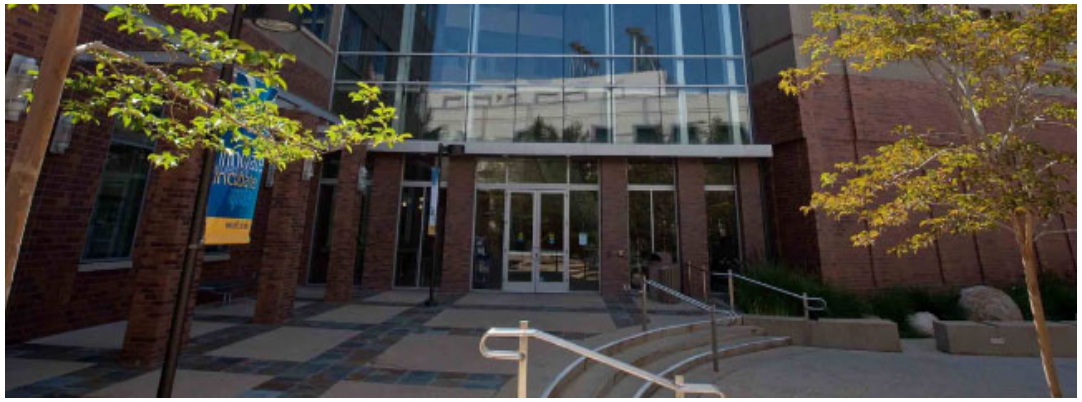


CalPlug Update:

Plug Load Energy Testing for Improving Codes and Standards (PLETICS)

Fall CalPlug Workshop

October 24, 2023

By: Katie Gladych

PLETICS: Project Overview

- Plug Load Energy Testing for Informing Codes and Standards
- Purpose:
  - Funded by California Energy Commission (CEC)
  - Assess opportunities for new CA codes and standards for products not currently included in state energy efficiency regulations (such as CA Titles 20 & 24)
  - Focused on three device categories: commercial imaging devices, residential networking equipment, and laboratory equipment
- Team:
  - California Energy Alliance (Prime)
  - CalPlug -- Commercial imaging devices
  - California State University Northridge (CSUN) – Commercial laboratory equipment
  - California Lighting Technology Center (CLTC), UC Davis – Residential networking devices

PLETICS: Current Progress

- Device selection (commercial imaging devices): Desktop laser printers; desktop laser MFDs; freestanding color MFDs; freestanding monochrome MFDs; desktop color inkjets
- Market and technology review assessment
  - Device features; unit energy consumption data; installed base; market growth rate
  - Current voluntary agreements and labeling programs
- Device sourcing (mostly in UCI buildings)
- Test Approaches and Methodologies
  - Existing solutions – Start with ENERGY STAR test method
  - Power management / Low power mode usage/Power factor
  - Uncover solutions
- Testing phase
  - Use HOBOware meters to record W, Wh, Power Factor (PF), Voltage (V), Current (A) and Apparent Power (VA)

Current Codes & Standards: Commercial Imaging Equipment

Commercial Imaging Devices Codes & Standards

Name	Type	Region/Country	Year last updated	Devices covered
ENERGY STAR® Product Specification for Imaging Equipment Eligibility Criteria Version 3.1	VA and Test Methodology	U.S., used in multiple other countries	2019	Printers, MFDs, scanners, digital duplicators, mailing machines, and professional imaging products (industrial printers)
EPEAT Ecolabel Conforms to: IEEE Standard for Environmental Assessment of Imaging Equipment Amendment 1	Label	U.S., used in multiple other countries	2017	Printers, MFDs
Blue Angel The German Ecolabel Office Equipment with Printing Function (Printers and Multifunction Devices)	Label	European Union	2017	Products with printing as primary function; capable to print monochrome or color; and either inkjet (IJ) or electrophotographic (EP)/laser print deposition
IEC 62301 Ed. 2.0 b:2011 Household Electrical Appliances - Measurement of Standby Power (measures standby only)	Standard	U.S., used in multiple other countries	2011	Electrical products with a rated input voltage or voltage range that lies wholly or partly in the range 100V to 250V for single phase products and 130V to 480V for other products

