



NEW GENERATION

Shipboard Energy

AND

Emissions Management



QUANTIFICATION • LIFE CYCLE ANALYSIS
VESSELS • OFFICES • FACILITIES • TERMINALS

Green Boats and Ports for Blue Waters

University of Rhode Island

Graduate School of Oceanography

Mike Gaffney, C.E.M., C.E.A., C.P.Q.

Certified Energy Manager and Auditor

Certified Power Quality Professional

USCG Licensed Chief Engineer

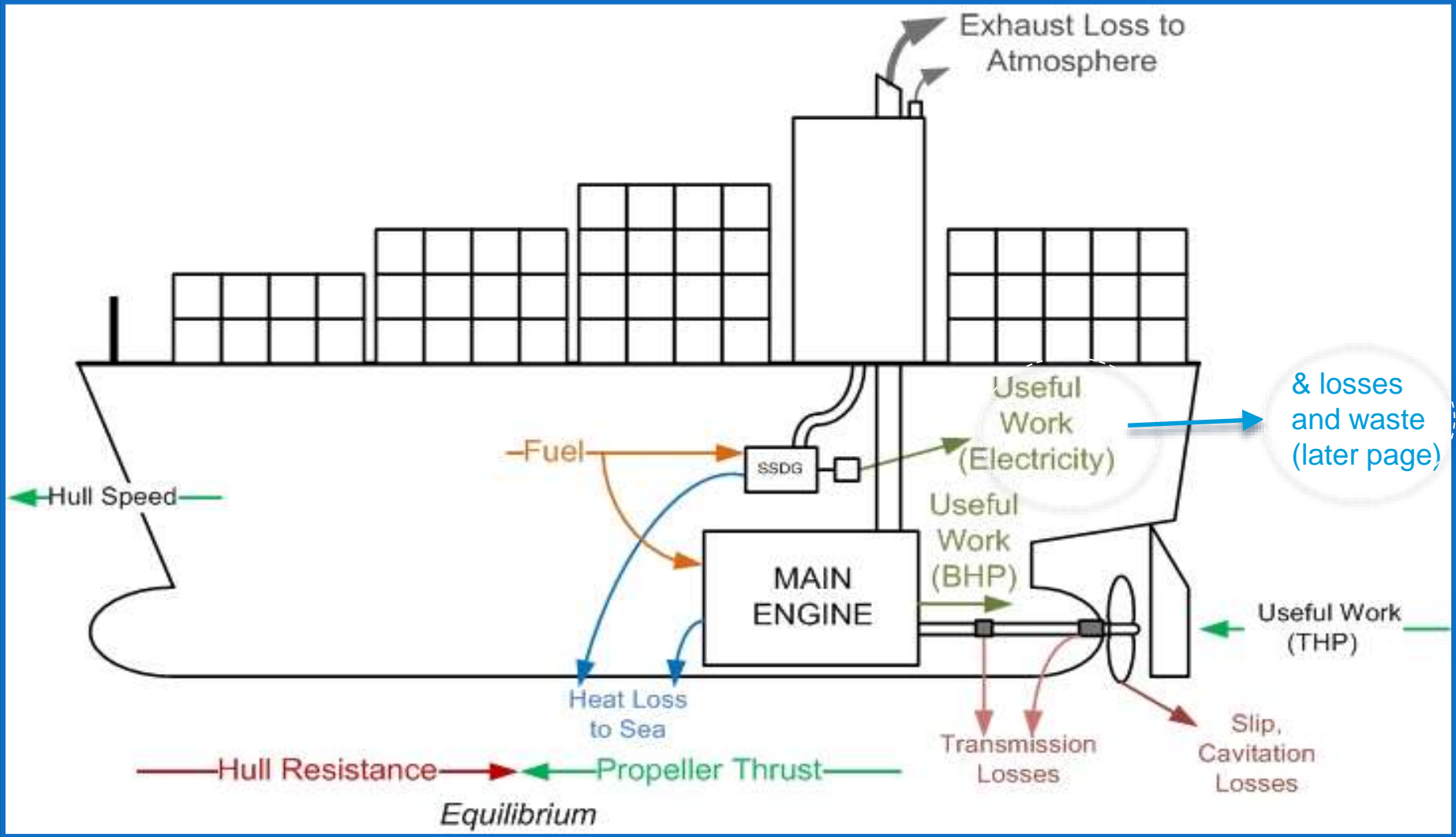
Exec VP Engineering, Alaris Companies

April 9, 2014

Presentation Topics

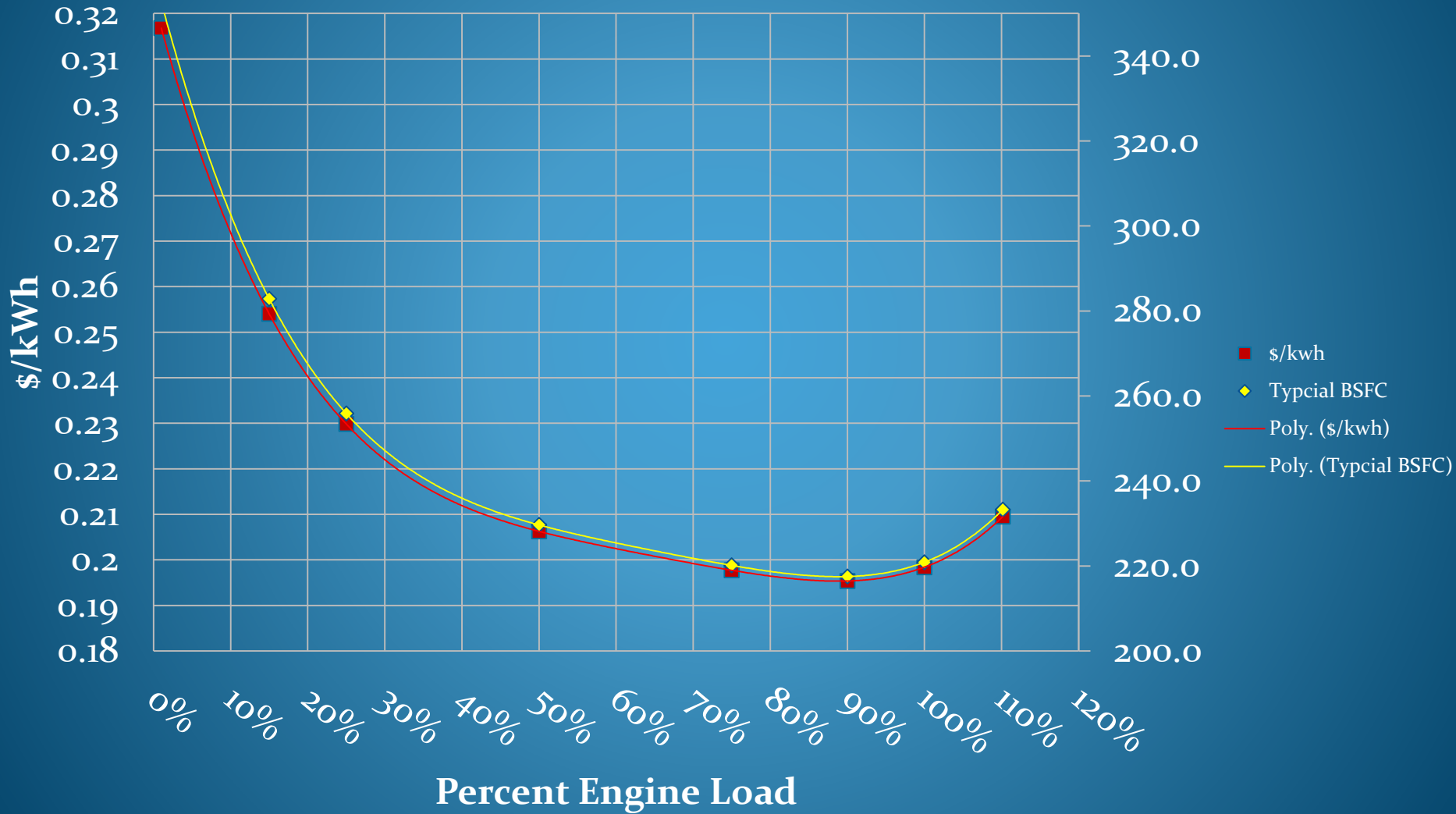
- Energy Efficiency and Cost
 - Engine
 - Motors
 - HVAC
- Baseline: Cost and Consumption
- Methods to Reduce Energy Cost

