Stroudsburg, Pennsylvania 18360

BASICPOWER™

Brodhead Creek Regional Authority

Energy Conservation Measure Project

April 11 2016

Project Level M&V Plan

Project Description

Project Name: BCRA Waste Water Treatment Plant

Project Address: Lower Main Street/Kitson Street, Stroudsburg, PA 18306

BPU Model(s) I-480-2

Measurement & Verification (M&V) Overview

The International Performance Measurement & Verification Protocol (IPMVP), AHSRAE Guideline 14 and the Federal Energy Management Program have identified four M&V protocols for energy conservation projects.

Option A – Partially Measured Retrofit Isolation

Energy savings projected through partial field measurement and engineering calculations, separate from the rest of the facility.

Application – Power draw is measured periodically. LED and other lighting retrofits.

Option B – Retrofit Isolation

Energy savings projected through field measurements of the energy use of the system to which the ECM is applied, separate from the energy use of the whole facility.

Application – Energy usage is measured by kwh meter installed on the electrical supply to determine savings by comparison of baseline (off) and operational (on) period when ECM is engaged. Baseline and post-retrofit periods can be part hour, multiple hour, day or week in duration.

Option C- Whole Facility

Energy savings determined by measuring energy use at the whole facility level using utility meter and sub-meter data through simple comparison and regression analysis.

Application - Multifaceted EMC projects affecting multiple building systems including electric, gas and water use. Energy use is based upon 12-month base year and throughout post-retrofit period utilizing utility bills and compensating for heating/cooling degree days, building occupancy, productivity, equipment and process changes and utility variables including meter changes. Baseline and Post-retrofit periods can be 12, 24 or 36 months.

Option D – Calibrated Simulation

Energy savings of technologies and components predicted through computer simulation software.

Basic Power Recommended M&V Protocol

Basic Power, Inc. recommends the adoption of an **Option B – Retrofit Isolation M&V Protocol** for all residential, commercial and industrial sector BPU installations.

This M&V Protocol is the most appropriate because the performance of the BPU Unit cannot be predetermined using a pure engineering approach **Option A – Partially Measured Retrofit Isolation**, as would be the case with an LED retrofit, as the BPU's performance is affected by electrical load variables within the building which cannot be predicted by engineering and must be fully measured.

Option B is also more appropriate for the M&V Plan for the BPU technology than **Option C – Whole Building Assessment** where multiple ECM's are applied and the M&V Plan utilizes utility meter data over a long period of analysis where additional variables (outside temperature, building occupancy, production levels, utility estimates and meter changes) might result in changes to the baseline conditions that make it harder to identify savings. BPU installations typically only target the major electrical loads of facilities where multiple transformers are present.

Option B is also more appropriate than **Option D – Calibrated Simulation** because no models exist to predict savings results in simulated analysis for the BPU technology.

Under the **Option B – Retrofit Isolation Protocol** the appropriately sized BPU technology will be installed on the demand side of the utility meter at the mains breaker panel (or sub-panel) to address voltage irregularities and power quality on the incoming voltage, kWh consumption, KVAR consumption, kW demand spikes from electrical loads on that electrical service and power factor improvements. In instances when addition BPU units are connected to breaker panels on lower voltage service within the same facility, because of high loads or power quality issues on that part of the service, the M&V will still take place on the electrical service entering the building on the demand side of the utility meter.

The post-retrofit improvements will be assessed through the establishment of a baseline energy consumption and power quality dataset of a predetermined duration and its comparison with post installation data of a similar duration collected using CT current probes on the three phase mains voltage feed.

This M&V Plan is developed to measure the effectiveness of the BPU technology in reducing kWh, kW, KVAR, and improving power quality issues at this facility.

