efficiency long duration electricity storage technology suitable for the offshore environment.

**[0007]** Additionally, the need for electricity generation and storage technologies to produce electricity reliably, consistently, and long term when needed is becoming increasingly more crucial due to the increasingly common occurrence of extreme and unusual weather due to climate change. Prior art energy storage technologies are unable to provide additional power beyond their nameplate electricity storage capacity, even in the event of an emergency, which has contributed to notable power outages in California and throughout the United States in recent years. For example, if a lithium ion battery or pumped hydro plant is rated at 1,000 MWh, and the 1,000 MWh has been fully used or is fully discharged, the lithium ion battery or pumped hydro plant will be incapable of providing more electricity if more electricity is needed.

**[0008]** There is a significant need for an electricity storage technology capable of functioning as both a high round trip efficiency (>70%) short, or medium, or long duration electricity storage system and, when needed, a multi-day, or multi-week, or multi-month electricity storage system. There is a significant need for an electricity storage technology capable of functioning as both a high round trip efficiency (>70%) 8+ hour duration electricity storage system and, when needed, a multi-day, or multi-week, or multi-month electricity storage system. There is a significant need for an electricity storage technology capable of functioning as both a high round trip efficiency (>70%) 8+ hour duration electricity storage system and, when needed, a multi-day, or multi-week, or multi-month source of power or electricity.

## SUMMARY

**[0009]** The present disclosure relates to systems and methods for energy storage, or energy generation, or combinations thereof.

**[0009a]** The present disclosure provides a system for storing and generating power comprising: a first storage reservoir near the surface of a body of water and configured to store a first fluid; a second storage reservoir located below the surface of the body of water and configured to store a

second fluid which has a higher density than the first fluid; a pump; and a generator; wherein the pump, generator, and the first and second reservoir are operatively connected such that power is stored by displacing the second fluid which has a higher density than the first fluid in the second storage reservoir by pumping the first fluid in the first storage reservoir to the second storage reservoir and power is generated or discharged by allowing the first fluid in the second storage reservoir to return to the first storage reservoir; and wherein the first fluid is a liquid.

**[0010]** Some embodiments may be applicable to, for example, an energy storage device. Some embodiments may involve a storage region beneath the surface of a water or liquid body and a

**What is claimed is:**

1. A system for storing and generating power comprising:

a first storage reservoir near the surface of a body of water and configured to store a first fluid;

a second storage reservoir located below the surface of the body of water and configured to store a second fluid which has a higher density than the first fluid;

a pump; and

a generator;

wherein the pump, generator, and the first and second reservoir are operatively connected such that power is stored by displacing the second fluid which has a higher density than the first fluid in the second storage reservoir by pumping the first fluid in the first storage reservoir to the second storage reservoir and power is generated or discharged by allowing the first fluid in the second storage reservoir to return to the first storage reservoir; and

wherein the first fluid is a liquid.

2. The system of claim 1 wherein said first fluid comprises a hydrocarbon.

3. The system of claim 1 wherein the density of said second fluid is greater than 1.02 kilograms per liter at 20° C.

4. The system of claim 1 wherein said first fluid comprises water.

5. The system of claim 1 wherein the pressure inside the second reservoir and the pressure of the adjacent body of water differ by from 0 bar to 10 bar.

6. The system of claim 1 further comprising a pressure exchanger.

7. The system of claim 6 wherein said pressure exchanger is located near the second reservoir.

8. The system of claim 6 wherein during storing of power, the pressure exchanger extracts pressure from the first fluid and transfers the extracted pressure to the second fluid.

9. The system of claim 8 wherein said pressure extraction occurs (1) while the first fluid is being transferred to the second reservoir or (2) prior to transfer or (3) both (1) and (2).

10. The system of claim 8 wherein the pressure exchanger extracts pressure less than or equal to the pressure of the first fluid near the second reservoir minus the hydrostatic pressure of the body of water at the elevation of the second reservoir.

11. The system of claim 6 wherein during generating of power, the pressure exchanger extracts pressure from the second fluid and transfers the extracted pressure to the first fluid.

12. The system of claim 11 wherein said pressure extraction occurs (1) while the second fluid is being transferred to the second reservoir or (2) prior to transfer or (3) both (1) and (2).

13. The system of claim 11 wherein the pressure exchanger extracts pressure less than or equal to the pressure of the second fluid near the second reservoir minus the hydrostatic pressure of the body of water at the elevation of the second reservoir.

14. The system of claim 6 wherein the pressure exchanger enables the use of the second fluid while enabling the second reservoir to be at pressure equilibrium with the body of water at the same elevation as the second reservoir.

15. The system of claim 6 wherein the pressure exchanger comprises a hydraulic pressure exchanger.

16. The system of claim 6 wherein the pressure exchanger adjusts pressure extraction to ensure the pressure of fluid inside the second reservoir differs from the hydrostatic pressure of the body of water at the same elevation as the second reservoir by less than a tolerance pressure.

17. The system of claim 16 wherein the second reservoir contains an internal pressure sensor and an external pressure sensor;

wherein the internal pressure sensor measures the pressure of fluids inside the second reservoir; and

wherein the external pressure sensor measures the pressure of the body of water adjacent to the second reservoir; and

wherein the internal pressure sensor and the external pressure sensor are configured to communicate with the pressure exchanger.

18. The system of claim 16 wherein said tolerance pressure is less than 10 atm.

19. The system of claim 16 wherein said tolerance pressure is less than 200 atmospheres.

20. The system of claim 6 wherein the pressure exchanger is a pump, or turbine, or rotary turbine, or any combination thereof.