US DOE Webinar Series

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

EERE Fuel Cell Technologies Program

4 September 2012

2011-2012 Hydrogen Student Design Contest

On-Campus Tri-Generation Fuel Cell Systems

Featuring Winners of the 2011-2012 Hydrogen Student Design Contest

This Webinar is brought to you by:

U.S. Department of Energy

Hydrogen Education Foundation

12 PM ET, September 4, 2012

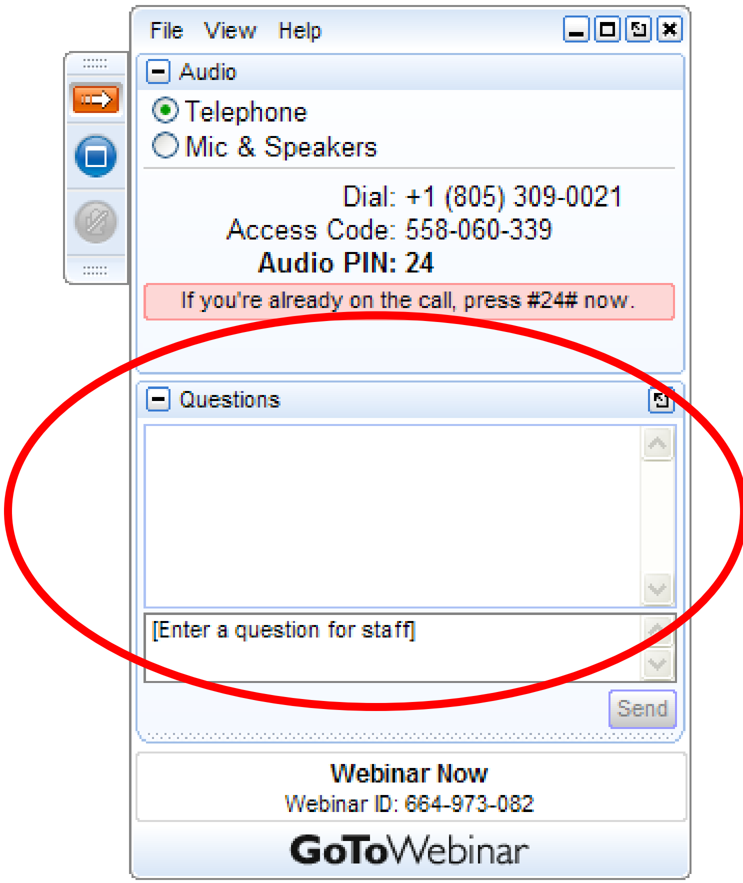
Webinar Overview

1. **DOE Introduction** – Eric Miller, Greg Kleen, Alli Aman, U.S. Department of Energy
2. **Contest Introduction** – Emanuel Wagner, HEF
3. **System Overview** – Joseph Daly, FuelCell Energy
4. **Winning Design Presentation** – University of Maryland
5. **Honorable Mention** – Washington State University
6. **Honorable Mention** – University of California, Davis
7. **2012-2013 Contest Theme** – Emanuel Wagner, HEF
8. **Q&A**

Instructions to Ask Questions

Submit questions in writing using the **Questions Panel** in the Control Panel on the right side of your screen (may be minimized).

This webcast will be recorded.



Contest Overview

- Emanuel Wagner, Hydrogen Education Foundation

HEF Contest Manager

Hydrogen Education Foundation

- Promotes clean hydrogen energy technologies through educational programs to encourage environmental stewardship, improve energy security, and create green jobs. More info: www.hydrogeneducationfoundation.org

- Programs include:
  - H-Prize
  - H2andYou
  - Hydrogen Student Design Contest
  - Washington Fuel Cell Summit

- For timely updates:

Like us at: www.facebook.com/Hydrogen.Education.Foundation

Follow us at: @h2andyou

What is the Contest?

- The annual Hydrogen Student Design Contest challenges university students to design hydrogen energy applications for real-world use.
- Technical, multidisciplinary competition
  - Engineering
  - Architecture/planning
  - Industrial design
  - Economics
  - Business/marketing
  - Environmental science
  - Political science
  - Chemistry

History of Contest

- Began in 2004
- Past themes:
  - Residential Fueling
  - Designing a Hydrogen Community
  - Green Buildings with Hydrogen
  - Hydrogen Applications for Airports
  - Hydrogen Power Park
  - Hydrogen Fueling Station
- Several winning designs were built, e.g. the 2008 winning design is now an active hydrogen fueling station at Humboldt State University

HYDROGEN EDUCATION FOUNDATION

The Hydrogen Education Foundation's Hydrogen Student Design Contest

2011-2012: Designing a CHHP System for Your University Campus

www.HydrogenContest.org

2011-2012 Contest Supporters

Media Partners

2011-2012 Theme:

Design a Combined Hydrogen, Heat and Power System for your University Campus – Using Local Resources

Why CHHP?

- Companies around the world are working to make hydrogen technologies a more common reality
- Decentralized renewable hydrogen production supports the transition to the hydrogen economy
- CHHP is a new and effective way to produce clean energy, reducing GHG emissions, health risks and supporting clean air
- Reduction of organic waste materials and capturing methane emissions for energy production

Theme Details

- Plan and design a CHHP system using local resources
- System should be designed for an existing facility or proposed new construction
- System must use available on-site or local fuel, may utilize natural gas when needed
- Design must provide uses for all three end-products

Contest Sections

1. Resource Assessment
2. Technical Design
3. Plan for End Uses
4. Safety Analysis
5. Economic Analysis and Business Plan
6. Environmental Analysis
7. Marketing and Public Education Plan

Who Participated?

- 33 teams from 10 countries registered for 2011-2012 Contest
- 20 team submitted final entries
- Top Teams:

University	Award	Score
University of Maryland	**Grand Prize**	91.10%
Washington State University	**Honorable Mention**	89.70%
UC Davis	**Honorable Mention**	88.30%
Missouri S+T	Top Ten Finisher	85.80%
National University of Malaysia	Top Ten Finisher	85.80%
Ohio University	Top Ten Finisher	77.70%
Latvia University	Top Ten Finisher	68.80%
Kyushu University	Top Ten Finisher	68.70%
Florida International University	Top Ten Finisher	65.50%
University of Bridgeport	Top Ten Finisher	63.70%

System Overview

- Joe Daly, FuelCell Energy

Manager Test & Validation Services at FuelCell Energy

Combined Heat, Hydrogen and Power from DFC® Fuel Cell

FCE Information Towards Design:

Hydrogen Education Foundation’s

2011-2012 CHHP Contest

Joseph Daly, Fred Jahnke
Pinakin Patel
September 4, 2012

POWERING A CLEANER FUTURE TODAY

FuelCell Energy

Outline

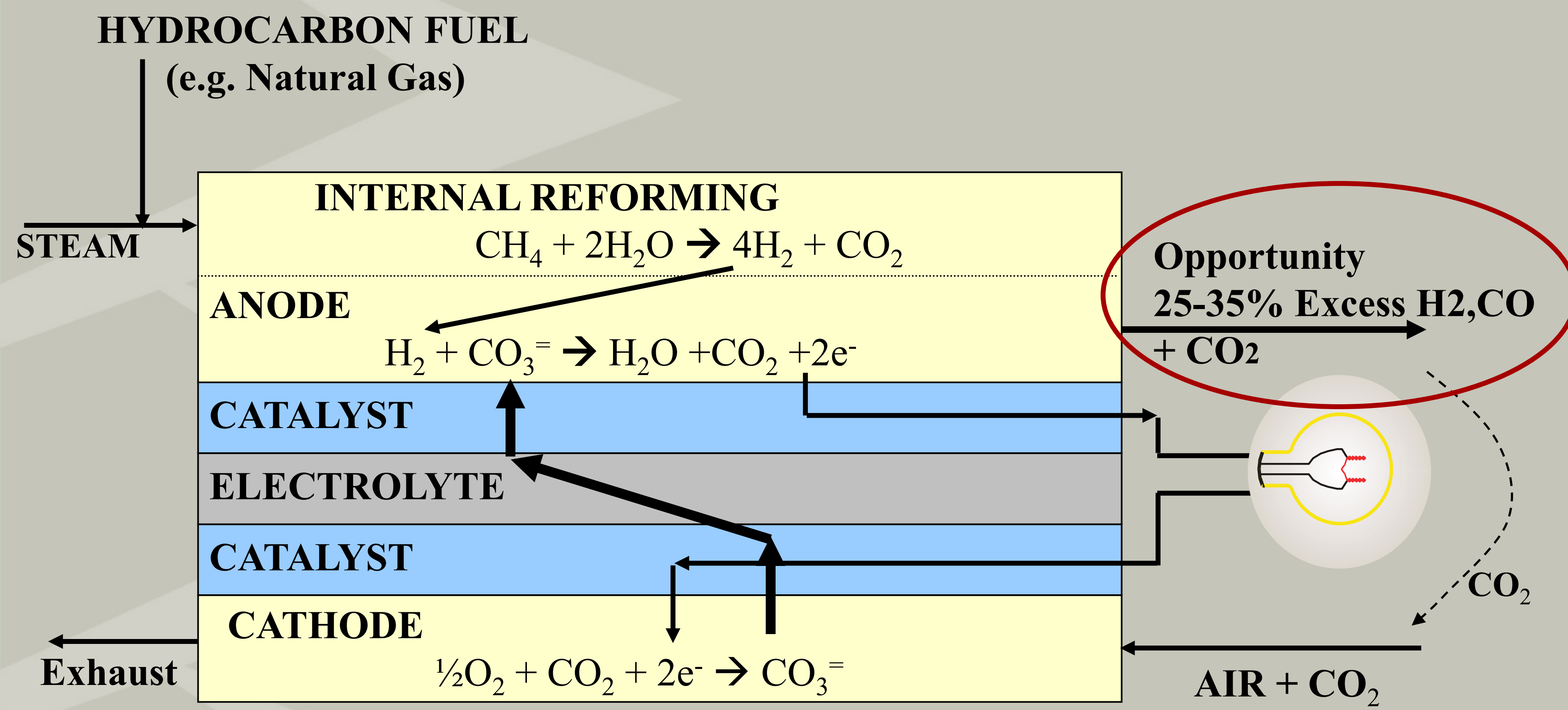
- Fuel Cell Background
- Process
- Design Specifications
- End Products and Uses

Background – Fuel Cell Technologies

	Fuel Cell Type			
	Polymer Electrolyte Membrane	**Phosphoric Acid**	**Carbonate Direct Fuel Cell®**	**<u>Future</u>** **Solid Oxide**
Electrolyte	Ion Exchange Membrane	Phosphoric Acid	Alkali Carbonate	Yttria Stabilized Zirconia
Operating Temp. °F	200	400	1200	1800
Charge Carrier	H^+	H^+	$CO_3^=$	$O^=$
Cell Hardware	Carbon /Metal Based	Graphite	Stainless Steel	Ceramic
Catalyst	Platinum	Platinum	Nickel	Perovskites

FuelCell Energy

Internal Reforming DFC® Technology

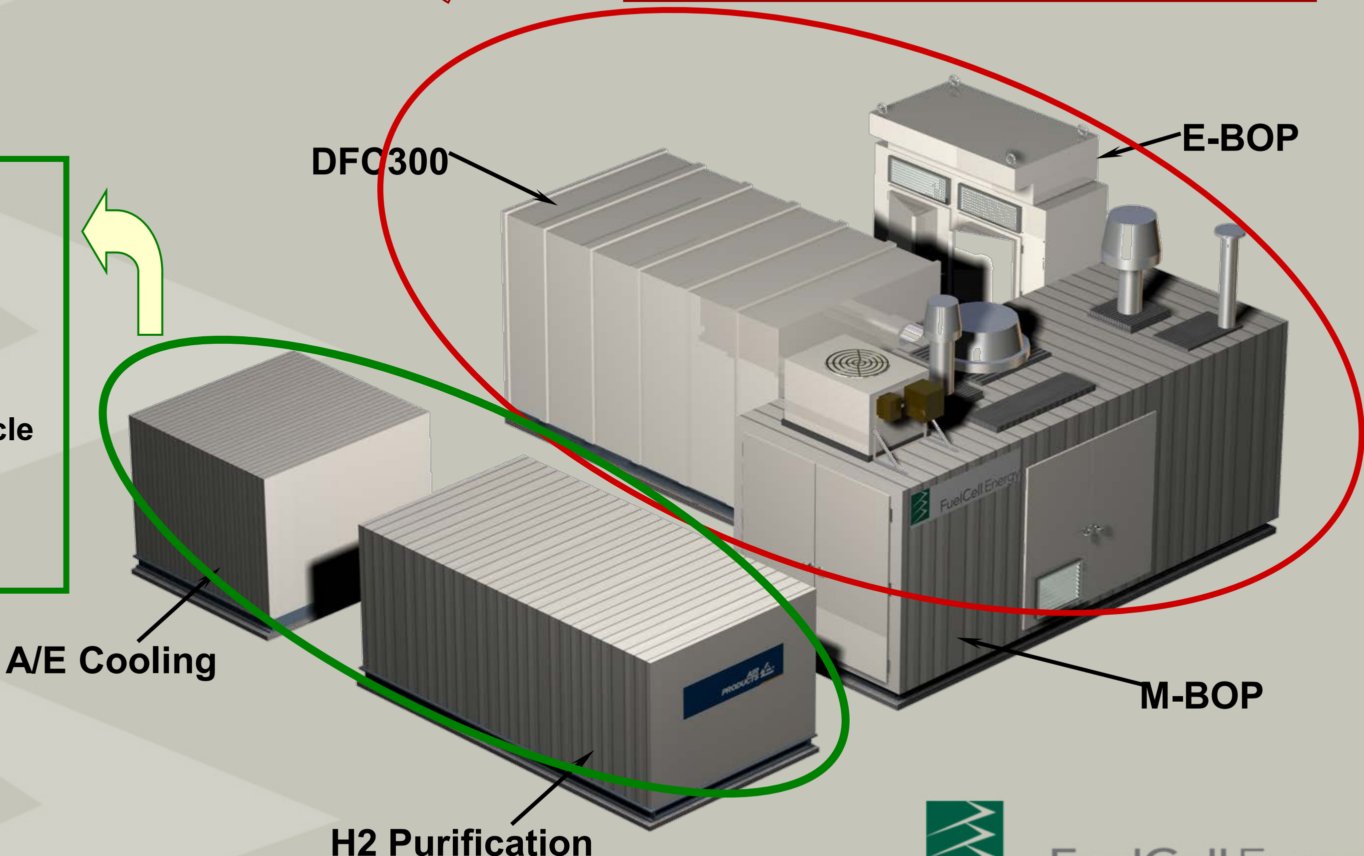


H2 Co-production expands market for fuel cells

CHHP System Design Basis

- Specifications for Simple Cycle DFC Power Plant
  - **Fuel in**
  - **Water in**
  - **Electrical efficiency (e.g. 47%)**
  - **Facility Exhaust waste heat**