Laser Printers: Energy Consumption and Market Data

Device Type - TEC Method (EP)	Speed/ Images per Minute (ipm)	UEC: TEC (kWh/yr)	Market Size ($ Millions)	Compound Annual Growth Rate (CAGR) 2021-2026
Monochrome Non-MFD	s ≤ 20	< 20	39,208 (All lasers)	3.6% (All lasers)
	20 < s ≤ 40	8.84 - 27.04		
	40 < s ≤ 60	18.2 - 46.28		
	60 < s ≤ 135	37.44 - 47.84		
	s > 135	>900		
Monochrome MFD	s ≤ 20	<15		
	20 < s ≤ 40	9.88- 30.68		
	40 < s ≤ 60	20.8 - 49.92		
	60 < s ≤ 80	35.88 - 76.96		
	s > 80	75.4 - >100		
Color Non-MFD	s ≤ 20	17.68		
	20 < s ≤ 40	10.92 - 38.48		
	40 < s ≤ 60	22.88 - 45.76		
	s > 60	> 452		
Color MFD	s ≤ 20	9.88 - 10.4		
	20 < s ≤ 40	12.48 - 32.76		
	40 < s ≤ 60	23.92 - 50.44		
	60 < s ≤ 80	53.04- 447.2		
	s > 80	>500		

Inkjet Printers: Energy Consumption and Market Data

Device Type	Speed (ipm)	UEC: Power in Sleep Mode (W)	Market Size Estimate 2026 ($ millions)	CAGR 2021-2026
Monochrome Non-MFD	20-24 ipm	0.6- 0.9	13,854 (All inkjets)	3.3% (All inkjets)
Monochrome MFD	20-24 ipm	0.6 - 1.1		
Color Non-MFD	01-25 ipm	0.5 - 1.6		
Color MFD	04-10 ipm	0.2 - 4.3		

Testing Phase: Device Set Up

- Plug HOBO meter between device and outlet to capture data
- Transmits data to laptop/HOBO software
- Begin with ENERGY STAR test method
- Records various phases:
  - Print job (x4)
    - Number of pages determined by printer speed (ipm)
  - Sleep (1 hour between printing)
  - Sleep ➡ Off
    - Capture successive low power modes (if applicable)
  - Capture additional details:
    - Power Factor
    - Apparent power

