CLAIMS

1. A multifunctional waste processing system for electricity and potable water generation, comprising:

a first stage fuel dryer assembly having a first pressurized vessel configured to contain sludge comprising water and solids, the first-stage dryer assembly having a second pressurized vessel adjacent to the first pressurized vessel, wherein the second pressurized vessel is configured to contain high temperature exhaust steam isolated from the sludge and that heats and partially dries the sludge and generates first sludge water in vapor phase and thickened sludge;

a second stage fuel dryer assembly having a third pressurize vessel configured to receive the thickened sludge, and fourth pressurized vessel adjacent to the third inner drying vessel, wherein the fourth pressurized vessel is configured to receive and contain the first sludge water in vapor phase so the first sludge water is isolated from the thickened sludge, and wherein the first sludge water in vapor phase heats and dries the thickened sludge to provide second sludge water in vapor phase and dried solid fuel material, and wherein at least a portion of the first sludge water is condensed to liquid phase;

a water treatment system that receives the first and second sludge water in either vapor phase or liquid phase or both, wherein the water treatment system has a condenser, a purifier, and filter, wherein the first or second sludge water in vapor phase are condensed and the first and second sludge water in liquid phase are purified and filtered to provide potable water;

a combustor assembly configured to burn the dried solid fuel from the second stage fuel dryer assembly to generate steam in a boiler; and

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a steam powered generator assembly powered by the steam from the boiler and configured to generate electricity, wherein the steam powered generator assembly creates the high temperature exhaust steam.

2. The system of claim 1 wherein first pressurized vessel is contained within the second pressurized vessel.

3. The system of claim 1 wherein third pressurized vessel is contained within the fourth pressurized vessel.

4. The system of claim 1 wherein first stage fuel dryer assembly includes a steam heated auger rotatably supported in the first pressurized vessel.

5. The system of claim 1 wherein the first-stage dryer assembly comprises a plurality of scraper plates positioned in the first pressure vessel and movable relative to the second pressure vessel to move the sludge relative to the second pressure vessel.

6. The system of claim 1, wherein the steam powered generator assembly comprises a steam engine and a generator.

7. The system of claim 1 where the first and second stage fuel dryer assemblies, the water treatment system, and the generator assembly are mounted on a frame and transportable with the frame as a unit.

8. A multifunctional wet waste processing system for electricity and clean water generation, comprising:

a fuel dryer assembly having a fuel path with a fuel inlet configured to receive a flow of wet organic-based sludge comprising a mixture of water and solid fuel material, the fuel dryer assembly having a heater

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portion configured to boil the sludge and thermally separate water from the solid fuel material to provide dried fuel, the fuel dryer having a first steam outlet, a dry fuel outlet, and a condenser portion having fluid path with a steam inlet and a fluid outlet, the fluid path being isolated from the fuel path;

a fresh water condenser assembly coupled to the first steam outlet and configured to condense water vaporized from the sludge into clean liquid water;

a dry fuel combustor assembly coupled to the dry fuel outlet of the fuel dryer assembly, the dry fuel combustor assembly having a combustor portion and having a boiler configured to receive heat from the combustor portion, the boiler having a first water inlet and a second steam outlet;

a steam-powered generator coupled to the second steam outlet of the boiler and configured to generate electricity, the steam-powered generator having a third steam outlet coupled to the steam inlet of the condenser portion; and

a water pump having a second water inlet coupled to the fluid outlet of the condenser portion of the fuel dryer; and the water pump having a water outlet coupled to the first water inlet of the boiler;

wherein the boiler is configured to convert a flow of water entering the boiler to a flow of steam to power the steam-powered generator.

9. The system of claim 8 wherein the fuel dryer assembly comprises a steam-heated auger in the fuel carrier and configured to move and heat the sludge during the drying process.

10. The system of claim 8 wherein the fuel dryer assembly is a multi-segment dryer having sequential first and second dryer segments each coupled to the condenser

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portion and each configured to dry the sludge by vaporizing water from the sludge using heat from exhaust steam from the steam-powered generator.

11. The system of claim 10 wherein the first dryer segment generates sludge steam from the sludge, and the second dryer segment uses the sludge steam from the first dryer segment to dry the sludge.

12. The system of claim 10 wherein the first dryer segment generates first dryer steam from water vaporized from the sludge, and the second dryer segment has a first steam carrier portion coupled to the first dryer segment and configured to carry the first dryer steam adjacent to the fecal sludge, and the second dryer segment having a second steam carrier portion isolated from the first steam carrier portion and configured to carry the exhaust steam from the steam-powered generator adjacent to the sludge, wherein heat from the first and second steam carrier portions dries the sludge moving therein.