- Specifications for Hydrogen Production
  - **Anode exhaust composition**
  - **DFC Fuel Utilization**
  - **Impact on simple-cycle waste heat**
  - **Supplemental Fuel Option**



FuelCell Energy

Design a CHHP System for your University Campus

- **CHHP means Co-production of Hydrogen Heat and Power.**
- **Power source is high efficiency internal reforming fuel cell.**
  - **e.g., FuelCell Energy's Direct Fuel Cell (DFC)**
  - **The internal reforming creates hydrogen for the fuel cell reaction and excess hydrogen for export.**
- DFC simple cycle power plant size options and costs:

Model	Net AC kW	Cost ($/kW)
DFC300	300	$3,500
DFC1500	1,400	$2,400
DFC3000	2,800	$2,300

- Fuel Options: Natural Gas, Biogas, Propane, etc.
- Simple Cycle Product Specifications available at: http://www.fuelcellenergy.com/products.php
  - **Heat rate, fuel consumption, efficiency (47%), emissions (NOx, SOx, PM10, CO2), exhaust temp. and heat capacity, flow rate, sound levels, etc.**

Fuel Specification for CHHP System

- Baseline Fuel: Natural gas
- Examples of Renewable Fuels:
  - Biogas derived from anaerobic digester, landfill
    - Minimum methane content 60%
  - Syngas derived from thermal gasification.
    - Must be methane rich, at least 50% methane
- Fuel pretreatment
  - Non required for pipeline natural gas
  - Clean up required for renewable/other fuels
    - Sulfur, siloxane, and halogens down to sub-PPMV level.
- Renewable fuels may be blended with natural gas.

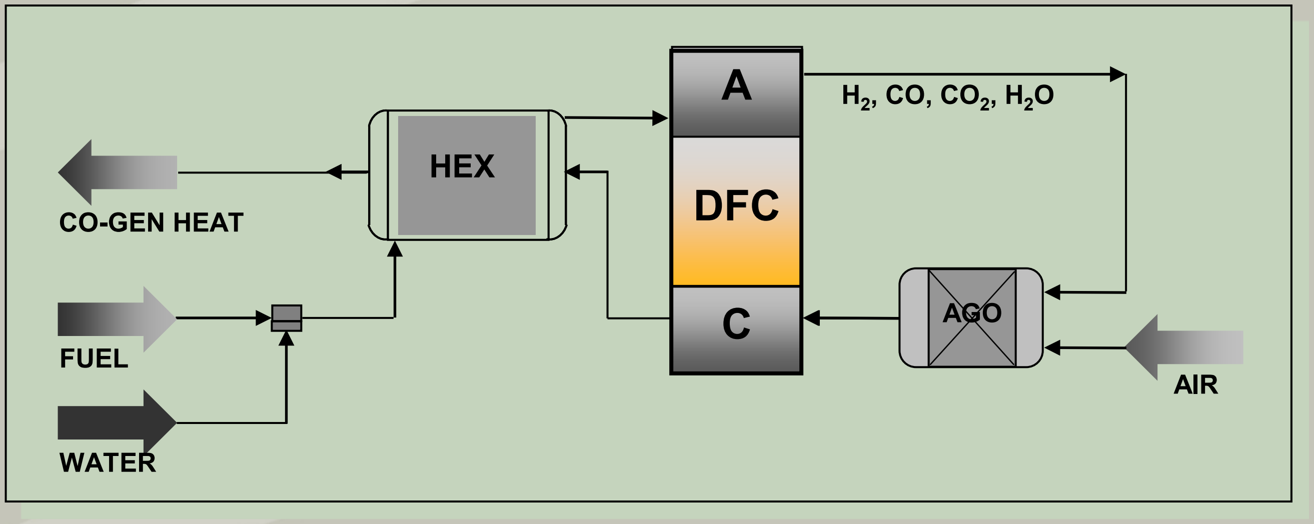
Basis for Hydrogen Co-Production

- Anode Exhaust Composition (at fuel utilization of 65%)
  - H_2 10%
  - H_2O 40%
  - CO 5%
  - CO_2 45%
  - N_2 0.3 – 0.8% (fuel dependent)
  - CH_4 <1%

(Shifted and Dried) H2 = 23%
H2O negligible
CO < 1%
CO2 = 77%

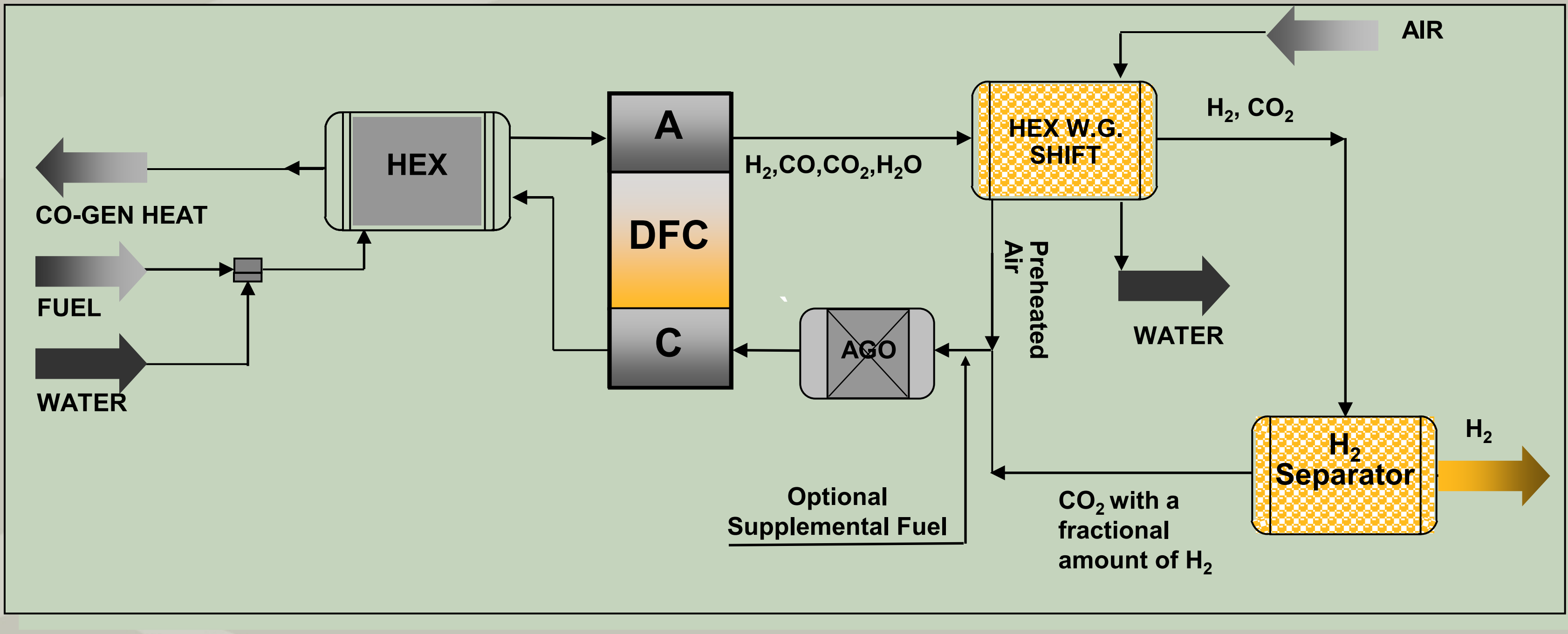
- Impact of Hydrogen Co-Production on Heat Energy available for recovery:
  - Available heat energy is reduced from simple-cycle specification on a one-for-one basis of the heat value of hydrogen product exported.
- Supplemental Fuel Option:
  - Supplemental fuel may be added to facilitate greater hydrogen production.
- Fuel Utilization – maintain 65%.

Configuration – Simple Cycle

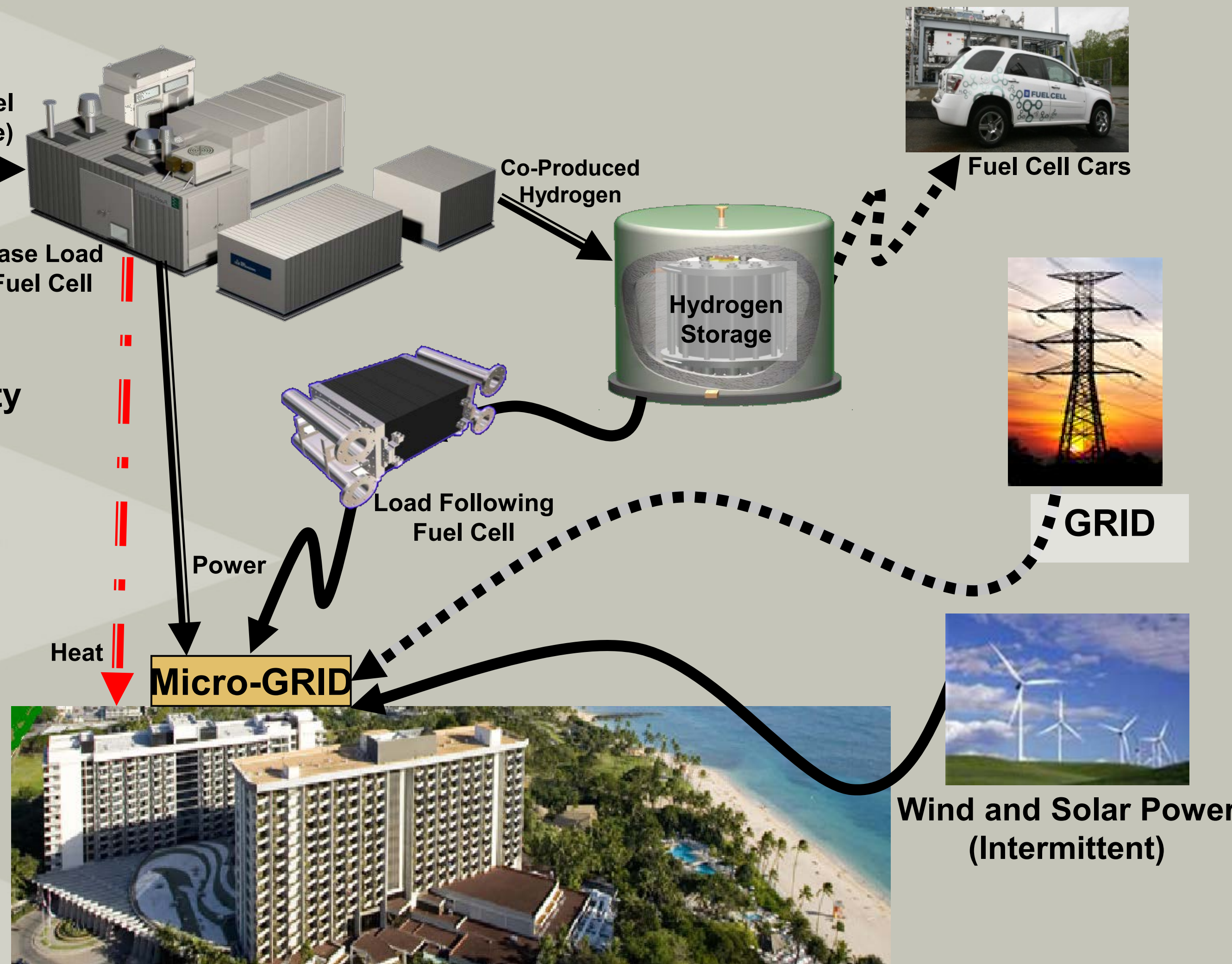


FuelCell Energy

Configuration – H2 Recovery



CHHP System: Enabler for FCV, EV, Smart Grid



- Enhanced Energy Security
- Maximize Green Energy Use
- Water Independent
- Load Following
- Fuel Flexible
- Ultra Clean
- Provides Distributed H_2 for Multiple Uses
- Compensates for Intermittent Supplies

FuelCell Energy

Winning Design

- University of Maryland
- Presenters:
  - Jennie Moton
  - Daniel Spencer
  - Richard Bourne
  - Kyle Gluesenkamp
  - William Gibbons

Report is available at: http://www.hydrogencontest.org/pdf/2012/University%20of%20Maryland%20-%20CHHP%20Phase%20II%20Submission.pdf

Combined Heat, Hydrogen, and Power Plant Design for the University of Maryland

UMD CHHP Design Team

represented by Jennie Moton, Daniel Spencer,
Richard Bourne, Kyle Gluesenkamp, and William Gibbons

Advisor: Prof. Greg Jackson, Associate Director, UMERC

2011-2012 Hydrogen Student Design Contest
sponsored by the Department of Energy

Hydrogen Education Foundation's 2011-2012 Competitive Challenge

Design Objective:

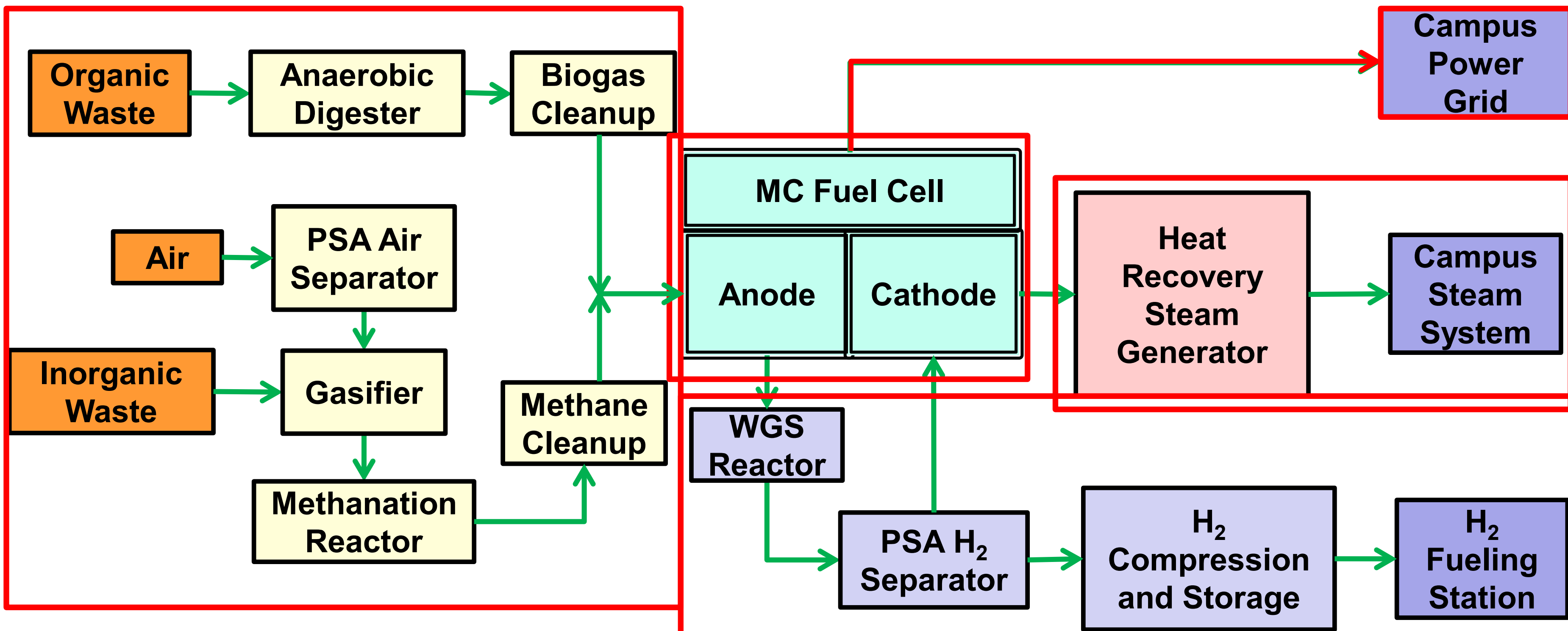
Combined Heat Hydrogen and Power (CHHP) plant for a campus utilizing local renewable waste resources.

UMD System Design Value Proposition:

- **Reduction of ~6,700 metric tons/yr landfill waste removal**
- **Electric power: average 1.2 MWe to reduce external load**
  - *offsets power purchased from the grid*
- **Steam: ~160 kg/hr at 900 kPa, 260°C for on-campus cooling/heating**
- **Hydrogen Fueling Station: ~17.8 kg H_2/hr**
  - *approximately 250 kWe net power in PEMFC systems for UMD shuttles, i.e., ~ 6 – 8 fuel cell powered buses*

CHHP System Summary

- Waste streams converted to methane via gasification and digestion
- Methane is reformed to H_2 in anode and utilized to produce electricity
- Excess H_2 is recovered from the fuel cell anode exhaust
- Remaining thermal energy in exhaust is used to create steam for cooling and heating



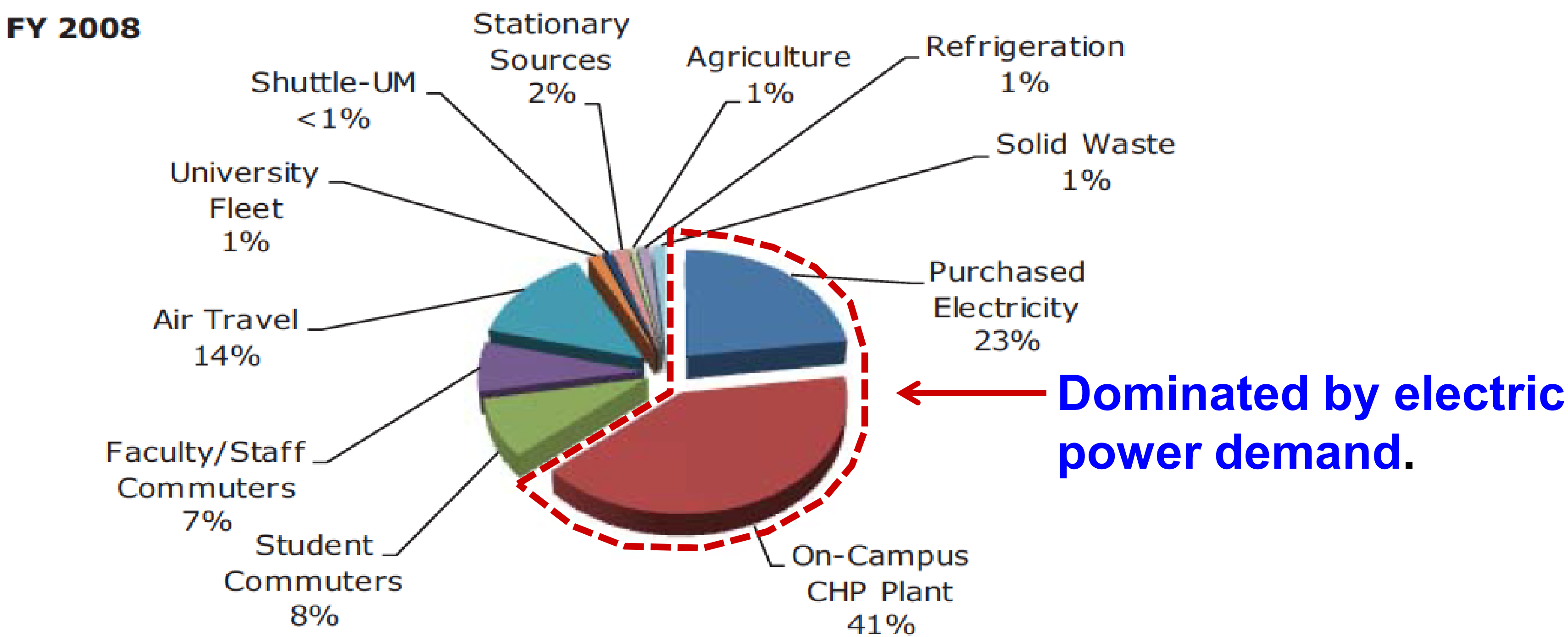
UMD Campus Existing Infrastructure

- **Existing infrastructure on campus was considered in the design stages of the project.**
- **UMD has on campus a natural-gas-fired combined cycle power plant that produces up to 25.9 $MW_{elec.}$**
- **Intermediate pressure steam (900 kPa, 260 C) shipped around campus**
  - Above 70 MW of heating for campus buildings in winter
  - Approximately 13 MW of building cooling in summer provided by steam-turbine-driven chillers


UMD combined cycle power plant

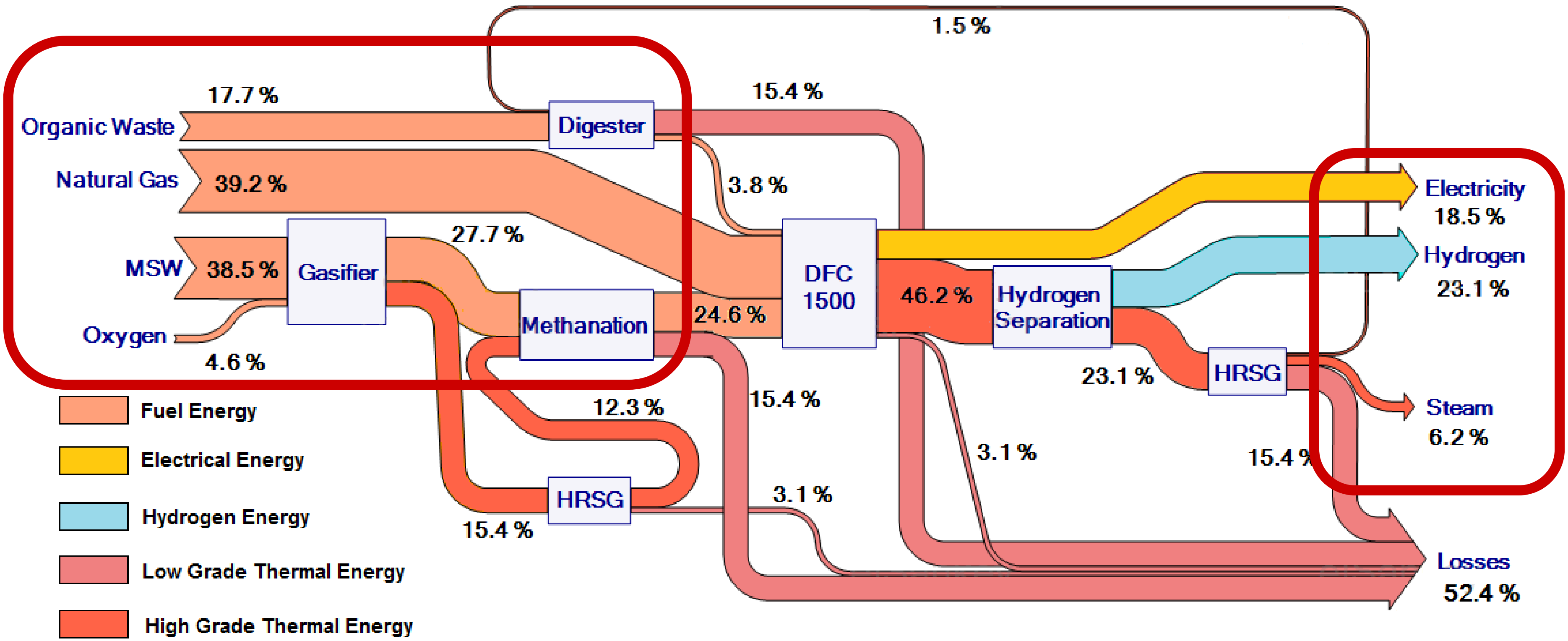

Steam-driven chiller for heat-driven cooling

UMD Campus Carbon Foot Print

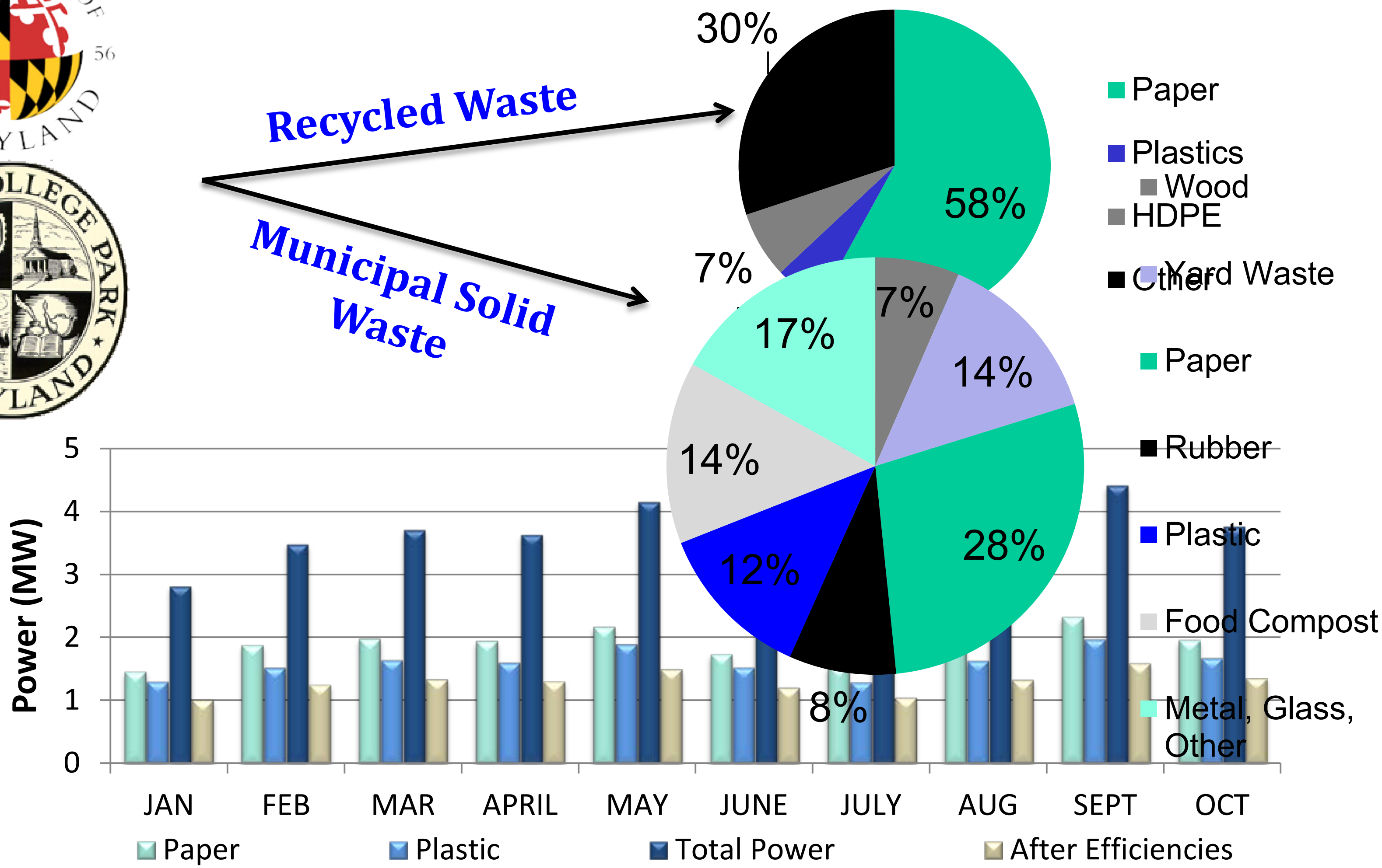


- Greatest gains to be made in reduction of power demand and transportation.
- UMD Carbon Footprint (FY 2008) based on “Carbon Footprint of the University of Maryland College Park: An updated inventory of greenhouse gas emissions: 2002-2008”

CHHP Sankey Diagram (Energy)