Testing Phase: Sample Test Data; Print Mode

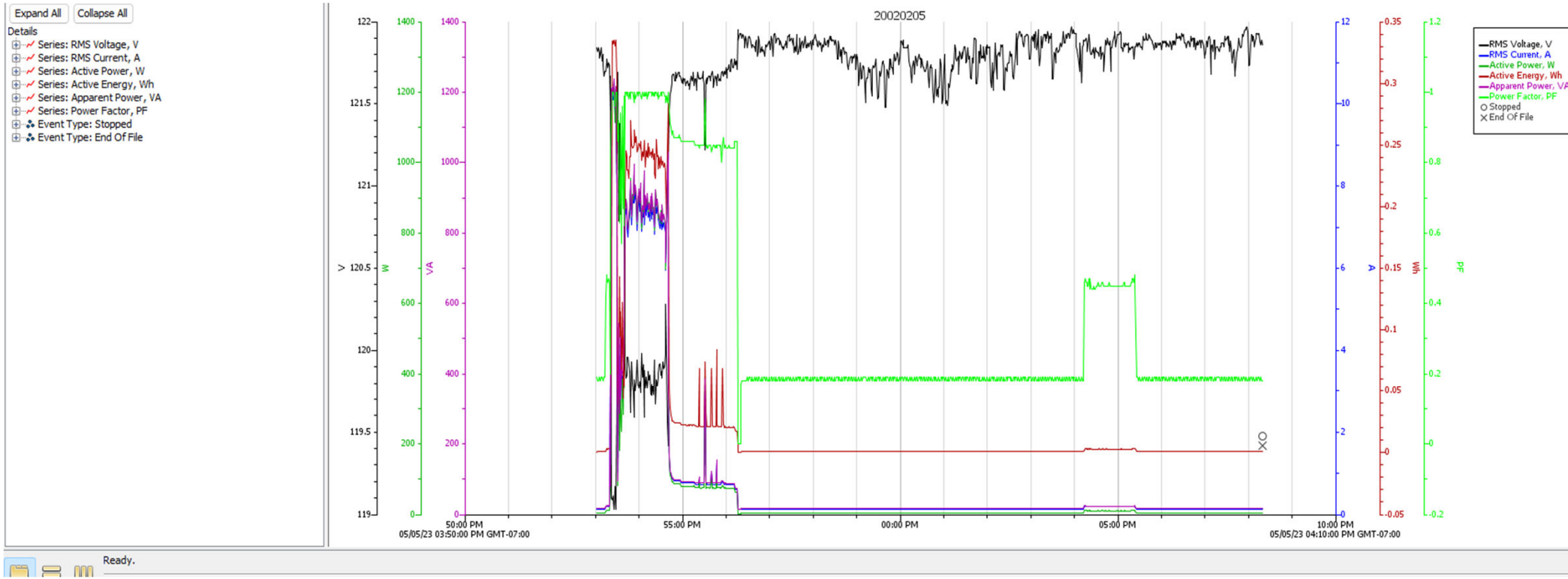


Image: Color MFD; Print mode

Testing Phase: Sample Test Data; Sleep Mode

