Current Power and Energy Requirements of Forward Deployed USMC Locations

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Outline

- Introduction
- PB Location Profile
- PB Level Data
  - COC Power Data
  - Billeting Power Data
  - ECU Power Estimate
  - PB Level Power Estimate
  - Generator Usage
- Results
- Discussion

Introduction

- Problem
  - USMC does not have current operational data for power consumption, ECU utilization, and equipment loads in forward deployed locations in AFG. Without this data, implementing a strategy to reduce fuel consumption is difficult
- Purpose
  - The purpose of this analysis is to better understand the load requirements of a Company COP and below operating in

What does a typical COC load profile look like?

What does a typical Billeting load profile look like?

What is the daily load profile for a COP and below?

How are ECUs being used? What is their contribution to total load?

How can the USMC use it's resources more efficiently?

Patrol Base Profile

Distance From Leatherneck: 8km

Re-supply Convoys: Every 5-7 days

Total Generator Capacity: 115kW (260kW back-up)

Mission: Show presence and secure area around Leatherneck

Months In Place: 18

Structures: 7 BaseX-305 tents with radiant barriers, 1 Wooden Building for COC and Officer/SNCO billeting

(Power and Cooling Capacity per location: Based on online generators and ECUs)

Evaluation Site:

PB (45 Marines):	2.6 kW/Marine	8.4 kBtu/Marine

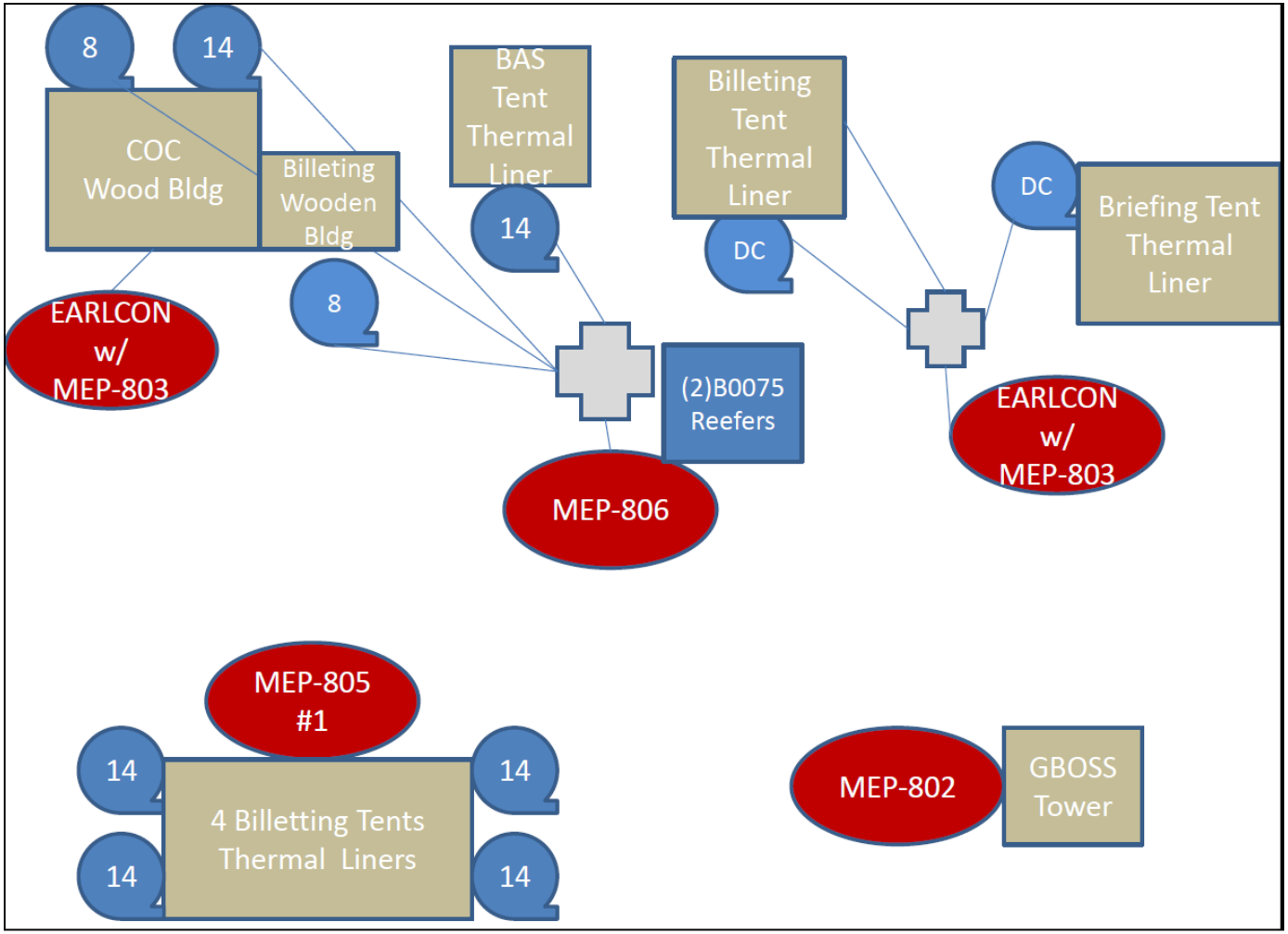
Comparison to Other Locations:

CO COP #1 (44 Marines):	0.8 kW/Marine	2.2 kBtu/Marine
CO COP #2 (75 Marines):	1.5kW/Marine	3.7 kBtu/Marine
Plt PB #1 (25 Marines):	1.4kW/Marine	1.4 kBtu/Marine

Data Collection

- Description
  - This analysis has been generated based on data collected during two periods Aug 29th – Sept 2nd, and Sep 29th - Oct 5th 2011 at PB
  - Data was gathered using “Watts-Up” power loggers, and Lascar temperature sensors at a rate of one data sample every one to five minutes
  - Additional data regarding available equipment, available generators and power sources, and observed operating practices was also captured
- Data Acquisition Equipment
  - All Data plotted from 0000 to 2400 each day
  - 11 “Watts-up” 120VAC power monitors
  - 15 Lascar Temperature Monitors
  - 1 Committed Marine

Tent and Equipment Layout



ECU		Heating	Cooling
"8"	-B0008	11kW	8.5kW
"14"	-B0014	9.6kW	4.5kW
"Reefer"	-B0075	n/a	2.5kW
"DC"	-DCAC	n/a	1.6kW

Generator

MEP-802	5kW TQG
MEP-803	10kW TQG
MEP-805	30kW TQG
MEP-806	60kW TQG

Structures

Tent -BaseX305
Thermal Liner – HDT Radiant Barrier
Wood Bldg – Plywood construction

COC Equipment Inventory

A

B

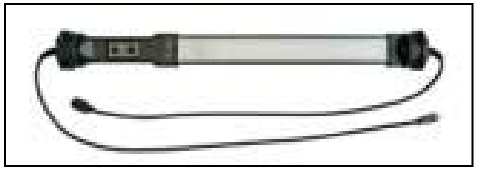
C

D

E

A - Motorola Battery Charger
B - Soldier Portable Charger
C - PRC-152 Battery Charger
D - CISCO 7911
E - GBOSS Heavy (w/ 2 flat screens)
F - Dell Laptops
G -Wireless Point-to-Point Link (WPPL)
H - VRC-110
I - Blue Force Tracker
J - Toughbook
K - 19” flat screen
L - PRC-150
M - LED lights
N – Microwave
O – Coffee pot

