# Original format of tables

Table 1. Metadata of warm and cold seawater data. Coordinates refer to coastal area in Ende, Indonesia, but the coordinates can be adjusted to download temperature data for any other location worldwide with suitable ocean thermal resources.

|  |  |
| --- | --- |
| Title | Seawater Temperature Data |
| Description | Seawater temperature data at a depth of 20 m (warm water) and 1,000 m (cold water) |
| Creator | Naval Research Laboratory: Ocean Dynamics and Prediction Branch |
| Publisher | HYCOM.org |
| Dataset | GOFS 3.0: HYCOM + NCODA Global 1/12° Reanalysis/GLBu0.08/reanalysis/ALL Data: 1992-10-02 to 2012-12-31 (3-hrly) |
| Web Link | https://ncss.hycom.org/thredds/catalogs/GLBu0.08/reanalysis.html?dataset=GLBu0.08-reanalysis-3hrly |
| Coordinate System | World Geodetic System1984 (WGS84) |
| Vertical Datum | Mean Sea Level |
| Coordinates | 121.52° E 9.04° S |
| Data Type | Point |
| Parameter Unit | °C |
| Depth Levels | 20 m and 1,000 m |
| Time Period | 01 January 1994 00:00 to 31 December 2012 21:00 |
| Temporal Resolution | 3 hours |

Table 2. Technical and economic assumptions of the design model.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical Value** | | | | **Assumption [References]** | | | |
| **Properties Ammonia & Seawater** | | | | | | | |
| Density liquid ammonia *ρNH3,liq* [kg/m3] | | | | 625 | | | |
| Specific heat capacity seawater *cp* [kJ/kgK] | | | | 4.0 [22] | | | |
| Density surface seawater *ρWW* [kg/m3] | | | | 1,024 [23] | | | |
| Density deep seawater *ρCW* [kg/m3] | | | | 1,027 [23] | | | |
| **Heat Exchangers** | | | | | | | |
| Pinch-Point temperature difference evaporator and condenser *∆T­pp.* [K] | | | | 1.0 [24,25] | | | |
| Nominal overall heat transfer coefficient evaporator *Uevap,nom* [kW/m2K] | | | | 4.5 [3,10] | | | |
| Nominal overall heat transfer coefficient condenser *Ucond,nom* [kW/m2K] | | | | 3.5 [9,10] | | | |
| **Turbine + Generator + Power Transmission** | | | | | | | |
| Isentropic efficiency turbine *ηis,turb* [%] | | | | 82 [26] | | | |
| Mechanical efficiency turbine *ηmech,turb* [%] | | | | 95 [12,26] | | | |
| Electrical efficiency generator *ηel,gen* [%] | | | | 95 [12,26] | | | |
| **Ammonia and Seawater Pumps** | | | | | | | |
| Isentropic efficiency pump *ηis,pump* [%] | | | | 80 [10,26] | | | |
| Electric efficiency pump *ηel,pump* [%] | | | | 95 [10] | | | |
| **Seawater Pipes** | | | | | | | |
| Length WW pipe *lpipe,WW* [m] | | | | 80 (20 m inlet, 60 m outlet) | | | |
| Length CW pipe *lpipe,CW* [m] | | | | 1,060 (1,000 m inlet, 60 m outlet) | | | |
| Pipe thickness *t* [m] | | | | 0.09 [27,28] | | | |
| Density HDPE *ρHDPE* [kg/m3] | | | | 995 [28] | | | |
| Density FRP-sandwich pipe *ρFRP* [kg/m3] | | | | 1,016 [27] | | | |
| Roughness factor *z* [mm] | | | | 0.0053 [26] | | | |
| Pressure drop coefficient evaporator & condenser *KL,evap/cond* [-] | | | | 120 | | | |
| Nominal flow velocity in the pipes *vpipe, CW/WW* [m/s] | | | | 2.0 [3,7] | | | |
