



Hydrogen Engines – Efficient & Powerful

with HyOx™ Hydrogen & Oxygen Engine Technology

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Comparison of HyOx™ to Hydrocarbon ICE

Efficiency - In terms of efficiency, today's internal combustion engine (ICE) is only 15-20% (combustion energy to wheel energy), power generating turbines 30-35% and jet engines 25-30% efficient.

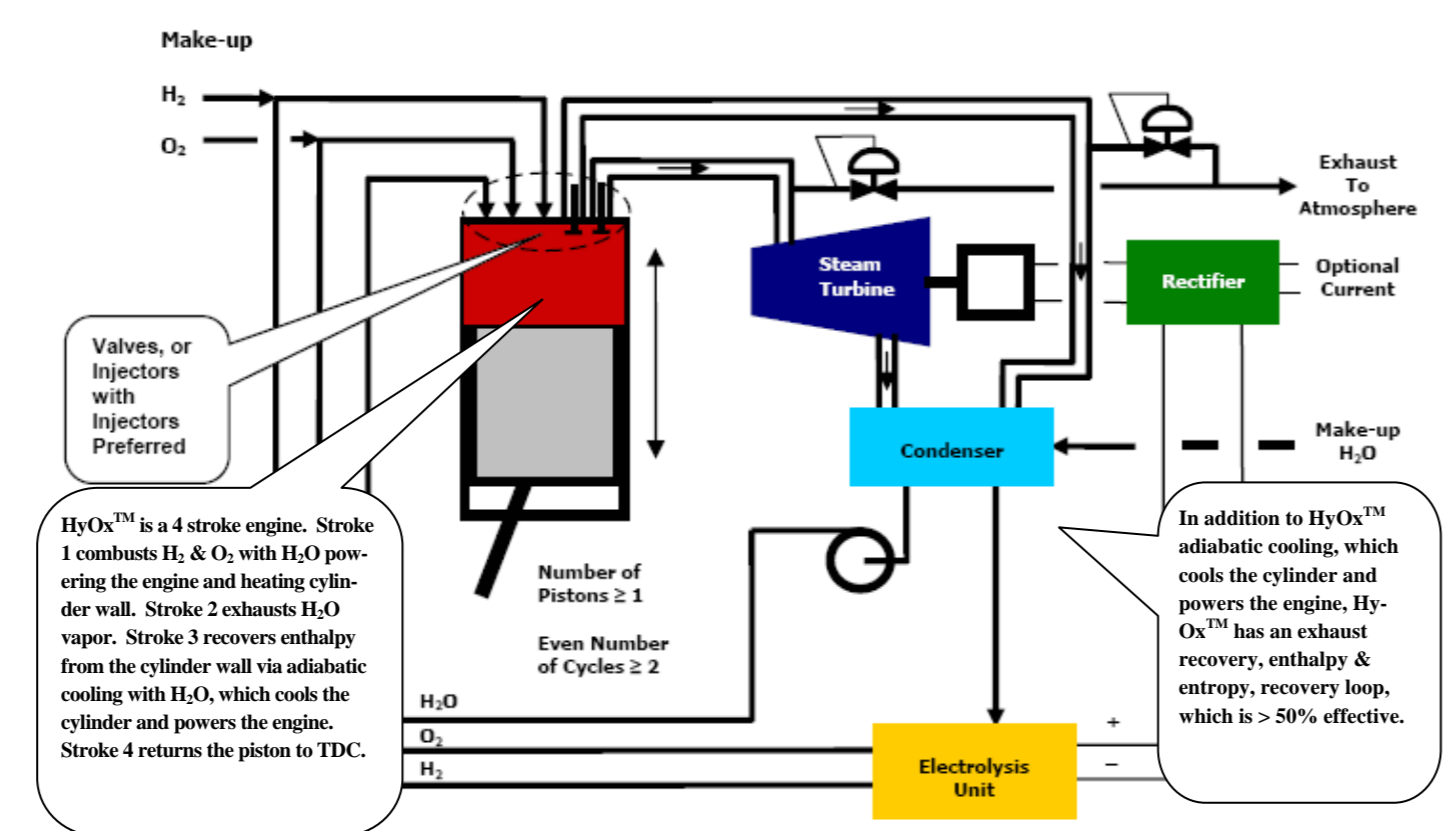
From the laws of thermodynamics:

