Electronic Supplementary Information

Narrow Bandgap Semiconductor Decorated Wood Membrane for High-Efficiency Solar-Assisted Water Purification

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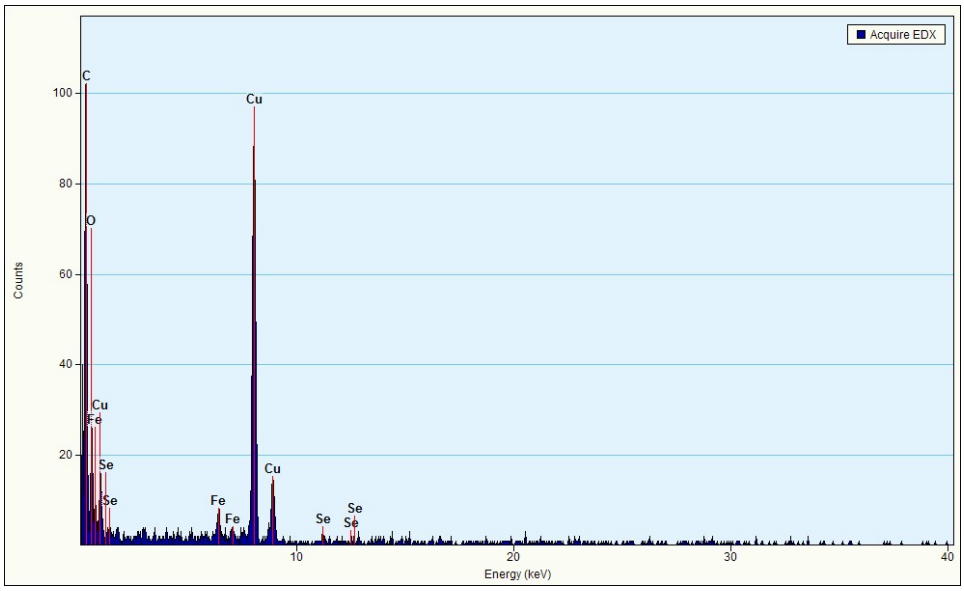

Figure S1. Energy dispersive X-ray spectroscopic (EDX) analysis of $CuFeSe_2$ NPs. The result shows that the presence of the three elements in the $CuFeSe_2$ NPs.

Table S1 Composition of NPs calculated from Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES).

