|  |  |  |  |
| --- | --- | --- | --- |
| **Product System** | **Unit Process** | **Plant A** | **Plant B** |
| Water Treatment | Primary treatment | 16 x 4,000 m3 rectangular sedimentation tanks | 12 x 5,000 m3 circular sedimentation tanks |
| Waste Activated Sludge (WAS) | 16 x 11,300 m3 aerobic reactors | 16 x 11,500 m3 aerobic reactors |
| 16 x 6,000 m3 circular clarification tanks | 16 x 6,000 m3 circular sedimentation tanks |
| Disinfection contact chambers | 2 x 15,000 m3 rectangular raceways | 2 x 15,000 m3 rectangular raceways |
| Biosolids Production | Primary Sludge Thickening | 4 x 7,000 m3 circular gravitational thickeners | 6 x 1,500 m3 circular gravitational thickeners |
| Secondary Sludge Thickening | 6 x 1,000 m3 flotation thickeners | 8 x 2.5 m wide table thickeners |
| Pre-thickening Thermal Hydrolysis |  | 6 x 1,500 m3 gravitational pre-thickeners |
| Thermal Hydrolysis CAMBI |  | 2 x hydrolysis tanks, 6-11 bars, 140 ◦C |
| Anaerobic Digestors | 8 x 15,000 m3 reactors | 7 x 14,000 m3 reactors |
| Centrifuge | 5 x 2,300 kg TS/ h centrifuges | 6 x 1,500 kg TS/ h centrifuges |
| Gasometers | 2 x 27.5 m diameter | 2 x 27.5 m diameter |
| Biogas Production | Biogas Scrubbers | 1 x 4,500 Nm3/ h capacity | 2 x 4,500 Nm3/ h capacity |
| Biogas Carbon Dioxide Removal | 1 x 4,500 Nm3/ h capacity |  |
| Nutrient Removal | Coagulation-Flocculation | 1 x 4,000 m3 rectangular tank |  |
| Sequencing Batch Reactors | 1 x 4,000 m3 rectangular tank | 1 x 4,000 m3 rectangular tank |
| Anammox DEMON Reactors | 1 x 4,000 m3 rectangular tank | 1 x 4,000 m3 rectangular tank |

Table S1 Detailed technology descriptions implemented in Plant A and Plant B product systems.

Table S2. Normalized wastewater flow rates and substance concentrations of both influent and effluent for Plant A and Plant B for scenarios o: discharge without treatment, 1: conventional WWTPs and 2: biofactory WW-CE [1].