Combustion Energy = Work + Enthalpy Losses + Entropy Losses + Friction and Combustion Losses

Within hydrocarbon ICE, for every \$1.00 spent on fuel, most unfortunately: \$1.00 = \$0.15 + \$0.35 (Cooling) + \$0.35 (Exhaust) + \$0.15

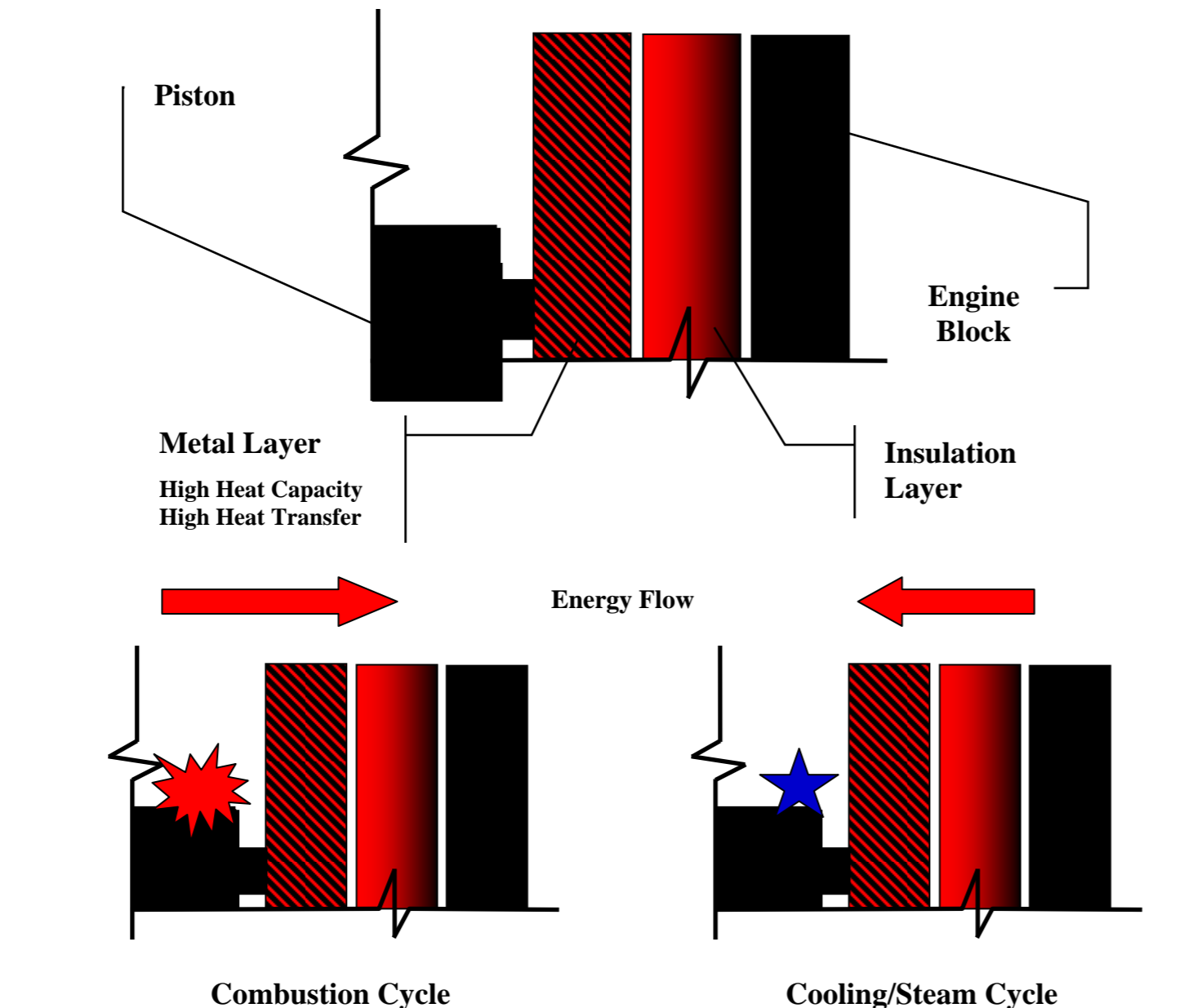
In thermodynamics, cooling losses are termed enthalpy (heat) losses and exhaust losses are termed enthalpy (heat) and entropy (pressure) losses.