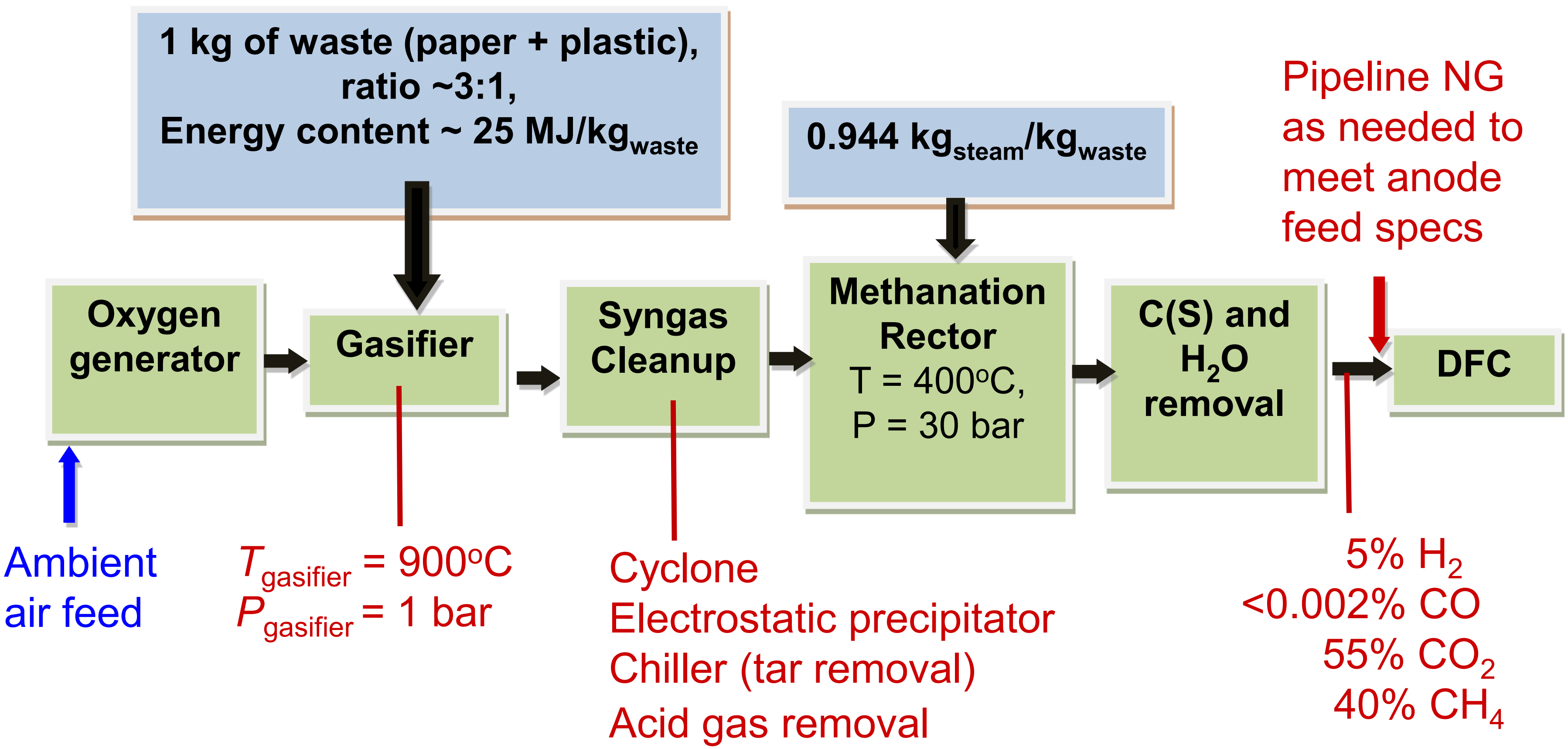
Feedstock Waste Streams



Combined monthly power from waste streams collected from UMD campus and City of College Park for 10 months in 2011.

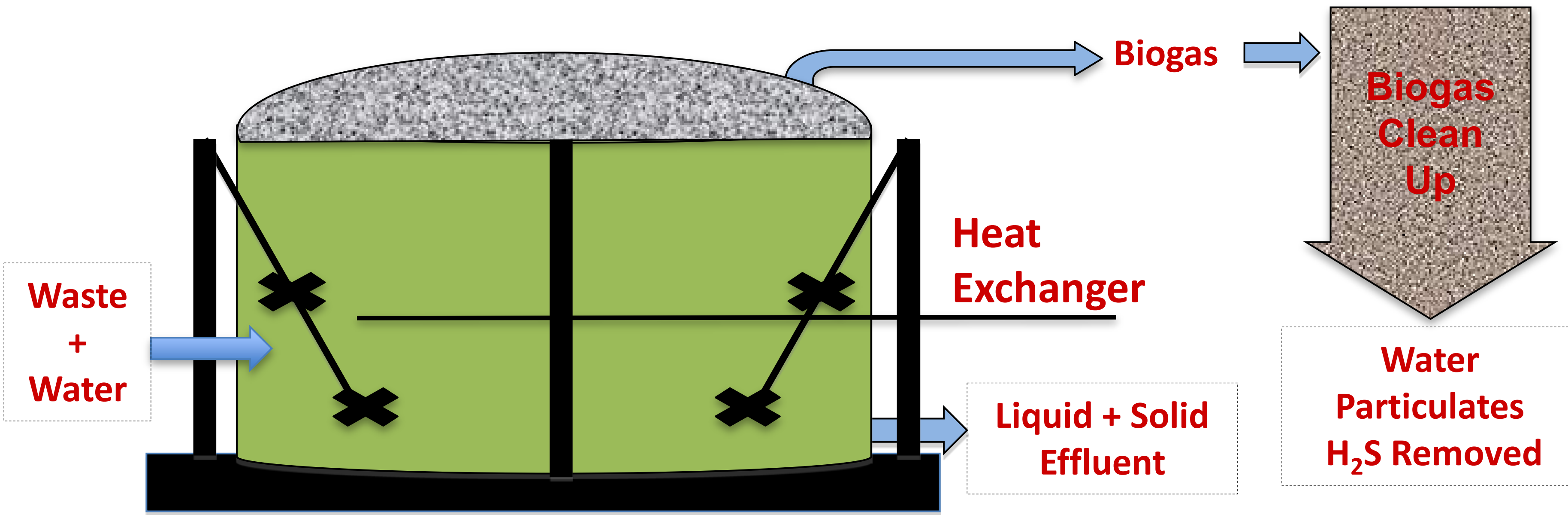
Gasifier and Fuel Processing

- **Metal separator, shredder, feed to gasifier (Thermogenics Model # 106)**
- **O_2 gasifying agent - high reaction rates and minimal syngas dilution**
- **Moving bed, refractory lined to enable high temp operation**



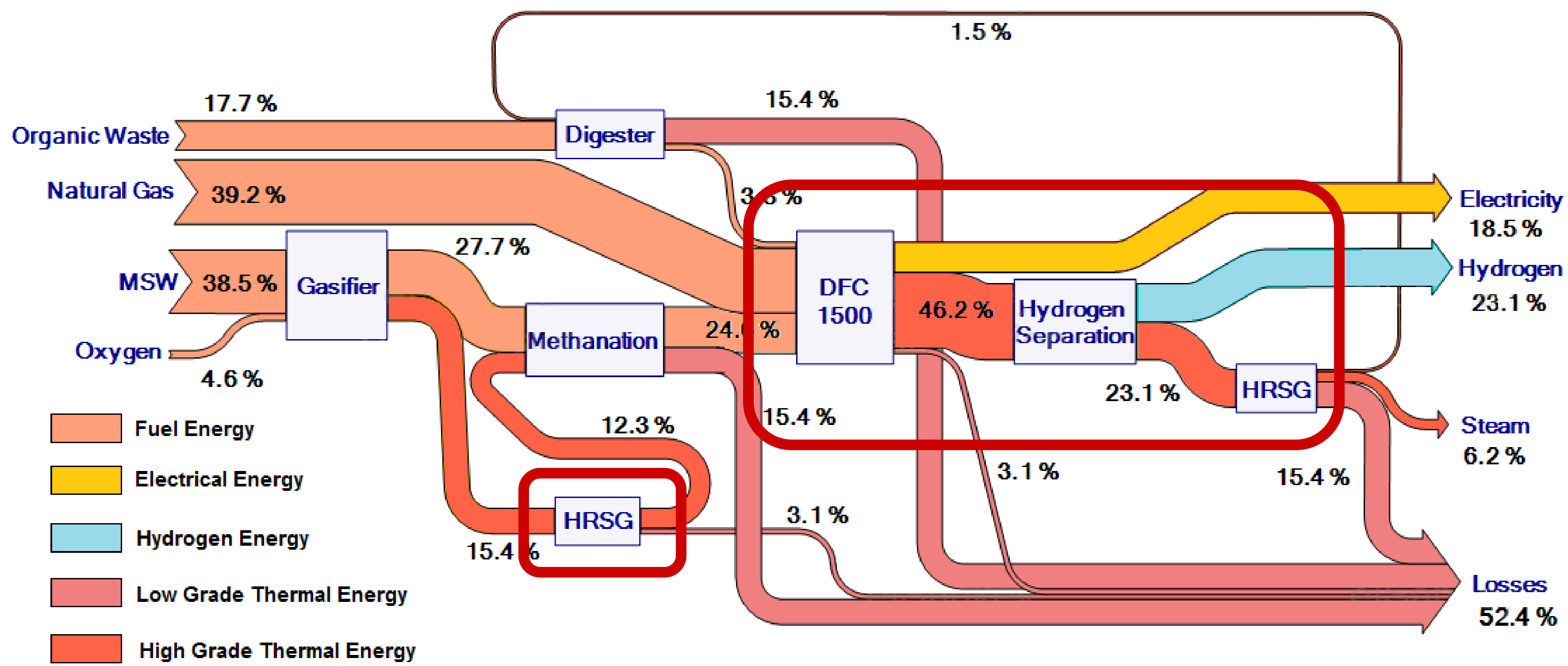
Anaerobic Digester

- Complete mix, mesophilic (32-35 ^{0}C; 21-day retention; 1,520 m^3)
- Wastes Processed: food, stall waste, leaves, yard waste
- Amount of waste processed: 1.56 m^3/hr
- Amount of biogas produced: 32.7 m^3/hr



* Commercial Designs Available from: Advanced Green Energy Solutions LLC , New Energy Solutions, Inc.

CHHP Sankey Diagram (Energy)

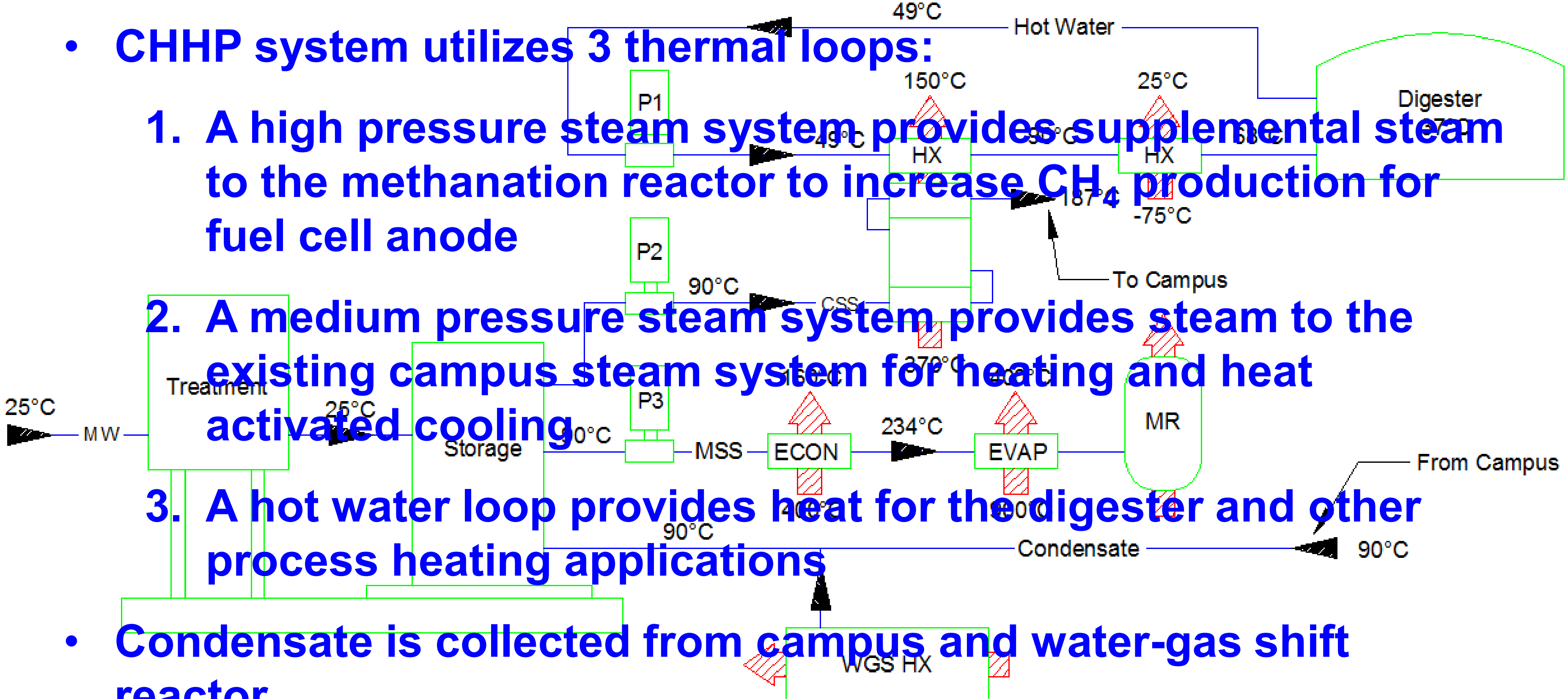


Fuel Cell Energy 1.5 MW MCFC

- **1.5 MW_{elec} Molten Carbonate Fuel Cell (MCFC) used as power plant and H_2 production**
  - ***Electric efficiency in simple-cycle configuration: 47%***
  - *Net electrical output in plant: 1.4 MWe*
  - *Fuel consumption: 308 standard m^3/hr*
  - *Average water consumption: 1.0 m^3/hr*
  - ***Exhaust temperature: 370 +/- 30 ^0C***

