Innovative Energy Solution

OVERVIEW AND PLASMA GASIFICATION

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Background

Energy technology development founded in 2004.

- 7 Employees: 6 engineers and 1 technician.
- Growing and in the process of spinning off first technology.

Mission Statement:

Innovative Energy Solution is dedicated to developing innovative, robust, and cost efficient solutions for the global energy sector.

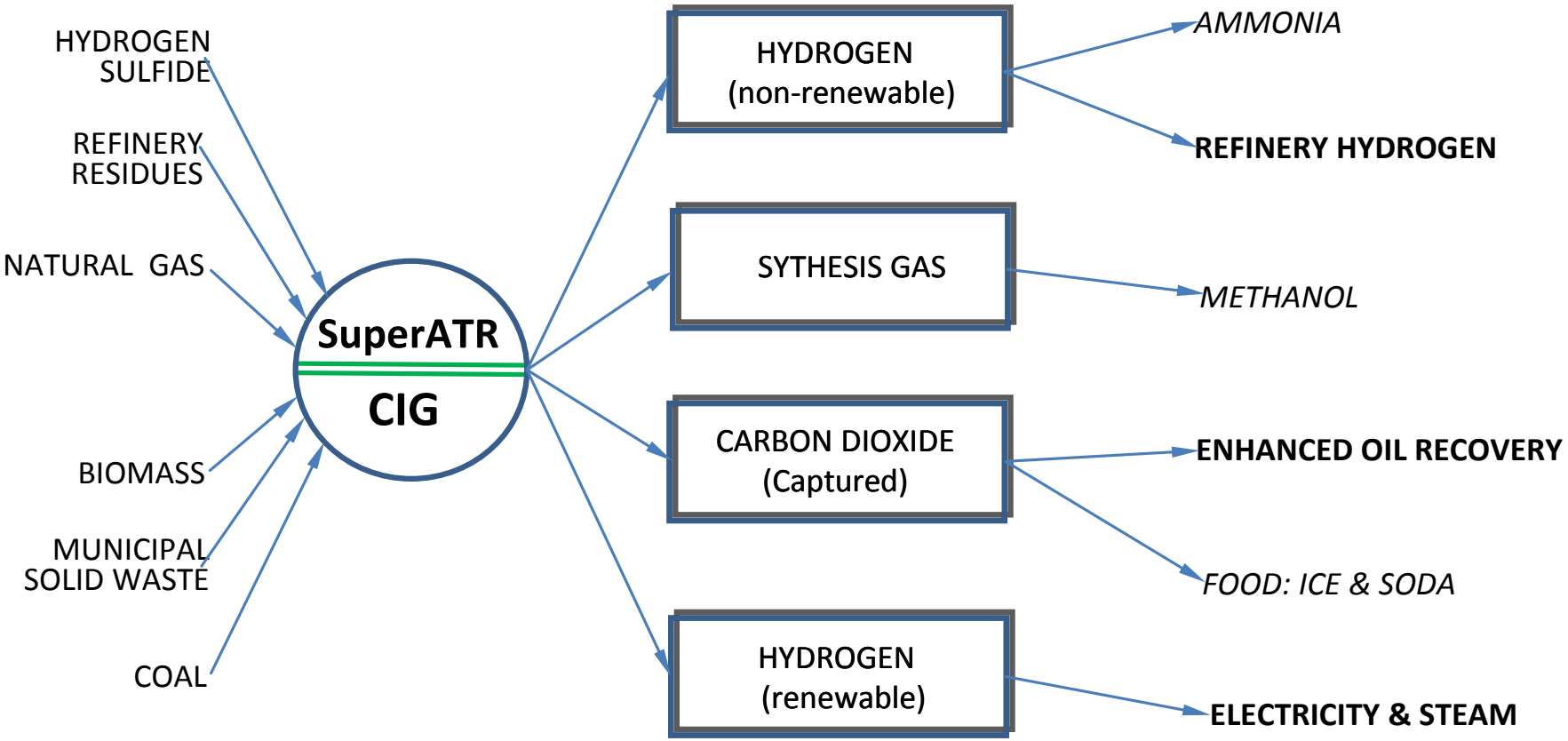
Goals:

Provide our customers with a single yet simple solution for solving multiple problems.

