Supporting Information

Directing the Research Agenda on Water and Energy Technologies with Process and Economic Analysis

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Note S1. Calculation of Extractable Energy.

The energy that can be extracted by mixing river water and seawater is limited by the Gibbs free energy of mixing, ΔG_{mix}, which can be calculated by

$$\Delta G_{mix} = \upsilon RT\left[c_M \ln\left(c_M\right) - \gamma c_B \ln\left(c_B\right) - (1-\gamma) c_D \ln(c_D)\right] \quad \text{(S1)}$$

where υ is the van't Hoff factor ($\upsilon = 2$ for NaCl solutions), γ is the volume ratio of brine solution over the total volume of both brine and dilute solutions, and c_M, c_B, and c_D are concentrations of final mixed solution, brine concentration, and dilute concentration, respectively. Note that ΔG_{mix} is the specific maximum energy that can be extracted normalized by the total volume of brine and dilute solutions.

Table S1. Summary of extractable energy achieved by various technologies

Technology	Extractable Energy (kWh m^{-3})	Reference
PRO	0.125	(Yip and Elimelech, 2014)
	0.153	(Yip and Elimelech, 2014)
RED	0.088	(Yip and Elimelech, 2012)
	0.094	(Yip and Elimelech, 2012)
	0.101	(Yip and Elimelech, 2012)
	0.111	(Yip and Elimelech, 2012)
NPG	0.020	(Wang et al., 2021)
	0.025	(Wang et al., 2022)

Table S2. Summary of power density achieved by various technologies

Technology	Power density (W m^{-2})	Reference
PRO	2.4	(Yip and Elimelech, 2014)
	3.7	(Yip and Elimelech, 2014)
	6.1	(Tiraferri et al., 2011)
	5.5	(Wang et al., 2010)
	15.2	(Song et al., 2013)
	21.3	(Song et al., 2013)
RED	1.16	(Yip and Elimelech, 2014)
	1.75	(Yip and Elimelech, 2014)
	3.45	(Yip and Elimelech, 2014)
	6.32	(Vermaas et al., 2012)
NPG	3.9	(Hwang et al., 2016)
	4.6	(Chen et al., 2020)
	5.1	(Zhang et al., 2020)
	7.7	(Kim et al., 2010)
	22.4	(Li et al., 2021)
	33.2	(Li et al., 2021)
	67	(Liu et al., 2020)

Table S3. Summary of levelized cost of electricity (LCOE) achieved by various technologies

Technology	LCOE ($ kWh^{-1})	Reference
PRO	0.3	(Lee et al., 1981)
	1.0	(Newby et al., 2021)
	1.2	(Makabe et al., 2021)
	2.37	(Newby et al., 2021)
	6.3	(Weiner et al., 2015)
	7.13	(Weiner et al., 2015)
RED	1.14	(Giacalone et al., 2019)
	1.52	(Giacalone et al., 2019)
	1.56	(Giacalone et al., 2019)
	1.89	(Giacalone et al., 2019)
	5.83	(Yip et al., 2016)
	5.88	(Giacalone et al., 2019)
	6.56	(Yip et al., 2016)
	7.85	(Giacalone et al., 2019)
Solar	0.09	(Mudgal et al., 2019)
	0.25	(Benti et al., 2022)
	0.3	(Benti et al., 2022)
	0.4	(Yip et al., 2016)
	0.6	(Musi et al., 2017)
Wind	0.048	(Dao et al., 2019)
	0.050	(Anonymous, n.d.)
	0.057	(Dao et al., 2019)
	0.061	(Dao et al., 2019)
	0.066	(Ashuri et al., 2014)
	0.093	(Dao et al., 2019)
	0.142	(Dao et al., 2019)

Note S2. Calculation of thermodynamic energy efficiency

From literature (Lin, 2020), the Gibbs free energy per volume of product water, Δg_w, can be calculated as

$$\Delta g_w = \pi_0\{\frac{1}{WR}\ln\left[\frac{1-WR(1-SR)}{1-WR}\right] - (1-SR)\ln\left[\frac{1-WR(1-SR)}{(1-SR)(1-WR)}\right]\} \quad \text{(S2)}$$

where π_0 is the osmotic pressure of the feed, WR is the water recovery, and SR is the salt rejection.

With the Δg_w, the thermodynamic energy efficiency, TEE, can be calculated as

$$TEE = \frac{\Delta g_w}{SEC} \quad \text{(S3)}$$

where SEC is the specific energy consumption per volume of product water.

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