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Influent Characteristics | | | | | | Effluent Characteristics | | | | | |
| **Plant A Scenarios** | | | **Plant B Scenarios** | | | **Plant A Scenarios** | | | **Plant B Scenarios** | | |
| Parameters | | | **0** | **1** | **2** | **0** | **1** | **2** | **0** | **1** | **2\*** | **0** | **1** | **2** |
| Normalized Flows (m3/ FU) | Description | Q | 131,395.1 | 129,391.3 | 130,823.0 | 153,745.3 | 155,767.5 | 156,685.8 | 131,395.1 | 125,724.5 | 127,115.6 | 153,745.3 | 144,686.4 | 145,539.3 |
| Substance Concentrations (mg/ L) | Total Solids | TS | 351.99 | 506.76 | 516.46 | 321.18 | 364.18 | 359.65 | 351.99 | 26.46 | 30.40 | 321.18 | 12.87 | 14.22 |
| Volatile Solids | VS | 268.86 | 384.81 | 394.21 | 266.60 | 296.99 | 294.27 | 268.86 | 22.13 | 25.88 | 266.60 | 11.48 | 12.67 |
| Total Kjeldahl Nitrogen | TKN | 77.94 | 98.72 | 74.03 | 71.58 | 83.94 | 72.30 | 77.94 | 54.48 | 38.88 | 71.58 | 40.92 | 36.34 |
| Nitrate | NO3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0 | 0.87 | 0.73 | 0 | 0.60 | 0.53 |
| Nitrite | NO2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0 | 0.44 | 0.48 | 0 | 0.68 | 0.60 |
| Total Nitrogen | TN | 77.94 | 98.72 | 77.00 | 71.58 | 83.94 | 72.30 | 77.94 | 55.79 | 39.81 | 71.58 | 41.20 | 36.59 |
| Total Phosphorous | TP | 8.70 | 9.98 | 8.93 | 7.09 | 8.84 | 7.84 | 8.70 | 2.24 | 1.88 | 7.09 | 1.83 | 1.75 |
| Biological Oxygen Demand | BOD5 | 338.67 | 343.92 | 339.83 | 289.44 | 285.68 | 284.01 | 338.67 | 17.68 | 19.19 | 289.44 | 17.81 | 17.96 |
| Chemical Oxygen Demand | COD | 616.19 | 627.94 | 618.56 | 645.27 | 640.49 | 631.73 | 616.19 | 52.83 | 58.99 | 645.27 | 55.27 | 56.99 |
| Chlorine | Cl | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.26 | 0.26 | 0.00 | 0.33 | 0.33 |
| Arsenic | As | 0.0027 | 0.0039 | 0.0039 | 0.0025 | 0.0028 | 0.0028 | 0.0027 | 0.0002 | 0.0002 | 0.0025 | 0.0001 | 0.0001 |
| Cadmium | Cd | 0.0005 | 0.0007 | 0.0007 | 0.0004 | 0.0004 | 0.0004 | 0.0005 | 0.0000 | 0.0000 | 0.0004 | 0.0000 | 0.0000 |
| Chromium | Cr | 0.0456 | 0.0656 | 0.0668 | 0.1058 | 0.1090 | 0.1077 | 0.0456 | 0.0034 | 0.0039 | 0.1058 | 0.0042 | 0.0047 |
| Copper | Cu | 0.1747 | 0.2534 | 0.2578 | 0.3285 | 0.3386 | 0.3344 | 0.1747 | 0.0155 | 0.0178 | 0.3285 | 0.0156 | 0.0172 |
| Mercury | Hg | 0.0004 | 0.0006 | 0.0006 | 0.0003 | 0.0004 | 0.0004 | 0.0004 | 0.0000 | 0.0000 | 0.0003 | 0.0000 | 0.0000 |
| Molybdenum | Mo | 0.0038 | 0.0055 | 0.0056 | 0.0054 | 0.0061 | 0.0061 | 0.0038 | 0.0003 | 0.0003 | 0.0054 | 0.0002 | 0.0002 |
| Nickle | Ni | 0.0156 | 0.0225 | 0.0229 | 0.0249 | 0.0157 | 0.0155 | 0.0156 | 0.0012 | 0.0014 | 0.0249 | 0.0010 | 0.0011 |
| Lead | Pb | 0.0146 | 0.0211 | 0.0214 | 0.0152 | 0.0164 | 0.0162 | 0.0146 | 0.0011 | 0.0013 | 0.0152 | 0.0006 | 0.0007 |
| Selenium | Se | 0.0010 | 0.0015 | 0.0015 | 0.0009 | 0.0011 | 0.0010 | 0.0010 | 0.0001 | 0.0001 | 0.0009 | 0.00004 | 0.00004 |
| Zinc | Zn | 0.4038 | 0.5834 | 0.5936 | 0.3685 | 0.3798 | 0.3751 | 0.4038 | 0.0331 | 0.0381 | 0.3685 | 0.0161 | 0.0178 |
| Iron | Fe | 0.0079 | 0.0114 | 0.0116 | 0.0072 | 0.0063 | 0.0062 | 0.0079 | 0.0006 | 0.0007 | 0.0072 | 0.0003 | 0.0003 |
| Calcium | Ca | 20.3237 | 29.2445 | 29.7547 | 18.5451 | 19.1164 | 18.8785 | 20.3237 | 1.5280 | 1.7555 | 18.5451 | 0.7429 | 0.8211 |
| Magnesium | Mg | 2.7475 | 3.9534 | 4.0224 | 2.4975 | 2.5744 | 2.5424 | 2.7475 | 0.2066 | 0.2373 | 2.4975 | 0.1000 | 0.1106 |
| Manganese | Mn | 0.1672 | 0.2395 | 0.2438 | 0.1526 | 0.1018 | 0.1005 | 0.1672 | 0.0118 | 0.0136 | 0.1526 | 0.0058 | 0.0064 |