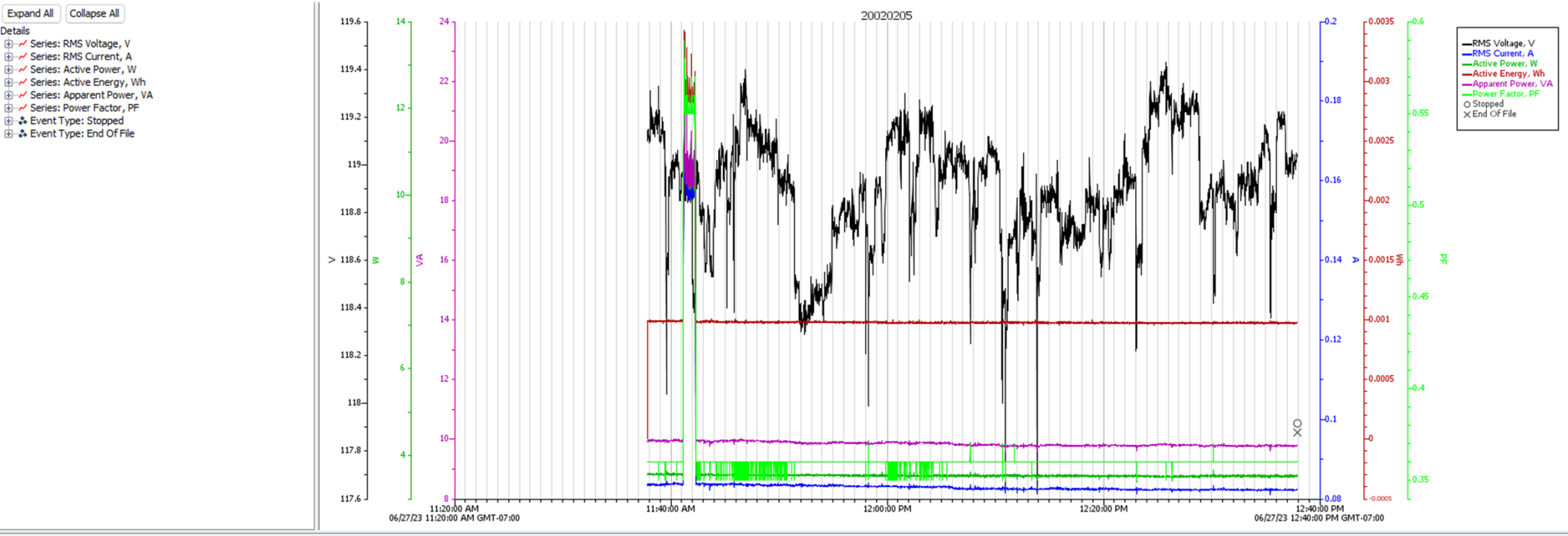


Image: Color MFD; Sleep mode

Testing Phase: Sample Test Data; Sleep to Off

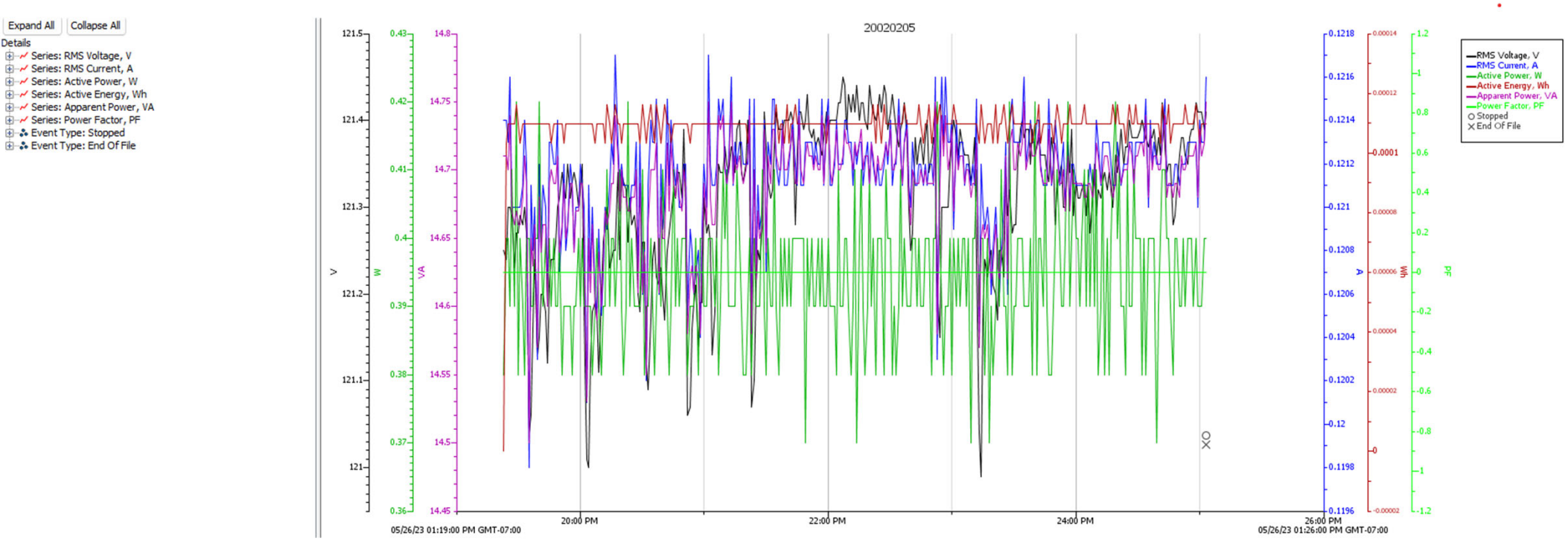
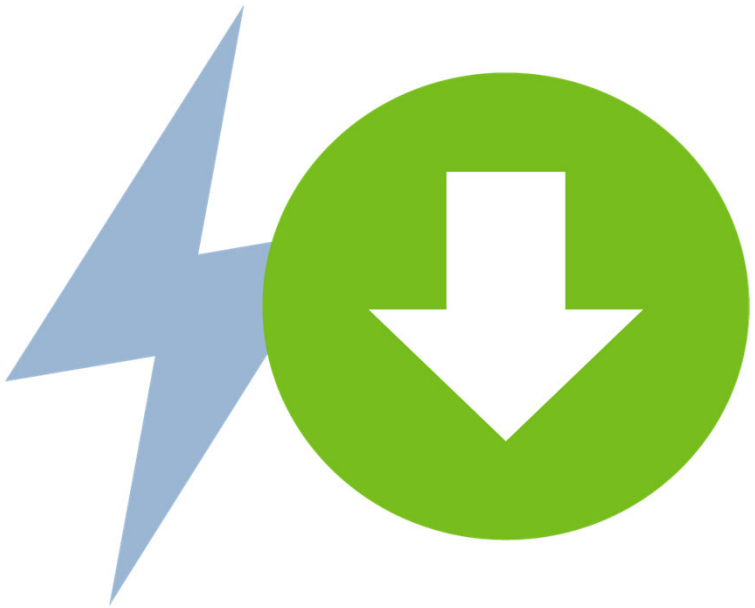


