Integrated Pumped Hydro Reverse Osmosis Systems (IPHROS)

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May 8, 2018

Renewable energy and water

- Renewable energy systems are often intermittent and require storage
  - Pumped Hydro systems are very robust, economical, mature, and efficient
  - Operate for tens of thousands of cycles
  - >80% round trip efficiency
  - Optimal hydraulic head: 50-70 atm (500-700m)
- Fresh water generation by reverse osmosis is a very mature and widely used technology
  - Large costly pump systems required
  - Brine outflow system is costly and can harm environment
  - 50-70 atm input pressure, 90% output pressure

Symbiosis between hydro energy and RO desal

- Ideal head height for pumped hydro energy storage/generation systems and reverse osmosis desalination plants coincide (500-700m)
- Many drought stricken coastal regions have nearby mountains of sufficient elevation to support upper reservoirs at this ideal head height
- Combining systems reduces capital investment, such as pump costs, and solves the desalination brine disposal

Yanbaru Plant seawater pumped hydro storage in Okinawa, Japan

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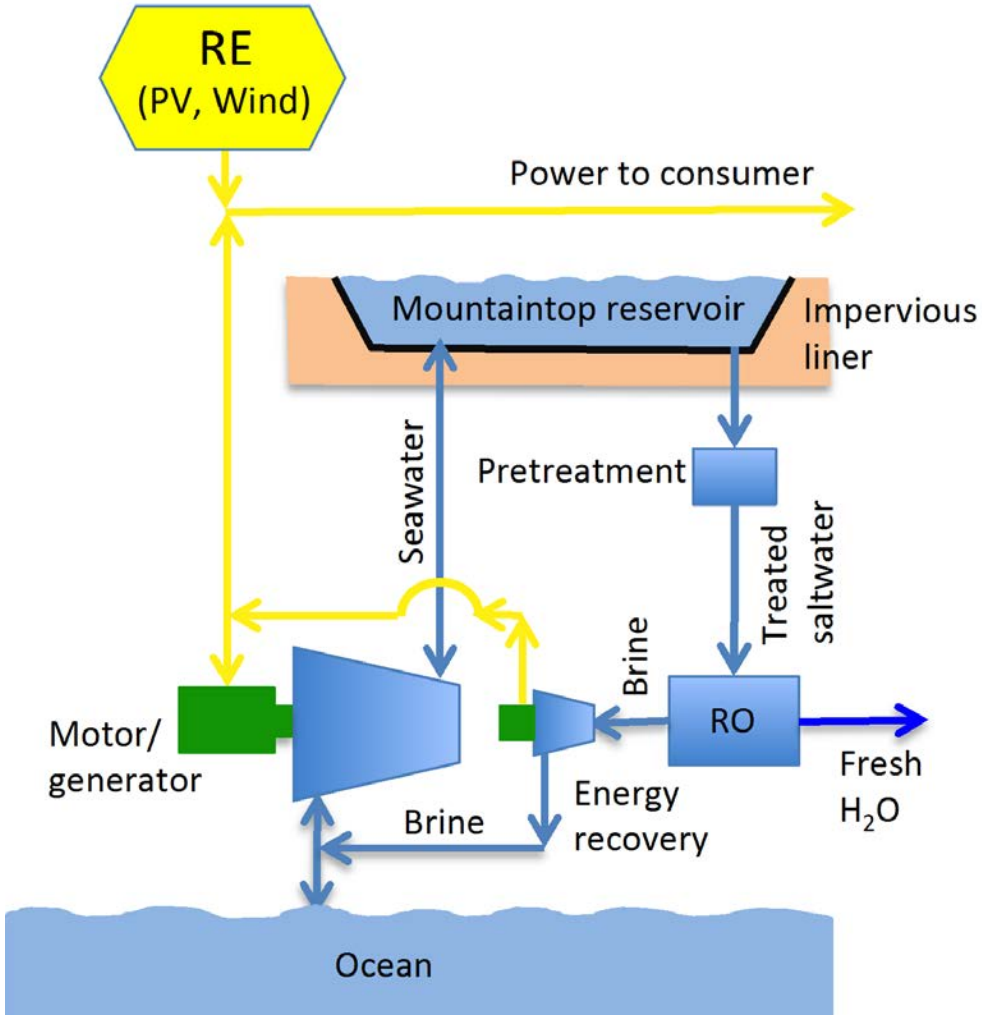

