PHOTOVOLTAIC POWER GENERATION SYSTEMS AND METHODS REGARDING SAME

CROSS-REFERENCES TO RELATED APPLICATIONS

This application claims the benefit of priority of U.S. Provisional Application Nos. 61/947,019, filed March 3, 2014; 61/949,271, filed March 7, 2014; 61/968,839, filed March 21, 2014; and 61/972,807, filed March 31, 2014, all of which are herein incorporated by reference in their entirety.

The present disclosure relates to the field of power generation and, in particular, to systems, devices, and methods for the generation of power. More specifically, embodiments of the present disclosure are directed to power generation devices and systems, as well as related methods, which produce optical power, plasma, and thermal power and produces electrical power via an optical to electric power converter, plasma to electric power converter, photon to electric power converter, or a thermal to electric power converter. In addition, embodiments of the present disclosure describe systems, devices, and methods that use the ignition of a water or water-based fuel source to generate optical power, mechanical power, electrical power, and/or thermal power using photovoltaic power converters. These and other related embodiments are described in detail in the present disclosure.

Power generation can take many forms, harnessing the power from plasma. Successful commercialization of plasma may depend on power generation systems capable of efficiently forming plasma and then capturing the power of the plasma produced.

Plasma may be formed during ignition of certain fuels. These fuels can include water or water-based fuel source. During ignition, a plasma cloud of electron-stripped atoms is formed, and high optical power may be released. The high optical power of the plasma can be harnessed by an electric converter of the present disclosure. The ions and excited state atoms can recombine and undergo electronic relaxation to emit optical power. The optical power can be converted to electricity with photovoltaics.

Summary

According to an aspect, the present disclosure refers to a power system that generates at least one of direct electrical energy and thermal energy comprising:

at least one vessel;

a reaction mixture comprising reactants comprising:

a) at least one source of nascent H_2O;

b) at least one source of atomic hydrogen;
c) at least one of a conductor and a conductive matrix; and
at least one set of electrodes, wherein said reaction mixture is disposed between said set of electrodes,
a source of electrical power to deliver electrical energy to the reaction mixture to produce a plasma and reaction products;
at least one system to regenerate one or more reactants from the reaction products and produce another reaction mixture,
a reloading system configured to deliver each reaction mixture to the electrodes; and
at least one plasma dynamic converter or at least one photovoltaic converter.

Certain ~~embodiments~~ examples of the present disclosure are directed to a power generation system comprising: a plurality of electrodes configured to deliver power to a fuel to ignite the fuel and produce a plasma; a source of electrical power configured to deliver electrical energy to the plurality of electrodes; and at least one photovoltaic power converter positioned to receive at least a plurality of plasma photons.

In one example~~embodiment~~, the present disclosure is directed to a power system that generates at least one of direct electrical energy and thermal energy comprising:

at least one vessel;

reactants comprising:

a) at least one source of catalyst or a catalyst comprising nascent H_2O;

b) at least one source of atomic hydrogen or atomic hydrogen;

c) at least one of a conductor and a conductive matrix; and

at least one set of electrodes to confine the hydrino reactants,

a source of electrical power to deliver a short burst of high-current electrical energy;

a reloading system;

at least one system to regenerate the initial reactants from the reaction products, and

at least one plasma dynamic converter or at least one photovoltaic converter.

In one example~~exemplary embodiment~~, a method of producing electrical power may comprise supplying a fuel to a region between a plurality of electrodes; energizing the plurality of electrodes to ignite the fuel to form a plasma; converting a plurality of plasma photons into electrical power with a photovoltaic power converter; and outputting at least a portion of the electrical power.

In another example~~exemplary embodiment~~, a method of producing electrical power may comprise supplying a fuel to a region between a plurality of electrodes; energizing the plurality of electrodes to ignite the fuel to form a plasma; converting a plurality of plasma photons into thermal power with a photovoltaic power converter; and outputting at least a portion of the electrical power.

In an example ~~embodiment~~ of the present disclosure, a method of generating power may comprise delivering an amount of fuel to a fuel loading region, wherein the fuel loading region is located among a plurality of electrodes; igniting the fuel by flowing a current of at least about 2,000 A/cm^2 through the fuel by applying the current to the plurality of electrodes to produce at least one of plasma, light, and heat; receiving at least a portion of the light in a photovoltaic power converter; converting the light to a different form of power using the photovoltaic power converter; and outputting the different form of power.

