## What Is Claimed Is:

1. A battery or fuel cell system that generates an electromotive force (EMF) from the catalytic reaction of hydrogen to lower energy (hydrino) states providing direct conversion of the energy released from the hydrino reaction into electricity comprising

reactants that constitute hydrino reactants during cell operation with separate electron flow and ion mass transport,

a cathode compartment comprising a cathode,

an anode compartment comprising an anode, and

a source of hydrogen,

wherein the reactants comprise at least two components chosen from: a catalyst or a source of catalyst; atomic hydrogen or a source of atomic hydrogen; reactants to form the catalysts or the source of catalyst and the atomic hydrogen or the source of atomic hydrogen; one or more reactants to initiate the catalysis of atomic hydrogen; and a support to enable the catalysis, and

wherein at least one of atomic hydrogen and the hydrogen catalyst is formed by a reaction of the reaction mixture, and one reactant that by virtue of it undergoing a reaction causes the catalysis to be active, wherein the reaction to cause the catalysis reaction comprises a reaction chosen from:

(i) exothermic reactions;

(ii) coupled reactions;

(iii) free radical reactions;

(iv) oxidation-reduction reactions;

(v) exchange reactions, and

(vi) getter, support, or matrix-assisted catalysis reactions.

2. The battery or fuel cell system of Claim 1 wherein at least one of different reactants or the same reactants under different states or conditions are provided in different cell compartments that are connected by separate conduits for electrons and ions to complete an electrical circuit between the compartments.

3. The battery or fuel cell system of Claim 2 wherein the mass flow provides at least one of the formation of the reaction mixture that reacts to produce hydrinos and the conditions that permit the hydrino reaction to occur at substantial rates, wherein the hydrino reaction does not

occur or does not occur at an appreciable rate in the absence of the electron flow and ion mass transport.

4. The battery or fuel cell system of Claim 3 wherein at least one of electrical and thermal power gain over that of an applied electrolysis power through the electrodes is produced.

5. The battery or fuel cell system of Claim 4 wherein the reactants to form hydrinos are at least one of thermally or electrolytically regenerative.

6. The battery or fuel cell system of Claim 5 wherein the thermally regenerative reactants comprise

(i) at least one catalyst or a source of catalyst chosen from the alkali hydrides;

(ii) a source of hydrogen chosen from an alkali hydride;

(iii) at least one oxidant chosen from

(a) an alkaline earth halide;

(b) an alkali halide;

(c) a rare earth halide;

(iv) at least one reductant chosen from Mg and $MgH_2$, Ca, CaH2, and Li, and

(v) at least one support chosen from TiC, WC, TiCN, $TiB_2$, $Cr_3C_2$, and $Ti_3SiC_2$.

7. The battery or fuel cell system of Claim 6 wherein the reaction mixture comprising an oxidation-reduction reaction to cause the catalysis reaction comprises:

(i) at least one catalyst chosen from Li, LiH, K, KH, NaH, Rb, RbH, Cs, and CsH;

(ii) $H_2$ gas, a source of $H_2$ gas, or a hydride;

(iii) at least one oxidant chosen from

metal compounds comprising halides, phosphides, borides, oxides, hydroxide, silicides, nitrides, arsenides, selenides, tellurides, antimonides, carbides, sulfides, hydrides, carbonate, hydrogen carbonate, sulfates, hydrogen sulfates, phosphates, hydrogen phosphates, dihydrogen phosphates, nitrates, nitrites, permanganates, chlorates, perchlorates, chlorites, perchlorites, hypochlorites, bromates, perbromates, bromites, perbromites, iodates, periodates, iodites, periodites, chromates, dichromates, tellurates, selenates, arsenates, silicates, borates, colbalt oxides, tellurium oxides, and oxyanions of halogens, P, B, Si, N, As, S, Te, Sb, C, S, P, Mn, Cr, Co, and Te;

a transition metal, Sn, Ga, In, lead, germanium, alkali metal and alkaline earth metal compound;