Energy Recovery Loop Depiction



Further improvements may be made via an innovative adiabatic cooling/steam cycle, wherein engine operation has an additional cycle between two combustion cycles (a cycle is one revolution of the crankshaft, e.g. one revolution from Top Dead Center (TDC) to TDC).

Combustion Cylinder/Block Depiction



Computer models demonstrate this cooling/steam cycle to be rather efficient in work and efficacious in displacement.

Table with 10 columns representing different parameters (Moles of H2O, Initial Temp, etc.) and 10 rows representing different values or conditions.

Now, with HyOx™, every \$1.00 spent on fuel becomes: \$1.00 = \$0.55 + \$0.15 (Cooling) + \$0.15 (Exhaust) + \$0.15

Powerful - HyOx™ has the capability of producing 2 to 10 times the power of hydrocarbon ICE per displacement. The HyOx™ oxidizer is O2, not air.

HyOx™ has the capability to add H2 fuel and pure O2 oxidizer to the combustion chamber under pressure. Therefore, HyOx™ has the capability to add H2 and O2 to the combustion chamber in amounts here-to-fore unavailable with hydrocarbon fuel and air combustion systems.

HyOx™, incorporating the Haase Cycle, a variant of the traditional Otto Cycle, furthers the power envelop, as presented in PCT/US2006/048057.

