SYSTEM AND METHOD FOR BIOMASS GROWTH AND PROCESSING

FIELD

[0001] The present disclosure relates to the field of private, public or municipal infrastructure and utility services and fields of renewable energy, biofuels, water treatment and environmental conservation and remediation.

[0002] Many different power generation and industrial systems involving the use of heat may be in use worldwide. These systems may use fuels of many types to produce power through a variety of processes. Combustion-based thermal power plants may also discharge carbon dioxide and other gases into the environment. It is generally recognized that carbon dioxide is a gas that produces an atmospheric greenhouse-effect, the excess production of which has a detrimental effect on climate worldwide. Also, power plants may discharge waste heat in ways which produce environmental damage. Other industrial systems discharge pollution in ways that may be destructive to the environment.

[0003] Thus, there may be a need to provide thermal energy production and other industrial processes that minimize the production and discharge of excess, or waste, carbon dioxide, heat, and other byproducts.

BRIEF SUMMARY

[0004] In one aspect, the present invention refers to a system comprising a biomass growth module (BGM) and optionally a. a thermal plant module optionally producing an exhaust gas comprising carbon dioxide optionally fueling the BGM; b. wherein the thermal plant module is optionally fuelable by a BGM outflow fluid from the BGM; c. wherein the BGM outflow fluid is optionally refined in whole or in part optionally by heat from the thermal plant module; and/or d. wherein the exhaust gas optionally may provide a substantial portion of the carbon content of the BGM outflow fluid. In another aspect, the present invention refers to a system comprising a BPP module collocated with a BBPP module. In yet another aspect, the present invention refers to a system wherein any two or more of the following are collocated a. a thermal plant module; b. a BGM; c. a refinery module; d. a gasification module; e. a BPP module; f. a BBPP module; and/or g. a desalination module wherein the modules are operatively

in communication with one another and may exchange heat, biomass, water, carbon dioxide, residuals and/or other resources and/or byproducts; optionally wherein any one or more of modules a-g is a retrofitted module; also optionally wherein biomass from any source(s) may be processed by: a. the refinery module; b. the gasification module; and/or c. the BPP module; preferably wherein residuals may be directed from any of these modules to any other(s) for processing a. a thermal plant module; b. a BGM; c. a refinery module; d. a gasification module; e. a BPP module; f. a BBPP module; and/or g. a desalination module; more preferably wherein fuels produced from processing may be provided as fuels to the thermal plant module either directly and/or with additional treatment, processing and/or heat recovery; suitably wherein the desalination module generates a water and/or brine outputs, optionally wherein the water output is directed to a BBPP module for packaging, and/or the brine output is discharged either with or without dilution from other water sources. In yet another aspect, the present invention refers to a method of integrating a thermal plant and a BGM comprising: providing the system of the present invention and generating a biomass in the BGM. In another aspect, the present invention refers to a method of integrating: a thermal plant module; a BGM; a refinery module; a gasification module; a BBP module; a BBPP module; and/or a desalination module; comprising providing the system of claim 38 wherein the one or more of: the thermal plant module; the BGM; the refinery module; the gasification module; the BBP module; the BBPP module; and/or the desalination module is a retrofitted module; and integrating the one or more retrofitted module into one or more grids which grids are in operative communication with one another; optionally wherein operative communication comprises exchanging: heat; biomass; water; carbon dioxide; residuals; and/or other resources and/or byproducts between the one or more retrofitted module and/or the one or more grids. In another aspect, the present invention refers to a system configured for biomass growth comprising a biomass growth module (BGM) wherein the BGM comprises one or more biomass growth units (BGUs) selected from the following configurations a) single; b) dual serial; c) dual parallel; d) dual parallel connected; e) serial simple networked; and/or f) complex networked. In yet another aspect, the present invention refers to a method for growing biomass comprising networking a set of biomass growth units in a biomass

growth module (BGM) wherein the set comprises a biomass growth unit which is: a) a single biomass growth unit; b) a dual serial biomass growth unit; c) a dual parallel biomass growth unit; d) dual parallel connected biomass growth unit; e) serial simple networked biomass growth unit; and/or f) complex networked biomass growth unit. In another aspect, the present invention refers to a system for biomass growth resource management comprising a pollution control module, a pollution entrainment module, and/or one or more heat recovery modules configured to optionally provide heat, water, gases, carbon dioxide, other fluid(s), and/or pollutants to a BGM and/or other heat or water use module or process in the system. In another aspect, the present invention refers to a system configured to grow biomass comprising a recovered solvent input configured to provide recovered solvent to a BGM; optionally wherein an evaporation module is in operative communication with the recovered solvent input. In another aspect, the present invention refers to a system comprising one or more collocated features which are stack of a thermal plant, one or more turbines, pollution control module(s), pollution entrainment module(s), emission control module(s), computer controls or modules, exhaust gas conveyances, fuels, heat, water, power, carbon dioxide, methane, biogas, water/biomass slurry, biofuel, other fuel, chemical storage, piping for water, chemicals and/or other materials, fluid transportation and/or storage, oxygen or other gas transport lines and/or storage, cooling systems, and/or heat exchangers wherein one or more thermal plant technologies and/or one or more solar thermal technologies share one or more of said module(s) or technologies in the system. The present disclosure provides a means of abating carbon dioxide and other gases generated by thermal plants through the growth of biomass, which uses these normally harmful emissions to produce biofuels and other useful products. Biofuels and/or biomass generated may also become a source of fuel for a thermal plant where appropriate. Water treatment methods and heat, water, and other byproduct abatement and resource conservation technologies may be incorporated e.g., as described herein.

