Proton Power

Biomass to Hydrogen Power

Clean Energy Systems & Green Hydrogen

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Companies have touch lives

- Neutron absorbers- Electrical generation
  - Al_2O_3-B_4C Burnable neutron absorbers
  - B_4C Control Rod Material
- Test Reactor Fuel-Radioisotopes for 10 Million people.
- Aircraft brakes for Boeing 767 and 777 plus military.
- Made first 2800C production furnaces for high strength, high modulus carbon fibers.
- Developed ceramic punch technology and equipment to make Coors the thinnest beer cans in world.

In 2006 started into renewable energy sector.

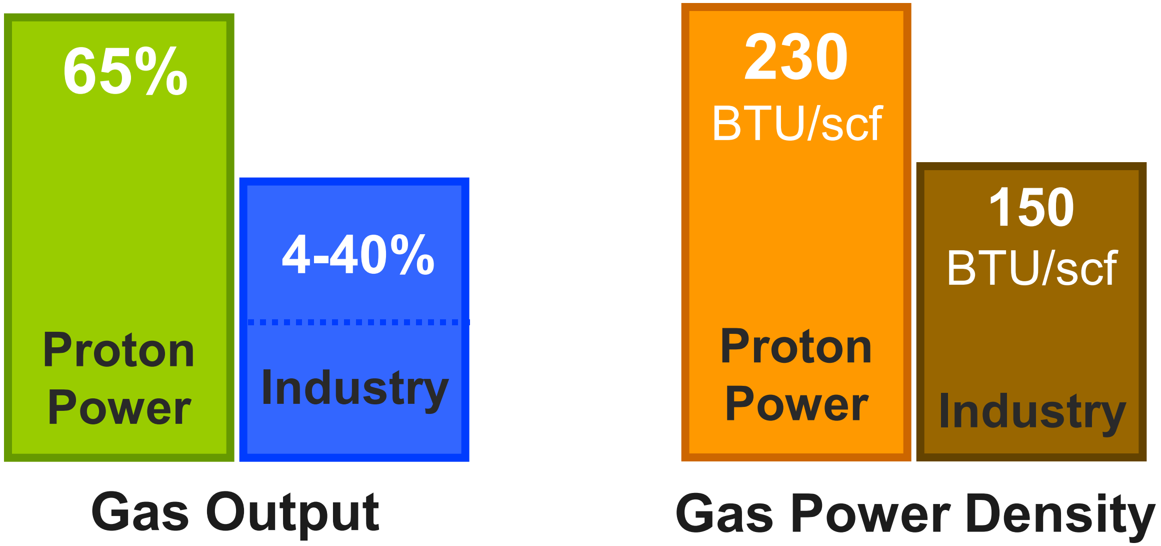
Overview

- Biomass to Hydrogen Gasification for green hydrogen and power generation
- Highest H_2 content (65%) of any syngas output
- Low capex costs, high ROI
- Operating 3rd generation prototype
- Multi $B addressable markets & 4 submitted patents
- Roadmap demonstrations of fuels production

General Advantages of CHyP Engine

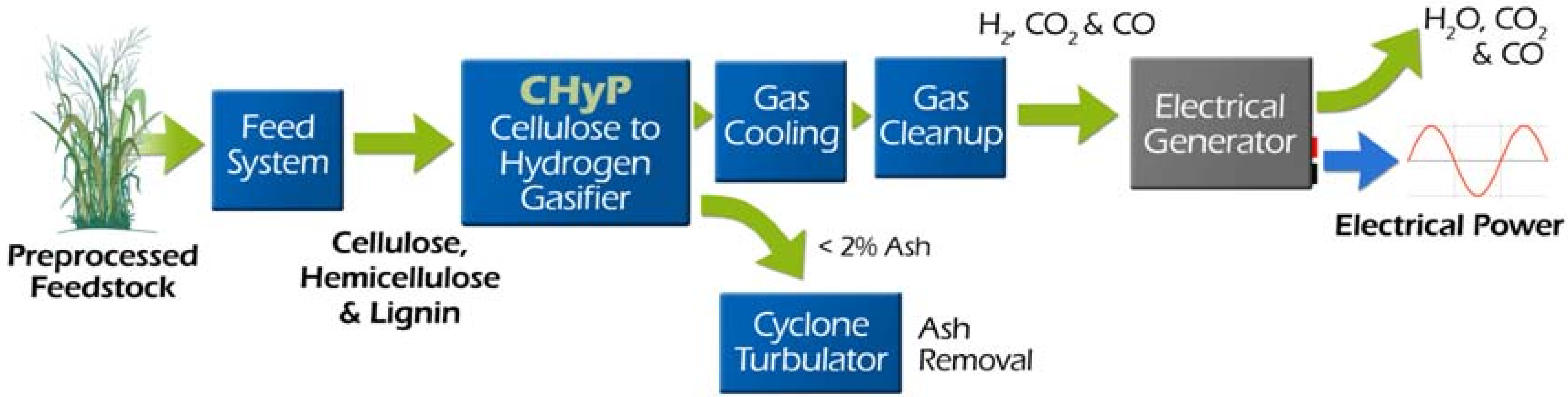
- Costs are competitive with hydrocarbon fuels.
- Eliminates the need for a hydrogen distribution system.
- Hydrogen storage systems are eliminated.
- The systems are scalable to suit the application.
- The cellulose fuel is renewable.
- The by-product of burning hydrogen is water.
- Much of fuel could be waste products.
- Process is carbon neutral.

Proton Power Advantage



- Proton Power *measured* hydrogen content is 65% by volume compared with a 15% industry average
- Energy density >50% higher than industry average

Cellulosic Biomass to Hydrogen Power (CHyP)



- Thermal gasification process for lignocellulosic feedstocks
- **65% H_2, 30%CO_2, <5% CO**, ash, tars in output stream
- H_2, CO_2 main produced gases for H2 production, electricity generation, CHP
- More clean, efficient burn than direct combustion (+30%)