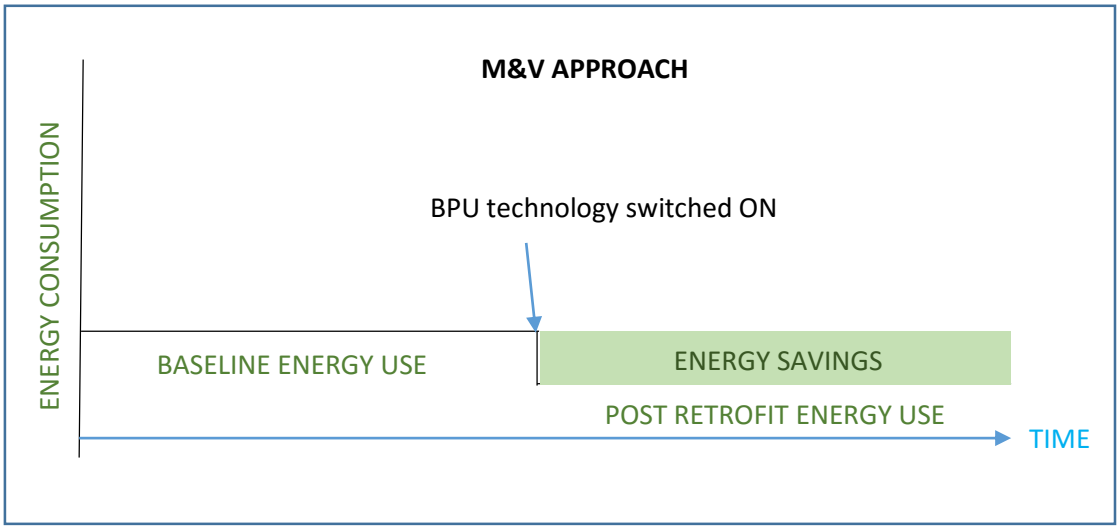
M&V Plan Overview

- **The Boundary** of this Energy Conservation Measure determination is defined as:
    - Measurements to be taken as close as possible to the electric utility meter of the kWh consumption, kW demand, KVAR consumption and Power Factor at the voltage feed on the consumer side of the electric utility meter.

- **The Baseline Conditions** are those measurements taken at the sampling source under normal operating conditions when the BPU technology is switched **OFF**. Baseline data sample should be a minimum of 10 minutes and any noticeable changes in energy consumption as evidenced by observation of the data during sampling should be noted on the M&V report. In order for an accurate comparison of the Baseline and Post-Retrofit periods, equipment operation should be equal in both periods. An analysis of building use will determine the optimum time to conduct the baseline data sampling and the duration of that sample.

- **The Post-Retrofit Conditions** are those measurements taken at the sampling source under normal operating conditions when the BPU technology is switched **ON**. The Post-Retrofit Conditions sampling period should match the Baseline Conditions in sampling source, sampling rate and sampling duration and should follow as close as possible to the sampling period for the Baseline Conditions in order to reduce variables in the building's operational activity.

  Please note that in large facilities it can take up to 15 minutes from initial switch on for the BPU technology to fully condition the electrical service and provide the desired kWh response.



Data Collection & Sampling Plan

Metering Systems

Basic Power, Inc. recommends two metering systems:

- Dranetz Power Quality Meter with DranView Software
    - Complies with IEC 61000-4-30 Class A and EN50160

      Dranetz, headquartered in Edison, NJ is the world's leading manufacturer of intelligent monitoring solutions with over 100,000 customers worldwide. Dranetz metering systems are utility grade devices. DranView is the leading power management software tool in the power industry.

- AcuVim II Power Quality Meter with AcuWatt EMS Dashboard
    - Revenue grade ANSI C12.20 class 0.2 & IEC 62053-22 class 0.2s

      Accuenergy is a manufacture of revenue grade power quality metering systems and is headquartered in Toronto with US offices in LA. The AcuVim II meter is a high performance, revenue grade meter.

This M&V Protocol and Sampling Plan can also include client's existing panel metering system provided that:

- The panel meter manufacture, model and software/dashboard can be identified
- The panel meter is capable of real time sampling
- The panel meter's software can provide the data necessary for accurate analysis
- The panel meter's current probes are located around each of the mains voltage feeds

This M&V Protocol and Sampling Plan can also include other metering systems as long as they can match the performance of the metering systems recommended above.