M



N

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K

J

I

H

G

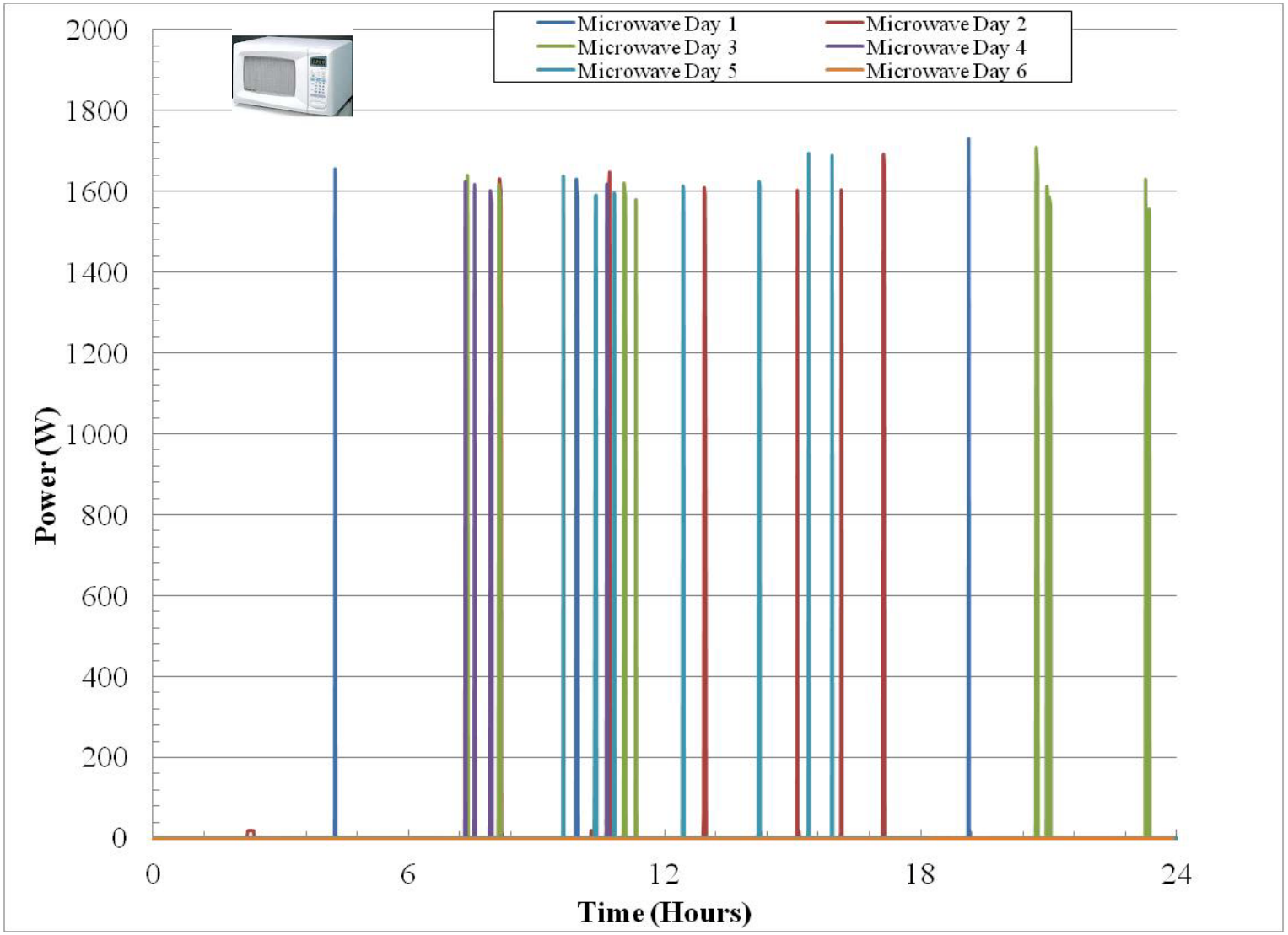
COC Equipment Comparison

	Evaluated PB	CO COP #1	CO COP #2	Plt PB #1
A - Motorola Battery Charger	-	-	-	-
B - Soldier Portable Charger	-	-	-	-
C - PRC-152 Battery Charger	-	-	-	-
D - CISCO 7911	-	-	-	-
E - GBOSS Heavy (w/ 2 flat screens)	-	-	-	-
F - Dell Laptops	-	-	-	-
G -Wireless Point-to-Point Link (WPPL)	-	-	-	-
H - VRC-110	-	-	-	-
I - Blue Force Tracker	-	-	-	-
J - Toughbook	-	-	-	-
K - 19” flat screen	-	-	-	-
L - PRC-150	-	-	-	-
M - LED lights	-	-	-	-
N - Microwave	-	-	-	-
O - Coffee Pot	-	-	-	-

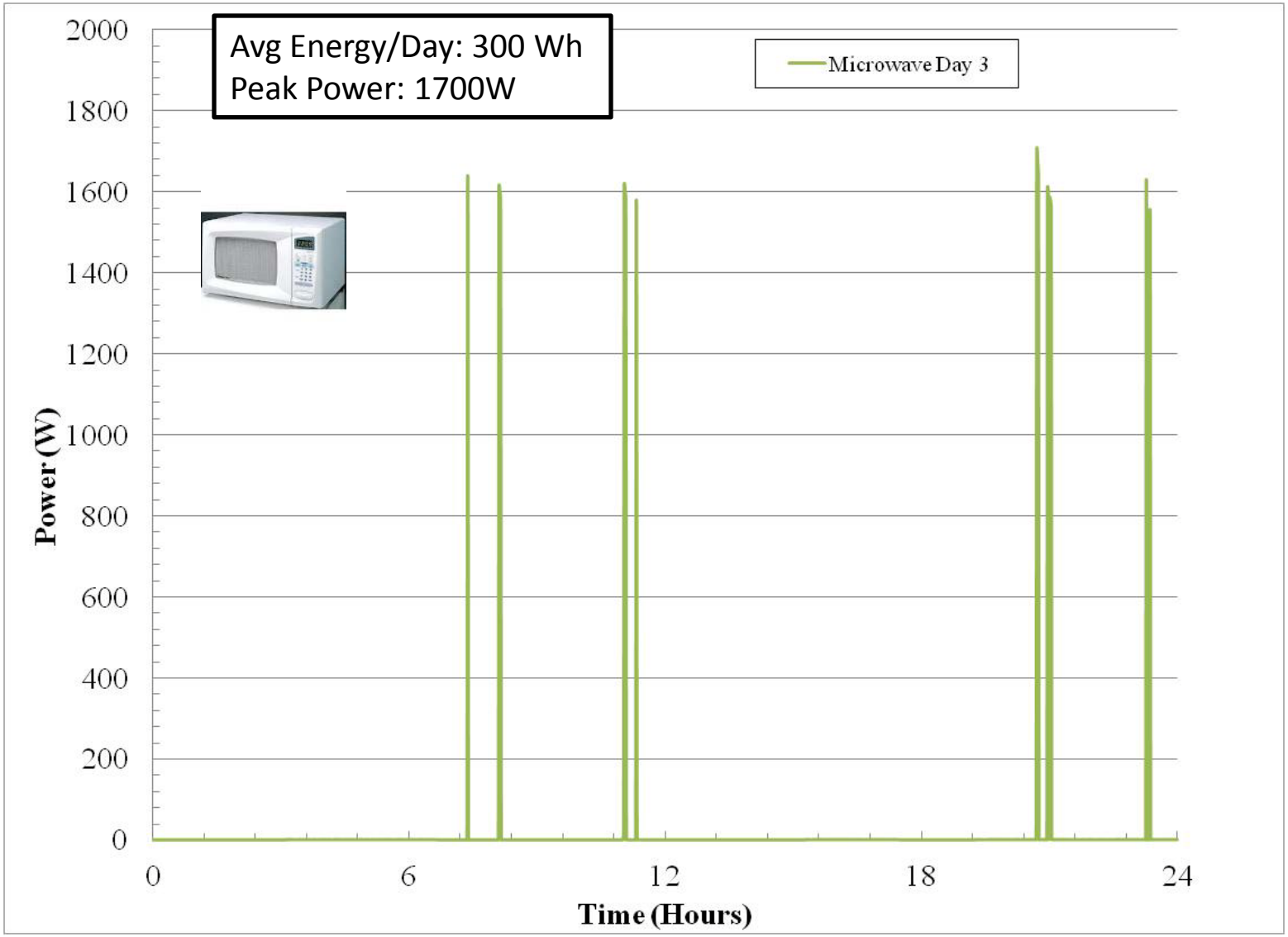
*All Company (and smaller) COCs use some variation of this equipment set

