Supplementary Materials

Thermodynamics Analysis of a Membrane Distillation Crystallization Ion Recovery System for Hydroponic Greenhouses Assisted with Renewable Energy

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Table S1. Balance mass and energy equations of each system.

Unit Name	Mass Balance Equation (MBE)	Energy Balance Equation (EBE)
Steam Rankine Cycle (SRC)		
Pump 1 (P1)	$\dot{m}_1 = \dot{m}_2$	$\dot{m}_1 h_1 + \dot{W}_{P1} = \dot{m}_2 h_2$
O-Feed Water Heater (OFWH)	$\dot{m}_{12} + \dot{m}_2 = \dot{m}_3$	$\dot{m}_{12} h_{12} + \dot{m}_2 h_2 = \dot{m}_3 h_3$
Pump 2 (P2)	$\dot{m}_3 = \dot{m}_4$	$\dot{m}_3 h_3 + \dot{W}_{P2} = \dot{m}_4 h_4$
C-Feed Water Heater (CFWH)	$\dot{m}_{14} + \dot{m}_4 = \dot{m}_6 + \dot{m}_5$	$\dot{m}_{14} h_{14} + \dot{m}_4 h_4 = \dot{m}_6 h_6 + \dot{m}_5 h_5$
Pump 3 (P3)	$\dot{m}_6 = \dot{m}_7$	$\dot{m}_6 h_6 + \dot{W}_{P3} = \dot{m}_7 h_7$
Mixing Chamber 1 (MC1)	$\dot{m}_7 + \dot{m}_5 = \dot{m}_8$	$\dot{m}_7 h_7 + \dot{m}_5 h_5 = \dot{m}_8 h_8$
Boiler (Br)	$\dot{m}_8 = \dot{m}_9$	$\dot{m}_8 h_8 + \dot{Q}_{PTC} = \dot{m}_9 h_9$
High-P Turbine (HPT)	$\dot{m}_9 = \dot{m}_{10}$	$\dot{m}_9 h_9 = \dot{W}_{HPT} + \dot{m}_{10} h_{10}$
Reheating (RH)	$(\dot{m}_{10} - \dot{m}_{14}) = \dot{m}_{11}$	$(\dot{m}_{10} h_{10} - \dot{m}_{14} h_{14}) + \dot{Q}_{PTC} = \dot{m}_{11} h_{11}$
Low-P Turbine (LPT)	$\dot{m}_{11} = \dot{m}_{12} + \dot{m}_{13}$	$\dot{m}_{11} h_{11} = \dot{W}_{LPT} + \dot{m}_{12} h_{12} + \dot{m}_{13} h_{13}$
Condenser 1 (Cond1)	$\dot{m}_{13} = \dot{m}_1$	$\dot{m}_{13} h_{13} = \dot{m}_1 h_1 + \dot{Q}_{Cond1}$
Dual Evaporator Vapor Compression Refrigeration System (DEVCR)		
Compressor (Comp)	$\dot{m}_{17} = \dot{m}_{18}$	$\dot{m}_{17} h_{17} + \dot{W}_{Comp} = \dot{m}_{18} h_{18}$
Condenser 2 (Cond2)	$\dot{m}_{18} = \dot{m}_{19}$	$\dot{m}_{18} h_{18} = \dot{m}_{19} h_9 + \dot{Q}_{Cond2}$
Expansion Valve 1 (ExpV1)	$\dot{m}_{19_{V_1}} = \dot{m}_{20}$	$\dot{m}_{19_{V_1}} h_{19_{V_1}} = \dot{m}_{20} h_{20}$
Expansion Valve 2 (ExpV2)	$\dot{m}_{19_{V_2}} = \dot{m}_{22}$	$\dot{m}_{19_{V_2}} h_{19_{V_2}} = \dot{m}_{22} h_{22}$
Expansion Valve 3 (ExpV3)	$\dot{m}_{21} = \dot{m}_{43}$	$\dot{m}_{21} h_{21} = \dot{m}_{43} h_{43}$
Evaporator 1 (Evap1)	$\dot{m}_{20} = \dot{m}_{21}$	$\dot{m}_{20} h_{20} + \dot{Q}_{Evap1} = \dot{m}_{21} h_{21}$
Evaporator 2 (Evap2)	$\dot{m}_{22} = \dot{m}_{23}$	$\dot{m}_{22} h_{22} + \dot{Q}_{Evap2} = \dot{m}_{23} h_{23}$
Mixing Chamber 2 (MC2)	$\dot{m}_{23} + \dot{m}_{43} = \dot{m}_{17}$	$\dot{m}_{23} h_{23} + \dot{m}_{43} h_{43} = \dot{m}_{17} h_{17}$
Direct Contact Membrane Distillation Crystallization System (DCMDC)		
Pump 4 (P4)	$\dot{m}_{24} = \dot{m}_{25}$	$\dot{m}_{24} h_{24} + \dot{W}_{P4} = \dot{m}_{25} h_{25}$
Heater (HT)	$\dot{m}_{25} = \dot{m}_{26}$	$\dot{m}_{25} h_{25} + \dot{Q}_{Cond2} = \dot{m}_{26} h_{26}$
(PVF) Membrane Module	$\dot{m}_{26} + \dot{m}_{31} = \dot{m}_{27} + \dot{m}_{32}$	$\dot{m}_{26} h_{26} + \dot{m}_{31} h_{31} = \dot{m}_{27} h_{27} + \dot{m}_{32} h_{32}$
Cooler (CO)	$\dot{m}_{27} = \dot{m}_{28}$	$\dot{m}_{27} h_{27} = \dot{m}_{28} h_{28} + \dot{Q}_{Evap2_{CO}}$
Freshwater Tank (FWT)	$\dot{m}_{28} + \dot{m}_{38} = \dot{m}_{29} + \dot{m}_{39}$	$\dot{m}_{28} h_{28} + \dot{m}_{38} h_{38} = \dot{m}_{29} h_{29} + \dot{m}_{39} h_{39}$
Pump 5 (P5)	$\dot{m}_{29} = \dot{m}_{30}$	$\dot{m}_{29} h_{29} + \dot{W}_{P5} = \dot{m}_{30} h_{30}$
Crystallizer (CR)	$\dot{m}_{32} = \dot{m}_{33} + \dot{m}_{35}$	$\dot{m}_{32} h_{32} = \dot{m}_{33} h_{33} + \dot{m}_{35} h_{35} + \dot{Q}_{Evap2_{CR}}$
Hydroponic Solution (HSP)	$\dot{m}_{33} + \dot{m}_{39} = \dot{m}_{34}$	$\dot{m}_{33} h_{33} + \dot{m}_{39} h_{39} = \dot{m}_{34} h_{34}$
Chlor-Alkali System (CAS)		
Chlor-Alkali Reactor (CAR)	$\dot{m}_{35} = \dot{m}_{36} + \dot{m}_{40} + \dot{m}_{41}$	$\dot{m}_{35} h_{35} + \dot{W}_{CAR} = \dot{m}_{36} h_{36} + \dot{m}_{40} h_{40} + \dot{m}_{41} h_{41}$
H_2 Short Storage Tank (HST)	$\dot{m}_{40} = \dot{m}_{37} + \dot{m}_{HST,loss}$	$\dot{m}_{40} h_{40} = \dot{m}_{37} h_{37} + \dot{m}_{HST,loss} h_{HST,loss}$
Proton Exchange Membrane Fuel Cell (PEMFC)		
PEMFC	$\dot{m}_{37} + \dot{m}_{42} = \dot{m}_{38}$	$\dot{m}_{37} h_{37} + \dot{m}_{42} h_{42} = \dot{m}_{38} h_{38} + \dot{W}_{PEMFC} + \dot{Q}_{loss,PEMFC}$