$GeF_2$, $GeCl_2$, $GeBr_2$, $GeI_2$, GeO, GeP, GeS, $GeI_4$, and $GeCl_4$, fluorocarbon,$CF_4$ , $ClCF_3$, chlorocarbon, $CCl_4$, $O_2$, $MNO_3$, $MClO_4$, $MO_2$, $NF_3$, $N_2O$, NO, $NO_2$, a boron-nitrogen compound such as $B_3N_3H_6$, a sulfur compound such as $SF_6$, S, $SO_2$, $SO_3$, $S_2O_5Cl_2$, $F_5SOF$, $M_2S_2O_8$, $S_xX_y$ such as $S_2Cl_2$, $SCl_2$, $S_2Br_2$, or $S_2F_2$, $CS_2$, $SO_xX_y$, $SOCl_2$, $SOF_2$, $SO_2F_2$, $SOBr_2$, $X_xX'_y$, $ClF_5$, $X_xX'_yO_z$, $ClO_2F$, $ClO_2F_2$, $ClOF_3$, $ClO_3F$, $ClO_2F_3$, boron-nitrogen compound, $B_3N_3H_6$, Se, Te, Bi, As, Sb, Bi, $TeX_x$, $TeF_4$, $TeF_6$, $TeO_x$, $TeO_2$, $TeO_3$, $SeX_x$, $SeF_6$, $SeO_x$, $SeO_2$ or $SeO_3$, a tellurium oxide, halide, tellurium compound, $TeO_2$, $TeO_3$, $Te(OH)_6$, $TeBr_2$, $TeCl_2$, $TeBr_4$, $TeCl_4$, $TeF_4$, $TeI_4$, $TeF_6$, CoTe, or NiTe, a selenium compound. a selenium oxide, a selenium halide, a selenium sulfide, $SeO_2$, $SeO_3$, $Se_2Br_2$, $Se_2Cl_2$, $SeBr_4$, $SeCl_4$, $SeF_4$, $SeF_6$, $SeOBr_2$, $SeOCl_2$, $SeOF_2$, $SeO_2F_2$, $SeS_2$, $Se_2S_6$, $Se_4S_4$, or $Se_6S_2$, P, $P_2O_5$, $P_2S_5$, $P_xX_y$, $PF_3$, $PCl_3$, $PBr_3$, $PI_3$, $PF_5$, $PCl_5$, $PBr_4F$, $PCl_4F$, $PO_xX_y$, $POBr_3$, $POI_3$, $POCl_3$ or $POF_3$, $PS_xX_y$, ($M$ is an alkali metal, x, y and z are integers, X and X' are halogen) $PSBr_3$, $PSF_3$, $PSCl_3$, a phosphorous-nitrogen compound, $P_3N_5$, $(Cl_2PN)_3$, $(Cl_2PN)_4$, $(Br_2PN)_x$, an arsenic compound, an arsenic oxide, arsenic halide, arsenic sulfide, arsenic selenide, arsenic telluride, AlAs, $As_2I_4$, $As_2Se$, $As_4S_4$, $AsBr_3$, $AsCl_3$, $AsF_3$, $AsI_3$, $As_2O_3$, $As_2Se_3$, $As_2S_3$, $As_2Te_3$, $AsCl_5$, $AsF_5$, $As_2O_5$, $As_2Se_5$, $As_2S_5$, an antimony compound, an antimony oxide, an antimony halide, an antimony sulfide, an antimony sulfate, an antimony selenide, an antimony arsenide, SbAs, $SbBr_3$, $SbCl_3$, $SbF_3$, $SbI_3$, $Sb_2O_3$, SbOCl, $Sb_2Se_3$, $Sb_2(SO4)_3$, $Sb_2S_3$, $Sb_2Te_3$, $Sb_2O_4$, $SbCl_5$, $SbF_5$, $SbCl_2F_3$, $Sb_2O_5$, $Sb_2S_5$, a bismuth compound, a bismuth oxide, a bismuth halide, a bismuth sulfide, a bismuth selenide, BiAsO4, $BiBr_3$, $BiCl_3$, $BiF_3$, $BiF_5$, $Bi(OH)_3$, $BiI_3$, $Bi_2O_3$, BiOBr, BiOCl, BiOI, $Bi_2Se_3$, $Bi_2S_3$, $Bi_2Te_3$, $Bi_2O_4$, $SiCl_4$, $SiBr_4$, a transition metal halide, $CrCl_3$, $ZnF_2$, $ZnBr_2$, $ZnI_2$, $MnCl_2$, $MnBr_2$, $MnI_2$, $CoBr_2$, $CoI_2$, $CoCl_2$, $NiCl_2$, $NiBr_2$, $NiF_2$, $FeF_2$, $FeCl_2$, $FeBr_2$, $FeCl_3$, $TiF_3$, CuBr, $CuBr_2$, $VF_3$, $CuCl_2$, a metal halide , $SnF_2$, $SnCl_2$, $SnBr_2$, $SnI_2$, $SnF_4$, $SnCl_4$, $SnBr_4$, $SnI_4$, InF, InCl, InBr, InI, AgCl, AgI, $AlF_3$, $AlBr_3$, $AlI_3$, $YF_3$, $CdCl_2$, $CdBr_2$, $CdI_2$, $InCl_3$, $ZrCl_4$, $NbF_5$, $TaCl_5$, $MoCl_3$, $MoCl_5$, $NbCl_5$, $AsCl_3$, $TiBr_4$, $SeCl_2$, $SeCl_4$, $InF_3$, $InCl_3$, $PbF_4$, $TeI_4$, $WCl_6$, $OsCl_3$, $GaCl_3$, $PtCl_3$, $ReCl_3$, $RhCl_3$, $RuCl_3$, metal oxide, a metal hydroxide, $Y_2O_3$, FeO, $Fe_2O_3$, or NbO, NiO, $Ni_2O_3$, SnO, $SnO_2$, $Ag_2O$, AgO, $Ga_2O$, $As_2O_3$, $SeO_2$, $TeO_2$, $In(OH)_3$, $Sn(OH)_2$, $In(OH)_3$, $Ga(OH)_3$, $Bi(OH)_3$, $CO_2$, $As_2Se_3$, $SF_6$, S, $SbF_3$, $CF_4$, $NF_3$, a metal permanganate, $KMnO_4$, $NaMnO_4$, $P_2O_5$, a metal nitrate, $LiNO_3$, $NaNO_3$, $KNO_3$, a boron halide , $BBr_3$, $BI_3$, a group 13 halide, an indium halide, $InBr_2$, $InCl_2$, $InI_3$, a silver halide, AgCl, AgI, a lead halide, a cadmium halide, a zirconoium halide, a transition metal oxide, a transition metal sulfide, or a transition metal halide (Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, or Zn with F, Cl, Br or I), a second or third transition series halide, $YF_3$, second or third transition series oxide, second or third transition series sulfide, $Y_2S_3$, a halide of Y, Zr, Nb, Mo, Tc, Ag, Cd, Hf, Ta, W, Os, such as $NbX_3$, $NbX_5$, or $TaX_5$, $Li_2S$, ZnS, FeS, NiS, MnS, $Cu_2S$, CuS, SnS, an alkaline earth halide, $BaBr_2$, $BaCl_2$, $BaI_2$, $SrBr_2$, $SrI_2$, $CaBr_2$, $CaI_2$, $MgBr_2$, or $MgI_2$, a rare earth halide, $EuBr_3$, $LaF_3$, $LaBr_3$, $CeBr_3$, $GdF_3$, $GdBr_3$, a rare earth halide with the metal in the II state, $CeI_2$, $EuF_2$, $EuCl_2$, $EuBr_2$, $EuI_2$, $DyI_2$, $NdI_2$, $SmI_2$, $YbI_2$, and $TmI_2$, a metal boride, a europium boride, an $MB_2$ boride, $CrB_2$, $TiB_2$,

