## Supplementary Information

## Nanofluidic energy conversion and molecular separation through highly

## stable clay-based membranes

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Figure S1. Steps to prepare reconstructed montmorillonite membrane (RMM) from montmorillonite (MMT) powders.



Figure S2. Scheme of a single-layer MMT nanosheet with a layer of CTAB on both sides of the surface. The dimension of CTA<sup>+</sup> is estimated from Chem3D Pro 10.0.



Figure S3. (a) AFM image of the RMM surface. (b) Height profiles of the RMM surface. Overall, the restacked nanosheets form a smooth surface.



Figure S4. Stress vs. strain curves of the RMM and the neat MMT membrane.



Figure S5. Energy dispersive X-ray spectroscopy mapping of the cross section of an

RMM.



Figure S6. FTIR spectra of the MMT membrane and the RMM.



Figure S7. Hydrophilicity of the MMT membrane (a) and the RMM (b). The contact angle

(CA) increased from 66.5° to 105.1° after modification.



Figure S8. XRD patterns of the dried RMM and the hydrated RMM. Only a very marginal interlayer distance increase was observed upon hydration of the RMM, suggesting a highly stable microstructure.



Figure S9. High stability of the RMMs in both strong acid and base for more than 180 days.



Figure S10. Output power density of the RMMs.

The cations transference number  $(t_+)$  is calculated as, <sup>[1]</sup>

$$2t_{+} - 1 = \frac{E_{diff}}{\frac{RT}{zF}\ln\left(\frac{\gamma_{H}C_{H}}{\gamma_{L}C_{L}}\right)}$$

where R, T, z, F,  $\gamma$ ,  $C_H$ , and  $C_L$  are the ideal gas constant (8.314J K<sup>-1</sup> mol<sup>-1</sup>), temperature, charge valence, Faraday constant (96485.3329 s A mol<sup>-1</sup>), activity coefficient of ions, high and low ion concentrations, respectively. *Ediff* is the diffusion potential across the membrane. The energy conversion efficiency corresponding to the maximum power generation is calculated as,

$$\eta = \frac{(2t_+ - 1)^2}{2}$$

When  $C_L = 1$  mM and  $C_H = 10$  mM, the measured diffusion potential is about 51.1 mV, corresponding to a  $t_+$  of 0.92 and  $\eta = 35.3\%$ . The difference in electrode potential has already been subtracted.



Figure S11. Water permeance of the RMM as a function of thickness.



Figure S12. Permeance and thickness comparison of the RMM with other separation

membranes reported in the literature.<sup>[2-7]</sup>

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