Table S2. Balance entropy and exergy balance equations for each system.

Unit Name	**Entropy Balance Equation (EnBE)**	**Exergy Balance Equation (ExBE)**
Steam Rankine Cycle (SRC)		
(P1)	$\dot{m}_1 s_1 + \dot{S}_{gen,P1} = \dot{m}_2 s_2$	$\dot{m}_1 ex_1 + \dot{W}_{P1} = \dot{m}_2 ex_2 + \dot{E}x_{d,P1}$
(OFWH)	$\dot{m}_{12} s_{12} + \dot{m}_2 s_2 + \dot{S}_{gen,OFWH} = \dot{m}_3 s_3$	$\dot{m}_{12} ex_{12} + \dot{m}_2 ex_2 = \dot{m}_3 ex_3 + \dot{E}x_{d,OFWH}$
(P2)	$\dot{m}_3 s_3 + \dot{S}_{gen,P2} = \dot{m}_4 s_4$	$\dot{m}_3 ex_3 + \dot{W}_{P2} = \dot{m}_4 ex_4 + \dot{E}x_{d,P2}$
(CFWH)	$\dot{m}_{14} s_{14} + \dot{m}_4 s_4 + \dot{S}_{gen,CFWH} = \dot{m}_6 s_6 + \dot{m}_5 s_5$	$\dot{m}_{14} ex_{14} + \dot{m}_4 ex_4 = \dot{m}_6 ex_6 + \dot{m}_5 ex_5 + \dot{E}x_{d,CFWH}$
(P3)	$\dot{m}_6 s_6 + \dot{S}_{gen,P3} = \dot{m}_7 s_7$	$\dot{m}_6 ex_6 + \dot{W}_{P3} = \dot{m}_7 ex_7 + \dot{E}x_{d,P3}$
(MC1)	$\dot{m}_7 s_7 + \dot{m}_5 s_5 + \dot{S}_{gen,MC1} = \dot{m}_8 s_8$	$\dot{m}_7 ex_7 + \dot{m}_5 ex_5 = \dot{m}_8 ex_8 + \dot{E}x_{d,MC1}$
(Br)	$\dot{m}_8 s_8 + \dot{S}_{gen,Br} + \frac{\dot{Q}_{PTC}}{T_9} = \dot{m}_9 s_9$	$\dot{m}_8 ex_8 + \dot{Q}_{PTC}\left(1 - \frac{T_0}{T_9}\right) = \dot{m}_9 ex_9 + \dot{E}x_{d,Br}$
(HPT)	$\dot{m}_9 s_9 + \dot{S}_{gen,HPT} = \dot{m}_{10} s_{10}$	$\dot{m}_9 ex_9 = \dot{W}_{HPT} + \dot{m}_{10} ex_{10} + \dot{E}x_{d,HPT}$
(RH)	$(\dot{m}_{10} s_{10} - \dot{m}_{14} s_{14}) + \dot{S}_{gen,RH} + \frac{\dot{Q}_{PTC}}{T_{11}} = \dot{m}_{11} s_{11}$	$(\dot{m}_{10} ex_{10} - \dot{m}_{14} ex_{14}) + \dot{Q}_{PTC}\left(1 - \frac{T_0}{T_{11}}\right) = \dot{m}_{11} ex_{11} + \dot{E}x_{d,RH}$
(LPT)	$\dot{m}_{11} s_{11} + \dot{S}_{gen,LPT} = \dot{m}_{12} s_{12} + \dot{m}_{13} s_{13}$	$\dot{m}_{11} ex_{11} = \dot{W}_{LPT} + \dot{m}_{12} ex_{12} + \dot{m}_{13} ex_{13} + \dot{E}x_{d,LPT}$
(Cond1)	$\dot{m}_{13} s_{13} + \dot{S}_{gen,Cond1} = \dot{m}_1 s_1 + \frac{\dot{Q}_{Cond1}}{T_{space}}$	$\dot{m}_{13} ex_{13} = \dot{m}_1 ex_1 + \dot{Q}_{Cond1}\left(1 - \frac{T_0}{T_{space}}\right) + \dot{E}x_{d,Cond1}$
Dual Evaporator Vapor Compression Refrigeration System (DEVCR)		
(Comp)	$\dot{m}_{17} s_{17} + \dot{S}_{gen,Comp} = \dot{m}_{18} s_{18}$	$\dot{m}_{17} ex_{17} + \dot{W}_{Comp} = \dot{m}_{18} ex_{18} + \dot{E}x_{d,Comp}$
(Cond2)	$\dot{m}_{18} s_{18} + \dot{S}_{gen,Cond2} = \dot{m}_{19} s_{19} + \frac{\dot{Q}_{Cond2}}{T_{space}}$	$\dot{m}_{18} ex_{18} = \dot{m}_{19} ex_9 + \dot{Q}_{Cond2}\left(1 - \frac{T_0}{T_{space}}\right) + \dot{E}x_{d,Cond2}$
(ExpV1)	$\dot{m}_{19_{V_1}} s_{19_{V_1}} + \dot{S}_{gen,ExpV1} = \dot{m}_{20} s_{20}$	$\dot{m}_{19_{V_1}} ex_{19_{V_1}} = \dot{m}_{20} ex_{20} + \dot{E}x_{d,ExpV1}$
(ExpV2)	$\dot{m}_{19_{V_2}} s_{19_{V_2}} + \dot{S}_{gen,ExpV2} = \dot{m}_{22} s_{22}$	$\dot{m}_{19_{V_2}} ex_{19_{V_2}} = \dot{m}_{22} ex_{22} \dot{E}x_{d,ExpV2}$
(ExpV3)	$\dot{m}_{21} s_{21} + \dot{S}_{gen,ExpV3} = \dot{m}_{43} s_{43}$	$\dot{m}_{21} ex_{21} = \dot{m}_{43} ex_{43} + \dot{E}x_{d,ExpV3}$
(Evap1)	$\dot{m}_{20} s_{20} + \dot{S}_{gen,Evap1} + \frac{\dot{Q}_{Evap1}}{T_{space}} = \dot{m}_{21} s_{21}$	$\dot{m}_{20} ex_{20} + \dot{Q}_{Evap1}\left(1 - \frac{T_0}{T_{space}}\right) = \dot{m}_{21} ex_{21} + \dot{E}x_{d,Evap1}$
(Evap2)	$\dot{m}_{22} s_{22} + \dot{S}_{gen,Evap2} + \frac{\dot{Q}_{Evap2}}{T_{space}} = \dot{m}_{23} s_{23}$	$\dot{m}_{22} ex_{22} + \dot{Q}_{Evap2}\left(1 - \frac{T_0}{T_{space}}\right) = \dot{m}_{23} ex_{23} + \dot{E}x_{d,Evap2}$
(MC2)	$\dot{m}_{23} s_{23} + \dot{m}_{43} s_{43} + \dot{S}_{gen,MC2} = \dot{m}_{17} s_{17}$	$\dot{m}_{23} ex_{23} + \dot{m}_{43} ex_{43} = \dot{m}_{17} ex_{17} + \dot{E}x_{d,MC2}$
Direct Contact Membrane Distillation Crystallization System (DCMDC)		
(P4)	$\dot{m}_{24} s_{24} + \dot{S}_{gen,P4} = \dot{m}_{25} s_{25}$	$\dot{m}_{24} ex_{24} + \dot{W}_{P4} = \dot{m}_{25} ex_{25} + \dot{E}x_{d,P4}$
(HT)	$\dot{m}_{25} s_{25} + \dot{S}_{gen,HT} + \frac{\dot{Q}_{Cond2}}{T_{26}} = \dot{m}_{26} s_{26}$	$\dot{m}_{25} ex_{25} + \dot{Q}_{Cond2}\left(1 - \frac{T_0}{T_{space}}\right) = \dot{m}_{26} ex_{26} + \dot{E}x_{d,HT}$
(PVF)	$\dot{m}_{26} s_{26} + \dot{m}_{31} s_{31} + \dot{S}_{gen,PVF} = \dot{m}_{27} s_{27} + \dot{m}_{32} s_{32}$	$\dot{m}_{26} ex_{26} + \dot{m}_{31} ex_{31} = \dot{m}_{27} ex_{27} + \dot{m}_{32} ex_{32} + \dot{E}x_{d,PVF}$