- Intelligent design ☺: Pumped Hydro Head = 500-700 m, = RO desal head
  - https://doi.org/10.1016/j.seta.2016.09.003
- 21m^3 seawater => 50kWh electricity and 500l freshwater
  - Brine out-flow from RO plant is readily diluted by the output from the turbine
- **With wind & solar farms, 1 km^2 lake @600m serves power & freshwater needs for 1 million people!**

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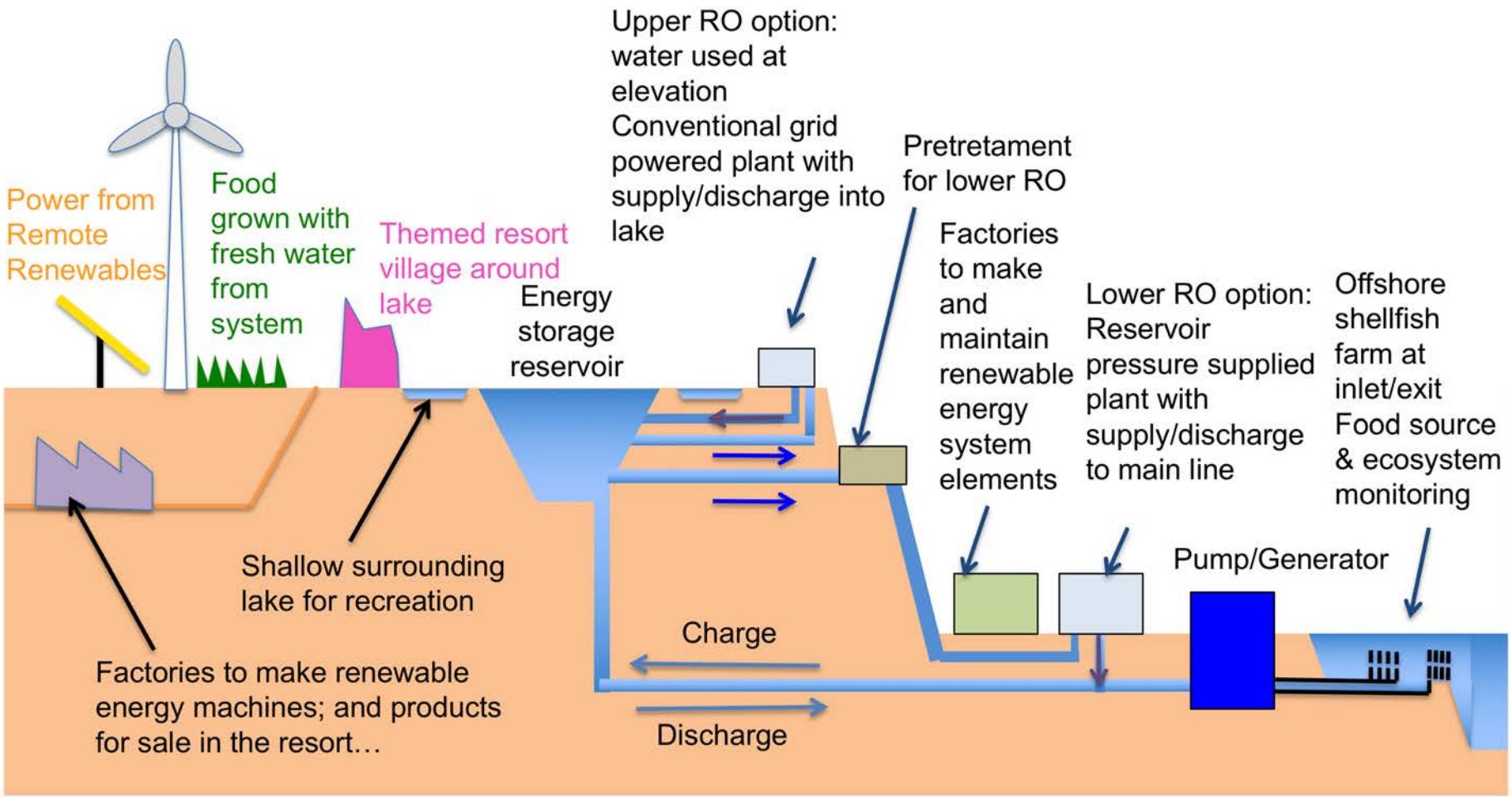
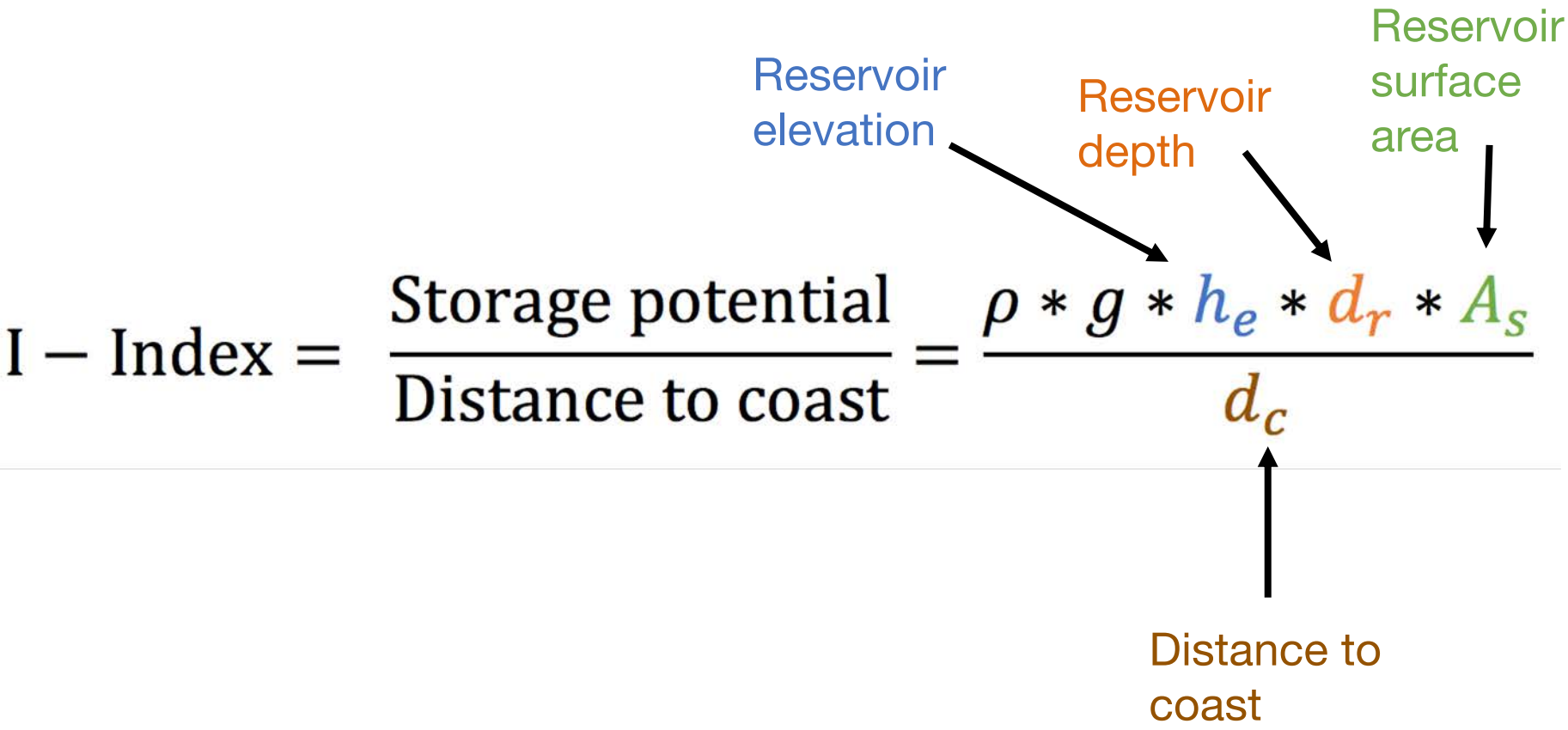
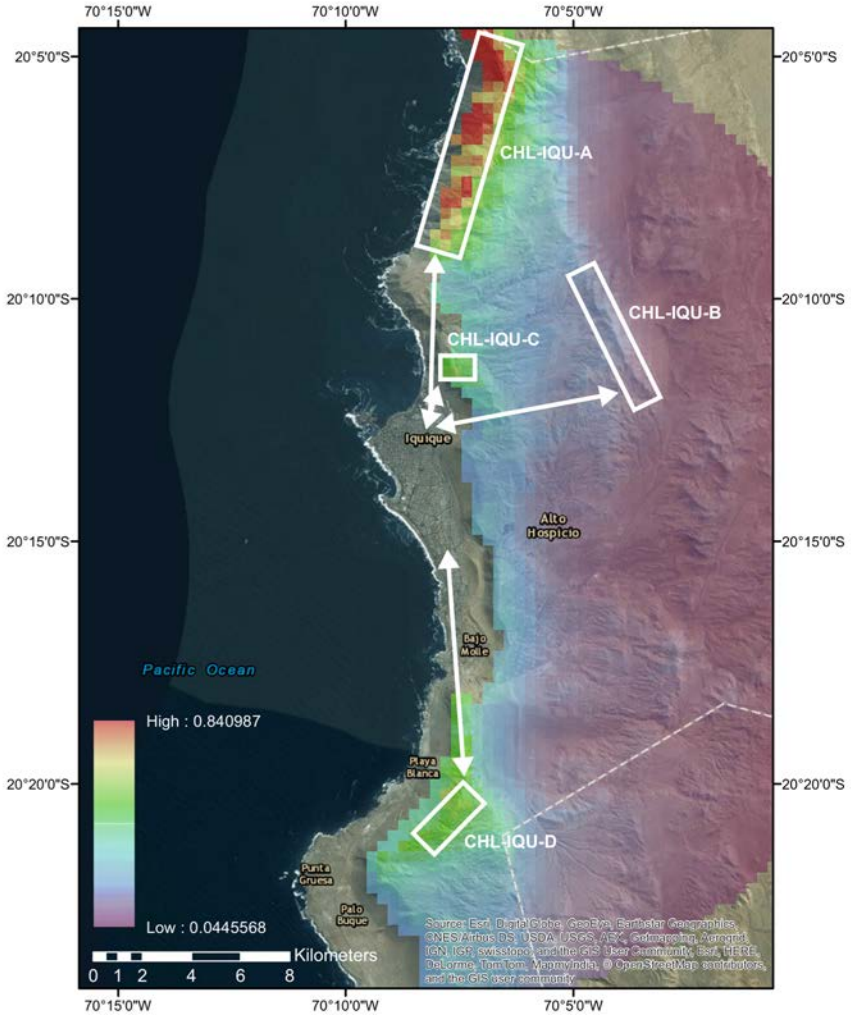