\*Not including water recovery

*Table S3. Normalized biosolid flow rates and substance concentrations for Plant A and Plant B for scenarios o: discharge without treatment, 1: conventional WWTPs and 2: biofactory WW-CE [1].*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | | Plant A Scenarios | | Plant B Scenarios | |
| **1** | **2** | **1** | **2** |
| Normalized Flows (m3/ FU) | Q | 100.16 | 100.16 | 131.15 | 132.39 |
| Substance Concentrations (mg/L) | TS | 202245.94 | 215142.51 | 196432.27 | 202245.94 |
| VS | 123572.27 | 133123.13 | 117458.08 | 129293.38 |
| TN (TKN) | 11366.22 | 8570.55 | 7250.86 | 7737.80 |
| TP | 3076.95 | 2672.56 | 5617.12 | 2009.89 |
| BOD5 | 196026.00 | 171690.96 | 152376.80 | 128943.03 |
| COD | 370948.98 | 371677.31 | 395834.80 | 325788.59 |
| Cl | 0.00 | 0.00 | 0.00 | 0.00 |
| As | 1.54 | 1.64 | 1.51 | 1.56 |
| Cd | 0.24 | 0.26 | 0.22 | 0.23 |
| Cr | 23.82 | 25.34 | 58.81 | 60.55 |
| Cu | 91.25 | 97.07 | 182.64 | 188.05 |
| Hg | 0.22 | 0.24 | 0.20 | 0.21 |
| Mo | 2.18 | 2.32 | 3.32 | 3.41 |
| Ni | 5.00 | 5.31 | 8.46 | 8.71 |
| Pb | 8.01 | 8.52 | 8.84 | 9.10 |
| Se | 0.59 | 0.62 | 0.57 | 0.59 |
| Zn | 210.94 | 224.39 | 204.88 | 210.94 |
| Fe | 3.50 | 3.73 | 3.40 | 3.50 |
| Ca | 10616.09 | 11293.05 | 10310.93 | 10616.09 |
| Mg | 1435.14 | 1526.65 | 1388.58 | 1429.68 |
| Mn | 56.51 | 60.11 | 54.88 | 56.51 |