Ship Energy Efficiency: The Big Picture



Engine Efficiency

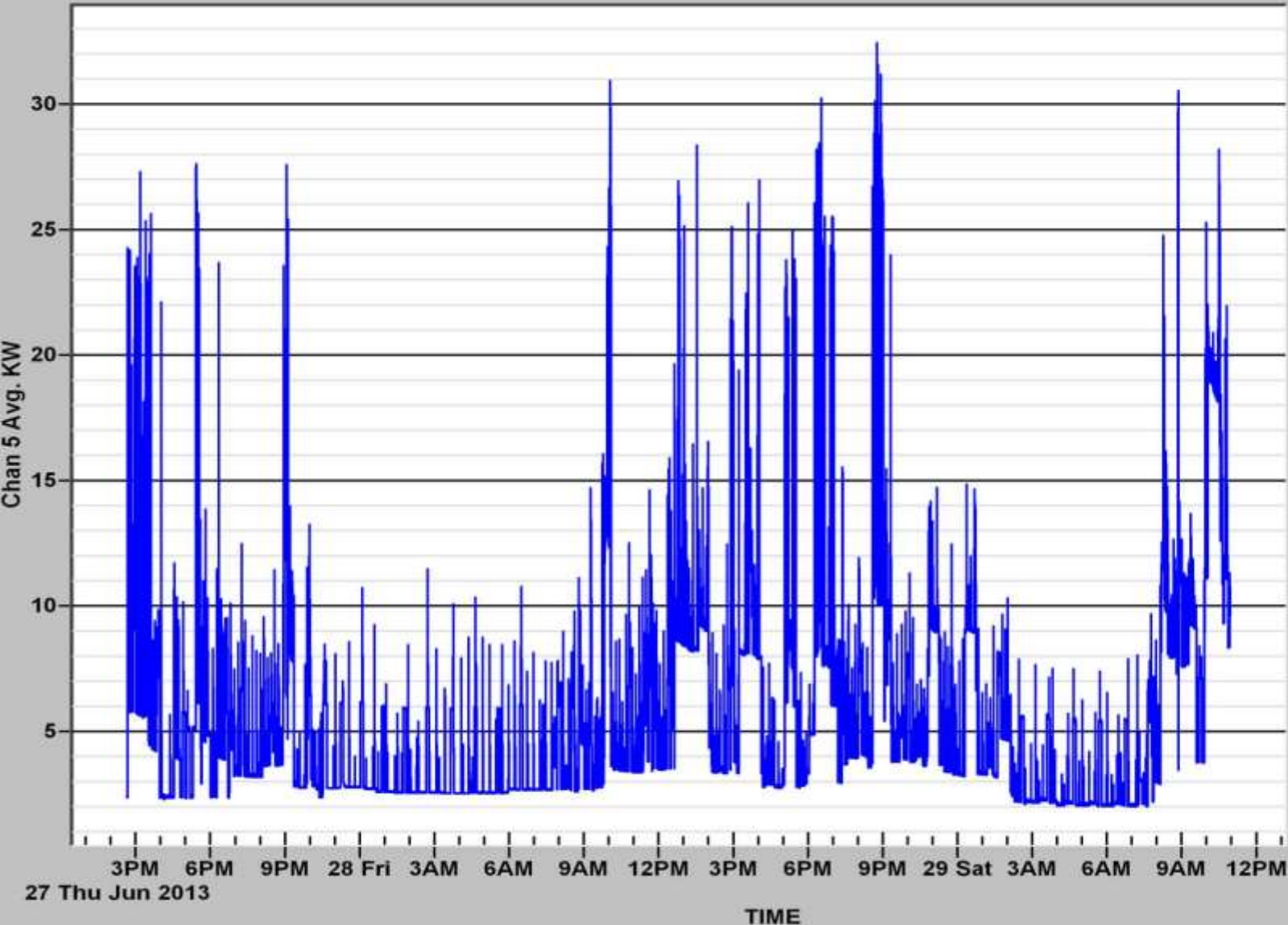
\$/kWh vs. Engine Load for a Typical Engine



