CLAIMS

What is claimed is:

1. An integrated system, comprising:

a gas turbine system having a first combustion chamber configured to stoichiometrically combust a first compressed oxidant and a first fuel in the presence of a compressed recycle stream, wherein the combustion chamber directs a first discharge stream to an expander to generate a gaseous exhaust stream and at least partially drive a main compressor;

an exhaust gas recirculation system, wherein the main compressor compresses the gaseous exhaust stream and thereby generates the compressed recycle stream, the compressed recycle stream acting as a diluent configured to moderate the temperature of the first discharge stream;

a CO_2 separator fluidly coupled to the compressed recycle stream via a purge stream; and

a gas expander fluidly coupled to the CO_2 separator via a residual stream consisting primarily of nitrogen-rich gas derived from the CO_2 separator.

2. The system of claim 1, wherein the exhaust gas recirculation system further comprises at least one boost compressor configured to receive and boost the pressure of the gaseous exhaust stream before directing a cooled recycle gas into the main compressor.

3. The system of claim 2, further comprising first and second cooling units fluidly coupled to the at least one boost compressor, the first cooling unit being configured to receive and cool the gaseous exhaust stream before introduction to the at least one boost compressor, and the second cooling unit being configured to receive the gaseous exhaust stream from the at least one boost compressor and further cool the gaseous exhaust stream to generate the cooled recycle gas.

4. The system of claim 1, further comprising a heater means adapted to heat the residual stream generating a heated nitrogen vapor stream.

5. The system of claim 4, wherein the gas expander is configured to expand the heated nitrogen vapor and thereby generate mechanical power and an exhaust gas.

6. The system of claim 5, further comprising an inlet compressor driven by the mechanical power generated by the gas expander, wherein the inlet compressor is configured to provide the first compressed oxidant.

7. The system of claim 4, wherein the heater means comprises a heat exchanger fluidly coupled to both the purge stream and the residual stream, the heat exchanger being configured to reduce the temperature of the purge stream and simultaneously increase the temperature of the residual stream.

8. The system of claim 1, further comprising a catalysis apparatus disposed in association with the purge stream, the catalysis apparatus being configured to increase the temperature of the purge stream prior to entering the heater means.

9. The system of claim 4, wherein the heater means comprises a second combustion chamber fluidly coupled to the residual stream and being configured to stoichiometrically combust a second fuel and a second compressed oxidant to generate a second discharge stream.

10. The system of claim 9, wherein the gas expander is configured to expand the second discharge stream and thereby generate mechanical power and an exhaust gas.

11. The system of claim 9, wherein the first and second compressed oxidants and the first and second fuels are derived from the same source, respectively.

12. The system of claim 9, wherein the second fuel is a hydrogen fuel.

13. A method of generating power, comprising:

stoichiometrically combusting a first compressed oxidant and a first fuel in a first combustion chamber and in the presence of a compressed recycle stream, thereby generating a first discharge stream, wherein the compressed recycle stream acts as a diluent configured to moderate the temperature of the first discharge stream;

expanding the first discharge stream in an expander to at least partially drive a first compressor and generate a gaseous exhaust stream;

directing the gaseous exhaust stream into the first compressor, wherein the first compressor compresses the gaseous exhaust stream and thereby generates the compressed recycle stream;

extracting a portion of the compressed recycle stream to a CO_2 separator via a purge stream, the CO_2 separator being fluidly coupled to a gas expander via a residual stream derived from the CO_2 separator and consisting primarily of nitrogen-rich gas; and

expanding the residual stream in a gas expander to thereby generate mechanical power and an exhaust gas.

14. The method of claim 13, further comprising at least one of a boost compressor and a cooling unit adapted to increase the mass flow rate of the gaseous exhaust stream to generate recycle gas.

15. The method of claim 14, comprising cooling the gaseous exhaust stream with a first cooling unit fluidly coupled to at least one boost compressor, the first cooling unit being configured to receive and cool the gaseous exhaust stream before introduction to the at least one boost compressor.

16. The method of claim 15, further comprising cooling the gaseous exhaust stream from the at least one boost compressor with a second cooling unit fluidly coupled to the at least one boost compressor to generate the recycle gas.

17. The method of claim 13, further comprising driving an inlet compressor with the mechanical power generated by the gas expander, the inlet compressor being configured to generate the first compressed oxidant.

18. The method of claim 13, further comprising a heater means adapted to increase the temperature of the residual stream to generate a heated nitrogen vapor stream.