[0005] In an example, the present disclosure relates to a biomass growth module optionally fuelable by an exhaust gas comprising carbon dioxide from a thermal plant; wherein the thermal plant may be optionally fuelable by a biomass and/or biofuel outflow fluid from the biomass growth module and wherein the biomass and/or biofuel

outflow fluid may be optionally refined by the thermal plant and wherein the exhaust gas may

provide a substantial portion of the carbon content of the biomass and/or biofuel outflow fluid.

[0006] In certain examples, e.g., those represented by FIG. 2, FIGs 7A, 7B, 11, 12A, 12B, 12C, 12D, 12E, 15A, 15B, 16, 17, 18, 19, 20A, 20B, 20C, 20D and/or other figures and examples regarding heat capture and/or transfer, the present disclosure relates to a method of providing a cooling fluid, e.g., a necessary cooling water, to a thermal plant, while concurrently making productive use of the waste heat energy generated by the thermal plant, which waste heat may otherwise be simply discharged unproductively, and at times, destructively, into the environment. The waste heat may be used productively, e.g., to regulate bioreactor temperature and/or in a process to refine water, fuels, and/or biomass produced in a biomass growth module into useful products. In certain examples, e.g., those represented by FIG. 3, FIG. 4 and/or other examples regarding the use of water and/or carbon dioxide e.g., in the Plan, the present disclosure relates to an integrated approach to minimization of CO_2 emissions, power generation, biofuel production, efficient use of heat and water, as well as production of biomass-derived non-fuel products, and treatment of wastewater and waste-to-energy in some examples. Various examples provide for a wide variety of other water sources or combinations to be used to provide a medium for biomass and/or biofuel production and CO_2 abatement, with conservation of water and heat energy.

[0007] In an example, one or more water sources may be provided for biomass growth, wherein the water may be wastewater, salt water, brackish water, purified water, potable water, non-potable water, and/or brine. The amount of carbon in the water may be from less than 0.1% to 15% by weight, or about 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, or 15 percent by weight or from one integer to another in the preceding array of numbers, e.g., from about 3% to about 8%

BRIEF DESCRIPTION OF THE FIGURES

[0008] FIG. 1 is a schematic representation of a design according to the present disclosure.

[0009] FIG. 2 is a schematic representation of heat flow within the Plan according to the present disclosure.

CLAIMS

1. A system comprising a biomass growth module (BGM) and optionally:

a. a thermal plant module optionally producing an exhaust gas comprising carbon dioxide optionally fueling the BGM;

b. wherein the thermal plant module is optionally fuelable by a BGM outflow fluid from the BGM;

c. wherein the BGM outflow fluid is optionally refined in whole or in part optionally by heat from the thermal plant module; and/or

d. wherein the exhaust gas optionally may provide a substantial portion of the carbon content of the BGM outflow fluid.

2. The system of claim 1 wherein;

(i) the BGM is configured to be supplied by BGM feed water which is optionally pretreated and comprising:

a. salt water;

b. fresh water;

c. high salinity water;

d. wastewater;

e. any source of water;

f. another water type(s); and/or

g. a combination thereof, wherein the BGM feed water is optionally processed through a primary treatment process, also referred to as "primary treatment", before being supplied to the BGM, optionally wherein the primary treatment process comprises:

a. screening;

b. grit removal;

c. sedimentation;

d. addition of chemicals;

e. and/or other means to prepare water for introduction into a BGM; and

optionally wherein sludge from the primary treatment process is optionally supplied to a gasification module;

(ii) the BGM is configured to produce a biofuel, which biofuel supplies the thermal plant module either directly or after additional processing;

(iii) wherein the BGM outflow fluid is optionally processed before optionally fueling the thermal plant module, and wherein the BGM outflow fluid is optionally being supplied to a gasification module, a BPP module and/or a BBPP module, wherein the BGM outflow fluid is processed by:

a. a tertiary treatment module;

b. a gravity thickener to concentrate, and separate the BGM outflow fluid;

c. a dilution module;

d. a refinery module;

e. processing; and/or

f. a heat recovery module;

optionally wherein the tertiary treatment module is configured to supply a biomass/water slurry to the gravity thickener to concentrate, separate, and/or dilute the BGM outflow fluid;