*Table S4. Capital investment and maintenance costs of Plant A and Plant B normalized to 1,000,000 p.e./ day for scenarios 0: discharge without treatment, 1: conventional wastewater treatment plants and 2: biofactory wastewater circular economies.*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Plant A Scenarios | | Plant B Scenarios | |  |
| Input | Product System | Unit/ FU | 1 | 2 | 1 | 2 | Sources |
| Capital Investment Civil Works and Equipment | Water Treatment | $USD | 74,522 | 76,038 | 158,312 | 159,246 | [1], [2] |
| Sludge Treatment | 42,312 | 42,780 | 60,058 | 79,545 |
| Biosolids Recovery | 0 | 12,680 | 0.00 | 18,301 |
| Biogas Recovery | 0 | 5,692 | 0.00 | 18,368 |
| Anammox | 0 | 21,844 | 0.00 | 23,887 |
| Maintenance Costs Civil Works and Equipment | Water Treatment | 775 | 791 | 1,200 | 1,106 |
| Sludge Treatment | 844 | 853 | 1,083 | 1,640 |
| Biosolids Recovery | 0 | 142 | 0 | 136 |
| Biogas Recovery | 0 | 234 | 0 | 844 |
| Anammox | 0 | 227 | 0 | 166 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Table S5. Integrated LCA and LCC inventories of Plant A and Plant B normalized to 1,000,000 p.e./ day for scenarios 0: discharge without treatment, 1: conventional wastewater treatment plants and 2: biofactory wastewater circular economies.* | | | | Plant A Scenarios | | Plant B Scenarios | |  | LCC Prices | Plant A Scenarios | | Plant B Scenarios | |  |
| Inputs/ Outputs | Product System | Inventory Description | Unit/ FU | 1 | 2 | 1 | 2 | Source | $USD/ Unit | 1 | 2 | 1 | 2 | Source |
| Chemicals | Water | Influent | m3 | 129,936 | 131,694 | 155,767 | 156,686 | [1] | 0.854 | 110,970 | 112,470 | 133,030 | 133,810 | [1] |
| Chlorine | kg | 579 | 636 | 890 | 890 | 0.68 | 394 | 433 | 605 | 605 |
| Sludge | Polymers | 1,064 | 1,039 | 395 | 790 | 4.62 | 4,916 | 4,800 | 1,826 | 3,648 |
|  | Ferric Chloride | 233 | 242 | 0 | 0 | 739.51 | 172,306 | 178,961 | 0 | 0 |
| Energy Recovery | Caustic Soda | 0 | 1,007 | 0 | 1,921 | 0.00344 | 0 | 3.5 | 0 | 6.6 |
|  | Nutrients | 0 | 5 | 0 | 2 | 3.3 | 0 | 16.5 | 0 | 5.9 |
|  | Activated Carbon | 0 | 16.5 | 0 | 0 | [3] | 0.28 | 0 | 46.2 | 0 | 0 |
|  | Refrigerant | 0 | 0 | 0 | 701 | [1] | 31.16 | 0 | 0 | 0 | 21,843 |
|  | Motor Oil | 0 | 0 | 0 | 124 | 12.15 | 0 | 0 | 0 | 1,507 |
| Nitrogen Abatement | Sulfuric Acid | 0 | 1,047 | 0 | 66 | [4] | 0.7 | 0 | 733 | 0 | 46 |
|  | Caustic Soda | 0 | 748 | 0 | 0 | 0.00344 | 0 | 2.6 | 0 | 0 |
|  | Ferric Chloride | 0 | 3 | 0 | 0 | 739.51 | 0 | 2,219 | 0 | 0 |
|  | Magnesium Oxide | 0 | 0 | 0 | 286 | 0.66 | 0 | 0 | 0 | 189 |
| Energy | Water | Activated Sludge | kWh | 25,669 | 27,396 | 31,996 | 32,975 | [1] | 0.0075 | 192.5 | 205.5 | 239.9 | 247.3 | Assumption |
| Sludge | Thickening | 2,294 | 2,427 | 2,866 | 2,969 | [3] | 0.0075 | 17.2 | 18.2 | 21.5 | 22.3 |
|  | Anaerobic Digestion | 17,052 | 18,040 | 17,676 | 18,308 | [1] | 0.0075 | 127.89 | 135.3 | 132.6 | 137.3 |
|  | Centrifuge | 1,529 | 1,618 | 1,911 | 1,979 | [3] | 0.0075 | 11.47 | 12.14 | 14.3 | 14.8 |
|  | THP | 0 | 0 | 0 | 11,875 | 0.0075 | 0 | 0 | 0 | 89.1 |
| Energy Recovery | Biogas Upgrading (H2S) | 0 | 3,291 | 0 | 2,944 | [5] | 0.0075 | 0 | 24.68 | 0 | 22.1 |
|  | Biogas Methanization (CO2) | 0 | 2,962 | 0 | 0 | 0.0075 | 0 | 22.22 | 0 | 0 |
|  | Biomethane Gas to Grid | 0 | 7,618 | 0 | 0 | [1] | 0.0075 | 0 | 57.12 | 0 | 0 |
| Nitrogen Abatement | Anammox | 0 | 1,250 | 0 | 3,010 | [3] | 0.0075 | 0 | 9.375 | 0 | 22.6 |
| Transport and Waste Transport\* | Water Treatment | Cl2 | t-km | 208 | 222 | 508 | 511 | [1] | 0 |  |  |  |  | [1] |
| Biosolids Management \* | Biosolids Landfill | kg | 20,256 | 5,130 | 25,762 | 3,350 | 47 | 151,920 | 38,475 | 193,215 | 25,125 |
|  | Biosolids Agriculture | 0 | 15,400 | 0 | 22,413 | 7.5 | 0 | 115,500 | 0 | 168,100 |
| Energy Recovery | NaOH | t-km |  | 612 |  | 1434 | 0 | 0 | 0 | 0 | 0 |
|  | Nutrients (Glucose) |  | 6 |  | 2 | 0 | 0 | 0 | 0 | 0 |
|  | AC |  | 9 |  |  | 0 | 0 | 0 | 0 | 0 |
|  | Refrigerant |  |  |  | 418 | 0 | 0 | 0 | 0 | 0 |
|  | Motor Oil Lubricant |  |  |  | 71 | 0 | 0 | 0 | 0 | 0 |
| Nitrogen Removal | H2SO4 |  |  |  | 2 | 0 | 0 | 0 | 0 | 0 |
|  | MgO |  |  |  | 378 | 0 | 0 | 0 | 0 | 0 |
|  | FeCl3 |  | 463 |  |  | 0 | 0 | 0 | 0 | 0 |
|  | NaOH |  | 599 |  |  | 0 | 0 | 0 | 0 | 0 |
| Products and avoided products | Water | Treated Effluent | m3 | 0 | 26,340 | 0 | 0 | 0.854 | 0 | 22,493 | 0 | 0 |
| Biosolids Management | Fertilizer | Kg | 0 | 7,700 | 0 | 11,207 | 0.65 | 0 | 5,005 | 0 | 7,285 | [6] |
| Energy Recovery | Natural Gas | kg | 0 | 31,355 | 0 | 0 | 0.132 | 0 | 4,160 | 0 | 0 | [1] |
|  | Electricity | kWh | 0 | 18,040 | 0 | 66,083 | 0.0075 | 0 | 0 | 0 | 496 | Assumption |