19. The method of claim 18, wherein the heater means comprises a heat exchanger fluidly coupled to both the purge stream and the residual stream, and further comprising reducing the temperature of the purge stream and increasing the temperature of the residual stream with the heat exchanger thereby generating the heated nitrogen vapor stream.

20. The method of claim 19, further comprising increasing the temperature of the purge stream by combusting oxygen and remaining fuel in a catalysis apparatus disposed within the purge stream prior to the heat exchanger.

21. The method of claim 13, further comprising injecting water into the heated nitrogen vapor stream to increase the mass throughput of the gas expander.

22. The method of claim 18, wherein the heater means comprises a second combustion chamber, and further comprising stoichiometrically combusting a second fuel and a second compressed oxidant in the second combustion chamber fluidly coupled to the residual stream, the second combustion chamber being configured to generate a second discharge stream.

23. The method of claim 22, further comprising moderating the temperature of the second discharge stream with the residual stream discharged from the CO_2 separator.

24. The method of claim 20, further comprising expanding the second discharge stream in the gas expander to generate mechanical power to drive an inlet compressor, the inlet compressor being configured to generate the first compressed oxidant.

25. An integrated system, comprising:

a first gas turbine system, comprising:

a first compressor configured to receive and compress a recycled exhaust gas and provide a first compressed recycle stream;

a first combustion chamber configured to receive the first compressed recycle stream, a first compressed oxidant, and a first fuel stream, the first combustion chamber being adapted to stoichiometrically combust the first fuel stream and first compressed oxidant, wherein the first compressed recycle stream serves as a diluent to moderate combustion temperatures; and

a first expander coupled to the first compressor and configured to receive a first discharge from the first combustion chamber and generate the recycled exhaust gas and at least partially drive the first compressor;

a purge stream taken from the compressed recycle stream and treated in a CO_2 separator to provide a CO_2 stream and a residual stream, the residual stream substantially comprising a nitrogen gas; and

a second gas turbine system fluidly coupled to the first gas turbine system via the purge stream, the second gas turbine system comprising:

a second compressor configured to receive and compress a feed oxidant and generate a second compressed oxidant, the first compressed oxidant being derived at least partially from the second compressed oxidant;

a second combustion chamber configured to receive the second compressed oxidant, the nitrogen gas from the residual stream, and a second fuel stream, the second combustion chamber being adapted to stoichiometrically combust the second fuel stream and second compressed oxidant, wherein the nitrogen gas serves as a diluent to moderate combustion temperatures; and

a second expander coupled to the second compressor and configured to receive a second discharge from the second combustion chamber and generate an exhaust and at least partially drive the second compressor.

26. The system of claim 25, wherein the first gas turbine system further comprises a boost compressor configured to increase the pressure of the recycled exhaust gas before injection into the first compressor to provide the compressed recycle stream.

27. The system of claim 26, wherein the second fuel is a hydrogen fuel.

28. The system of claim 26, wherein the second gas turbine system further comprises a heat recovery steam generator configured to receive the exhaust from the second expander and provide steam for a steam gas turbine.

29. An integrated system, comprising:

a gas turbine system having a first combustion chamber configured to stoichiometrically combust a compressed oxidant and a fuel in the presence of a compressed recycle stream, wherein the combustion chamber provides a discharge stream to an expander in order to generate a gaseous exhaust stream and at least partially drive a first compressor;

an exhaust gas recirculation system having at least one boost compressor configured to receive and boost the pressure of the gaseous exhaust stream before directing a cooled recycle gas into the first compressor, wherein the first compressor compresses the cooled recycle gas and thereby generates the compressed recycle stream, the compressed recycle stream acting as a diluent configured to moderate the temperature of the discharge stream;

a CO_2 separator fluidly coupled to the compressed recycle stream via a purge stream; and

a downstream compressor fluidly coupled to the CO_2 separator via a residual stream derived from the CO_2 separator and consisting primarily of nitrogen-rich gas.

30. The system of claim 29, wherein the downstream compressor is configured to compress the nitrogen-rich gas for pressure maintenance.