(iv) the thermal plant module is configured to optionally provide heat and/or cooling to the following:

a. the refinery module;

b. a BPP module;

c. biomass products;

d. a BBPP module;

e. the BGM;

f. the gasification module;

g. processing of biofuel; and/or

h. a desalination module;

optionally wherein in (iii) or (iv) the water that is the result of the tertiary treatment is routed for water reuse and/or optional recirculation to the BGM; and

optionally wherein the gravity thickener in (iii) to concentrate, separate, and/or dilute the BGM outflow fluid comprises:

a. a water, biomass and/or extract output;

b. a treated biomass/water slurry output (also defined as a BGM outflow fluid); and/or

c. a water output;

and advantageously any portion of the treated biomass/water slurry is directed to:

a. the refinery module; and/or

b. the gasification module;

preferably wherein the water, biomass, and/or an extract thereof is supplied to the BPP module; or

wherein the water output from the gravity thickener to concentrate, separate, and/or dilute the BGM outflow fluid is routed for water reuse;

(v) in any of (iii) or (iv) the BPP module comprises:

a. biomass products outputs which are optionally routed to a BBPP module;

b. heat, water, and/or carbon dioxide outputs which are optionally routed for reuse; and/or

c. residuals optionally routed to the refinery module;

optionally wherein the refinery module receives optional inputs selected from:

a. other biomass source(s);

b. other waste; and/or

c. pressure.

further optionally wherein the refinery module has optional outputs selected from:

a. biocrude;

b. biofuel;

c. water; and/or

d. residuals;

preferably wherein the biocrude and/or biofuel outputs from the refinery module serve in whole or in part as the BGM outflow fluid output which output optionally fuels the thermal plant module,

wherein the biocrude and/or biofuel outputs from the refinery module undergo additional steps selected from the following before optionally fueling the thermal plant module:

a. a heat recovery module; and/or

b. processing;

suitably wherein the refinery module generates residuals which are optionally sent to a gasification module;

(vi) the gasification module produces a biogas output, which is optionally further processed, or wherein the biogas output optionally partially or fully fuels the thermal plant module, or wherein the gasification module produces a residuals output (and optionally wherein the residuals output is supplied to the BGM);

(vii) in (v) the refinery module's water output is directed to an optional heat and/or pressure recovery module, optionally wherein the heat and/or pressure recovery module produces a water output wherein the water is reused;

(viii) the thermal plant module optionally provides power to the Plan.

3. A system comprising a BPP module collocated with a BBPP module.

4. The system of claim 3, wherein:

(i) the BPP module provides a biomass and/or biomass product output stream(s) to the BBPP module;

(ii) the BPP module receives inputs of:

a. water;
b. biomass;
c. extract;
d. heat; and/or
e. any combination of the above;

(iii) the following are reclaimed from the BPP module:

a. heat;
b. carbon dioxide;
c. water; and/or
d. residuals;

optionally wherein residuals may comprise any portion of material not used in a process or module, including optionally:

a. biomass;
b. water;
c. sediment;
d. sludge;
e. solvent(s); and/or

f. chemical residues;

or wherein the residuals are sent to a refinery module;

(iv) the BBPP module receives an input of heat, preferably provided by a thermal plant module, such as wherein the thermal plant module and the BBPP module are collocated.

5. A system wherein any two or more of the following are collocated:

a. a thermal plant module;
b. a BGM;
c. a refinery module;
d. a gasification module;
e. a BPP module;
f. a BBPP module; and/or
g. a desalination module

wherein the modules are operatively in communication with one another and may exchange heat, biomass, water, carbon dioxide, residuals and/or other resources and/or byproducts;

optionally wherein any one or more of modules a-g is a retrofitted module;

also optionally wherein biomass from any source(s) may be processed by:

a. the refinery module;
b. the gasification module; and/or
c. the BPP module;

preferably wherein residuals may be directed from any of these modules to any other(s) for processing:

a. a thermal plant module;
b. a BGM;
c. a refinery module;
d. a gasification module;
e. a BPP module;
f. a BBPP module; and/or
g. a desalination module;

more preferably wherein fuels produced from processing may be provided as fuels to the thermal plant module either directly and/or with additional treatment, processing and/or heat recovery;

suitably wherein the desalination module generates a water and/or brine outputs, optionally wherein the water output is directed to a BBPP module for packaging, and/or the brine output is discharged either with or without dilution from other water sources.

6. A method of integrating a thermal plant and a BGM comprising: providing the system of claim 1 and generating a biomass in the BGM.