Table S6. LCA inventory outputs of Plant A and Plant B normalized to 1,000,000 p.e./ day for scenarios 0: discharge without treatment, 1: conventional wastewater treatment plants and 2: biofactory wastewater circular economies.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | Plant A Scenarios | | Plant B Scenarios | |  |
| Outputs | System | Description | Unit/FU | 1 | 2 | 1 | 2 | Sources |
| Emissions to Air | All | CO2 | kg | 16620 | 17184 | 28800 | 6490 | Table E.3 and E.6 Supplementary Data |
|  |  | CO2 Biogenic |  | 124200 | 125270 | 209100 | 192982 |
|  |  | CO |  | 0 | 0 | 0 | 3 |
|  |  | CH4 Biogenic |  | 24208 | 25306 | 25784 | 25029 |
|  |  | NOx |  | 0 | 0 | 1 | 3 |
|  |  | PM |  | 3 | 2 | 4 | 1 |
|  |  | H2S |  | 310 | 0 | 368 | 0 |
|  |  | N-NO2 |  | 76 | 99 | 91 | 70 |
| Energy | Sludge Treatment | Anaerobic Digestor Boiler | kWh |  | 17076 |  | 18627 | [1] |
|  | Energy Recovery | DBM Supply |  |  | 31355 |  |  |
|  |  | Electricity CHP Self-Supply |  |  |  |  | 32692 |
|  |  | Electricity Injected to Grid |  |  |  |  | 4458 |
|  |  | Heat Recovery THP Boiler |  |  |  |  | 10306 |

Table S7. Type II SLCA stakeholder quantities per product system of Plant A and Plant B normalized to 1,000,000 p.e./ day for scenarios 0: discharge without treatment, 1: conventional wastewater treatment plants and 2: biofactory wastewater circular economies.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | | Plant A Scenarios | | Plant B Scenarios | |
| Stakeholder | Product System | Description | 1 | 2 | 1 | 2 |
| Workers | Water |  | 8 | 11 | 14 | 19 |
| Sludge |  | 8 | 11 | 14 | 19 |
| Biosolids Management |  | 0 | 1 | 0 | 1 |
| Energy |  | 0 | 2 | 0 | 1 |
| Anammox |  | 0 | 0 | 0 | 0 |
| Local Community | Water | Community 1 | 248 | 248 | 9 | 9 |
|  | Community 2 | 579 | 579 | 112 | 112 |
|  | Community 3 | 6,617 | 6,617 | 0 | 0 |
|  | Laundry Service | 0 | 1 | 0 | 0 |
|  | Clothes Recycling | 0 | 1 | 0 | 0 |
|  | Water Provider | 0 | 1 | 0 | 0 |
| Biosolids | Community 1 | 0 | 496 | 0 | 398 |
|  | Community 2 | 0 | 33 | 0 | 27 |
| Children | All | Local Communities | 1,861 | 1,901 | 30 | 136 |
|  | School Supplies | 191 | 191 | 268 | 268 |
|  | School Visits | 1,006 | 791 | 1,414 | 1,112 |
|  | School Education | 2,188 | 9,429 | 3,076 | 13,253 |
| Farmers | Water |  | 0 | 34 | 0 | 0 |
| Biosolids |  | 0 | 66 | 0 | 93 |
| Clients | Water | Population Equivalent | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 |
| Energy | Gas Company | 0 | 496 | 0 | 0 |
| VCA (Maintenance, Laboratory, Chemicals, Transport, Energy) | Water | Total | 1.2 | 1.2 | 1.6 | 1.6 |
| Sludge | Total | 1.3 | 1.3 | 1.6 | 1.6 |
| Biosolids | Total | 0.2 | 0.2 | 0.2 | 0.2 |
| Energy | Total | 0.0 | 0.7 | 0.0 | 0.7 |
| Anammox | Total | 0.0 | 0.8 | 0.0 | 0.9 |
| Society | All | Metropolitan Region | 1,164,046 | 1,134,271 | 1,636,169 | 1,594,317 |

