

What is Claimed Is

1. 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 nascent H₂O;

b) at least one source atomic hydrogen;

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

at least one set of electrodes to confine the reactants,

a source of electrical power to deliver a short burst of high-current electrical energy to the reactants between the electrodes to produce reaction products and a plasma;

at least one regeneration system to regenerate one or more of the initial reactants from the reaction products;

a reloading system to position regenerated reactants between the electrodes; and

at least one direct plasma to electricity converter and at least one thermal to electric power converter.

2. The power system of claim 1 wherein the vessel is capable of a pressure of at least one of atmospheric, above atmospheric, and below atmospheric.

3. The power system of claim 1 wherein reactants comprise a source of H₂O and a conductive matrix.

4. The power system of claim 3 wherein the source of H₂O comprises at least one of bulk H₂O, a state other than bulk H₂O, a compound or compounds that undergo at least one of react to form H₂O and release bound H₂O.

5. The power system of claim 1 wherein the reactants comprise a conductor and one or more compounds or materials that undergo at least one of release of bulk H₂O, absorbed H₂O, bound H₂O, physisorbed H₂O, and waters of hydration, and have H₂O as a reaction product.

6. The power system of claim 1 wherein at least one of the source of nascent H₂O and the source of atomic hydrogen comprises at least one of:

at least one source of H₂O;

at least one source of oxygen, and

at least one source of hydrogen.

7. The power system of claim 1 wherein the reactants comprise at least one of:

O₂, H₂O, HOOH, OOH⁻, peroxide ion, superoxide ion, hydride, H₂, a halide, an oxide, an oxyhydroxide, a hydroxide, a compound that comprises oxygen, a hydrated compound, a hydrated compound selected from the group of at least one of a halide, an oxide, an oxyhydroxide, a hydroxide, a compound that comprises oxygen, and a conductive matrix.

8. The power system of claim 7 wherein the oxyhydroxide comprises at least one from the group of TiOOH, GdOOH, COOH, InOOH, FeOOH, GaOOH, NiOOH, AlOOH, CrOOH, MoOOH, CuOOH, MnOOH, ZnOOH, and SmOOH;

the oxide comprises at least one from the group of CuO, Cu₂O, CoO, Co₂O₃, Co₃O₄, FeO, Fe₂O₃, NiO, and Ni₂O₃;

the hydroxide comprises at least one from the group of Cu(OH)₂, Co(OH)₂, Co(OH)₃, Fe(OH)₂, Fe(OH)₃, and Ni(OH)₂;

the compound that comprises oxygen comprises at least one from the group of a sulfate, phosphate, nitrate, carbonate, hydrogen carbonate, chromate, pyrophosphate, persulfate, perchlorate, perbromate, and periodate, MXO₃, MXO₄ (M=metal such as alkali metal such as Li, Na, K, Rb, Cs; X=F, Br, Cl, I), cobalt magnesium oxide, nickel magnesium oxide, copper magnesium oxide, Li₂O, alkali metal oxide, alkaline earth metal oxide, CuO, CrO₄, ZnO, MgO, CaO, MoO₂, TiO₂, ZrO₂, SiO₂, Al₂O₃, NiO, FeO, Fe₂O₃, TaO₂, Ta₂O₅, VO, VO₂, V₂O₃, V₂O₅, P₂O₃, P₂O₅, B₂O₃, NbO, NbO₂, Nb₂O₅, SeO₂, SeO₃, TeO₂, TeO₃, WO₂, WO₃, Cr₃O₄, Cr₂O₃, CrO₂, CrO₃, CoO, Co₂O₃, Co₃O₄, FeO, Fe₂O₃, NiO, Ni₂O₃, rare earth oxide, CeO₂, La₂O₃, an oxyhydroxide, TiOOH, GdOOH, COOH, InOOH, FeOOH, GaOOH, NiOOH, AlOOH, CrOOH, MoOOH, CuOOH, MnOOH, ZnOOH, and SmOOH, and

the conductive matrix comprises at least one from the group of a metal powder, carbon, carbide, boride, nitride, carbonitrile such as TiCN, or nitrile.

9. The power system of claim 1 wherein the reactants comprise a mixture of a metal, its metal oxide, and H₂O wherein the reaction of the metal with H₂O is not thermodynamically favorable.

10. The power system of claim 1 wherein the reactants comprise a mixture of a metal, a metal halide, and H₂O wherein the reaction of the metal with H₂O is not thermodynamically favorable.