COC Equipment Power And Energy Draw 9/29-10/5

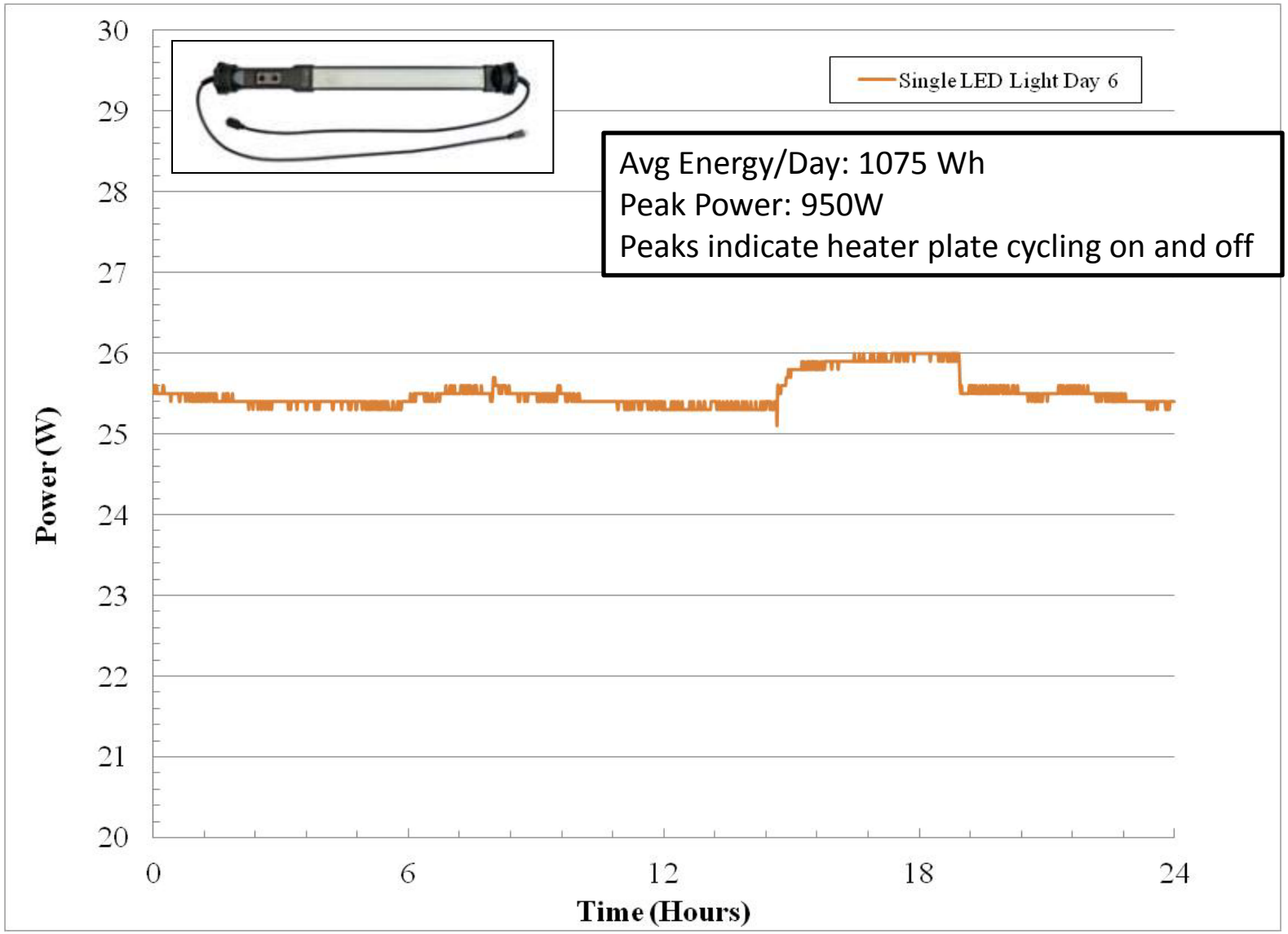
Microwave 5 Day Data



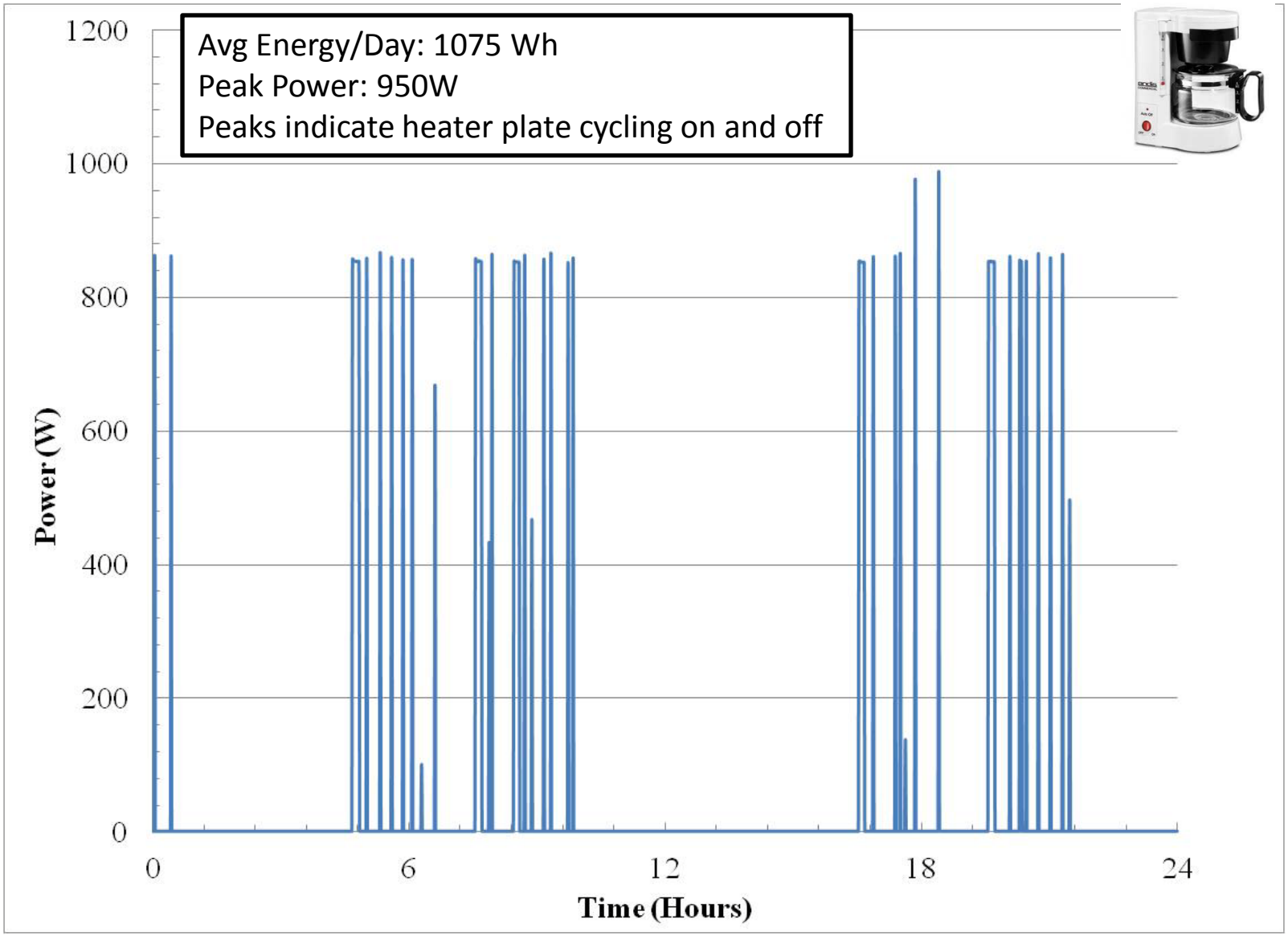
Microwave Representative Day



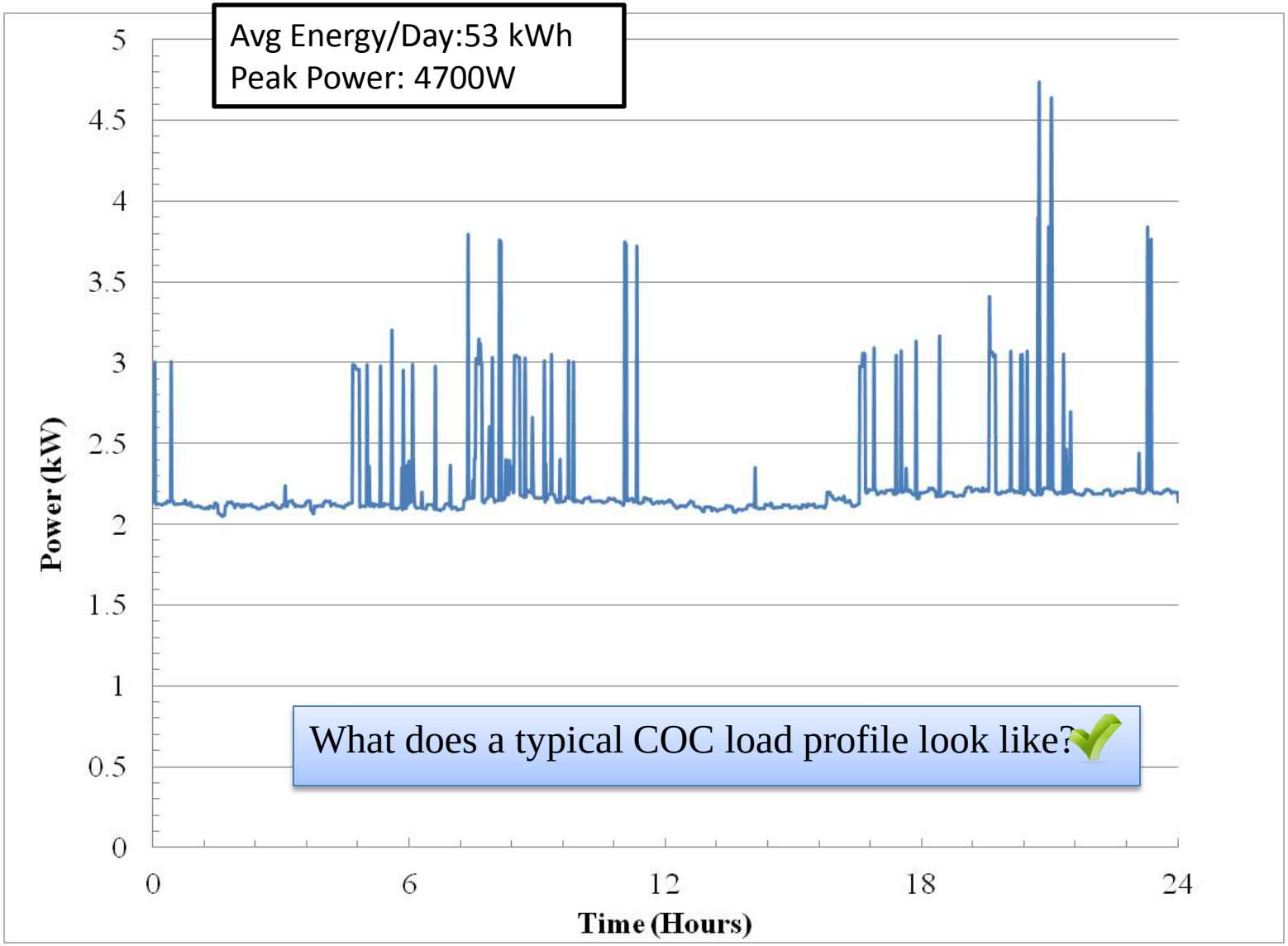
LED Lights Representative Day



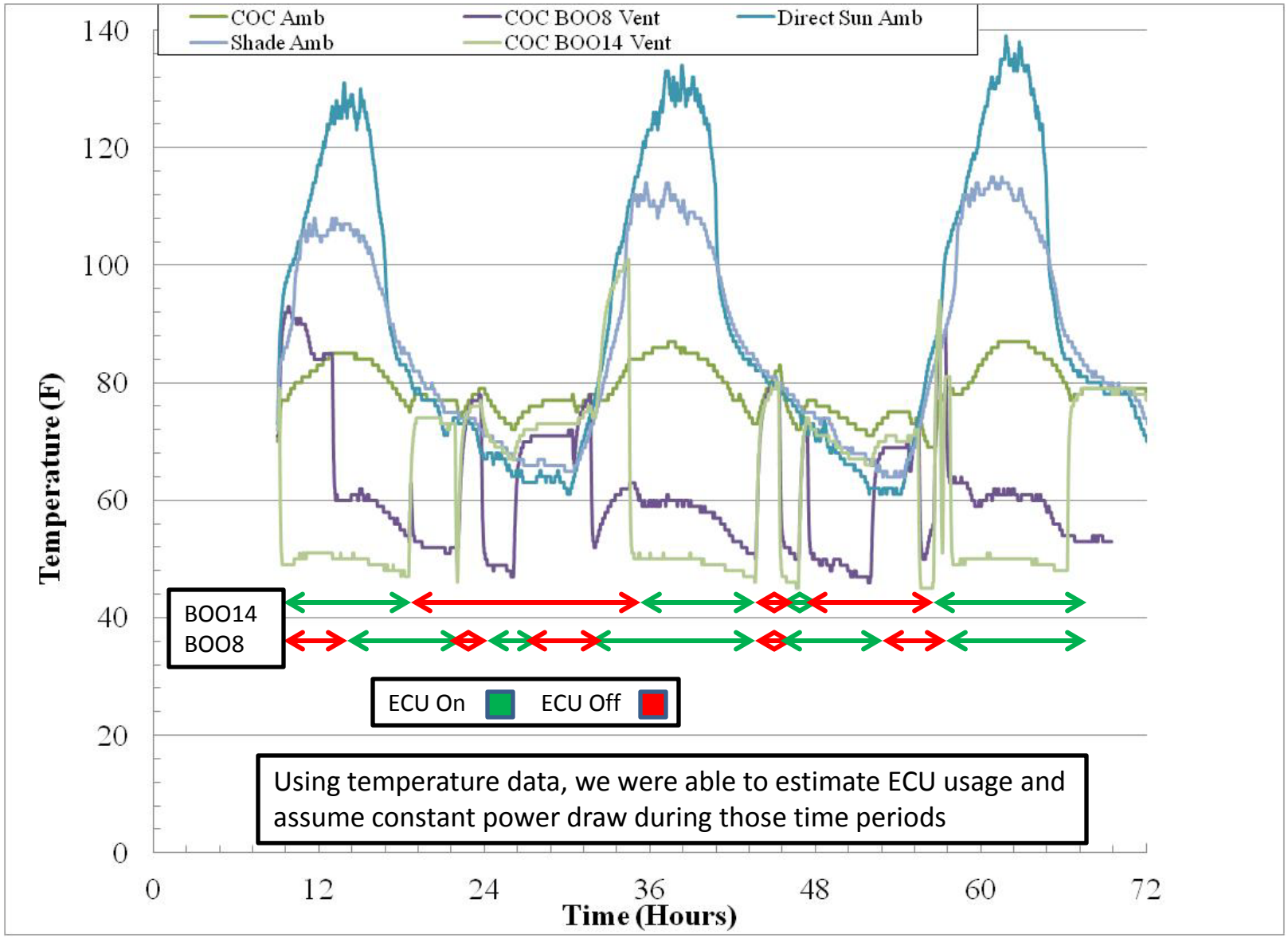
Coffee Pot Representative Day



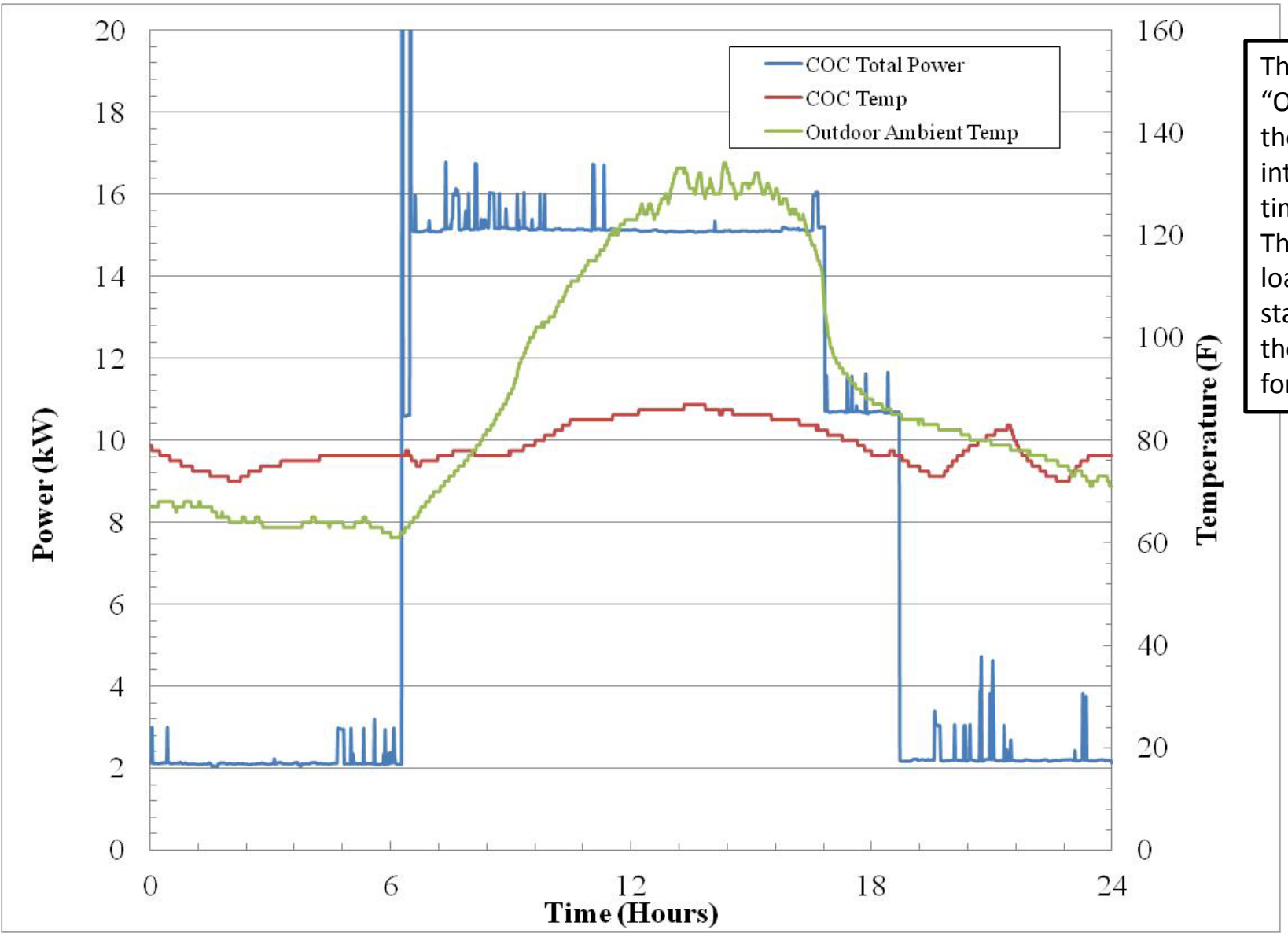
PB COC Representative 24 Hour Load



COC ECU Usage Estimate