Fishing Tender Auxiliary Electrical Load

The mouse cursor is not on a data point

06/27/13 - 06/29/13



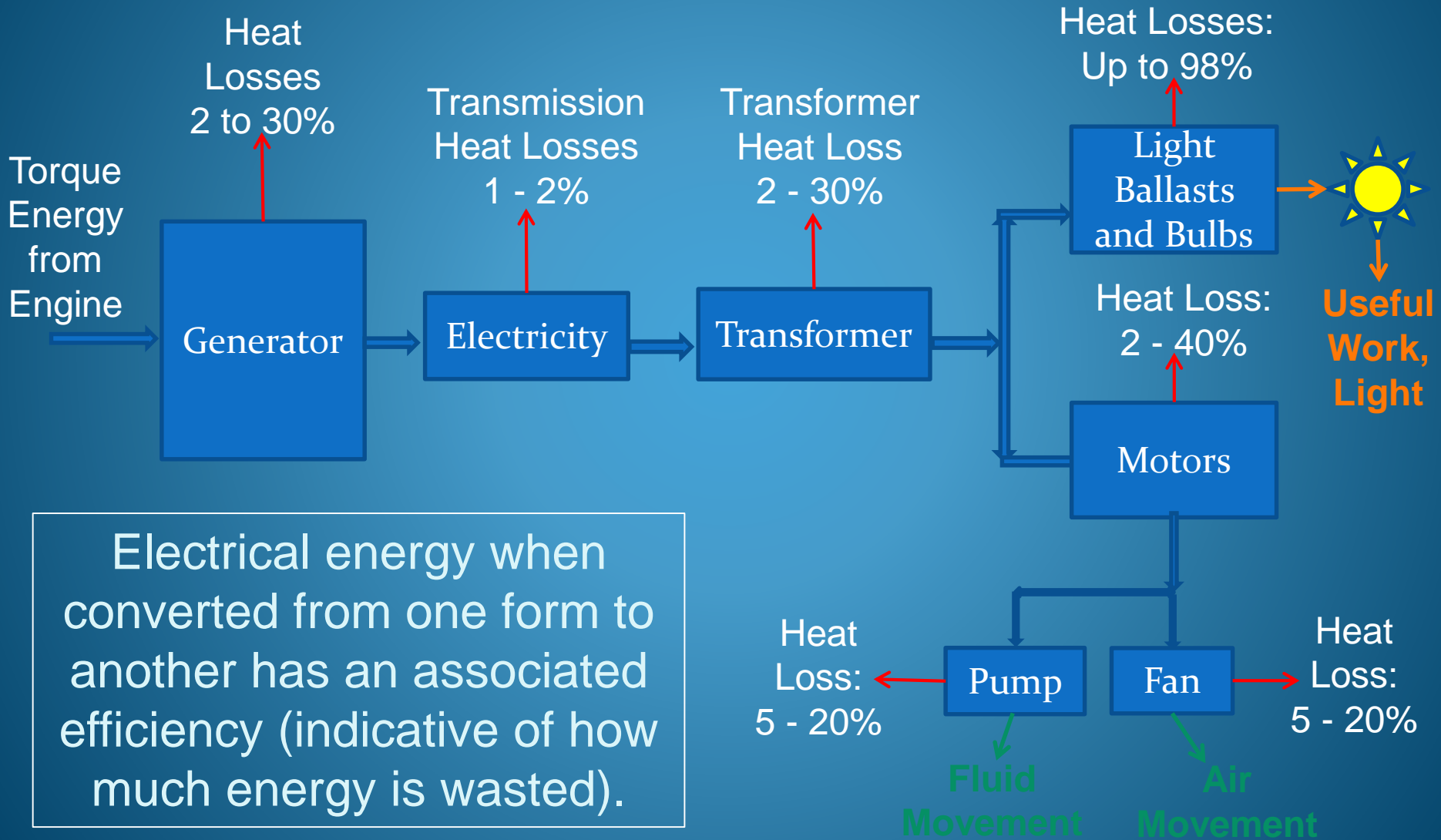
Analysis Summary
Average: 5.41
Minimum: 2.00
Maximum: 32.43

Baseline

Engine Efficiency and Costs

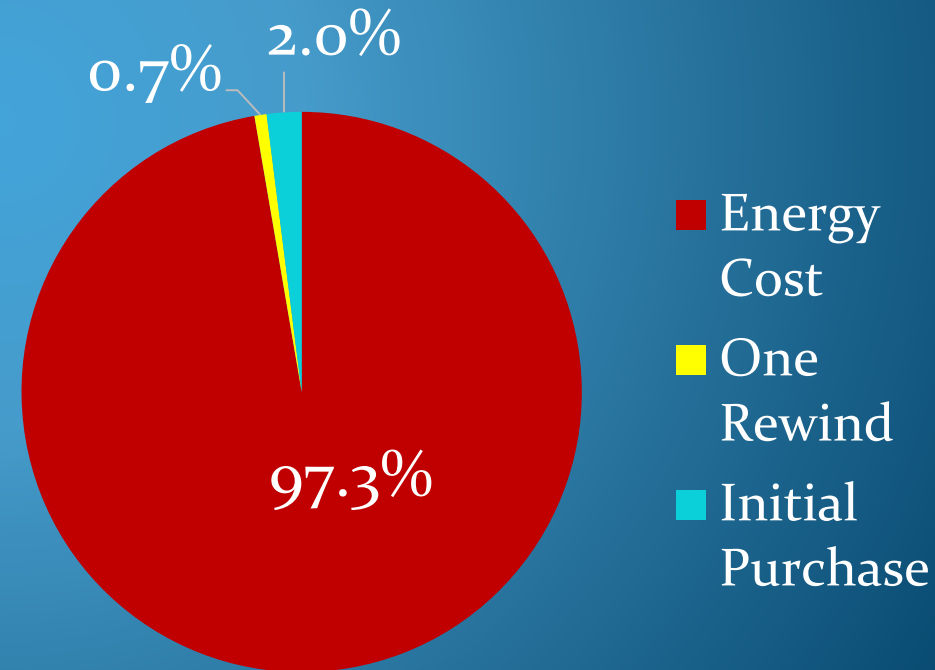
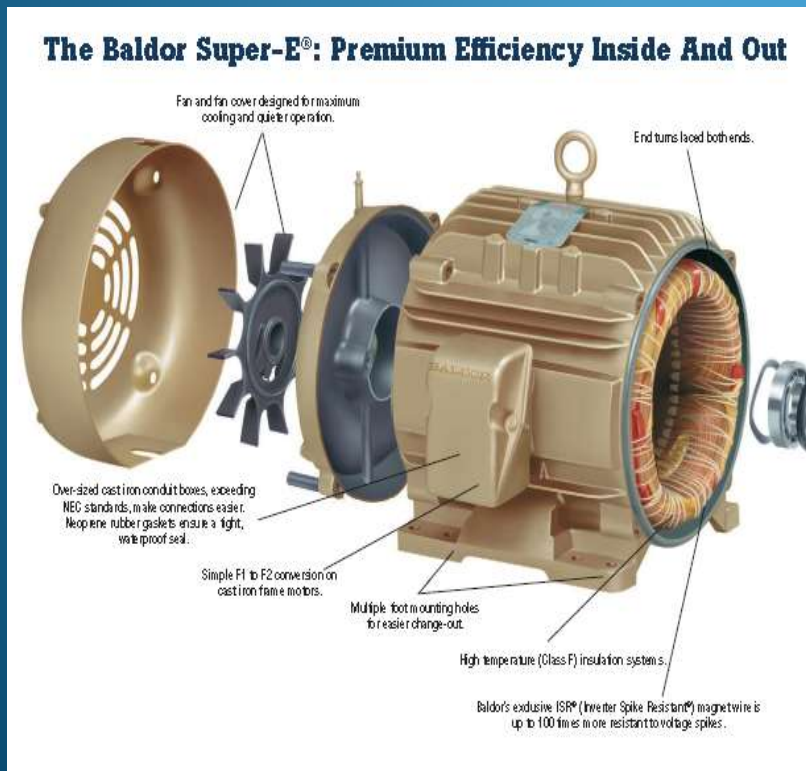
Load (kW)	Annual hours	Cost with 105 kW Engine	Cost with 55 kW Engine	Cost with a 55 kW and 10 kW Engines
3	3000	\$3,780	\$3,690	\$2,790
8	1750	\$5,460	\$4,900	\$3,780
20	125	\$850	\$750	\$750
30	125	\$1,163	\$1,050	\$1,050
	Total	\$11,253	\$10,390	\$8,370
			Savings	\$2,883

