MONITORING PLAN
FOR THE
PURECELL 400 FUEL CELL
AT
VERIZON NYC JAMAICA
IN QUEENS, NY

November 7, 2013

Submitted to:

ClearEdge Power
195 Governor's Hwy
South Windsor, CT 06074

Submitted by:

CDH Energy Corp.
PO Box 641
2695 Bingley Rd.
Cazenovia, NY 13035
(315) 655-1063

TABLE OF CONTENTS

Introduction 4
System Description 4
Monitoring System 4
Calculated Quantities 7
Project Web Site 7

Appendix A – Monitoring System Details

Introduction

This plan describes our approach to monitoring the performance of the fuel cell system installed at 163 St, Jamaica in Queens, NY. The 2 Clear Edge Power PureCell™ Model 400 fuel cells provide clean and efficient electric power and thermal output to the facility. These fuel cells are expected to supply electricity in addition to standby power in the event of a power grid failure.

System Description

The PureCell® Model 400 unit is installed physical location on site. The fuel cells (FC) have separate electrical feeds for parallel operation with the utility or to provide backup power when isolated from the grid. Each fuel cell is able to provide 400 kW of electrical power.

Power Output: 400 kW
480V, 3ph

Figure 1. PureCell 400 Unit

Monitoring System

The monitoring system has been designed to capture the electrical performance of the system. Table 1 summarizes the measurements that will be captured at the site.

Data is extracted from the Power Plant Controller (PPC) via MODBUS TCP. The Obvius AcquiSuite EMB datalogger logs the required data.

Table 1. Summary of Measured and Collected Data at the Site

	Channel / Source	Data Pt	Description	Instrument / Meter	Signal / Register	Eng Units	Wire	Notes
	Exp1-1	FGP	GASPULSE	Gas Meter Pulser	pulse	CF		
	Exp1-2	AHT	HTALARM	Status	Boolean/Int	On/Off		
	Exp1-3	ABR1	BRALARM1	Status	Boolean/Int	On/Off		
	Exp1-4	ABR2	BRALARM2	Status	Boolean/Int	On/Off		
	Channel / Source	**Data Pt**	**Description**	**Instrument / Meter**	**Signal / Register**	**Eng Units**	**Wire**	**Notes**
Fuel Cell 1	Modbus TCP	FG1	Fuel flow rate, FC1	PPC1	7173	kg/h	Float	page 12 of FCFR
	Modbus TCP	FGcum1	Cumulative fuel consumed at standard temperature	PPC1	7191	m^3	Float	page 12 of FCFR
	Modbus TCP	WFC1	Electrical power output, FC1	PPC1	10535	kW	Float	page 12 of FCFR
	Modbus TCP	WFCcum1	Cumulative electrical power output, FC1	PPC1	7217	MWh	Float	page 12 of FCFR
	Modbus TCP	SWV1	Make-up water tank fill valve status, FC1	PPC1	763	On/Off	Boolean/Int	page 12 of FCFR
	Modbus TCP	EFF_ELEC1	Instantaneous electrical efficiency, FC1	PPC1	7505	%	Float	page 12 of FCFR
	Modbus TCP	FC_STATE1	Fuel cell state Number, FC1	PPC1	5	Number	Unsigned Int	page 12 of FCFR
	Modbus TCP	SGI1	Grid independent status, FC1	PPC1	60	On/Off	Boolean/Int	page 12 of FCFR
	Modbus TCP	SGC1	Grid connect status , FC1	PPC1	59	On/Off	Boolean/Int	page 12 of FCFR
	Modbus TCP	RTIME1	Cumulative load time hr, FC1	PPC1	7205	hrs	Float	page 12 of FCFR
	Modbus TCP	NALARM1	Total number of alarms, FC1	PPC1	21	Number	Unsigned Int	page 12 of FCFR
	Modbus TCP	FC_ISTATE1	Inverter State Number, FC1	PPC1	13	Number	Unsigned Int	page 12 of FCFR
	Modbus Dev 11	WREC1_pos	Energy Output through RECs meter, FC1	SHARK1	1100	kWh	Double	
	Modbus Dev 11	WREC1_neg	Energy Input through RECs meter, FC1	SHARK1	1102	kWh	Double	
	Modbus Dev 11	WDREC1	Power through RECs meter, FC1	SHARK1	900	Watts	Float	
Fuel Cell 2	Modbus TCP	FG2	Fuel flow rate, FC2	PPC2	7173	kg/h	Float	page 12 of FCFR
	Modbus TCP	FGcum2	Cumulative fuel consumed at standard temperature	PPC2	7191	m^3	Float	page 12 of FCFR
	Modbus TCP	WFC2	Electrical power output, FC2	PPC2	10535	kW	Float	page 12 of FCFR
	Modbus TCP	WFCcum2	Cumulative electrical power output, FC2	PPC2	7217	MWh	Float	page 12 of FCFR
	Modbus TCP	SWV2	Make-up water tank fill valve status, FC2	PPC2	763	On/Off	Boolean/Int	page 12 of FCFR
	Modbus TCP	EFF_ELEC2	Instantaneous electrical efficiency, FC2	PPC2	7505	%	Float	page 12 of FCFR
	Modbus TCP	FC_STATE2	Fuel cell state Number, FC2	PPC2	5	Number	Unsigned Int	page 12 of FCFR
	Modbus TCP	SGI2	Grid independent status, FC2	PPC2	60	On/Off	Boolean/Int	page 12 of FCFR
	Modbus TCP	SGC2	Grid connect status , FC2	PPC2	59	On/Off	Boolean/Int	page 12 of FCFR
	Modbus TCP	RTIME2	Cumulative load time hr, FC2	PPC2	7205	hrs	Float	page 12 of FCFR
	Modbus TCP	NALARM2	Total number of alarms, FC2	PPC2	21	Number	Unsigned Int	page 12 of FCFR
	Modbus TCP	FC_ISTATE2	Inverter State Number, FC2	PPC2	13	Number	Unsigned Int	page 12 of FCFR
	Modbus Dev 11	WREC2_pos	Energy Output through RECs meter, FC2	SHARK2	1100	kWh	Double	
	Modbus Dev 11	WREC2_neg	Energy Input through RECs meter, FC2	SHARK2	1102	kWh	Double	
	Modbus Dev 11	WDREC2	Power through RECs meter, FC2	SHARK2	900	Watts	Float	