Element	percentage
Cu	1
Fe	0.95
Se	1.98

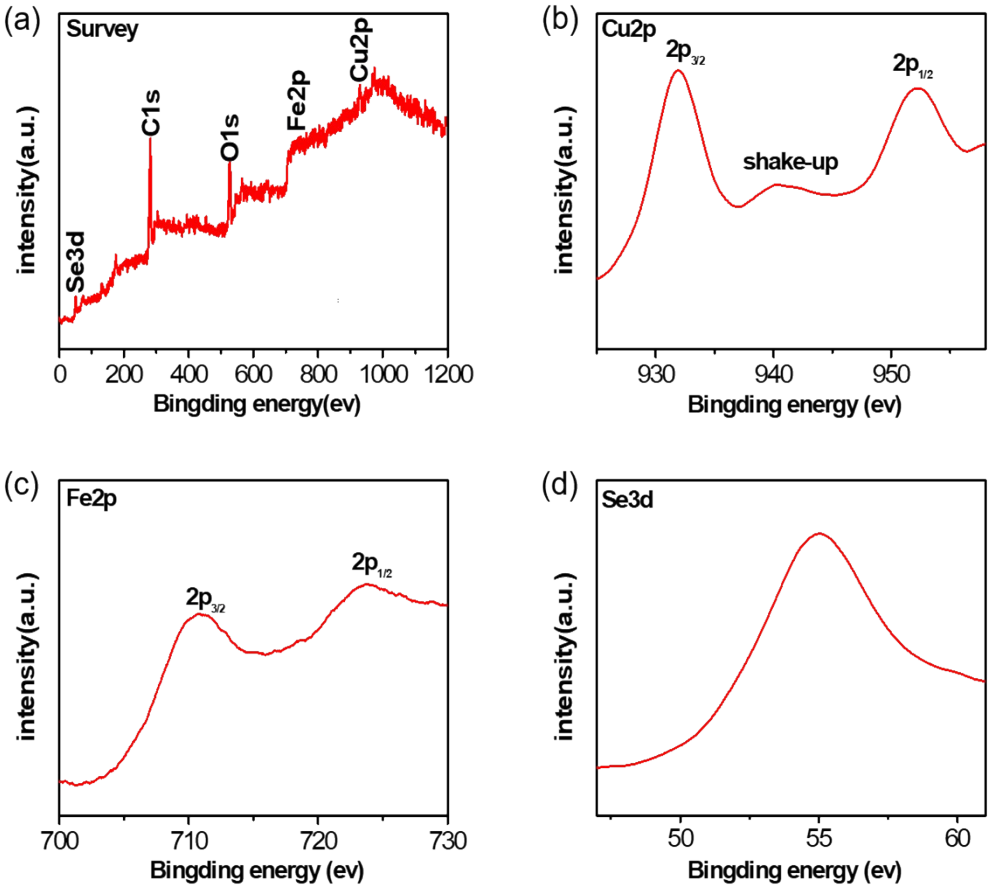

Figure S2. (a) Survey XPS scan for $CuFeSe_2$ NPs. (b) Cu $2p_{3/2}$ and $2p_{1/2}$ peaks are observed at 932.0 and 952.3 eV. (c) Fe $2p_{3/2}$ and $2p_{1/2}$ peaks are observed at 710.9 and 723.8 eV. (d) Se 3d peak is observed at 55.0 eV.

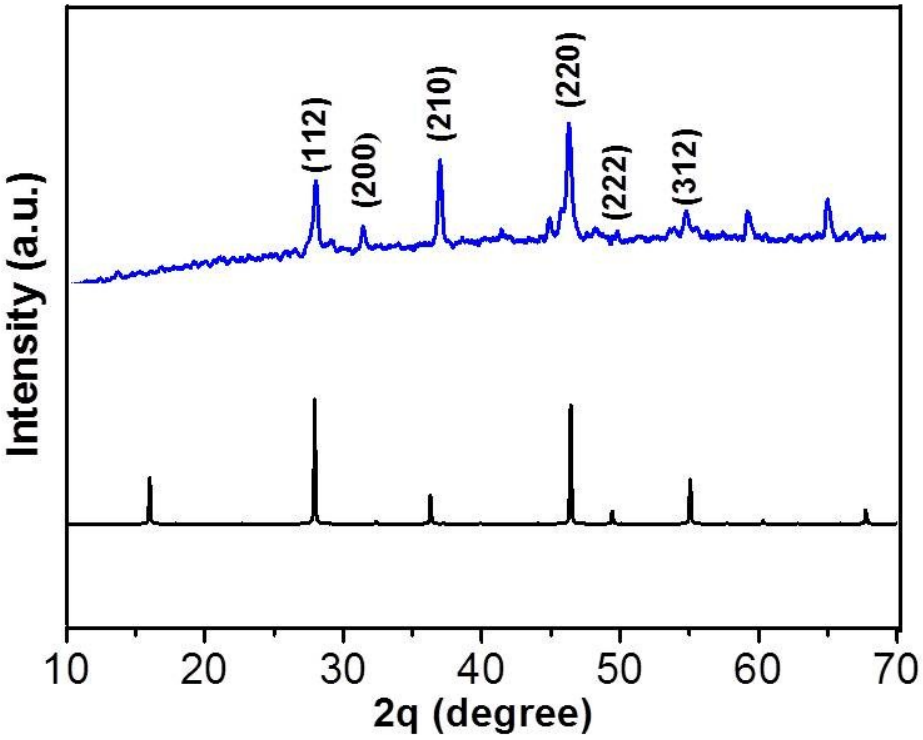

Figure S3. XRD pattern of synthesized $CuFeSe_2$ NPs and the standard data of tetragonal phase $CuFeSe_2$ in eskebornite form (JCPDS No. 81-1959)

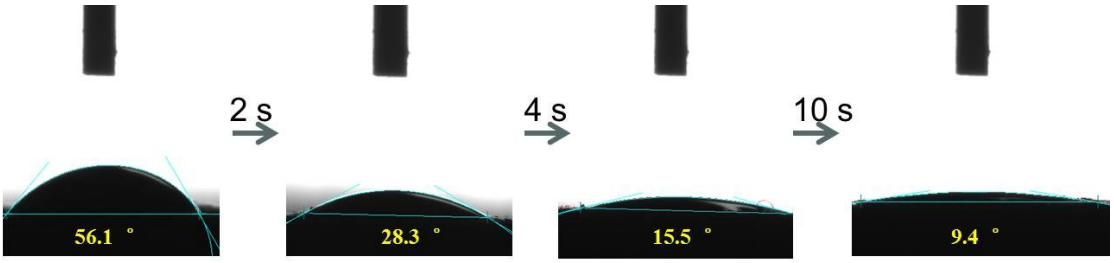

Figure S4. $CuFeSe_2$ NP-decorated wood membrane is highly hydrophilic.