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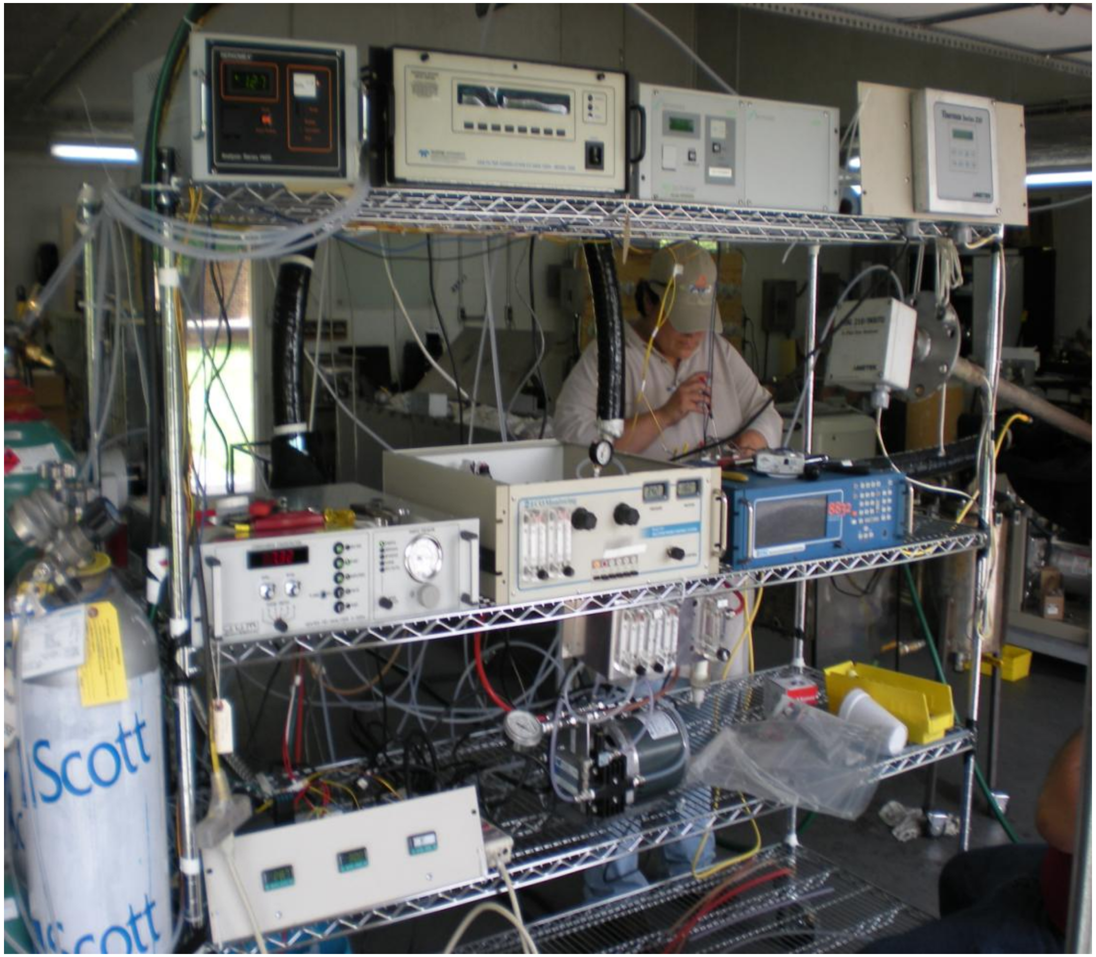
Scott

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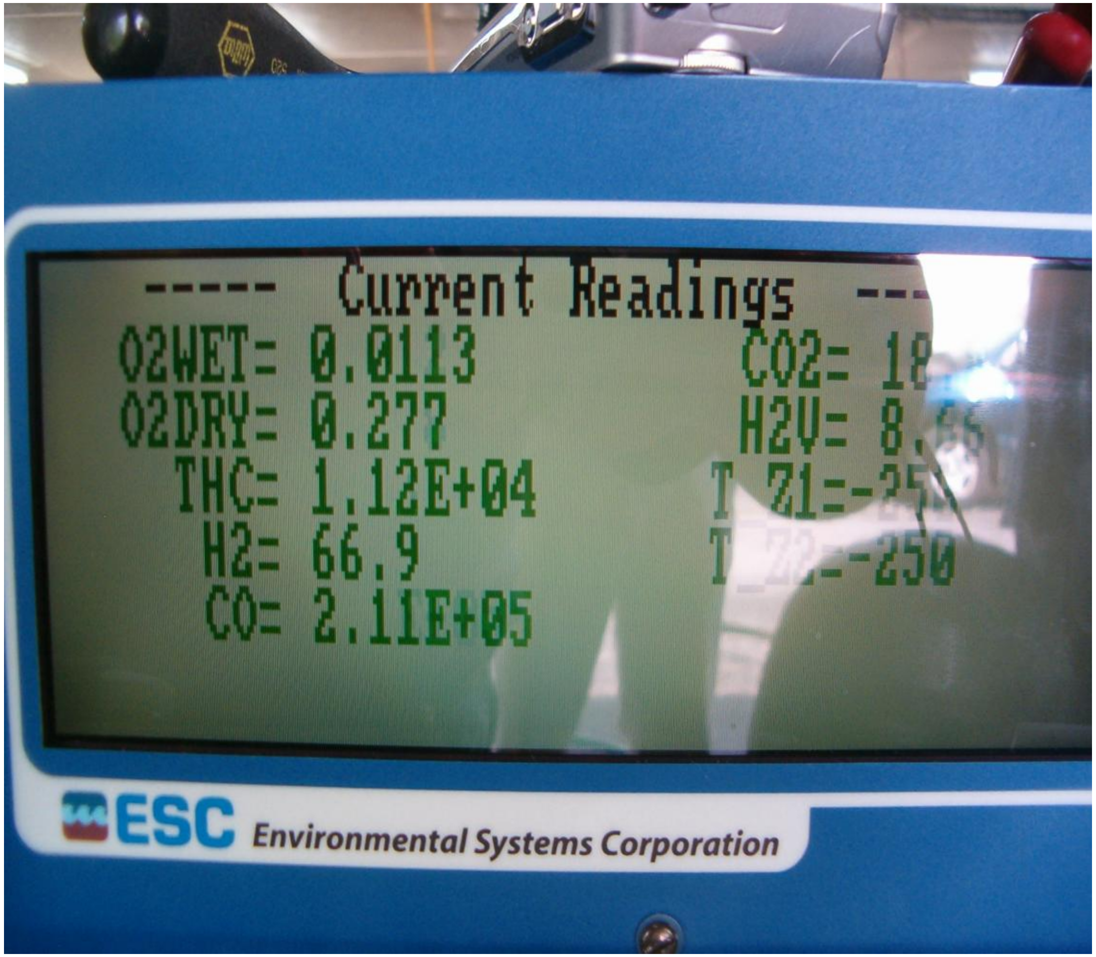
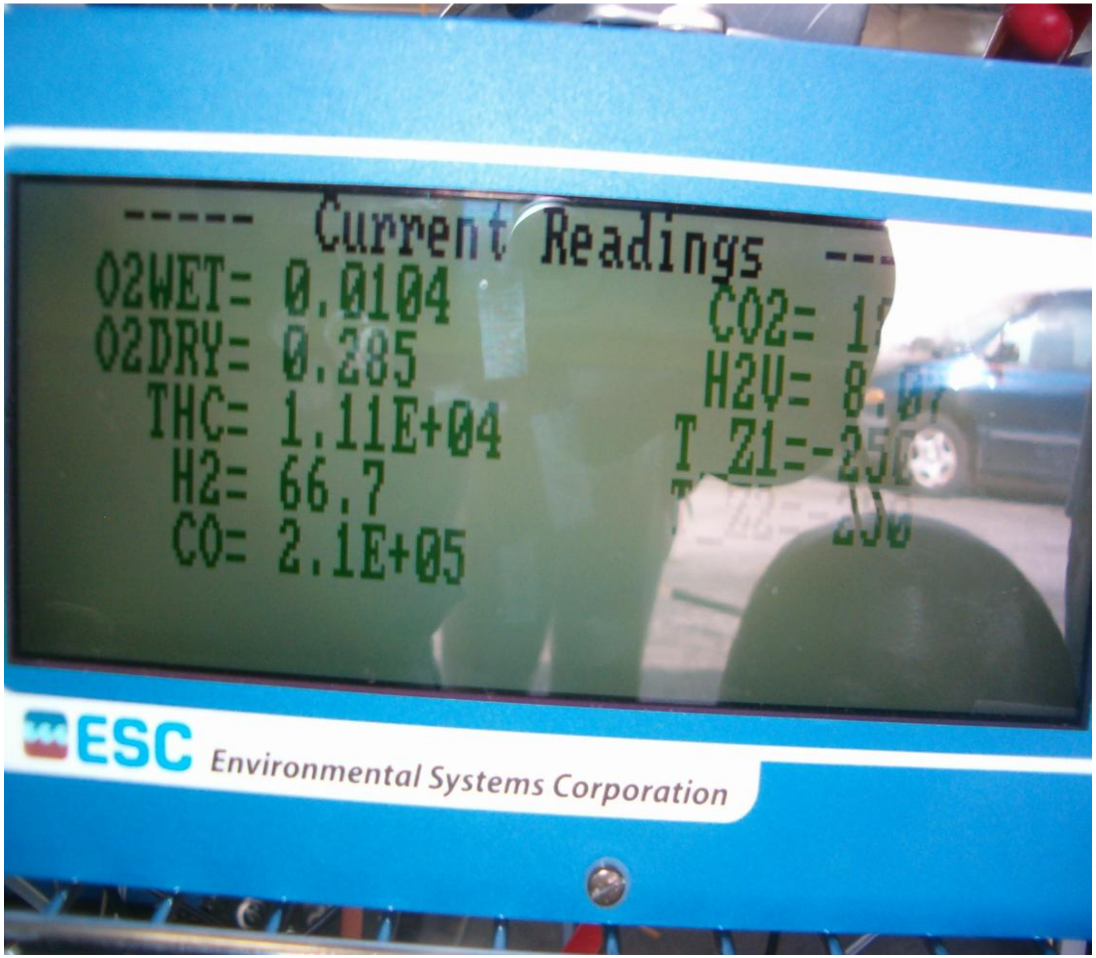
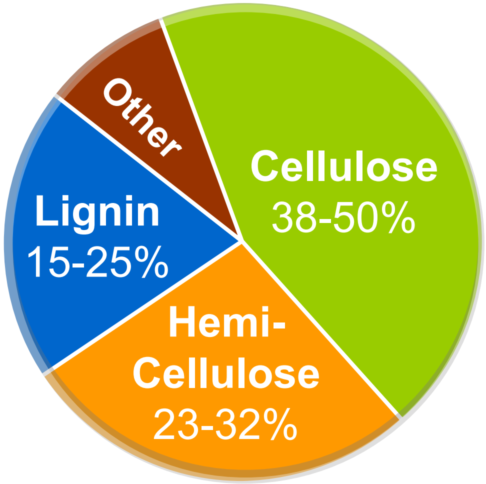