Table S8. Social Life Cycle Assessment Type II midpoint characterization inventories of Plant A and Plant B normalized to 1,000,000 p.e./ day for scenarios 0: discharge without treatment, 1: conventional wastewater treatment plants and 2: biofactory wastewater circular economies.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | Plant A Scenarios | | Plant B Scenarios | |
| Impact Category | Subcategory Description | Indicator | Measure/Stakeholder/ FU | 1 | 2 | 1 | 2 |
| Working Conditions | Equal Opportunities $ | Training | Hours | 0.16 | 6.67 | 0.26 | 4.16 |
| Fair Wage | % | 73.58 | 96.00 | 99.16 | 140.99 |
| Inclusion % | Gender Equality | % | 3.71 | 3.54 | 6.29 | 4.27 |
| Indigenous | % | 0.00 | 0.00 | 0.00 | 0.00 |
| Disability | % | 0.00 | 0.41 | 0.00 | 0.25 |
| Health and Safety ($) | Accidents |  | -137.71 | -68.13 | -233.42 | -91.40 |
| Training Health and Safety | Hours | 3.38 | 12.90 | 5.72 | 11.59 |
| Risk | Risk Level | Risk | -516.15 | -555.92 | -519.74 | -1310.91 |
| Socio-cultural Responsibility | Access to Immaterial Resources and Security % | Local Jobs/ VCA |  | 19.21 | 30.60 | 31.76 | 39.02 |
| Promotion of Corporate Social Responsibility (CSR) with VCA | % | 0.00 | 0.00 | 0.00 | 0.00 |
| Investigation and Development $ | Investigations and Development | $ | 0.00 | 408.34 | 0.00 | 573.95 |
| Education $ | Education | Hours | 1.84 | 16.08 | 4.05 | 34.05 |
| Participation in Farmers Organization | Hours | 0.00 | 0.00 | 0.00 | 0.00 |
| Contribution to Preservation of Culture | Hours | 0.00 | 0.00 | 0.00 | 0.00 |
| Community Initiatives and Corporate Social Responsibility (CSR) | $ | 59.55 | 218.09 | 16.08 | 60.19 |
| Environmental Responsibility | Access to Material Resources ($) | Infrastructure with Community Access | $ | 22.33 | 22687.61 | 48.36 | 1353.71 |
| Quality Assurance and Crop Yield | % | 100.00 | 220.00 | 100.00 | 120.00 |
| End of Life Management | % | 0.00 | 135.00 | 0.00 | 163.00 |
| Data ($) | Legislative Compliance |  | -11.91 | -0.71 | -0.19 | -0.11 |
| Data Monitoring | Hours | 7.00 | 9.02 | 7.00 | 7.49 |
| Management Systems |  | 42.00 | 84.00 | 42.00 | 84.00 |
| Conservation (Ha) | Contribution to Ecological Conservation | Ha | 2.23 | 2.23 | 0.04 | 0.04 |
| Governance | Feedback Mechanisms ($) | Feedback Mechanisms | Hours | 1.95 | 65.92 | 7.49 | 49.93 |
| Complaints |  | -6252.80 | -20637.78 | -29.02 | -148.90 |
| Engagement ($) | Inclusion of first nations | Hours | 0.00 | 0.00 | 0.00 | 0.00 |
| Engagement | Hours | 447.03 | 750.07 | 3.02 | 10.77 |
| Collective Bargaining (%) | Collective Bargaining | % | 6.58 | 9.67 | 11.16 | 14.87 |