| Nominal flow velocity in the heat exchangers *vevap/cond, nom* [m/s] | | | | 1.0 [3] | | | |
| Maximum inner diameter *dmax* [m] | | | | 8 | | | |
| **Economic Value** | **Specific Reference Cost for Scaling** | | | **Scale Factor *b* [-]** | | **Ref Size for Scaling [MWgross/pump]** | |
| **LC** | | **HC** | **LC** | **HC** | **LC** | **HC** |
| **CAPEX** | | | | | | | |
| Turbine *capexturb* [US$/kWgross] | 328 [9] | | 512 [16] | 0.16 [9,28] | | 136 | 136 |
| Heat Exchangers *capexHX* [US$/m2] | 226 [16] | | 916 [28] | 0.16 [23,28] | 0.09 [9,28] | 80 | 4.4 |
| Pumps *capexpump* [US$/kWpump] | 1,674 [23] | | 2,480 [23] | 0.38 [16,23] | | 5.6 | 5.6 |
| Seawater pipes *capexpipe*[US$/kgpipe] | 9 [3,28] | | 30.1 [16,27] | - | | - | - |
| Power Transmission *capextrans*[US$/kWgross] | [29] | [17] | | - | | - | - |
| Design & Management *capexdes*[US$/kWgross] | 3,113 [3] | | 6,085 [28] | 0.70 [3,9] | | 4.0 | 4.4 |
| Structure & Mooring *capexstruct* [US$/kWgross] | 4,465 [23] | | 7,442 [23] | 0.35 [9,23] | | 28.1 | 28.1 |
| Deployment *capexdepl*[US$/kWgross] | 650 [9] | | 667 [16] | - | | - | - |
| Extra Costs *percext* [% of CAPEX] | 5 [28] | | 20 [9] | - | | - | - |
| *OPEX* [% of CAPEX/year] | 3 [16] | | 5 [9] | - | | - | - |
| **LCOE** | | | | | | | |
| Project lifetime *n* [years] | 30 [1] | | | | | | |
| Discount rate *DR* [%] | 10 [17] | | | | | | |
| Capacity factor *cf* [%] (on-design model) | 91.3 [3,30] | | | | | | |

Table 3. Overview of the four analysed locations. The download setup for the seawater temperature data is the same as in Table 1.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | **Jayapura** | **Tarakan** | **Ende** | **Sabang** |
| Coordinates OTEC plants | | 140.72° E 2.32° S | 118.4° E 3.44° N | 121.52° E 9.04° S | 95.6° E 5.84° N |
| Surface seawater temperature [°C] | Min | 27.8 | 27.5 | 23.7 | 27.0 |
| Med | 29.2 | 28.8 | 28.3 | 28.9 |
| Max | 30.5 | 30.0 | 31.1 | 31.0 |
| Deep-sea water temperature [°C] | Min | 4.3 | 4.0 | 4.2 | 6.1 |
| Med | 4.6 | 4.5 | 4.6 | 6.6 |
| Max | 4.8 | 5.2 | 5.1 | 7.1 |
| Distance to shore [km] | | 23.5 | 92.0 | 7.8 | 31.4 |
| Electricity tariff [US¢(2021)/ kWh] | | 13.61 | 9.49 | 15.77 | 14.49 |

Table 4. System designs for 136 MWgross for all nine temperature configurations and low-cost assumptions. For high-cost assumptions, only configuration 5 yielded different designs as presented in Appendix G. WW: warm water; CW: cold water. The energy and exergy balances do not always add up exactly to zero due to round-off errors.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Configuration with Low-Cost Assumptions** | | | | | | | | |
| **1**  **Min WW**  **Max CW** | **2**  **Med WW**  **Max CW** | **3**  **Max WW**  **Max CW** | **4**  **Min WW**  **Med CW** | **5**  **Med WW**  **Med CW** | **6**  **Max WW**  **Med CW** | **7**  **Min WW**  **Min CW** | **8**  **Med WW**  **Min CW** | **9**  **Max WW**  **Min CW** |
|  | Energy Balance (units in MW if not stated otherwise) | | | | | | | | |