Current Readings
O2WET= 0.0113
O2DRY= 0.277
THC= 1.12E+04
H2= 66.9
CO= 2.11E+05
CO2= 18
H2V= 8.
T_Z1=-25
T_Z2=-250
ESC
Environmental Systems Corporation


Current Readings
O2WET= 0.0104
O2DRY= 0.285
THC= 1.11E+04
H2= 66.7
CO= 2.1E+05
ESC
Environmental Systems Corporation

Cellulosic Feedstocks Demonstrated

- Ag/forest residues, paper waste, wood chips, sawdust, paper
- Energy crops – switchgrass
- Process gasifies cellulose, hemicelluloses and lignins
- Excellent fuel LCA (>85% CO_2 reduction) with waste streams
- Carbon-negative with switchgrass and other energy crops



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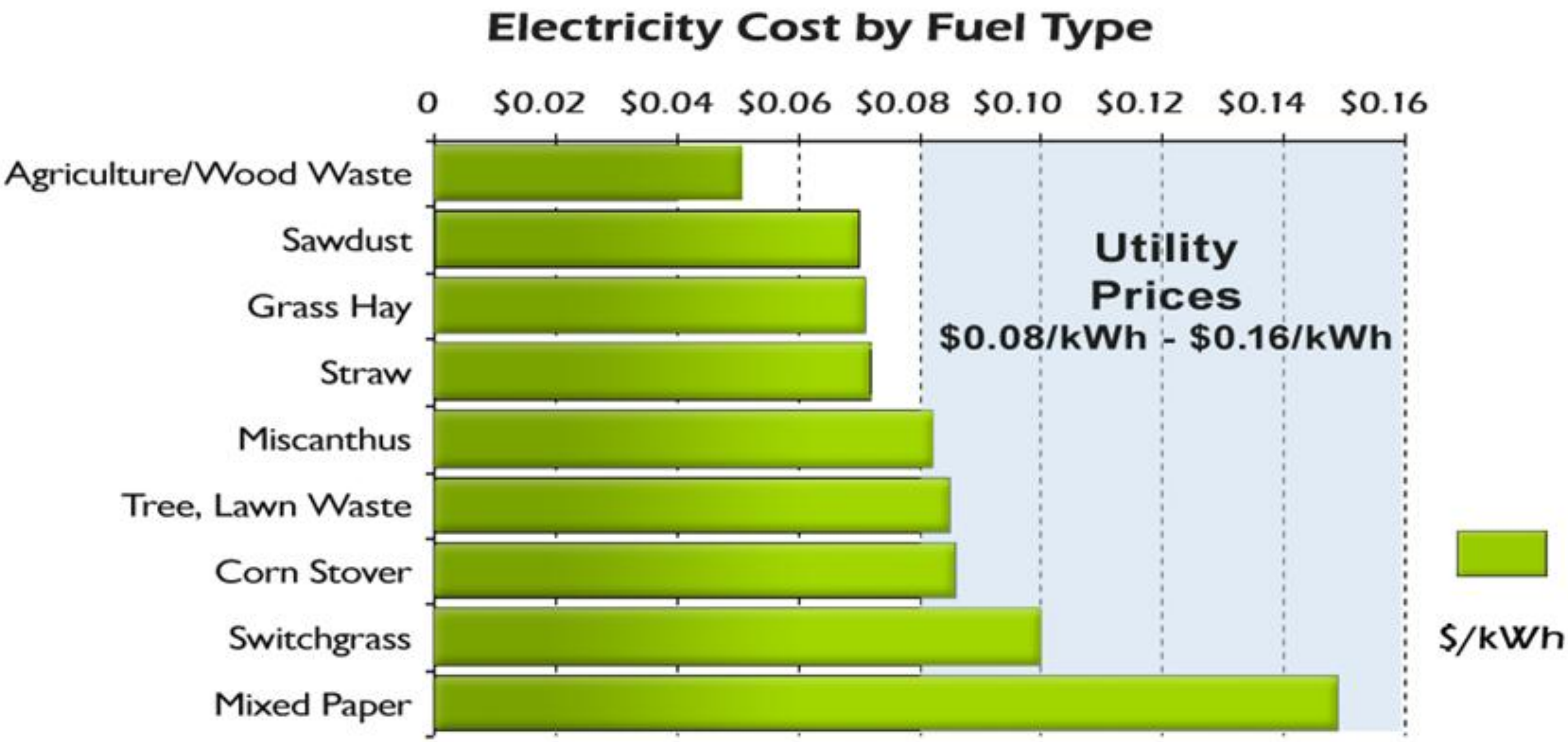
Electricity Economics