$MgB_2$, $ZrB_2$, $GdB_2$, an alkali halide, LiCl, RbCl, or CsI, a metal phosphide, as $Ca_3P_2$, a noble metal halide, a noble metal oxide, a noble metal sulfide, $PtCl_2$, $PtBr_2$, $PtI_2$, $PtCl_4$, $PdCl_2$, $PbBr_2$, $PbI_2$, a rare earth sulfide, CeS, a La halide, a Gd halide, a metal and an anion, $Na_2TeO_4$, $Na_2TeO_3$, $Co(CN)_2$, CoSb, CoAs, $Co_2P$, CoO, CoSe, CoTe, NiSb, NiAs, NiSe, $Ni_2Si$, MgSe, a rare earth telluride, EuTe, a rare earth selenide, EuSe, a rare earth nitride, EuN, a metal nitride, AlN, GdN, $Mg_3N_2$, a compound containing at least two atoms chosen from oxygen and different halogen atoms, $F_2O$, $Cl_2O$, $ClO_2$, $Cl_2O_6$, $Cl_2O_7$, ClF, $ClF_3$, $ClOF_3$, $ClF_5$, $ClO_2F$, $ClO_2F_3$, $ClO_3F$, $BrF_3$, BrF5, $I_2O_5$, IBr, ICl, $ICl_3$, IF, $IF_3$, $IF_5$, $IF_7$, a metal second or third transition series halide, $OsF_6$, $PtF_6$, or $IrF_6$, a compound that can form a metal upon reduction, a metal hydride, rare earth hydride, alkaline earth hydride, or alkali hydride;

(iv) at least one reductant chosen from a metal, an alkali, alkaline earth, transition, second and third series transition, and rare earth metals, Al, Mg, $MgH_2$, Si, La, B, Zr, and Ti powders, and $H_2$, and

(v) at least one electrically conducting support chosen from AC, 1% Pt or Pd on carbon (Pt/C, Pd/C), a carbide, TiC, and WC.

8. The battery or fuel cell system of Claim 7 wherein the reaction mixture comprising an oxidation-reduction reaction to cause the catalysis reaction comprises:

(i) at least one catalyst or a source of catalyst comprising a metal or a hydride from the Group I elements;

(ii) at least one source of hydrogen comprising $H_2$ gas or a source of $H_2$ gas, or a hydride;

(iii) at least one oxidant comprising an atom or ion or a compound comprising at least one of the elements from Groups 13, 14, 15, 16, and 17 chosen from F, Cl, Br, I, B, C, N, O, Al, Si, P, S, Se, and Te;

(iv) at least one reductant comprising an element or hydride chosen from Mg, $MgH_2$, Al, Si, B, Zr, and a rare earth metal ; and

(v) at least one electrically conductive support chosen from carbon, AC, graphene, carbon impregnated with a metal, Pt/C, Pd/C, a carbide, TiC, and WC.

9. The battery or fuel cell system of Claim 8 wherein the reaction mixture comprising an oxidation-reduction reaction to cause the catalysis reaction comprises:

(i) at least one catalyst or a source of catalyst comprising a metal or a hydride from the Group I elements;

(ii) at least one source of hydrogen comprising $H_2$ gas or a source of $H_2$ gas, or a hydride;

(iii) at least one oxidant comprising a halide, oxide, or sulfide compound of the elements chosen from Groups IA, IIA, 3d, 4d, 5d, 6d, 7d, 8d, 9d, 10d, 11d, 12d, and lanthanides;

(iv) at least one reductant comprising an element or hydride chosen from Mg, $MgH_2$, Al, Si, B, Zr, and a rare earth metal; and

(v) at least one electrically conductive support chosen from carbon, AC, graphene, carbon impregnated with a metal such as Pt or Pd/C, a carbide, TiC, and WC.

10. The battery or fuel cell system of Claim 9 wherein the exchange reaction to cause the catalysis reaction comprises an anion exchange between at least two of the oxidant, reductant, and catalyst wherein the anion is chosen from halide, hydride, oxide, sulfide, nitride, boride, carbide, silicide, arsenide, selenide, telluride, phosphide, nitrate, hydrogen sulfide, carbonate, sulfate, hydrogen sulfate, phosphate, hydrogen phosphate, dihydrogen phosphate, perchlorate, chromate, dichromate, cobalt oxide, and oxyanions.

11. The battery or fuel cell system of Claim 1, wherein the catalyst is capable of accepting energy from atomic hydrogen in integer units of one of 27.2 eV ± 0.5 eV and $\frac{27.2}{2}\ eV$ ± 0.5 eV.

12. The battery or fuel cell system of Claim 1, wherein the catalyst comprises an atom or ion M wherein the ionization of $t$ electrons from the atom or ion M each to a continuum energy level is such that the sum of ionization energies of the $t$ electrons is approximately one of $m \times 27.2\ eV$ and $m \times \frac{27.2}{2}\ eV$ where $m$ is an integer.