(CO)	$\dot{m}_{27}s_{27} + \dot{S}_{gen,CO} = \dot{m}_{28}s_{28} + \frac{\dot{Q}_{Evap2_{CO}}}{T_{Space}}$	$\dot{m}_{27}ex_{27} = \dot{m}_{28}ex_{28} + \dot{Q}_{Evap2_{CO}}\left(1 - \frac{T_0}{T_{space}}\right) + \dot{E}x_{d,CO}$
(FWT)	$\dot{m}_{28}s_{28} + \dot{m}_{38}s_{38} + \dot{S}_{gen,FWT} = \dot{m}_{29}s_{29} + \dot{m}_{39}s_{39}$	$\dot{m}_{28}ex_{28} + \dot{m}_{38}ex_{38} = \dot{m}_{29}ex_{29} + \dot{m}_{39}ex_{39} + \dot{E}x_{d,FWT}$
(P5)	$\dot{m}_{29}s_{29} + \dot{S}_{gen,P5} = \dot{m}_{30}s_{30}$	$\dot{m}_{29}ex_{29} + \dot{W}_{P5} = \dot{m}_{30}ex_{30} + \dot{E}x_{d,P5}$
(CR)	$\dot{m}_{32}s_{32} + \dot{S}_{gen,CR} = \dot{m}_{33}s_{33} + \dot{m}_{35}s_{35} + \frac{\dot{Q}_{Evap2_{CR}}}{T_{Space}}$	$\dot{m}_{32}ex_{32} = \dot{m}_{33}ex_{33} + \dot{m}_{35}ex_{35} + \dot{Q}_{Evap2_{CR}}\left(1 - \frac{T_0}{T_{space}}\right) + \dot{E}x_{d,CR}$
(HSP)	$\dot{m}_{33}s_{33} + \dot{m}_{39}s_{39} + \dot{S}_{gen,HSP} = \dot{m}_{34}s_{34}$	$\dot{m}_{33}ex_{33} + \dot{m}_{39}ex_{39} = \dot{m}_{34}ex_{34} + \dot{E}x_{d,HSP}$
	Chlor-Alkali System (CAS)	
(CAR)	$\dot{m}_{35}s_{35} + \dot{S}_{gen,CAR} = \dot{m}_{36}s_{36} + \dot{m}_{40}s_{40} + \dot{m}_{41}s_{41}$	$\dot{m}_{35}ex_{35} + \dot{W}_{CAR} = \dot{m}_{36}ex_{36} + \dot{m}_{40}ex_{40} + \dot{m}_{41}ex_{41} + \dot{E}x_{d,CAR}$
(HST)	$\dot{m}_{40}s_{40} + \dot{S}_{gen,HST} = \dot{m}_{37}s_{37} + \dot{m}_{HST,loss}s_{HST,loss}$	$\dot{m}_{40}ex_{40} = \dot{m}_{37}ex_{37} + \dot{m}_{HST,loss}ex_{HST,loss} + \dot{E}x_{d,HST}$
	Proton Exchange Membrane Fuel Cell (PEMFC)	
PEMFC	$\dot{m}_{37}s_{37} + \dot{m}_{42}s_{42} + \dot{S}_{gen,PEMFC} = \dot{m}_{38}s_{38} + \frac{\dot{Q}_{loss,PEMFC}}{\frac{T_{37}+T_0}{2}}$	$\dot{m}_{37}ex_{37} + \dot{m}_{42}ex_{42} = \dot{m}_{38}ex_{38} + \dot{W}_{PEMFC} + \dot{Q}_{loss,PEMFC}\left(1 - \frac{T_0}{\frac{T_{37}+T_0}{2}}\right) + \dot{E}x_{d,PEMFC}$

Table S3. Energy and exergy efficiencies equations for each system.