Electrical Equipment Efficiency



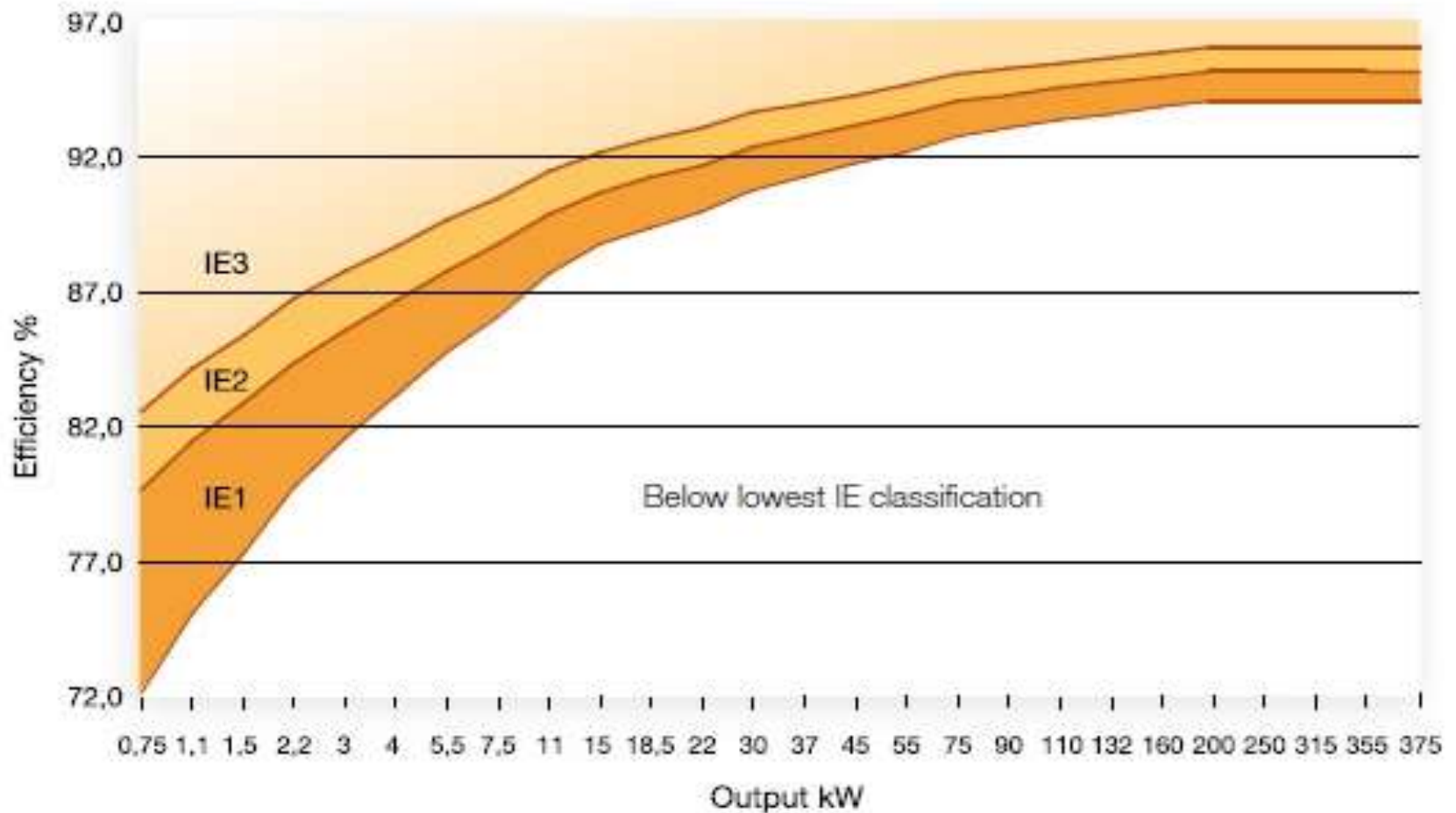
MOTOR LIFE CYCLE COST

Motors: 96%-98% of life cycle cost is energy
(~64% of US electrical energy use)