Metering equipment, probes, data logging software and data communication must be thoroughly checked for calibration and optimal performance prior to commencement of M&V activity by the equipment owner. All meters MUST be recalibrated annually and the date of calibration indicated on the meter. All meters supplied by Basic Power, Inc. to its distributor network will be recalibrated at our Marshall's Creek facility.

THE PARTY RESPONSIBLE FOR ALL DATA COLLECTION FOR THIS ECM PROJECT IS:

BASIC POWER, INC.

SAMPLING METER BEING USED FOR THIS PROJECT IS: **DRANETZ POWER EXPLORER PXS-XFAST #PX50ZA035**

PARTY RESPONSIBLE FOR MAINTENANCE OF SAMPLING EQUIPMENT IS: **ADVANCED TEST EQUIPMENT, SAN DIEGO, CA.**

DATE OF CALIBRATION IS: **5/26/2015 CALIBRATION ID 16863**

SOURCE OF CALIBRATION: **ADVANCED TEST EQUIPMENT (AS SUPPLIED TO BASIC POWER, INC 7/3/2015)**

If meter is other than Drantez or AcuVim II please attach full description of meter and its performance capabilities to this Plan.

Sampling Probes

Current probes, Current Transformers, Flex Probes, Rogowski Coils or other sampling probes (all hereinafter referred to "CTs") must be those approved for use with the meter/analyzer being used for this M&V. CTs must be orientated and positioned as per meter manufacturer's specifications in order to collect accurate data.

SAMPLING CTs WILL BE: **DRANFLEX 3K 3000A** CT SIZE: **18"**

ATTENTION: CTs incorrectly orientated will produce incorrect data. CTs that are too close to each other or other electrical components within the panel will be affected by additional magnetic fields and may not produce accurate data.

Sampling Location

CTs must encircle each phase of the mains voltage feed. Facility manager must communicate with electric utility to obtain access if panel containing mains voltage feed is locked.

CAUTION: All work within the mains panel must be undertaken by a licensed electrician using appropriate safety equipment.

THE SAMPLING LOCATION WILL BE: **480 MAINS PANEL SBR Blower Building, MCC-10**

Sampling Rate

Basic Power, Inc. recommends sampling rates at intervals appropriate to the sampling period in order to assimilate sufficient data points for energy savings calculations.

SAMPLING RATE FOR THIS PROJECT IS: **VOLTAGE, CURRENT, POWER, DEMAND = 30 SECONDS**

Sampling Period

Basic Power, Inc. recommends matching sampling periods of 15 minutes for baseline (BPU off) and comparison (BPU on). Longer matching sampling periods may be appropriate based upon human, mechanical or electrical activity within the facility that may create issues in obtaining a consistent baseline and comparison period. Other factors may make sampling periods of one hour, one day or one week necessary and/or desirable. Longer sampling periods may require regression calculation to equalize data for fair comparison. In large facilities, the M&V sampling period will allow a period of up to fifteen minutes for the operation of the BPU unit to affect the impedance on the line, condition the electrical service and reduce the kWh consumption.

SAMPLING PERIOD FOR THIS M&V PROJECT IS: **BASELINE 10 MINUTES (UNIT OFF). COMPARISON 10 MINUTES (UNIT ON)**

Sampling Date/Time

In order to obtain data which is representative of the normal energy use within a facility it is recommended that all M&V activity takes place during normal operating hours of the facility and that the installation team work closely with the client to establish the most appropriate day and time for the M&V to be conducted.

