

Microsoft - Cheyenne Board of Public Utilities Biogas CHP Demonstration Project

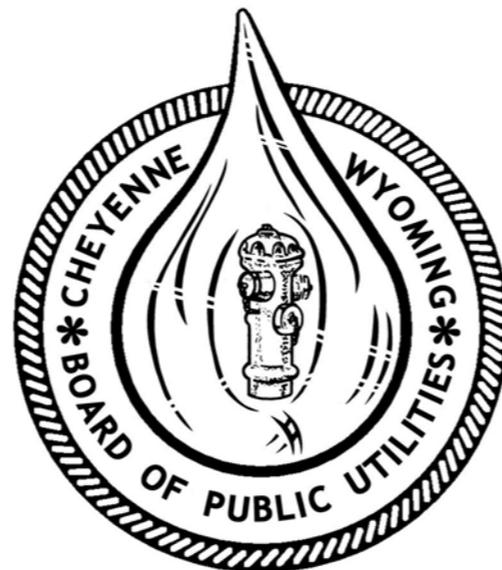
Presented By:

Sean James - Microsoft

Ryan Smith - BOPU

Todd Lovell - Jacobs

E.B. Jensen - Jacobs



Sean James



- Microsoft - Advanced Data Center Development Group
- Sr. Research Program Manager

Sean James is responsible for research and developing new datacenter technology for Microsoft's Global Foundation Services (GFS) group. GFS provides the foundational cloud infrastructure for over 200 Microsoft online and cloud services for consumers and businesses worldwide. Sean drives new datacenter technology for Microsoft's next generation data centers including the evaluation, development, and testing.

Sean joined Microsoft in 2007 to manage one of Microsoft's data centers. Later, he joined the construction team and oversaw the design and building of new Microsoft data centers.

Prior to joining Microsoft, Sean worked in data center management overseeing the day-to-day maintenance and repair operations for both IT hardware and critical infrastructure, such as backup generators and electrical switchgear. Prior to joining Microsoft, Sean served in the US Navy Submarine Fleet as an electrician.

Ryan Smith



- Cheyenne - Board of Public Utilities (BOPU)
- Plant Supervisor Operations & Maintenance
- Ryan Smith has been in wastewater treatment for 7 years, the last 5 with the BOPU in his current position.

Todd Lovell

- Jacobs Project Management Company
- Senior Projects Manager
- Mr. Lovell has 30 years of diverse project management experience, 6 years with Jacobs, the last 4 working in alternative energy solutions, including multiple CHP business projects and numerous gas to energy projects utilizing fuel cell technologies.

E.B. Jensen, P.E., CEM

- Jacobs Engineering
- Director - Power & Energy
- Mr. Jensen has been with Jacobs for over 11 years and has been in the CHP business for over 25 years. He has been involved in numerous biogas gas to energy projects and projects involving fuel cells - both simple cycle and ones in CHP configurations.