Position

Focused portfolio of unique thermal-based solutions in renewable and non-renewable hydrogen generation

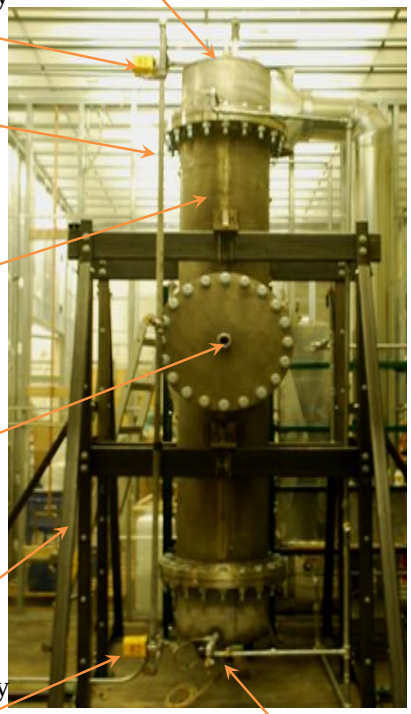
- Superadiabatic autothermal reforming (SuperATR)
- Charge induced gasification (CIG)



SuperATR (Green Pasture Energy)

Spinning off GPE to help refineries and natural gas plants decrease utility costs and emission footprints with tri-generation:

- Hydrogen: refinery off-gases, residual fuels (very cheap), hydrogen sulfide (waste)
- Cogeneration: Electricity and steam
- Emissions: Carbon (reduce and/or capture), NO_x and SO_x reduction