| **Heat Evaporator** | 5,551 | 4,150 | 3,506 | 4,979 | 4,143 | 3,387 | 5,020 | 4,008 | 3,298 |
| **Heat Condenser** | -5,417 | -4,016 | -3,372 | -4,845 | -4,009 | -3,253 | -4,886 | -3,874 | -3,164 |
| **Gross Power Turbine** | -136 | -136 | -136 | -136 | -136 | -136 | -136 | -136 | -136 |
| **Power NH3 Pump** | 1.9 | 2.0 | 2.1 | 1.9 | 2.0 | 2.1 | 1.8 | 2.0 | 2.1 |
| **Power WW Pump** | 26.3 | 15.3 | 11.6 | 23.6 | 13.8 | 11.2 | 20.8 | 13.3 | 10.9 |
| **Power CW Pump** | 21.7 | 14.5 | 12.3 | 21.8 | 14.5 | 11.9 | 22.0 | 14.0 | 11.6 |
| **Losses NH3 Pump** | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| **Losses Turbine and Transmission** | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 |
| **Net Power Turbine at Shore** | -72.6 | -90.6 | -96.4 | -75.2 | -92.2 | -97.2 | -77.8 | -93.2 | -97.9 |
| **Net Thermal Efficiency [%]** | 1.3% | 2.2% | 2.8% | 1.5% | 2.2% | 2.9% | 1.5% | 2.3% | 3.0% |
|  | Exergy Balance (units in MW if not stated otherwise) | | | | | | | | |
| **Exergy Inflow Evaporator** | 275 | 256 | 244 | 259 | 259 | 241 | 264 | 256 | 239 |
| **Exergy Loss Evaporator** | -38.1 | -35.1 | -32.5 | -33.7 | -38.1 | -31.3 | -37.8 | -36.8 | -30.4 |
| **Exergy Loss Turbine** | -29.5 | -29.4 | -29.4 | -29.5 | -29.4 | -29.4 | -29.5 | -29.4 | -29.4 |
| **Exergy Loss Condenser** | -73.0 | -57.4 | -48.2 | -61.7 | -57.6 | -46.7 | -62.5 | -55.9 | -45.6 |
| **Exergy Loss NH3 Pump** | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 |
| **Exergy Loss WW Pump** | -26.3 | -15.3 | -11.6 | -23.6 | -13.8 | -11.2 | -20.8 | -13.3 | -10.9 |
| **Exergy Loss CW Pump** | -21.7 | -14.5 | -12.3 | -21.8 | -14.5 | -11.9 | -22.0 | -14.0 | -11.6 |
| **Exergy Loss Conversion Losses** | -13.5 | -13.5 | -13.5 | -13.5 | -13.5 | -13.5 | -13.5 | -13.5 | -13.5 |
| **Exergy Outflow at Shore** | -72.6 | -90.6 | -96.4 | -75.2 | -92.2 | -97.2 | -77.8 | -93.2 | -97.9 |
| **Net Exergy Efficiency [%]** | 26.4% | 35.4% | 39.5% | 29.0% | 35.6% | 40.3% | 29.5% | 36.4% | 40.9% |
| **Carnot Efficiency [%]** | 4.9% | 6.2% | 7.0% | 5.2% | 6.2% | 7.1% | 5.3% | 6.4% | 7.3% |
| **Second Law Efficiency [%]** | 26.4% | 35.4% | 39.5% | 29.0% | 35.6% | 40.3% | 29.5% | 36.4% | 40.9% |
|  | Mass Flows | | | | | | | | |
| **Mass Flow NH3 [kg/s]** | 4,523 | 3,379 | 2,850 | 4,043 | 3,368 | 2,749 | 4,073 | 3,254 | 2,673 |
| **Mass Flow WW [kg/s]** | 396,531 | 230,564 | 175,284 | 355,627 | 207,150 | 169,357 | 313,781 | 200,403 | 164,899 |
| **Mass Flow CW [kg/s]** | 300,962 | 200,808 | 168,589 | 302,789 | 200,449 | 162,661 | 305,395 | 193,702 | 158,202 |
|  | Temperature Changes | | | | | | | | |
| **Temperature Change WW [K]** | 3.5 | 4.5 | 5.0 | 3.5 | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 |
| **Temperature Change CW [K]** | 4.5 | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 |
|  | Evaporator and Condenser | | | | | | | | |
| **Area Evaporator [m2]** | 530,146 | 349,381 | 279,171 | 475,458 | 329,923 | 269,730 | 448,899 | 319,177 | 262,630 |