13. The battery or fuel cell system of Claim 1 wherein the catalyst comprised a diatomic molecule MH wherein the breakage of the M-H bond plus the ionization of $t$ electr ons from the atom M each to a continuum energy level is such that the sum of the bond energy and ionization energies of the $t$ electrons is approximately one of $m \times 27.2\ eV$ and $m \times \frac{27.2}{2}\ eV$ where $m$ is an integer.

14. The battery or fuel cell system of Claim 1 wherein the catalyst comprises atoms, ions, and/or molecules chosen from molecules of AlH, BiH, ClH, CoH, GeH, InH, NaH, RuH, SbH, SeH, SiH, SnH, $C_2$, $N_2$, $O_2$, $CO_2$, $NO_2$, and $NO_3$ and atoms or ions of Li, Be, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As,

Se, Kr, Rb, Sr, Nb, Mo, Pd, Sn, Te, Cs, Ce, Pr, Sm, Gd, Dy, Pb, Pt, Kr, $2K^{+}$, $He^{+}$, $Ti^{2+}$, $Na^{+}$, $Rb^{+}$, $Sr^{+}$, $Fe^{3+}$, $Mo^{2+}$, $Mo^{4+}$, $In^{3+}$, $He^{+}$, $Ar^{+}$, $Xe^{+}$, $Ar^{2+}$ and $H^{+}$, and $Ne^{+}$ and $H^{+}$.

**What Is Claimed Is:**

1. A power source comprising:

a reaction cell for the catalysis of atomic hydrogen ;

a reaction vessel;

a vacuum pump;

a source of atomic hydrogen in communication with the reaction vessel;

a source of a hydrogen catalyst comprising a bulk material in communication with the reaction vessel,

the source of at least one of the source of atomic hydrogen and the source of hydrogen catalyst comprising a reaction mixture of at least one reactant comprising the element or elements that form at least one of the atomic hydrogen and the hydrogen catalyst and at least one other element, whereby at least one of the atomic hydrogen and hydrogen catalyst is formed from the source,

at least one other reactant to cause catalysis; and

a heater for the vessel,

whereby the catalysis of atomic hydrogen releases energy in an amount greater than about 300 kJ per mole of hydrogen.

2. The power source of Claim 1 wherein the reaction to cause the catalysis reaction comprises a reaction chosen from:

(i) exothermic reactions;

(ii) coupled reactions;

(iii) free radical reactions;

(iv) oxidation-reduction reactions;

(v) exchange reactions, and

(vi) getter, support, or matrix-assisted catalysis reactions.

3. The power source of Claim 1 wherein the reaction to cause the catalysis reaction comprises a reaction chosen from

(i) a reaction of the catalyst or source of catalyst and source of hydrogen with a material or compound to form an intercalation compound,

(ii) at least one of a hydride exchange and a halide exchange between at least two species wherein at least one species is a catalyst or a source of a catalyst to form hydrinos,

(iii) a hydride exchange between at least two hydrides, at least one metal and at least one hydride, at least two metal hydrides, at least one metal and at least one metal hydride, and other such combinations with the exchange between or involving two or more than two species, and

(iv) a hydride exchange or halide-hydride exchange reaction wherein the hydride

exchange forms a mixed metal hydride.

4. The power source of Claim 1 wherein the catalyst is an atom or ion of at least one of a bulk material, a metal, a metal of an intermetalic compound, a supported metal, and a compound,

wherein at least one electron of the atom or ion accepts about an integer multiple of 27.2 eV from atomic hydrogen to form hydrinos.

5. The power source of Claim 1 wherein the catalyst comprises the combination of molecular hydrogen, atomic hydrogen, or hydride ion, and a species wherein the sum of the ionization of one or more electrons of the species and either the bond energy of $H_2$ (4.478 eV), the ionization energy of H (13.59844 eV), or the ionization energy of $H^-$ (IP=0.754 eV) is about an integer multiple of 27.2 eV.

6. The power source of Claim 1 further comprising systems and species that perform at least one of the functions of

accepting electrons from the ionizing catalyst due to the energy transfer from H,

transferring accepted electrons to an electrical circuit for the flow of electrons to at least one of the ground and a path terminating internal to the cell,

transferring electrons to at least one of the ground and a species that undergoes reduction to serve as a final electron acceptor or an electron carrier, and

allowing the electron carrier to transfer the electron to the catalyst ion formed during catalysis.

7. A power system comprising:

(i) a chemical fuel mixture comprising at least two components chosen from: a catalyst or a source of catalyst; atomic hydrogen or a source of atomic hydrogen; reactants to form the catalyst or the source of catalyst and the atomic hydrogen or the source of atomic hydrogen; one or more reactants to initiate the catalysis of atomic hydrogen; and a support to enable the catalysis,

(ii) at least one thermal system for reversing an exchange reaction to thermally regenerate the fuel from the reaction products comprising a plurality of reaction vessels,

wherein regeneration reactions comprising reactions that form the initial chemical fuel mixture from the products of the reaction of the mixture are performed in at least one reaction vessel of the plurality in conjunction with the at least one of the other vessels undergoing power reactions ,

the heat from a power-producing vessel flows to at least one vessel that is undergoing regeneration to provide the energy for the thermal regeneration,

the vessels are embedded in a heat transfer medium to achieve the heat flow,

at least one vessel further comprising a vacuum pump and a source of hydrogen, and further comprising two chambers having a temperature difference maintained between a hotter chamber and a colder chamber such that a species preferentially accumulates in the colder chamber,

wherein a hydride reaction is performed in the colder chamber to form at least one initial reactant that is returned to the hotter chamber,

(iii) a heat sink that accepts the heat from the power-producing reaction vessels across a thermal barrier, and

(iv) a power conversion system that comprises a heat engine chosen from a Rankine or Brayton-cycle engine, a turbine, a steam engine, a Stirling engine, and thermoelectric and thermionic converters.