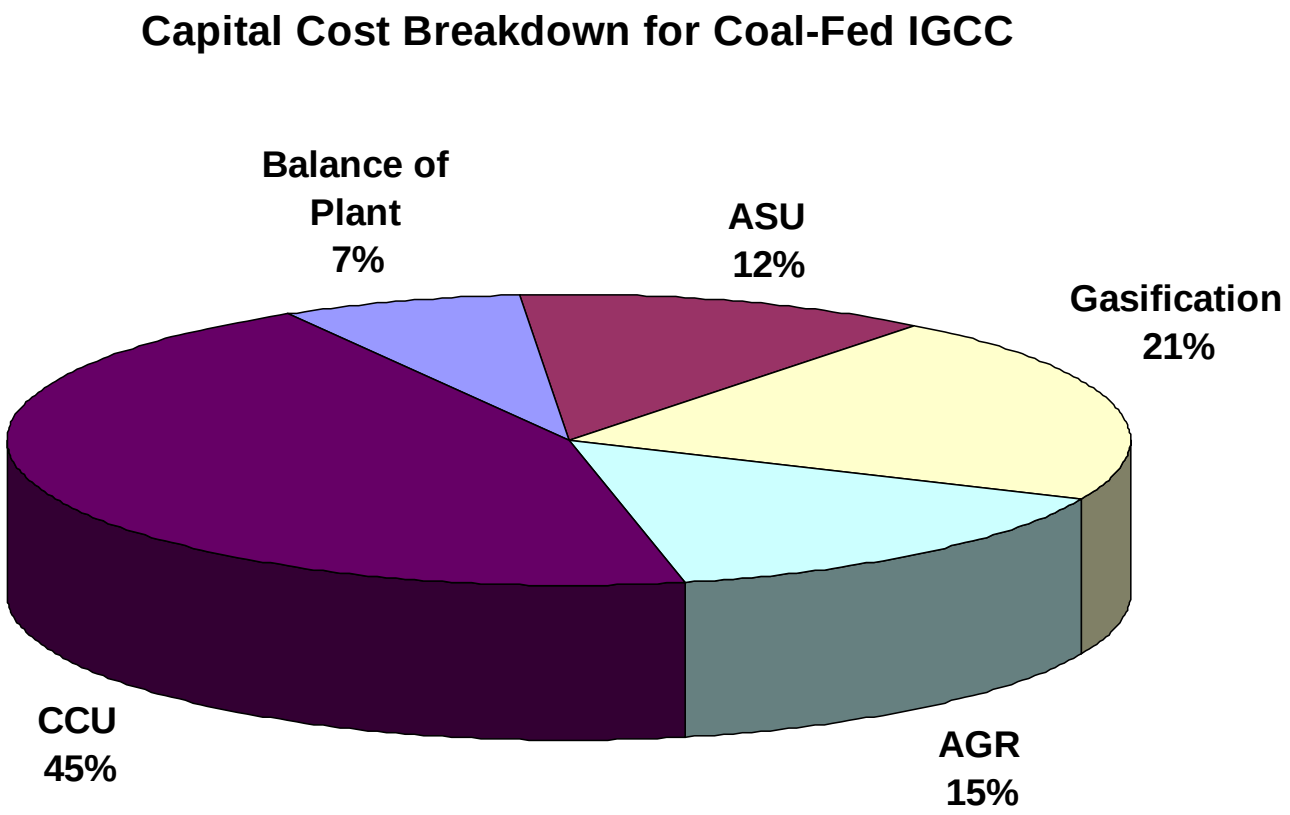


Two pilot units at the primary laboratory in Highland (IN)

CIG Motivation

Conventional Partial Oxidation (fluidized bed, entrained flow**)**

- ***High capital cost***: cryogenic oxygen generation, large reactors, gas clean-up.