The monitoring system is based around the Obvius AcquiSuite EMB data logger. The layouts of the HRM and the connections with other network components of the Fuel Cell system are shown in Figure 3. A Babel Buster gateway device reads MODBUS data from the PPC and makes that data available to the Obvius data logger.

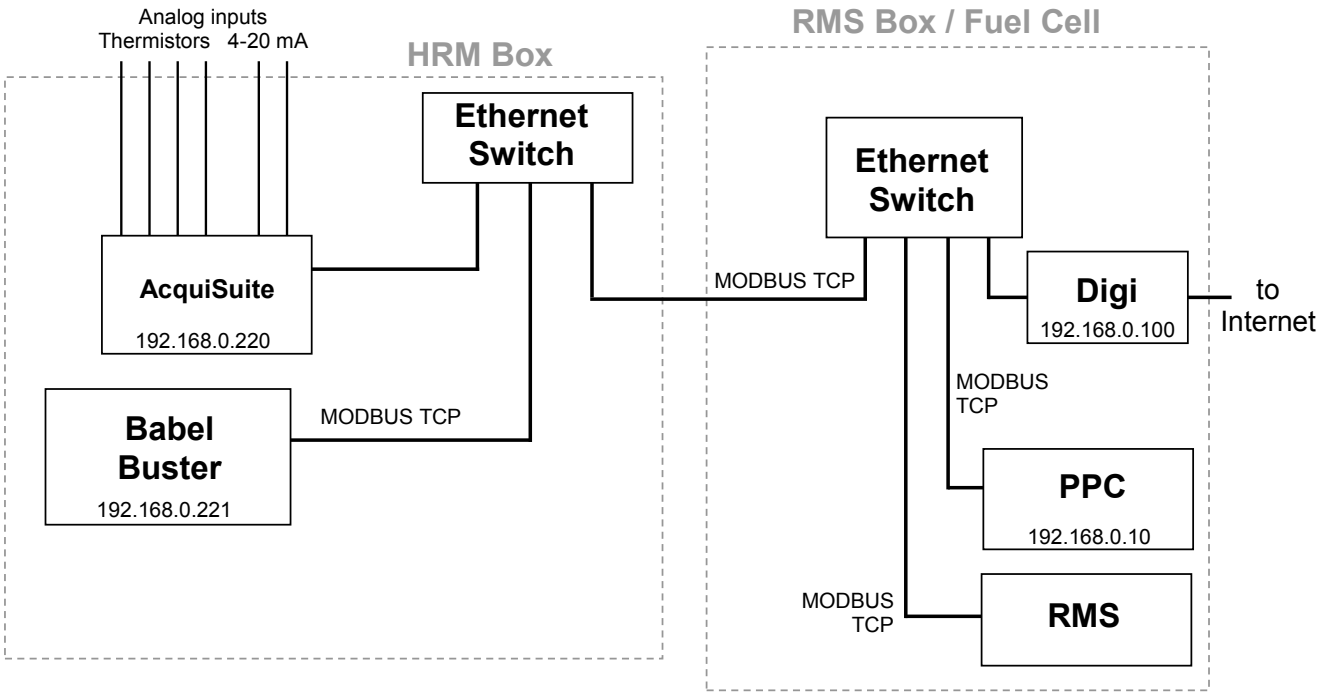

Figure 3. Layout of HRM, RMS and PPC Network

Calculated Quantities

Power and Energy

Generally power meters can provide a host of data points, many of them redundant. Our approach, where possible, is to grab the register value associated with energy (kWh) and from that value determine the average power for each 15-minute interval. This average power value is defined as:

$$\mathrm{kW}_{\mathrm{avg}} = \frac{\mathrm{kWh}}{\Delta t}$$

This average Power over a short time interval (15 minutes) is usually indistinguishable from the "demand" or instantaneous power data reported by most meters (most utilities use a sliding 15-minute interval). The fuel cell PPC is given as instantaneous kW. Cumulative reads are in kWh.

Efficiency Calculations

The electrical and total efficiency of the Fuel Cell, based on the lower heating value of the fuel, will be calculated using:

$$\eta_{electrical} = \frac{WFC}{LHV \times FG \times \frac{1}{3600}}$$

where:

	WFC	-	Power output (kW)
	FG	-	Generator gas input (kg/h)
	LHV	-	Lower heating value for natural gas (~48,667 kJ/kg)

Project Web Site

CDH will create a web site for Verizon NYC Jamaica that provides access to all the historic data collected at the site. The website will provide custom, detailed plots and tables of the collected data from the site that will be updated once a day.