7. The method of claim 6 further comprising:

a. refining the biomass to a biofuel;

b. delivering the biomass to the thermal plant;

c. delivering the biofuel to the thermal plant;

d. combusting the biofuel in the thermal plant;

e. delivering thermal plant exhaust gas to the BGM;

f. processing the biomass into non-fuel products; and/or

g. removing pollutants from the thermal plant exhaust gas.

8. A method of integrating: a thermal plant module; a BGM; a refinery module; a gasification module; a BBP module; a BBPP module; and/or a desalination module; comprising providing the system of claim 38 wherein the one or more of: the thermal plant module; the BGM; the refinery module; the gasification module; the BBP module; the BBPP module; and/or the desalination module is a retrofitted module; and integrating the one or more retrofitted module into one or more grids which grids are in operative communication with one another;

optionally wherein operative communication comprises exchanging: heat; biomass; water; carbon dioxide; residuals; and/or other resources and/or byproducts between the one or more retrofitted module and/or the one or more grids.

9. A system configured for biomass growth comprising a biomass growth module (BGM) wherein the BGM comprises one or more biomass growth units (BGUs) selected from the following configurations:

a) single;
b) dual serial;
c) dual parallel;
d) dual parallel connected;
e) serial simple networked; and/or
f) complex networked.

10. The system of claim 9 wherein any one or more of the BGUs is:

a) an autotrophic BGU;
b) a heterotrophic BGU; and/or
c) a mixotrophic BGU; and/or

wherein any of the BGUs may share and/or exchange inputs and/or outputs optionally comprising:

a) carbon dioxide;
b) oxygen;
c) water;
d) nutrients;
e) biomass;
f) growth medium;
g) solvent;
h) carbon source;
i) nitrogen or other gases; and/or
j) light source(s).

11. A method for growing biomass comprising networking a set of biomass growth units in a biomass growth module (BGM) wherein the set comprises a biomass growth unit which is:

a) a single biomass growth unit;

b) a dual serial biomass growth unit;

c) a dual parallel biomass growth unit;

d) dual parallel connected biomass growth unit;

e) serial simple networked biomass growth unit; and/or

f) complex networked biomass growth unit.

12. The method of claim 11, wherein any one or more of the BGUs is operating:

a) autotrophically;

b) heterotrophically; and/or

c) mixotrophically; and/or

wherein any of the BGUs is sharing and/or exchanging inputs and/or outputs optionally comprising:

k) carbon dioxide;

l) oxygen;

m) water;

n) nutrients;

o) biomass;

p) growth medium;

q) solvent;

r) carbon source;

s) nitrogen or other gases; and/or

t) light source(s).

13. A system for biomass growth resource management comprising a pollution control module, a pollution entrainment module, and/or one or more heat recovery modules configured to optionally provide heat, water, gases, carbon dioxide, other fluid(s), and/or pollutants to a BGM and/or other heat or water use module or process in the system.

14. The system of claim 13 wherein:

the pollution control module, a pollution entrainment module, and/or one or more heat recovery modules are optionally configured to provide heat, water, gases, carbon dioxide, other

fluid(s), and/or pollutants to a another module, design, component, and the like, either directly, after treatment, and/or after mixing with other fluids and/or for storage for later use in the BGM and/or for discharge;

optionally wherein the pollution control module, pollution entrainment module, and/or heat recovery module(s) utilize a heat exchanger;

or the pollution control module, pollution entrainment module, and/or heat recovery module(s) utilize:

a. activated carbon;
b. hearth furnace cokes;
c. zeolites;
d. lime;
e. chlorine;
f. sprayers;
g. sorbents;
h. filtration;
i. photochemical methods;
j. selective catalytic reduction;
k. dry scrubber;
l. wet scrubber, e.g., spray tower, tray tower, packed bed tower, two-pass wet scrubber, and/or other wet scrubber;
m. other pollution control/entrainment techniques known to those skilled in the art; and/or
n. any of the above in any sequence or combination.

15. A system configured to grow biomass comprising a recovered solvent input configured to provide recovered solvent to a BGM;

optionally wherein an evaporation module is in operative communication with the recovered solvent input.

16. A system comprising one or more collocated features which are stack of a thermal plant, one or more turbines, pollution control module(s), pollution entrainment

module(s), emission control module(s), computer controls or modules, exhaust gas conveyances, fuels, heat, water, power, carbon dioxide, methane, biogas, water/biomass slurry, biofuel, other fuel, chemical storage, piping for water, chemicals and/or other materials, fluid transportation and/or storage, oxygen or other gas transport lines and/or storage, cooling systems, and/or heat exchangers wherein one or more thermal plant technologies and/or one or more solar thermal technologies share one or more of said module(s) or technologies in the system.