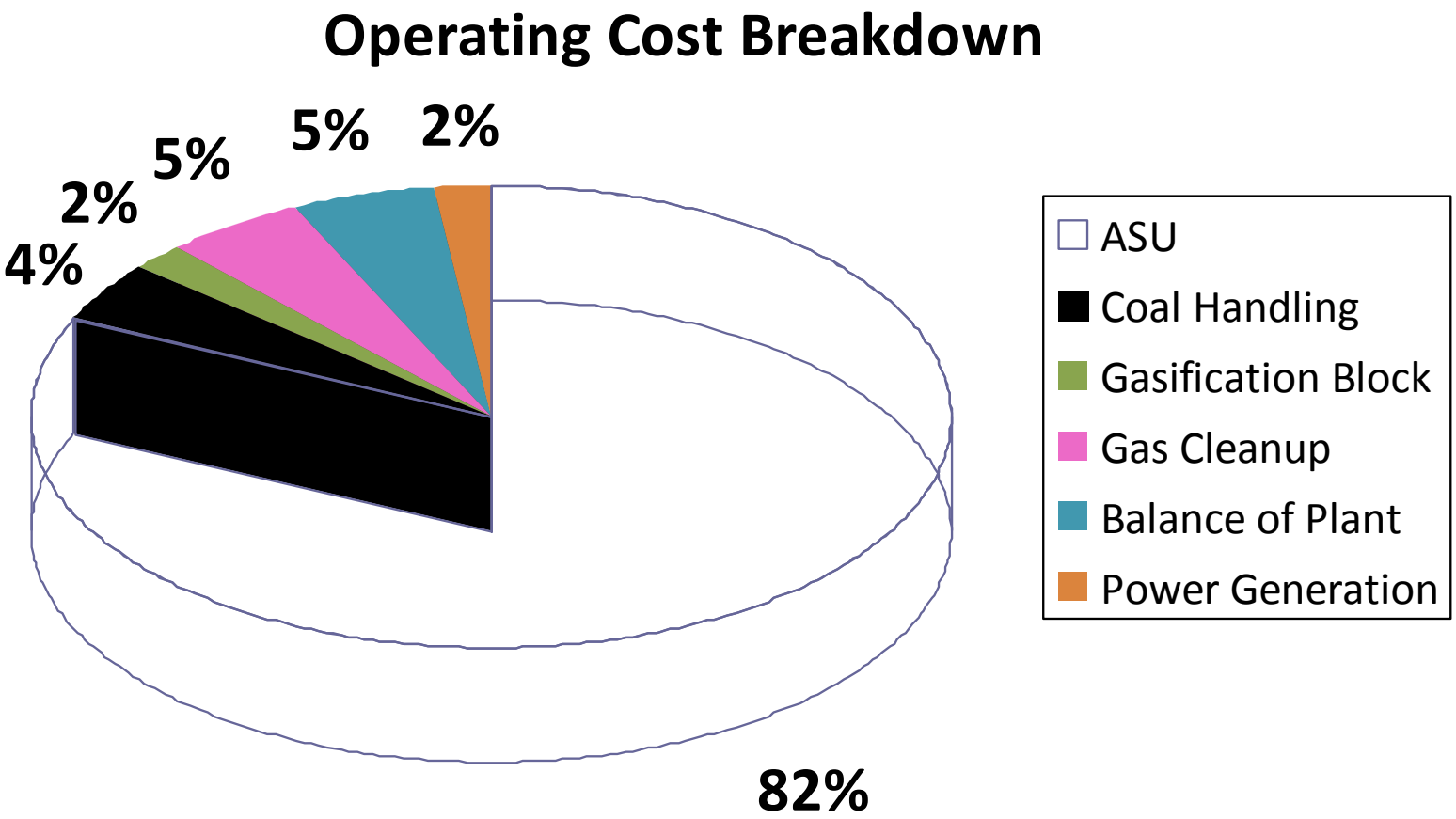


C. Higman and M. van der Burgt, *Gasification*, Elsevier 2008.

CIG Motivation

Conventional Partial Oxidation (continued)

- ***High operating costs***: large quantities of oxygen and fuel to generate high temperatures.



US Department of Energy, *Cost and Performance Baseline for Fossil Energy Plants (2007)*.

Solution

Hybrid Plasma / Partial oxidation

- ***Gliding arc plasma***: a crossbreed between thermal (equilibrium) and non-thermal (non-equilibrium) plasma.
- ***Ultra-substoichiometric partial oxidation***: Less oxygen consumption. Air Operation (biomass) has less nitrogen in product
- ***High efficiency*:** Reduces oxygen usage.
- ***Catalytic effect***: speed reactions (smaller reactor)

Gliding Arc Plasma Discharge (very different from normal plasma)