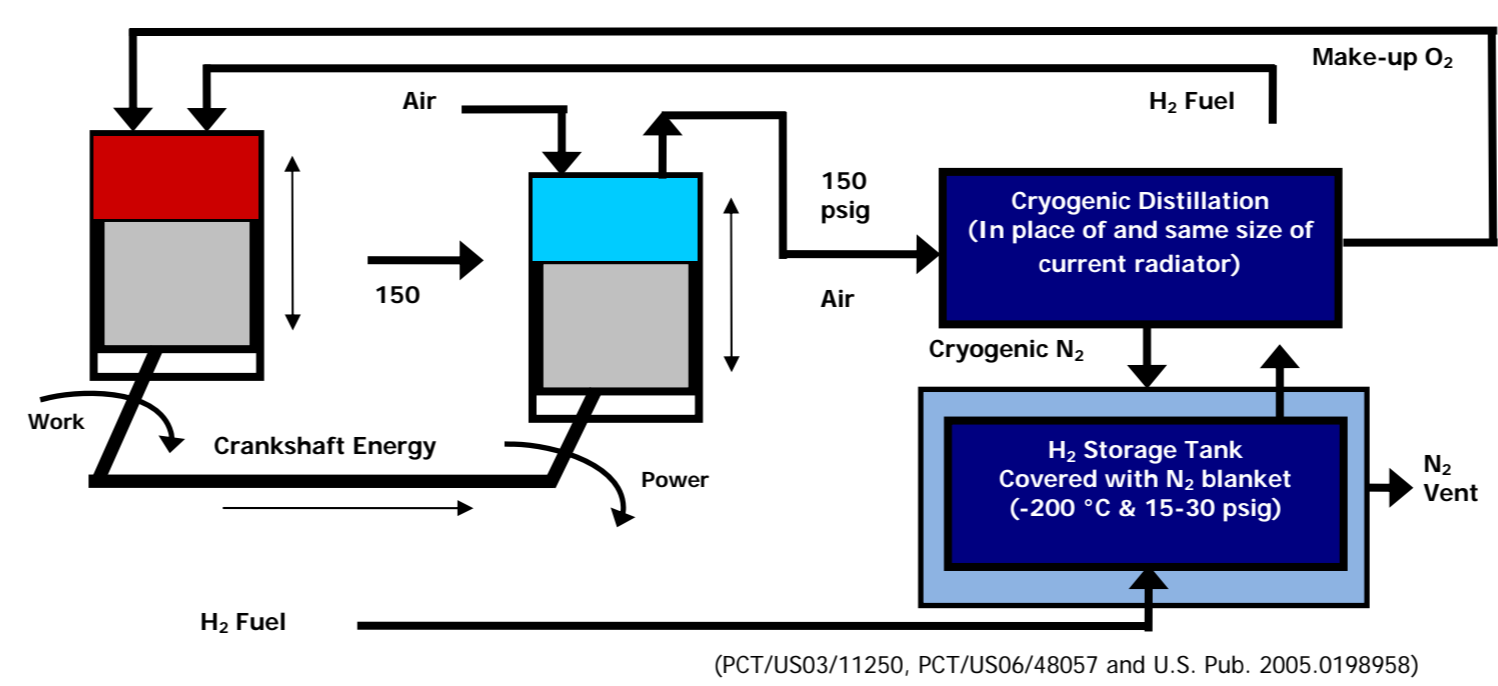
HyOx™ Computer models demonstrate that the above advantages provide significant power improvement.

HyOx™ Computer Model – High Torque

Large data table with multiple columns including C.R., D.S., Vo, To, Ps, atm, n, Po, gamma, P1, T1, Q, delta, T, P2, P3, T3, W, net work, and HP.

O2 and Cryogenic N2 - As a safety measure, HyOx™ stores little to no O2. HyOx™ makes its own O2 as needed with cryogenic air distillation, which is the same process used for decades in the chemical industry.

Air Separation/Fuel Storage Depiction



Another benefit of air distillation is cryogenic N2, which is a good heat sink (absorbs heat). Cryogenic N2 provides HyOx™ an ability to store H2 at cryogenic temperatures, about -350 °F.

The same thermodynamics which make HyOx™ a success in ICE, presents combustion solutions in power and jet propulsion applications. Attached is a diagram of a turbine power application along with a description of the minimal changes necessary within a jet engine to provide for HyOx™ jet propulsion.