System	Energy Efficiency	Exergy Efficiency
SRC	$\eta_{en_{SRC}} = 1 - \frac{\dot{Q}_{out_{SRC}}}{\dot{Q}_{in_{SRC}}}$	$\eta_{ex_{SRC}} = 1 - \frac{\dot{W}_{net_{SRC}}}{\dot{Q}_{in_{SRC}} \cdot \left(1 - \frac{T_0}{T_9}\right)}$
DEVCR	$COP_{en_{DEVCR}} = \frac{\dot{Q}_{Evap1} + \dot{Q}_{Evap2}}{\dot{W}_{Comp}}$	$COP_{ex_{DEVCR}} = \frac{\dot{Q}_{Evap1} \cdot \left(1 - \frac{T_0}{T_{out}}\right) + \dot{Q}_{Evap2} \cdot \left(1 - \frac{T_0}{T_{23}}\right)}{\dot{W}_{Comp}}$
DCMDC-CR	$\eta_{en_{\mathrm{DCMDC-CR}}} = \frac{\dot{m}_{28} \cdot h_{28} + \dot{m}_{33} \cdot h_{33} + (\dot{m}_{26} \cdot h_{26} - \dot{m}_{32} \cdot h_{3}}{\dot{m}_{24} \cdot h_{24} + \dot{Q}_{in,DCMDC-CR} + \dot{W}_{in,DCMDC-CR}}$	$\eta_{ex_{\mathrm{DCMDC-CR}}} = \frac{\dot{m}_{28} \cdot ex_{28} + \dot{m}_{33} \cdot ex_{33} + (\dot{m}_{26} \cdot ex_{26} - \dot{m}_{32} \cdot ex_{32}}{\dot{m}_{24} \cdot ex_{24} + \dot{Q}_{in,DCMDC-CR} * \left(1 - \frac{T_0}{T_{space}}\right) + \dot{W}_{in_{\mathrm{DCMDC}}}}$
CAS	$\eta_{en_{CAS}} = \frac{\dot{m}_{40} \cdot h_{40} + \dot{m}_{41} \cdot h_{41} + \dot{m}_{36} \cdot h_{36}}{\dot{m}_{35} \cdot h_{35} + \dot{W}_{in_{CAS}}}$	$\eta_{ex_{CAS}} = \frac{\dot{m}_{40} \cdot ex_{40} + \dot{m}_{41} \cdot ex_{41} + \dot{m}_{36} \cdot ex_{36}}{\dot{m}_{35} \cdot ex_{35} + \dot{W}_{in_{CAS}}}$
PEMFC	$\eta_{en_{PEM}} = \frac{\dot{W}_{PEM}}{\dot{m}_{37} \cdot h_{37} + \dot{m}_{42} \cdot h_{42}}$	$\eta_{ex_{PEM}} = \frac{\dot{W}_{PEM}}{\dot{m}_{37} \cdot ex_{37} + \dot{m}_{42} \cdot ex_{42}}$
PTC	$\eta_{en_{PTC}} = \frac{\dot{m}_{15} \cdot h_{15} - \dot{m}_{16} \cdot h_{16}}{\dot{Q}_{PTC}}$	$\eta_{ex_{PTC}} = \frac{\dot{m}_{15} \cdot ex_{15} - \dot{m}_{16} \cdot ex_{16}}{\dot{Q}_{PTC} \cdot \left(1 - \frac{T_0}{T_{sun}}\right)}$

Table S4. Input parameters for the whole system.

Parameter	Value
Ambient temperature, T_0	298.15 K
Ambient pressure, P_0	101.325 kPa
SRC Lower pressure, P_1	10 kPa [45]
High-pressure turbine inlet pressure, P_9	15000 kPa [45]
High-pressure turbine inlet temperature, T_9	673.15 K [45]
High-pressure turbine outlet pressure, P_{10}	4000 kPa [45]
Turbines isentropic efficiency, $\eta_{is,T}$	80 % [45]
Pumps isentropic efficiency, $\eta_{is,Pu}$	80 % [45]
Sun temperature, T_{sun}	5700 K [51]
Solar irradiation, I_{sun}	0.5 kW/m^2 (assumed)
Energy efficiency, $\eta_{en,PTC}$	90 % [52]
DCMDC Feed salinity	35 g/kg (assumed)
DCMDC Output salinity	0.5 g/kg (assumed)
DCMDC feed temperature, T_{26}	313.15 K (assumed)
DCMDC Recovery ratio	70 % [48]
Seawater feed mass flow rate	5 kg/s (assumed)
CR Recovery ratio	60 % [48]
Cl_2 Chemical exergy	123600 kJ/kmol [38]
NaCl Chemical exergy	14300 kJ/kmol [38]
NaOH Chemical exergy	74900 kJ/kmol [38]
H_2 Chemical exergy	236090 kJ/kmol [38]
H_2 Chemical exergy	117108 kJ/kg [53]
H_2 Lower heating value	120000 kJ/kg [50]
O_2 Chemical exergy	124.1 kJ/kg [50]
DEVCR High-pressure, P_{18}	1200 kPa [46]
DEVCR ExpV2 pressure, P_{17}	250 kPa [46]
DEVCR ExpV1 pressure, P_{22}	100 kPa [46]
Compressor isentropic efficiency	80 % [46]
Greenhouse dimensions	10 m x 20 m x 3 m (assumed)
Number of greenhouses	25 greenhouses (assumed)
Greenhouse space temperature	293.15 K [54]

Table S5. Thermodynamics data for the state points.