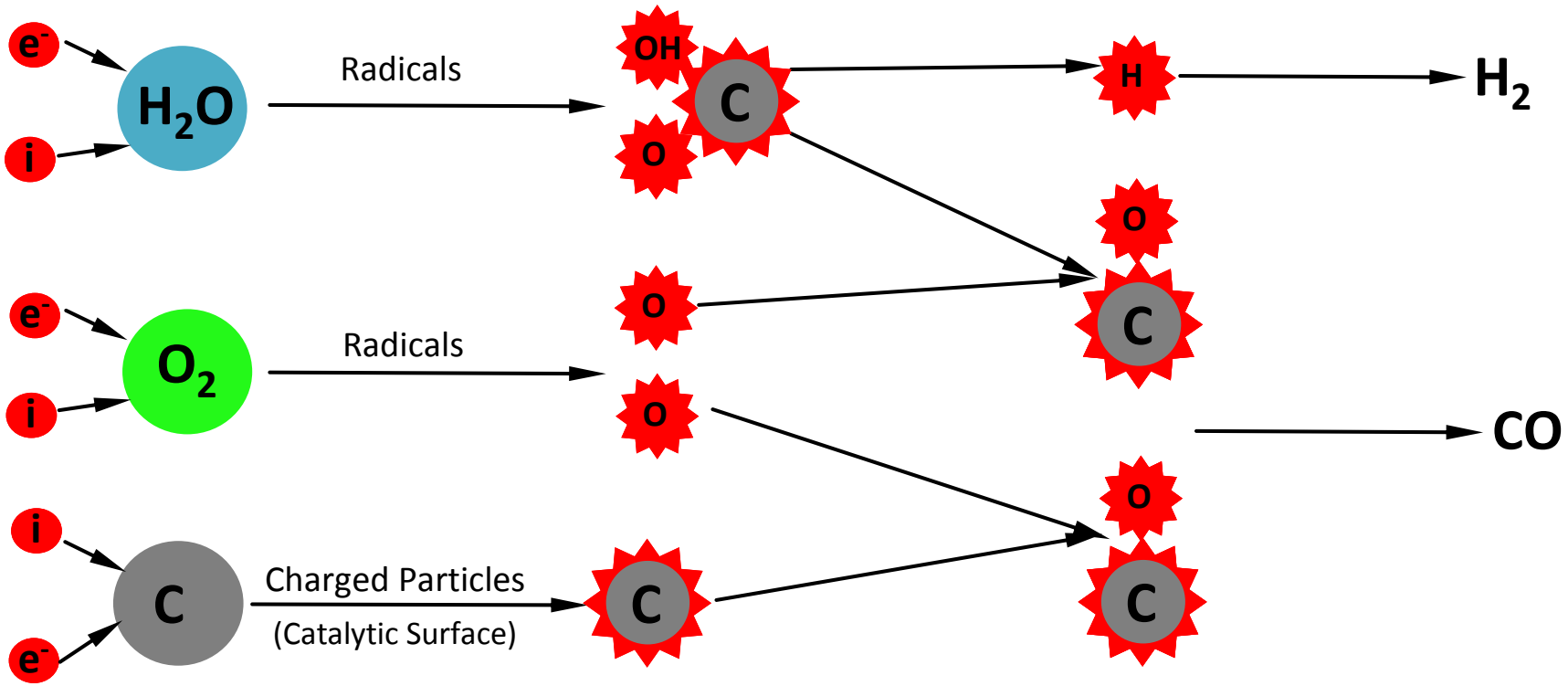
- ***Part thermal***: for stability and high pressure operation.
- ***Part non-Thermal***: Offers good catalytic potential for high selectivity.

Radical concept...but also challenging.

CIG Concept

Catalytic Effect for speeding reactions

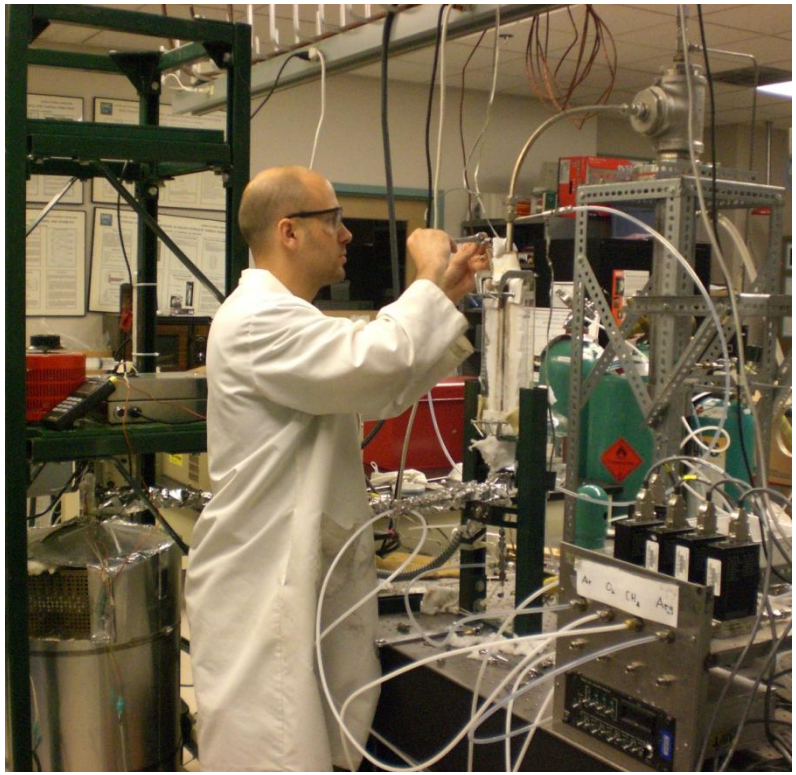
- ***ions***: for creating catalytic surfaces.
- ***electrons***: for radical generations.