Project Background

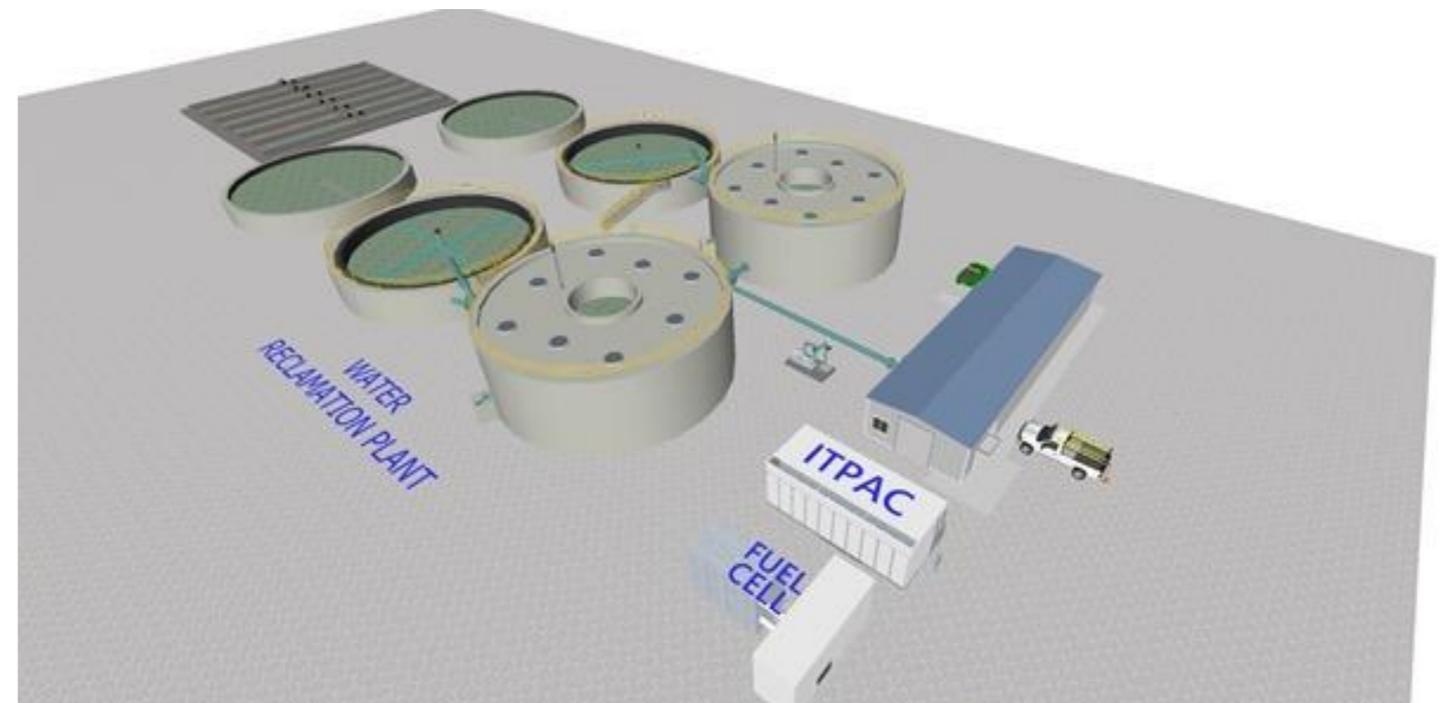
- The rising demand for online services is driving the need to identify and development new sources of energy
- In May 2012, Microsoft made a commitment to make our operations carbon neutral; including datacenters
- In addition to renewable project investments and internal carbon tax, we were looking for innovative sources of clean energy



Project Background

- Based on the benefits of waste to energy projects, we invited proposals from various sewer utilities.
- Cheyenne LEADS and Western Research Institute coordinated the winning proposal.
- The team included:

- City of Cheyenne
- Cheyenne Board of Public Utilities
- Cheyenne Light Fuel & Power
- FuelCell Energy
- The University of Wyoming
- Wyoming Business Council



Project Background

- Microsoft provided matching funds to the Wyoming Business Counsel grant of \$1.5M to fund infrastructure upgrades to the BOPU site
- In addition, Microsoft provided a server container and purchased a 300kW fuel cell from FuelCell Energy
- FuelCell Energy also contributed \$700k in-kind

Why BOPU participated

- BOPU was interested in the project because:
- It gave the facility the opportunity to implement a new CHP technology that would not have been achieved with public only funds.
- By installing such a system with sophisticated monitoring systems, the plant would be able to better monitor and analyze the plants operational behaviors.
- Through the fuel cell plant power and thermal outputs, it was expected the Wastewater treatment plant would see a decrease in utility electric and natural gas consumption.

Wastewater Treatment Plant

- The Wastewater treatment plant has been in operations since 1975 and is designed for a daily wastewater inlet capacity of 10.5 million gallons per day.
- The plant consumes on average 360642.74 kWhrs of electricity per month.
- The plant consumes on average 494.22 decatherms of natural gas on a monthly basis primarily for use in sludge heating.