8. The power system of Claim 7 wherein the plurality of cells comprise at least one multi-cell thermally interacting bundle wherein heat is transferred between the cells and to the periphery to the heat sink.

9. The power system of Claim 8 wherein the thermally regenerative reactants comprise

(i) at least one catalyst or a source of catalyst chosen from the alkali hydrides;

(ii) a source of hydrogen chosen from an alkali hydride;

(iii) at least one oxidant chosen from

(a) an alkaline earth halide;

(b) an alkali halide;

(iv) at least one reductant chosen from Mg and $MgH_2$, Ca, CaH2, and Li, and

(v) at least one support chosen from TiC, WC, TiCN, $TiB_2$, $Cr_3C_2$, and $Ti_3SiC_2$.

10. A power system comprising:

(i) a chemical fuel mixture comprising at least two components chosen from: a catalyst or a source of catalyst; atomic hydrogen or a source of atomic hydrogen; reactants to form the catalyst or source of catalyst and the atomic hydrogen or a source of atomic hydrogen; one or more reactants to initiate the catalysis of atomic hydrogen; and a support to enable the catalysis,

(ii) a thermal system for reversing an exchange reaction to thermally regenerate the fuel from the reaction products comprising at least one reaction vessel,

wherein regeneration reactions comprising reactions that form the initial chemical fuel mixture from the products of the reaction of the mixture are performed in the at least one reaction vessel in conjunction with power reactions,

the heat from power-producing reactions flows to regeneration reactions to provide the energy for the thermal regeneration,

at least one vessel is insulated on one section and in contact with a thermally conductive medium on another section to achieve a heat gradient between the hotter and colder sections, respectively, of the vessel ,

at least one vessel further comprising a vacuum pump and a source of hydrogen,

wherein a hydride reaction is performed in the colder section to form at least one initial reactant that is returned to the hotter section,

(iii) a heat sink that accepts the heat from the power-producing reactions transferred through the thermally conductive medium and optionally across at least one thermal barrier, and

(iv) a power conversion system that comprises a heat engine selected from a Rankine or Brayton-cycle engine, a turbine, a steam engine, a Stirling engine, and thermoelectric and thermionic converters.

11. The power system of Claim 10 comprising a multi-tube reactor system to continuously generate power comprising a plurality of repeating planar layers of insulation, reactor cell, thermally conductive medium, and heat exchanger or collector.

12. The power system of Claim 11 wherein at least one cell is a circular tube, at least one cell is horizontally oriented with a dead space along the longitudinal axis of the cell that allows the alkali metal vapor to escape from the reactants along the bottom of the cell during continuous regeneration,

and the heat exchanger is parallel with the cell and accepts heat to maintain a cell thermal gradient.

13. The power system of Claim 10 wherein the thermally regenerative reactants comprise

(i) at least one catalyst or a source of catalyst chosen from the alkali hydrides;

(ii) a source of hydrogen chosen from an alkali hydride;

(iii) at least one oxidant chosen from

(a) an alkaline earth halide;

(b) an alkali halide;

(iv) at least one reductant chosen from Mg and $MgH_2$, Ca, CaH2, and Li, and

(v) at least one support chosen from TiC, WC, TiCN, $TiB_2$, $Cr_3C_2$, and $Ti_3SiC_2$.

14. A battery or fuel cell system that generates an electromotive force (EMF) from the catalytic reaction of hydrogen to lower energy (hydrino) states providing direct conversion of the energy released from the hydrino reaction into electricity comprising

reactants that constitute hydrino reactants during cell operation with separate electron flow and ion mass transport,

a cathode compartment comprising a cathode,

an anode compartment comprising an anode, and

a source of hydrogen.

15. A battery or fuel cell system of Claim 14 wherein the reactants comprise at least two components chosen from: a catalyst or a source of catalyst; atomic hydrogen or a source of atomic hydrogen; reactants to form the catalysts or the source of catalyst and the atomic hydrogen or the source of atomic hydrogen; one or more reactants to initiate the catalysis of atomic hydrogen; and a support to enable the catalysis.

16. The battery or fuel cell system of Claim 15 wherein the reaction mixtures and reactions to initiate the hydrino reaction cause electrical power to be developed by the reaction of hydrogen to form hydrinos wherein due to oxidation-reduction cell half reactions, the hydrino-producing reaction mixture is constituted with the migration of electrons through an external circuit and ion mass transport through a separate path to complete an electrical circuit.

17. The battery or fuel cell system of Claim 16 wherein at least one of

atomic hydrogen and the hydrogen catalyst is formed by a reaction of the reaction mixture,

and one reactant that by virtue of it undergoing a reaction causes the catalysis to be active,

wherein the reaction to cause the catalysis reaction comprises a reaction chosen from:

(i) exothermic reactions;

(ii) coupled reactions;

(iii) free radical reactions;

(iv) oxidation-reduction reactions;

(v) exchange reactions, and

(vi) getter, support, or matrix-assisted catalysis reactions.

18. The battery or fuel cell system of Claim 17 wherein at least one of different reactants or the same reactants under different states or conditions are provided in different cell compartments that are connected by separate conduits for electrons and ions to complete an electrical circuit between the compartments.