In an additional example~~embodiment~~, the present disclosure is directed to a water arc plasma power system comprising: at least one closed reaction vessel; reactants comprising at least

one of source of H_2O and H_2O; at least one set of electrodes; a source of electrical power to deliver an initial high breakdown voltage of the H_2O and provide a subsequent high current, and a heat exchanger system, wherein the power system generates arc plasma, light, and thermal energy, and at least one photovoltaic power converter.

Certain examples ~~embodiments~~ of the present disclosure are directed to a power generation system comprising: an electrical power source of at least about 2,000 A/cm^2 or of at least about 5,000 kW; a plurality of electrodes electrically coupled to the electrical power source; a fuel loading region configured to receive a solid fuel, wherein the plurality of electrodes is configured to deliver electrical power to the solid fuel to produce a plasma; and at least one of a plasma power converter, a photovoltaic power converter, and thermal to electric power converter positioned to receive at least a portion of the plasma, photons, and/or heat generated by the reaction. Other examples ~~embodiments~~ are directed to a power generation system, comprising: a plurality of electrodes; a fuel loading region located between the plurality of electrodes and configured to receive a conductive fuel, wherein the plurality of electrodes are configured to apply a current to the conductive fuel sufficient to ignite the conductive fuel and generate at least one of plasma and thermal power; a delivery mechanism for moving the conductive fuel into the fuel loading region; and at least one of a photovoltaic power converter to convert the plasma photons into a form of power, or a thermal to electric converter to convert the thermal power into a nonthermal form of power comprising electricity or mechanical power. Further examples ~~embodiments~~ are directed to a method of generating power, comprising: delivering an amount of fuel to a fuel loading region, wherein the fuel loading region is located among a plurality of electrodes; igniting the fuel by flowing a current of at least about 2,000 A/cm^2 through the fuel by applying the current to the plurality of electrodes to produce at least one of plasma, light, and heat; receiving at least a portion of the light in a photovoltaic power converter; converting the light to a different form of power using the photovoltaic power converter; and outputting the different form of power.

Additional examples ~~embodiments~~ are directed to a power generation system, comprising: an electrical power source of at least about 5,000 kW; a plurality of spaced apart electrodes, wherein the plurality of electrodes at least partially surround a fuel, are electrically connected to the electrical power source, are configured to receive a current to ignite the fuel, and at least one of the plurality of electrodes is moveable; a delivery mechanism for moving the

fuel; and a photovoltaic power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power. Additionally provided in the present disclosure is a power generation system, comprising: an electrical power source of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes, wherein the plurality of electrodes at least partially surround a fuel, are electrically connected to the electrical power source, are configured to receive a current to ignite the fuel, and at least one of the plurality of electrodes is moveable; a delivery mechanism for moving the fuel; and a photovoltaic power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power.

Another examples ~~embodiments~~ is directed to a power generation system, comprising: an electrical power source of at least about 5,000 kW or of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes, wherein at least one of the plurality of electrodes includes a compression mechanism; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes so that the compression mechanism of the at least one electrode is oriented towards the fuel loading region, and wherein the plurality of electrodes are electrically connected to the electrical power source and configured to supply power to the fuel received in the fuel loading region to ignite the fuel; a delivery mechanism for moving the fuel into the fuel loading region; and a photovoltaic power converter configured to convert photons generated from the ignition of the fuel into a non-photon form of power. Other examples ~~embodiments~~ of the present disclosure are directed to a power generation system, comprising: an electrical power source of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes, wherein at least one of the plurality of electrodes includes a compression mechanism; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes so that the compression mechanism of the at least one electrode is oriented towards the fuel loading region, and wherein the plurality of electrodes are electrically connected to the electrical power source and configured to supply power to the fuel received in the fuel loading region to ignite the fuel; a delivery mechanism for moving the fuel into the fuel loading region; and a plasma power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power.

Examples~~Embodiments~~ of the present disclosure are also directed to power generation system,