| **Evaporation Temperature [°C]** | 19.2 | 22.8 | 25.1 | 19.2 | 22.3 | 25.1 | 18.7 | 22.3 | 25.1 |
| **Evaporation Pressure [bar]** | 8.4 | 9.4 | 10.1 | 8.4 | 9.2 | 10.1 | 8.2 | 9.2 | 10.1 |
| **Area Condenser [m2]** | 586,360 | 411,201 | 345,223 | 556,938 | 410,465 | 333,084 | 561,731 | 396,648 | 323,954 |
| **Condensation Temperature [°C]** | 10.6 | 11.1 | 11.1 | 9.6 | 10.6 | 10.6 | 9.2 | 10.2 | 10.2 |
| **Condensation Pressure [bar]** | 6.3 | 6.4 | 6.4 | 6.1 | 6.3 | 6.3 | 6.0 | 6.2 | 6.2 |
|  | Seawater Pipes | | | | | | | | |
| **Diameter CW Pipes [m]** | 7.9 | 7.9 | 7.2 | 7.9 | 7.9 | 7.1 | 7.9 | 7.7 | 7.0 |
| **Number of CW Pipes** | 6 | 4 | 4 | 6 | 4 | 4 | 6 | 4 | 4 |
| **Diameter WW Pipes [m]** | 7.9 | 6.9 | 7.4 | 7.4 | 6.6 | 7.3 | 7.0 | 7.9 | 7.2 |
| **Number of WW Pipes** | 8 | 6 | 4 | 8 | 6 | 4 | 8 | 4 | 4 |

Table 5. Key results from the techno-economic analysis of a 136 MWgross OTEC plant in Ende, Indonesia with (a) total capital expenses, (b) lifecycle electricity production, and LCOE with (c) well and (d) poorly timed maintenance.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **(a) LC-CAPEX**  **[US$ million]** | | **Warm Water** | | | **HC-CAPEX**  **[US$ million]** | | **Warm Water** | | |
| *Min* | *Med* | *Max* | *Min* | *Med* | *Max* |
| **Cold Water** | *Max* | 921 | 810 | 772 | **Cold Water** | *Max* | 2,314 | 1,918 | 1,784 |
| *Med* | 902 | 804 | 766 | *Med* | 2,244 | 1,888 | 1,762 |
| *Min* | 895 | 797 | 761 | *Min* | 2,224 | 1,872 | 1,747 |
| **(b) LC-/ HC Lifecycle Electricity Production Good O&M [TWh]** | | **Warm Water** | | | **LC-/ HC Lifecycle Electricity Production Bad O&M [TWh]** | | **Warm Water** | | |
| *Min* | *Med* | *Max* | *Min* | *Med* | *Max* |
| **Cold Water** | *Max* | 24.6 | 22.0 | 17.9 | **Cold Water** | *Max* | 24.5 | 21.4 | 17.4 |
| *Med* | 23.3 | 21.3/ 21.4 | 17.6 | *Med* | 23.2 | 20.8/ 20.9 | 17.1 |
| *Min* | 21.9 | 20.6 | 17.1 | *Min* | 21.8 | 20.2 | 16.6 |
| **(c) LC-LCOE Good Downtime [US**¢/**kWh]** | | **Warm Water** | | | **HC-LCOE Good Downtime [US**¢/**kWh]** | | **Warm Water** | | |
| *Min* | *Med* | *Max* | *Min* | *Med* | *Max* |
| **Cold Water** | *Max* | 15.33 | 15.12 | 17.65 | **Cold Water** | *Max* | 44.16 | 41.09 | 46.81 |
| *Med* | 15.83 | 15.46 | 17.86 | *Med* | 45.21 | 41.52 | 47.15 |
| *Min* | 16.70 | 15.84 | 18.24 | *Min* | 47.58 | 42.69 | 48.00 |
| **(d) LC-LCOE Bad Downtime [US**¢/**kWh]** | | **Warm Water** | | | **HC-LCOE Bad Downtime [US**¢/**kWh]** | | **Warm Water** | | |
| *Min* | *Med* | *Max* | *Min* | *Med* | *Max* |
| **Cold Water** | *Max* | 15.39 | 15.52 | 18.19 | **Cold Water** | *Max* | 44.35 | 42.17 | 48.20 |
| *Med* | 15.90 | 15.86 | 18.38 | *Med* | 45.41 | 42.59 | 48.53 |
| *Min* | 16.77 | 16.25 | 18.77 | *Min* | 47.79 | 43.81 | 49.41 |

Table 6. Cost breakdown for different system sizes of (a) low-cost and (b) high-cost OTEC in Ende.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **(a) Low-Cost OTEC** | **Absolute Cost [US$(2021) Thousand]/ Specific Cost [US$(2021)/Unit]/ Relative Cost [%]** | | | | | | | | |