Motor Efficiency

IE Classes - 4 pole



Baseline

Energy Costs and Consumption

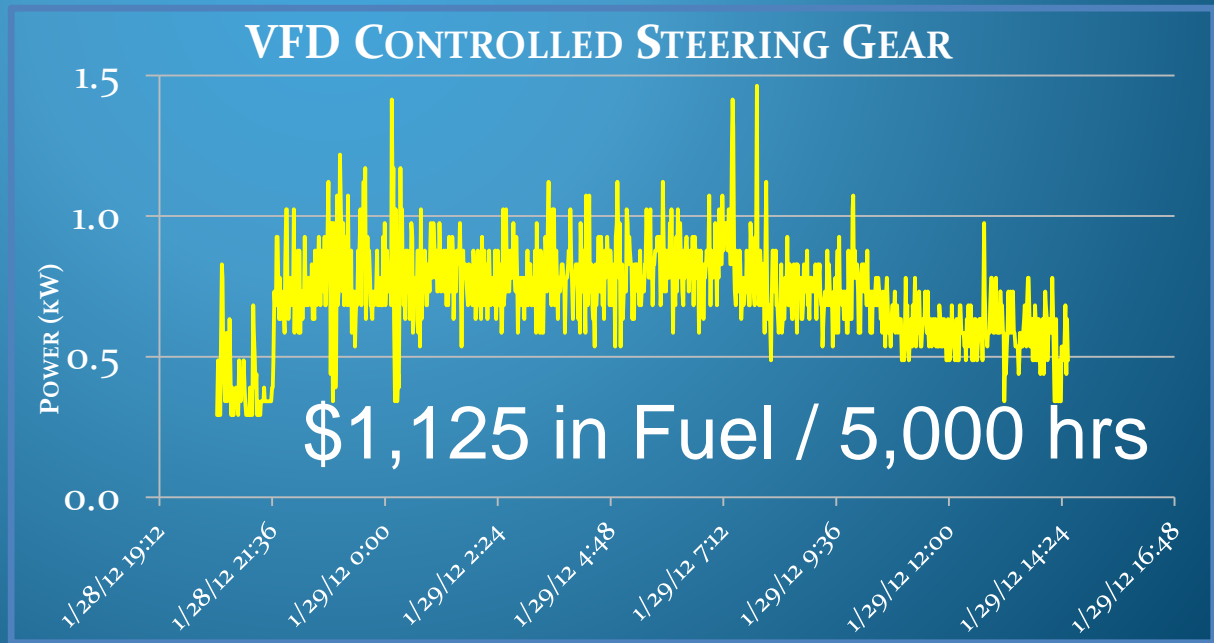
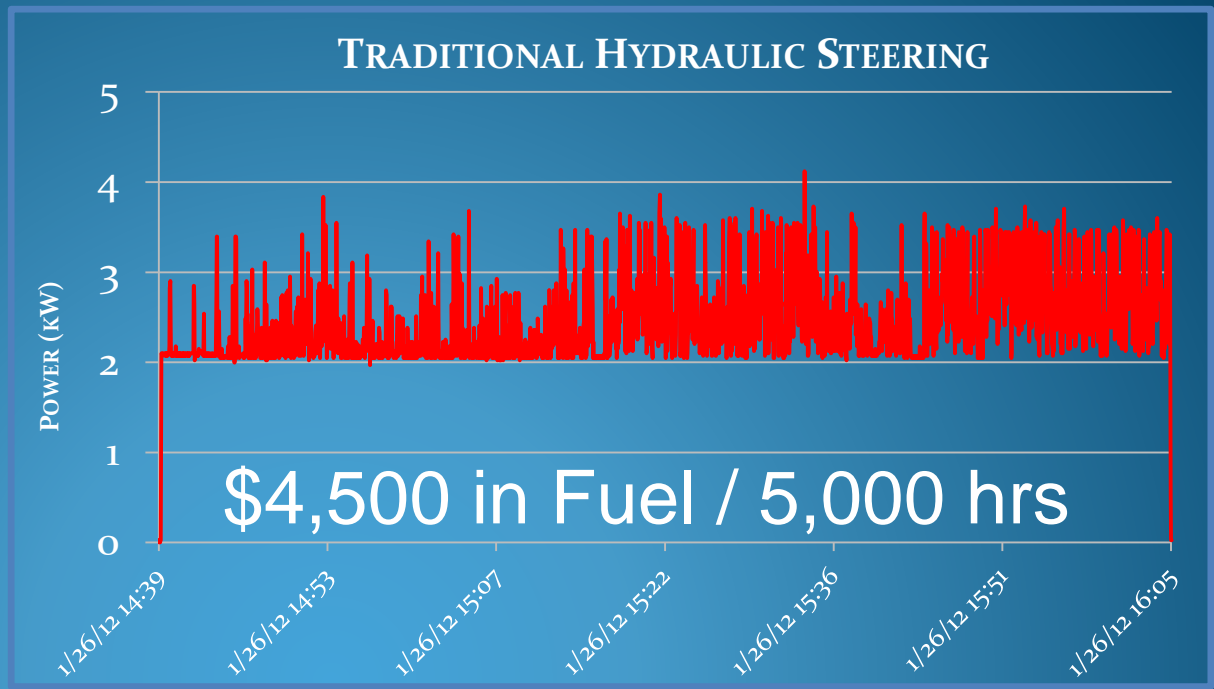
Name	Load (kW)	In Port Cost (\$)	At Sea Cost (\$)	Total Annual Energy cost (\$)
Central FW Cool Pump	156	\$131,563	\$170,040	\$301,603
Sea Water Cool Pump	111	\$93,612	\$120,990	\$214,602
ME LO Stbd	79	\$66,625	\$86,110	\$152,735
ME JW Stbd Pump	72	\$60,721	\$78,480	\$139,201
CPP STBD Pump	56.3	\$47,481	\$61,367	\$108,848
SS Air Compressor	40.5	\$34,156	\$44,145	\$78,301
A/C Compressor (Ave)	25.2	\$21,252	\$27,468	\$48,720
LO Purifier #1	12	\$10,120	\$13,080	\$23,200
Chilled Water Pump	11.6	\$9,783	\$12,644	\$22,427
Red Gear Port	11.6	\$9,783	\$12,644	\$22,427
ER Supply Fan 06-92-2 Low	5.9	\$4,976	\$6,431	\$11,407

Government Ship Equipment Energy Operating Cost

VFD on Hydraulic Steering
70% reduction in Energy Usage



Figure 23 VFD Controlled Steering Gear



Utility Rate Structure Components

- **Energy Cost**
- **Demand Cost**
- Demand Ratchet Cost
- Power Factor Cost
- Fuel Charge
- Time of Day Schedules
(on-peak and off-peak)
- Seasonal rate schedules
- Distribution Charges
- Fixed Fees



Shore Power Usage/Cost

RATE PER MONTH

I. Basic Facilities Charge: \$ 1,925.00

II. Demand Charge:

A. On-Peak Billing Demand

1. Summer Months of June-September @	1:00 PM and 9:00 PM	\$ 17.75	per KW
2. Non-Summer Months of October-May @	6 -12 AM : 5 -9 PM	\$ 12.42	per KW

B. Off-Peak Billing Demand

1. All Off-Peak Billing Demand @		\$ 5.38	per KW
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III. Energy Charge:

A. On-Peak kWh

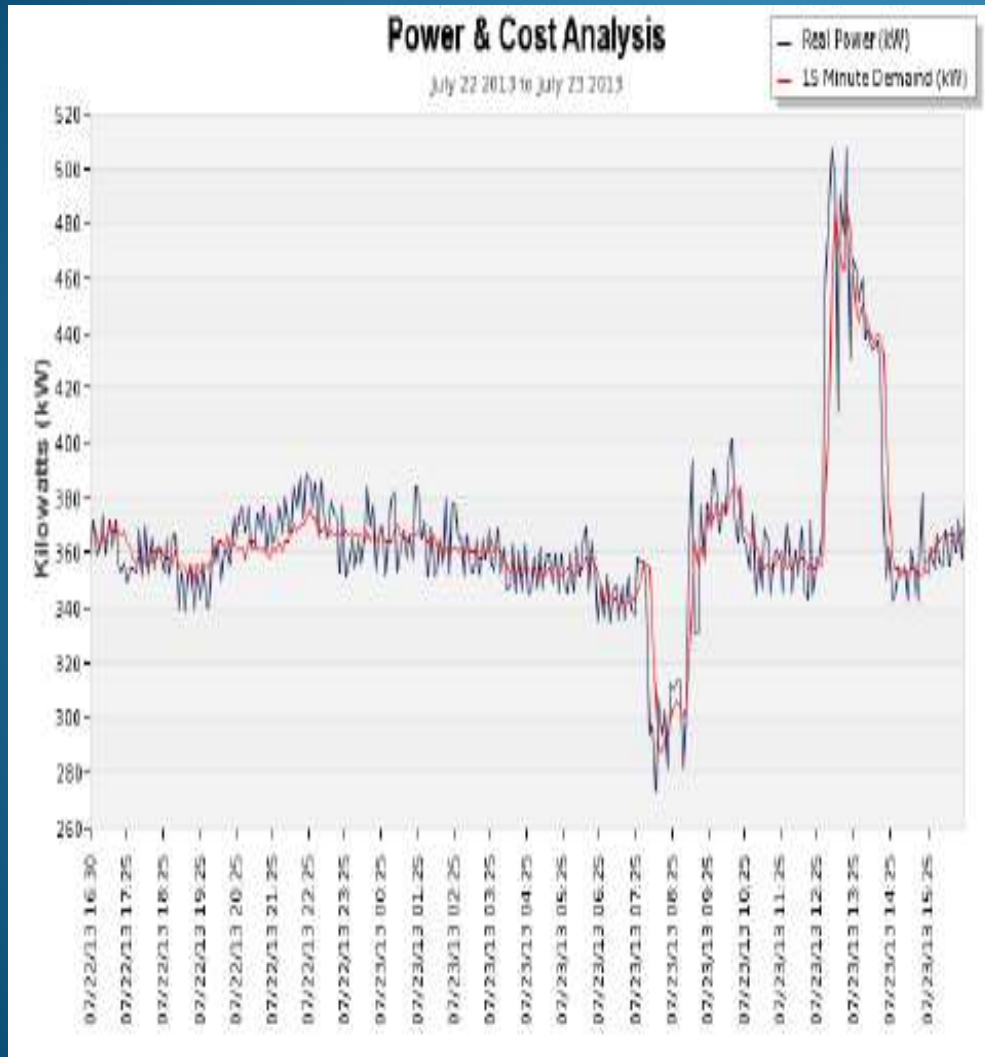
1. Summer Months of June-September @	\$ 0.08318	per kWh
2. Non-Summer Months of October-May @	\$ 0.06011	per kWh