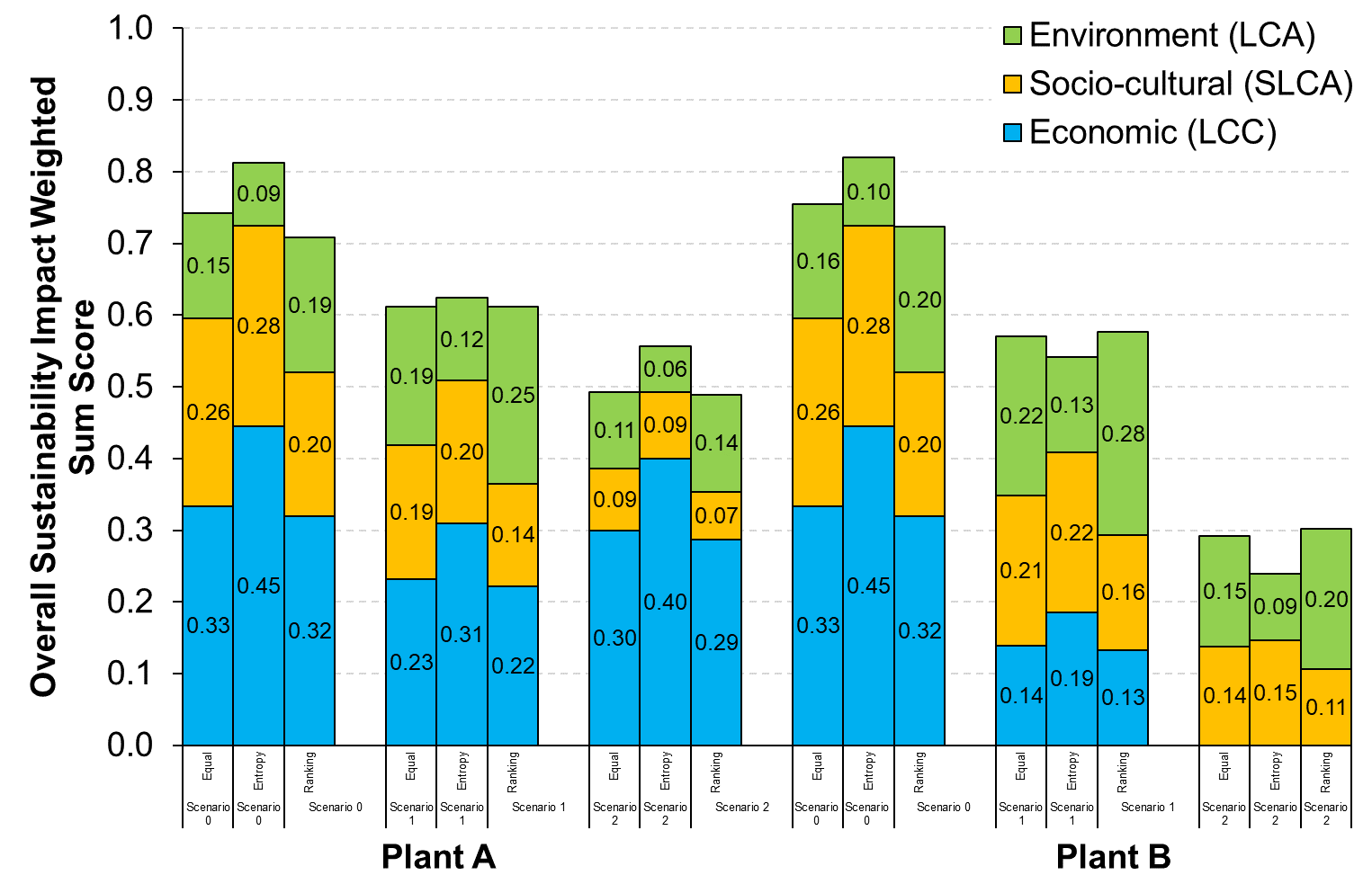
Table S9. Summary of the relationships between social impact categories, inventory categories and subcategories to relevant stakeholders [7].