| **Component** | **4.4 MWgross** | | | **80 MWgross** | | | **136 MWgross** | | |
| Turbine + Generator | 2,499 | 568 US$/ kWgross | 3% | 28,565 | 357 US$/ kWgross | 5% | 44,608 | 328 US$/ kWgross | 6% |
| Evaporator | 4,006 | 359 US$/m2 | 5% | 46,447 | 226 US$/m2 | 8% | 72,533 | 208 US$/m2 | 9% |
| Condenser | 4,990 | 6% | 54,665 | 10% | 85,367 | 11% |
| Pumps | 3,653 | 2,983 US$/kWpump | 5% | 20,035 | 1,051 US$/kWpump | 4% | 27,570 | 864 US$/kWpump | 3% |
| Seawater Pipes | 6,184 | 9 US$/kg | 8% | 35,629 | 9 US$/kg | 6% | 47,085 | 9 US$/kg | 6% |
| Power Transmission | 655 | 19 US$/kW/km | 1% | 11,915 | 19 US$/kW/km | 2% | 20,256 | 19 US$/kW/km | 3% |
| Structure + Mooring | 37,594 | 8,544 US$/kWgross | 48% | 247,672 | 3,096 US$/kWgross | 45% | 349,678 | 2,571 US$/kWgross | 43% |
| Design + Management | 12,723 | 2,892 US$/kWgross | 16% | 30,373 | 380 US$/kWgross | 5% | 35,615 | 262 US$/kWgross | 4% |
| Installation | 2,860 | 650 US$/kWgross | 4% | 52,000 | 650 US$/kWgross | 9% | 88,400 | 650 US$/kWgross | 11% |
| Extra Cost | 3,758 | 854 US$/kWgross | 5% | 26,365 | 330 US$/kWgross | 5% | 38,556 | 283.5 US$/kWgross | 5% |
| **Total CAPEX** | **78,922** |  |  | **553,667** |  |  | **809,668** |  |  |
| OPEX | **2,368** |  |  | 16,610 |  |  | 24,290 |  |  |
| **(b) High-Cost OTEC** | **Absolute Cost [US$(2021) Thousand]/ Specific Cost [US$(2021)/Unit]/ Relative Cost [%]** | | | | | | | | |
| **Component** | **4.4 MWgross** | | | **80 MWgross** | | | **136 MWgross** | | |
| Turbine + Generator | 3,901 | 887 US$/ kWgross | 2% | 44,589 | 557 US$/ kWgross | 3% | 69,632 | 512 US$/ kWgross | 4% |
| Evaporator | 10,354 | 916 US$/m2 | 6% | 143,747 | 699 US$/m2 | 11% | 232,604 | 666 US$/m2 | 12% |
| Condenser | 12,186 | 7% | 169,182 | 13% | 273,761 | 14% |
| Pumps | 5,436 | 4,407 US$/kWpump | 3% | 29,681 | 1,557 US$/kWpump | 2% | 40,844 | 1,280 US$/kWpump | 2% |
| Seawater Pipes | 20,770 | 30.1 US$/kg | 12% | 121,673 | 30.1 US$/kg | 9% | 160,798 | 30.1 US$/kg | 8% |
| Power Transmission | 2,328 | 68 US$/kW/km | 1% | 42,319 | 68 US$/kW/km | 3% | 71,942 | 68 US$/kW/km | 4% |
| Structure + Mooring | 62,659 | 12,241 US$/kWgross | 35% | 412,805 | 5,161 US$/kWgross | 32% | 582,824 | 4,285 US$/kWgross | 30% |
| Design + Management | 26,774 | 6,085 US$/kWgross | 15% | 63,915 | 799 US$/kWgross | 5% | 74,944 | 551 US$/kWgross | 4% |
| Installation | 2,935 | 667 US$/kWgross | 2% | 53,360 | 667 US$/kWgross | 4% | 90,712 | 667 US$/kWgross | 5% |
| Extra Cost | 29,468 | 6,697 US$/kWgross | 17% | 216,254 | 2,703 US$/kWgross | 17% | 319,612 | 2,350 US$/kWgross | 17% |
| **Total CAPEX** | **176,811** |  |  | **1,297,527** |  |  | **1,917,673** |  |  |
| OPEX | 8,841 |  |  | 64,876 |  |  | 95,884 |  |  |

Appendix A. Equations used in the design model (I/II). For work and heat, the following sign convention applies: flows into the system are positive, flows out of the system are negative.