B. Off-Peak kWh

1. All Off-Peak @	\$ 0.04608	per kWh
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BILLING DEMAND

Shore Power Usage/Cost



**500 kW Demand
On-Peak: \$8,875**

**500 kW Demand
Off-Peak: \$2,690**

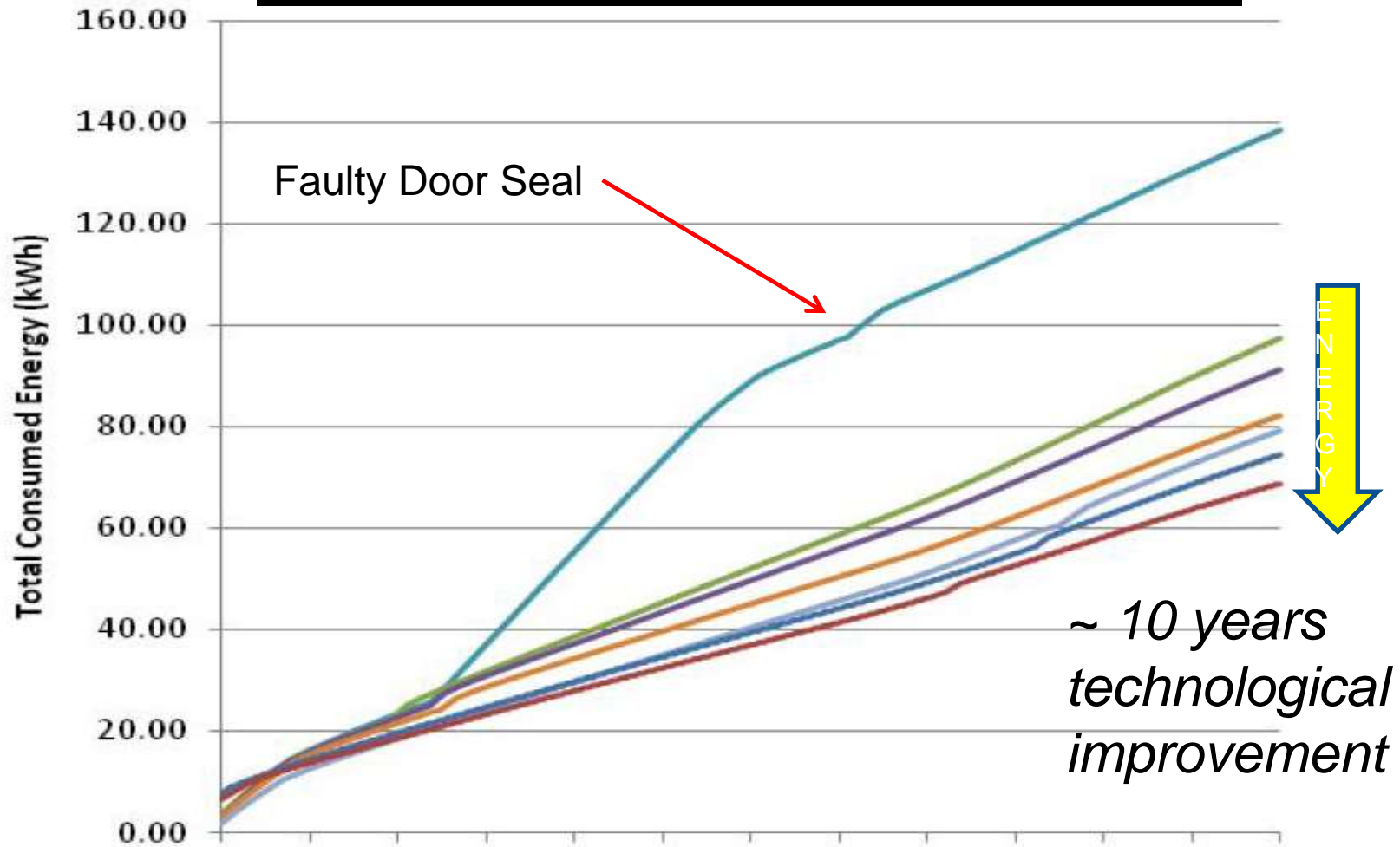
**200,000 kWh On-
Peak: \$16,636**

**200,000 kWh Off-
Peak : \$9,216**

From Alaris' EQUATE ERMS Module

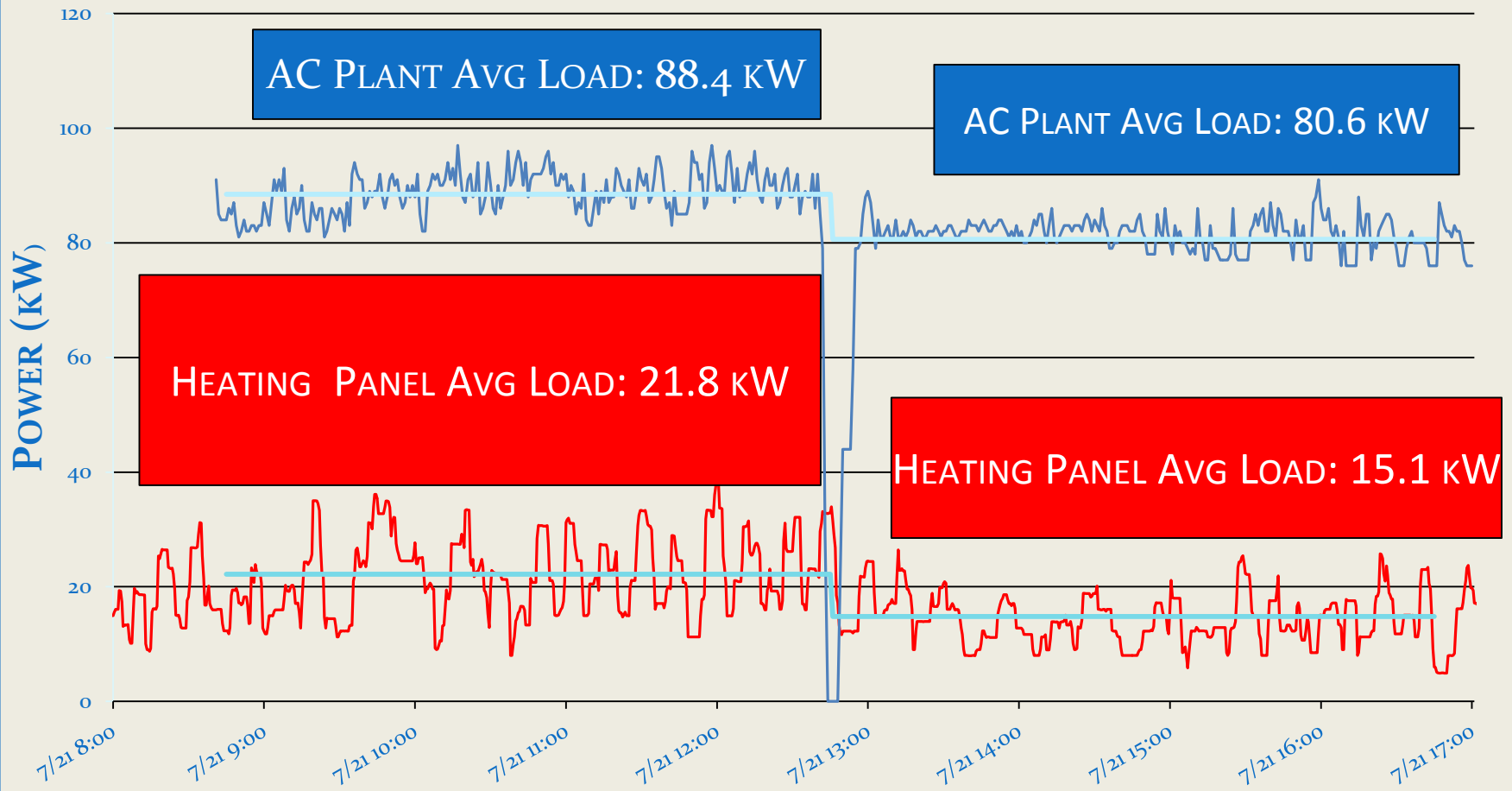
Maintenance vs. Technology

Cumulative Energy – 24 Hours



Chill Water Reset