13. The system of claim 8 wherein the fuel dryer assembly is configured to receive in the condenser portion exhaust steam from the steam-powered generator, the fuel dryer having a first dryer segment connected to the fuel inlet and has a first heater portion coupled to the condenser and configured to vaporize a first portion of the water from the sludge with heat from the exhaust steam, and a second dryer segment connected in series to the first dryer segment and configured to vaporize a second portion of the water from thickened sludge received from the first dryer segment with heat from the exhaust steam.

14. The system of claim 8 wherein the condenser portion of the fuel dryer assembly is configured to receive exhaust steam from the steam powered generator through the first steam inlet, and the fuel dryer assembly having a dryer portion connected to the fuel inlet and adjacent to the condenser portion, the dryer portion is

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configured to vaporize water from the sludge using the heat from the exhaust steam in the condenser.

15. The system of claim 8 wherein the combustor portion is a fluidized bed combustor assembly.

16. The system of claim 8 wherein the fuel dryer assembly, the fresh water condenser, the dry fuel combustor assembly, the steam powered generator, and the water pump are mounted on a frame and transportable with the frame as a unit.

17. The system of claim 8 wherein the steam-powered generator is a single action, liquid cooled steam engine.

18. A sludge processing system for electricity and clean water generation, comprising:

a sludge dryer assembly having a fuel path with a sludge inlet configured to receive a flow of sludge comprising a mixture of water and solid fuel material, the sludge dryer assembly having a heater portion configured to heat the sludge and thermally separate water from the solid fuel material to provide dried fuel material, the heater portion having a first steam outlet, the sludge dryer assembly having a condenser portion adjacent to the heater portion and having fluid path isolated from the fuel path and having a steam inlet and a fluid outlet;

a fresh water condenser assembly coupled to the first steam outlet and configured to condense water evaporated from the sludge into clean liquid water;

a combustor assembly coupled to the sludge dryer assembly and configured to receive the dried fuel material therefrom, the combustor assembly

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having a combustor configured to receive and burn the dried fuel material, and having a boiler configured to receive heat from the combustor for creating steam in a fluid path extending between a water inlet and a second steam outlet; and

a power plant comprising a steam engine and a generator driven by the steam engine, the steam engine being coupled to the second steam outlet of the boiler to receive steam therefrom, and the generator being configured to generate electricity, the steam powered generator having a third steam outlet coupled to the steam inlet of the condenser portion;

wherein heat from the steam exhausted from the steam engine boils the water in the sludge in the sludge dryer;

wherein the steam exhausted from the steam engine is condensed to a flow of liquid water; and

wherein the boiler is configured to receive and convert the flow of liquid water to a flow of steam to power the generator.

19. The system of claim 18 wherein the heater portion of the sludge dryer assembly comprises a sludge carrier portion through which the sludge moves, a steam carrier adjacent to the sludge carrier and positioned adjacent to the sludge for delivery of heat from steam in the steam carrier to the sludge, and a plurality of propulsion members moveably disposed within the fuel carrier and configured to move the sludge in the fuel carrier relative to the steam carrier.

20. The system of claim 18 wherein the fuel dryer assembly is a two-stage dryer having sequential first and second dryer stages each coupled to the condenser portion and each configured to dry the sludge by boiling the water in the sludge to provide dried solid fuel material using heat from exhaust steam from the steam engine.

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21. The system of claim 18 wherein the fuel dryer assembly is a two-stage dryer having sequential first and second dryer stages, wherein the first dryer stage generates sludge steam from the sludge, and the second dryer stage uses the sludge steam from the first dryer stage to dry the sludge.

22. The system of claim 18 wherein the fuel dryer assembly is a multi-segment dryer having sequential first and second dryer segments, the first dryer segment generates first dryer steam from water vaporized from the sludge, and the second dryer segment has a first steam carrier portion coupled to the first dryer segment and configured to carry the first dryer steam adjacent to the sludge, and the second dryer segment having a second steam carrier portion isolated from the first steam carrier portion and configured to carry the exhaust steam from the steam engine adjacent to the sludge, wherein heat from the first and second steam carrier portions dries the sludge moving therein.

23. The system of claim 22 wherein the first dryer segment comprises a first fuel carrier, a first steam carrier adjacent to the first fuel carrier, a plurality of propulsion members moveably disposed within the first fuel carrier and configured to move the sludge through the first fuel carrier past the first steam carrier; and the second dryer segment comprises a second fuel carrier, a plurality of steam-heated members within the second fuel carrier and being stationary relative to the second fuel carrier, and a second steam carrier assembly rotatably disposed within the second fuel carrier and configured to move the sludge within the second fuel carrier and past the steam-heated members.