Comparison of HyOx™ to Fuel Cells and Electric Vehicles

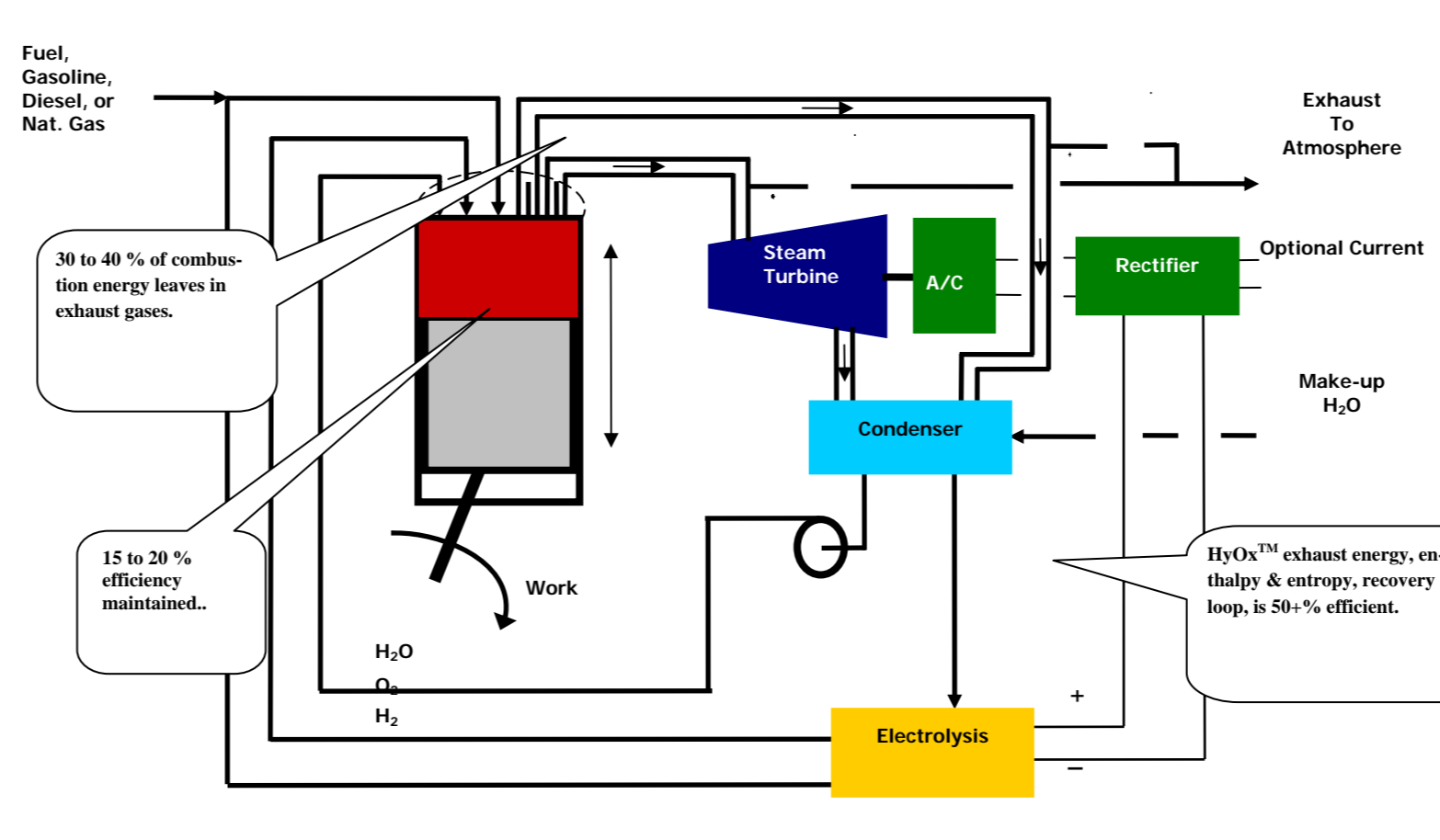
First and foremost, literally billions of research \$ have been invested in fuel cells worldwide. With these research \$, fuel cells remain: 1) requiring platinum, wherein there is not enough platinum in the Earth's crust for 1 year's automotive production,

In addition, literally decades and billions of research \$ have been invested in batteries. Electric vehicles are energy storage limited, thereby distance and/or power limited.