State #	T(K)	P(kPa)	h(kJ/kg)	s(kJ/kg-K)	ex(kJ/kg)	$\dot{m}$(kg/s)	Material
0	298.2	101.3	104.8	0.3669	0	-	Water
1	319	10	191.8	0.6493	2.814	0.8782	Water
2	319	500	192.5	0.6496	3.317	0.8782	Water
3	425	500	640.4	1.861	90.07	1.058	Water
4	427.5	15000	660.1	1.87	107	1.058	Water
5	523.5	15000	1088	2.771	266	1.058	Water
6	523.5	4000	1087	2.796	258.1	0.271	Water
7	527.1	15000	1104	2.803	273.3	0.271	Water
8	524.3	15000	1091	2.777	267.5	1.329	Water
9	673.2	15000	2975	5.88	1226	1.329	Water
10	523.5	4000	2756	5.984	976.6	1.329	Water
11	673.2	4000	3213	6.769	1200	1.058	Water
12	458.6	500	2824	6.991	743.7	0.1802	Water
13	319	10	2358	7.439	144.2	0.8782	Water
14	523.5	4000	2756	5.984	976.6	0.271	Water
15	673.2	15000	2975	5.88	1226	1.277	Water
16	475.4	15000	867.9	2.331	177.5	1.277	Water
17	356.7	100	328.9	1.267	4.33	7.4	R134a
18	374.8	1200	426.8	1.31	89.23	7.4	R134a
19	319.4	1200	117.8	0.4244	44.31	7.4	R134a
20	268.8	250	117.8	0.4498	36.72	2.22	R134a
21	288.9	250	265.4	0.9966	21.33	2.22	R134a
22	246.8	100	117.8	0.4791	28.01	5.18	R134a
23	385	100	356.1	1.34	9.662	5.18	R134a
24	298.2	100	99.76	0.3498	-0.001293	5	Seawater
25	298.8	100	102.2	0.3579	-0.002195	5	Seawater
26	353.2	100	320.5	1.029	18.14	5	Seawater
27	348.2	100	313.8	1.015	18.14	3.684	Freshwater
28	288.2	100	63.02	0.2245	3.118	3.684	Freshwater
29	288.2	100	63.02	0.2245	3.118	0.1842	Freshwater
30	288.8	100	65.53	0.2332	3.034	0.1842	Freshwater
31	288.8	100	65.53	0.2332	3.034	0.1842	Freshwater
32	339.2	100	246.8	0.7883	16.25	1.5	Brine
33	283.2	100	42.09	0.1512	4.037	0.9	Irrigation-water
34	285.7	100	52.56	0.188	3.53	4.394	Hydroponic solution
35	283.2	100	35.51	0.1068	8.201	0.6	Brine NaCl+H2O
36	285.2	100	-6.203	3.125	1743	0.03254	Cl_2
37	285.2	100	123746	52.79	117096	0.0008326	H_2
38	294.2	100	88.11	0.3104	527.4	0.007494	H_2O
39	288.2	100	63.02	0.2245	3.118	3.494	Freshwater
40	285.2	100	123746	52.79	117096	0.0009252	H_2
41	285.2	100	-12296	2.213	1456	0.01835	NaOH
42	303.2	101.3	4.3	0.01446	124.1	0.006661	O_2
43	285.1	100	265.4	1.068	-0.06586	2.22	R134a
44	285.2	100	-15688	3.63	521.1	0.5621	Depleted NaCl

Table S6. Inputs and outputs of each and overall system.

SRC	$\dot{W}_{P1}$ (kW)	0.54	**DEVCR**	$\dot{W}_{Comp}$ (kW)	724.20
	$\dot{W}_{P2}$ (kW)	20.88		$\dot{Q}_{Cond2}$ (kW)	2287.00
	$\dot{W}_{P3}$ (kW)	4.64		$\dot{Q}_{Evap1}$ (kW)	327.80
	$\dot{Q}_{BR}$ (kW)	2504		$\dot{Q}_{Evap2}$ (kW)	1235.00
	$\dot{Q}_{RH}$ (kW)	483.8		$COP_{en,DEVCR}$	2.16
	$\dot{Q}_{Cond1}$ (kW)	1902		$COP_{ex,DEVCR}$	0.37
	$\dot{Q}_{in,SRC}$ (kW)	2988	**PTC**	$\dot{Q}_{PTC}$ (kW)	2988
	$\dot{W}_{HPT}$ (kW)	290.4		$\dot{Q}_{loss,PTC}$ (kW)	298.80
	$\dot{W}_{LPT}$ (kW)	821.7		A_{PTC} (m^2)	5976
	$\dot{W}_{net,SRC}$ (kW)	1086		Isun (kW/m^2)	0.5
	$\eta_{en,SRC}$ (%)	36.34		$\eta_{en,PTC}$ (%)	90.00
	$\eta_{ex,SRC}$ (%)	34.76		$\eta_{ex,PTC}$ (%)	47.30
DCMDC-CR	$\dot{m}_{SW}$ (kg/s)	5.00	**CAS**	$\dot{W}_{CAS}$ (kW)	420.00
	$\dot{m}_{FW}$ (kg/s)	3.5		$\dot{m}_{NaCl}$ (kg/s)	0.60
	$\dot{m}_{Brine}$ (kg/s)	1.50		$\dot{m}_{H2}$ (g/s)	0.93
	$\dot{W}_{P4}$ (kW)	11.97		$\dot{m}_{Cl2}$ (g/s)	32.54
	$\dot{W}_{P5}$ (kW)	0.46		$\dot{m}_{NaOH}$ (g/s)	18.35
	$\dot{Q}_{CL}$ (kW)	923.80		$\eta_{en,CAS}$ (%)	27.25
	$\dot{Q}_{HT}$ (kW)	1092.00		$\eta_{ex,CAS}$ (%)	25.79
	$\dot{Q}_{CR}$ (kW)	311.00	**PEMFC**	$\dot{W}_{PEM}$ (kW)	70.62
	$\eta_{en,DCMDC}$ (%)	52.95		$\dot{Q}_{loss,PEM}$ (kW)	31.78
	$\eta_{ex,DCMDC}$ (%)	60.81		$\eta_{en,PEM}$ (%)	68.52
				$\eta_{ex,PEM}$ (%)	71.83
Overall system	$\dot{W}_{in,overall}$ (kW)	1182.69	$\dot{Q}_{in,overall}$ (kW)		5314.60
	$\dot{W}_{out,overall}$ (kW)	1182.69	$\dot{Q}_{out,overall}$ (kW)		8739.80
	$\eta_{en,overall}$ (%)	39.80	$\eta_{ex,overall}$ (%)		41.39