24. The system of claim 18 wherein the condenser portion of the sludge dryer assembly is positioned to receive exhaust steam from the steam engine, the sludge dryer assembly has a first dryer stage with a first heater portion coupled to the condenser portion and configured to vaporize a first portion of the water from the sludge

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with heat from the exhaust steam, and a second dryer stage connected to the first dryer stage and configured to vaporize a second portion of the water from thickened wet sludge received from the first dryer stage with heat from the exhaust steam.

25. The system of claim 18 wherein the condenser portion is configured to receive exhaust steam from the steam powered generator, and the fuel dryer assembly has a dryer portion adjacent to the condenser portion and configured to vaporize water from the sludge using the heat from the exhaust steam in the condenser.

26. The system of claim 18 wherein the combustor portion is a fluidized bed combustor assembly with a firebox having a combustor bed for dry fuel combustion and an air grate configured to provide combustion air to the combustor bed, and the boiler comprising first heat exchanger connected to the water inlet and configured to heat water flowing therethrough, a steam drum coupled to the first heat exchanger, an evaporator coupled to the steam drum and configured to receive heated, saturated fluid therefrom, the steam drum being configured to receive a flow of steam from the evaporator, and a second heat exchanger coupled to the steam drum and configured to receive dry steam from the steam drum, the second heat exchanger connected to the second steam outlet.

27. The system of claim 18, further comprising a

a sludge containment tank

a sludge transporter connected to the sludge containment tank and configured to provide the sludge to the sludge inlet of the sludge dryer assembly.

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28. A fecal waste processing system for electricity and potable water generation, comprising:

a steam-powered electricity generation system comprising a boiler assembly, a steam engine, and a condenser interconnected and having a primary water circuit that carries primary water through the boiler assembly, steam engine assembly, and condenser, wherein operation of the steam engine assembly generates electricity;

a fecal sludge system that receives at least a portion of the electricity generated from the steam engine assembly, the fecal sludge system comprising a sludge dryer assembly and a sludge delivery system configured to deliver a flow fecal sludge to the sludge dryer assembly, wherein the condenser is attached to the sludge dryer assembly and configured to deliver first heat to the flow of fecal sludge to liberate water as first steam from the fecal sludge and to dry solid fuel material in the fecal sludge;

a water collection system connected to the sludge dryer assembly and configured to receive and condense the first steam for collection in a collection portion as clean, liquid potable water; and

combustor system connected to the fecal sludge system and the boiler of the electricity generation system, the combustor system comprising a combustor configured to burn the dry solid from the fecal sludge system and provide heat to water circuit in the boiler assembly, wherein the boiler assembly provides steam to the steam engine.

29. The system of claim 28 wherein the sludge dryer assembly is a two-stage dryer having sequential first and second dryer stages, wherein the first dryer stage generates sludge steam from the sludge, and the second dryer stage uses the sludge steam from the first dryer stage to dry the sludge.

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30. The system of claim 28 wherein the sludge dryer assembly comprises sequential first and second dryer stages, where the first dryer stage receive a substantially continuous flow of fecal sludge from the sludge delivery system and provides a substantially continuous flow of partially dried thickened fecal sludge to the second dryer stage, and the second dryer stage provides substantially dried solid fuel material to the combustor, and wherein steam from the first and second dryer stages is provided to water collection system.

31. The system of claim 27, wherein the sludge containment tank is a fecal sludge containment tank, and the sludge transporter is configured to provide fecal sludge to the sludge inlet of the sludge dryer assembly.

32. The system of claim 18, further comprising a water filtration system coupled to the freshwater condenser assembly and configured to receive the clean water, the water filtration system having one or more filters that filters the clean water and provides potable water.

33. The system of claim 18, wherein the sludge inlet of the sludge dryer assembly is configured to receive a flow of organic-based sludge.

34. The system of claim 18 wherein the fuel dryer assembly comprises a steam-heated auger in the heater portion, the steam-heated auger being configured to move and heat the sludge during the drying process.

35. The system of claim 18, wherein the sludge dryer assembly comprises a rotatable, hollow auger in the heater portion and configured to receive steam exhausted from the steam engine to heat the auger, wherein the auger is configured to move and heat the sludge during the drying process.

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36. The system of claim 8, further comprising a water filtration system coupled to the freshwater condenser assembly and configured to receive the clean water, the water filtration system having one or more filters that filters the clean water and provides potable water.

37. The system of claim 8, wherein the fluid inlet of the fluid dryer assembly is configured to receive a flow of fecal sludge.

38. The system of claim 8, wherein the sludge dryer assembly comprises a rotatable, hollow auger in the heater portion and configured to receive steam exhausted from the steam engine to heat the auger, wherein the auger is configured to move and heat the sludge during the drying process.

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