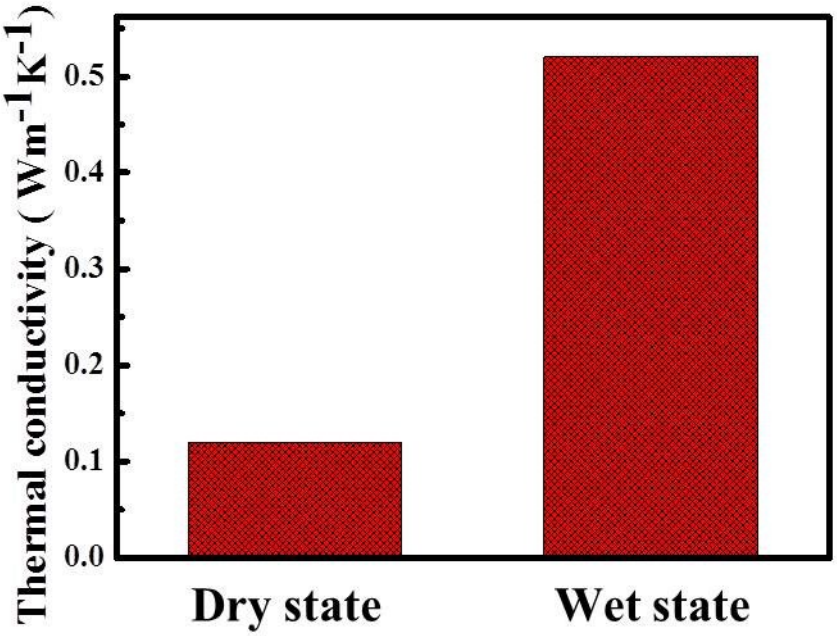

Figure S5. The thermal conductivity of $CuFeSe_2$ NP-decorated wood membrane under dry and wet states.

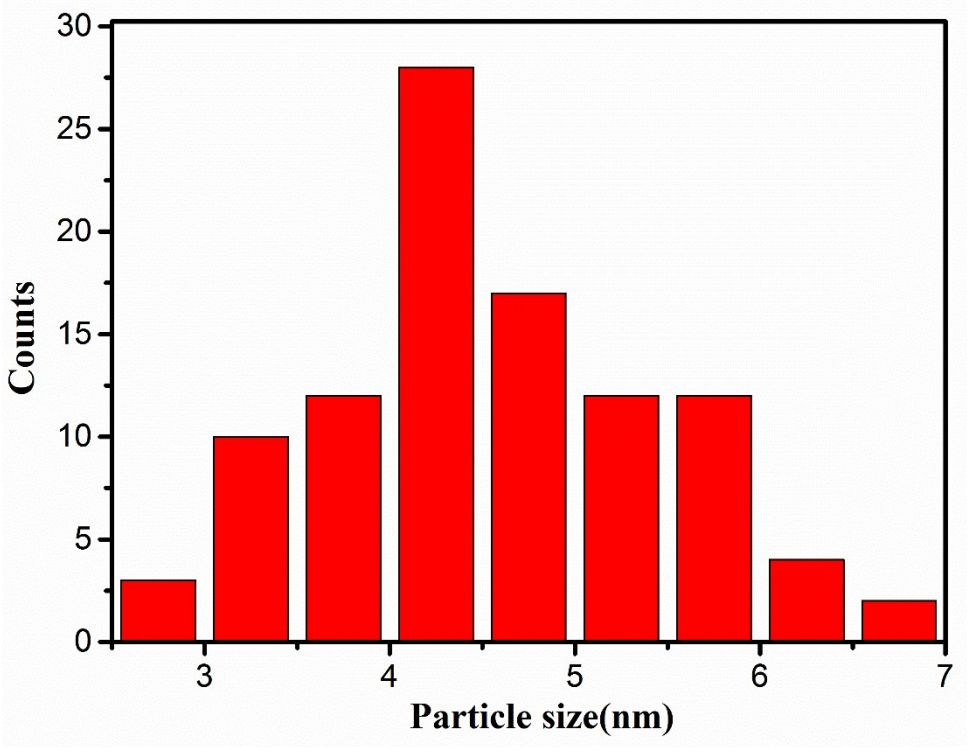

Figure S6. The size distribution of $CuFeSe_2$ NPs.