19. The battery or fuel cell system of Claim 18 wherein the mass flow provides at least

one of the formation of the reaction mixture that reacts to produce hydrinos and the conditions that permit the hydrino reaction to occur at substantial rates,
wherein the hydrino reaction does not occur or does not occur at an appreciable rate in the absence of the electron flow and ion mass transport.

20. The battery or fuel cell system of Claim 19 whereinat least one of electrical and thermal power gain over that of an applied electrolysis power through the electrodes is produced.

21. The battery or fuel cell system of Claim 20 wherein the reactants to form hydrinos are at least one of thermally or electrolytically regenerative.

22. The battery or fuel cell system of Claim 21 wherein the thermally regenerative reactants comprise

(i) at least one catalyst or a source of catalyst chosen from the alkali hydrides;
(ii) a source of hydrogen chosen from an alkali hydride;
(iii) at least one oxidant chosen from
(a) an alkaline earth halide;
(b) an alkali halide;
(c) a rare earth halide;
(iv) at least one reductant chosen from Mg and $MgH_2$, Ca, CaH2, and Li, and
(v) at least one support chosen from TiC, WC, TiCN, $TiB_2$, $Cr_3C_2$, and $Ti_3SiC_2$.

23. The battery or fuel cell system of Claim 22 wherein the reaction mixture comprising an oxidation-reduction reaction to cause the catalysis reaction comprises:

(i) at least one catalyst chosen from Li, *LiH* , K, *KH* , *NaH* , Rb, RbH, Cs, and CsH;
(ii) $H_2$ gas, a source of $H_2$ gas, or a hydride;
(iii) at least one oxidant chosen from

metal compounds comprising halides, phosphides, borides, oxides, hydroxide, silicides, nitrides, arsenides, selenides, tellurides, antimonides, carbides, sulfides, hydrides, carbonate, hydrogen carbonate, sulfates, hydrogen sulfates, phosphates, hydrogen phosphates, dihydrogen phosphates, nitrates, nitrites, permanganates, chlorates, perchlorates, chlorites, perchlorites, hypochlorites, bromates, perbromates, bromites, perbromites, iodates, periodates, iodites, periodites, chromates, dichromates, tellurates, selenates, arsenates, silicates, borates, colbalt oxides, tellurium oxides, and oxyanions of halogens, P, B, Si, N, As, S, Te, Sb, C, S, P, Mn, Cr, Co, and Te;

a transition metal, Sn, Ga, In, lead, germanium, alkali metal and alkaline earth metal compound;