|  |  |
| --- | --- |
| **Value** | **Formula** |
| **Saturation Temperature & Pressure, Enthalpy and Entropy of Ammonia (NH3)** | |
| Saturation Temperature *Tsat* [°C] | Evaporation:  Condensation: |
| Saturation pressure *psat* [bar]  (approximation function based on saturation table) |  |
| Enthalpy liquid phase *h’* [kJ/kg]  (approximation function based on saturation table) |  |
| Enthalpy vapour phase *h”* [kJ/kg]  (approximation function based on saturation table) |  |
| Entropy liquid phase *s’* [kJ/kgK]  (approximation function based on saturation table) |  |
| Entropy vapour phase *s”* [kJ/kgK]  (approximation function based on saturation table) |  |
| **Turbine + Generator + Power Transmission** | |
| Isentropic quality at turbine outlet *xturb,out,is*[%] |  |
| Isentropic enthalpy at turbine outlet *hturb,out,is*[kJ/kg] |  |
| Enthalpy at turbine outlet *hturb,out*[kJ/kg] |  |
| Mass flow ammonia [kg/s] |  |
| Transmission efficiency *ηtrans* [%] |  |
| **Ammonia Pump** | |
| Enthalpy at pump outlet *hpump,out* [kJ/kg] |  |
| Pump power consumption [kW] |  |
| **Evaporator** | |
| Logarithmic temperature difference *∆Tlog,evap* [K] |  |
| Evaporation heat [kW] |  |
| Mass flow warm seawater [kg/s] |  |
| Heat transfer area evaporator *Aevap* [m2] |  |
| **Condenser** | |
| Logarithmic temperature difference *∆Tlog,cond* [K] |  |
| Condensation heat [kW] |  |
| Mass flow cold seawater [kg/s] |  |
| Heat transfer area condenser *Acond* [m2] |  |

Appendix B. Equations used in the design model (II/II). For work and heat, the following sign convention applies: flows into the system are positive, flows out of the system are negative.

