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

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

Analysis Summary
Average: 5.41
Minimum: 2.00
Maximum: 32.43
## Baseline

### Engine Efficiency and Costs

<table>
<thead>
<tr>
<th>Load (kW)</th>
<th>Annual hours</th>
<th>Cost with 105 kW Engine</th>
<th>Cost with 55 kW Engine</th>
<th>Cost with a 55 kW and 10 kW Engines</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3000</td>
<td>$3,780</td>
<td>$3,690</td>
<td>$2,790</td>
</tr>
<tr>
<td>8</td>
<td>1750</td>
<td>$5,460</td>
<td>$4,900</td>
<td>$3,780</td>
</tr>
<tr>
<td>20</td>
<td>125</td>
<td>$850</td>
<td>$750</td>
<td>$750</td>
</tr>
<tr>
<td>30</td>
<td>125</td>
<td>$1,163</td>
<td>$1,050</td>
<td>$1,050</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$11,253</td>
<td>$10,390</td>
<td>$8,370</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Savings</strong></td>
<td></td>
<td><strong>$2,883</strong></td>
</tr>
</tbody>
</table>
Electrical energy when converted from one form to another has an associated efficiency (indicative of how much energy is wasted).
Motor Life Cycle Cost

Motors: 96%-98% of life cycle cost is energy (~64% of US electrical energy use)
## Baseline Energy Costs and Consumption

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

70% reduction in Energy Usage

Traditional Hydraulic Steering

$4,500 in Fuel / 5,000 hrs

VFD Controlled Steering Gear

$1,125 in Fuel / 5,000 hrs
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**

<table>
<thead>
<tr>
<th>RATE PER MONTH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Basic Facilities Charge:</strong></td>
</tr>
<tr>
<td><strong>II. Demand Charge:</strong></td>
</tr>
<tr>
<td>A. On-Peak Billing Demand</td>
</tr>
<tr>
<td>1. Summer Months of June-September</td>
</tr>
<tr>
<td>2. Non-Summer Months of October-May</td>
</tr>
<tr>
<td>B. Off-Peak Billing Demand</td>
</tr>
<tr>
<td>1. All Off-Peak Billing Demand</td>
</tr>
</tbody>
</table>

| **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 |

**BILLING DEMAND**

1:00 PM and 9:00 PM

6-12 AM : 5-9 PM
Shore Power Usage/Cost

From Alaris’ EQUATE ERMS Module

500 kW Demand
On-Peak: $8,875
Off-Peak: $2,690

200,000 kWh On-Peak: $16,636
Off-Peak: $9,216
Maintenance vs. Technology

Cumulative Energy – 24 Hours

Faulty Door Seal

~ 10 years technological improvement
Chill Water Reset

HVAC Chilled Water Increased 6°F

AC Plant Avg Load: 88.4 kW

AC Plant Avg Load: 80.6 kW

Heating Panel Avg Load: 21.8 kW

Heating Panel Avg Load: 15.1 kW
IT Space Temperature **Recommendation**
Refrigerated Sea Water Compressor: Power VS. Compressor Discharge Pressure

180 PSI: $18,000 Fuel /2,000 hrs of operation

160 PSI

140 PSI: $13,800 Fuel/2,000 hrs of operation
Culture: Reduce heating and cooling at the same time

- AC on
- Reheat at 90°F
- 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!