- Favorable Scaling - Distributed, Community, Industrial and Utility
- Waste disposal and power generation for excellent customer ROI

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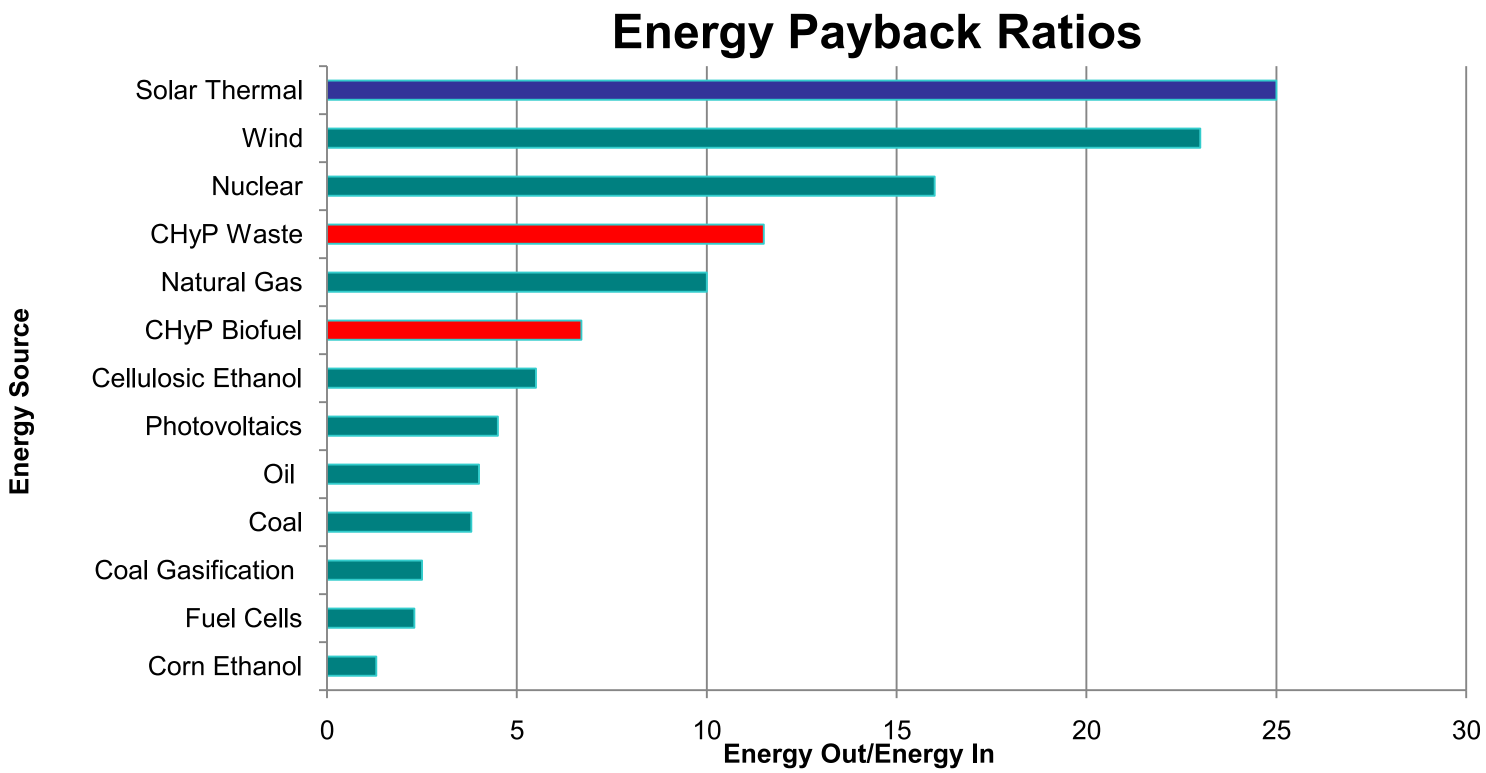
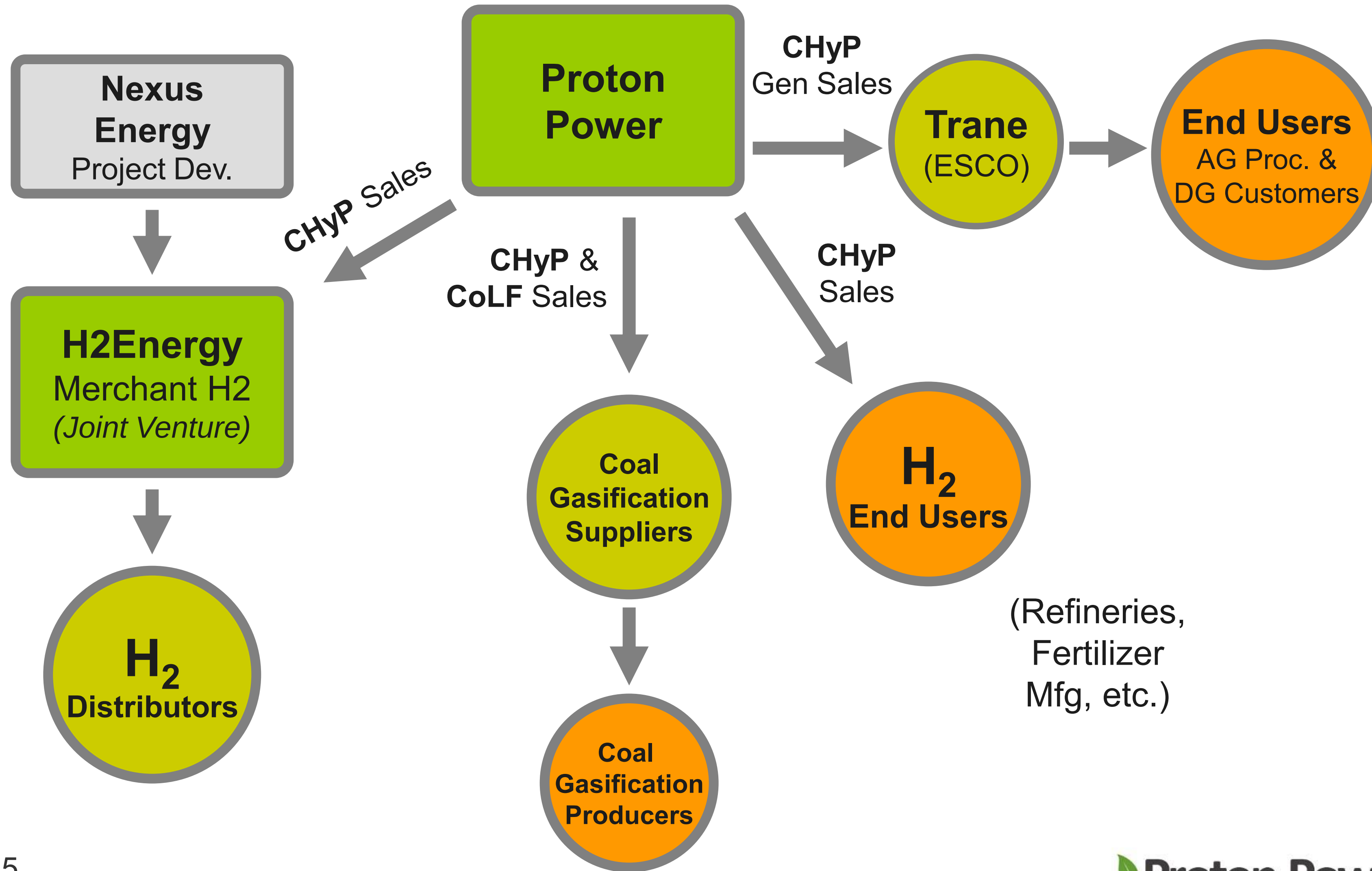
Energy Payback Ratios