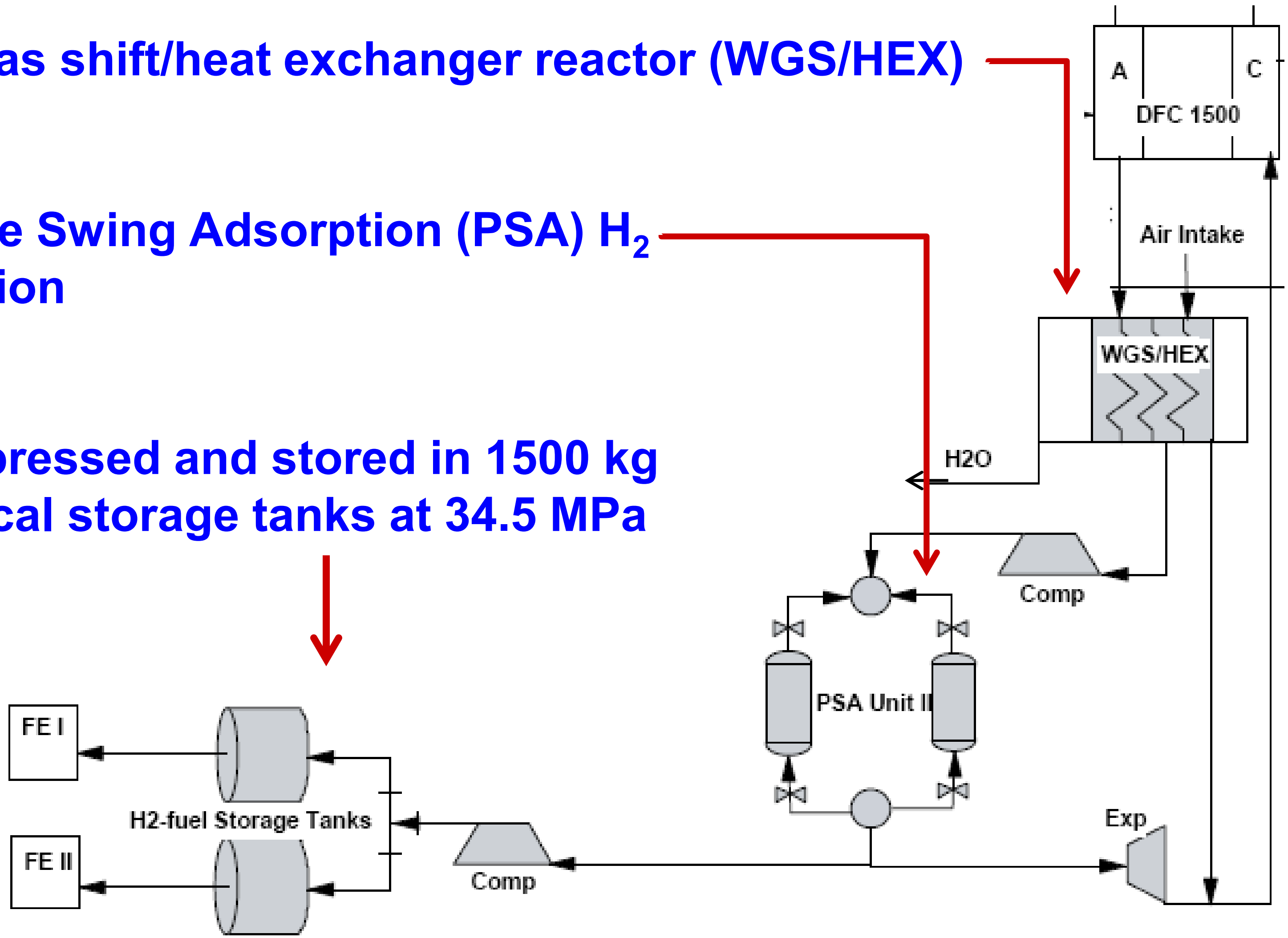
Heat Recovery System

- CHHP system utilizes 3 thermal loops:
  1. A high pressure steam system provides supplemental steam to the methanation reactor to increase CH_4 production for fuel cell anode
  2. A medium pressure steam system provides steam to the existing campus steam system for heating and heat activated cooling
  3. A hot water loop provides heat for the digester and other process heating applications
- Condensate is collected from campus and water-gas shift reactor



H_2 Recovery, Compression, and Storage

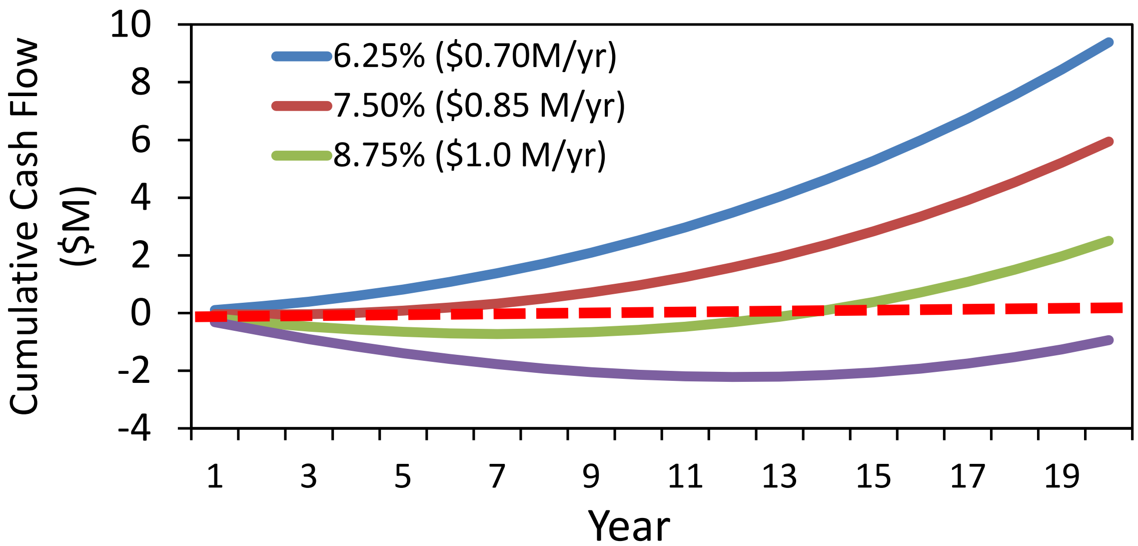
- Water gas shift/heat exchanger reactor (WGS/HEX)
- Pressure Swing Adsorption (PSA) H_2 Separation
- H_2 compressed and stored in 1500 kg cylindrical storage tanks at 34.5 MPa



Environmental Analysis

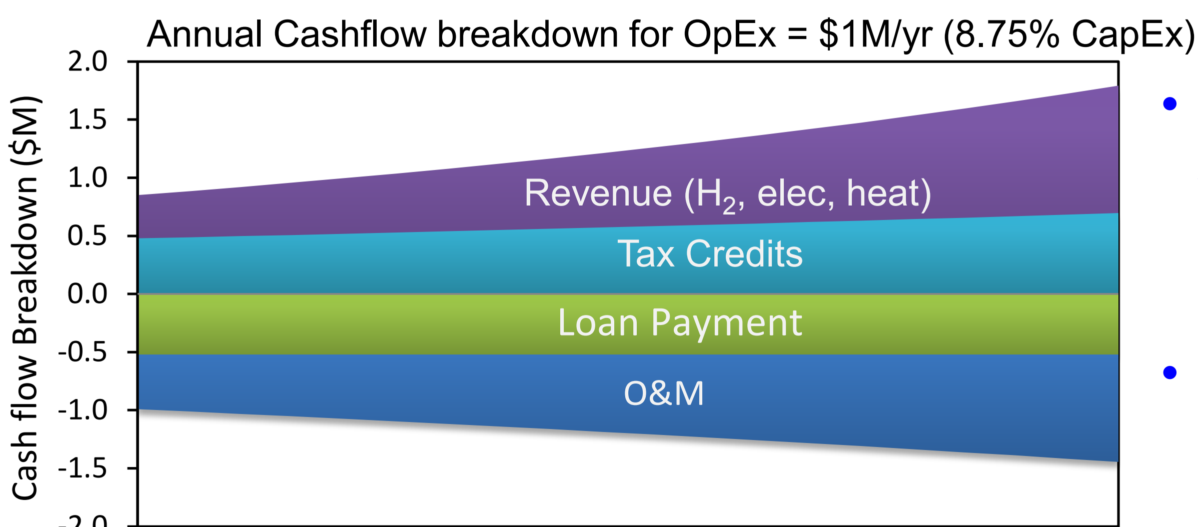
- **Avoided fuel consumption: 52,000 MW-hr/yr.**
- **Equivalent CO_2 emissions reduction:**
  - 13,000 metric tons/yr
    - Over 4% of 300,000 metric tons/yr. for entire campus and commuter operation. (according to campus Carbon Footprint Report)

System Economics



Analysis assumptions

- **20-year system lifetime**
- **3 % financing (fixed payment) over 20 years**
- **2 % inflation**
- **Operating costs: variable fraction of capital cost** (6.25%, 7.5%, 8.75%, 10%)



- **System feasibility strongly dependent on managing operating costs.**
- **Operating costs of ~$1M/yr are realistic**

Challenges and Opportunities for CHHP Technology Advances

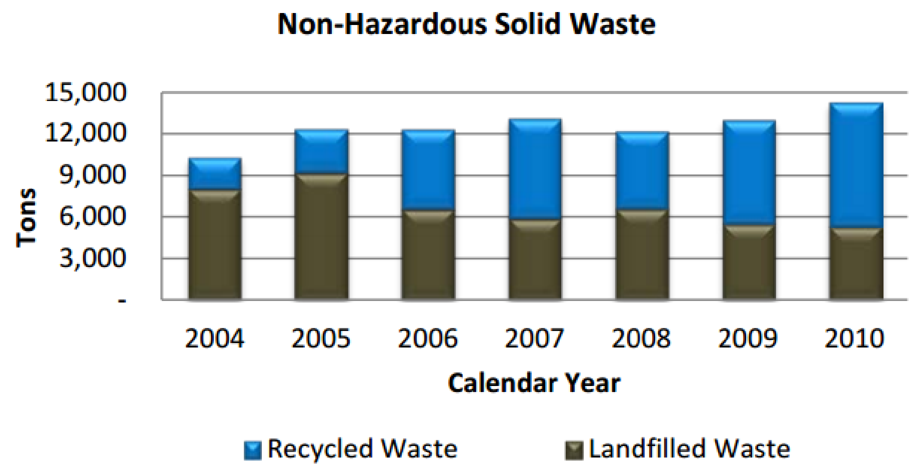
- **Cost effective waste separation**
- **Efficient O_2 from air separation**
- **Durable methanation catalyst and reactor designs**
- **Regenerable sulfur and/or silicon traps for fuel cell and/or reactors.**

- ***Current capital costs of overall plant requires minimal operating costs for a reasonable payback, even with existing credits. Capital cost reduction in major components remains the critical challenge.***
- ***A test plant at a university campus (like UMD) facility provides ideal location for implementing urban waste for CHHP in order to promote such technological advances***
  - *Educational vehicle for industry, R&D community, future engineers*
  - *Flexible and forward thinking facilities managers with aggressive mandates to reduce energy requirements and carbon footprint*

Is CHHP feasible?
Technical/Economic Challenges and Future Studies

- **Detailed assessment of available waste resources**
- **Appropriate solution for recyclable waste?**
- **Arrangement for times of low resource input.**
- **CHHP System upfront cost/profitable waste.**

UMD Sustainability Report



<u>University's Commitment to Sustainability</u>

"I hope we will have some form of waste to energy on campus before I retire, and hopefully we can use some of your design concepts."

from Joan Kowal, Energy Facilities Manager at UMD

University of Maryland Team Members

Jennie Moton
Kyle Gluesenkamp
Will Gibbons
Sahil Popli
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Jorge Prado
Casey Smith

Prof. Greg Jackson (Faculty Advisor, Associate Director of UMERC)

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<u>Corporate Partners</u>

World Hydrogen Energy Conference 2012
FuelCell Energy
Thermogenics Inc.
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Clayton Industries
Applied Compression Systems
Pepco Energy Services
BioFerm Energy
TEMCo Industrial Power Supply
GDF Suez Energy NA

<u>UMD Faculty and Staff</u>

Joan Kowal (campus energy manager)
Bill Guididas
Michael Dwyer
Dr. Stephanie Lansing
Sally DeLeon
Erika Laubach

And special thanks to the City of College Park for their waste

Honorable Mention

- Washington State University
- Presenters:
  - Brennan Pecha

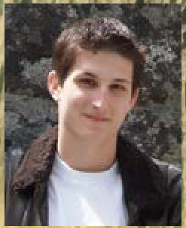
Report is available at:
http://www.hydrogencontest.org/pdf/2012/Washington%20State%20University-CHHP%20System%20Design.pdf

CougsCARE: Clean And Renewable Energy at Washington State University

Brennan Pecha

September 4, 2012

Dr. Jacob Leachman



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Faculty Advisors: J. Leachman, M. Garcia-Perez, and S. Ha