HyOx™ Interim/Assist

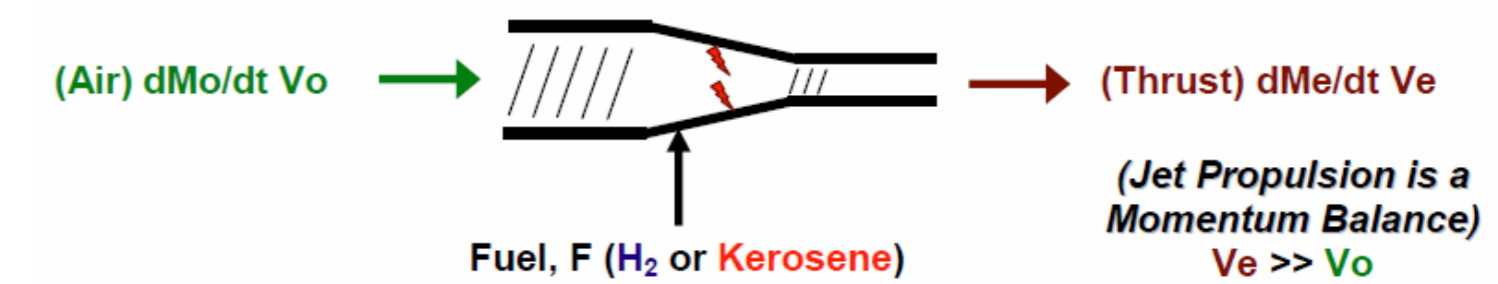
While the before mentioned HyOx™ presentation is the preferred means for HyOx™, at this time humanity has not developed an infrastructure for H2 or electric vehicles. In any event, should a H2 infrastructure be available today, there exist in excess of 600 million vehicles in the world today which operate with gasoline, diesel or propane.

HyOx™ Assist Depiction



PCT/US03/11250, PCT/US06/48057, U.S. Pubs. 2005. 0198958 & 2009.0194996.

HyOx™ - Jet Propulsion



Thrust = dMe/dt Ve - dMo/dt Vo, Let Me = Mo + Mf, Mf = mass of fuel.

F = w1^11 v0^1v0 Me - Mo = w1^11 v0^1v0 Mo + Mf - Mo = w1^11 v0^1v0 Mf

Is, FWCT ≥ Fk? ∴ is, {Mh2 + M02 + Mh20} ≥ {Mk} ? And, if air is used instead of O2, then is {Mh2 + Mh20 + MAir} ≥ {Mk + MAir} ?

ΔHh2 = 51,571 BTU/lb., ΔHk = 19,314 BTU/lb., H2 + 1/2 O2 → H2O C14H30 + 43/2 O2 → 14 CO2 + 15 H2O

CPk = 0.6 BTU °F/lb., CPH20 = 0.46 BTU °F/lb., CpH2 = 3.45 BTU °F/lb., CpAIR = 0.46 BTU °F/lb., ΔHVh20 = 974 BTU/lb., ΔHFh20 = 144 BTU/lb., Kerosene(K) a liquid, H2 vaporizes @ STP

ΔH Combustion = Σ ΔH's

ΔHk = CpK (lb. K)(1000) + CpAIR (3.47/0.18)(1000) + CpAIR(lb. AIR)(1000) 19,314 = (0.6)(1)(1000) + 0.46(3.47/0.18)(1000) + 0.46(lb. Air)(1000) .

∴ For Kerosene, 1 lb. K/40.3 lb. air = 41.3 lb. thrust @ 1000°F.

ΔHh2 = 3.45(1)(1000) + 0.46(8/0.18)(1000) + 0.46(lb. H2O)(1000) + 974(lb. H2O) 51,571 = 3450 + 20,444 + 1434(lb. H2O), H2O cooling = 19.3 lb., Air = 8/0.18 = 44.4 lb.

∴ lb. H2/44.4 lb. air/19.3 lb. H2O = 64.7 lb. thrust. (Requires 10% air increase @ 1000°F).

∴ H2 w/air cooling, 0.37 lb. H2/39.22 lb. Air = 39.6 lb. Thrust

∴ Lb. thrust/lb. fuel: H2/Air = 39.6; Kerosene/Air = 41.3; H2/H2O = 3.18

∴ Previous H2 issues now obvious; H2 w/air simply requires more air.

∴ H2/Air Engines Require Increased Air Compression to Balance Thermodynamics, e.g. about 160% more air.

∴ Liquid O2 and H2O supplement combustion at high altitudes, and

∴ H2O & H2O/Air JTC Can Cool Exhaust Reducing Heat Trail.