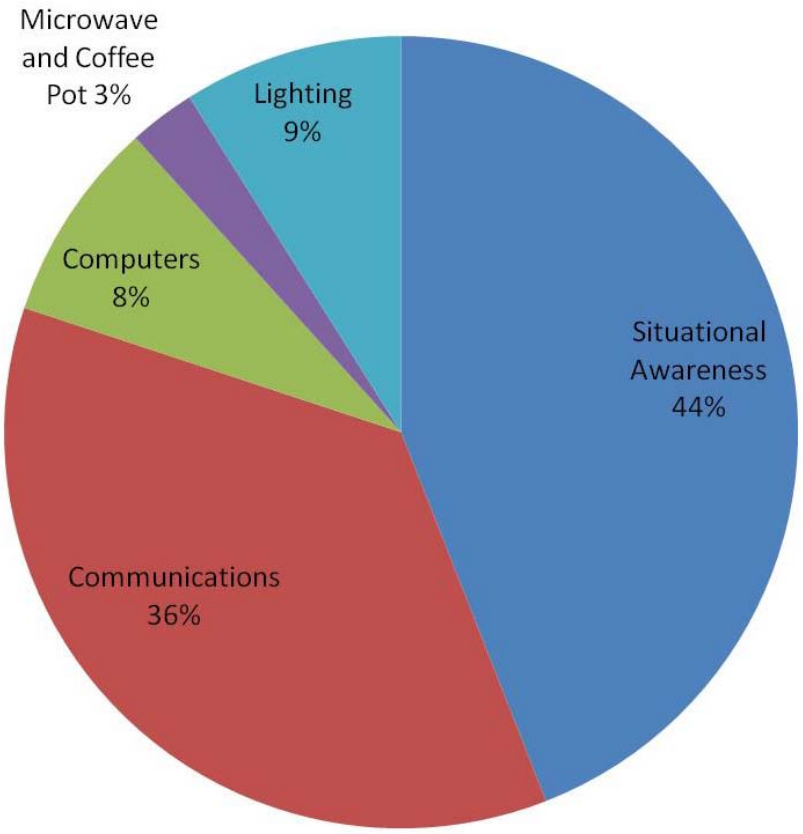
Total COC Representative 24 Hour Load



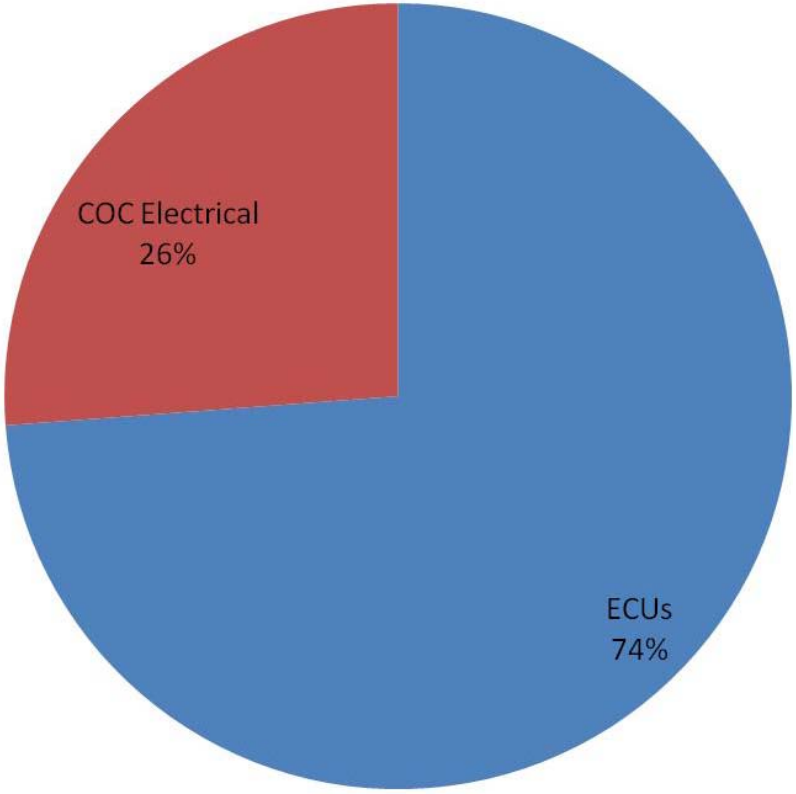
Those sections of "On" time were then combined into one large "On" time for each ECU. The steps in the load indicate the start and end of those "On" periods for each ECU

PB COC Electrical Distribution

COC Electrical Energy Demand Per Day (54* kWh)



Total COC Energy Demand Per Day (207** kWh)