Special Thanks to Hydrogen Education Foundation

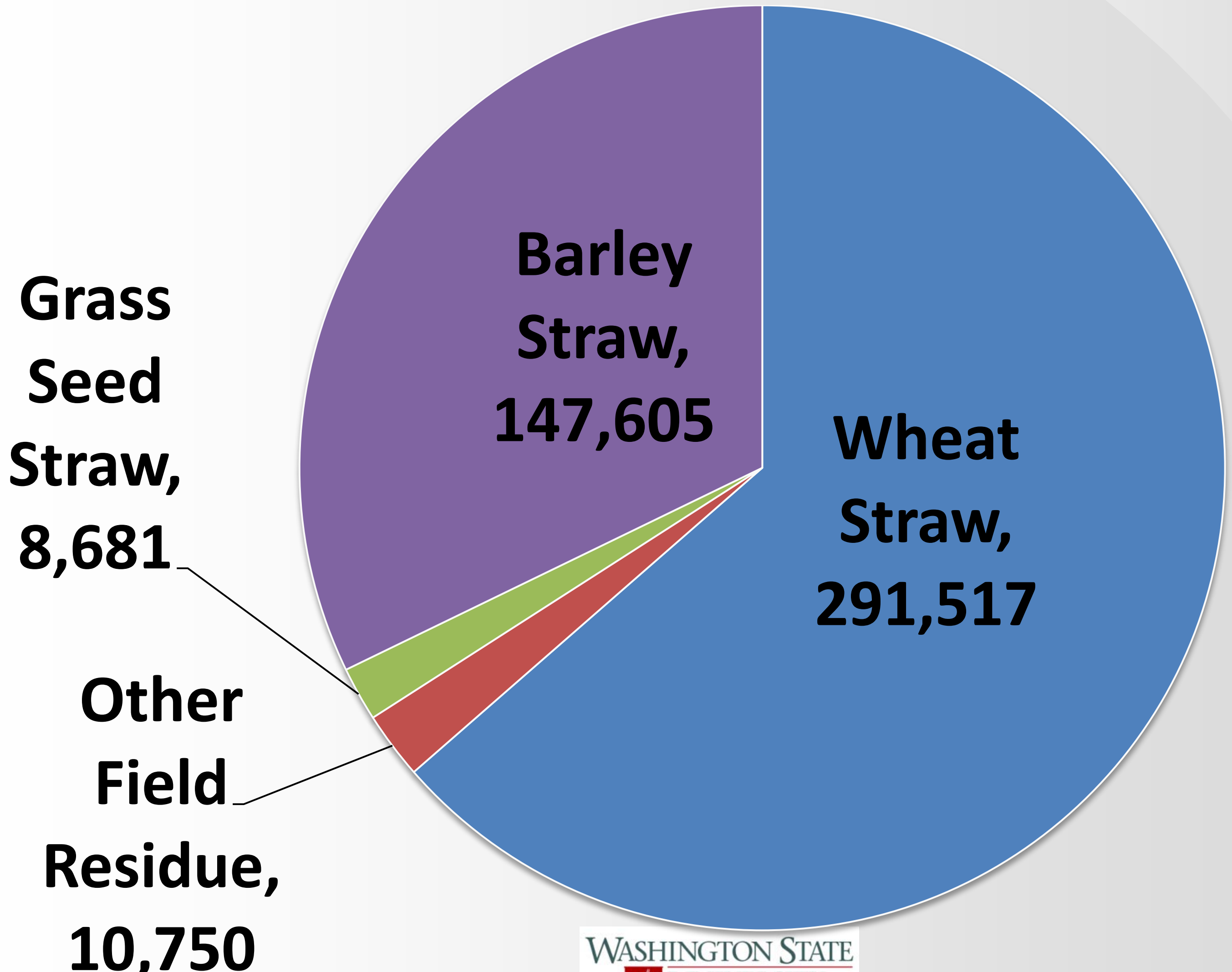
- Opportunity to learn about technologies
- **Competitive incentive to come up with something feasible**
- Finally something tangible to put knowledge to work

WASHINGTON STATE UNIVERSITY

Problem and Solution

- WSU "Climate Action Plan": President Elson Floyd vows **15% CO_2 reduction** by 2020
- EPA restricts field burning for farmers
  - (No use for field residue)
- Lignocellulose feedstock- what do we do with it?
- Technologies exist, unique to each situation

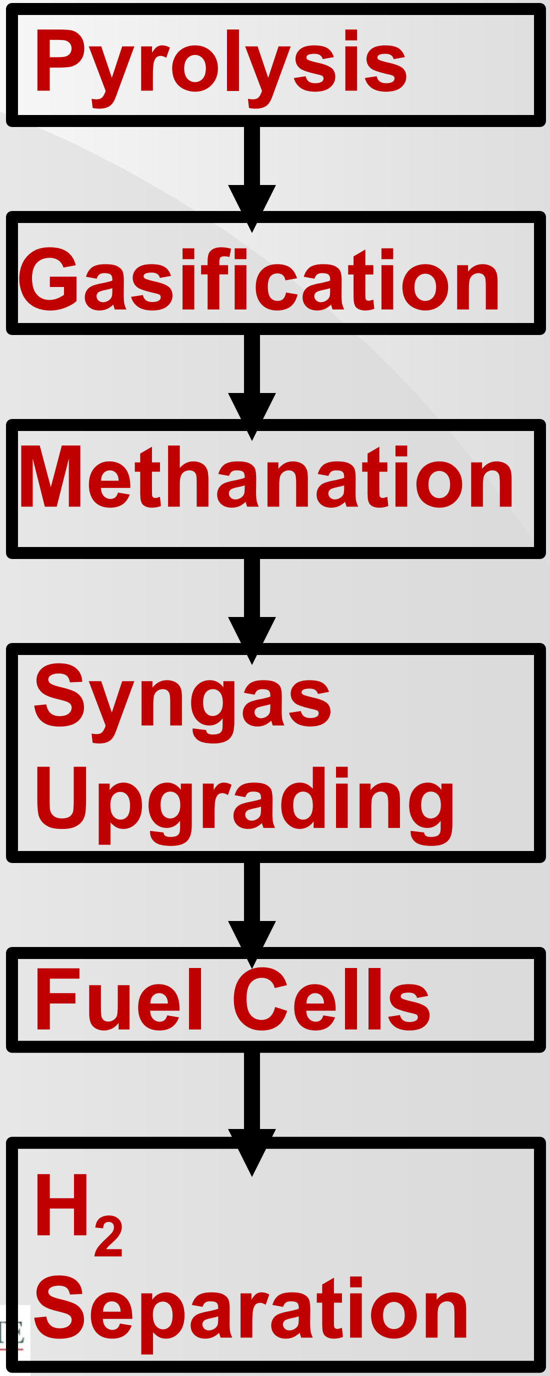
An Abundance of Wheat Straw: Palouse Biomass Residue 2005 (tonnes)



WASHINGTON STATE UNIVERSITY

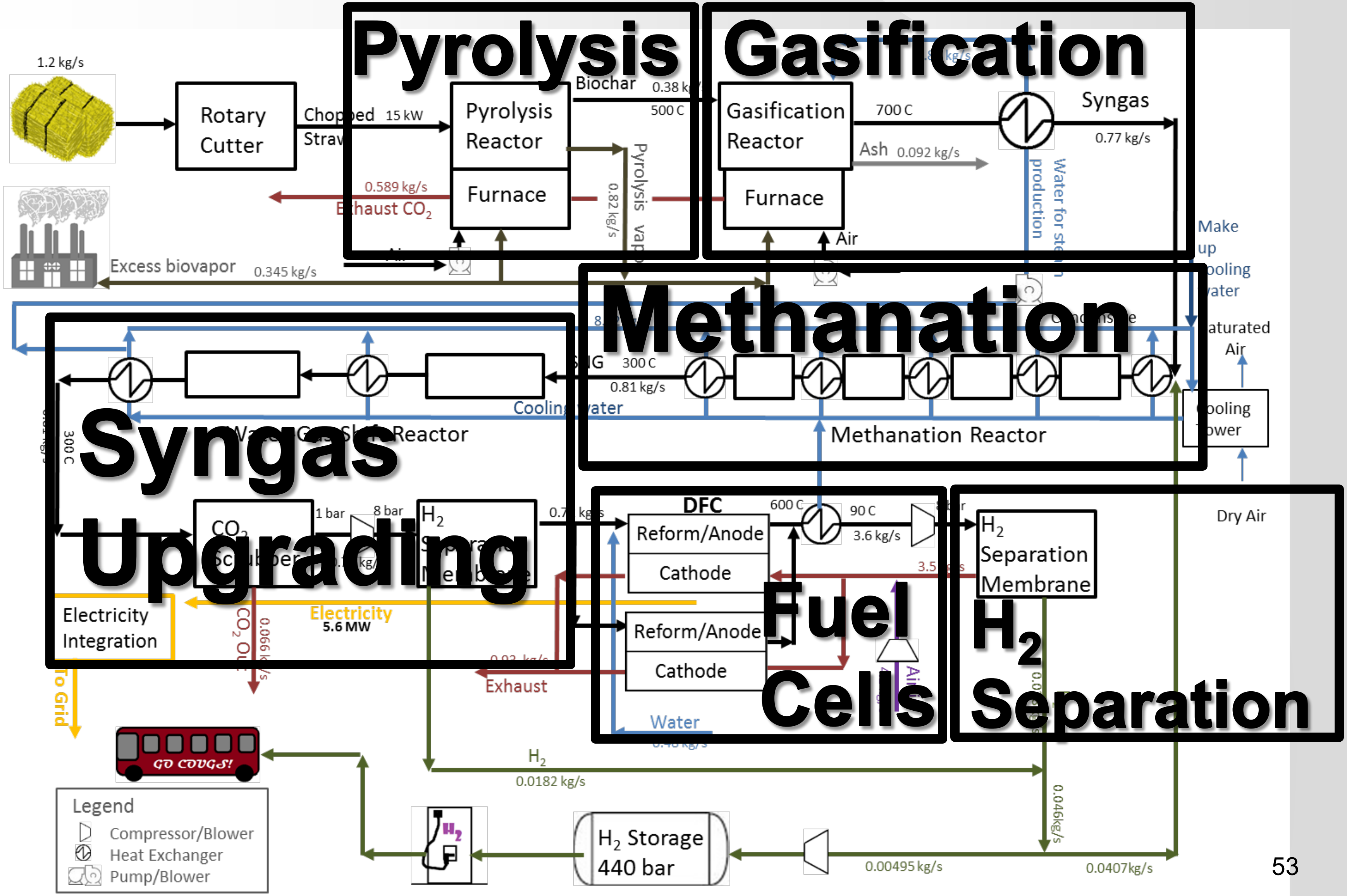
Solution

- System mass/energy balance, economic analysis
- **Thermochemical conversion**- step by step
- Production of **methane** to feed to DFC



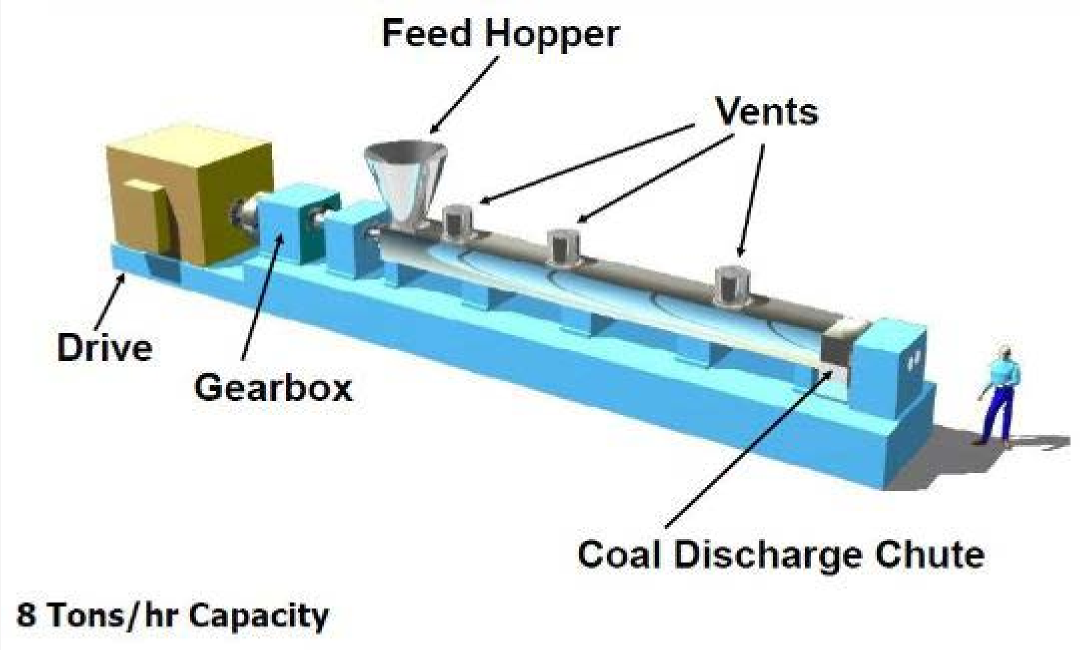
WASHINGTON STATE UNIVERSITY

Thermochemical Conversion for Hydrogen Heat and Power (CHHP)



Pyrolysis

- The **pyrolysis reactor**, producing char and pyrolysis vapor
- 68 wt% pyrolysis vapor, 32 wt % char