CLAIMS

1. An integrated system, comprising:

a gas turbine system having a first combustion chamber configured to substantially stoichiometrically combust a first compressed oxidant and a first fuel in the presence of a compressed recycle stream, wherein the combustion chamber directs a first discharge stream to an expander to generate a gaseous exhaust stream and at least partially drive a main compressor;

an exhaust gas recirculation system, wherein the main compressor compresses the gaseous exhaust stream and thereby generates the compressed recycle stream, the compressed recycle stream acting as a diluent configured to moderate the temperature of the first discharge stream;

a CO_2 separator fluidly coupled to the compressed recycle stream via a purge stream; and

a gas expander either fluidly coupled to the CO_2 separator via a residual stream consisting primarily of nitrogen-rich gas derived from the CO_2 separator without the introduction of additional fuel or oxidant to the residual stream, or fluidly coupled with a second combustion chamber via a second discharge stream, wherein the second combustion chamber is configured to substantially stoichiometrically combust a combination of the residual stream, a second fuel, and a second oxidant.

2. The system of claim 1, wherein the exhaust gas recirculation system further comprises at least one boost compressor configured to receive and boost the pressure of the gaseous exhaust stream before directing a cooled recycle gas into the main compressor.

3. The system of claim 2, further comprising first and second cooling units fluidly coupled to the at least one boost compressor, the first cooling unit being configured to receive and cool the gaseous exhaust stream before introduction to the at least one boost compressor, and the second cooling unit being configured to receive the gaseous exhaust stream from the at least one boost compressor and further cool the gaseous exhaust stream to generate the cooled recycle gas.

4. The system of claim 1 or 2, further comprising a heater means adapted to heat the residual stream generating a heated nitrogen vapor stream.

5. The system of claim 4, wherein the gas expander is configured to expand the heated nitrogen vapor and thereby generate mechanical power and an exhaust gas.

6. The system of claim 5, further comprising an inlet compressor driven by the mechanical power generated by the gas expander, wherein the inlet compressor is configured to provide the first compressed oxidant.

7. The system of any one of claims 4 to 6, wherein the heater means comprises a heat exchanger fluidly coupled to both the purge stream and the residual stream, the heat exchanger being configured to reduce the temperature of the purge stream and simultaneously increase the temperature of the residual stream.

8. The system of any one of claims 4 to 7, further comprises a catalysis apparatus disposed in association with the purge stream, the catalysis apparatus being configured to increase the temperature of the purge stream prior to entering the heater means.

9. The system of any one of claims 4 to 8, wherein the heater means comprises the second combustion chamber fluidly coupled to the residual stream and being configured to substantially stoichiometrically combust the second fuel and the second compressed oxidant to generate the second discharge stream.

10. The system of any one of claims 1 to 9, wherein the gas expander is configured to expand the second discharge stream and thereby generate mechanical power and an exhaust gas.

11. The system of any one of the preceding claims 9, wherein the first and second compressed oxidants and the first and second fuels are derived from the same source, respectively.

12. A method of generating power, comprising:

substantially stoichiometrically combusting a first compressed oxidant and a first fuel in a first combustion chamber and in the presence of a compressed recycle stream, thereby generating a first discharge stream, wherein the compressed recycle stream acts as a diluent configured to moderate the temperature of the first discharge stream;

expanding the first discharge stream in an expander to at least partially drive a first compressor and generate a gaseous exhaust stream;

directing the gaseous exhaust stream into the first compressor, wherein the first compressor compresses the gaseous exhaust stream and thereby generates the compressed recycle stream;

extracting a portion of the compressed recycle stream to a CO_2 separator via a purge stream, the CO_2 separator being fluidly coupled to a gas expander via a residual stream derived from the CO_2 separator and consisting primarily of nitrogen-rich gas; and

using a gas expander to either expand expanding the residual stream in a gas expander to thereby generate mechanical power and an exhaust gas, wherein the expander receives the residual stream without the introduction of additional fuel or oxidant to the residual stream, or receive a second discharge stream via fluid communication with a second combustion chamber configured to substantially stoichiometrically combust a combination of the residual stream, a second fuel, and a second oxidant.

13. The method of claim 12, further comprising at least one of a boost compressor and a cooling unit adapted to increase the mass flow rate of the gaseous exhaust stream to generate recycle gas.

14. The method of claim 13, comprising cooling the gaseous exhaust stream with a first cooling unit fluidly coupled to at least one boost compressor, the first cooling unit being configured to receive and cool the gaseous exhaust stream before introduction to the at least one boost compressor.

15. The method of claim 13 or 15, further comprising cooling the gaseous exhaust stream from the at least one boost compressor with a second cooling unit fluidly coupled to the at least one boost compressor to generate the recycle gas.