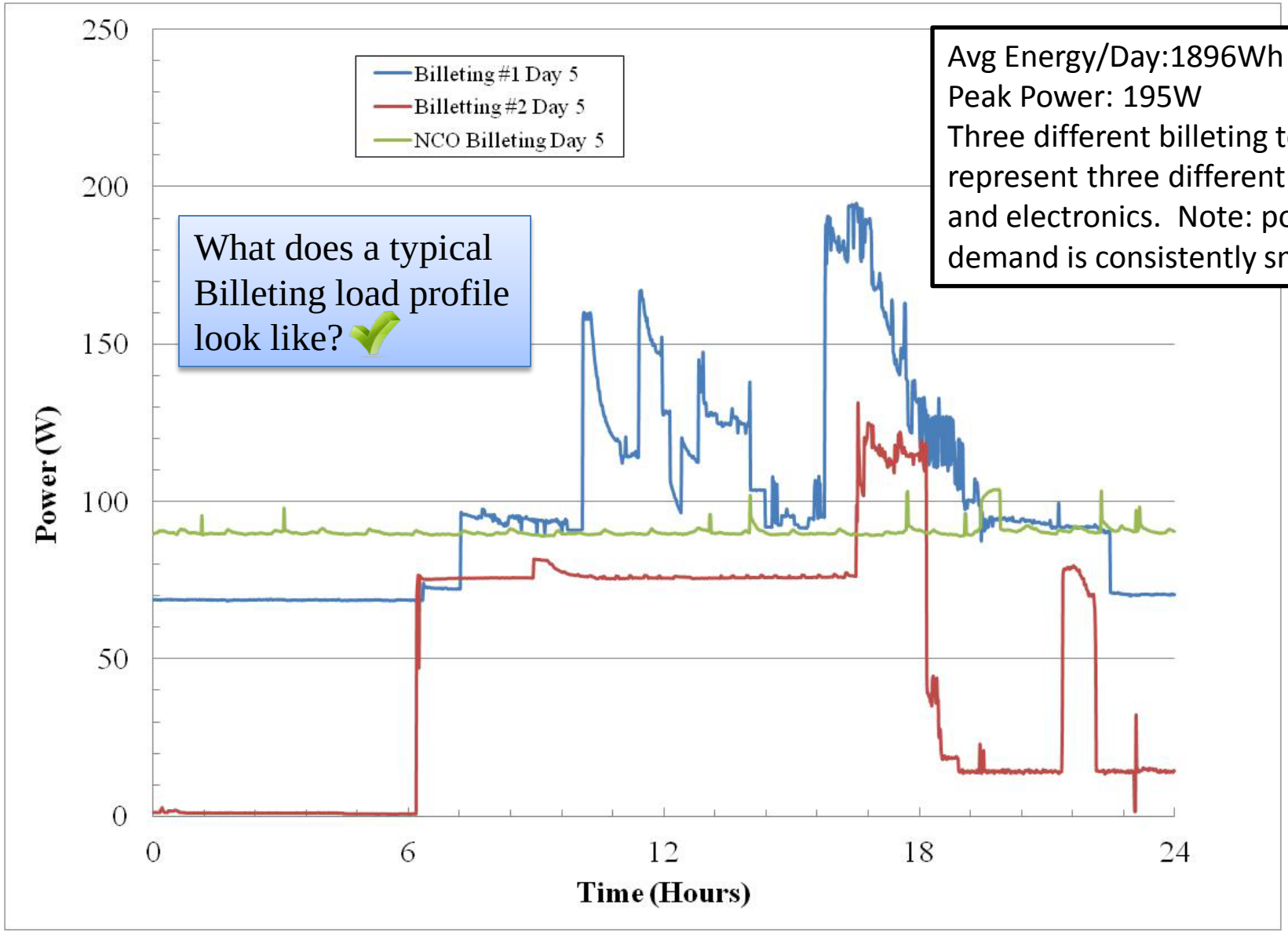


*Note: Distribution of electrical load depends on equipment onsite

**Note: Distribution and total energy is heavily dependent on ECU availability and time of year

Billeting Equipment Power And Energy Draw 9/29-10/5

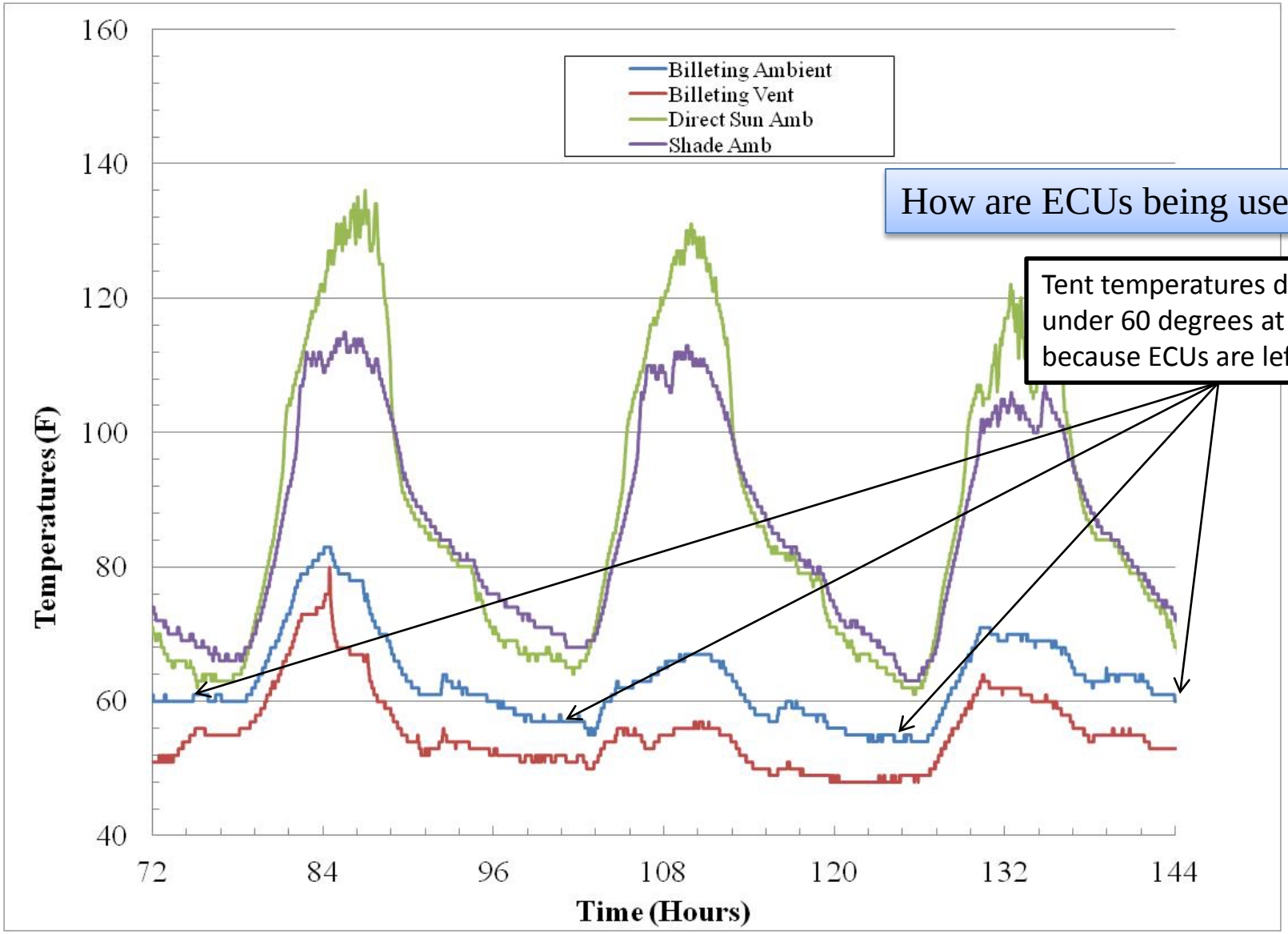
Billeting Electrical Usage



What does a typical Billeting load profile look like? ✔

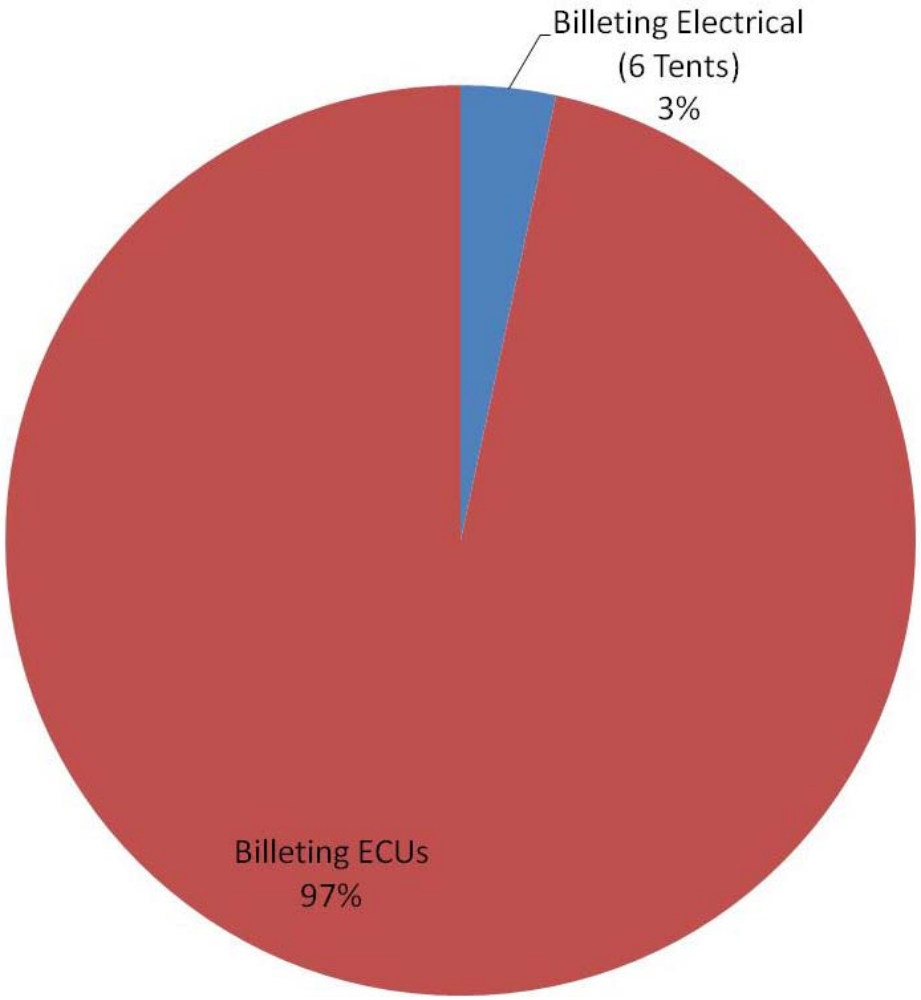