SAMPLING DATE AND APPROXIMATE TIME FOR THIS M&V PROJECT IS: **MEASURED FROM 04/11/2016 9:33:00 TO 9:55:00**

Record of Sampling

Baseline and Post-Retrofit Comparison Data will be saved electronically on the meter's memory storage under the following naming protocol: distributor_client_sitename_date_off(on)

FILE NAME: **BASIC_BCRA_WWTP_04 011 2016_ONOFF**

A permanent copy of the data collected under M&V activities must be kept by contractor for future reference and attached to the M&V Report. Copies of all files used in this M&V will be distributed to Basic Power, Inc. upon request.

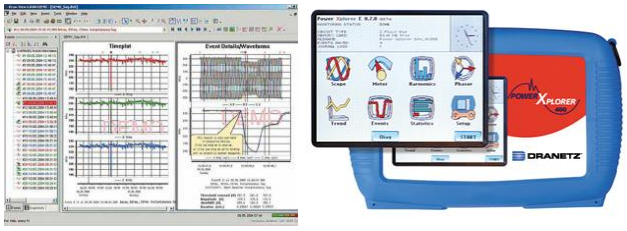
Data Presentation

In addition to the visual LED displays built into the metering hardware, the two metering systems recommended by Basic Power, Inc. for this M&V Plan, provide proprietary software to display data sampled during the baseline and post-retrofit periods. In addition to providing the client access to the LED display during the M&V process, a written report will be provided using the proprietary reporting software associated with the sampling meter.

Dranetz – DranView Software

The Dranview software provides an advanced analysis of sample points recorded and saved by the Dranetz meter in a Windows based platform. This software requires extensive training in order to be able to operate and generate reports.

A sample page of the presentation style of a Dranetz report is attached to this M&V Plan. The Dranetz Report will provide kW, kWh, kVAR and Power Factor data recorded during the baseline and post-retrofit periods in graphed form allowing the client to visually compare data for each measurement within one graph. Additional data such as harmonics and phase balancing can also be requested by the client or provided by the distributor/contractor in the report. Basic Power, Inc. recommends this metering system for installers who are power professionals and for M&V testing which is completed within 24 hours.



AcuVimm II – AcuView & AcuWatt EMS

Accuenergy provides the AcuView software as a PC based datalogging software to interpret data collected by the AcuVim II meter. This software is a Microsoft Excel based software and is therefore easier to use by non-power professionals. A sample Acuview dataset is attached to this M&V Plan.

In addition to the AcuView software, Accuenergy provides a proprietary cloud-based energy management system to display real time data gathering presented in a dashboard style interface. The AcuWatt Report will provide kW, kWh, kVAR and Power Factor data recorded during the baseline and post-retrofit periods in graphed form allowing the client to visually compare data for each measurement within one graph. Additional data such as harmonics and phase balancing can also be requested by the client or provided by the distributor/contractor in the report. Basic Power, Inc. recommends this metering system for installers who are non-power professionals and for M&V testing where baseline and post-retrofit periods exceed 24 hours and where remote access to dashboard data is desired. Please note that the shortest time period that can be sampled by the Acuvim II meter is one minute using the AcuView software. AcuWatt, as viewed through wattic.com can only display data in 5 minute intervals.

Post Retrofit kWh, kW, kVAR and Power Factor Analysis

KWH Consumption

The post-retrofit metered energy use will be compared to the baseline metered energy use to determine the actual energy savings, calculated using the following formula:

$$\text{Actual energy savings \%} = \left[1 - \frac{\text{metered post-retrofit energy use}}{\text{metered baseline energy use}}\right] \times 100$$

Metered baseline energy use will be calculated as the **average kWh consumption** during the initial OFF period.

Metered post-retrofit energy use will be calculated as the **average kWh consumption** during the comparison ON period.

KW Demand

The post-retrofit metered energy use will be compared to the baseline metered energy use to determine the actual energy savings, calculated using the following formula:

$$\text{Actual energy savings \%} = \left[1 - \frac{\text{metered post-retrofit energy demand}}{\text{metered baseline energy demand}}\right] \times 100$$

Metered baseline energy demand will be calculated as the **average kW demand** during the initial OFF period.

Metered post-retrofit energy demand will be calculated as the **average kW demand** during the comparison ON period.