|  |  |
| --- | --- |
| **Seawater Pipes (for both WW and CW)** | |
| Required total inner pipe area *A*tot [m2] |  |
| Inner diameter *dpipe* [m]  Number of pipes *Npipe* [-] | Increase *Npipe*­ in steps of 1 until *dpipe* ≤ *dmax* |
| Mass of pipes *mpipe* [kg] |  |
| Dynamic viscosity seawater *μ* [Pa\*s]  (Approximation function based on state table) |  |
| Reynolds number *Re* [-] |  |
| Darcy friction factor *fD* [-]  (Swamee-Jain equation) |  |
| Pressure drop in pipe *∆ppipe* [Pa] |  |
| Pressure drop in heat exchanger *∆pevap/cond* [Pa] |  |
| Power consumption seawater pump [kW] |  |
| **Net Power and Efficiency** | |
| Net Power Production [kW] |  |
| Net Thermal Efficiency [%] |  |
| **Exergy Analysis, Carnot Efficiency, and Second Law Efficiency** | |
| Dead-State Temperature *T0* [K] |  |
| Net Exergy Change *∆Ex* [kW] |  |
| Net Exergy Efficiency [%]  (*Exin* is the exergy inflow from the surface water in the evaporator) |  |
| Logarithmic Mean Surface Seawater Temperature *Tlog,WW* [K] |  |
| Carnot Efficiency [%] |  |
| Second Law Efficiency [%] |  |
| **LCOE** | |
| Capital Recovery Factor *CRF* [%] |  |
| Scaled specific capital expenses *capex* [US$ million/unit] |  |
| CAPEX without extra costs [US$ million]  (sum of *H* cost components. Unit can be gross power output, power consumption, mass or area) |  |
| Total *CAPEX* [US$ million] |  |
| Annual Electricity Production *AEP* [kWh/year]  (Sum of all 3-hour power outputs in a year. For leap years: *M* = 2,928; for non-leap years: *M* = 2,920) | On-Design Model:  Off-Design Model: |
| Levelized Cost of Electricity *LCOE* [US¢/kWh]  Annual Electricity Production *AEP* in year *i* calculated by off-design model in steps 6 and 7 in Figure 1. | On-Design LCOE:  Off-Design LCOE: |

Appendix G. System designs for 136 MWgross for all nine temperature configurations and high-cost assumptions in Ende. Only configuration 5 differs from the configurations with low-cost assumptions shown in Table 4 in the main text.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Configuration with High-Cost Assumptions** | | | | | | | | |
| **1**  **Min WW**  **Max CW** | **2**  **Med WW**  **Max CW** | **3**  **Max WW**  **Max CW** | **4**  **Min WW**  **Med CW** | **5**  **Med WW**  **Med CW** | **6**  **Max WW**  **Med CW** | **7**  **Min WW**  **Min CW** | **8**  **Med WW**  **Min CW** | **9**  **Max WW**  **Min CW** |
|  | Energy Balance (units in MW if not stated otherwise) | | | | | | | | |
| **Heat Evaporator** | 5,551 | 4,150 | 3,506 | 4,979 | 3,983 | 3,387 | 5,020 | 4,008 | 3,298 |
| **Heat Condenser** | -5,417 | -4,016 | -3,372 | -4,845 | -3,849 | -3,253 | -4,886 | -3,874 | -3,164 |
| **Gross Power Turbine** | -136 | -136 | -136 | -136 | -136 | -136 | -136 | -136 | -136 |
| **Power NH3 Pump** | 1.9 | 2.0 | 2.1 | 1.9 | 2.0 | 2.1 | 1.8 | 2.0 | 2.1 |
| **Power WW Pump** | 26.3 | 15.3 | 11.6 | 23.6 | 14.7 | 11.2 | 20.8 | 13.3 | 10.9 |
| **Power CW Pump** | 21.7 | 14.5 | 12.3 | 21.8 | 13.9 | 11.9 | 22.0 | 14.0 | 11.6 |
| **Losses NH3 Pump** | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| **Losses Turbine and Transmission** | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 |