$GeF_2$, $GeCl_2$, $GeBr_2$, $GeI_2$, GeO, GeP, GeS, $GeI_4$, and $GeCl_4$, fluorocarbon, $CF_4$, $ClCF_3$, chlorocarbon, $CCl_4$, $O_2$, $MNO_3$, $MClO_4$, $MO_2$, $NF_3$, $N_2O$, NO, $NO_2$, a boron-nitrogen compound such as $B_3N_3H_6$, a sulfur compound such as $SF_6$, $S$, $SO_2$, $SO_3$, $S_2O_5Cl_2$, $F_5SOF$, $M_2S_2O_8$, $S_xX_y$ such as $S_2Cl_2$, $SCl_2$, $S_2Br_2$, or $S_2F_2$, $CS_2$, $SO_xX_y$, $SOCl_2$, $SOF_2$, $SO_2F_2$, $SOBr_2$, $X_xX'_y$, $ClF_5$, $X_xX'_yO_z$, $ClO_2F$, $ClO_2F_2$, $ClOF_3$, $ClO_3F$, $ClO_2F_3$, boron-nitrogen compound, $B_3N_3H_6$, Se, Te, Bi, As, Sb, Bi, $TeX_x$, $TeF_4$, $TeF_6$, $TeO_x$, $TeO_2$, $TeO_3$, $SeX_x$, $SeF_6$, $SeO_x$, $SeO_2$ or $SeO_3$, a tellurium oxide, halide, tellurium compound, $TeO_2$, $TeO_3$, $Te(OH)_6$, $TeBr_2$, $TeCl_2$, $TeBr_4$, $TeCl_4$, $TeF_4$, $TeI_4$, $TeF_6$, CoTe, or NiTe, a selenium compound. a selenium oxide, a selenium halide, a selenium sulfide, $SeO_2$, $SeO_3$, $Se_2Br_2$, $Se_2Cl_2$, $SeBr_4$, $SeCl_4$, $SeF_4$, $SeF_6$, $SeOBr_2$, $SeOCl_2$, $SeOF_2$, $SeO_2F_2$, $SeS_2$, $Se_2S_6$, $Se_4S_4$, or $Se_6S_2$, P, $P_2O_5$, $P_2S_5$, $P_xX_y$, $PF_3$, $PCl_3$, $PBr_3$, $PI_3$, $PF_5$, $PCl_5$, $PBr_4F$, $PCl_4F$, $PO_xX_y$, $POBr_3$, $POI_3$, $POCl_3$ or $POF_3$, $PS_xX_y$, ($M$ is an alkali metal, x, y and z are integers, X and X' are halogen) $PSBr_3$, $PSF_3$, $PSCl_3$, a phosphorous-nitrogen compound, $P_3N_5$, $(Cl_2PN)_3$, $(Cl_2PN)_4$, $(Br_2PN)_x$, an arsenic compound, an arsenic oxide, arsenic halide, arsenic sulfide, arsenic selenide, arsenic telluride, AlAs, $As_2I_4$, $As_2Se$, $As_4S_4$, $AsBr_3$, $AsCl_3$, $AsF_3$, $AsI_3$, $As_2O_3$, $As_2Se_3$, $As_2S_3$, $As_2Te_3$, $AsCl_5$, $AsF_5$, $As_2O_5$, $As_2Se_5$, $As_2S_5$, an antimony compound, an antimony oxide, an antimony halide, an antimony sulfide, an antimony sulfate, an antimony selenide, an antimony arsenide, SbAs, $SbBr_3$, $SbCl_3$, $SbF_3$, $SbI_3$, $Sb_2O_3$, SbOCl, $Sb_2Se_3$, $Sb_2(SO4)_3$, $Sb_2S_3$, $Sb_2Te_3$, $Sb_2O_4$, $SbCl_5$, $SbF_5$, $SbCl_2F_3$, $Sb_2O_5$, $Sb_2S_5$, a bismuth compound, a bismuth oxide, a bismuth halide, a bismuth sulfide, a bismuth selenide, BiAsO4, $BiBr_3$, $BiCl_3$, $BiF_3$, $BiF_5$, $Bi(OH)_3$, $BiI_3$, $Bi_2O_3$, BiOBr, BiOCl, BiOI, $Bi_2Se_3$, $Bi_2S_3$, $Bi_2Te_3$, $Bi_2O_4$, $SiCl_4$, $SiBr_4$, a transition metal halide, $CrCl_3$, $ZnF_2$, $ZnBr_2$, $ZnI_2$, $MnCl_2$, $MnBr_2$, $MnI_2$, $CoBr_2$, $CoI_2$, $CoCl_2$, $NiCl_2$, $NiBr_2$, $NiF_2$, $FeF_2$, $FeCl_2$, $FeBr_2$, $FeCl_3$, $TiF_3$, CuBr, $CuBr_2$, $VF_3$, $CuCl_2$, a metal halide , $SnF_2$, $SnCl_2$, $SnBr_2$, $SnI_2$, $SnF_4$, $SnCl_4$, $SnBr_4$, $SnI_4$, InF, InCl, InBr, InI, AgCl, AgI, $AlF_3$, $AlBr_3$, $AlI_3$, $YF_3$, $CdCl_2$, $CdBr_2$, $CdI_2$, $InCl_3$, $ZrCl_4$, $NbF_5$, $TaCl_5$, $MoCl_3$, $MoCl_5$, $NbCl_5$, $AsCl_3$, $TiBr_4$, $SeCl_2$, $SeCl_4$, $InF_3$, $InCl_3$, $PbF_4$, $TeI_4$, $WCl_6$, $OsCl_3$, $GaCl_3$, $PtCl_3$, $ReCl_3$, $RhCl_3$, $RuCl_3$, metal oxide, a metal hydroxide, $Y_2O_3$, FeO, $Fe_2O_3$, or NbO, NiO, $Ni_2O_3$, SnO, $SnO_2$, $Ag_2O$, AgO, $Ga_2O$, $As_2O_3$, $SeO_2$, $TeO_2$, $In(OH)_3$, $Sn(OH)_2$, $In(OH)_3$, $Ga(OH)_3$, $Bi(OH)_3$, $CO_2$, $As_2Se_3$, $SF_6$, S, $SbF_3$, $CF_4$, $NF_3$, a metal permanganate, $KMnO_4$, $NaMnO_4$, $P_2O_5$, a metal nitrate, $LiNO_3$, $NaNO_3$, $KNO_3$, a boron halide , $BBr_3$, $BI_3$, a group 13 halide, an indium halide, $InBr_2$, $InCl_2$, $InI_3$, a silver halide, AgCl, AgI, a lead halide, a cadmium halide, a zirconoium halide, a transition metal oxide, a transition metal sulfide, or a transition metal halide (Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, or Zn with F, Cl, Br or I), a second or third transition series halide, $YF_3$, second or third transition series oxide, second or third transition series sulfide, $Y_2S_3$, a halide of Y, Zr, Nb, Mo, Tc, Ag, Cd, Hf, Ta, W, Os, such as $NbX_3$, $NbX_5$, or $TaX_5$, $Li_2S$, ZnS, FeS, NiS, MnS, $Cu_2S$, CuS, SnS, an alkaline earth halide, $BaBr_2$, $BaCl_2$, $BaI_2$, $SrBr_2$, $SrI_2$, $CaBr_2$, $CaI_2$, $MgBr_2$, or $MgI_2$, a rare earth halide, $EuBr_3$, $LaF_3$, $LaBr_3$, $CeBr_3$, $GdF_3$, $GdBr_3$, a rare earth halide with the metal in the II state, $CeI_2$, $EuF_2$,

$EuCl_2$, $EuBr_2$, $EuI_2$, $DyI_2$, $NdI_2$, $SmI_2$, $YbI_2$, and $TmI_2$, a metal boride, a europium boride, an $MB_2$ boride, $CrB_2$, $TiB_2$, $MgB_2$, $ZrB_2$, $GdB_2$, an alkali halide, LiCl, RbCl, or CsI, a metal phosphide, as $Ca_3P_2$, a noble metal halide, a noble metal oxide, a noble metal sulfide, $PtCl_2$, $PtBr_2$, $PtI_2$, $PtCl_4$, $PdCl_2$, $PbBr_2$, $PbI_2$, a rare earth sulfide, CeS, a La halide, a Gd halide, a metal and an anion, $Na_2TeO_4$, $Na_2TeO_3$, $Co(CN)_2$, CoSb, CoAs, $Co_2P$, CoO, CoSe, CoTe, NiSb, NiAs, NiSe, $Ni_2Si$, MgSe, a rare earth telluride, EuTe, a rare earth selenide, EuSe, a rare earth nitride, EuN, a metal nitride, AlN, GdN, $Mg_3N_2$, a compound containing at least two atoms chosen from oxygen and different halogen atoms, $F_2O$, $Cl_2O$, $ClO_2$, $Cl_2O_6$, $Cl_2O_7$, ClF, $ClF_3$, $ClOF_3$, $ClF_5$, $ClO_2F$, $ClO_2F_3$, $ClO_3F$, $BrF_3$, BrF5, $I_2O_5$, IBr, ICl, $ICl_3$, IF, $IF_3$, $IF_5$, $IF_7$, a metal second or third transition series halide, $OsF_6$, $PtF_6$, or $IrF_6$, a compound that can form a metal upon reduction, a metal hydride, rare earth hydride, alkaline earth hydride, or alkali hydride;