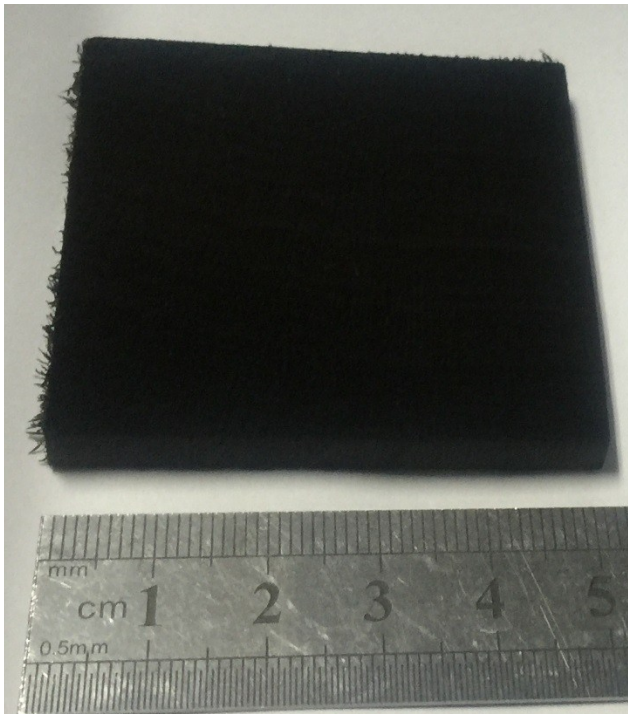

Figure S7. A piece of basswood was cut with the dimension of 5.0 × 5.0 × 0.5 cm^3, which was soaked in the chloroform solution of $CuFeSe_2$ NPs by vacuum assistance. The color of the wood changes from yellow to black.

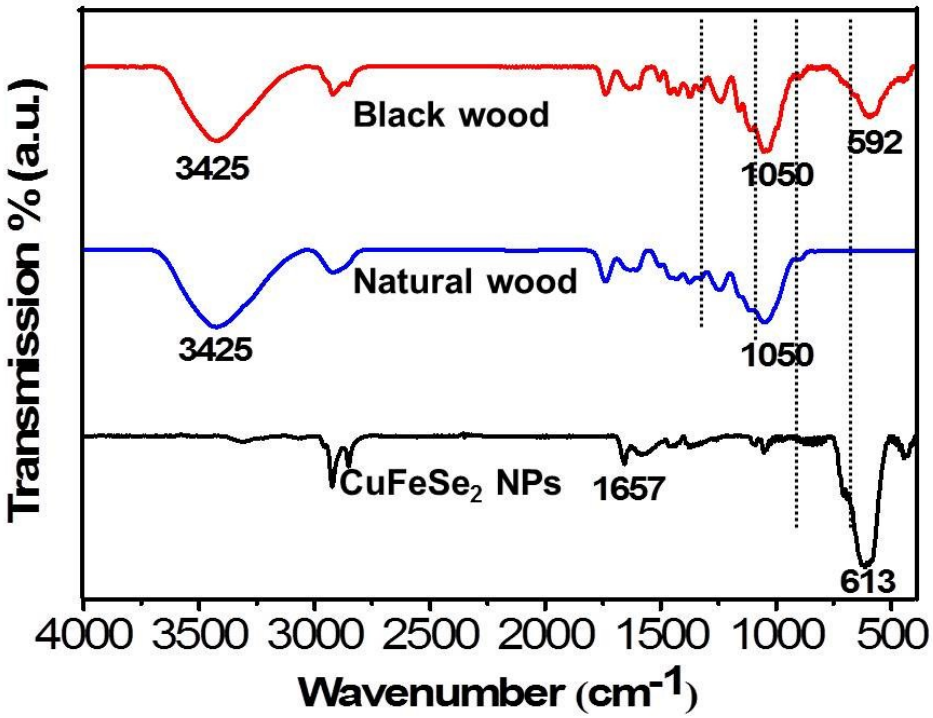

Figure S8. FT-IR spectra of $CuFeSe_2$ NPs, natural wood, and black wood membrane. The stretching band of $CuFeSe_2$ NPs at 613 cm^{-1} moved to 592 cm^{-1} which demonstrate the Fe-O formation between $CuFeSe_2$ and the hydroxyl groups of cellulose in wood.

