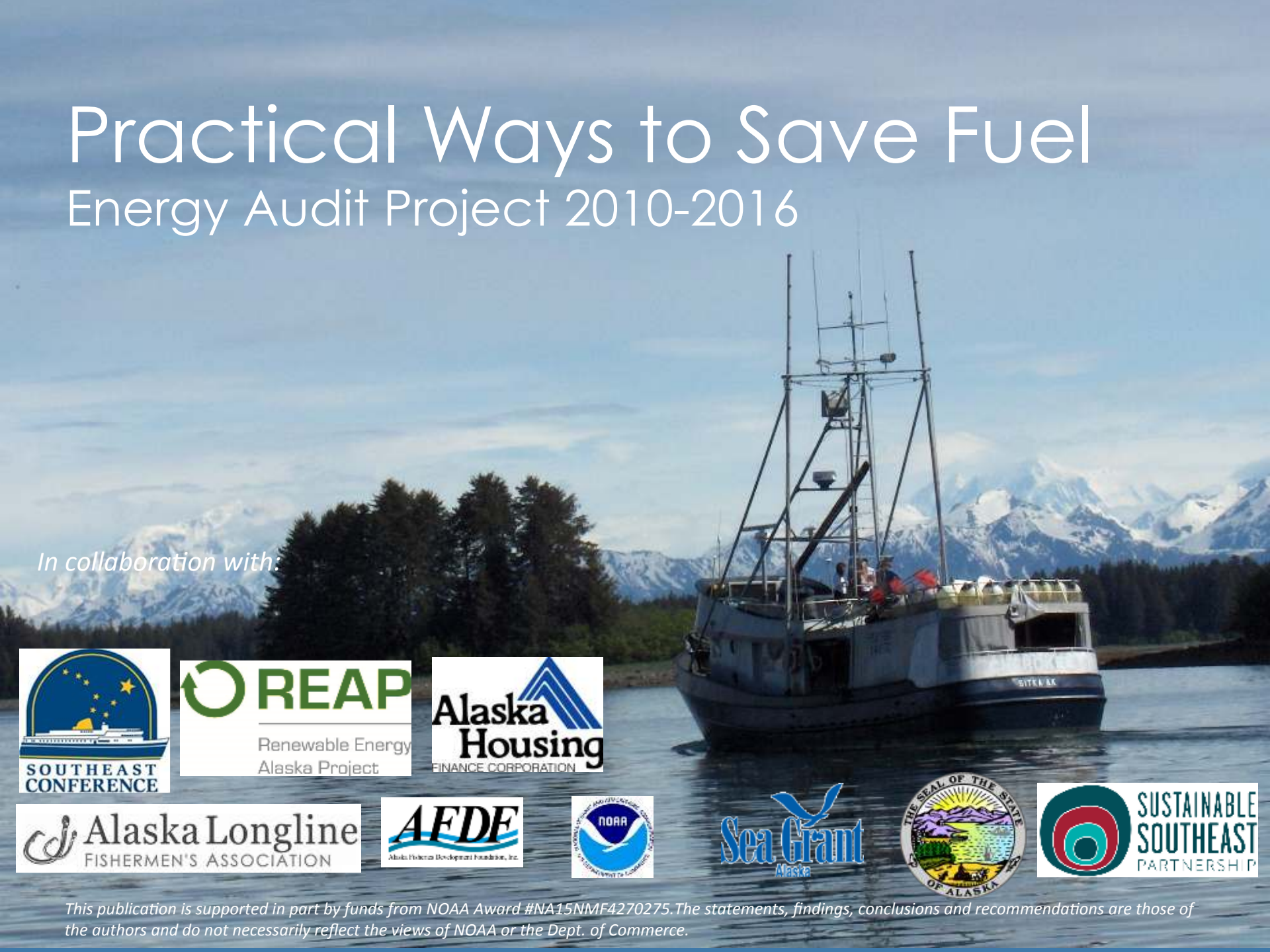
Practical Ways to Save Fuel

Energy Audit Project 2010-2016



In collaboration with:

SOUTHEAST CONFERENCE

REAP Renewable Energy Alaska Project

Alaska Housing FINANCE CORPORATION

Alaska Longline FISHERMEN'S ASSOCIATION

AFDF Alaska Fisheries Development Foundation, Inc.

NOAA

Sea Grant Alaska

THE SEAL OF THE STATE OF ALASKA

SUSTAINABLE SOUTHEAST PARTNERSHIP

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Sitka, AK October 29, 2016

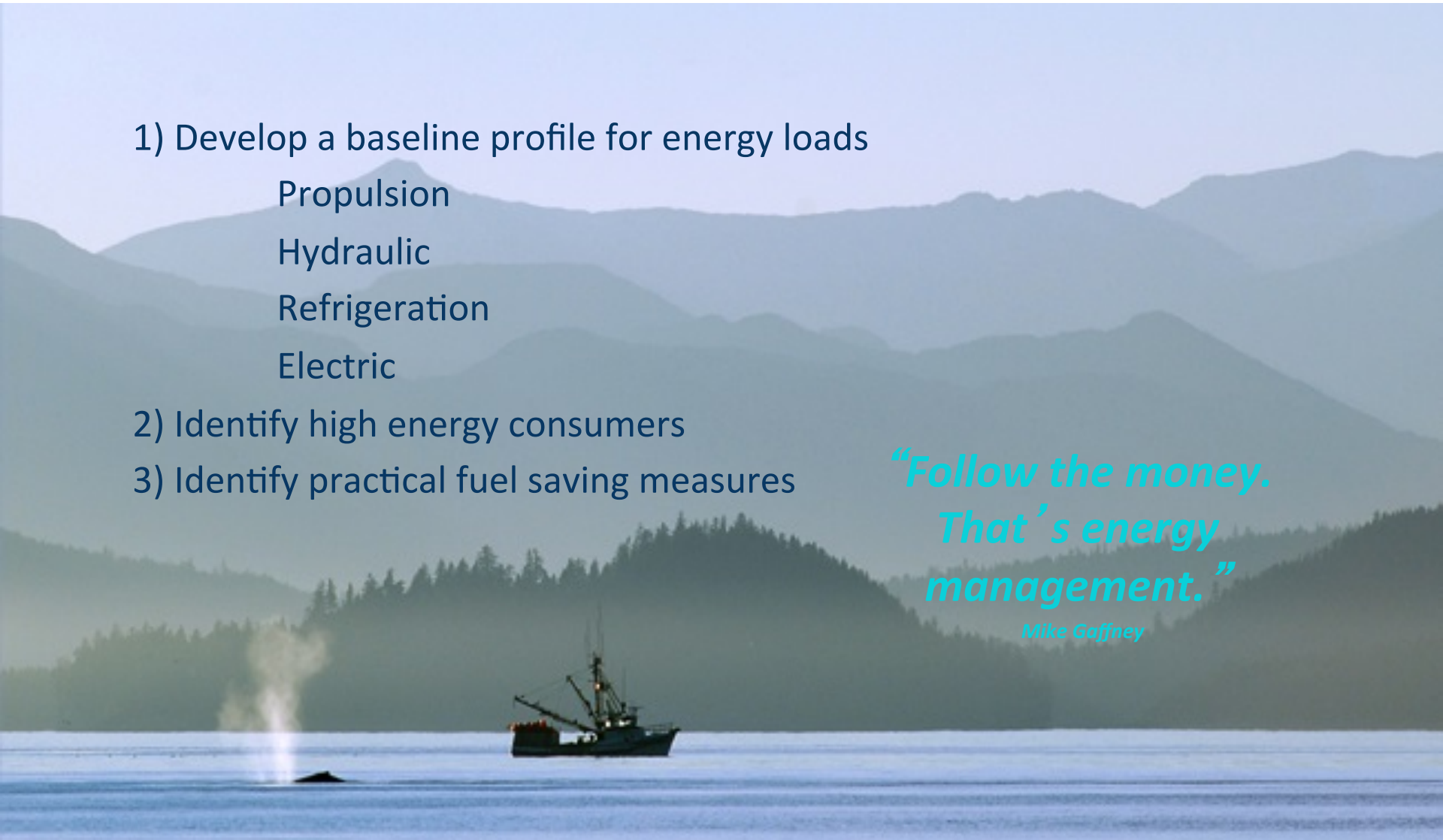
End of Module 5: DC / AC Loads

- Fishing vessel fuel efficiency project
- Propulsion
- Hydraulics
- Refrigeration
- **DC Loads**
- **AC Loads**

Energy Audit Project:

3 Step Approach

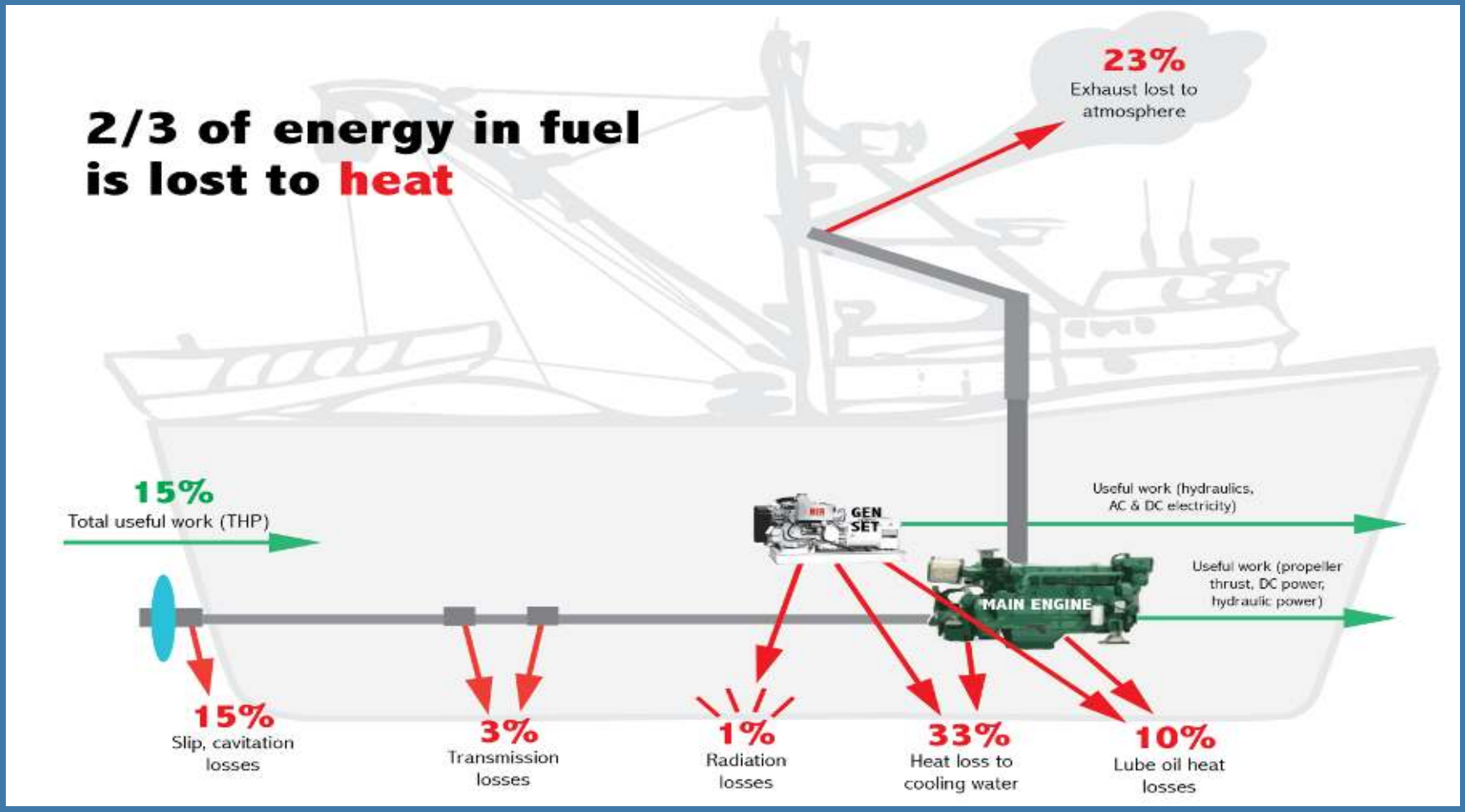
1) Develop a baseline profile for energy loads
   - Propulsion
   - Hydraulic
   - Refrigeration
   - Electric
2) Identify high energy consumers
3) Identify practical fuel saving measures



"Follow the money. That's energy management."

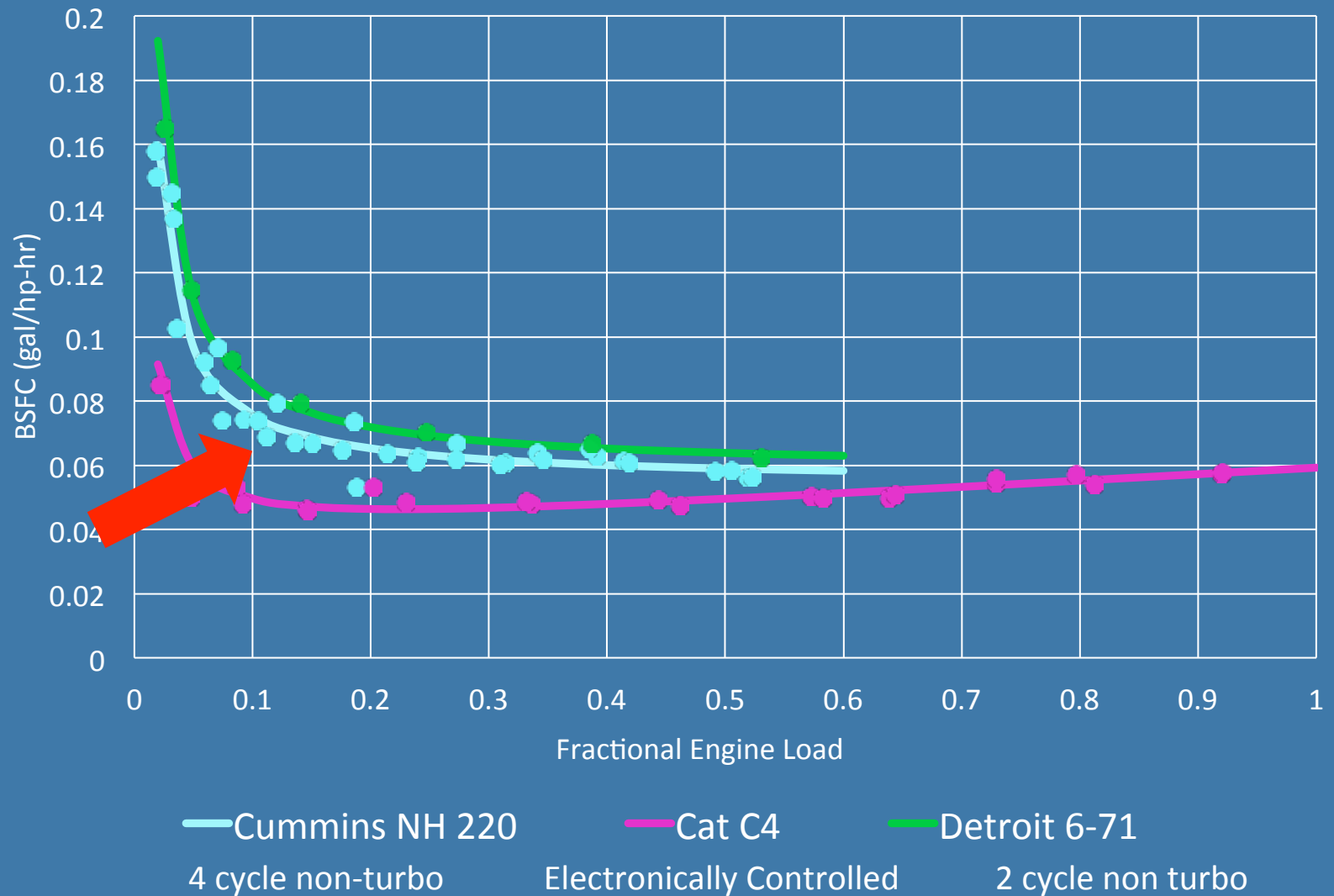
Mike Gaffney

Fuel Efficiency Basics



Engine Efficiency:

Engine Efficiency Depends on Load



Fishing Vessel Energy Analysis Tool

Vessel Name		
Type		
Length	47	feet
Fuel Cost /gallon	$4.00	$/gallon
Shore power cost $/kWh	$0.12	$/kWh
Propulsion Engine #1 Size	165	Horsepower
Propulsion Engine #1 Type	4 cycle non-turbo	
Propulsion Engine #2 Size	0	HP
Propulsion Engine #2 Type	NA	
Auxiliary Engine #1 size	50	HP
Auxiliary Engine #1 Type	4 cycle turbo	
Aux Generator Engine #2 Size	0	HP
Aux Generator Engine #2 Type	NA	

If you know the kW for your engine, use the calculator below to convert the kW number into HP.