H_2 Production Economics

- **Plant Capital Costs (mid-scale)**
  - $15 Million : 1 tonne/hr CHyP hydrogen plant
  - $25 Million : Commercial hydrogen-natural gas reform plant
- **H2 Feedstock Cost**
  - CHyP: $0.40 – 0.80/kg depending on cellulose source
  - NG reform plant: $1-2/kg depending on gas price
- **H2 Merchant Market Price**
  - Wholesale rail: $5-10/kg depending on NG price, delivery location
  - Wholesale truck: $5-$20/kg depending on NG price, delivery location
  - Retail truck: $20-$50/kg depending on quantity, delivery location
- **Production plant savings using CHyP generator**
  - $24,000/day @ $1/kg H2, payback in 2 years
- **End-user savings using CHyP generator**
  - $120,000/day @ $5/kg H2, payback in 5 months

Business Channels



Team

- **Dr. Sam C. Weaver** –Chairman, CEO and Co-founder
  - Serial entrepreneur, CEO of 9 companies over 35 years. 40+ years in advanced materials and energy
  - Exits: Millennium Materials to Dyson Group - Nuclear Ceramics to Eagle-Picher
  - Ph.D., M.S., B.S. Metallurgical Engineering
- **Dan Hensley**–COO
  - Business partner with Dr. Weaver for 35 years
  - Served as President, V.P. or COO of many of Dr. Weaver's companies
- **Samuel P. Weaver**–VP, Co-founder
  - CEO, Cool Energy. Engineering Lead: Network Photonics, InPhase Technologies. Board Secretary: Colorado Clean Energy Development Authority. B.S., Engineering & Applied Science, Caltech
- **Greg Shillings**–BS, Electrical Engineering, Tennessee Tech
- **Terrence Johnson**–Senior year Mech. Engineering, UT
- **Nick Shaffer-**Senior year Mech. Engineering, UT
- **Dr. Jeff Hodgson**– Mechanical Engineering, UT
- **Dr. Mike Maskarinec-** Chemistry, Indiana University
- **Dr. Ramez Elgammon-**Chemical Physics, Caltech

Advisors

Glenn Booth – Marketing Advisor from Cool Energy. Previously VP of Marketing: Rajant Corp. BSEE, CU
Leslie Weise – Legal & Policy Affairs Advisor from Cool Energy. J.D., Masters Env. & IP Law, B.S. Engineering
Lee Smith, BS, Mechanical Engineering, RPI
Brian Nuel, MS, Mechanical Engineering, U. Ill.
Kevin McWilliams, MS, Aerospace Engineering, CU
Nathanial Farber, BS, Mechanical Engineering, CU
Dan Harrison, BS, Eng. and Applied Science, Caltech
Rod Pullman, Mathematics/Computer Science, CU

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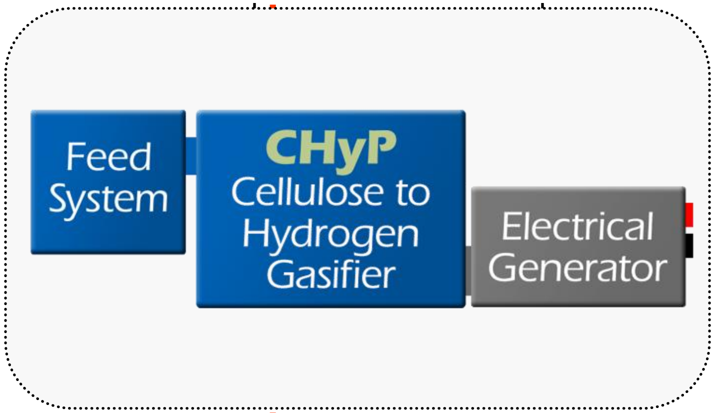
Roadmap

2nd Generation

- Prototype currently running daily
- CHyP H_2 generator producing **450 kW** heat
- Running at **9 kWe** on 12 kWe IC genset
- 2 Patents pending on IP

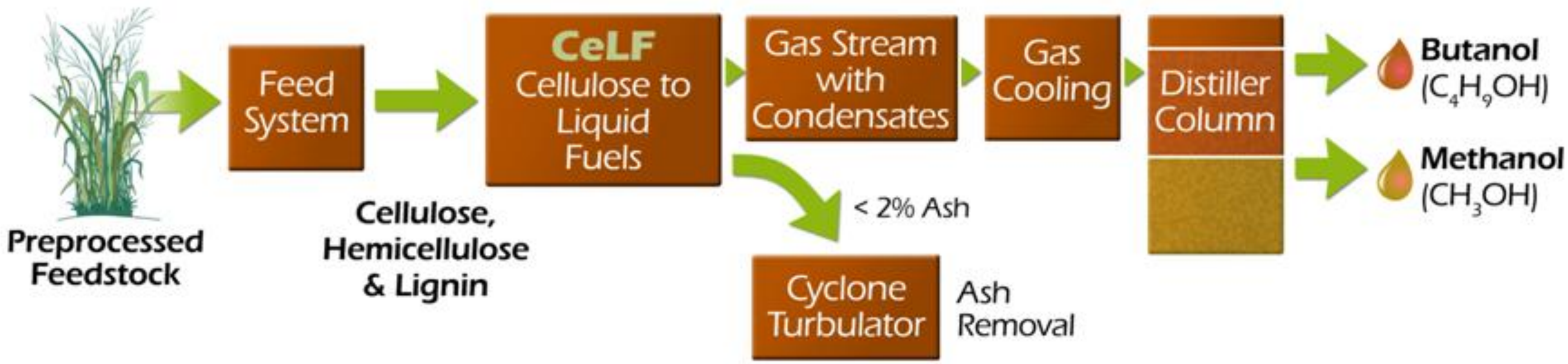
3rd Generation



- Prototype parts on order
- CHyP H_2 generator producing **4,500 kW heat**
- Running at **100 kWe** on 125 kWe IC genset

Q1 2009	Q2 2009	Q3 2009	Q4 2009	Q1 2010	Q2 2010

Cellulose to Liquid Fuels (CeLF)



- Biofuels from Thermal Process (Pyrolysis)
- **Butanol** - Direct gasoline replacement (current price is $6/gal in chemical markets)
- Process COGS of ~ $1.50/gallon
- **Methanol** co-product