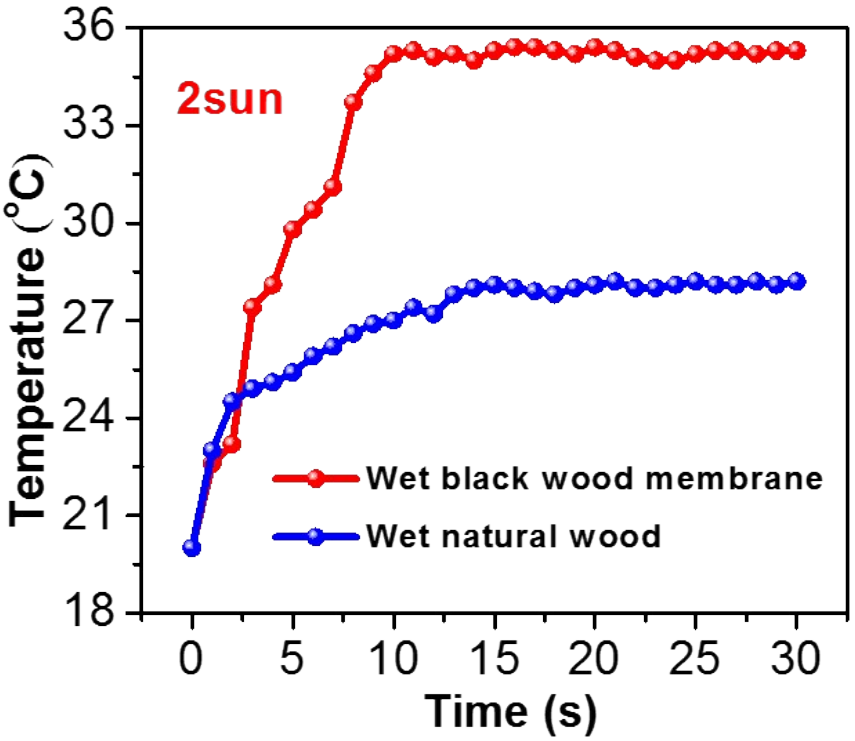

Figure S9. The surface temperature increasing process of the natural black wood membrane under solar illumination of 2 kW·m^{-2}.