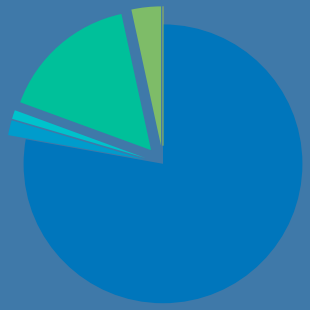
KW to HP Conversion	
KW	HP
25	33.5

Operating Mode	Name (e.g.. Ice troll, gillnet, family outing)	Propulsion Engine #1		Propulsion Engine #2		Aux Engine #1	Aux Engine #2
		Hrs Transit	Hrs Fishing	Hrs Transit	Hrs Fishing	Hrs Fishing	Hrs Fishing
1	Longline	125	160	0	0	15	0
2	Ice Troll	70	150	0	0	10	0
3	Freeze Troll	160	480	0	0	450	0
4	Misc	40	20	0	0	0	0
Total		**395**	**810**	**0**	**0**	**475**	**0**
		Total hrs	**1205**	Total hrs	0		

		Calculated Efficiency
Estimate Hydraulic System Condition	Good	0.8
Estimate Alternator Performance	Standard	0.7

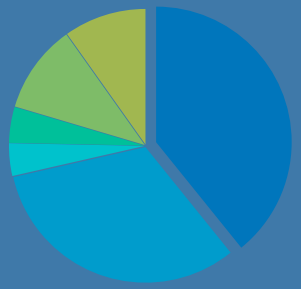
Baseline Profile
Fuel Consumption by System

Tender

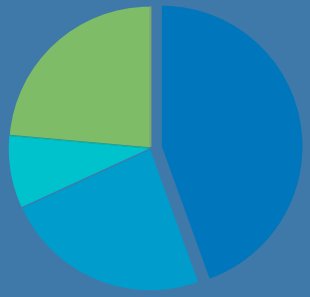


Freeze Troller

Seiner



Longliner

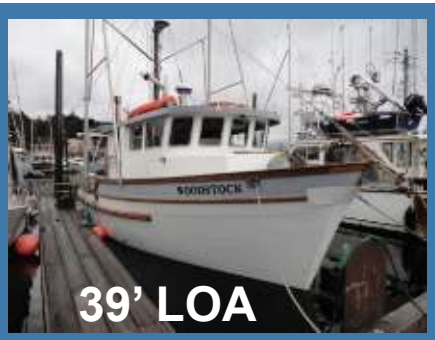


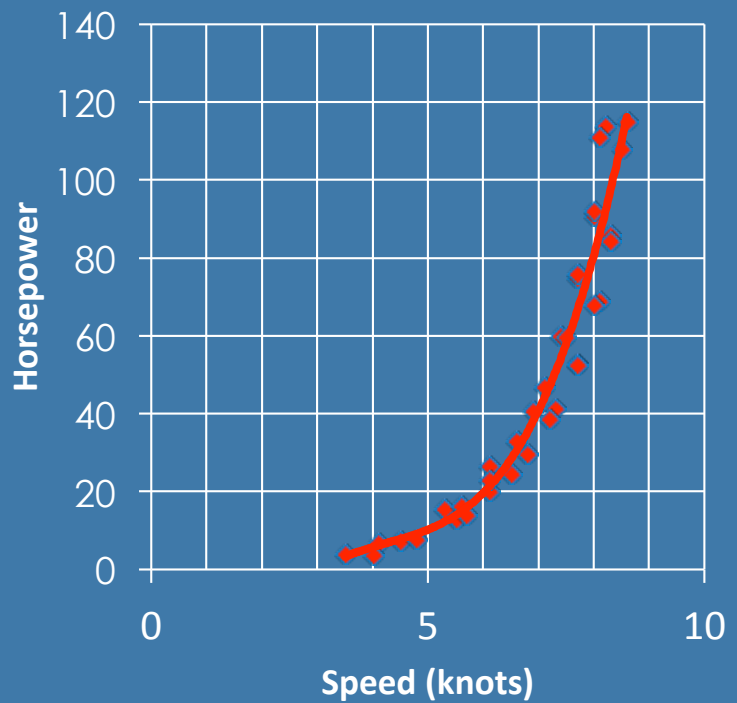
Propulsion Loads

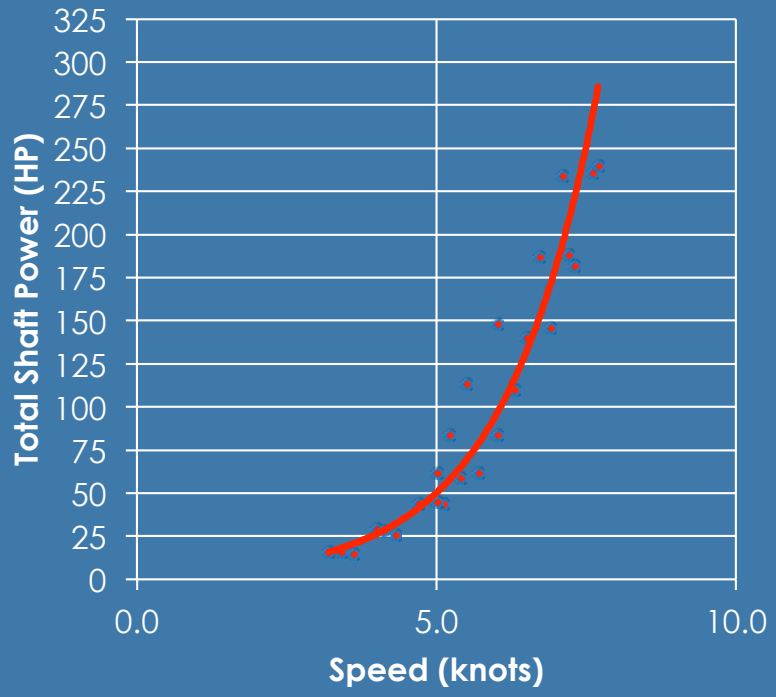
- Transit speed
- Right size the engine
- Vessel configuration
- Hull and propeller maintenance

Propulsion Loads:

Measured Loads



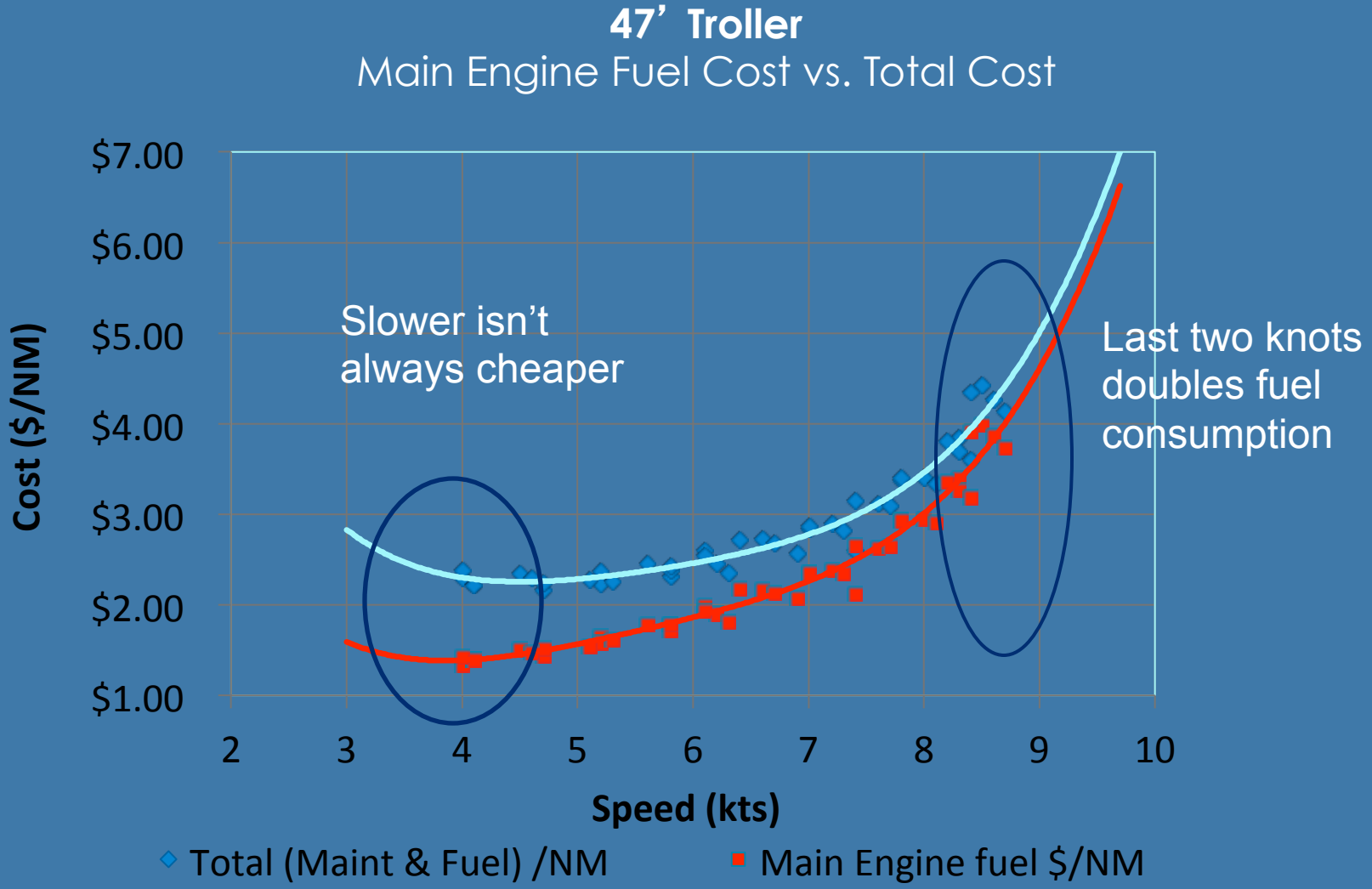




*Values based on audit measurements

Propulsion Loads:

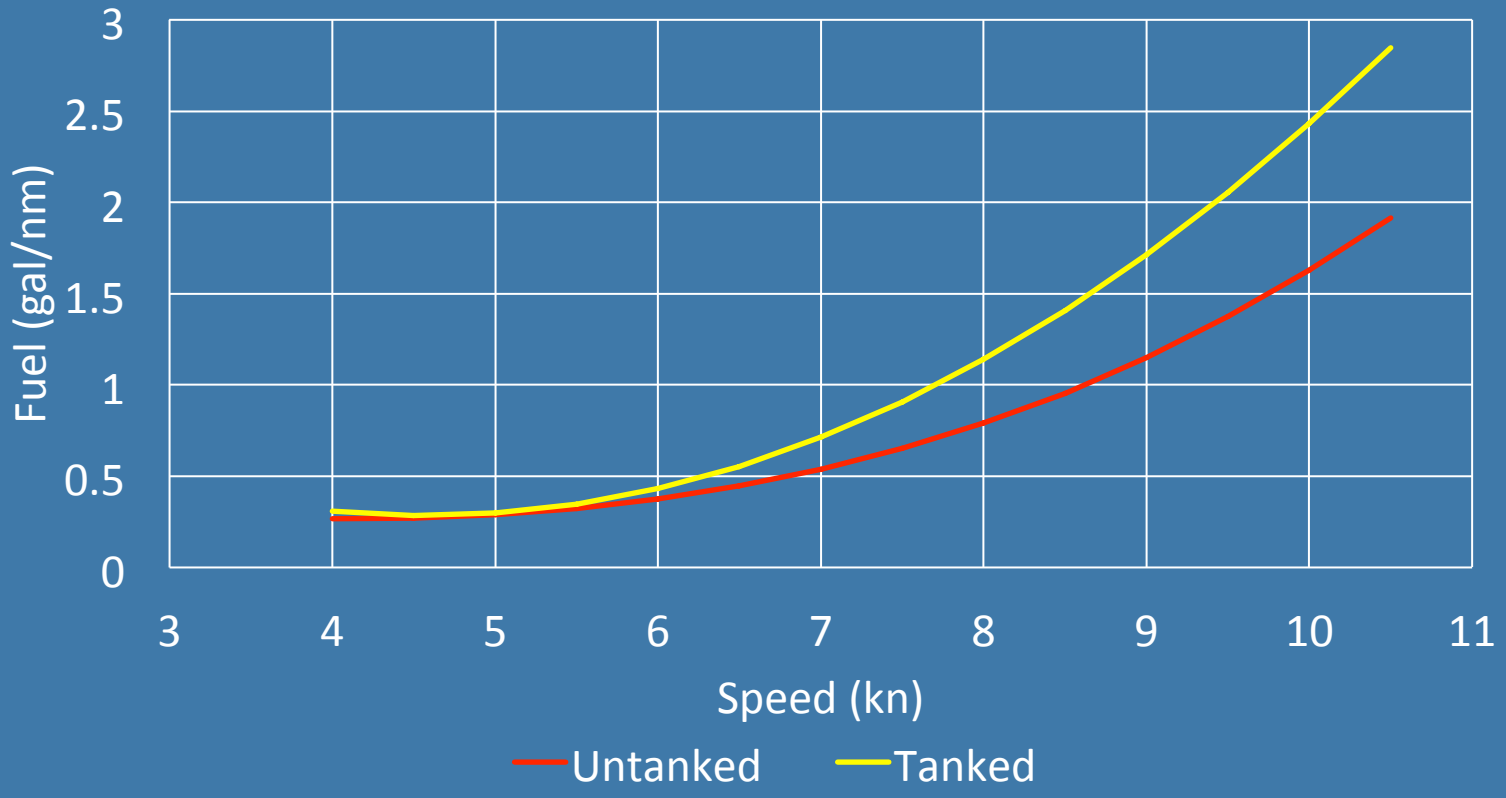
Transit Speed



Propulsion Loads:

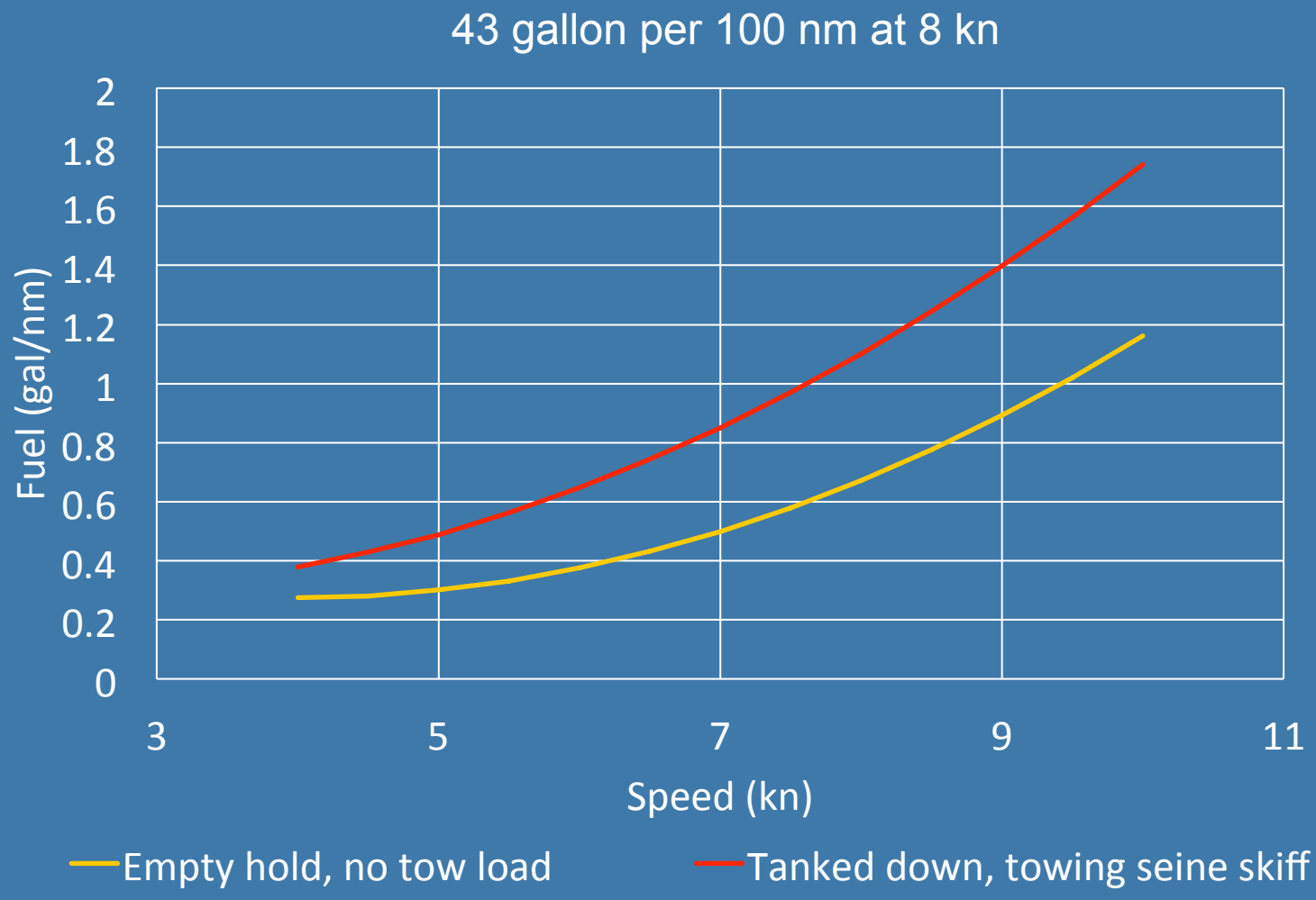
Vessel Configuration--Tanked

45,000 lbs hold capacity
35 gallons per 100 nm at 8 kt



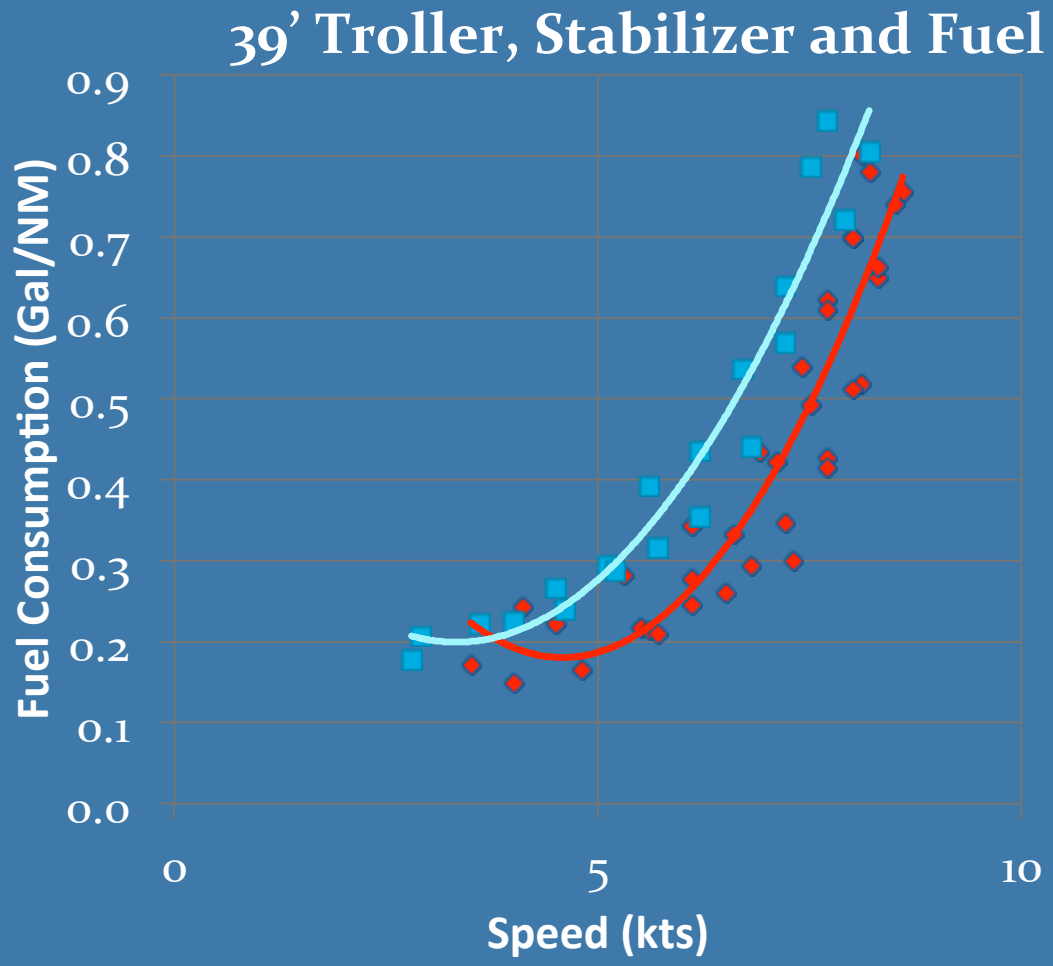
Propulsion Loads:

Vessel Configuration--Towing



Propulsion Loads:

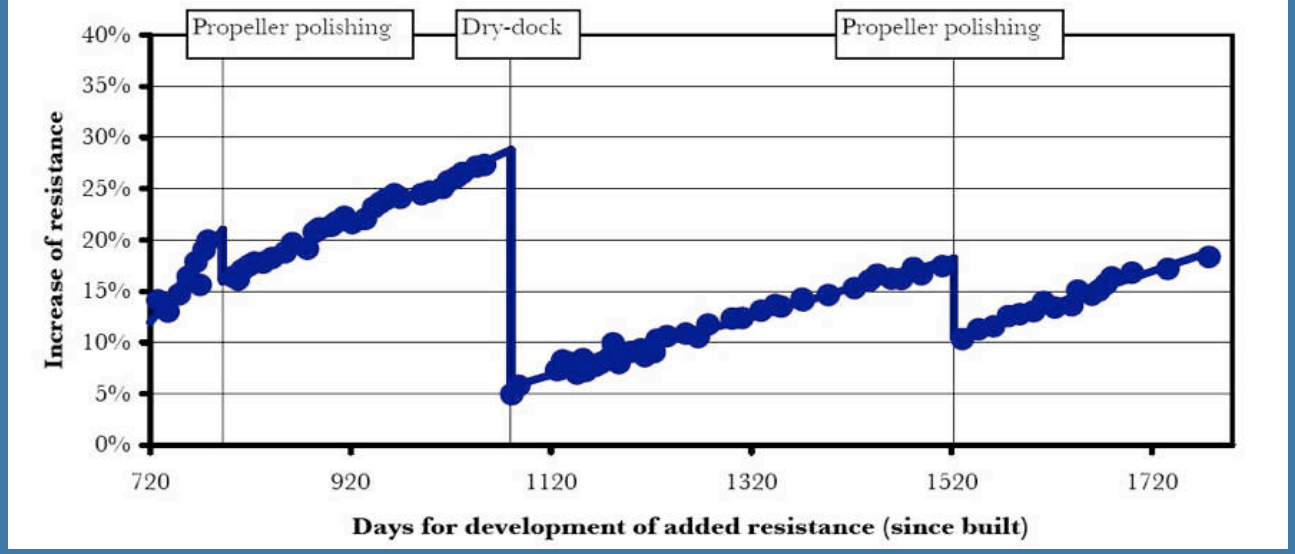
Vessel Configuration--Stabilizers



Fuel Cost:
1,000 NM/yr @ 6kts

With: $1,600
Without: $1,000
Difference:$600

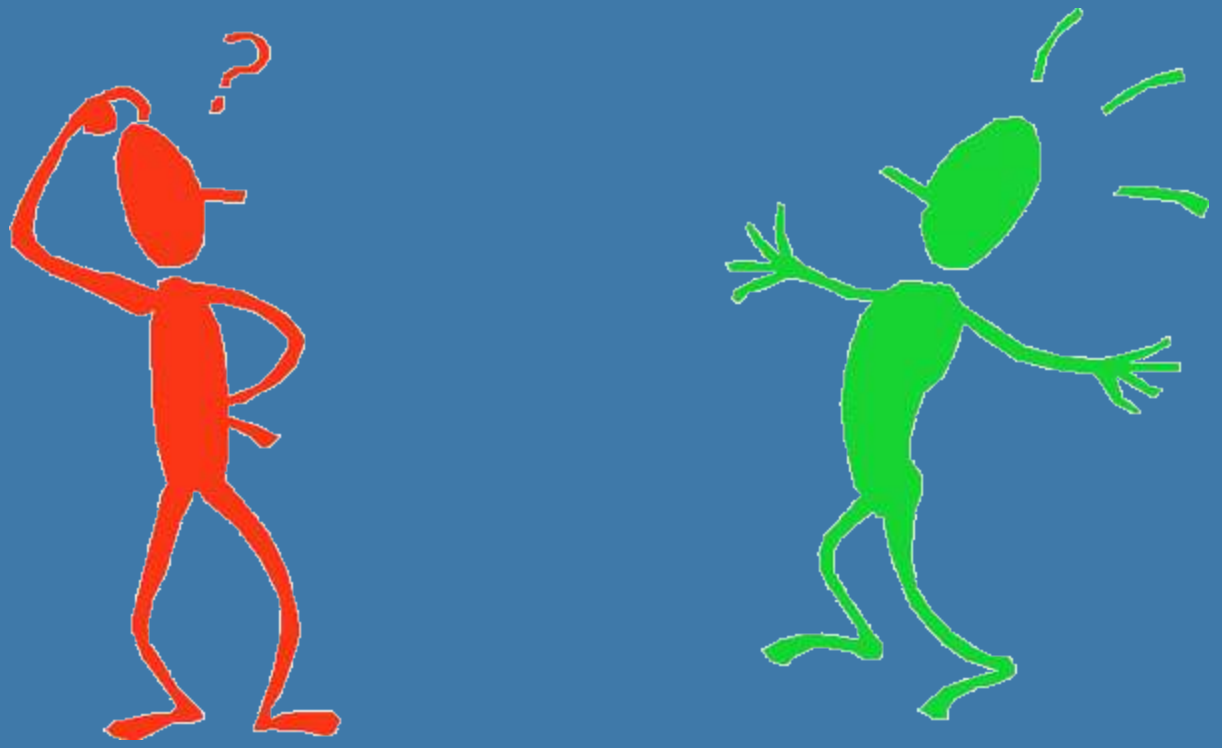
Underlying hull roughness increases with age



Source: Propulsion Dynamics Inc.

Commercial Ship

Questions?