The Project Management

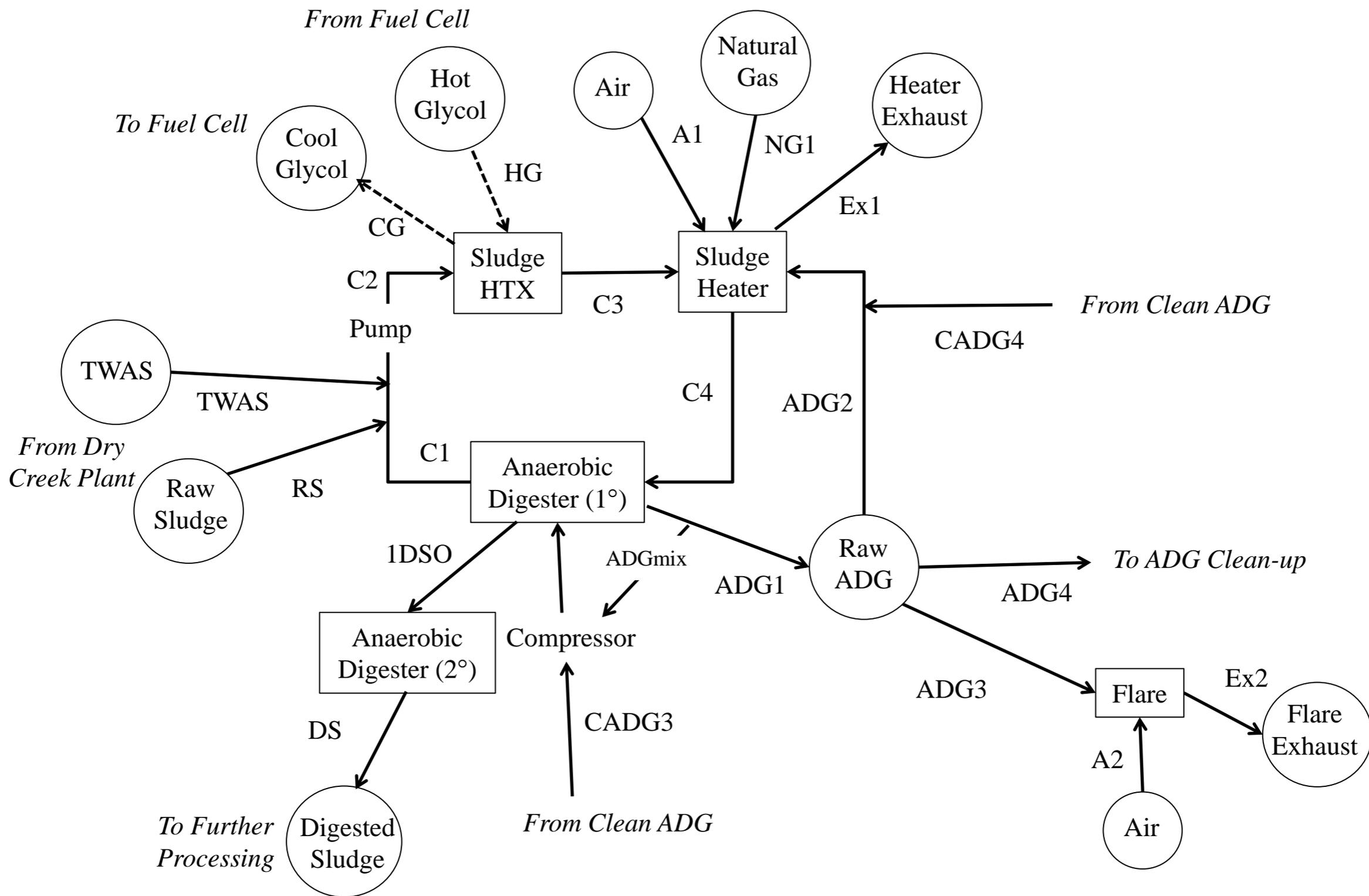
- The project execution approach was thru an EPC arrangement with Fuel Cell Energy performing as both equipment supplier and turnkey EPC provider.
- Jacobs performed as Microsoft's PM/CM provider and Owner's Engineer.
- As PM - Jacobs assisted MS with the receipt and distribution of public funds from Wyoming Business Council/City of Cheyenne.