KVAR Consumption

The post-retrofit metered energy use will be compared to the baseline metered energy use to determine the actual energy savings, calculated using the following formula:

$$\text{Actual energy savings \%} = \left[1 - \frac{\text{metered post-retrofit energy use}}{\text{metered baseline energy use}}\right] \times 100$$

Metered baseline energy use will be calculated as the **average kVAR consumption** during the initial OFF period.

Metered post-retrofit energy use will be calculated as the **average kVAR consumption** during the comparison ON period.

Power Factor

The post-retrofit metered power factor will be compared to the baseline metered power factor use to determine improvements to the facility's power quality, calculated using the following formula:

$$\text{Actual PF improvement \%} = \left[1 - \frac{\text{metered post-retrofit power factor}}{\text{metered baseline power factor}}\right] \times 100$$

Metered baseline power factor will be calculated as the **average power factor** during the initial OFF period.

Metered post-retrofit power factor will be calculated as the **average power factor** during the comparison ON period.

Project Schedule

The following dates represent the anticipated Project Schedule for this ECM

M&V Plan sign off: DATE:

Equipment Purchase: DATE:

Installation: DATE: **Temporary Installation 480-2 SBR Blower Building, MCC-10 04/11/2016**

M&V Start: DATE: **04/11/2016** TIME: **09:33 AM**

M&V End: DATE: **04/11/2016** TIME: **9:55 AM**

Reporting

Post Installation Reports to be prepared and attached to this M&V Plan are:

- M&V Report Summary– *Baseline Period and Post-Retrofit analysis and Energy Savings Analysis*

Roles & Responsibility Matrix

ACTIVITY	Distributor	BCRA	Basic Power	Facility
Presentations	NA		x	
Site Survey			x	
Utility Bill Analysis			x	
BPU Unit Sizing			X	
Tech Assistance			X	X
Data Collection			x	
M&V Plan			x	
Agreements			x	
Unit delivery			X	
Installation				X
M&V Report			x	
Project Sign Off		X	x	

M&V Report Summary

Date of M&V **04/11/2016**

Project Description

Project Name: BCRA Wastewater Treatment Plant

Project Address: Lower Main St., Kitson Street, Stroudsburg PA 18360

BPU Model(s): I-480-2

Metering System: Dranetz Power Explorer, Dranflex Probes, Dran-View Software 7.1

Baseline & Post-Retrofit Comparisons

POWER

ACTIVE POWER, P (W)

Baseline Period **306.0** Post-Retrofit **239.9** % Reduction **21.60%**

APPARENT POWER, S (VA)

Baseline Period **363.4** Post-Retrofit **267.5** % Reduction **26.38%**

REACTIVE POWER ,Q AT FUND. FREQ. (VAR)

Baseline Period **186.0** Post-Retrofit **101.83** % Reduction **45.51%**

POWER FACTOR

Baseline Period **0.843** Post-Retrofit **0.897** % Improvement **6.40%**

DEMAND

REAL POWER DEMAND

Baseline Period **306.0** Post-Retrofit **239.9** % Reduction **21.60%**

ENERGY

ENERGY-INTEGRATED ACTIVE POWER (W-HRS)

Baseline Period **56.60** Post-Retrofit **39.95** % Reduction **29.41%**

M&V PROJECT DESCRIPTION

Basic Power originally supplied a I-480-3 unit which Paul Brennan installed at the mains panel of the SBR Blower Building on March 28, 2016. An Acuvim II meter with flex probes on the incoming three phase power was also installed. As the kWh consumption on this mains panel was unknown at the time of installation an assumption was made based on the average monthly kWh consumption of the entire facility. Basic Power tested the I-480-3 unit between March 28 and April 4, 2016 and monitored daily kWh consumption through wattics.com. The unit was observed to be saving approximately 5% in energy use when comparing periods where the unit was on to periods when the unit was off. The wattics.com dashboard revealed that average kWh consumption through the mains panel in the SBR blower building was approximately 7200 kWh per day which would equate to a monthly kWh consumption of approximately 223,200 which indicated that the BPU unit being tested was wrongly sized and was too large a unit for this location.