Earth – 2/3 Water

Our bodies are nearly 2/3 water; similarly, the Earth's Surface is nearly 2/3 water. This is while water is required for all life. As a major component of and supporting all life, our atmosphere manages the water cycle with evaporation, clouds and precipitation.



Today, we know of past mistakes. We have the opportunity to improve upon our support system before irreparable harm is done to our home.

ClearValue's Vision has been that pure water and clean energy will become more important to humanity than oil. It is ClearValue's Mission to bring forth innovations to improve our water, our air, our health and our world.

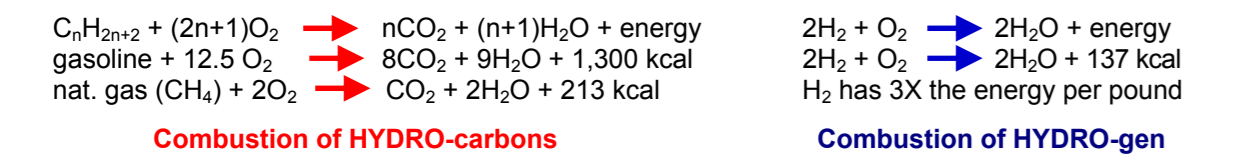
Earth's atmosphere, compared to the size of our planet, is comparatively as thin as the skin of an apple. This atmosphere, again, supports all life. A Most Significant Human Challenge While humanity has been rather creative in the use of fossil fuels, it is without question that excessive fossil fuel use leads to environmental consequences which may be of biblical proportions.

which will melt glaciers and polar ice caps. Such a melting and thereby dilution of the oceans may stop the oceans' warm water conveyance systems. Should this come to pass, we should remember how cold it is just outside our atmosphere, Space, where the temperature is only 100 K, e.g. -260 °F.

HyOx™ Technology

HyOx™ triples performance efficiency while capable of 5-10 times available power per displacement. HyOx™ has no carbon, nitrogen or sulfur footprint. This is because H2 can be easily produced via electrolysis of water with Zero Carbon™ Energy, as well as wind, water, nuclear and photovoltaic sources.