11. The power system of claim 1 wherein the reactants comprise a mixture of a transition metal, an alkaline earth metal halide, and H₂O wherein the reaction of the metal with H₂O is not thermodynamically favorable.

12. The power system of claim 1 wherein the reactants comprise a mixture of a conductor, a hygroscopic material, and H₂O.

13. The power system of claim 1 wherein the conductor comprises a metal powder or carbon powder wherein the reaction of the metal or carbon with H₂O is not thermodynamically favorable.

14. The power system of claim 12 wherein the hygroscopic material comprises at least one of the group of lithium bromide, calcium chloride, magnesium chloride, zinc chloride, potassium carbonate, potassium phosphate, carnallite such as KMgCl₃·6(H₂O), ferric ammonium citrate, potassium hydroxide and sodium hydroxide and concentrated sulfuric and phosphoric acids, cellulose fibers, sugar, caramel, honey, glycerol, ethanol, methanol, diesel fuel, methamphetamine, a fertilizer chemical, a salt, a desiccant, silica, activated charcoal, calcium sulfate, calcium chloride, a molecular sieves, a zeolite, a deliquescent material, zinc chloride, calcium chloride, potassium hydroxide, sodium hydroxide and a deliquescent salt.

15. The power system of claim 14 comprising a mixture of a conductor, hydroscopic materials, and H₂O wherein the ranges of relative molar amounts of (metal), (hydroscopic material), (H₂O) are about (0.000001 to 100000), (0.000001 to 100000), (0.000001 to 100000).

16. The power system of claim 9, wherein the metal having a thermodynamically unfavorable reaction with H₂O is at least one of the group of Cu, Ni, Pb, Sb, Bi, Co, Cd, Ge, Au, Ir, Fe, Hg, Mo, Os, Pd, Re, Rh, Ru, Se, Ag, Tc, Te, Tl, Sn, W, Al, V, Zr, Ti, Mn, Zn, Cr, and In.

17. The power system of claim 16 wherein reactants are regenerated in the regeneration system by addition of H₂O to the reaction products.

18. The power system of claim 1 wherein the reactants comprise a mixture of a metal, its metal oxide, and H₂O wherein the metal oxide is capable of H₂ reduction at a temperature less than 1000° C.

19. The power system of claim 1 wherein the reactants comprise a mixture of an oxide that is not easily reduced with H₂ and mild heat; a metal having an oxide capable of being reduced to the metal with H₂ at a temperature less than 1000° C., and H₂O.

20. The power system of claim 18 wherein the metal having an oxide capable of being reduced to the metal with H₂ at a temperature less than 1000° C. is at least one of the group of Cu, Ni, Pb, Sb, Bi, Co, Cd, Ge, Au, Ir, Fe, Hg, Mo, Os, Pd, Re, Rh, Ru, Se, Ag, Tc, Te, Tl, Sn, W, Al, V, Zr, Ti, Mn, Zn, Cr, and In.

21. The power system of claim 1 wherein the metal oxide that is not easily reduced with H₂, and mild heat comprises at least one of alumina, an alkaline earth oxide, and a rare earth oxide.

22. The power system of claim 1 wherein the reactants comprise carbon or activated carbon and H₂O wherein the mixture is regenerated by rehydration comprising addition of H₂O.

23. The power system of claim 1 wherein the reactants comprise at least one of a slurry, solution, emulsion, composite, and a compound.

24. The power system of claim 1 wherein the H₂O mole % content may be in the range of about 0.000001% to 100%.

25. The power system of claim 1 wherein the source of electrical power to deliver a short burst of high-current electrical energy comprises at least one of the following:
a voltage selected to cause a high AC, DC, or an AC-DC mixture of current that is in the range of 100 A to 1,000,000 A;
a DC or peak AC current density in the range of 100 A/cm² to 1,000,000 A/cm²;
wherein the voltage is determined by the conductivity of solid fuel or energetic material comprising the reactants and the voltage is given by the desired current times the resistance of the solid fuel or energetic material sample;

the DC or peak AC voltage may be from about 0.1 V to 500 kV, and the AC frequency may be about 0.1 Hz to 10 GHz.

26. The power system of claim 25 wherein the resistance of the solid fuel or energetic material sample is from about 0.001 milliohm to 100 Mohm, and the conductivity of a suitable load per electrode area active is from about $10^{-10} \text{ ohm}^{-1} \text{ cm}^{-2}$ to $10^6 \text{ ohm}^{-1} \text{ cm}^{-2}$.

27. The power system of claim 1 wherein the regeneration system comprises at least one of a hydration, thermal, chemical, and electrochemical system.