Avg Energy/Day:1896Wh
Peak Power: 195W
Three different billeting tents represent three different habits and electronics. Note: power demand is consistently small.

Billeting ECU Usage



Billeting Electrical Distribution

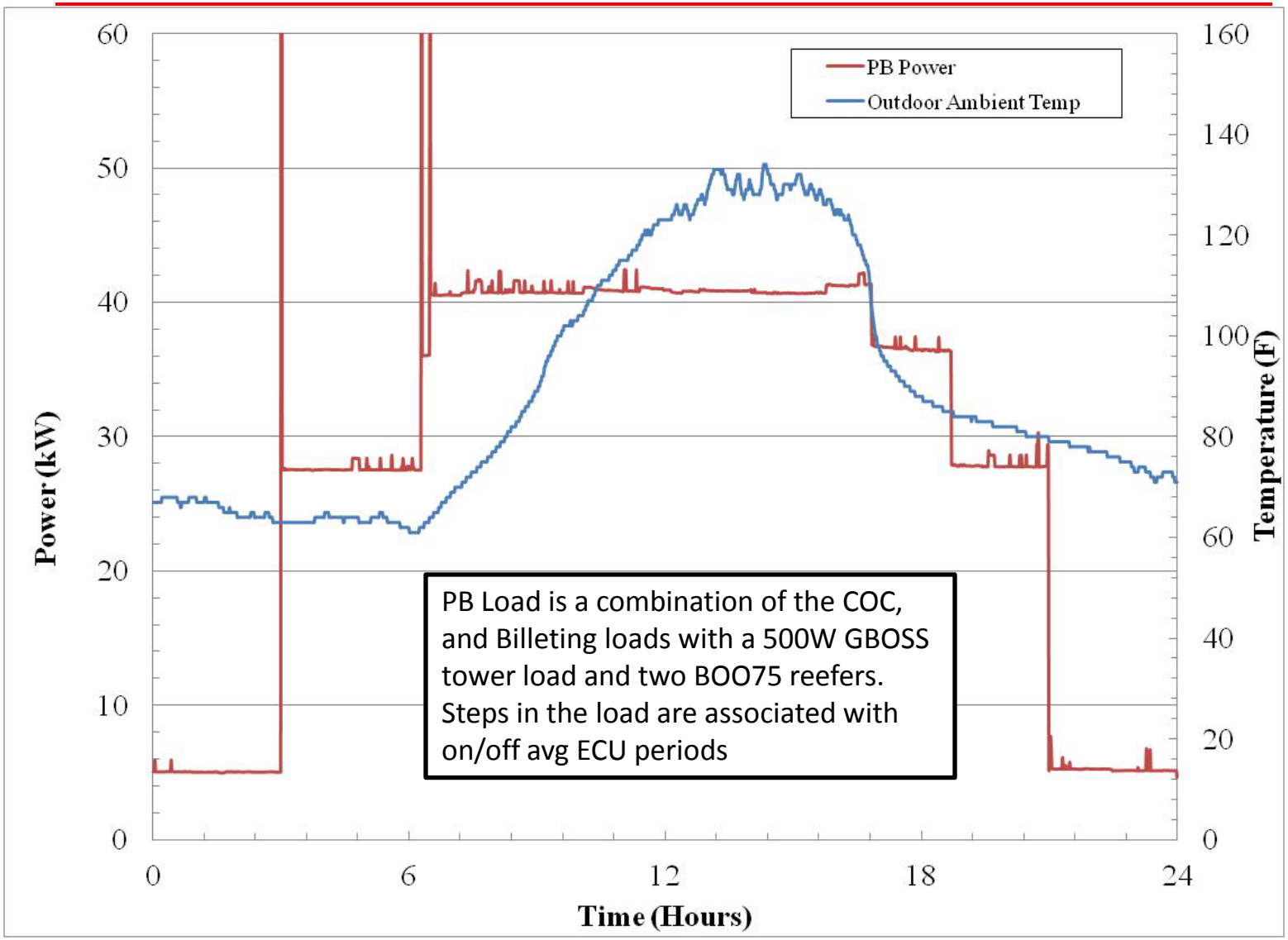
Daily Billeting Energy Use for 6 Tents (419* kWh)



*Note: Distribution and total energy is heavily dependent on ECU availability and time of year