| **Net Power Turbine at Shore** | -72.6 | -90.6 | -96.4 | -75.2 | -91.8 | -97.2 | -77.8 | -93.2 | -97.9 |
| **Net Thermal Efficiency [%]** | 1.3% | 2.2% | 2.8% | 1.5% | 2.3% | 2.9% | 1.5% | 2.3% | 3.0% |
|  | Exergy Balance (units in MW if not stated otherwise) | | | | | | | | |
| **Exergy Inflow Evaporator** | 275 | 256 | 244 | 259 | 252 | 241 | 264 | 256 | 239 |
| **Exergy Loss Evaporator** | -38.1 | -35.1 | -32.5 | -33.7 | -33.6 | -31.3 | -37.8 | -36.8 | -30.4 |
| **Exergy Loss Turbine** | -29.5 | -29.4 | -29.4 | -29.5 | -29.4 | -29.4 | -29.5 | -29.4 | -29.4 |
| **Exergy Loss Condenser** | -73.0 | -57.4 | -48.2 | -61.7 | -55.3 | -46.7 | -62.5 | -55.9 | -45.6 |
| **Exergy Loss NH3 Pump** | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 |
| **Exergy Loss WW Pump** | -26.3 | -15.3 | -11.6 | -23.6 | -14.7 | -11.2 | -20.8 | -13.3 | -10.9 |
| **Exergy Loss CW Pump** | -21.7 | -14.5 | -12.3 | -21.8 | -13.9 | -11.9 | -22.0 | -14.0 | -11.6 |
| **Exergy Loss Conversion Losses** | -13.5 | -13.5 | -13.5 | -13.5 | -13.5 | -13.5 | -13.5 | -13.5 | -13.5 |
| **Exergy Outflow at Shore** | -72.6 | -90.6 | -96.4 | -75.2 | -91.8 | -97.2 | -77.8 | -93.2 | -97.9 |
| **Net Exergy Efficiency [%]** | 26.4% | 35.4% | 39.5% | 29.0% | 35.6% | 40.3% | 29.5% | 36.4% | 40.9% |
| **Carnot Efficiency [%]** | 4.9% | 6.2% | 7.0% | 5.2% | 6.2% | 7.1% | 5.3% | 6.4% | 7.3% |
| **Second Law Efficiency [%]** | 26.4% | 35.4% | 39.5% | 29.0% | 35.6% | 40.3% | 29.5% | 36.4% | 40.9% |
|  | Mass Flows | | | | | | | | |
| **Mass Flow NH3 [kg/s]** | 4,523 | 3,379 | 2,850 | 4,043 | 3,237 | 2,749 | 4,073 | 3,254 | 2,673 |
| **Mass Flow WW [kg/s]** | 396,531 | 230,564 | 175,284 | 355,627 | 221,260 | 169,357 | 313,781 | 200,403 | 164,899 |
| **Mass Flow CW [kg/s]** | 300,962 | 200,808 | 168,589 | 302,789 | 192,434 | 162,661 | 305,395 | 193,702 | 158,202 |
|  | Temperature Changes | | | | | | | | |
| **Temperature Change WW [K]** | 3.5 | 4.5 | 5.0 | 3.5 | 4.5 | 5.0 | 4.0 | 5.0 | 5.0 |
| **Temperature Change CW [K]** | 4.5 | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 |
|  | Evaporator and Condenser | | | | | | | | |
| **Area Evaporator [m2]** | 530,146 | 349,381 | 279,171 | 475,458 | 335,283 | 269,730 | 448,899 | 319,177 | 262,630 |
| **Evaporation Temperature [°C]** | 19.2 | 22.8 | 25.1 | 19.2 | 22.8 | 25.1 | 18.7 | 22.3 | 25.1 |
| **Evaporation Pressure [bar]** | 8.4 | 9.4 | 10.1 | 8.4 | 9.4 | 10.1 | 8.2 | 9.2 | 10.1 |
| **Area Condenser [m2]** | 586,360 | 411,201 | 345,223 | 556,938 | 394,052 | 333,084 | 561,731 | 396,648 | 323,954 |
| **Condensation Temperature [°C]** | 10.6 | 11.1 | 11.1 | 9.6 | 10.6 | 10.6 | 9.2 | 10.2 | 10.2 |
| **Condensation Pressure [bar]** | 6.3 | 6.4 | 6.4 | 6.1 | 6.3 | 6.3 | 6.0 | 6.2 | 6.2 |
|  | Seawater Pipes | | | | | | | | |
| **Diameter CW Pipes [m]** | 7.9 | 7.9 | 7.2 | 7.9 | 7.7 | 7.1 | 7.9 | 7.7 | 7.0 |
| **Number of CW Pipes** | 6 | 4 | 4 | 6 | 4 | 4 | 6 | 4 | 4 |
| **Diameter WW Pipes [m]** | 7.9 | 6.9 | 7.4 | 7.4 | 6.8 | 7.3 | 7.0 | 7.9 | 7.2 |
| **Number of WW Pipes** | 8 | 6 | 4 | 8 | 6 | 4 | 8 | 4 | 4 |