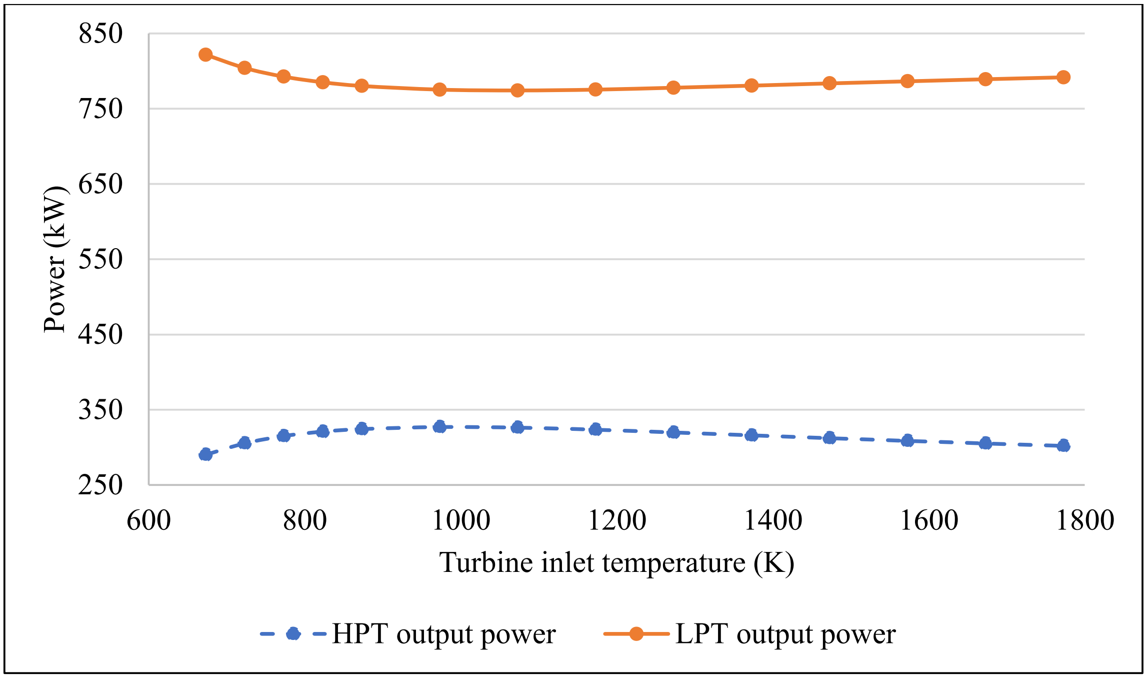

Figure S1. Turbine inlet temperature vs. HPT and LPT output power.

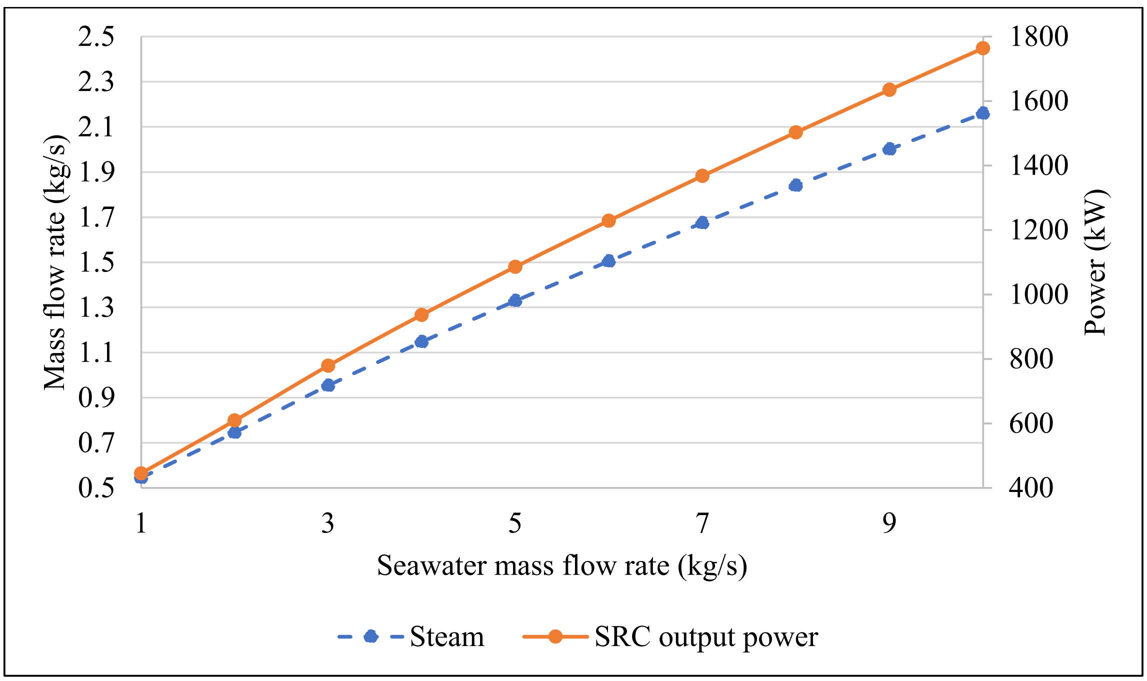

Figure S2. Seawater mass flow rate vs. steam mass flow rate and SRC output power.

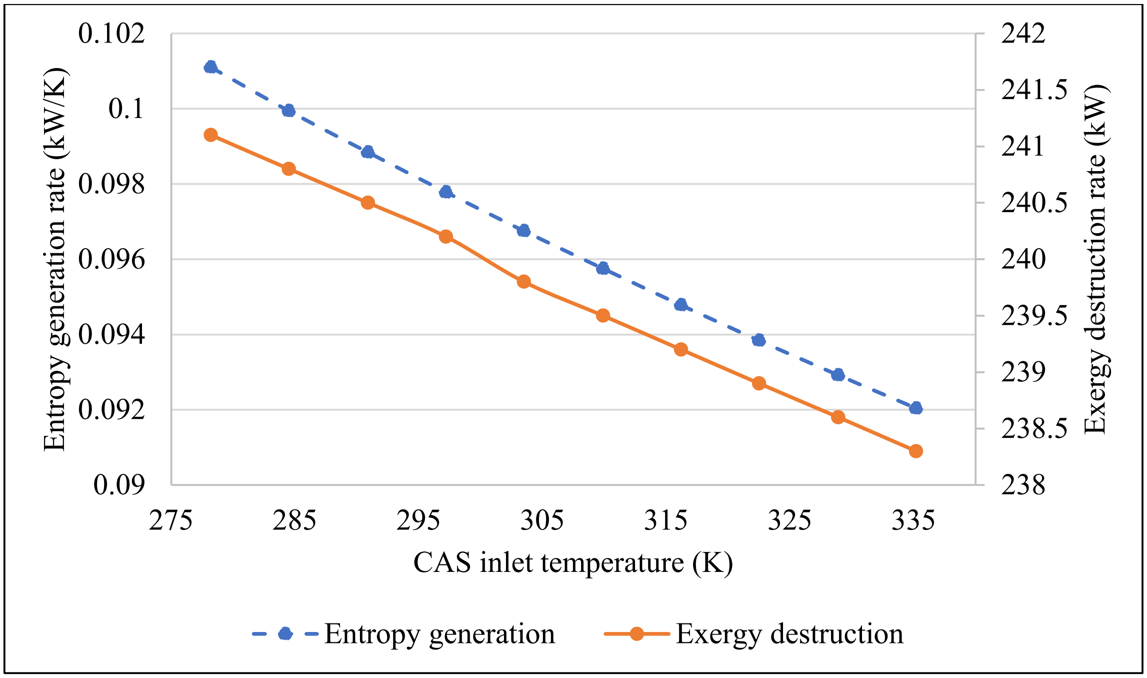

Figure S3. CAS inlet temperature vs. CAS entropy generation and CAS exergy destruction rates.