comprising: a plurality of electrodes; a fuel loading region surrounded by the plurality of electrodes and configured to receive a fuel, wherein the plurality of electrodes is configured to ignite the fuel located in the fuel loading region; a delivery mechanism for moving the fuel into the fuel loading region; a photovoltaic power converter configured to convert photons generated from the ignition of the fuel into a non-photon form of power; a removal system for removing a byproduct of the ignited fuel; and a regeneration system operably coupled to the removal system for recycling the removed byproduct of the ignited fuel into recycled fuel. Certain examples ~~embodiments~~ of the present disclosure are also directed to a power generation system, comprising: an electrical power source configured to output a current of at least about 2,000 A/cm^2 or of at least about 5,000 kW; a plurality of spaced apart electrodes electrically connected to the electrical power source; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes, and wherein the plurality of electrodes is configured to supply power to the fuel to ignite the fuel when received in the fuel loading region; a delivery mechanism for moving the fuel into the fuel loading region; and a photovoltaic power converter configured to convert a plurality of photons generated from the ignition of the fuel into a non-photon form of power. Certain examples ~~embodiments~~ may further include one or more of output power terminals operably coupled to the photovoltaic power converter; a power storage device; a sensor configured to measure at least one parameter associated with the power generation system; and a controller configured to control at least a process associated with the power generation system. Certain examples ~~embodiments~~ of the present disclosure are also directed to a power generation system, comprising: an electrical power source configured to output a current of at least about 2,000 A/cm^2 or of at least about 5,000 kW; a plurality of spaced apart electrodes , wherein the plurality of electrodes at least partially surround a fuel, are electrically connected to the electrical power source, are configured to receive a current to ignite the fuel, and at least one of the plurality of electrodes is moveable; a delivery mechanism for moving the fuel; and a photovoltaic power converter configured to convert photons generated from the ignition of the fuel into a different form of power.

Additional examples ~~embodiments~~ of the present disclosure are directed to a power generation system, comprising: an electrical power source of at least 5,000 kW or of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes electrically connected to the electrical power

source; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes, and wherein the plurality of electrodes is configured to supply power to the fuel to ignite the fuel when received in the fuel loading region; a delivery mechanism for moving the fuel into the fuel loading region; a photovoltaic power converter configured to convert a plurality of photons generated from the ignition of the fuel into a non-photon form of power; a sensor configured to measure at least one parameter associated with the power generation system; and a controller configured to control at least a process associated with the power generation system. Further examples ~~embodiments~~ are directed to a power generation system, comprising: an electrical power source of at least 2,000 A/cm^2; a plurality of spaced apart electrodes electrically connected to the electrical power source; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes, and wherein the plurality of electrodes is configured to supply power to the fuel to ignite the fuel when received in the fuel loading region; a delivery mechanism for moving the fuel into the fuel loading region; a plasma power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power; a sensor configured to measure at least one parameter associated with the power generation system; and a controller configured to control at least a process associated with the power generation system.

Certain examples ~~embodiments~~ of the present disclosure are directed to a power generation system, comprising: an electrical power source of at least about 5,000 kW or of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes electrically connected to the electrical power source; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes, and wherein the plurality of electrodes is configured to supply power to the fuel to ignite the fuel when received in the fuel loading region, and wherein a pressure in the fuel loading region is a partial vacuum; a delivery mechanism for moving the fuel into the fuel loading region; and a photovoltaic power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power. Some examples ~~embodiments~~ may include one or more of the following additional features: the photovoltaic power converter may be located within a vacuum cell; the photovoltaic power converter may include at least one of an antireflection coating, an optical impedance matching coating, or a protective coating; the photovoltaic power

converter may be operably coupled to a cleaning system configured to clean at least a portion of the photovoltaic power converter; the power generation system may include an optical filter; the photovoltaic power converter may comprise at least one of a monocrystalline cell, a polycrystalline cell, an amorphous cell, a string/ribbon silicon cell, a multi-junction cell, a homojunction cell, a heterojunction cell, a p-i-n device, a thin-film cell, a dye-sensitized cell, and an organic photovoltaic cell; and the photovoltaic power converter may comprise at multi-junction cell, wherein the multi-junction cell comprises at least one of an inverted cell, an upright cell, a lattice-mismatched cell, a lattice-matched cell, and a cell comprising Group III-V semiconductor materials.

Additional examples ~~exemplary embodiments~~ are directed to a system configured to produce power, comprising: a fuel supply configured to supply a fuel; a power supply configured to supply an electrical power; and at least one gear configured to receive the fuel and the electrical power, wherein the at least one gear selectively directs the electrical power to a local region about the gear to ignite the fuel within the local region. In some examples~~embodiments~~, the system may further have one or more of the following features: the fuel may include a powder; the at least one gear may include two gears; the at least one gear may include a first material and a second material having a lower conductivity than the first material, the first material being electrically coupled to the local region; and the local region may be adjacent to at least one of a tooth and a gap of the at least one gear. Other examples ~~embodiments~~ may use a support member in place of a gear, while other examples ~~embodiments~~ may use a gear and a support member. Some examples ~~embodiments~~ are directed to a method of producing electrical power, comprising: supplying a fuel to a gear; rotating the gear to localize at least some of the fuel at a region of the gear; supplying a current to the gear to ignite the localized fuel to produce energy; and converting at least some of the energy produced by the ignition into electrical power. In some examples~~embodiments~~, rotating the gear may include rotating a first gear and a second gear, and supplying a current may include supplying a current to the first gear and the second gear.