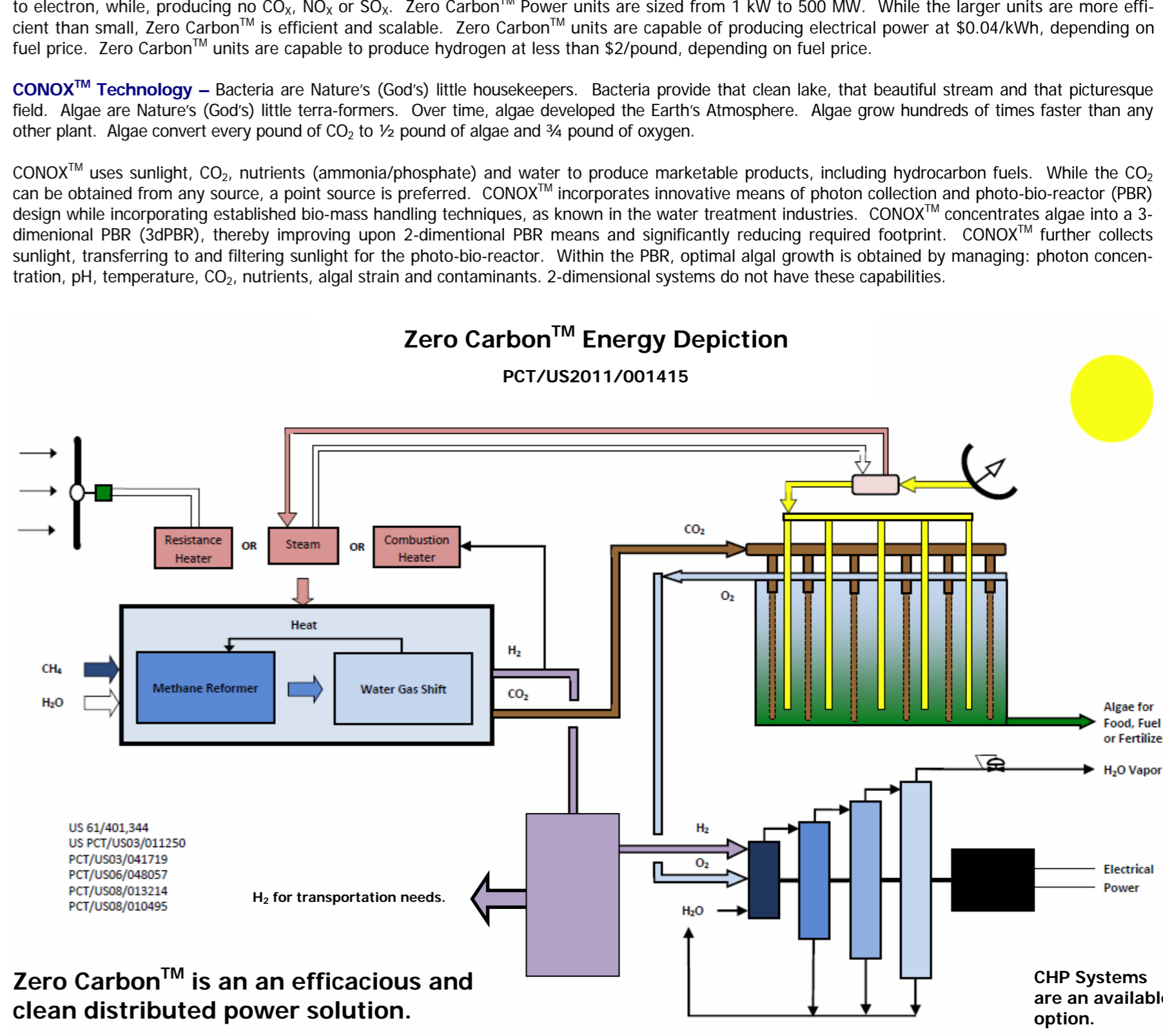
The combustion of fossil fuels is the combustion of HYDRO-carbons. HyOx™ is the combustion of HYDRO-gen. The processes are chemically very similar; while, H2 is very light compared to hydrocarbons, e.g. gasoline is 112 pound/mole, natural gas is 16 pound/mole and H2 is only 2 pound/mole. On a molar basis, combustion and energy output from each fuel source:



(Note: 112 lbs of gasoline converts to 1,300 kcal while 4 pounds of H2 convert to 137 kcal. In comparison, then, 112 lbs of gasoline results in 1,300/112 = 11.6 kcal per pound while 4 pounds of H2 (2 X 2) results in 137 kcal / 34.2 kcal per pound. And, 34.2/11.6 = 3.0.)

In all, O2 is the oxidant and H2O is a combustion product. In hydrocarbon combustion, though, carbon forms CO2, a greenhouse gas. (During incomplete combustion, carbon monoxide (CO), a poisonous gas is formed.) To complicate matters, also, hydrocarbon combustion is performed with air instead of O2. While air is 20% O2, air is also 80% Nitrogen (N2). A portion of the N2 then combusts endothermically (adsorbing energy) to produce oxides of nitrogen, NOx (NO, NO2, and NO3); while, NO3 forms ozone (O3).

Zero Carbon™ Energy Depiction



Zero Carbon™ is an efficacious and clean distributed power solution.



In combination, Zero Carbon™, CONOX™ and HyOx™ provide efficacious and clean energy solutions in both power generation and in transportation. Natural gas is a plentiful resource; while, there exists enough landfill natural gas, which converted to H2, and used in HyOx™ engines, could power about 1/2 of our transportation needs, regardless of well production.