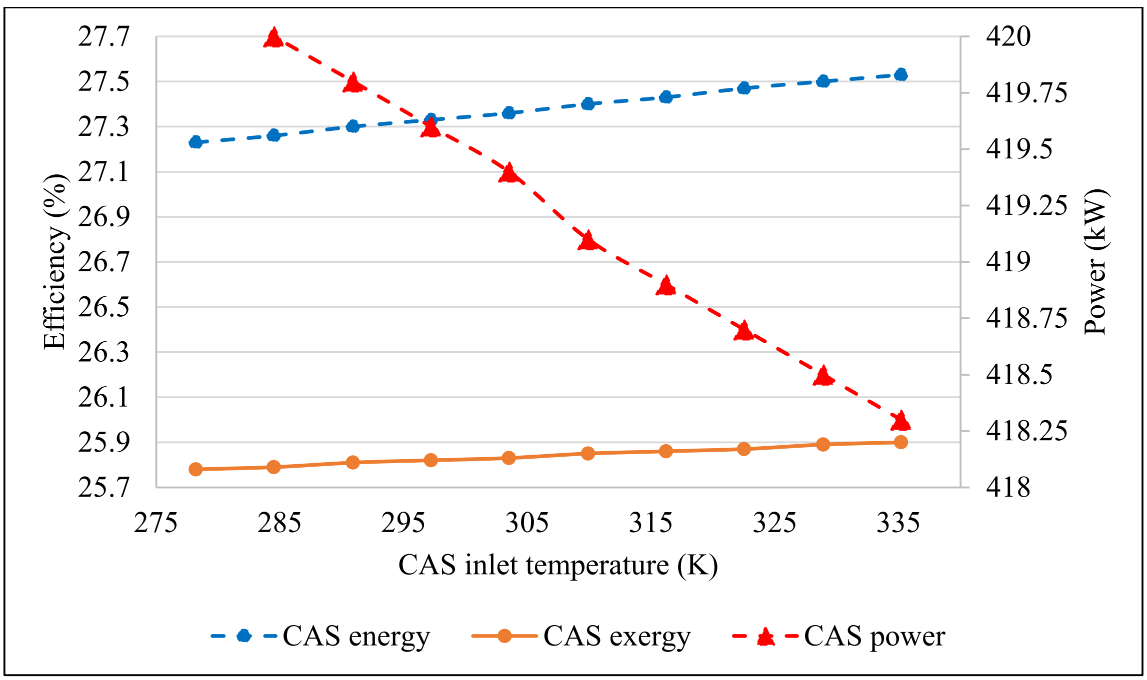

Figure S4. CAS inlet temperature vs. CAS power and efficiency.

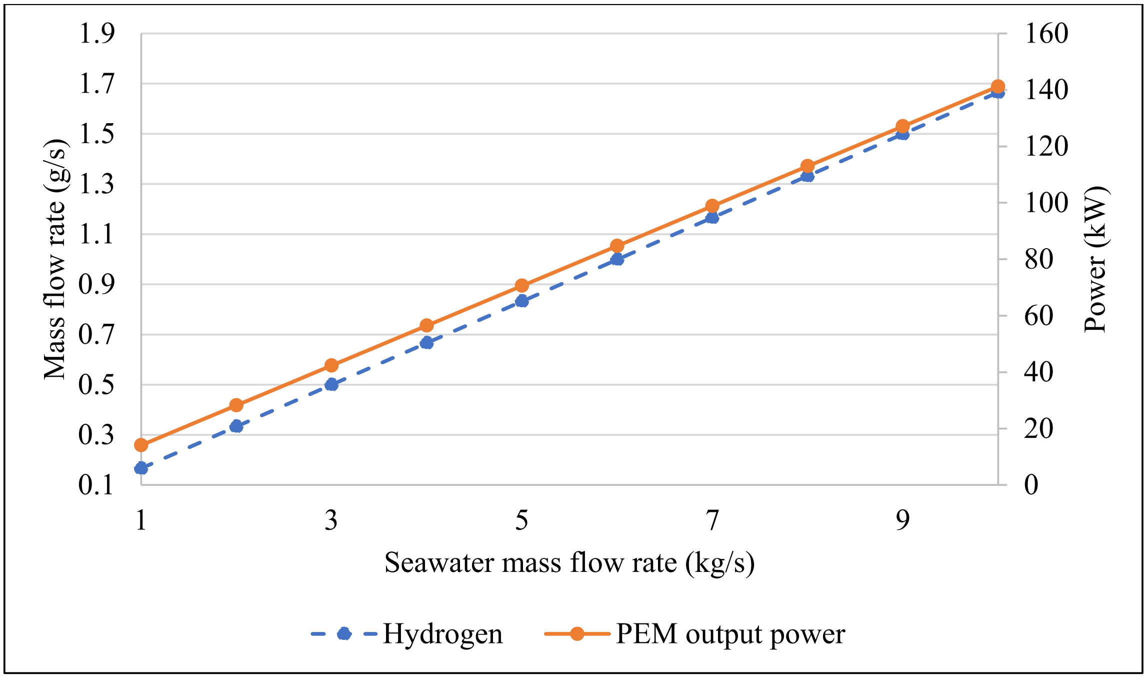

Figure S5. Seawater mass flow rate vs. Hydrogen mass flow rate and PEMFC output power.