Other examples ~~embodiments~~ are directed to a power generation system, comprising: an electrical power source of at least about 2,000 A/cm^2; a plurality of spaced apart electrodes electrically connected to the electrical power source; a fuel loading region configured to receive a fuel, wherein the fuel loading region is surrounded by the plurality of electrodes,

and wherein the plurality of electrodes is configured to supply power to the fuel to ignite the fuel when received in the fuel loading region, and wherein a pressure in the fuel loading region is a partial vacuum; a delivery mechanism for moving the fuel into the fuel loading region; and a photovoltaic power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power.

Further examples ~~embodiments~~ are directed to a power generation cell, comprising: an outlet port coupled to a vacuum pump; a plurality of electrodes electrically coupled to an electrical power source of at least 5,000 kW; a fuel loading region configured to receive a water-based fuel comprising a majority H_2O, wherein the plurality of electrodes is configured to deliver power to the water-based fuel to produce at least one of an arc plasma and thermal power; and a power converter configured to convert at least a portion of at least one of the arc plasma and the thermal power into electrical power. Also disclosed is a power generation system, comprising: an electrical power source of at least 5,000 A/cm^2; a plurality of electrodes electrically coupled to the electrical power source; a fuel loading region configured to receive a water-based fuel comprising a majority H_2O, wherein the plurality of electrodes is configured to deliver power to the water-based fuel to produce at least one of an arc plasma and thermal power; and a power converter configured to convert at least a portion of at least one of the arc plasma and the thermal power into electrical power. In an example~~embodiment~~, the power converter comprises a photovoltaic converter of optical power into electricity.

Additional examples ~~embodiments~~ are directed to a method of generating power, comprising: loading a fuel into a fuel loading region, wherein the fuel loading region includes a plurality of electrodes; applying a current of at least about 2,000 A/cm^2 to the plurality of electrodes to ignite the fuel to produce at least one of an arc plasma and thermal power; performing at least one of passing the arc plasma through a photovoltaic converter to generate electrical power; and passing the thermal power through a thermal-to-electric converter to generate electrical power; and outputting at least a portion of the generated electrical power. Also disclosed is a power generation system, comprising: an electrical power source of at least 5,000 kW; a plurality of electrodes electrically coupled to the power source, wherein the plurality of electrodes is configured to deliver electrical power to a water-based fuel comprising a majority H_2O to produce a thermal power; and a heat exchanger configured to convert at least a portion of the thermal power into electrical power; and a photovoltaic power converter

configured to convert at least a portion of the light into electrical power. In addition, another example ~~embodiment~~ is directed to a power generation system, comprising: an electrical power source of at least 5,000 kW; a plurality of spaced apart electrodes, wherein at least one of the plurality of electrodes includes a compression mechanism; a fuel loading region configured to receive a water-based fuel comprising a majority H_2O, wherein the fuel loading region is surrounded by the plurality of electrodes so that the compression mechanism of the at least one electrode is oriented towards the fuel loading region, and wherein the plurality of electrodes are electrically connected to the electrical power source and configured to supply power to the water-based fuel received in the fuel loading region to ignite the fuel; a delivery mechanism for moving the water-based fuel into the fuel loading region; and a photovoltaic power converter configured to convert plasma generated from the ignition of the fuel into a non-plasma form of power.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate several embodiments of the disclosure and together with the description, serve to explain the principles of the disclosure. In the drawings:

FIGURE 1 is a schematic drawing of a SF-CIHT cell power generator showing a plasmadynamic converter in accordance with an embodiment of the present disclosure.

FIGURE 2A is a schematic drawing of a SF-CIHT cell power generator showing a photovoltaic converter in accordance with an embodiment of the present disclosure.

FIGURE 2B is a schematic drawing of an arc H_2O plasma cell power generator showing a photovoltaic converter in accordance with an embodiment of the present disclosure.

FIGURE 3 is a schematic view of a grid-connected photovoltaic power generation system, according to an exemplary embodiment.

FIGURE 4 is a schematic view of a hybrid photovoltaic power generation system, according to an exemplary embodiment.

FIGURE 5 is a schematic view of a direct-coupled photovoltaic power generation system, according to an exemplary embodiment.

FIGURE 6A is a schematic view of a DC photovoltaic power generation system, according to an exemplary embodiment.