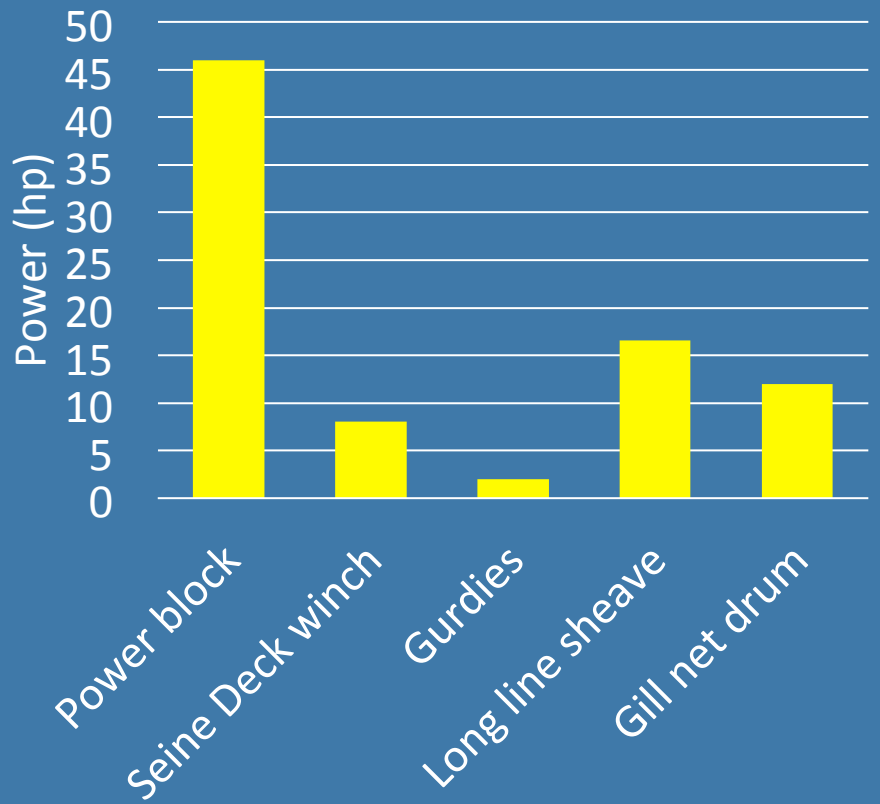


Hydraulic Loads:

- Heat
- Wear/filtering
- Idle loss

Hydraulic Loads:

Measured Hydraulic Loads



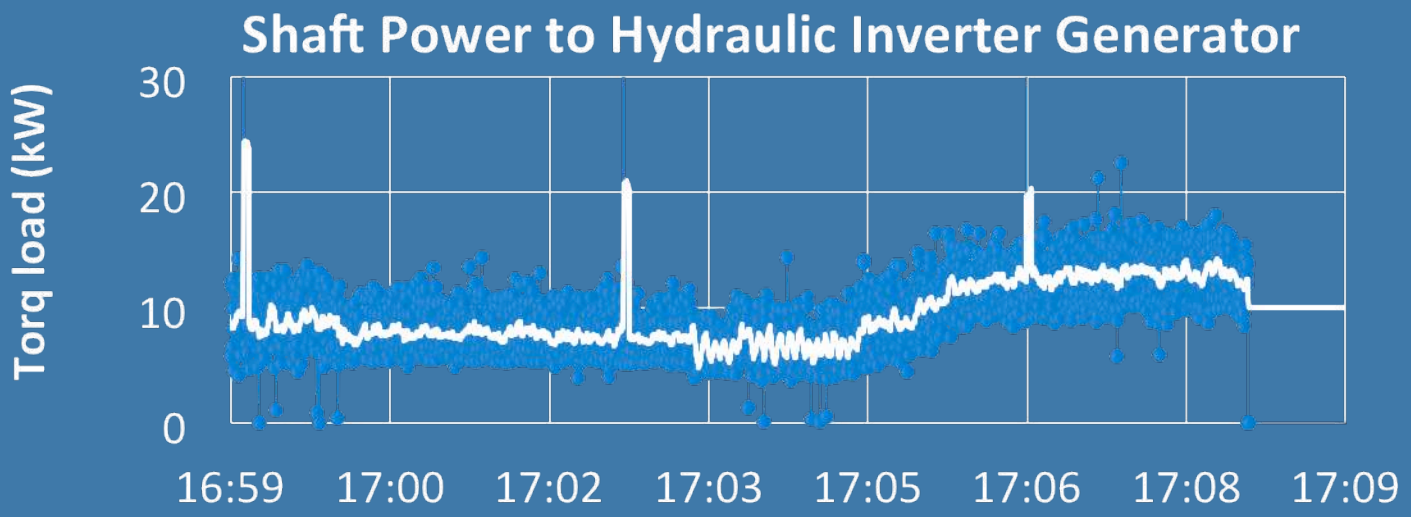
Hydraulic Loads:

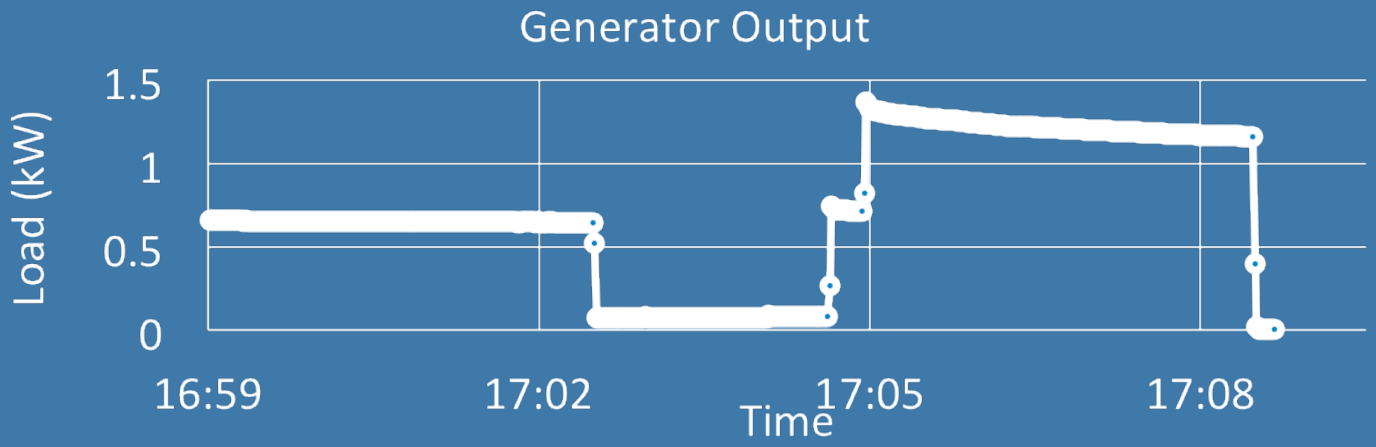
Heat

- Hydraulic Energy Losses are in the form of heat
- Heat is created when hydraulic fluid goes from high pressure to a lower pressure
  - Leaking from high side to low side in pumps and motors
  - Fluid flow through hoses

Heat From Hydraulics Wastes Fuel: Worn Pumps and Motors, undersized hoses, sharp hose bends, keeping pumps on when not needed

Hydraulic Loads

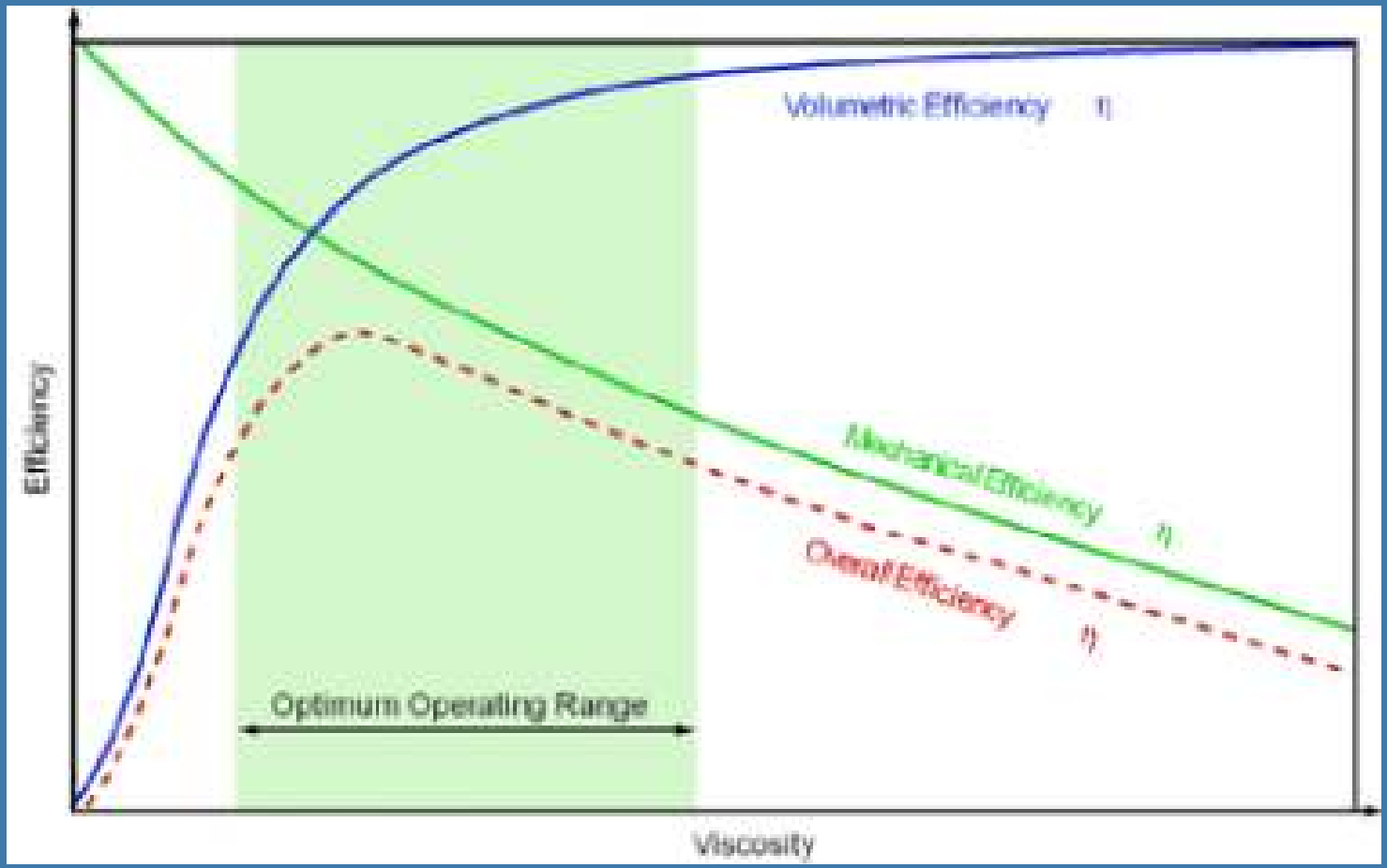




Losses in converting shaft power to hydraulic power to electrical power

Hydraulic Loads:

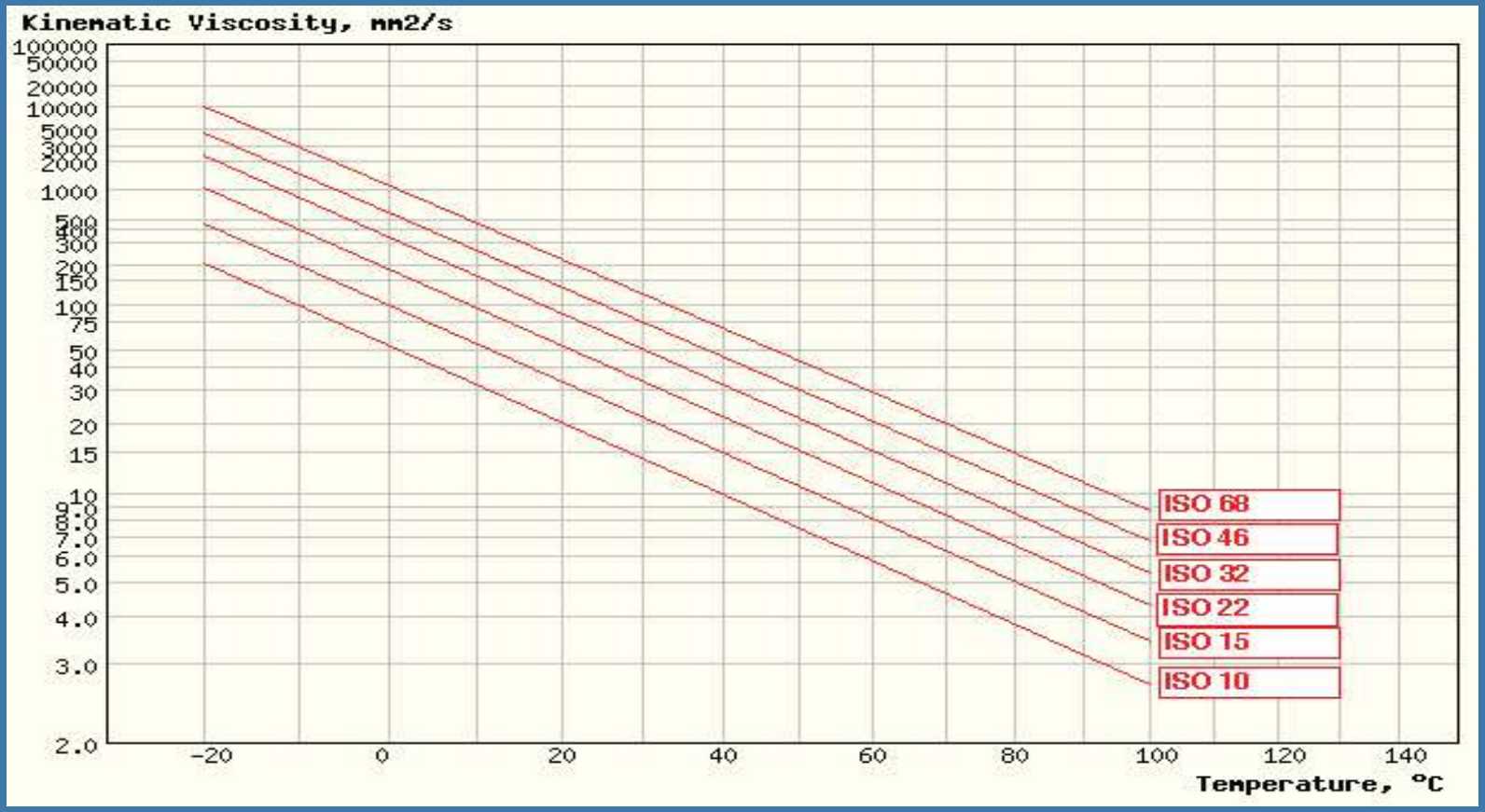
Efficiency vs Viscosity of Hydraulic Oil



Maintain Proper Oil Viscosity

Hydraulic Loads:

Heat



Vickers Viscosity Range = 13 to 54 mm2/s (cSt)

Always check for proper range for your equipment

Hydraulic Loads:

Wear/Filtering

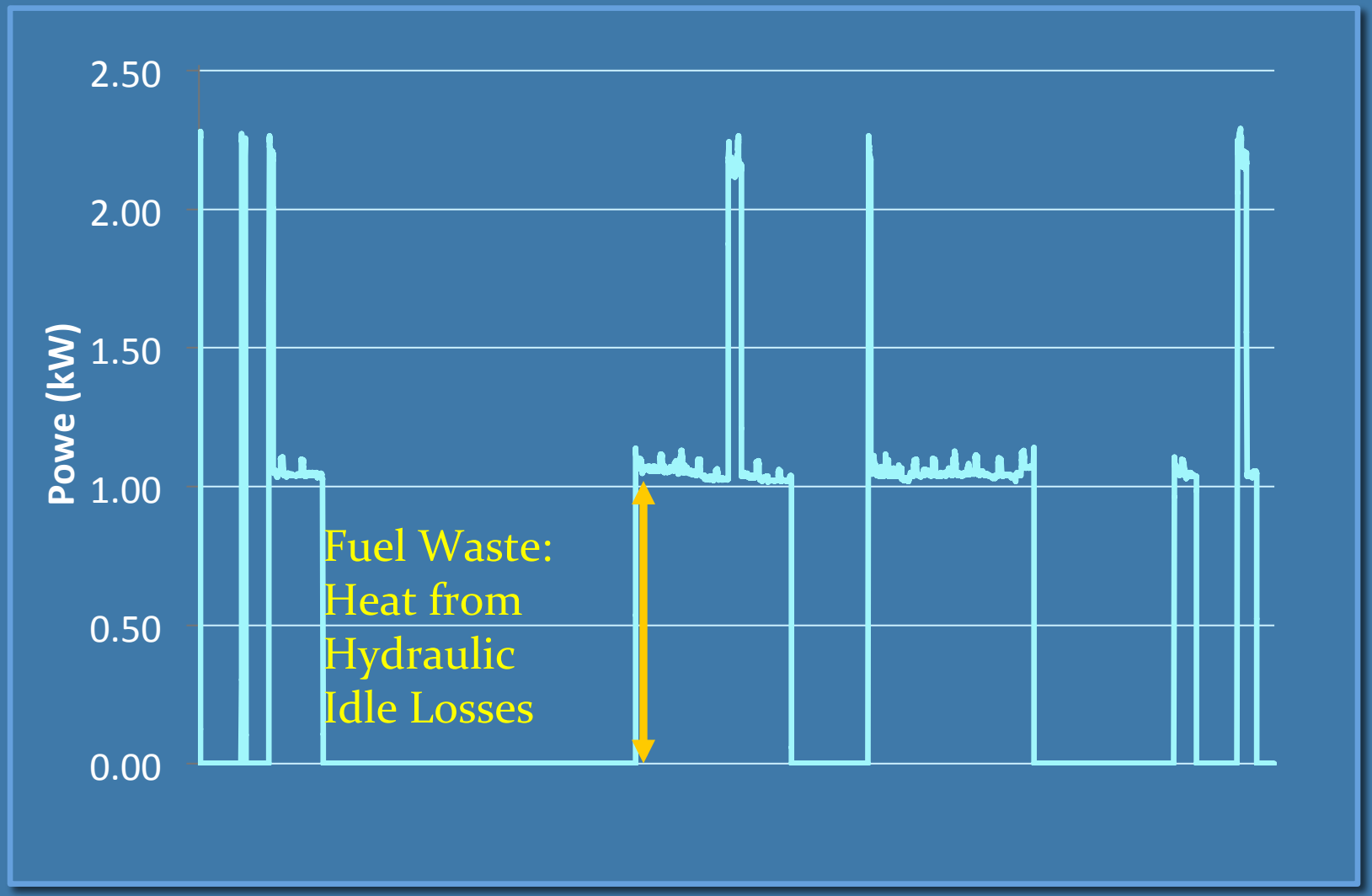
- Contaminants in hydraulic oils increase wear in pumps, motors, and controls
- Worn pumps increase fuel consumption
- Fine filter oil with external filter pump or filter cart (two Filters)
  - 3 micron Absolute fine filter
  - 10 micron water absorbing filter
- Filter New Oil Through Fine Filter When Adding
- Consider Pre-Season Fine Filtering of Hydraulic Oil

Contaminant in hydraulic systems is now recognized as the most frequent cause of malfunction or failure of hydraulic equipment

Vickers: General Product Support Guide

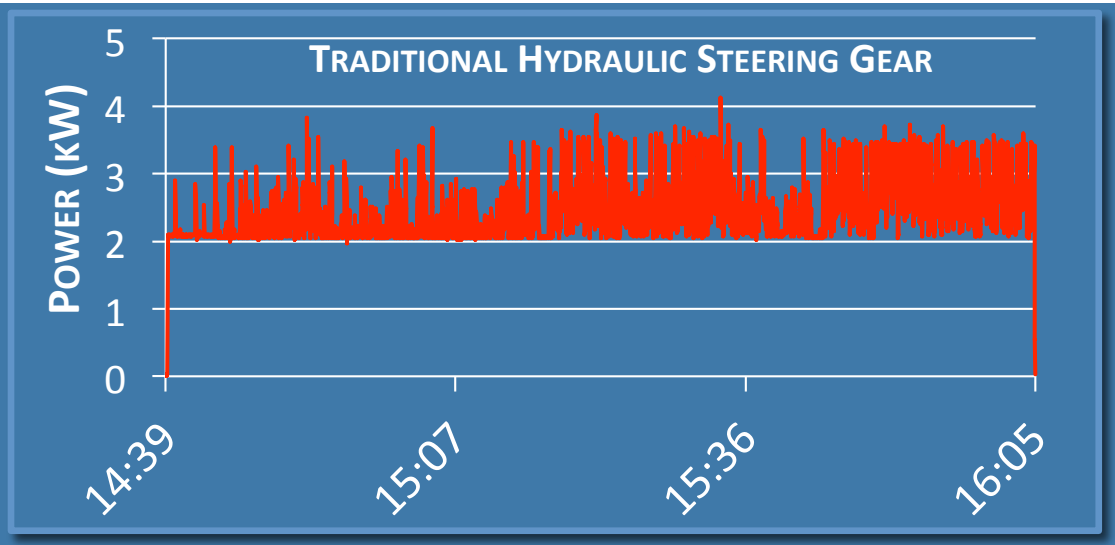
Hydraulic Loads:

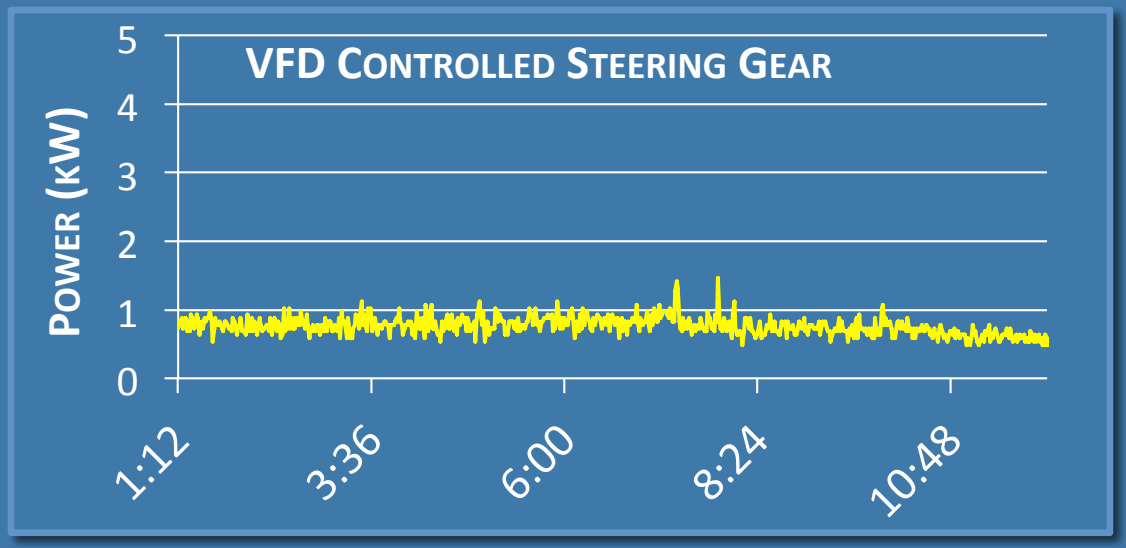
Idle Loss



Hydraulic Loads

VFD Electrically Driven Hydraulic Pump

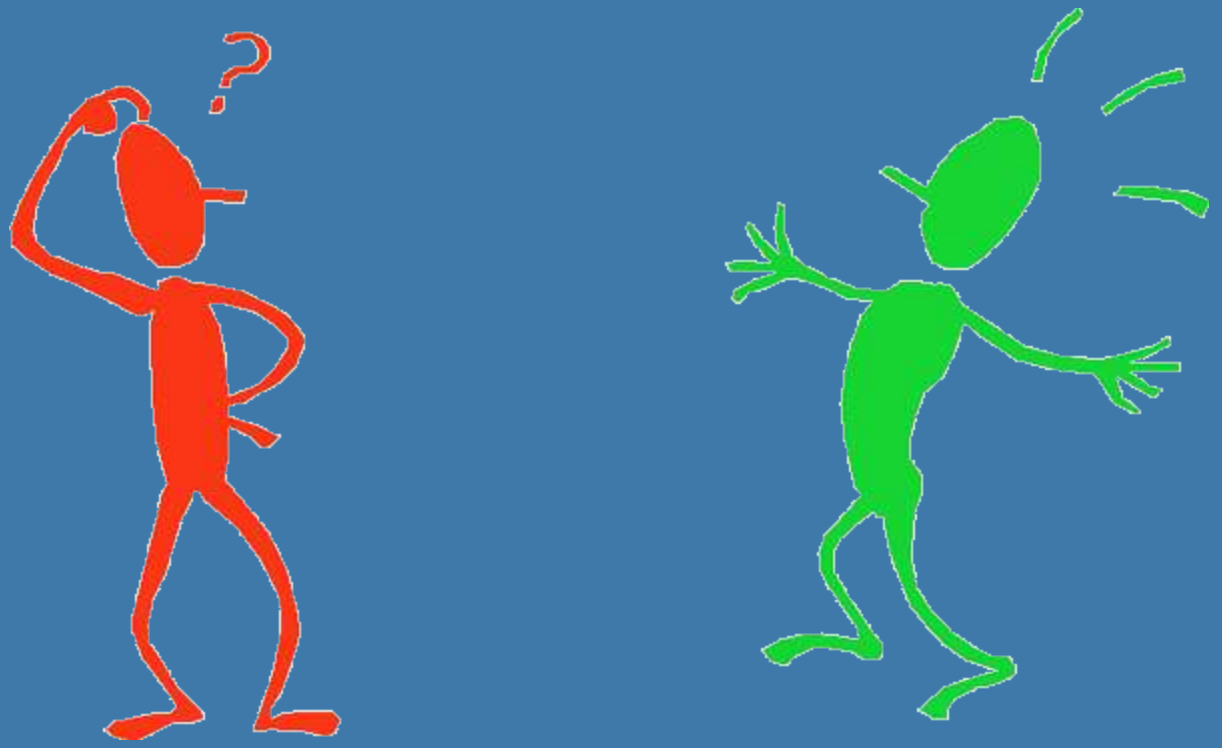




VFD on Hydraulic Steering

- 70% reduction in Energy Usage
- No Cooler Needed

Questions?

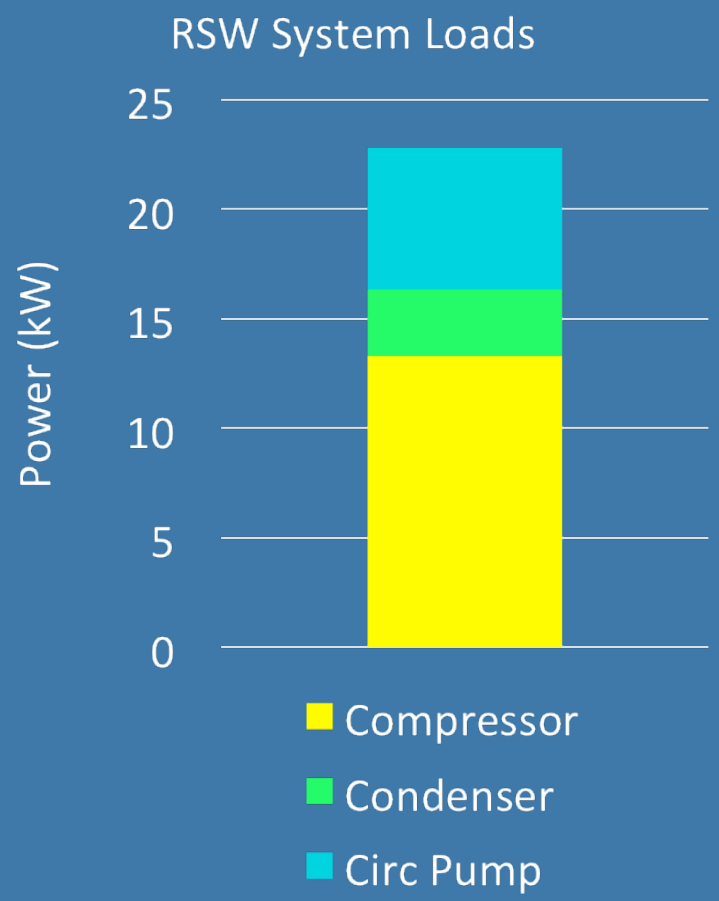


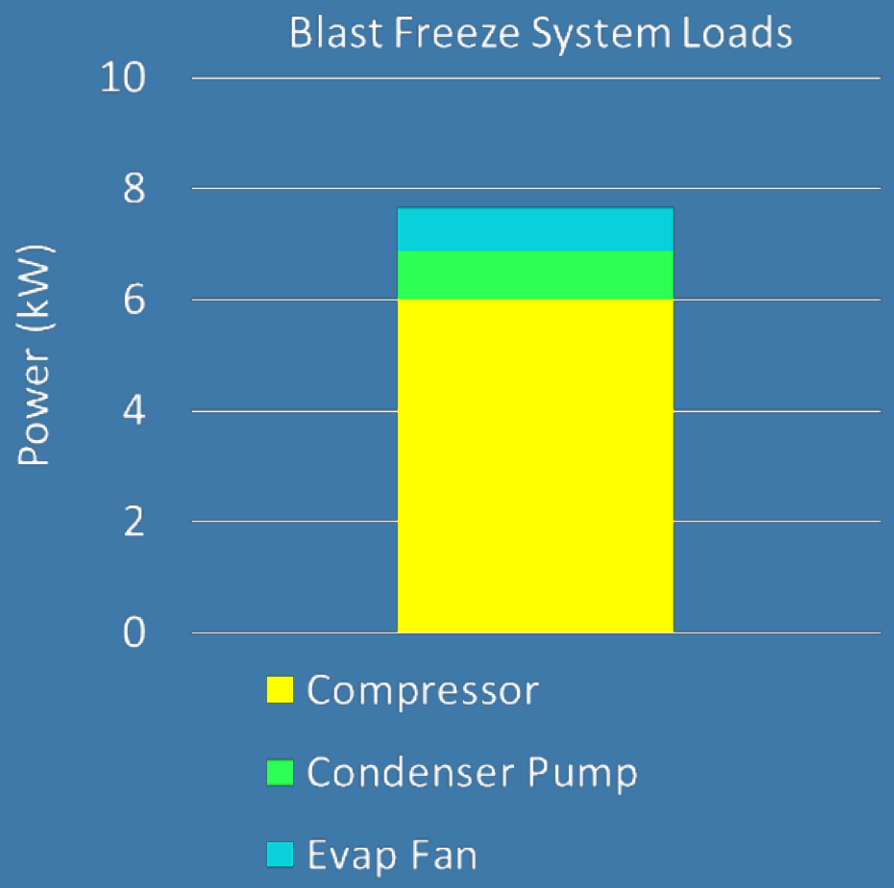
Refrigeration Loads

- Discharge Pressure
- Variable Frequency Drives
- Power source—Electric vs. hydraulic