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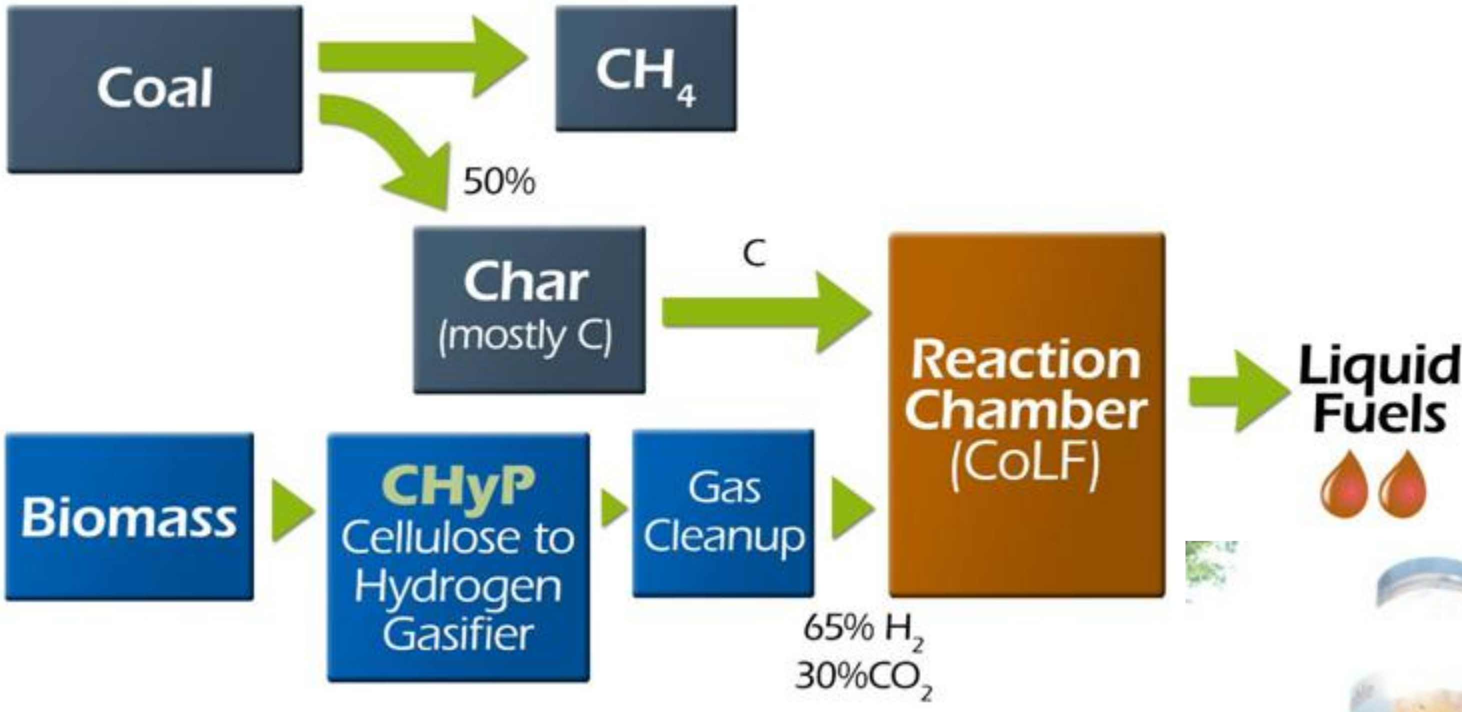
Coal to Liquid Fuels (CoLF)



- ChyP gas output and coal char input
- Liquid Fuels can be used directly or refined
- 45% of energy is from renewable source
- 57% system reduction in carbon emissions

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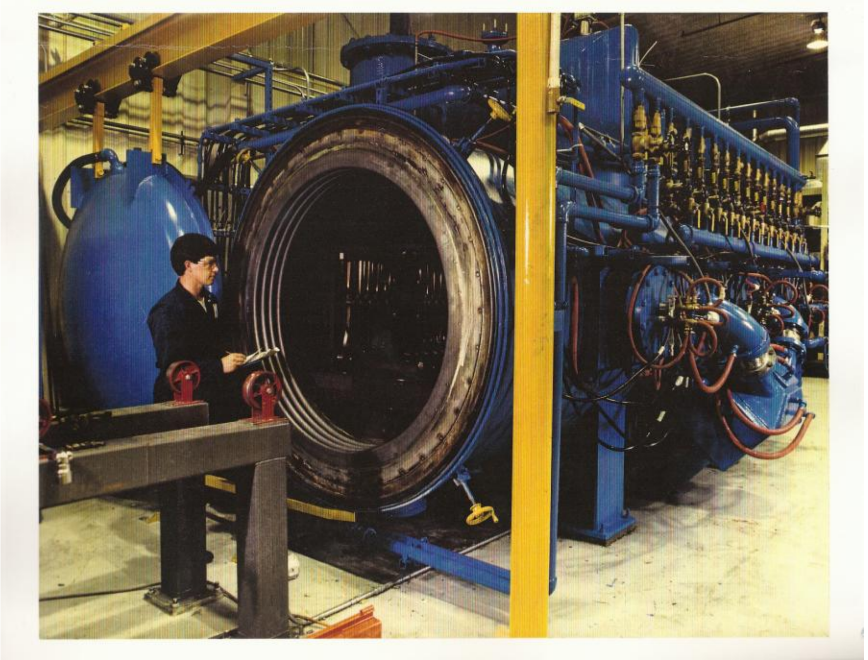
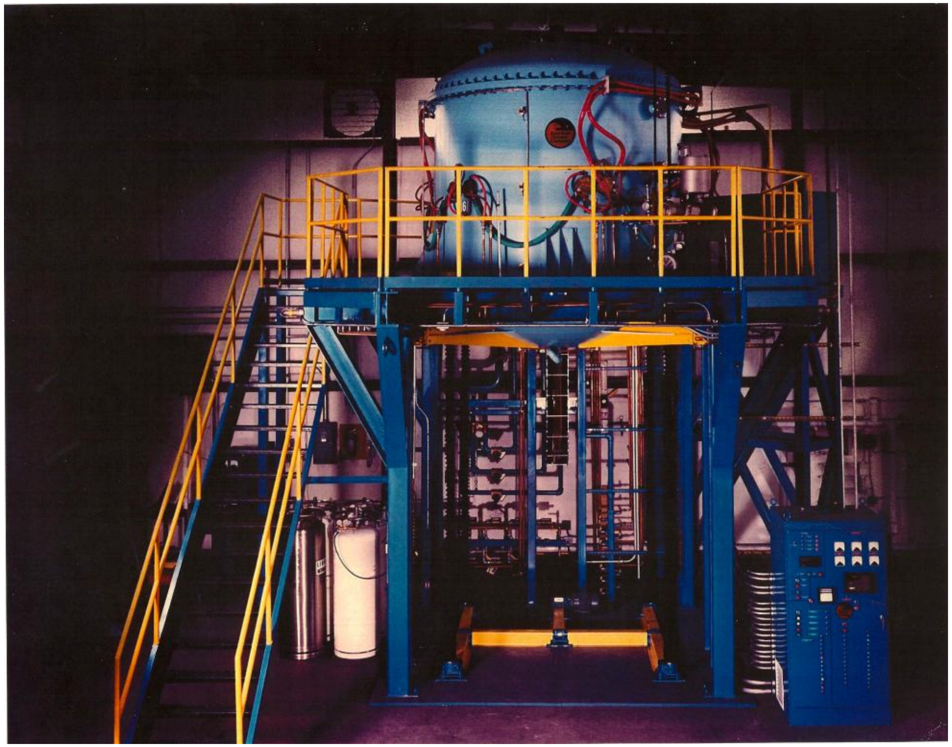
Proton Power Summary