(iv) at least one reductant chosen from a metal, an alkali, alkaline earth, transition, second and third series transition, and rare earth metals, *Al*, *Mg*, $MgH_2$, *Si*, La, B, Zr, and Ti powders, and $H_2$, and

(v) at least one electrically conducting support chosen from AC, 1% Pt or Pd on carbon (Pt/C, Pd/C), a carbide, TiC, and WC.

24. The battery or fuel cell system of Claim 23 wherein the reaction mixture comprising an oxidation-reduction reaction to cause the catalysis reaction comprises:

(i) at least one catalyst or a source of catalyst comprising a metal or a hydride from the Group I elements;

(ii) at least one source of hydrogen comprising $H_2$ gas or a source of $H_2$ gas, or a hydride;

(iii) at least one oxidant comprising an atom or ion or a compound comprising at least one of the elements from Groups 13, 14, 15, 16, and 17 chosen from F, Cl, Br, I, B, C, N, O, Al, Si, P, S, Se, and Te;

(iv) at least one reductant comprising an element or hydride chosen from Mg, $MgH_2$, Al, Si, B, Zr, and a rare earth metal ; and

(v) at least one electrically conductive support chosen from carbon, AC, graphene, carbon impregnated with a metal, Pt/C, Pd/C, a carbide, TiC, and WC.

25. The battery or fuel cell system of Claim 24 wherein the reaction mixture comprising an oxidation-reduction reaction to cause the catalysis reaction comprises:

(i) at least one catalyst or a source of catalyst comprising a metal or a hydride from the Group I elements;

(ii) at least one source of hydrogen comprising $H_2$ gas or a source of $H_2$ gas, or a hydride;

(iii) at least one oxidant comprising a halide, oxide, or sulfide compound of the elements chosen from Groups IA, IIA, 3d, 4d, 5d, 6d, 7d, 8d, 9d, 10d, 11d, 12d, and lanthanides;

(iv) at least one reductant comprising an element or hydride chosen from Mg, $MgH_2$, Al, Si, B, Zr, and a rare earth metal; and

(v) at least one electrically conductive support chosen from carbon, AC, graphene, carbon impregnated with a metal such as Pt or Pd/C, a carbide, TiC, and WC.

26. The battery or fuel cell system of Claim 25 wherein the exchange reaction to cause the catalysis reaction comprises an anion exchange between at least two of the oxidant, reductant, and catalyst wherein the anion is chosen from halide, hydride, oxide, sulfide, nitride, boride, carbide, silicide, arsenide, selenide, telluride, phosphide, nitrate, hydrogen sulfide, carbonate, sulfate, hydrogen sulfate, phosphate, hydrogen phosphate, dihydrogen phosphate, perchlorate, chromate, dichromate, cobalt oxide, and oxyanions.

27. The battery or fuel cell system of Claim 14, wherein the catalyst is capable of accepting energy from atomic hydrogen in integer units of one of about 27.2 eV ± 0.5 eV and $\frac{27.2}{2}$ $eV$ ± 0.5 eV.

28. The battery or fuel cell system of Claim 14, wherein the catalyst comprises an atom or ion M wherein the ionization of $t$ electrons from the atom or ion M each to a continuum energy level is such that the sum of ionization energies of the $t$ electrons is approximately one of $m \cdot 27.2\ eV$ and $m \cdot \frac{27.2}{2}\ eV$ where $m$ is an integer.

29. The battery or fuel cell system of Claim 14 wherein the catalyst comprised a diatomic molecule MH wherein the breakage of the M-H bond plus the ionization of $t$ electrons from the atom M each to a continuum energy level is such that the sum of the bond energy and ionization energies of the $t$ electrons is approximately one of $m\ X\ 27.2\ eV$ and $m \cdot \frac{27.2}{2}\ eV$ where $m$ is an integer.

30. The battery or fuel cell system of Claim 14 wherein the catalyst comprises atoms, ions, and/or molecules chosen from molecules of AlH, BiH, ClH, CoH, GeH, InH, NaH, RuH, SbH, SeH, SiH, SnH, $C_2$, $N_2$, $O_2$, $CO_2$, $NO_2$, and $NO_3$ and atoms or ions of Li, Be, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Kr, Rb, Sr, Nb, Mo, Pd, Sn, Te, Cs, Ce, Pr, Sm, Gd, Dy, Pb, Pt, Kr, $2K^+$, $He^+$, $Ti^{2+}$, $Na^+$, $Rb^+$, $Sr^+$, $Fe^{3+}$, $Mo^{2+}$, $Mo^{4+}$, $In^{3+}$, $He^+$, $Ar^+$, $Xe^+$, $Ar^{2+}$ and $H^+$, and $Ne^+$ and $H^+$.