PB Combined Power and Energy Estimates 9/29-10/5

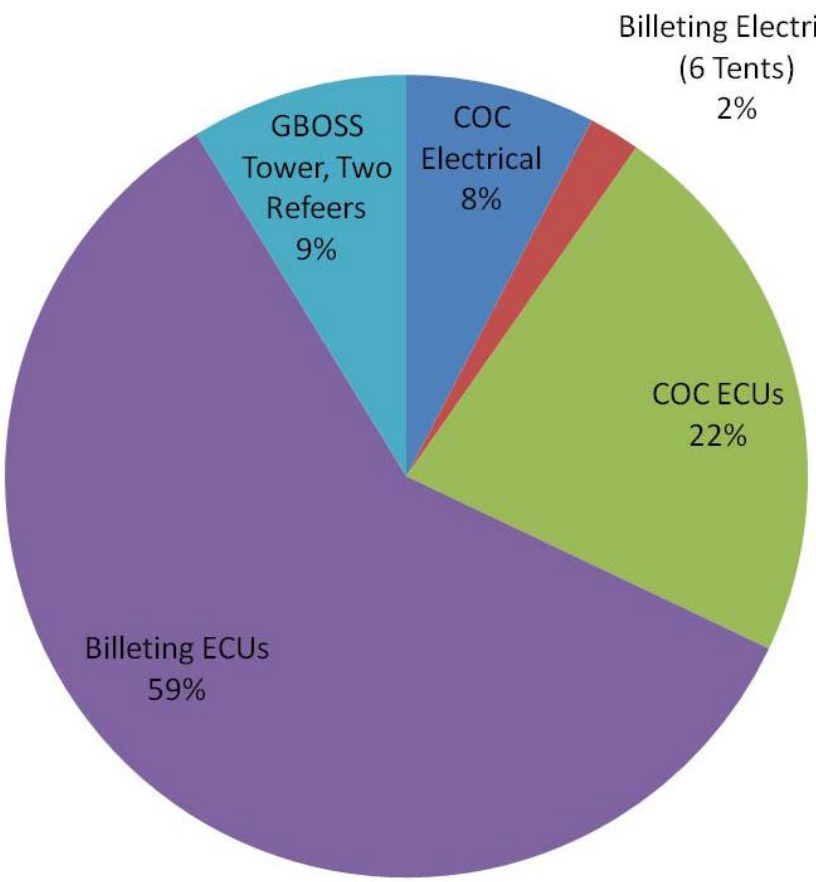
PB Load Profile



What is the daily load profile for a COP and below?

PB Electrical Distribution

PB Energy Demand Per Day (685* kWh)



How are ECUs being used? What is their contribution to total load?

Results
- 0.63 kW continuous /Marine (Avg)
- 81% of load is ECUs

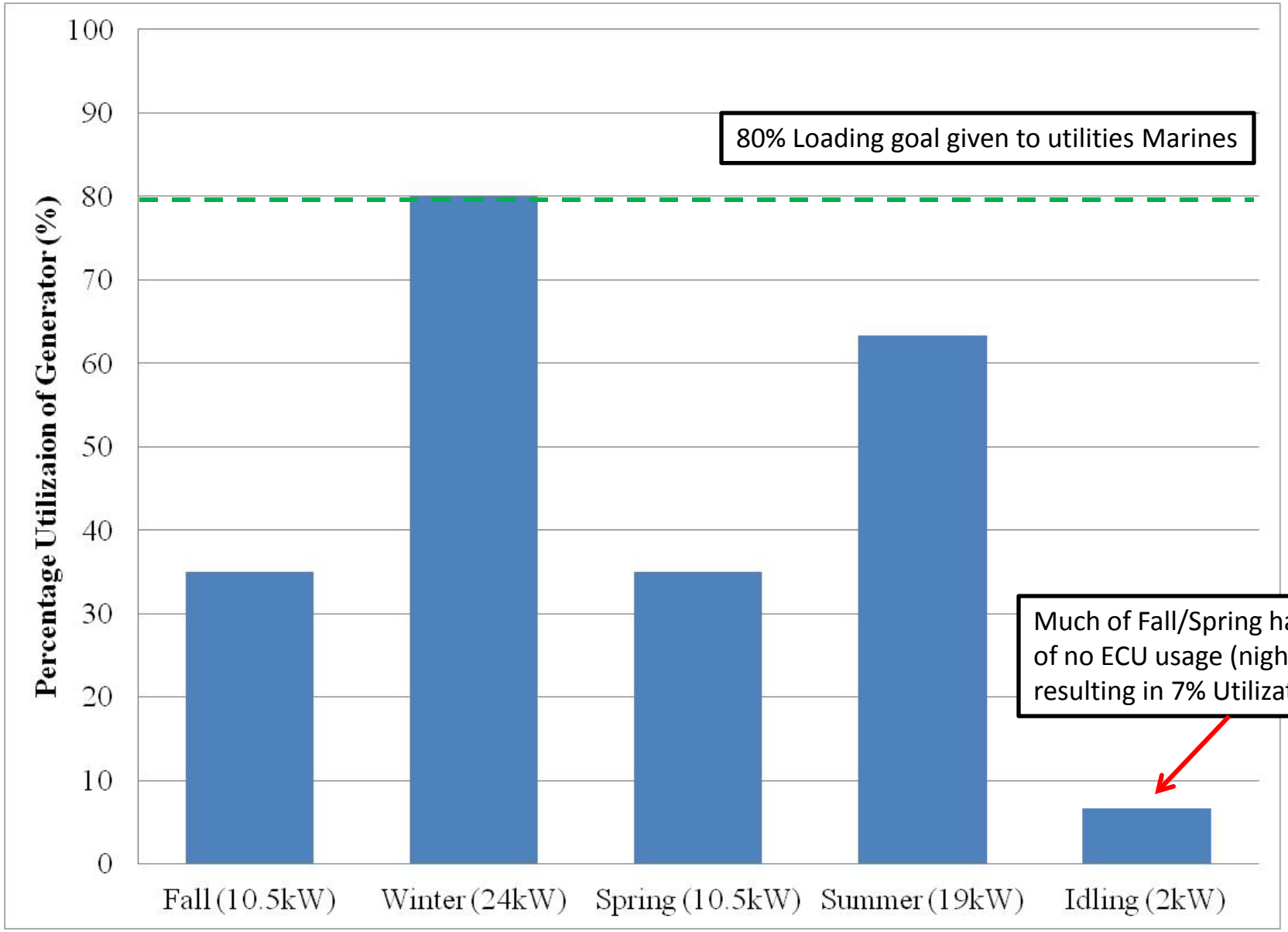
*Note: Distribution and total energy is dependent on equipment availability and time of year

Example of Inherent Inefficiencies in the Expeditionary Sizing of Generators and Loads

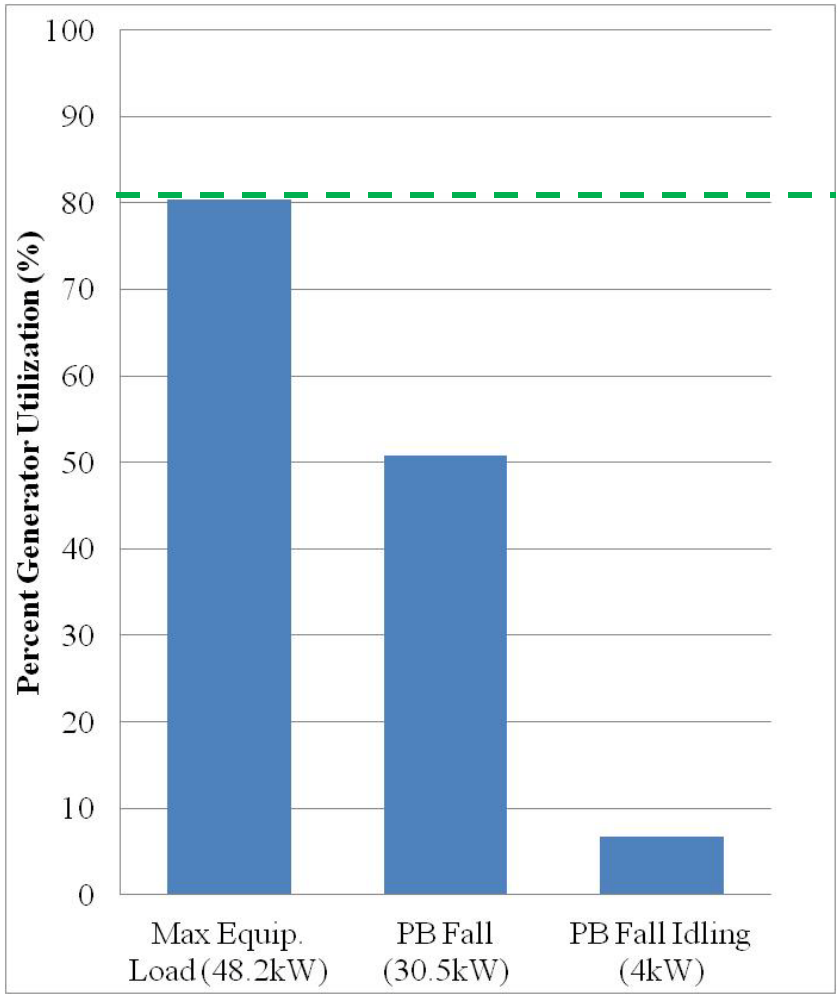
How Utilities Marines are Trained to Size Generator Loads