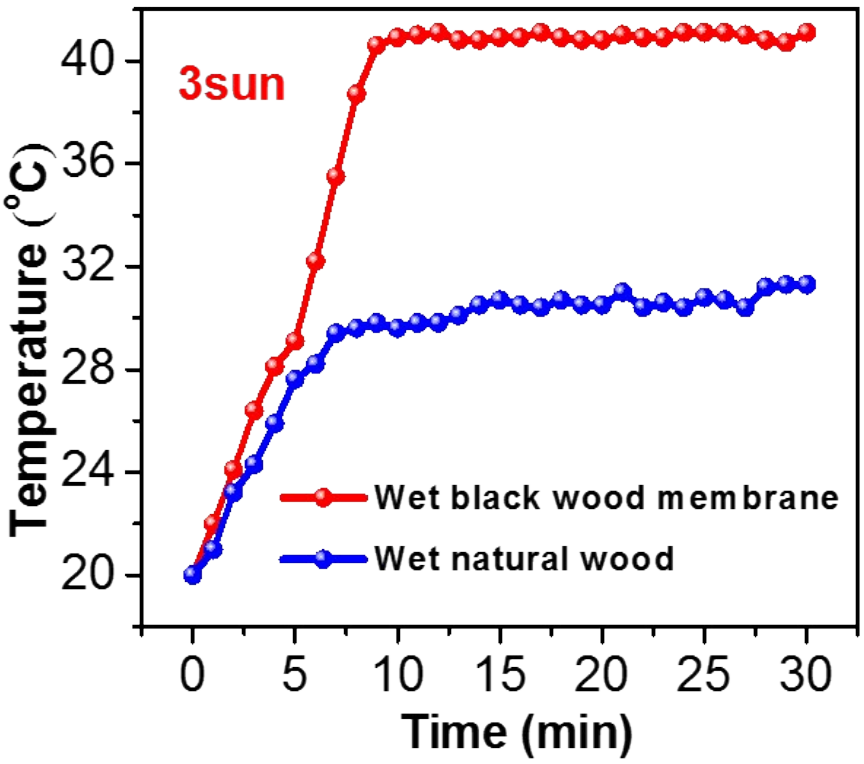

Figure S10. The surface temperature increasing process of natural and black wood membrane under solar illumination of 3 kW·m^{-2}.

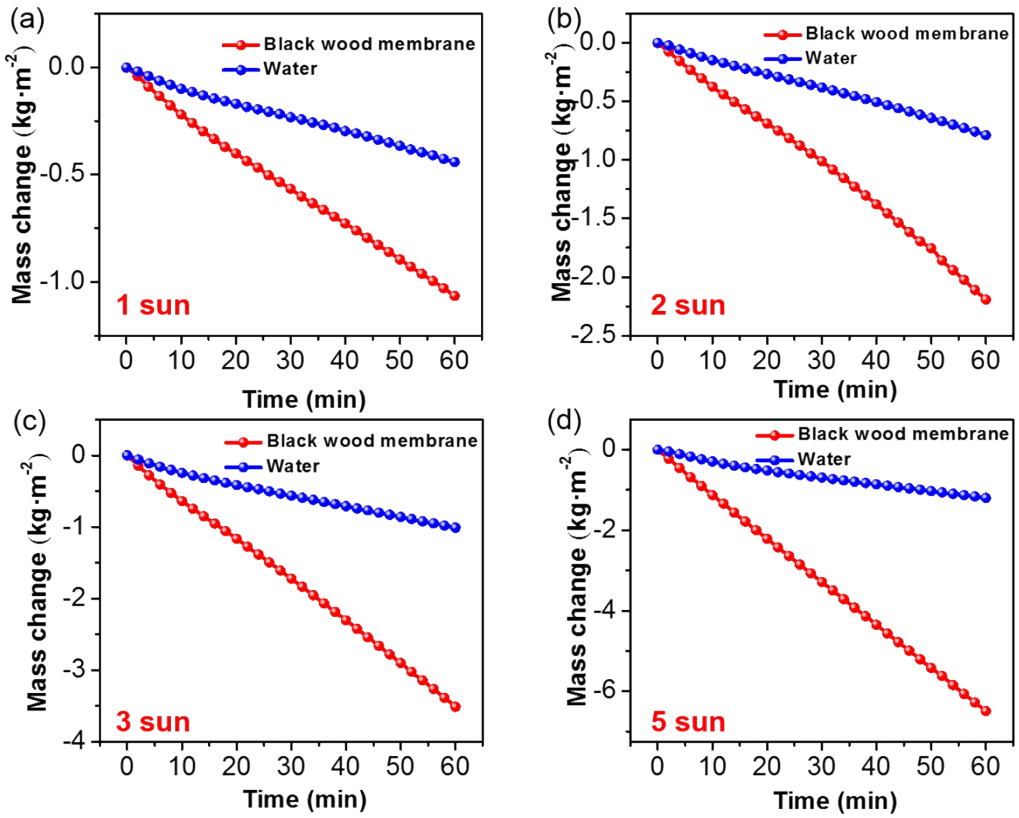

Figure S11. Mass change through water evaporation for black wood membrane and bare water only under different solar illuminations.