On Monday April 11 at 9am, Basic Power delivered a I-480-2 unit to the facility and disconnected and removed the I-480-3 after Paul Brennan had switched off the breaker to which it had been temporarily installed.

An analysis of the kW, kWh, KVAR and Power Factor at this location was then conducted using a Dranetz Power Explorer PXS-XFAST.

09:25 Dranflex CT probes placed on 480V main voltage feeds at SBR blower building.
09:30 Guy Lestician confirms Dranetz Power Explorer is configured correctly and operational
09:33 Dranetz recording begins with BPU Unit on. Average kWh consumption is 239.9 kWh.
09:33 Reactive Power records at a minimum of 100.31 KVAR
09:37 Reactive Power record at a maximum of 104.47 KVAR
09:38 Power Factor records at a maximum of 0.9. Real Power Demand is a maximum of 242.5 kWh/h.
09:39 Apparent Power records at a maximum of 271.5 VA. Active Power records at a maximum of 244.2 kW.
09:43 Power Factor records at a minimum of 0.892. Apparent Power records at a minimum of 261.9.
09:43 Active Power records at a minimum of 233.6 kW. Real Power Demand is a minimum of 236.3 kWh/h.
09:43 Integrated Active Power is at 39.95 kWh.
09:43 BPU I-480-2 is switched off.
09:44 Active Power is recorded at a minimum of 231.6 kW and then begins to climb. Power Factor is a max of .893.
09:44 Apparent Power is recorded at a minimum of 259.8 kVA. Real Power Demand a minimum of 245.8 kWh
09:45 Power Factor is a minimum of .777. Reactive Power is a maximum of 252.51 VAR.
09:45 Apparent Power is a maximum of 415.1 VA.
09:49 Active Power is a maximum of 327.2 kW. Real Power Demand is a maximum of 321.5 kWh/h.
09:55 Integrated Active Power is at 56.60 kWh.
09:55 M&V Ends.

The kWh reduction demonstrated by the BPU technology during the M&V period was 29.41% which exceeds the projected 11% kWh savings communicated to BCRA.

The kWh savings realized have little relation to any improvement in Power Factor as the BCRA had an average PF of 0.843 in the Baseline Period. The BPU technology improved this PF by 6.4% to an average of 0.897. This is further evidence that our unit is not simply a Power Factor Correction Device.

Those present during the M&V process who observed the metering and baseline and comparison data were:
Paul Brennan – Brennan Electric, contractor to BCRA.
Guy Lestician – CEO Basic Power, Inc.
Stephen Washington – V.P. Business Development, Basic Power, Inc.

ADDITIONAL OBSERVATIONS

The BCRA WWTP is a fully automated, state of the art facility. Prior to the M&V Period, the status of the blower activity was checked on the control panel interface to ensure a uniform load for both the Baseline and Post Retrofit data sampling periods to provide an equitable comparison. At 9:56 am, shortly after the M&V period ended, blower activity reduced and kWh consumption declined to 260 kWh. The BPU I-480-2 was switched back on at 10:05 AM and reduced energy consumption to 210 kWh which represents a reduction of 19.2% during the reduced blower activity period.

POST RETROFIT PERIOD – BPU UNIT IS ON

MIN/MAX/AVG POWER REPORT

Site: Strouds 480 volt
Measured from 04/11/2016 09:33:00.0 to 04/11/2016 09:43:00.0

POWER

ACTIVE POWER, P (W)

	A	B	C	TOTAL
Min kW	80.83	71.55	79.66	233.6 on 04/11/2016 09:43:00
Max kW	86.49	77.84	82.42	244.2 on 04/11/2016 09:39:30
Median kW	83.89	74.53	81.12	240.2
Average kW	83.89	74.88	81.14	239.9