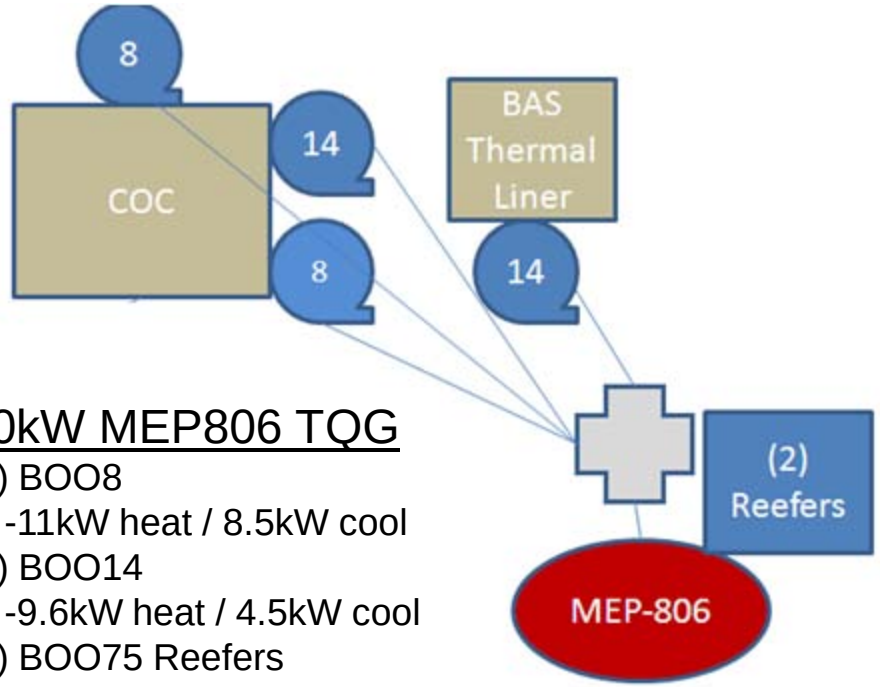
- Calculating Peak Power
  - Utilities Marines focus on calculating peak power draw of each system, regardless of time of year
  - Example: B0008 draws 11 kW when providing heat and 8.5 kW when providing cool air. Therefore a B0008 has a 11 kW peak power draw. This only applies during the winter when the heater is on.
- Sizing a Generator
  - Utilities Marines have an 80% load objective. This allows room for the generator to handle transience and for a small amount of growth
  - After calculating the peak load, they chose a generator size for which the load will constitute 80% of the generators capacity.
  - Example: (2) B0008s and a 2kW COC has a peak load of 24 kW. A 30 kW generator is the appropriate size, since 24 kW represents 80%.

Average 30kW TQG Seasonal Generator Utilization



60kW MEP806 PB (October)

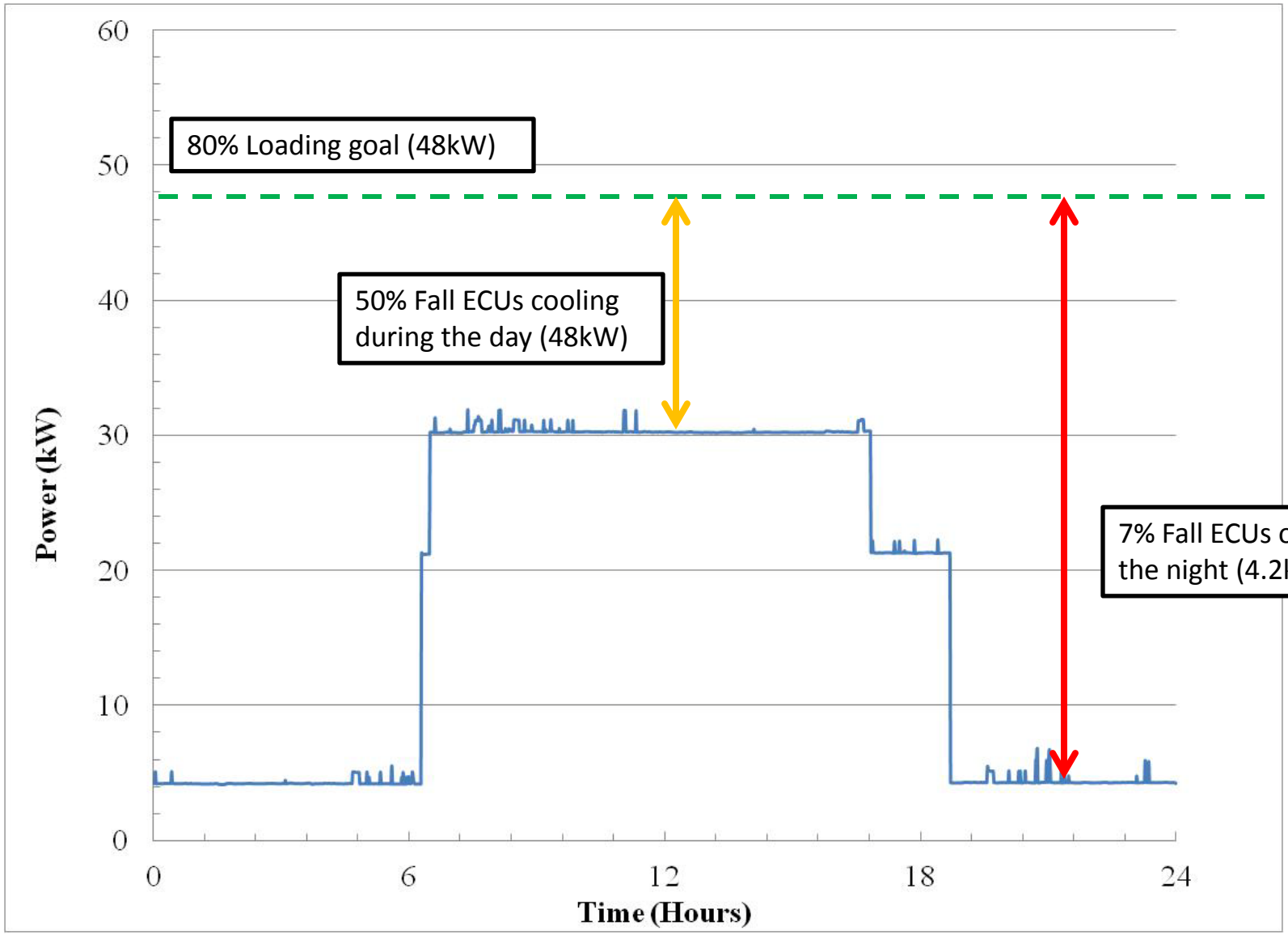




60kW MEP806 TQG

(2) BOO8
-11kW heat / 8.5kW cool
(2) BOO14
-9.6kW heat / 4.5kW cool
(2) BOO75 Reefers
-2.5kW cool
COC
-2kW continuous

60kW MEP806 Generator Loading at PB



How to Fix the Generator Utilization Problem

Two options exist to fix the generator sizing and utilization problem:

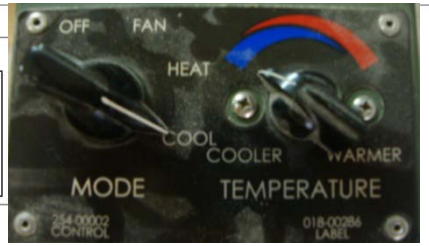
Option A: Rearrange generators twice a year, after winter, and before winter to size them for more appropriate power draws during the remaining 9 months.

- Pros: Non-technical solution. Inexpensive. Simple.
- Cons: Impractical in an environment where it takes months to get a single generator. Utilities Marines would resist the requirement. Additional logistics burden added.

Option B: Hybridize generators. Pros and Cons will be identified in the upcoming AoA, but below is a short list.

- Pros: Simplifies requirements on Marines, reduces generator run times, reduces maintenance, and saves fuel.
- Cons: Expensive up front cost, will require additional training of Utilities Marines, larger up front deployed weight.

Current ECU User Behavior



With the improper setting, ~50% more energy is used during nighttime hours

Assumptions

- It is assumed 6 billeting tents behaved in the same way with the same average load and ECU usage habits
- It is assumed all electrical loads were identified and are listed on the spreadsheet
- It is assumed all equipment remained onsite during the week
- It is assumed the data rate of one sample per minute identified true peak power values
- It is assumed 45 Marines occupied the PB during the test week (only one data sample was taken during the week)
- It is assumed a BOO75 unit draws 1 kW continuous
- It is assumed a GBOSS tower draws 500W continuous
- It is currently assumed ECU's draw zero power when "off" although blower power draw needs to be added
- Data acquisition equipment error is negligible

Results

What does a typical COC load profile look like? ✓

What does a typical Billeting load profile look like? ✓

What is the daily load profile for a COP and below? ✓

How are ECUs being used? What is their contribution to total load? ✓

How can the USMC use it's resources more efficiently?

- Reducing ECU usage is the most critical target for making an impact in fuel usage
  - This can come from technology solutions (Thermostats) or from user behavioral changes (improved ECU confidence, behavioral modification)
- Reducing transient peaks in equipment can also play a key role in improving energy efficiency by enabling the right sizing of generators (Raise target utilization from 80% to 90% or 95%)
- Hybridization/Right sizing generator efforts offer the potential for enormous fuel savings in fall and spring seasons

Acknowledgements

- Col. Charette Director Expeditionary Energy Office (E_2O) for providing funding
- Maj Newell (E_2O) for doing the hard work
- MARCORSYSCOM PM-EPS supporting ECU and TQG data gathering and analysis

Questions or creative solutions?