Pyrolysis

Gasification

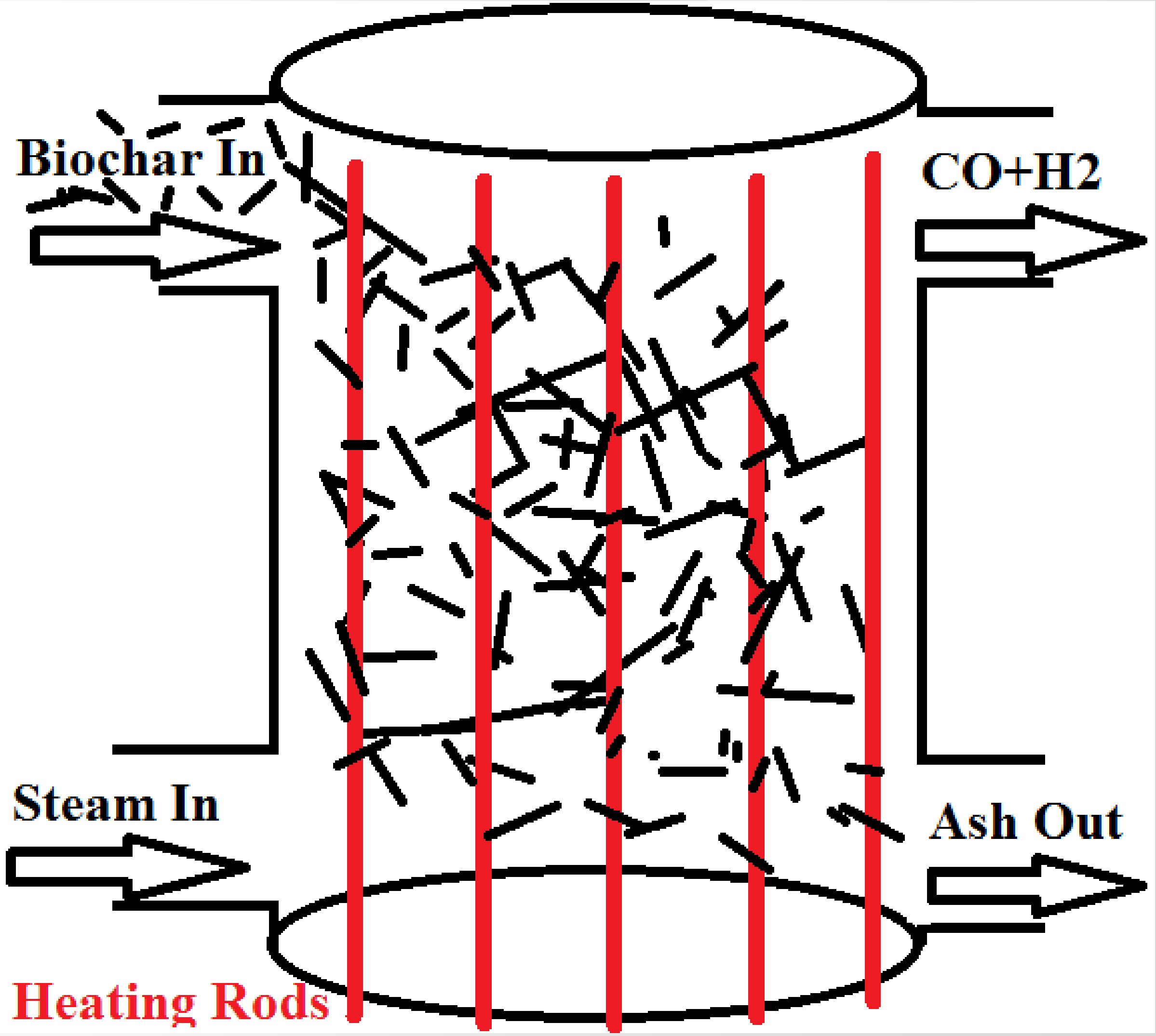
Methanation

Syngas Upgrading

Fuel Cells

H_2 Separation

Gasification



Pyrolysis

Gasification

Methanation

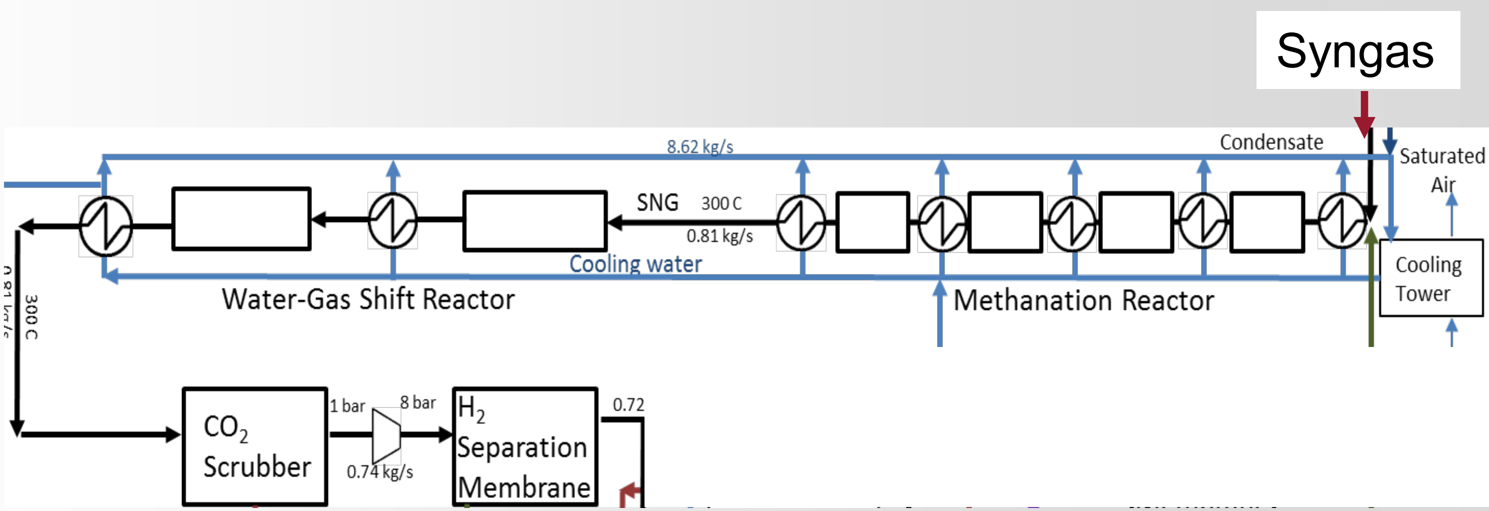
Syngas Upgrading

Fuel Cells

H_2 Separation

Methanation and Syngas Upgrading

- **Methanation**: $H_2 + CO \rightarrow CH_4$
- The methane concentration raised with a **water gas shift** reactor, a **CO_2 scrubber**, and a **H_2 separation** membrane



Pyrolysis

Gasification

Methanation

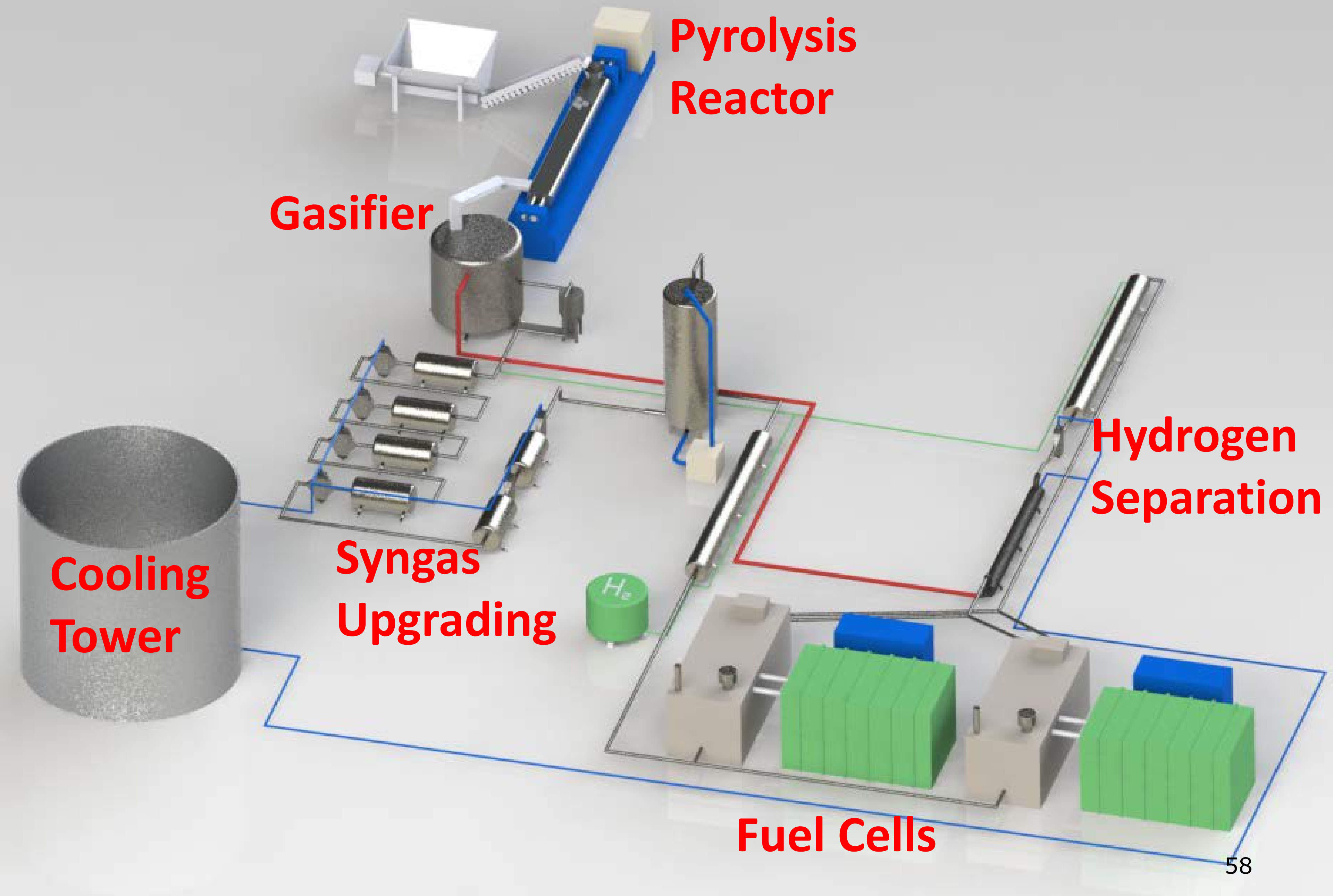
Syngas Upgrading

Fuel Cells

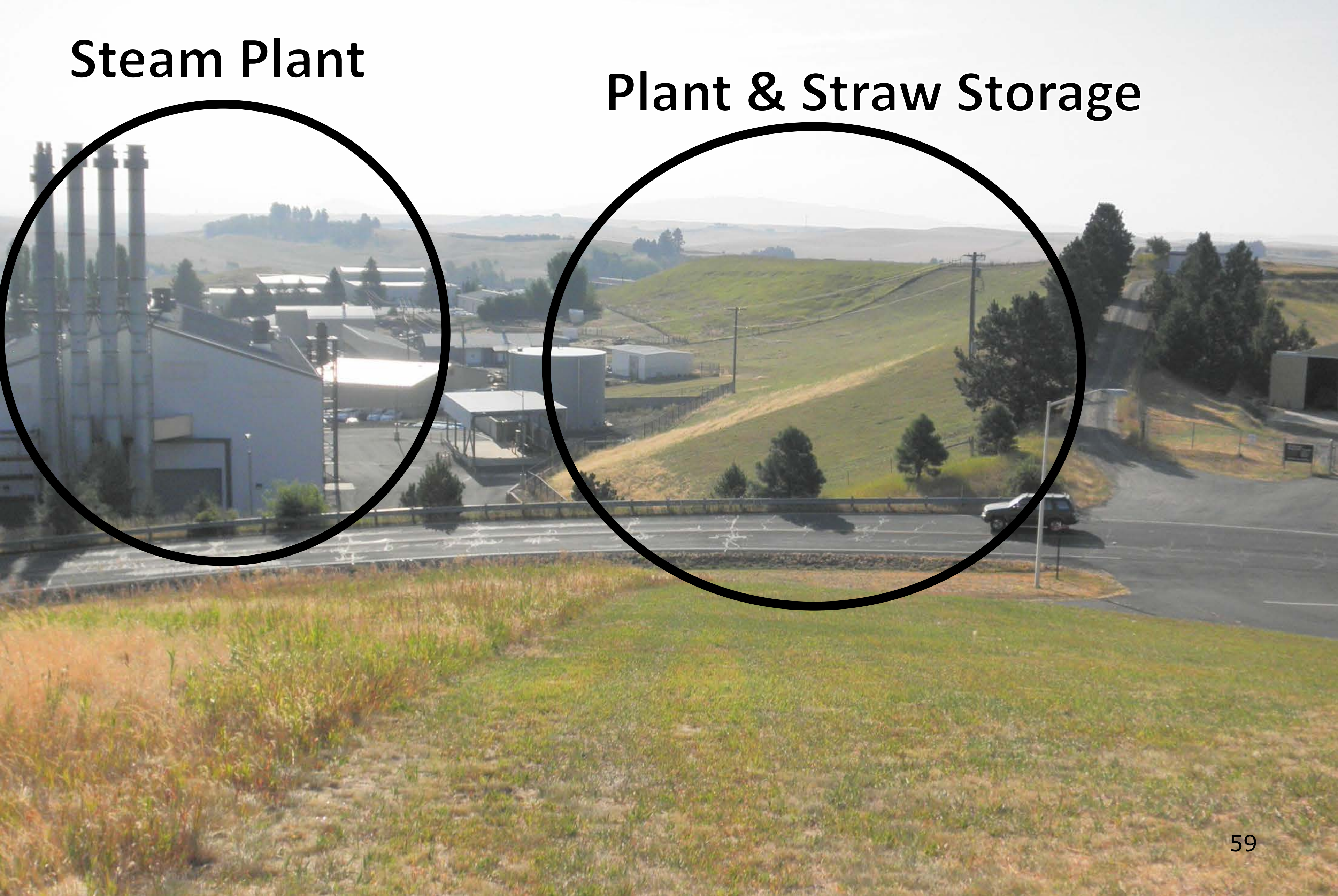
H_2 Separation

Fuel Cell Electricity + H_2 Separation

- DFC: Reformer + molten carbonate fuel cell
- Residual hydrogen can be separated and used


Pyrolysis
Reactor
Gasifier
Hydrogen
Separation
Cooling
Tower
Syngas
Upgrading
Fuel Cells

Plant and Straw Storage Location



Overall Daily System Balance

In		*Out*	
Straw	104 tonnes	Ash	7.97 tonnes
Water	164 tonnes	Pyrolysis Vapor	29.8 tonnes
		CO_2	15.8 tonnes
		CO	18.2 tonnes
		H_2	428 kg
		Electricity	105,600 kW-hr
		Heat	86,400 kW-hr

Primary Uses for Products

- Hydrogen to **mass transit**, vehicles, and **system recycling**
- **4.4 MW** electricity to grid (Pullman's draw is 18.5 MW)
- Heat to adjacent **greenhouses**
- Excess pyrolysis vapor to supplement natural gas at the **steam plant**

Conservative Cost & Environmental Analysis

	2012	2012 With CHHP
Electricity Usage from Avista	162,352,083 kW-hr/year	125,630,000 kW-hr/year
Estimated Unit Cost ($)	0.062/kW-hr	0.062/kW-hr
Electricity Cost ($)	10,065,000	7,789,000
Natural Gas for Steam Production ($)	5,837,000	4,404,000
Fueling Cost for Campus Vehicles ($)	833,000	372,000
Avoided CO_2 Emissions	**0 tons/year**	**54,000 tons/years**
CHHP System Op. Cost ($)	-	5,560,200
Total Energy Costs ($)	16,735,000	18,125,200
Net Savings with CHHP System ($)		**(1,390,200)**

Future Development, Now!

- **Refining plant** location, size, equipment selection (Ha, Garcia-Perez, Mehrizi-Sani)
- **Ammonia synthesis** via Haber reactions (Leachman, Haselbach)
- **Economic & soil-mineral** nitrogen & phosphorous cycle analyses (Fortenbery, Pan)
- Production of **plastics, concrete** from **char/ash**, preliminary proposal and marketing (All above)







A Win-Win for the Community

1. It **minimizes air pollution** to benefit overall community health
2. It **creates clean energy** to supplement the grid of an expanding WSU campus
3. It finally gives **Whitman County farmers** a use for their wasted straw

WASHINGTON STATE UNIVERSITY

Thank You!