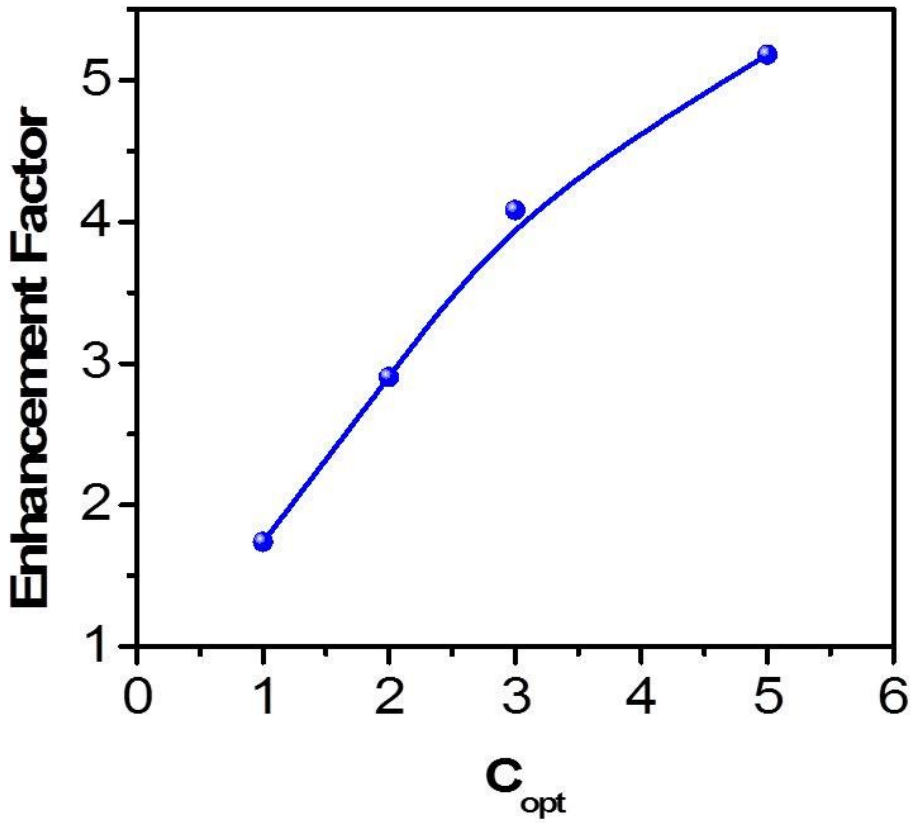

Figure S12. The enhancement factor (E.F.) of the black wood membrane. As the light intensity increases, the black wood membrane exhibits enhanced solar steam generation. E.F. refers to the evaporation rate ratio of bare water under different illumination intensities.

Energy balance analysis:

According to previous report of J. Zhu's group [1], the main energy consumption under input heat flux of 1 kW·m^{-2} could be caused by the approach as follows:

(1) Water evaporation consumption ($\boldsymbol{\eta}$):

The water evaporation consumption is 66.7%, which is equal to the evaporation efficiency.

(2) Refection loss ($\boldsymbol{\eta_{ref}}$):

The solar absorption of black wood membrane is up to 99%. Thus, η_{ref} is about 1%.

(3) Conduction loss ($\boldsymbol{\eta_{cond}}$):

The energy consumption caused by the conductive heat flux from wood to water. On the basis of Prof. Zhu's calculation method, the $\boldsymbol{\eta_{cond}}$ of black wood membrane is 25.6%, which is a major part of the energy loss.

(4) Radiation loss ($\boldsymbol{\eta_{rad}}$):

The Radiation loss is caused by the radiation heat from the black wood membrane to the environment. The $\boldsymbol{\eta_{rad}}$ is 4.87%, which is calculated refer to previous report.

(5) Convection loss ($\boldsymbol{\eta_{conv}}$):

The heat is transferred from the black wood membrane to the environment. The $\boldsymbol{\eta_{conv}}$ is 1.2%, which is calculated by Newton's law of cooling[2].

In summary, the total energy consumption of the five main parts is about 99.4% (66.7% + 1% + 25.6% + 4.87% + 1.2%≈99.4%), which is almost all input energy.

Table S2: Comparison of the concentration of Cu, Fe, Se elements in the desalinated water and the World Health Organization (WHO) standards.

Element	Concentration (mg/L)	WHO standards (mg/L)
Cu	0.02	2.0
Fe	0.02	null
Se	0.005	0.01

Supplementary Reference

1 N. Xu, X. Hu, W. Xu, X. Li, L. Zhou, S. Zhu and J. Zhu, *Adv. Mater.*, 2017, **29**, 1606762.

2 H. Ghasemi, G. Ni, A. M. Marconnet, J. Loomis, S. Yerci, N. Miljkovic, G. Chen, *Nat. Commun.* 2014, **5**, 4449.