- **High hydrogen output** and syngas energy density
- Initial market focuses:
  - C&I customers for DG equipment (Trane)
  - merchant hydrogen supply (JV with Nexus Energy)
- Team with prior product development, mfg history
- Demonstrated technology, product ready for pilots
- Deep engagement with channel -Trane, Bass Electric, Nexus Energy (JV with Proton Power: H2Energy)

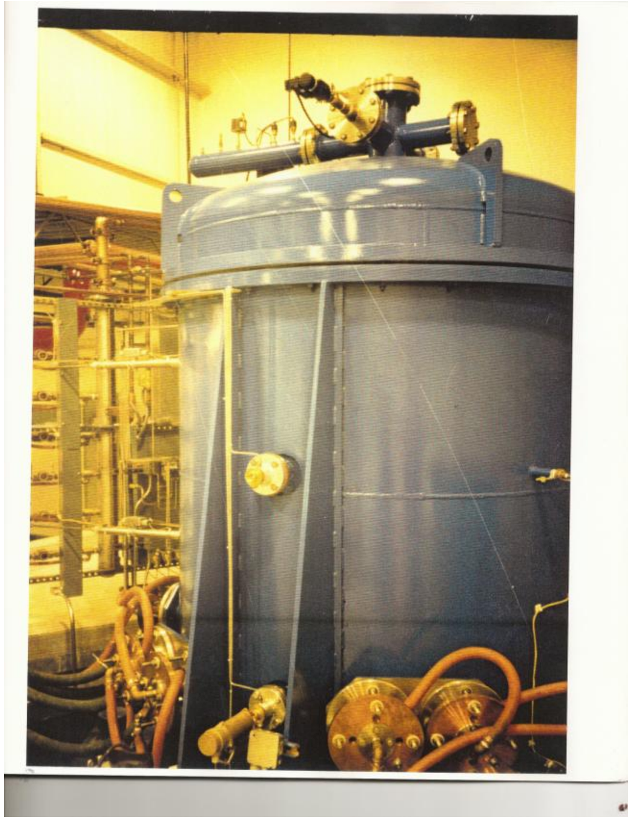
Large Vacuum Furnace



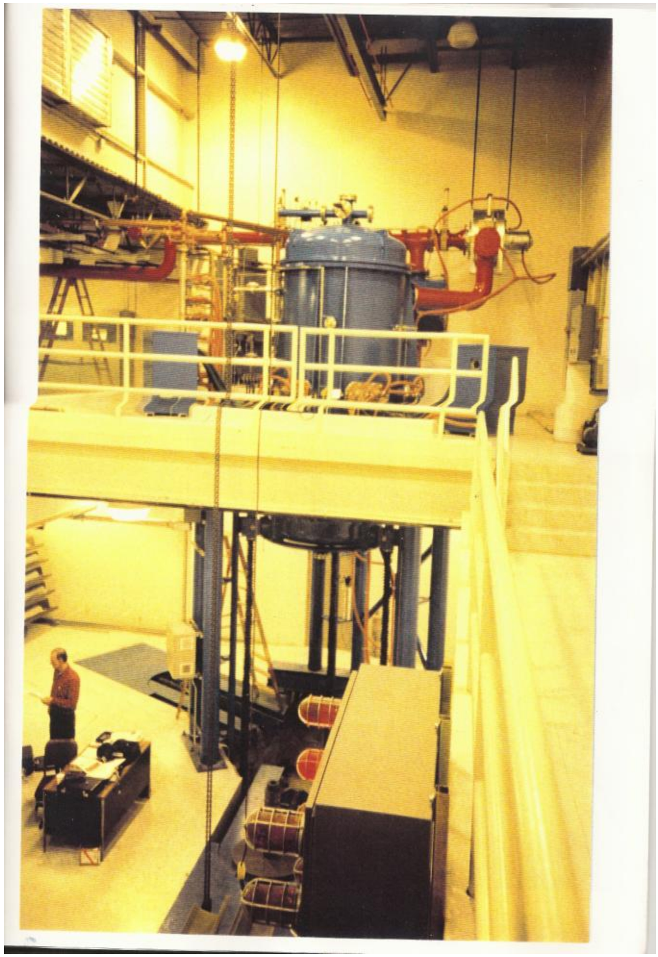
CVD Furnace



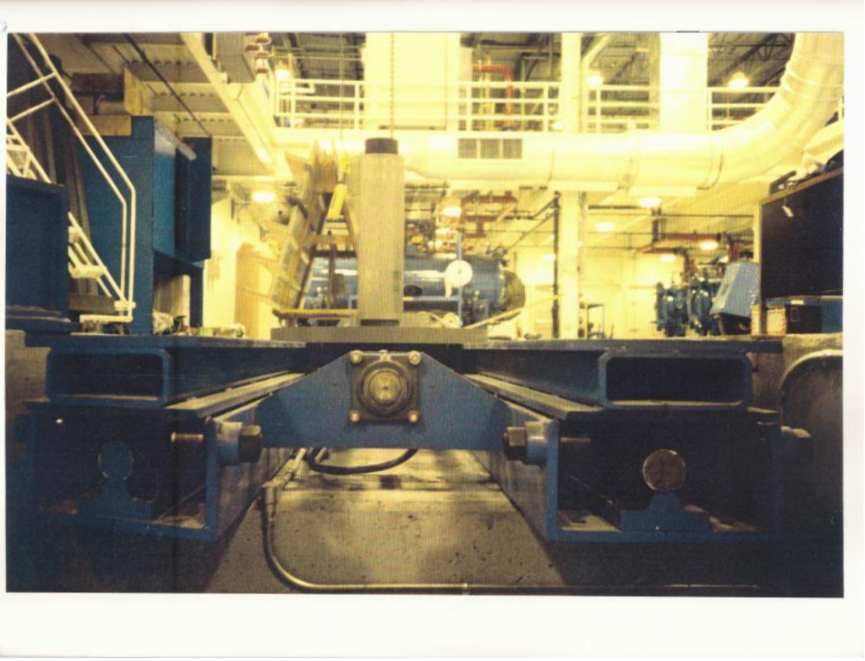
CVD Furnace



Chemical Vapor Deposition



Large Controlled Atmosphere Furnace

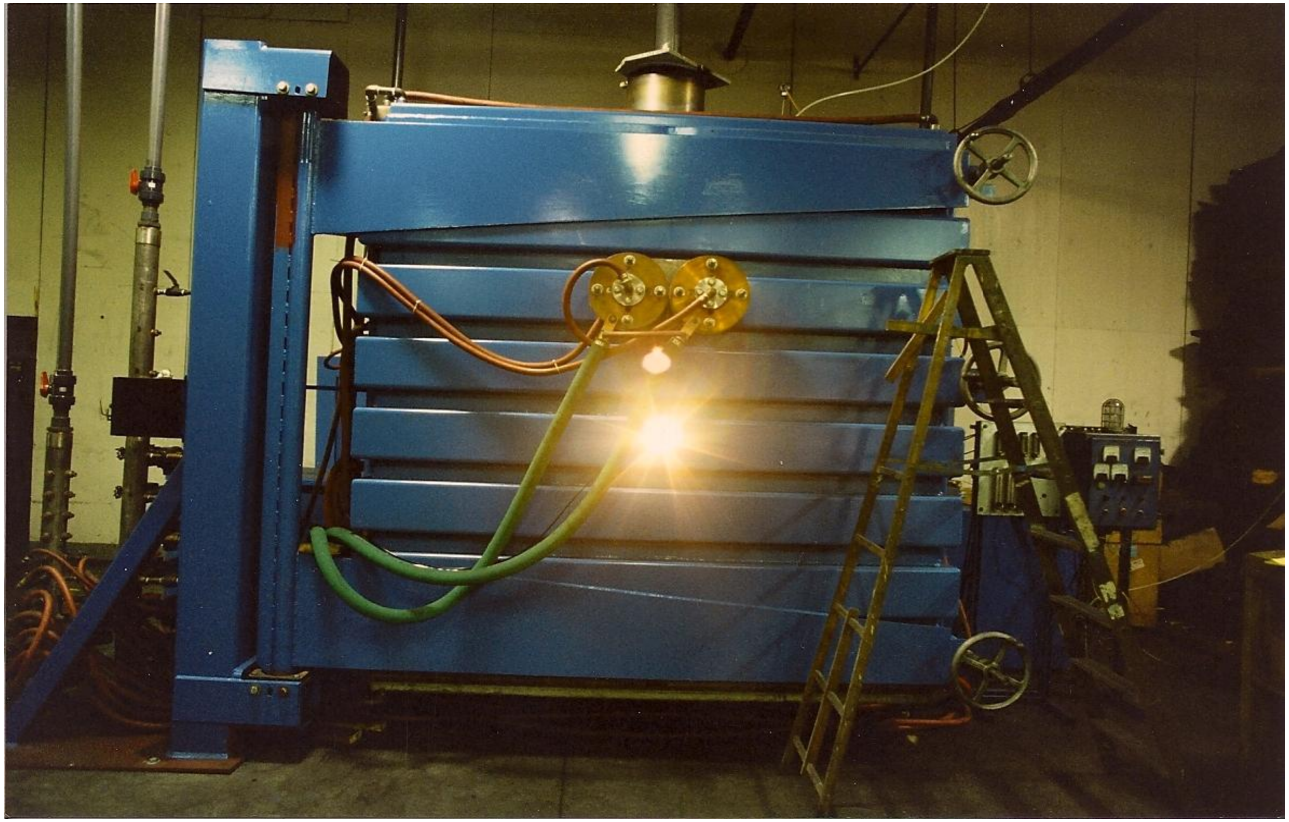


High temperature, controlled atmosphere

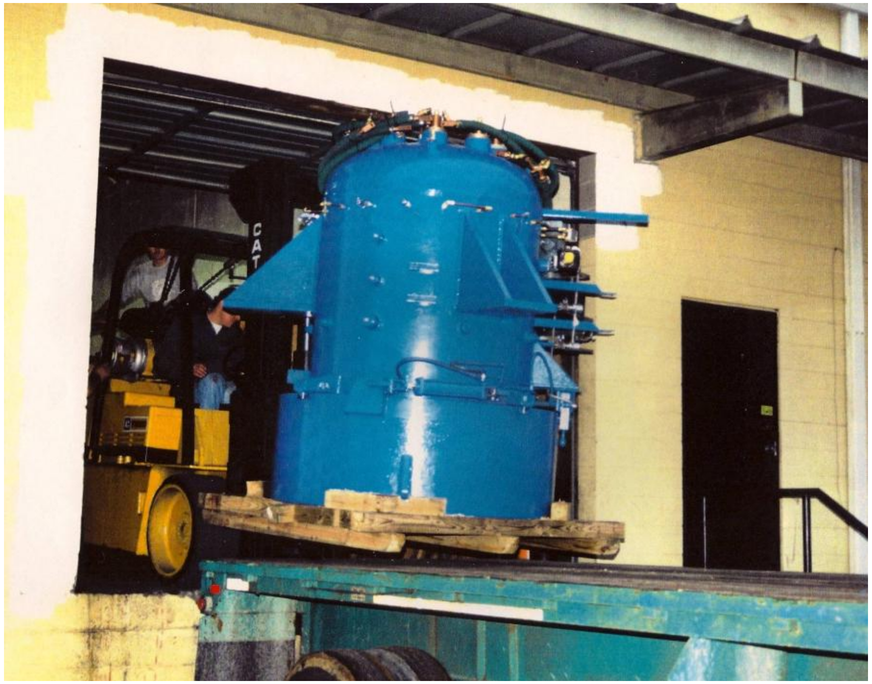
Precision loader

Large Ceramic Furnace

2800C Fuel Cell Carbon-Carbon



High Pressure, High Temperature



CVD High Temperature

Engineering Staff

- Tennessee
- Sam C. Weaver-Ph.D.-Metallurgical Engineering-UT
- Jeff Hodgson-Ph.D.-Mechanical Engineering-UT
- Greg Shillings-B.S. Electrical Engineering-Tennessee Tech
- Dan Hensley-University of Tennessee
- Terrence Johnson-Fourth year Mechanical Engineering-UT
- Colorado
- Sam P. Weaver-B.S.-Engineering Physics-Caltech
- Lee Smith-B.S.-Mechanical Engineering-RPI