The Project Management

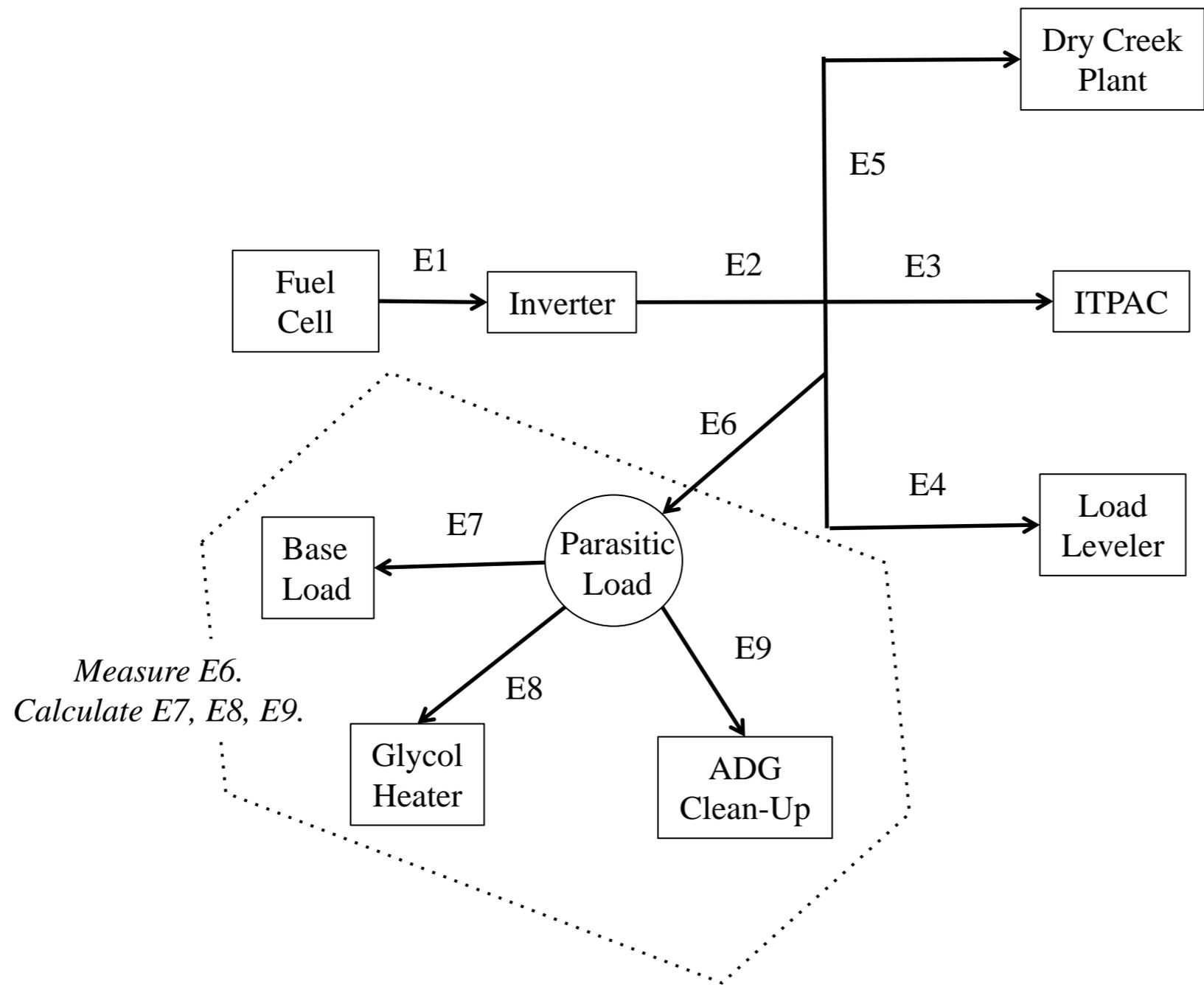
- Jacobs PM, acting as the MS representative, also provided the PM/CM services :
 - Subject Matter Expertise
 - Infrastructure & System Design Review as Owner's Engineer
 - Quality Assurance (Owners Rep) - Design & Construction
 - Coordination of stakeholders
 - BOPU
 - Microsoft
 - LEADS
 - City of Cheyenne
 - WRI
 - UWO
 - FCE
 - EPC Team
 - Project financial tracking