Image: Color MFD; Sleep to Off Mode

Highlight: Low Power Mode



- Mode the printer goes into when not in use for specific length of time
- Saves energy while keeping the printer online and in “ready” mode
- Users may have some control over setting time to sleep, depending on the device
- Does ENERGY STAR method capture all low power mode data?
- What are the gaps in data characterization?

Source: momentumiot.com

Highlight: Power Factor

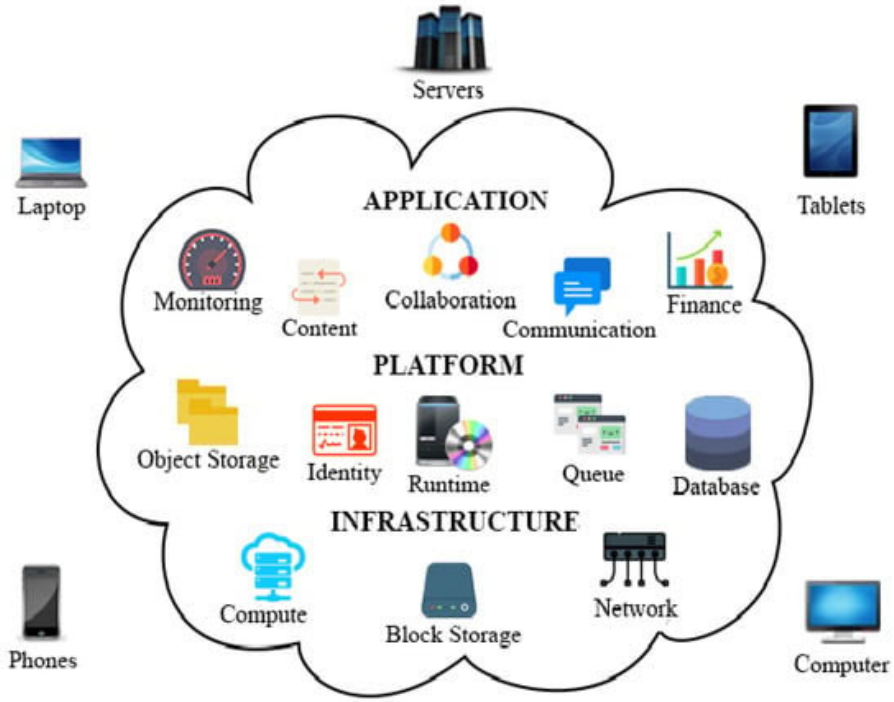
Source: fluke.com

- Power Factor = ratio of KW to apparent power (%)
- Measure of energy efficiency
- Useful in detecting harmonics between native DC device and building AC current
- What can we learn about PF from test data?

- **Beer analogy**
  - **Beer** is active power (kW)—the useful power is the energy that is doing work. This is the part you want.
  - **Foam** is reactive power (kVAR)—the foam is wasted power or lost power. It's the energy being produced that isn't doing any work, such as the production of heat or vibration.
  - **The mug** is apparent power (kVA)—the mug is the demand power, or the power being delivered by the utility.

Highlight: Internet Connectivity Effects

- Printers communicate wirelessly or through connected ethernet with PCs, phones, and other networked devices
- Even in low power mode, connectivity remains
- What can our data tell us about how connectivity affects printer behavior?
  - E.g., waking from sleep mode if network disruption is detected?



Source: Tahirkeli et al 2021. *Electronics*

PLETICS: Looking Ahead

- Analyze results, estimate energy savings and non-energy benefits, and make recommendations to CEC for adopting codes and standards in final report (Oct 2023 -- April 2024)

- Recently hired two research student assistants to perform additional tests and data analysis

Thank you!
Questions and comments welcome

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