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Impact Category | Abbreviation | Inventory Subcategory | Inventory Subcategory Indicators | Monetized Factors  (USD/ Unit) | Unit/ FU | W | LC | F | VCA | C | S |
| Working Conditions | WC | Equal Opportunities ($) | Training | 2 | Hours | ü |  |  |  |  |  |
| Fair Wage | 2 | % | ü |  |  |  |  |  |
| Inclusion (%) | Gender Equality | 1 | % | ü |  |  |  |  |  |
| Indigenous | 1 | % | ü |  |  |  |  |  |
| Disability | 1 | % | ü |  |  |  |  |  |
| Health and Safety ($) | Accidents\* | 12 |  | ü |  |  |  |  |  |
| Training Health and Safety | 2 | Hours | ü |  |  |  |  |  |
| Risk | Risk Level\* | 1 | Risk | ü |  |  |  |  |  |
| Socio-cultural Responsibility | SR | Access to Immaterial (%) | Local Jobs/ VCA | 1 |  |  | ü |  | ü |  |  |
| Promotion of CSR | 1 | % |  |  |  |  |  |  |
| Technology ($) | Investigations and Development | 1 | $ |  |  |  |  |  | ü |
| Education ($) | Education | 2 | Hours |  | ü | ü | ü |  |  |
| Participation in Farmers Organization | 2 | Hours |  |  | ü |  |  |  |
| Contribution to Preservation of Culture | 2 | Hours |  | ü |  |  |  |  |
| Community Initiatives and CSR | 1 | $ |  | ü |  |  |  |  |
| Environmental Responsibility | ER | Access to Material Resources ($) | Infrastructure with Community Access | 1 | $ |  | ü |  |  |  |  |
| Quality Assurance and Crop Yield | 1 | % |  |  | ü |  | ü |  |
| End of Life Management | 1 | % |  |  |  |  | ü |  |
| Data ($) | Legislative Compliance\* | 80 |  |  | ü |  |  |  |  |
| Data Monitoring | 2 | Hours |  | ü |  |  | ü |  |
| Management Systems | 14 |  |  |  |  |  |  | ü |
| Conservation (Ha) | Contribution to Ecological Conservation | 1 | Ha |  | ü |  |  |  |  |
| Public Governance | PG | Feedback Mechanisms ($) | Feedback Mechanisms | 2 | Hours |  | ü | ü | ü | ü |  |
| Complaints\* | 12 |  |  |  |  |  |  |  |
| Engagement (Hours) | Inclusion of First Nations | 1 | Hours |  |  | ü |  |  |  |
| Engagement | 1 | Hours |  | ü | ü | ü |  |  |
| Collective Bargaining (%) | Unionized workers | 1 | % | ü |  |  |  |  |  |

\*Measures/ activity variables considered negative values to represent social risk

Supplementary Data 1

[Link to LCSA WW-CE survey Spanish](https://questionpro.com/t/AWJbyZzPaA​)

Figure S1. Comparison of equal, entropy and ranked reciprocal weighted sum methods for overall sustainability impact.

**References**

[1] LWC, “Operational Data,” Santiago, 2019.

[2] D. Vineyard, A. Hicks, K. G. Karthikeyan, and P. Barak, “Economic analysis of electrodialysis, denitrification, and anammox for nitrogen removal in municipal wastewater treatment,” *J. Clean. Prod.*, vol. 262, p. 121145, 2020, doi: 10.1016/j.jclepro.2020.121145.

[3] N. Mills *et al.*, “Second Generation Thermal Hydrolysis Processes,” *Proc. Water Environ. Fed.*, vol. 2014, no. 2, pp. 1–13, 2015, doi: 10.2175/193864714816196925.

[4] R. C. Maggi, “Implementacion de Tecnologias Anammox en Biofactorias,” Valparaiso, 2017.

[5] F. Ardolino, G. F. Cardamone, F. Parrillo, and U. Arena, “Biogas-to-biomethane upgrading: A comparative review and assessment in a life cycle perspective,” *Renew. \& Sustain. ENERGY Rev.*, vol. 139, 2021, doi: 10.1016/j.rser.2020.110588.

[6] ODEPA, “Evolucion de precios de fertilizantes internacional, importacion y nacional al mes de junio 2023,” *Reporte Interactivo de Precios de Fertilizantes*, 2023. https://apps.odepa.gob.cl/powerBI/reporte\_fertilizantes.html (accessed Aug. 11, 2023).

[7] SETAC, “Guidelines for Social Life Cycle Assessment of Products,” *Management*, vol. 15, no. 2, p. 104, 2020, [Online]. Available: http://www.unep.fr/shared/publications/pdf/DTIx1164xPA-guidelines\_sLCA.pdf