The Project Configuration

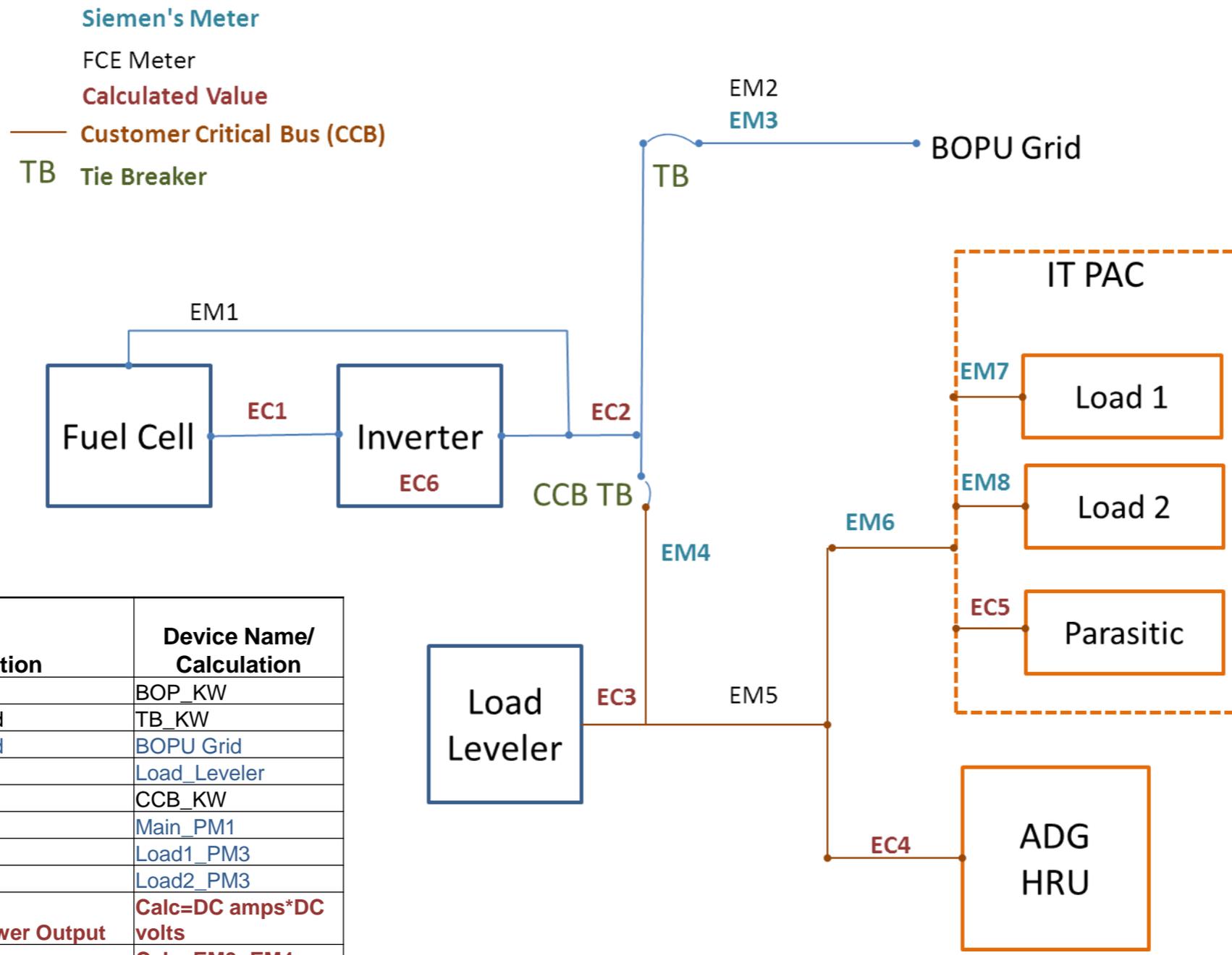
- Fuel Cell – DFC 300
- Waste Heat Recovery – Sludge Heater
- Natural Gas &/or ADG
- Electric Islanding Capability for ITPAC



Schematic of Digester Components



Schematic of Electricity “Flow”



	System / Location	Device Name/ Calculation
EM1	FuelCell Parasitic Load	BOP_KW
EM2	Tie Breaker Output to Grid	TB_KW
EM3	Tie Breaker Output to Grid	BOPU Grid
EM4	Total CCB Load	Load_Leveler
EM5	CCB Customer Loads	CCB_KW
EM6	IT PAC Total Load	Main_PM1
EM7	Server Load 1	Load1_PM3
EM8	Server Load 2	Load2_PM3
EC1	Fuel Cell Module DC Power Output	Calc=DC amps*DC volts
EC2	FuelCell NET AC Output	Calc=EM3+EM4
EC3	Load Leveler Consumption	Calc=EM4-EM5
EC4	HRU and DG Cleanup Skid Load	Calc=EM5-EM6
EC5	IT PAC Parasitics	Calc=EM6-EM7-EM8
EC6	Inverter Losses	Calc=EC1-EC2-EM1

Schematic of Electricity “Flow”



Test Data - thru Sept 2014

- Project is still in construction (HRU & ADG) – Operations to date on Fuel Cell with natural gas.
- The operational testing of the fuel cell has enabled the Wastewater treatment plant to gain a better understanding of how the operations of high power consuming equipment can impact the overall electric power demand for the entire facility.
- Thru the testing to date, the peak load reduction has been identified thru a modification to the plant operator's methodology for equipment sequencing.