- Brian Nuel-M.S.-Mechanical Engineering-U.of Illinois
- Kevin McWilliams-M.S. Aerospace Engineering-U. of Colorado
- Dan Harrison-B.S. Engineering and Applied Science-Caltech
- Leslie Weise-B.S. Engineering, J.D. Law-University of Denver
- Nathanial Farber-B.S. Mechanical Engineering-U. of Colorado
- Rod Pullman-Mathematics/Computer Science-U. of Colorado

100 kWe-PPI vs. CPI

PPI 100 kWe

CPI 100 kWe

Competitive Landscape

Company	Fuel Type	Hydrogen Output	Gas Ene BTU / scf	Scale	Application
Proton Power Tennessee	cellulose	**65%**	**230**	**500kW – 5MW**	DG, CHP, IPP & H_2
Energy Products	mill residues, ag. crops & wastes animal wastes municipal wastes	0%	180-200	CHP 16MW	DG. Mostly EPC and fluidized bed energy systems
Community Power	Wood chips Sawdust	20%	120-165	5-75kW	DG
Nexterra Energy	wood residue	~4-40%	117	1.38 MWe	CHP
Kopf		~4-40%	112		
Frontline BioEnergy	wood chips, saw dust, grain hulls, corn stalks, switchgrass, straw	4-40%	150-300		CHP
Chiptec	sawdust, ag waste, paper pellets, rail road ties	~4-40%	130 – 150	2 – 20 MW	CHP
Ankur Scientific		15%	130 - 150	100 – 500 KW	DG
Flex Energy	low BTU waste gases	~4-40%	150 - 300		
Carbona		~4-40%		1 – 10MW	CHP

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