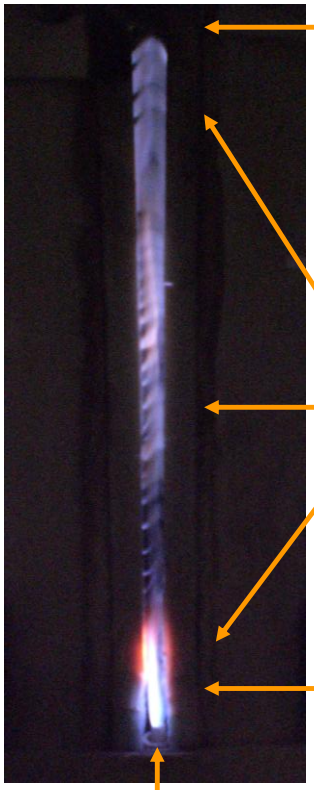


CIG Research and Developments

Unique design being developed:

- Coal, biomass, refuse





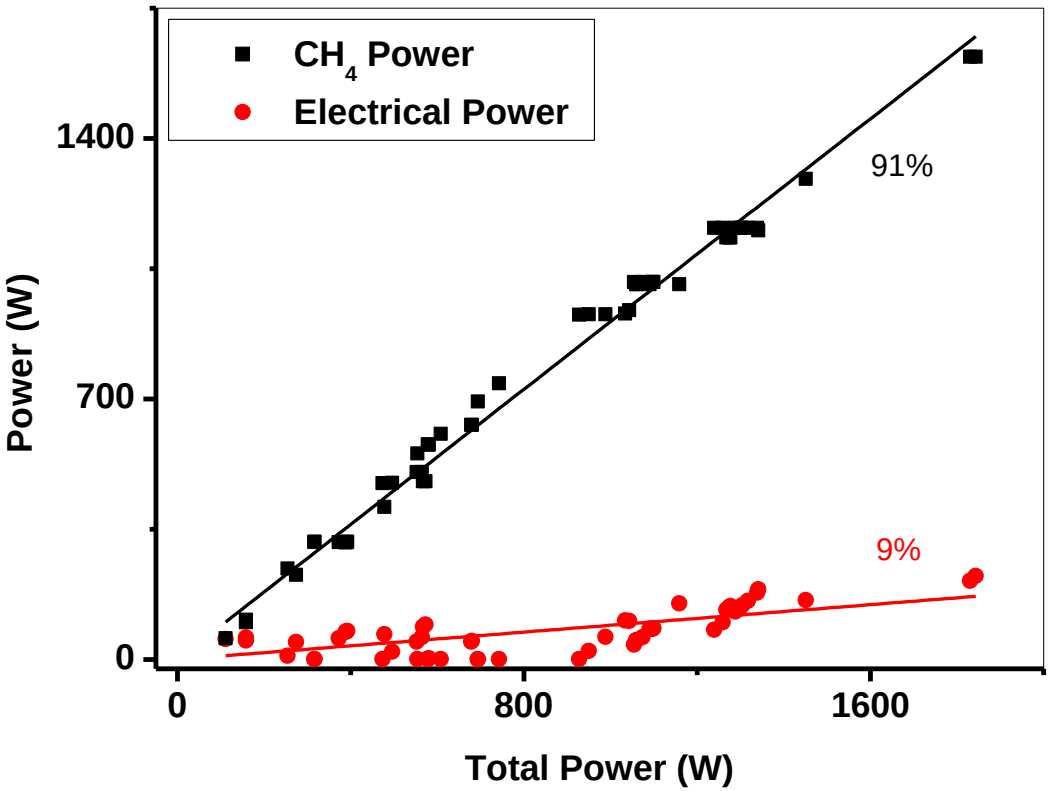
CIG In Operation

CIG In Operation

Electrical vs Chemical Power

Power Input

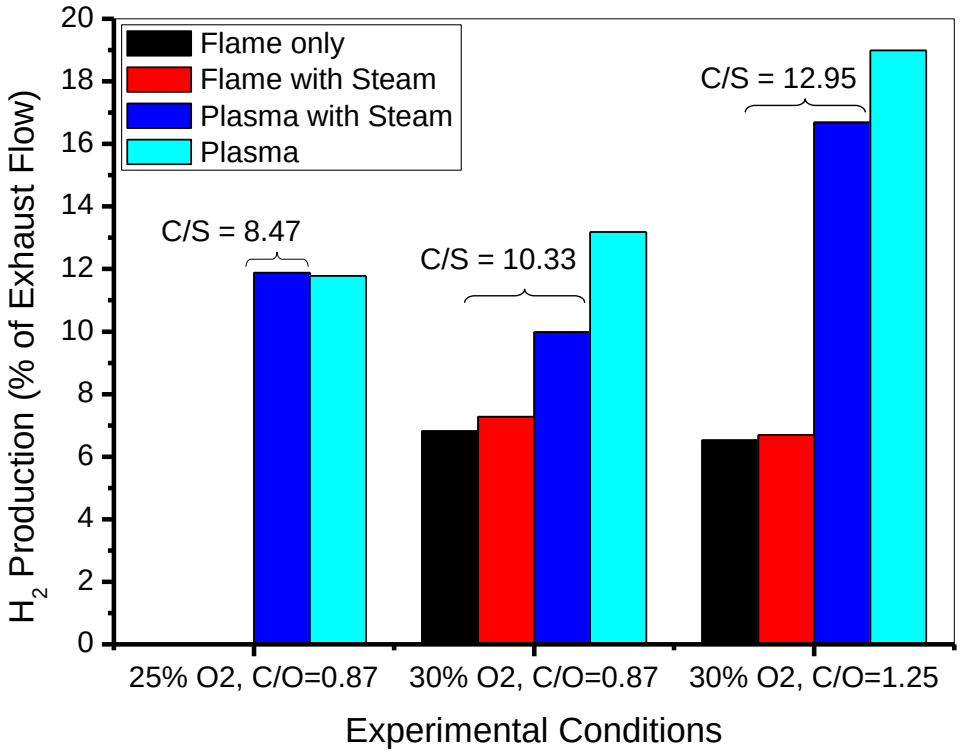
- Chemical Power: greater 91%
- Electric Power: less than 9%



Hydrogen Production

Initial testing with methane

- Hydrogen production increased by almost 3x
- Ultra-substoichiometric operation



Plasma Benefit (higher overall efficiency)

- Decreased oxygen usage (C/O >> 1)
- Air operation much more viable

Commercial Outlooks

Mini gasifiers: < 100 kW

- Wastes from processing plants and farms

Small gasifiers for distributed generation: ~ 1 MW

- Refuse from large military installations
- Agricultural residue from small farm communities
- Dust from saw mills

Cogeneration (electricity and steam) units: ~ 10 MW

- Refuse from transfer stations
- Agricultural residue from very large farm communities
- Pulp and paper mills
- Waste coal and fines in upgrading operations

Large gasifiers: > 100 MW

- Refinery hydrogen from petroleum coke
- Power generation from integrated gasification combined cycle

Acknowledgments

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