APPARENT POWER,S (VA)

	A	B	C	TOTAL
Min kVA	89.02	79.87	90.84	261.9 on 04/11/2016 09:43:00
Max kVA	94.34	85.61	93.96	271.5 on 04/11/2016 09:39:30
Median kVA	92.15	82.67	92.43	267.6
Average kVA	91.99	83.04	92.48	267.5

REACTIVE POWER Q, AT FUND. FREQ. (VAR)

	A	B	C	TOTAL
Min kVAR	31.25	29.36	37.93	100.31 on 04/11/2016 09:33:30
Max kVAR	33.69	31.34	40.08	104.47 on 04/11/2016 09:37:00
Median kVAR	32.26	30.32	39.18	101.73
Average kVAR	32.29	30.39	39.16	101.83

POWER FACTOR, PF

	A	B	C	TOTAL
Min	0.905	0.895	0.873	0.892 on 04/11/2016 09:43:00
Max	0.917	0.909	0.881	0.900 on 04/11/2016 09:38:30
Median	0.912	0.901	0.877	0.897
Average	0.912	0.902	0.877	0.897

DEMAND

REAL POWER DEMAND

	A	B	C	TOTAL
Min kWh/h				236.3 on 04/11/2016 09:43:00
Max kWh/h				242.5 on 04/11/2016 09:38:00
Median kWh/h				240.2
Average kWh/h				239.9

ENERGY

ENERGY - INTEGRATED ACTIVE POWER (W-HRS)

	A	B	C	TOTAL
kWh	13.95	12.47	13.53	39.95 on 04/11/2016 09:43:00

BASELINE PERIOD – BPU UNIT IS OFF

MIN/MAX/AVG POWER REPORT

Site: Strouds 480 volt
Measured from 04/11/2016 09:44:00.0 to 04/11/2016 09:55:00.0

POWER

ACTIVE POWER, P (W)

	A	B	C	TOTAL
Min kW	80.82	70.76	80.05	231.6 on 04/11/2016 09:44:00
Max kW	113.33	102.51	111.39	327.2 on 04/11/2016 09:49:30
Median kW	106.56	96.40	105.62	308.4
Average kW	105.72	95.58	104.75	306.0

APPARENT POWER,S (VA)

	A	B	C	TOTAL
Min kVA	89.20	79.13	91.52	259.8 on 04/11/2016 09:44:00
Max kVA	140.47	130.49	144.12	415.1 on 04/11/2016 09:45:00
Median kVA	126.17	115.34	129.40	371.2
Average kVA	123.52	113.27	126.60	363.4

REACTIVE POWER Q, AT FUND. FREQ. (VAR)

	A	B	C	TOTAL
Min kVAR	32.29	29.78	39.26	101.41 on 04/11/2016 09:44:00
Max kVAR	83.04	79.37	90.10	252.51 on 04/11/2016 09:45:00
Median kVAR	66.50	62.91	73.83	203.70
Average kVAR	60.93	57.83	68.13	186.88

POWER FACTOR, PF

	A	B	C	TOTAL
Min	0.791	0.776	0.763	0.777 on 04/11/2016 09:45:00
Max	0.907	0.896	0.876	0.893 on 04/11/2016 09:44:00
Median	0.849	0.838	0.820	0.836
Average	0.857	0.845	0.828	0.843

