CLAIMS

WHAT IS CLAIMED IS:

1. A system for producing a hydrocarbon-based fuels, the system comprising:

a biomass feedstock processing unit configured to remove waste from a feedstock to produce a processed feedstock;

a gasification unit in communication with the biomass feedstock processing unit, wherein the gasification unit is configured to convert the processed feedstock into syngas comprising carbon dioxide, carbon monoxide, and hydrogen;

a reactor downstream from the gasification unit, wherein the reactor is operated at suitable conditions to promote conversion of portions of the syngas to produce a proper ratio of hydrogen to CO;

a scrubber in communication with the reactor, wherein the scrubber removes carbon dioxide from the syngas to produce a purified syngas having a hydrogen to carbon monoxide ratio of at least 1.5:1;

a Fischer Tropsch reactor for receiving the purified syngas, wherein the Fischer Tropsch reactor converts the purified syngas into Fischer-Tropsch liquids, water, and tail gas;

an electrolysis unit configured to receive the water from the Fischer Tropsch reactor, wherein the electrolysis unit converts the water into an oxygen stream and a hydrogen stream; and

a reverse water-gas shift reactor, wherein a portion of the carbon dioxide removed from the syngas in the scrubber is recycled to the reverse water-gas shift reactor;

wherein a portion of the oxygen stream is recycled to the gasification unit, the reactor, or combinations thereof; and

wherein the system achieves at least 90 % carbon conversion of the processed feedstock.

2. The system of claim 1, wherein a portion of the hydrogen stream produced by the electrolysis unit is provided to the reverse water-gas shift reactor, wherein the reverse

water-gas shift reactor is configured to produce carbon monoxide that is supplied to the Fischer Tropsch reactor.

3. The system of claim 2, wherein the syngas streams and the hydrogen stream are pressurized prior to being supplied to the Fischer Tropsch reactor.

4. The system of claim 1, wherein the tail gas from the Fischer Tropsch reactor is recycled to the reactor.

5. The system of claim 1, further comprising a hydrocracker unit, a fractionation unit, an isomerization unit, or combinations configured to upgrade the Fischer-Tropsch liquids into fuel, wherein a byproduct of the hydrocracker unit comprises tail gas, wherein a byproduct of the fractionation unit comprises naphtha.

6. The system of claim 5, wherein the tail gas, naphtha, or both, are recycled to the reactor.

7. The system of claim 1, further comprising a flue gas scrubber configured to scrub any flue gas generated by the system, wherein the reactor is a dry reformer.

8. The system of claim 7, further comprising a carbon dioxide treatment and compression system, wherein carbon dioxide produced from the scrubber and the flue gas scrubber is processed in the carbon dioxide treatment and compression system to produce a purified carbon dioxide stream, wherein the purified carbon dioxide stream is recycled to the dry reformer, the reverse water-gas shift reactor, a CO_2 electrolysis unit, or combinations thereof.

9. The system of claim 1, wherein the feedstock comprises one or more of railroad ties, greasewood, corn stover, orchard prunings, forest thinnings, slash, switch grass, wood chips, lignin, and cellulosic material.

10. The system of claim 1, wherein the feedstock comprises woody biomass.

11. The system of claim 1, further comprising a pre-reformer and an autothermal reforming unit configured to convert a natural gas feedstock into syngas.

12. The system of claim 1, further comprising a CO_2 electrolysis unit configured to convert a portion of the carbon dioxide and water removed from the system into carbon monoxide and hydrogen.

13. A process for producing a hydrocarbon-based fuel, the process comprising the steps of:

gasifying a biomass feedstock to produce a syngas stream comprising carbon dioxide, hydrogen, and carbon monoxide;

reforming the syngas stream to produce a hydrogen-enriched syngas stream;

separating carbon dioxide from the hydrogen-enriched syngas stream in a separation unit to produce a carbon dioxide stream and a purified syngas stream having a hydrogen to carbon monoxide ratio of at least 1.5:1;

enriching the purified syngas with additional hydrogen;

reacting the purified syngas stream and hydrogen enriched syngas stream, in a Fischer Tropsch reactor to produce Fischer-Tropsch liquids, water, and tail gas;

recycling a portion of the water from the Fischer Tropsch reactor to an electrolysis unit;

electrolyzing the water in the electrolysis unit to produce an oxygen stream and a hydrogen stream; and

recycling a portion of the hydrogen stream and a portion of the carbon dioxide stream to a reverse water-gas-shift reactor to produce carbon monoxide.

14. The process of claim 13, further comprising purifying the carbon dioxide stream generated from the separation unit to produce a purified carbon dioxide stream, recycling the purified carbon dioxide stream to the reforming step.

15. The process of claim 13, further comprising recycling a portion of the oxygen stream and a portion of the hydrogen stream to the gasification step, the reforming step, or combinations thereof.

16. The process of claim 13, further comprising processing natural gas in a reforming unit to produce a second syngas stream that is supplied to the Fischer Tropsch reactor.

17. The process of claim 13, wherein the electrolysis unit is powered by solar energy, wind energy, hydroelectric energy, nuclear energy, or tidal energy.

18. The process of claim 13, further comprising treating the water from the Fischer Tropsch reactor to produce purified water, wherein the purified water is electrolyzed in the electrolysis unit.