HVAC CHILLED WATER INCREASED 6°F



IT Space Temperature Recommendation



ASHRAE PSYCHROMETRIC CHART NO. 1

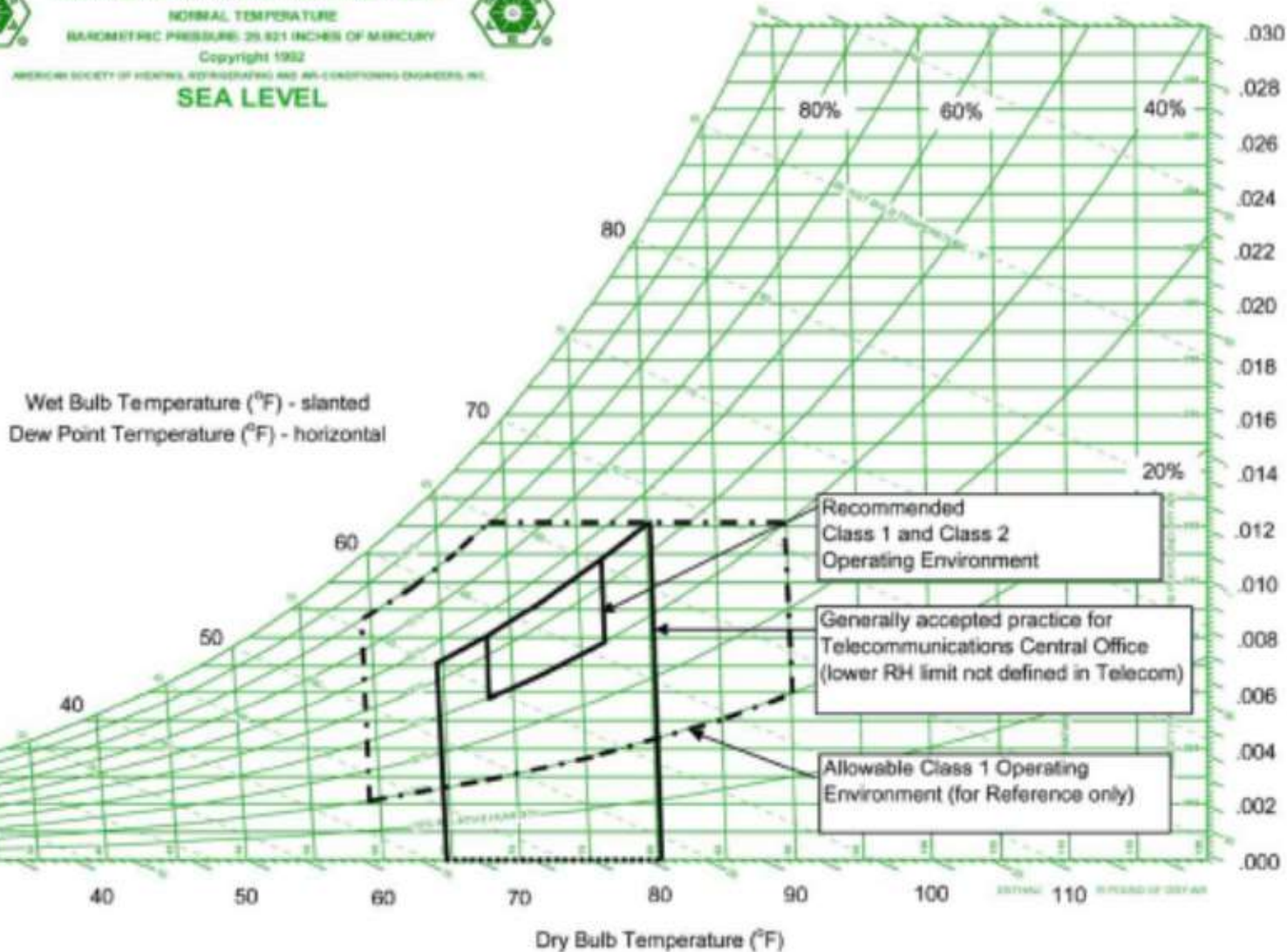
NORMAL TEMPERATURE

BAROMETRIC PRESSURE: 29.921 INCHES OF MERCURY

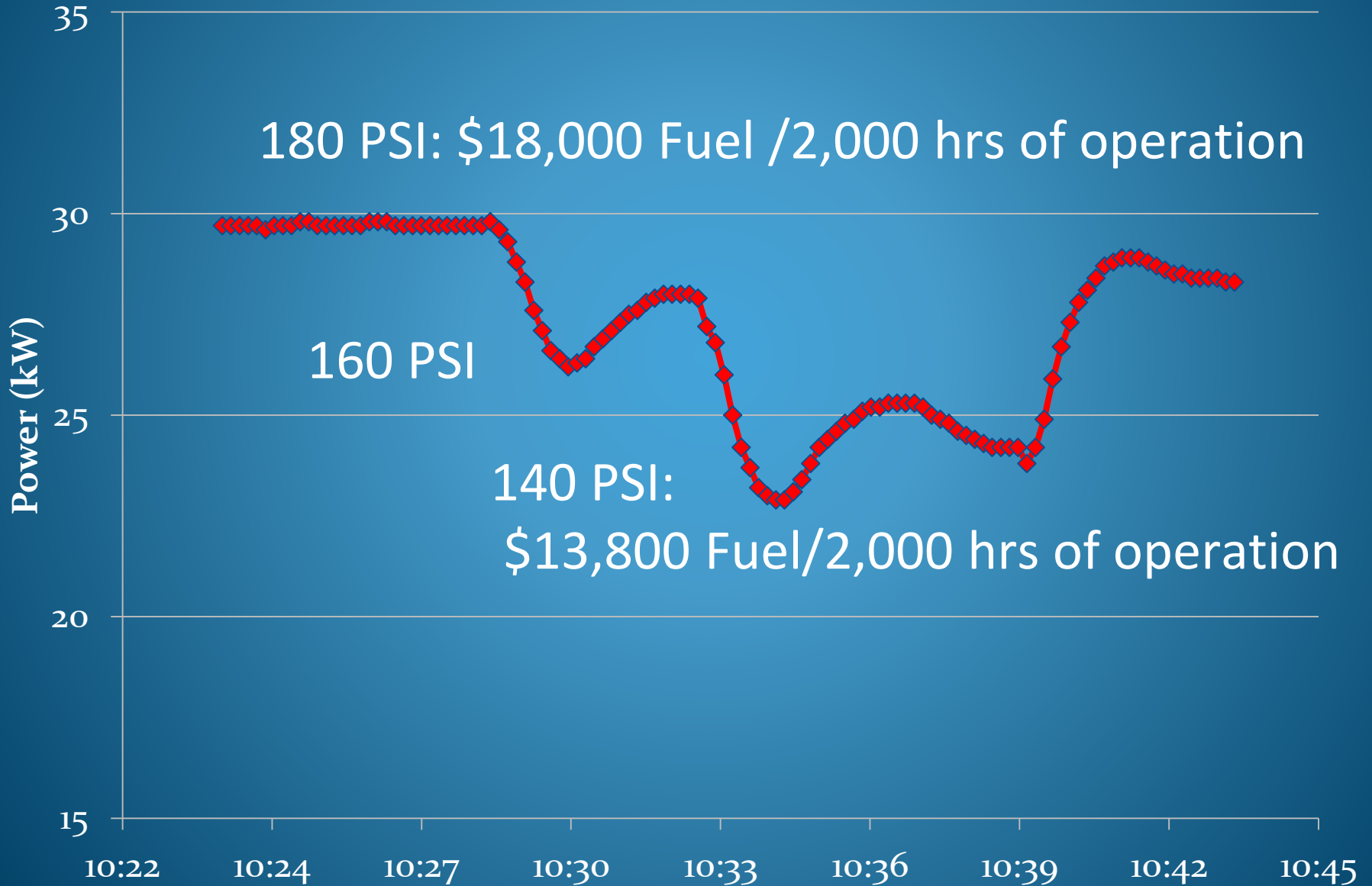
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AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.

SEA LEVEL



Refrigerated Sea Water Compressor: Power VS. Compressor Discharge Pressure



Culture: Reduce heating and cooling at the same time