Where in the world would this work?

- Geographic assessment to determine feasibility across globe

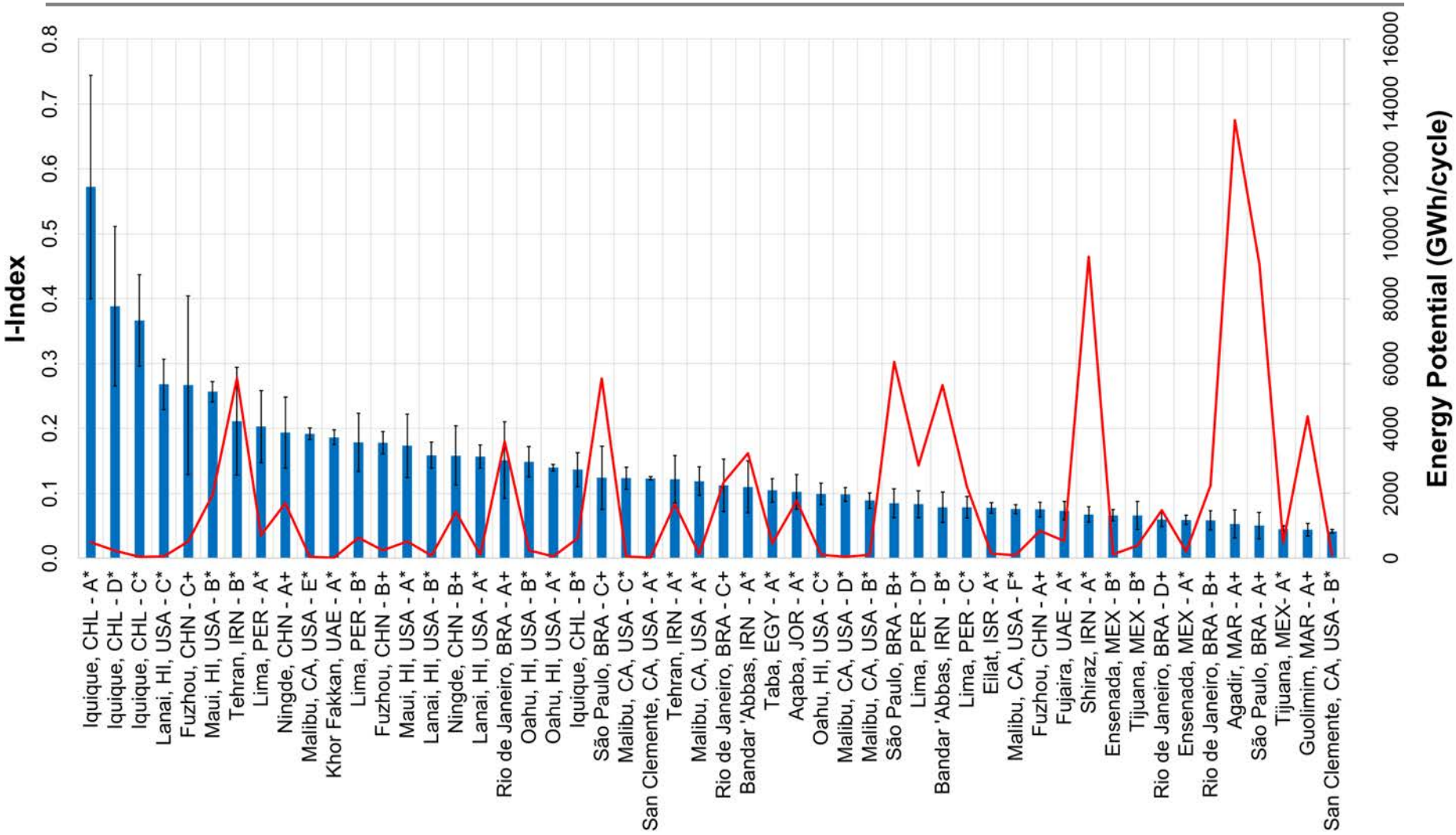


Example: Iquique, Chile



Region	I-Index	Energy potential (GWh)
CHL-IQU-A	0.57	491
CHL-IQU-B	0.14	618
CHL-IQU-C	0.37	46
CHL-IQU-D	0.39	232

Tremendous opportunity!



Thank you

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A. H. Slocum, **M. N. Haji**, A. Z. Trimble M. Ferrera, S. J. Ghaemsaidi, "Integrated Pumped Hydro Reverse Osmosis Systems," *Sustainable Energy Technologies and Assessments*, 18, 2016, 80-99.

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