**Supplementary Materials**

**Table S1.** Properties of the feedstocks.

|  |  |  |  |
| --- | --- | --- | --- |
| Properties | Oat straw | Sawdust | Source |
| Bulk density (kg/m3) | 127.87 | 158.00 | [29,31] |
| HHV (MJ/kg) | 16.84 | 18.02 | [29,31,34] |
| Cellulose (%) | 47.45 | 41.24 | [29,31] |
| Hemicellulose (%) | 24.70 | 15.72 | [29,31,34] |
| Lignin (%) | 12.92 | 25.16 | [29,31] |
| Ash (%) | 5.32 | 0.54 | [29,31] |
| Other solids (%) | 9.61 | 7.34 | [29,31] |
| Moisture content (%) | 10 | 10 | [29,31] |

**NB**; HHV: Higher heating value

**Table S2.** Cost assumptions and economic evaluation parameters.

|  |  |  |
| --- | --- | --- |
| Parameters | Value | Source |
| Time parameters |  |  |
| Year of analysis | 2023 |  |
| Currency | US Dollars ($) |  |
| Construction period | 12 months |  |
| Startup period | 6 months |  |
| Project lifetime | 20 years |  |
| Inflation | 2% |  |
| Financial parameters |  |  |
| Depreciation style | Straight line |  |
| Depreciation time | 10 years |  |
| Revenue tax rate | 40% |  |
| Salvage value | 5% of DFC |  |
| Discount rate | 7% |  |
| Operating cost |  |  |
| Operation capacity | 90% |  |
| Labor | $ 69/h | SuperPro designer databank |
| Sawdust | $ 75/t | Antonio et al. [40] |
| Oat straw | $ 70/t | BIMAT [36] |
| Nitrogen gas | 0.11 / Nm3 | EIA [6] |
| Selling price of pellet | $60/t - $260/t | [18,26,51] |
| Selling price of torrefaction liquid | $0.25/L | Badger et al. [27] |
| Utilities |  |  |
| Steam (High P) | $ 20/t | SuperPro designer databank |
| Steam | $ 12/t | SuperPro designer databank |
| Cooling water | $ 0.05/t | SuperPro designer databank |
| Electricity | $ 0.1/kW-h | SuperPro designer databank |

**NB;** DFC: Direct fixed capital cost.



**Figure S1.** The process of pelleting raw sawdust (Case scenario 1).



**Figure S2.** The process of pelleting raw oat straw (Case scenario 2).



**Figure S3.** Integrated torrefied treated oat straw pelletization plant utilizing torrefaction liquid (TL) as binder (Case scenario 4).



**Figure S4.** Integrated steam exploded treated sawdust pellet plant (case scenario 5).

**Table S3.** Major equipment costs (2023 prices in US$) for scenarios 1 and 2.

|  |  |  |
| --- | --- | --- |
| Description | Cost ($) (number of units in parentheses) | |
| **Scenario 1** | **Scenario 2** |
| Silo/bin | 477,000 (4) | 247,000 (2) |
| Grinder |  | 154,000 (1) |
| Screw conveyor | 176,000 (2) | 162,000 (2) |
| Belt conveyor |  | 177,000 (1) |
| Pelletizer | 212,000 (1) | 212,000 (1) |
| Heat exchanger | 23,000 (1) | 23,000 (1) |
| Bucket elevator | 20,000 (1) | 20,000 (1) |
| Unlisted equipment | 230,000 | 265,000 |
| Total | **1,148,000** | **1,323,000** |

**Table S4.** Major equipment costs (2023 prices in US$) for scenarios 3 and 4.

|  |  |  |
| --- | --- | --- |
| Description | Cost ($) (number of units in parentheses) | |
| **Scenario 3** | **Scenario 4** |
| Silo/bin | 477,000 (4) | 338,000 (3) |
| Grinder |  | 301,000 (2) |
| Screw conveyor | 374,000 (4) | 254,000 (3) |
| Torrefaction reactor | 3,875.000 (1) | 3,875.000 (1) |
| Condenser | 34,000 (1) | 34,000 (1) |
| Flow splitter | 163,000 (1) | 163,000 (1) |
| Horizontal tank | 48,000 (2) | 24,000 (1) |
| Belt conveyor |  | 789,000 (3) |
| Pelletizer | 185,000 (1) | 212,000 (1) |
| Vibrating screen | 33,000 (1) | 38,000 (1) |
| Heat exchanger | 420,000 (8) | 236,000 (4) |
| Bucket elevator | 20,000 (1) | 23,000 (1) |
| Unlisted equipment | 1,410,000 | 1,572,000 |
| Total | **7,048,000** | **7,859,000** |

**Table S5.** Major equipment costs (2023 prices in US$) for scenarios 5 and 6.

|  |  |  |
| --- | --- | --- |
| Description | Cost ($) (number of units in parentheses) | |
| **Scenario 5** | **Scenario 6** |
| Steam generator | 638,000 (1) | 641,000 (1) |
| Dryer | 131,000 (1) | 264,000 (2) |
| Silo/bin | 140,000 (2) | 70,000 (1) |
| Grinder |  | 109,000 (1) |
| Screw conveyor | 272,000 (3) | 275,000 (3) |
| Belt conveyor |  | 263,000 (3) |
| Pelletizer | 273,000 (1) | 273,000 (1) |
| Vibrating screen | 13,000 (1) | 12,000 (1) |
| Heat exchanger | 210,000 (4) | 363,000 (6) |
| Bucket elevator | 23,000 (1) | 23,000 (1) |
| Unlisted equipment | 425,000 | 535,000 |
| Total | **2,125,000** | **2,675,000** |