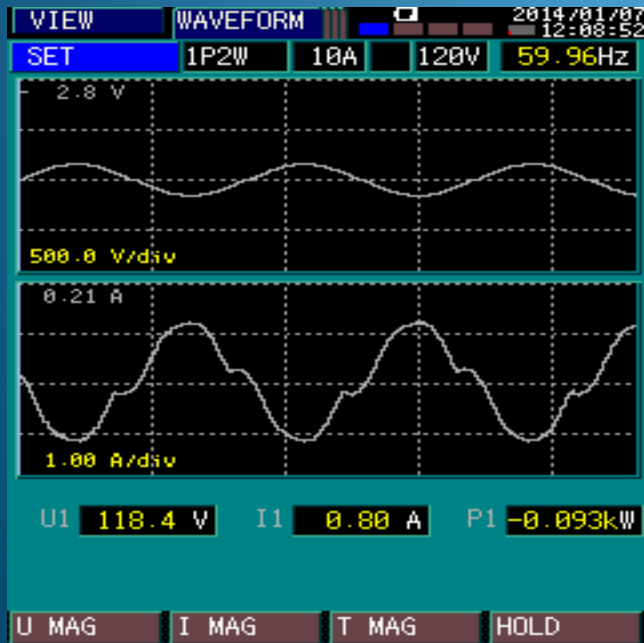
- AC on
- Reheat at 90F
- Doors Open



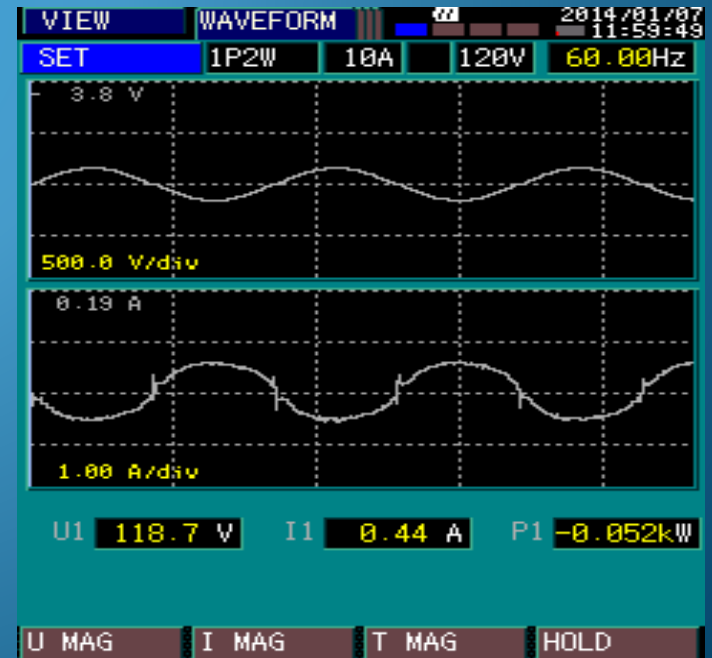
Baseline and Analysis (Lighting)

2 Bulb 4', T-12 34 W
Fluorescent Magnetic Ballast
Power Draw: 92 Watts/fixture
Measured Lux/Watt @ 6': 3.07
1,000 fixtures/ship
Energy Cost: \$177,868/yr

2 Bulb 4' LED,
External Driver
Power Draw: 52 Watts/fixture
Measured Lux/Watt @ 6': 9.04
1,000 fixtures/ship
Energy Cost: \$100,534/yr



Annual
Savings
\$77,334/yr



Thank You!