DEMAND

REAL POWER DEMAND

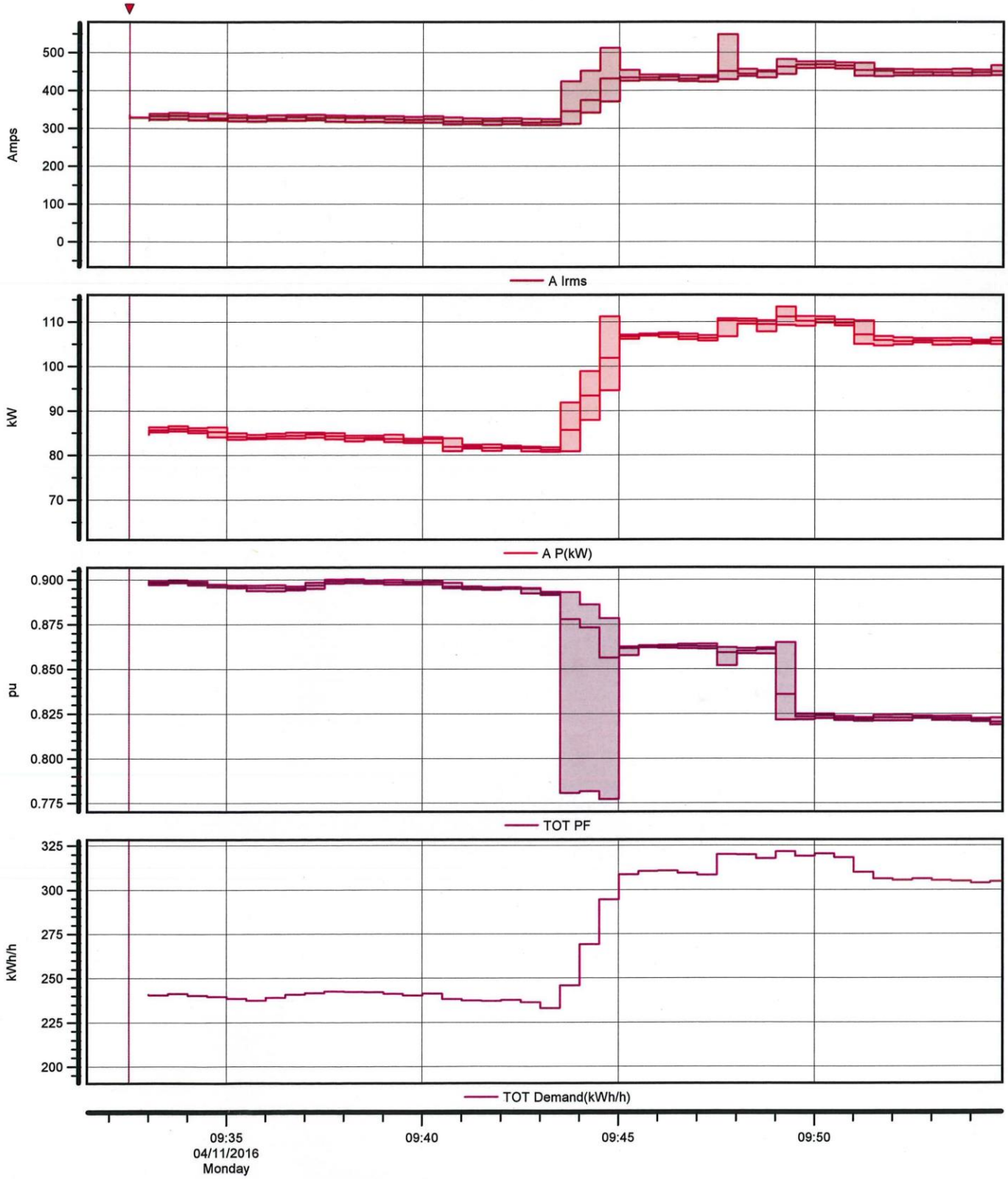
	A	B	C	TOTAL
Min kWh/h				245.8 on 04/11/2016 09:44:00
Max kWh/h				321.5 on 04/11/2016 09:49:30
Median kWh/h				308.4
Average kWh/h				306.0

ENERGY

ENERGY - INTEGRATED ACTIVE POWER (W-HRS)

	A	B	C	TOTAL
kWh	19.55	17.68	19.37	56.60 on 04/11/2016 09:55:00

Timeplot



Event #1 at 04/11/2016 09:32:29.800
Timed

BASICPOWER™

120 Marshalls Creek Road, East Stroudsburg, PA 18302 Telephone: 570 872 9666

www.basicpower.co