16. The method of any one of claims 12 to 15, further comprising driving an inlet compressor with the mechanical power generated by the gas expander, the inlet compressor being configured to generate the first compressed oxidant.

17. The method of any one of claims 12 to 16, further comprising a heater means adapted to increase the temperature of the residual stream to generate a heated nitrogen vapor stream.

18. The method of claim 17, wherein the heater means comprises a heat exchanger fluidly coupled to both the purge stream and the residual stream, and further comprising reducing the temperature of the purge stream and increasing the temperature of the residual stream with the heat exchanger thereby generating the heated nitrogen vapor stream.

19. The method of claim 18, further comprising increasing the temperature of the purge stream by combusting oxygen and remaining fuel in a catalysis apparatus disposed within the purge stream to the heat exchanger.

20. The method of any one of claims 12 to 19, further comprising injecting water into the heated nitrogen vapor stream to increase the mass throughput of the gas expander.

21. The method of any one of claims 17 to 19, wherein the heater means comprises a second combustor chamber, and further comprising substantially stoichiometrically combusting the second fuel and the second compressed oxidant in the second combustion chamber fluidly coupled to the residual stream, the second combustion chamber being configured to generate the second discharge stream.

22. The method of claim 21, further comprising moderating the temperature of the second discharge stream with the residual stream discharged from the CO_2 separator.

23. The method of claim 19, further comprising expanding the second discharge stream in the gas expander to generate mechanical power to drive an inlet compressor, the inlet compressor being configured to generate the first compressed oxidant.

24. An integrated system, comprising:

a first gas turbine system, comprising:

a first compressor configured to receive and compress a recycled exhaust gas and provide a first compressed recycle stream;

a first combustion chamber configured to receive the first compressed recycle stream, a first compressed oxidant, and a first fuel stream, the first combustion chamber being adapted to substantially stoichiometrically combust the first fuel stream and first compressed oxidant, wherein the first compressed recycle stream serves as a diluent to moderate combustion temperatures; and

a first expander coupled to the first compressor and configured to receive a first discharge from the first combustion chamber and generate the recycled exhaust gas and at least partially drive the first compressor;

a purge stream taken from the compressed recycle stream and treated in a CO_2 separator to provide a CO_2 stream and a residual stream, the residual stream substantially comprising a nitrogen gas; and

a second gas turbine system fluidly coupled to the first gas turbine system via the purge stream, the second gas turbine system comprising:

a second compressor configured to receive and compress a feed oxidant and generate a second compressed oxidant, the first compressed oxidant being derived at least partially from the second compressed oxidant;

a second combustion chamber configured to receive the second compressed oxidant, nitrogen gas from the residual stream, and a second fuel stream, the second combustion chamber being adapted to substantially stoichiometrically combust the second fuel stream and second compressed oxidant, wherein the nitrogen gas serves as a diluent to moderate combustion temperatures; and

a second expander coupled to the second compressor and configured to receive a second discharge from the second combustion chamber and generate an exhaust and at least partially drive the second compressor.

25. The system of claim 24, wherein the first gas turbine system further comprises a boost compressor configured to increase the pressure of the recycled exhaust gas before injection into the first compressor to provide the compressed recycle stream.

26. The system of claim 11 or 25, wherein the second fuel is a hydrogen fuel.

27. The system of claim 25 or 26, wherein the second gas turbine system further comprises a heat recovery steam generator configured to receive the exhaust from the second expander and provide steam for a steam gas turbine.

28. An integrated system, comprising:

a gas turbine system having a first combustion chamber configured to substantially stoichiometrically combust a compressed oxidant and a fuel in the presence of a compressed recycle stream, wherein the combustion chamber provides a discharge stream to an expander in order to generate a gaseous exhaust stream and at least partially drive a first compressor;

an exhaust gas recirculation system having at least one boost compressor configured to receive and boost the pressure of the gaseous exhaust stream before directing a cooled recycle gas into the first compressor, wherein the first compressor compresses the cooled recycle gas and thereby generates the compressed recycle stream, the compressed recycle stream acting as a diluent configured to moderate the temperature of the discharge stream;

a CO_2 separator fluidly coupled to the compressed recycle stream via a purge stream; and

a downstream compressor fluidly coupled to the CO_2 separator via a residual stream derived from the CO_2 separator and consisting primarily of nitrogen-rich gas without the introduction of additional fuel or oxidant to the residual stream.

29. The system of claim 28, wherein the downstream compressor is configured to compress the nitrogen-rich gas for pressure maintenance.