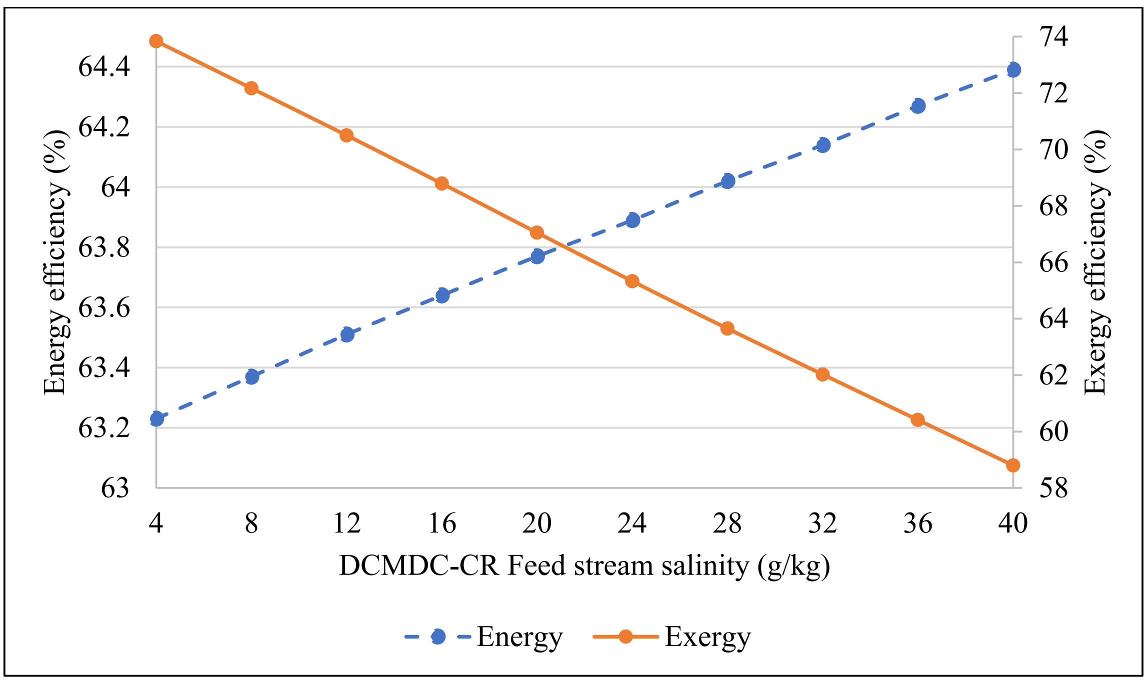

Figure S6. DCMDC-CR Feed stream salinity vs. DCMDC-CR energy and exergy efficiencies.

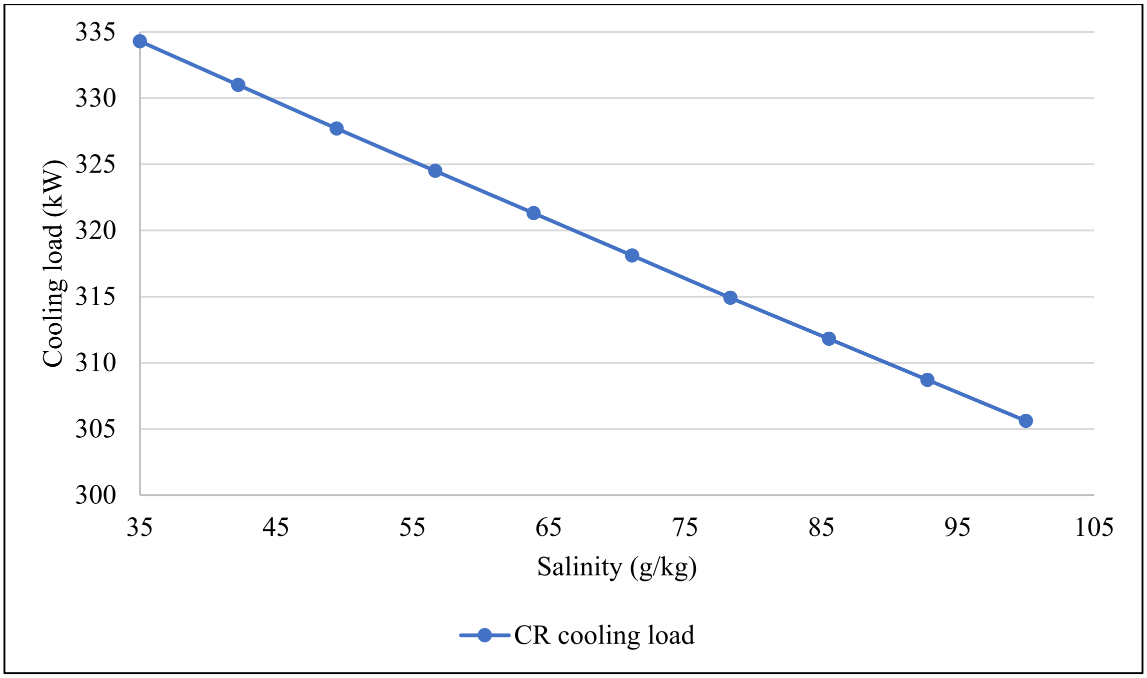

Figure S7. CR inlet salinity vs. CR cooling load.

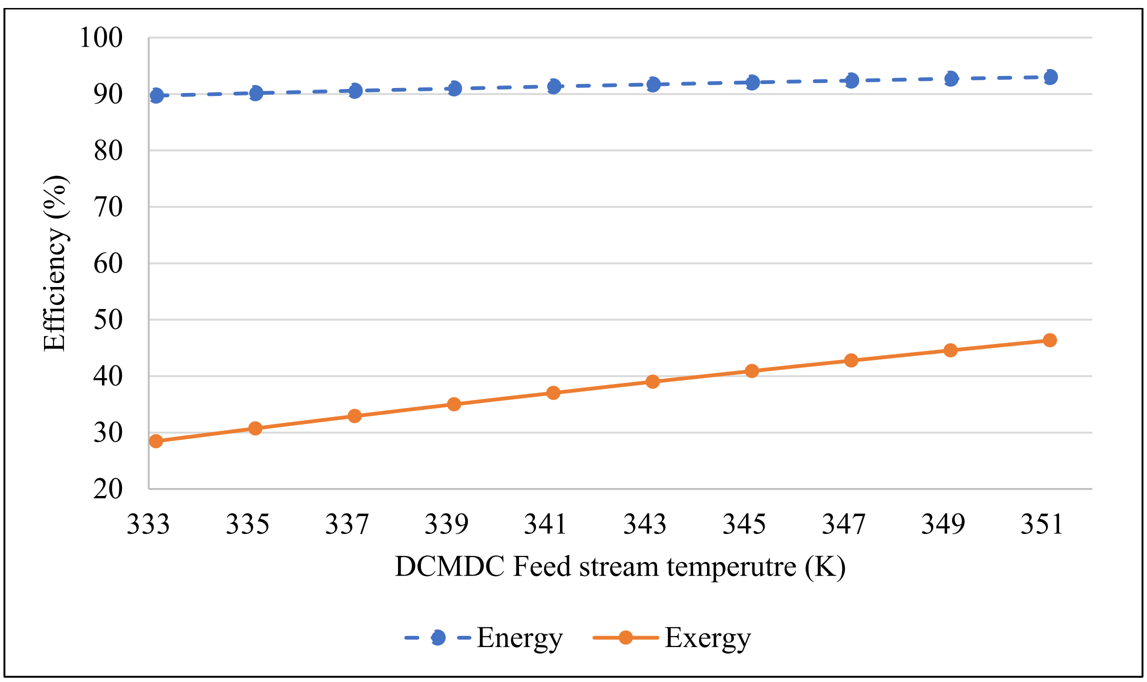

Figure S8. DCMDC Feed stream temperature vs. DCMDC energy and exergy efficiencies.