- Special thanks to:
  - Drs. Leachman, Ha, & Garcia; The Bair family
  - Ryan Terry of WSU Energy Services; Avista

- Faculty contact: **Jacob Leachman,** jacob.leachman@wsu.edu

- View full report at www.HydrogenContest.org

Honorable Mention

- University of California, Davis
- Presenters:
  - Mengjing (Irene) Yu

Report is available at:
http://www.hydrogencontest.org/pdf/2012/UC%20Davis%20-%20Hydrogen%20Contest%20Entry-2012.pdf

COMBINED HYDROGEN, HEAT, AND POWER (CHHP) PLANT DESIGN

University of California, Davis

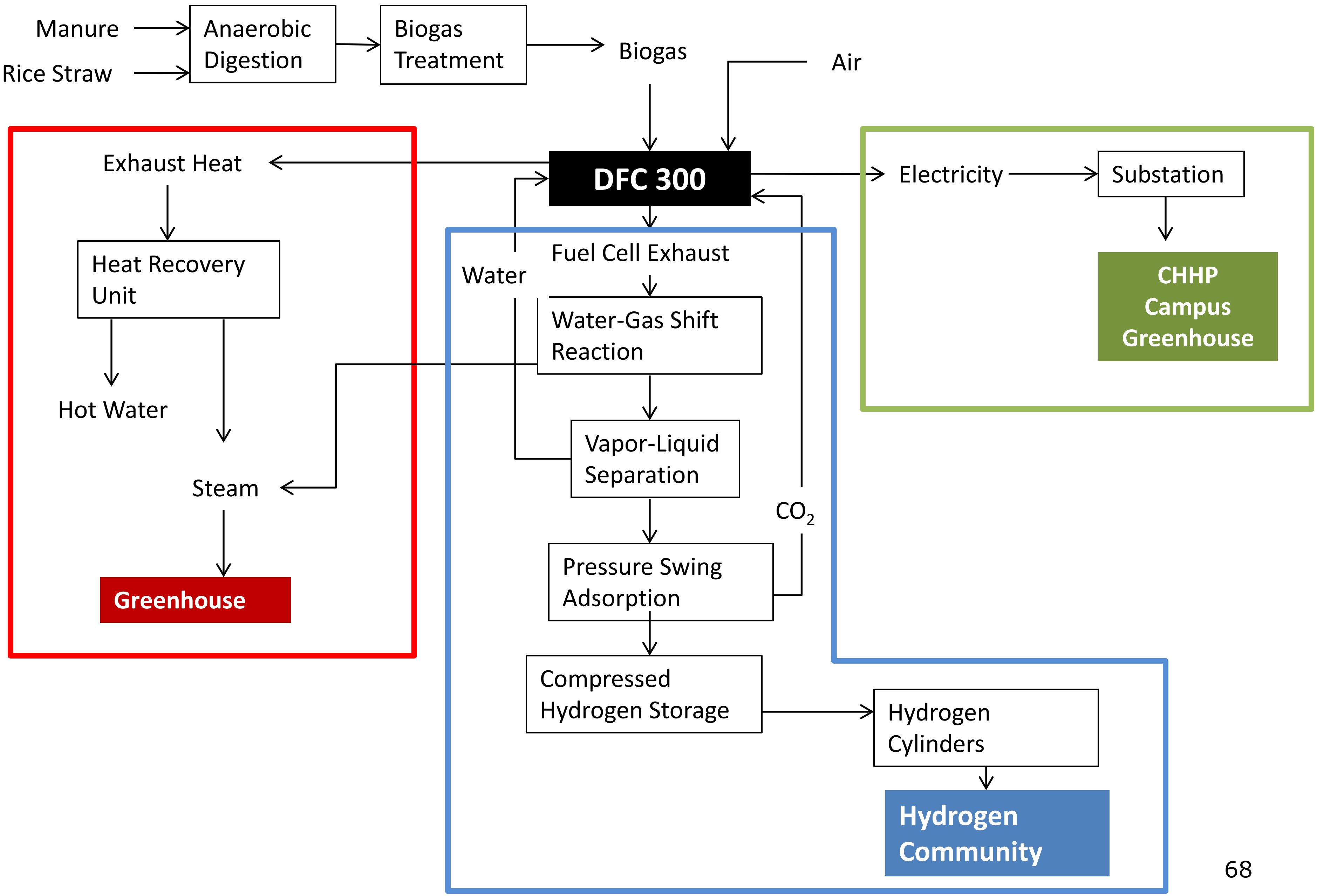
Presenter: Mengjing (Irene) Yu

Team Members: Maya Biery Maggie Mei

Elisha Clerigo, Abigail Bonifacio, Suzann Muy, Dustin Cutler, Roshni Varghese, Farah Quader

Faculty Advisor: Julie Schoenung, Paul Erickson

CHHP Overview



Feedstock Overview

- The feedstock for DFC300 is biogas produced from digesting manure and rice straw, both readily available in Davis.
- Collectable manure can come from cattle, milk cow, horse, sheep, lamb, and goat. Total manure available per day is 27,387 kg.
- 95% of rice production in California takes place within 161km of Sacramento. Annually, California produces 1.3 billion kg of straw waste.
- Combination of manure and rice straw gives good carbon-nitrogen ratio and optimum moisture content.

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Technical Design

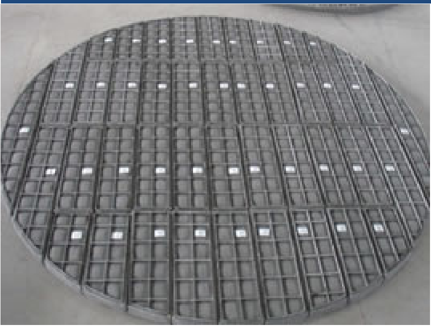
Hydrogen Purification

Water-Gas Shift Reaction

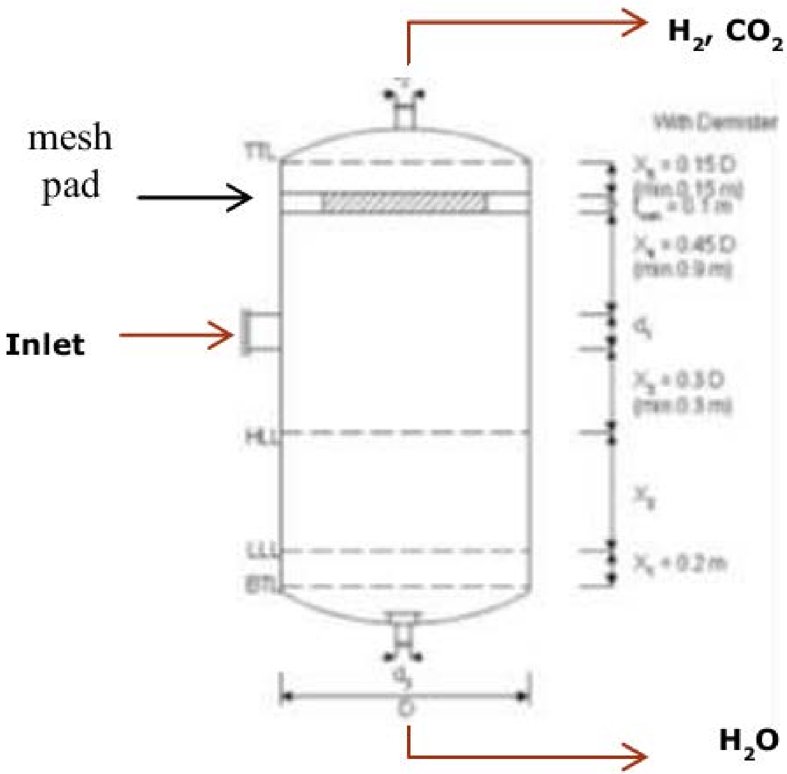
$$CO + H_2O \longrightarrow CO_2 + H_2$$

Reactor Design:

- Fixed Bed Plug Flow Reactor with Shell and Tube Configuration
- Optimum Temperature is 350° C
- Cooling Water Jacket
- Catalyst is Iron Oxide containing 5-15% Cr_2O_3



Vapor-Liquid Separation



<u>Vessel Specifications:</u>

- Vessel Dimension is Calculated using Design Heuristic
- Liquid Hold-Up Time is 3 to 5 Minutes
- An Entrainment Wire Mesh Served as Mist Eliminator

Pressure Swing Adsorption (PSA)

- H_2-CO_2 Mixture is Compressed to 200 psig Before Entering PSA
- Catalyst is Zeolite, Activated Carbon, Silica Gel
- Cycling Schedule: Pressurization, Regeneration, Repressurization
- Minimum of 2 Adsorbers

Photo Credit: Full System Engineering Co., LTD.

Hydrogen Storage

- Hydrogen is Stored at 5000 psig
- Hydrogen Flow Rate is 29 scfm
- Composite Material for the Tank
- Tuffshell® Fuel Storage Systems

Photo Credit: Lincoln Composites

Hydrogen End Use

- DFC300 produces 62 kg hydrogen per day
- Hydrogen is transported to the Hydrogen Community using hydrogen cylinders
- A 60 kW and a 5 kW Altergy Freedom Energy PEM fuel cell is used to generate electricity
- Capable of supporting approximately 51 households

Photo Credit: Altergy Freedom Energy

Exhaust Heat

Exhaust heat is recovered to produce steam and hot water. Steam is used for steam heating greenhouses. Hot water is mainly for nearby buildings and facilities.

Electricity

A substation including meters, breakers, transformer, and transmission lines is built to support the interconnection. CHHP itself consumes about 126 kW of electricity, so net electricity available is about 154 kW.

Thank You

2012-2013 Contest

The theme of the 2012-2013 Hydrogen Student Design Contest is **"Development of a Hydrogen Fueling Infrastructure in the Northeast United States".**

The challenge for student teams is to create a feasible plan for the implementation of a hydrogen infrastructure, using only commercially available technology, designed to facilitate fuel cell vehicle travel within and between major urban areas in the Northeast and Mid-Atlantic.

2012-2013 Contest

Identifying the Hydrogen Production and Fueling Station Locales

- develop a comprehensive list of potential hydrogen production locations using any commercially available technology for hydrogen production
- develop a comprehensive list of possible hydrogen refueling station locations

Rollout Scheme

- devise a detailed timeline to rollout their hydrogen infrastructure
- amount of hydrogen production and fueling stations must meet or exceed the demand for hydrogen at that time

Cost and Economic Analysis

- address all the costs associated with building the proposed infrastructure

Hydrogen Storage and Fueling Station Regulations

- review of existing regulation pertaining to hydrogen fueling and storage in the Northeast
- develop suitable regulations for the states in which new fueling stations are proposed

Marketing and Education Outreach

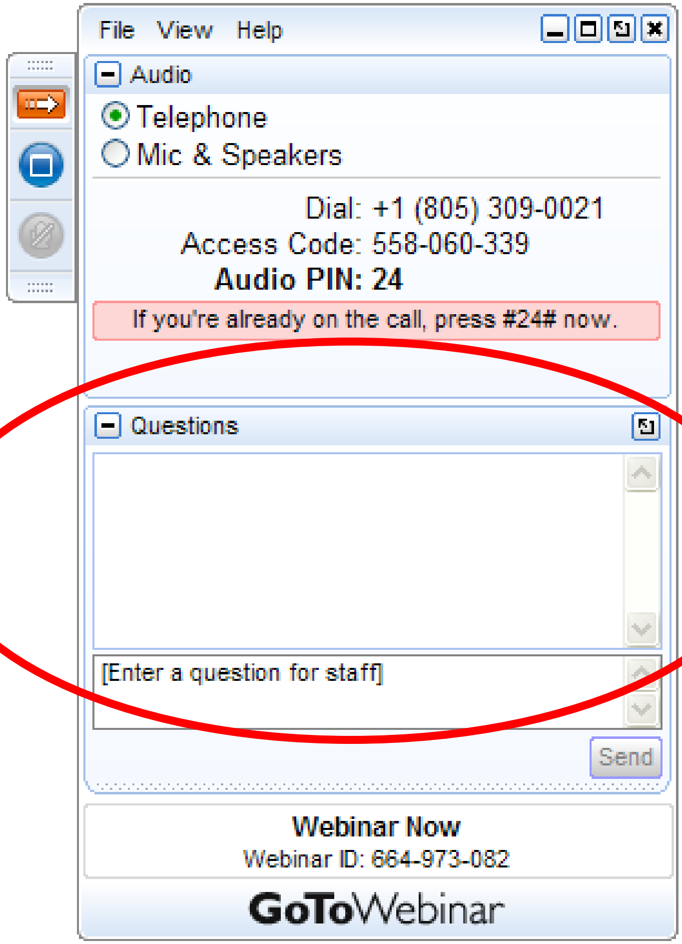
- develop a plan to educate and market the new hydrogen infrastructure to the public

How to Register

- Details on the Contest and team registration at www.hydrogencontest.org
- Team leader is only person required to sign up
  - Registration Deadline - October 1, 2012
  - Team Member List due - October 15, 2012

Question and Answer

- Please type your question into the question box



Thank you!

- The presentation will be made available after the conclusion of the webcast.

- Deadline to register for 2012-2013 Contest is October 1, 2012

www.hydrogencontest.org

US DOE Webinar Series

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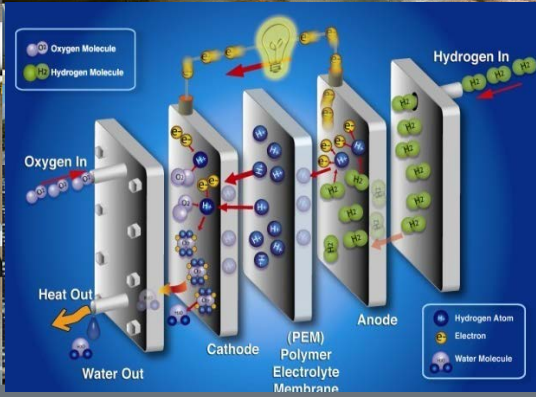

EERE Fuel Cell Technologies Program

4 September 2012

Thank You for Your Participation