Refrigeration Loads:

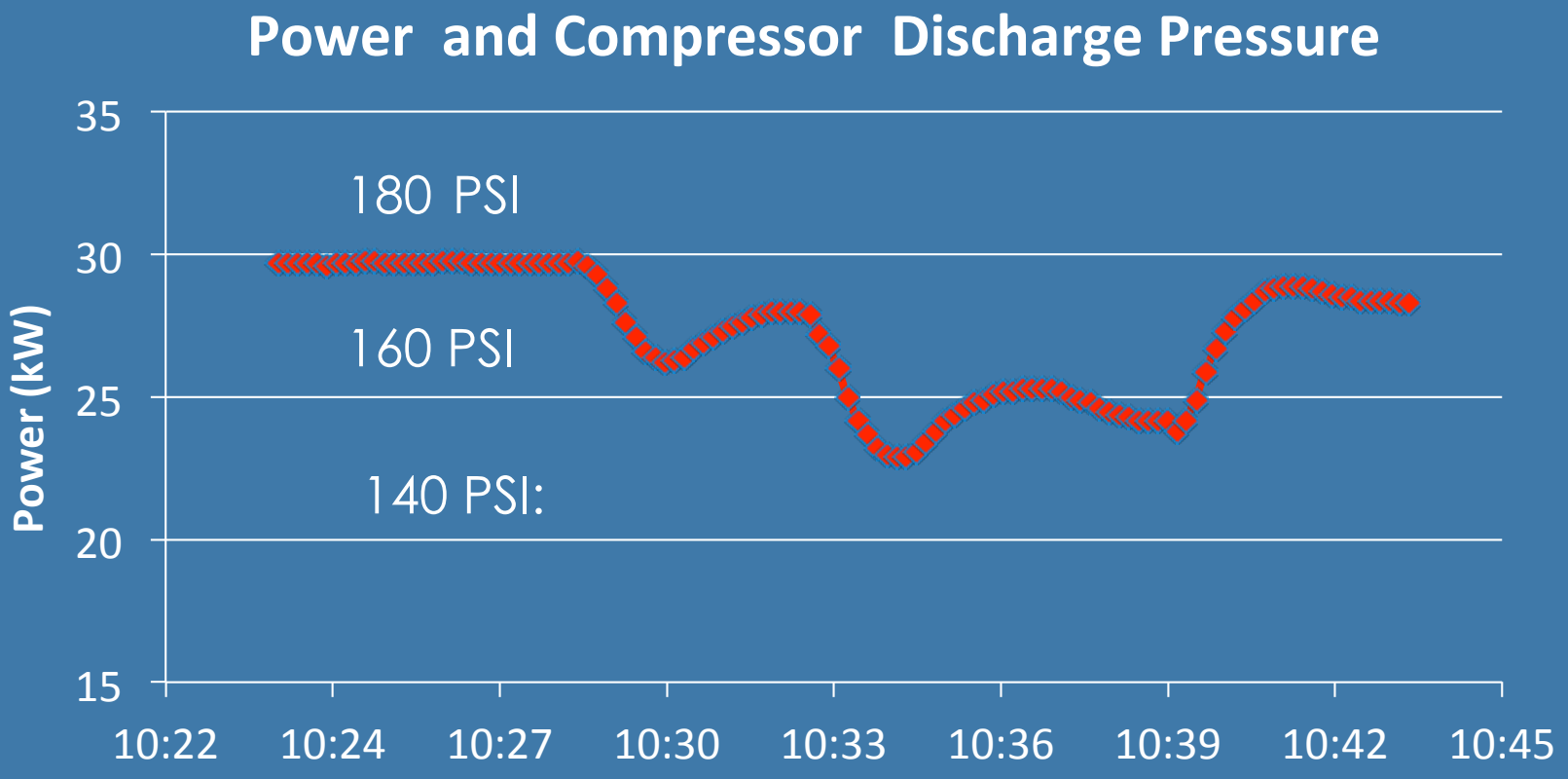
Measured Refrigeration Loads





Refrigeration Loads:

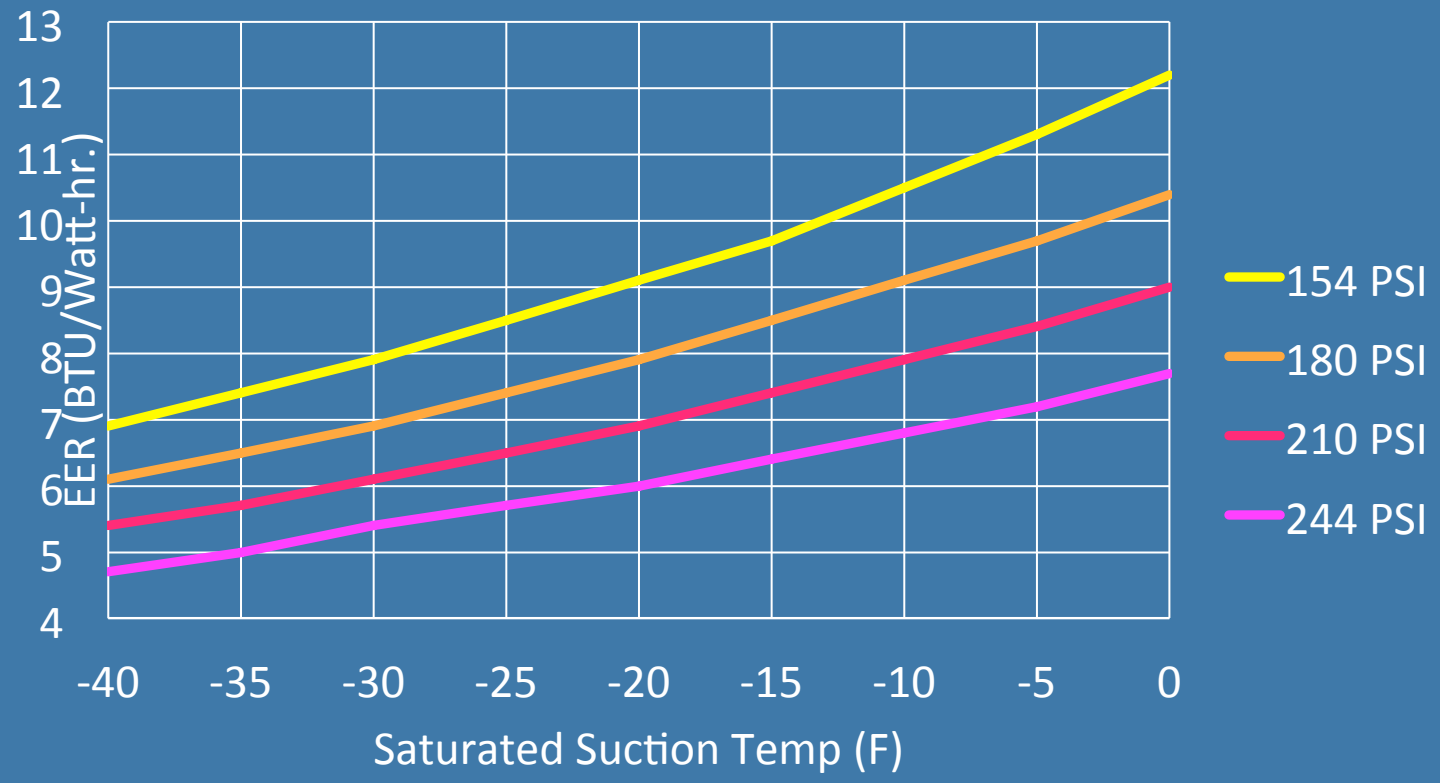
RSW Compressor Discharge Pressure



High Discharge Pressure Waste Fuel

Refrigeration Loads:

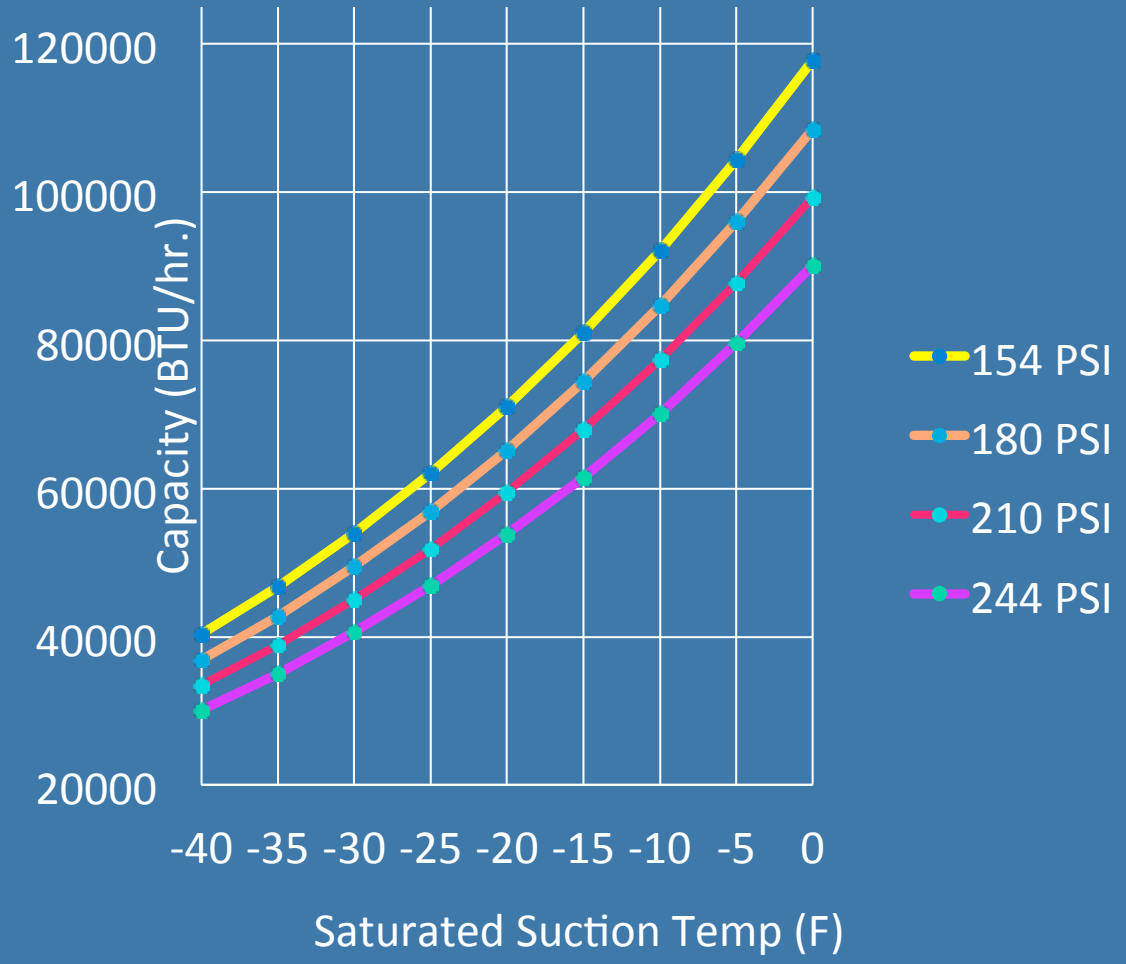
Discharge Pressure And Efficiency



Compressor efficiency increases as discharge pressure decreases

Refrigeration Loads:

Discharge Pressure And Capacity



Refrigeration capacity increases as lift decreases

Refrigeration Loads:

Variable Frequency Drives (VFDs)

- VFD Controllers adjust AC motor RPM's to meet torque demand

Motor Variable Frequency Drives (VFD)
Steering Gear, Fans, Pumps, Winches

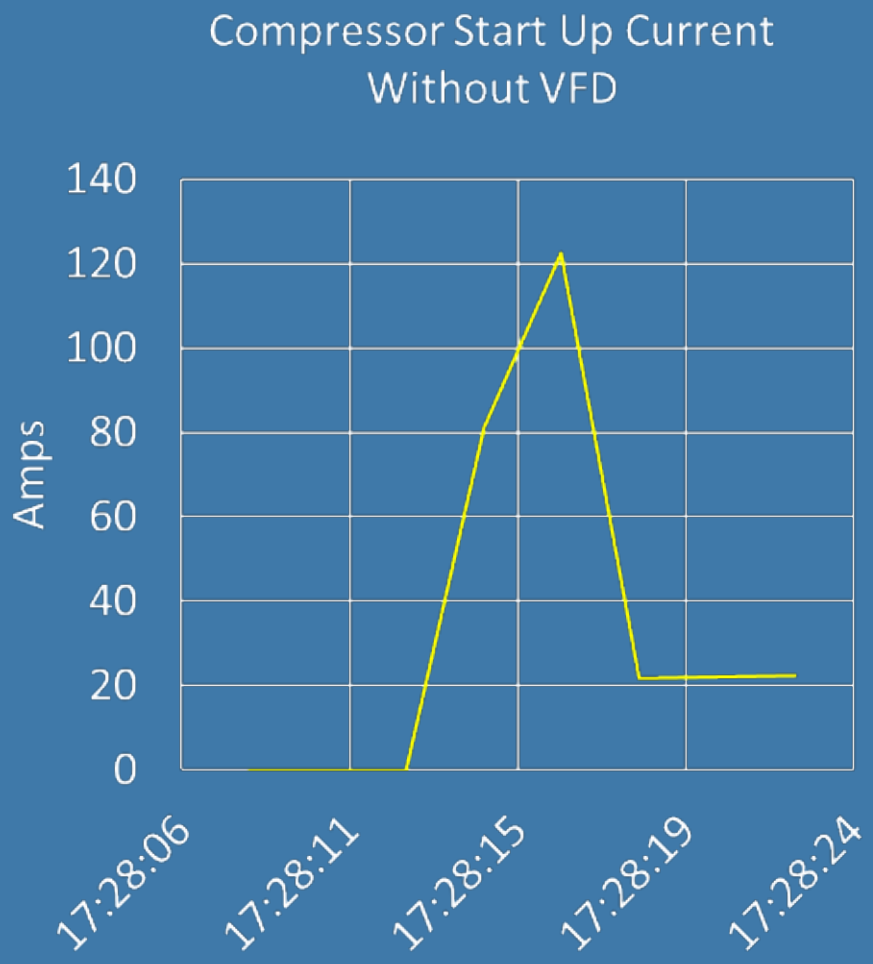
Refrigeration Loads:

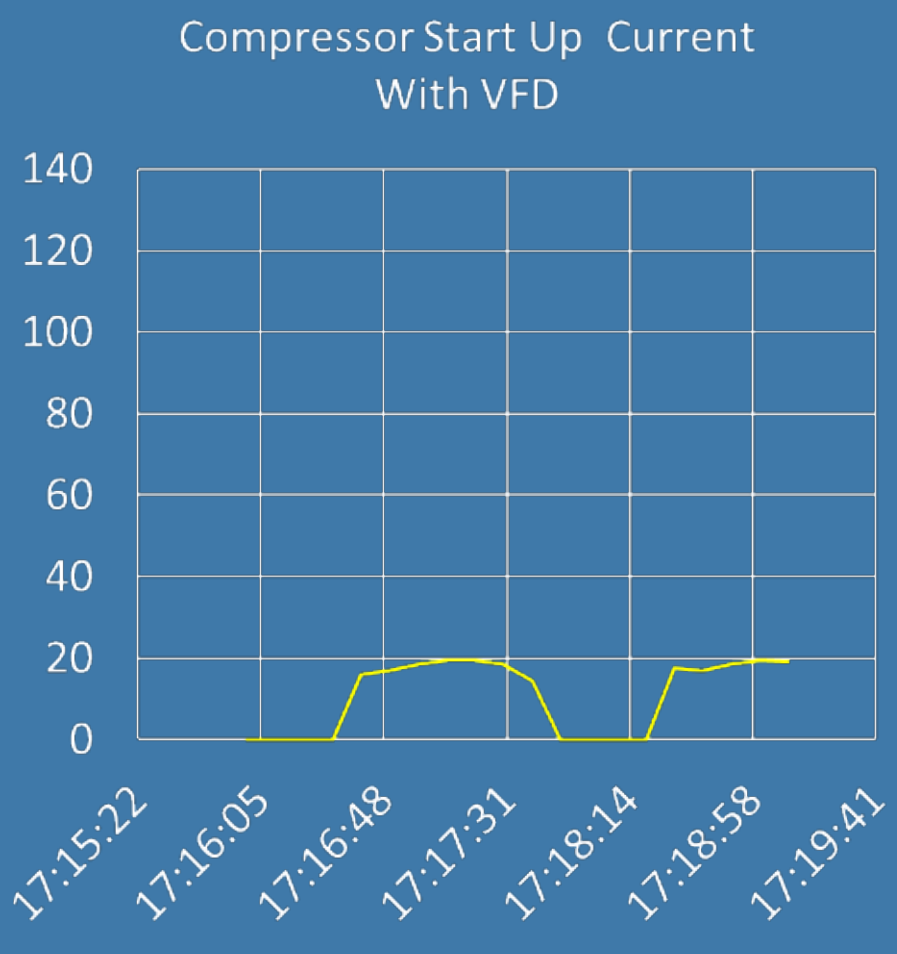
VFD

- Eliminates short cycling
- Matches compressor capacity (RPM) with load
- Corrects Power Factor
- Reduces start-up current demands

Refrigeration Loads:

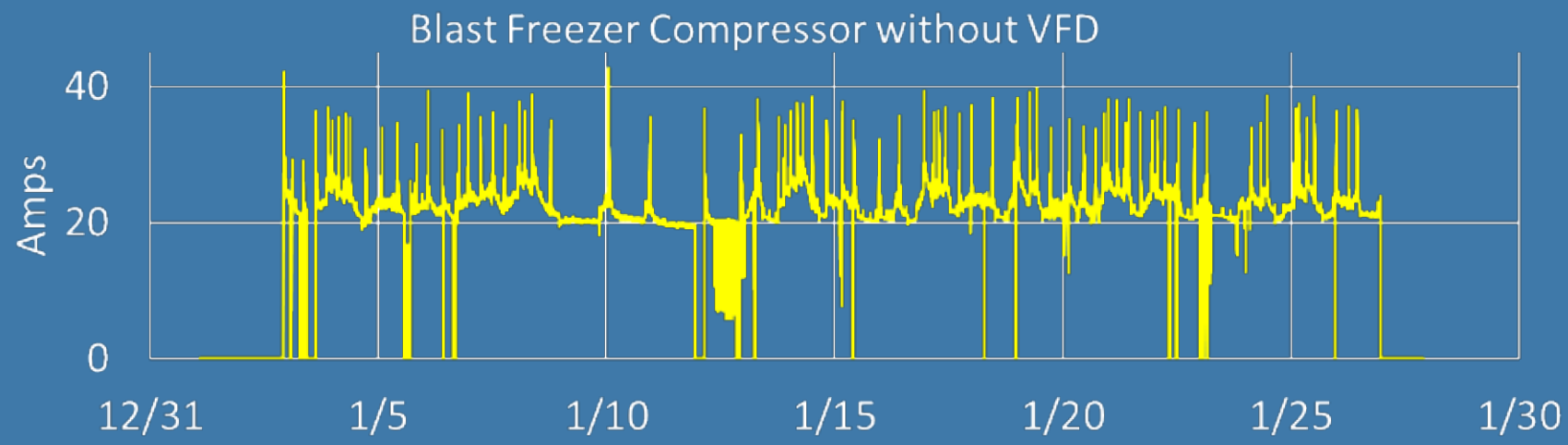
VFD Use on Refrigeration Compressor

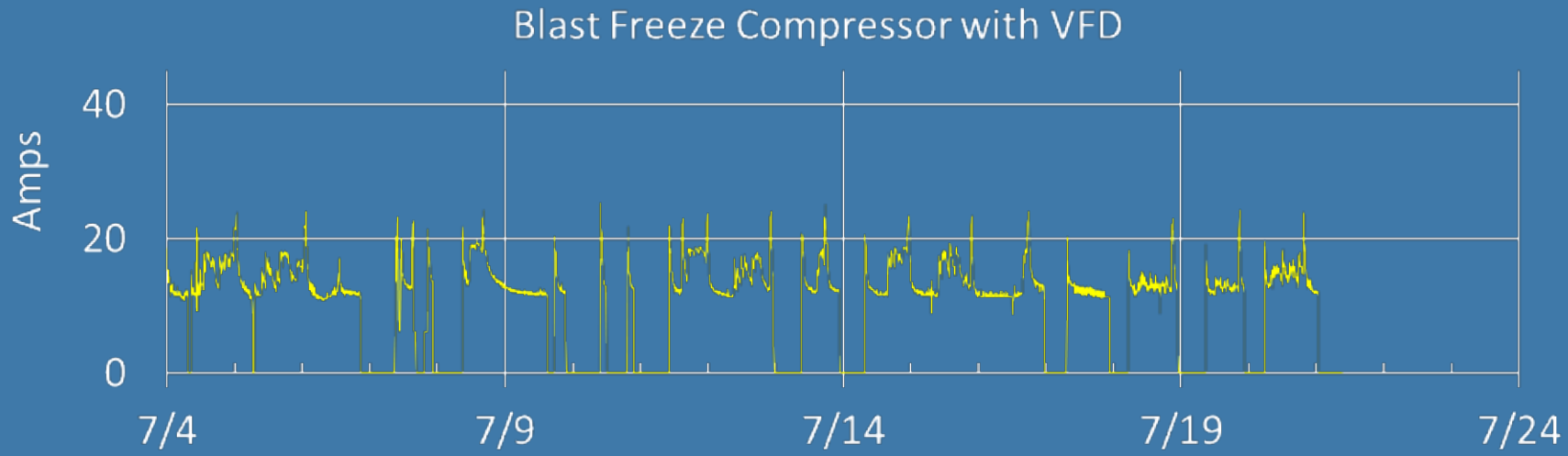




Refrigeration Loads:

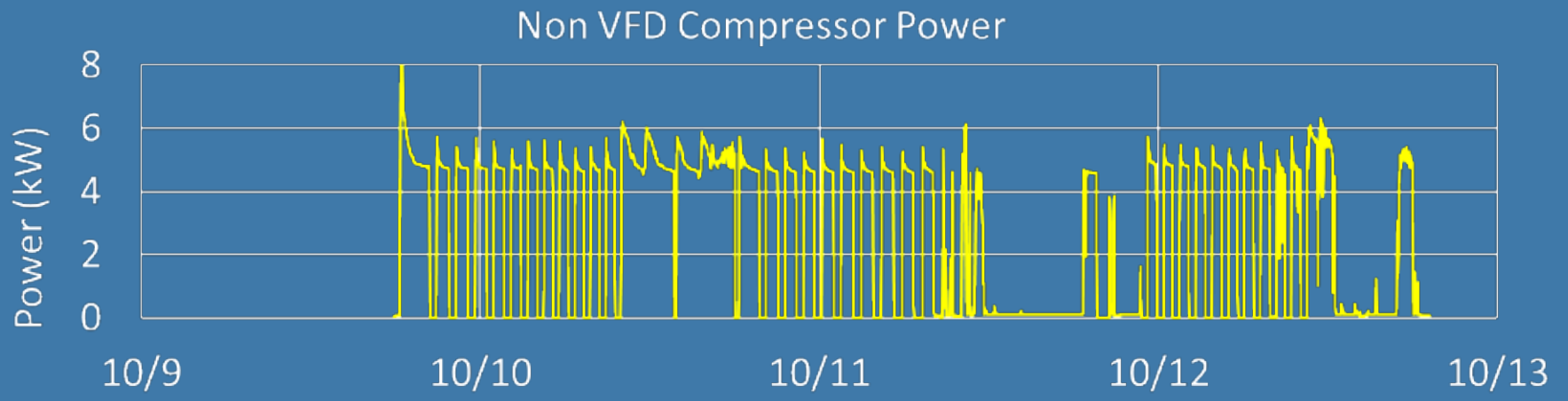
Amps: VFD Compressor Comparison

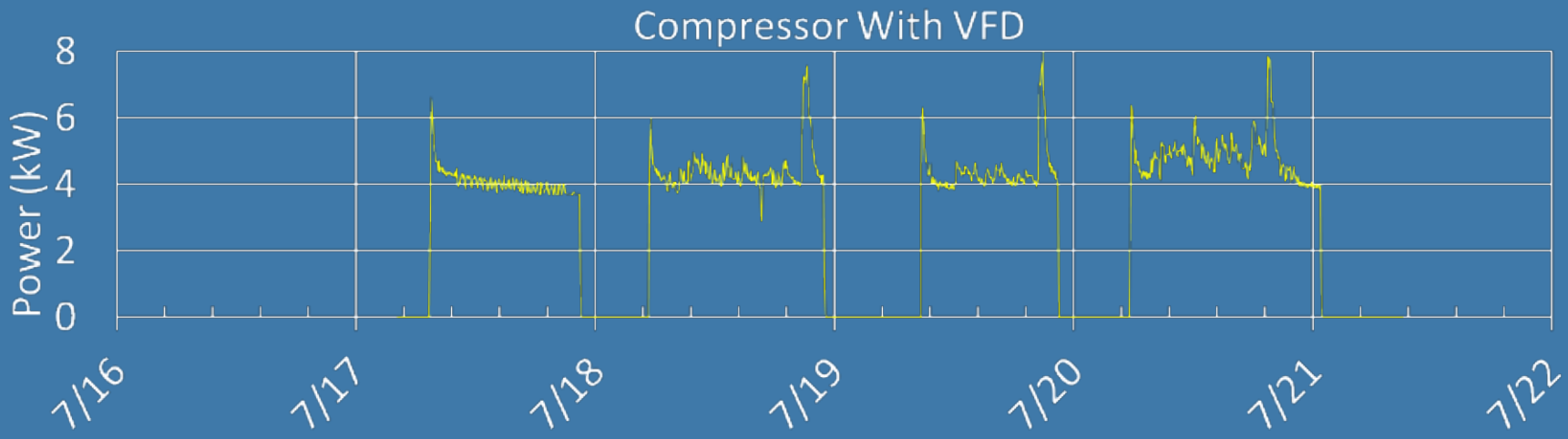




Refrigeration Loads:

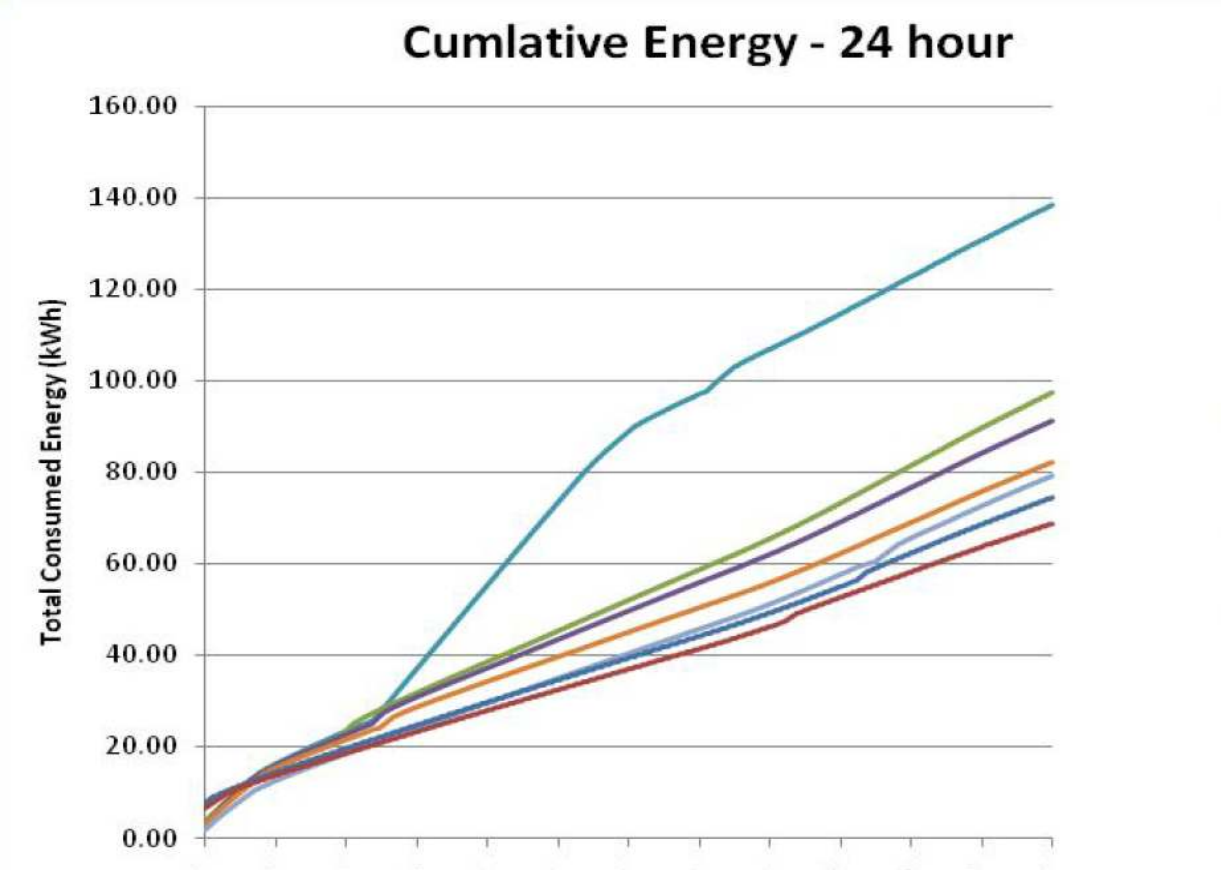
Power: VFD Compressor Comparison





Refrigeration Loads

Compressor Efficiency & Maintenance

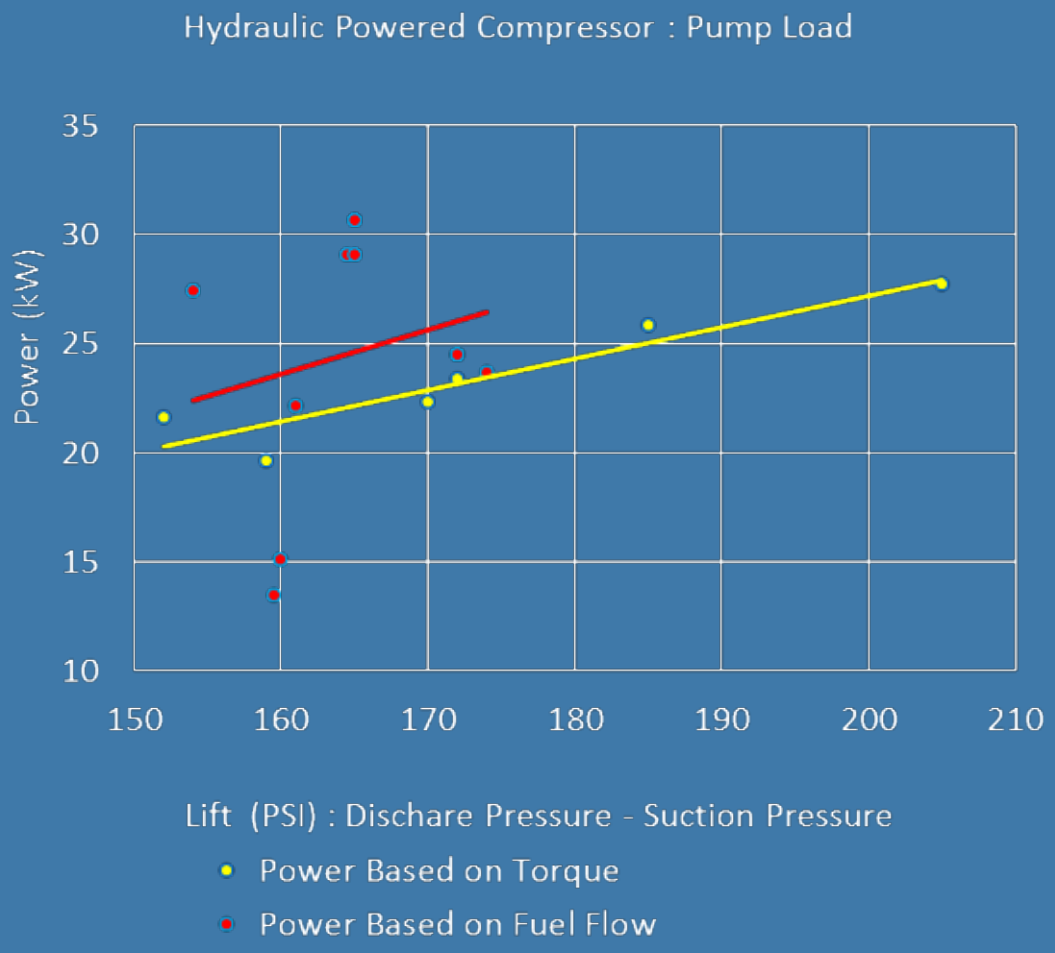


Maintenance vs. Technology
Compressor Power on Reefer Containers

Refrigeration Loads:

Power Source

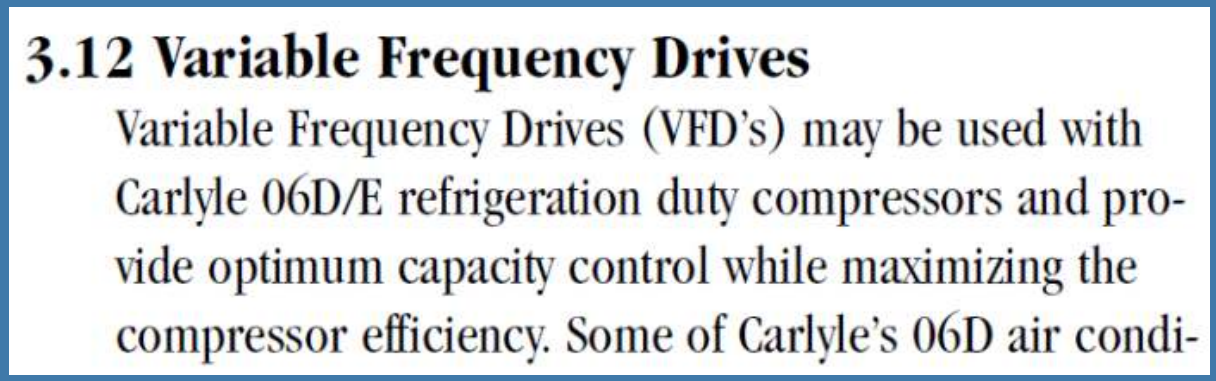
- More than 2X HP required for hydraulic drives
- Evaluate trade-off between 1 engine and 2
  - Base requirement for 2nd engine
  - Improved efficiency of right sized engine
- VFD provide capacity control similar to hydraulic drives



Refrigeration Loads:

Summary

- Keep Discharge Pressure at Minimum
  - Keep Condenser Clean
  - Provide Sufficient Cooling Water Flow
- Keep Suction Pressure as high as possible
- Maintain Proper Refrigerant Level
- Maintain Compressor

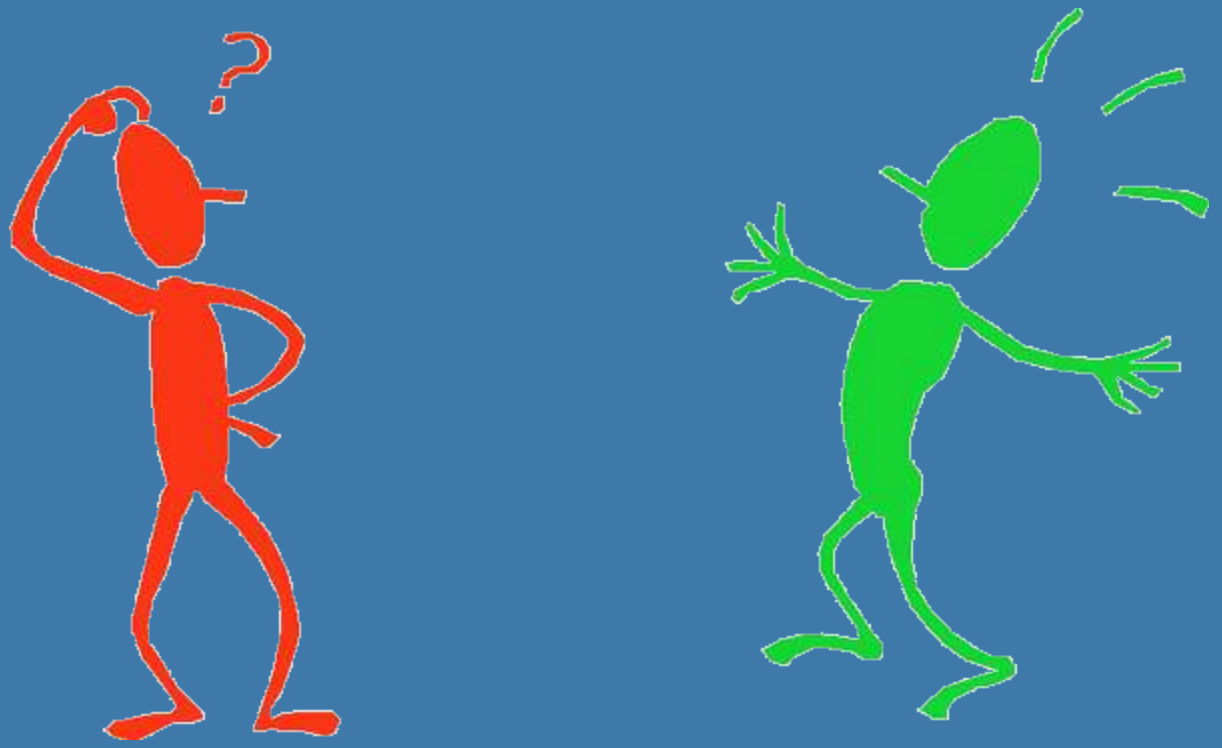


3.12 Variable Frequency Drives

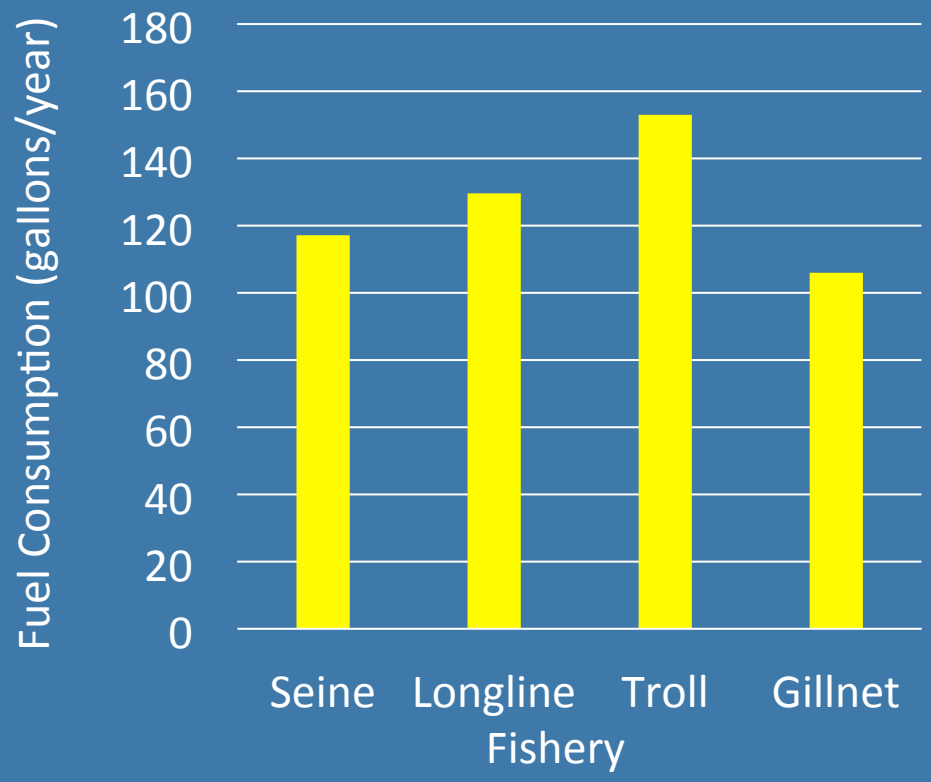
Variable Frequency Drives (VFD's) may be used with Carlyle 06D/E refrigeration duty compressors and provide optimum capacity control while maximizing the compressor efficiency. Some of Carlyle's 06D air condi-

Carlyle 06D/D Application Guide

Questions?



DC Electric Loads

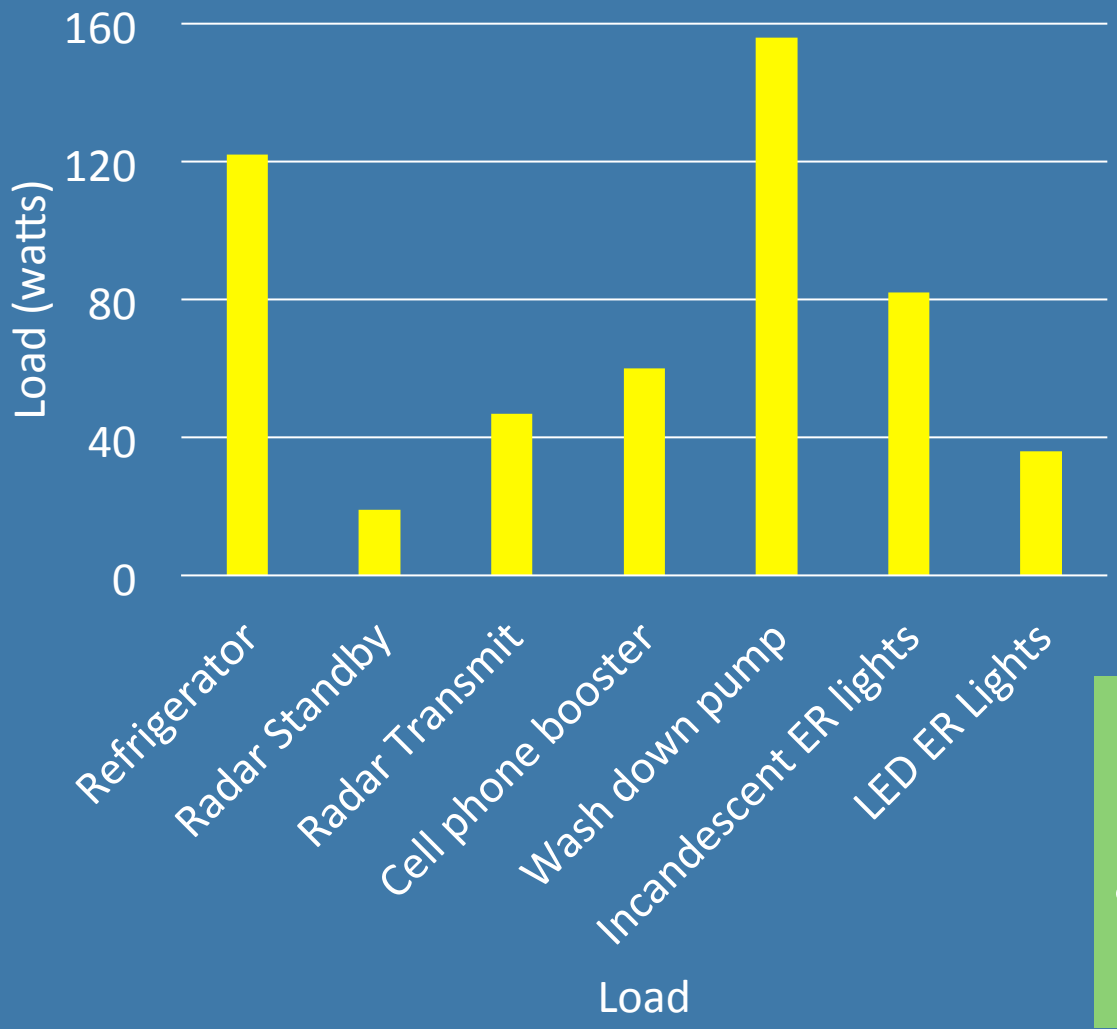


- Alternator sizing
- Belts
- Premium efficiency

DC Loads are small but Not FREE

DC Electric Loads:

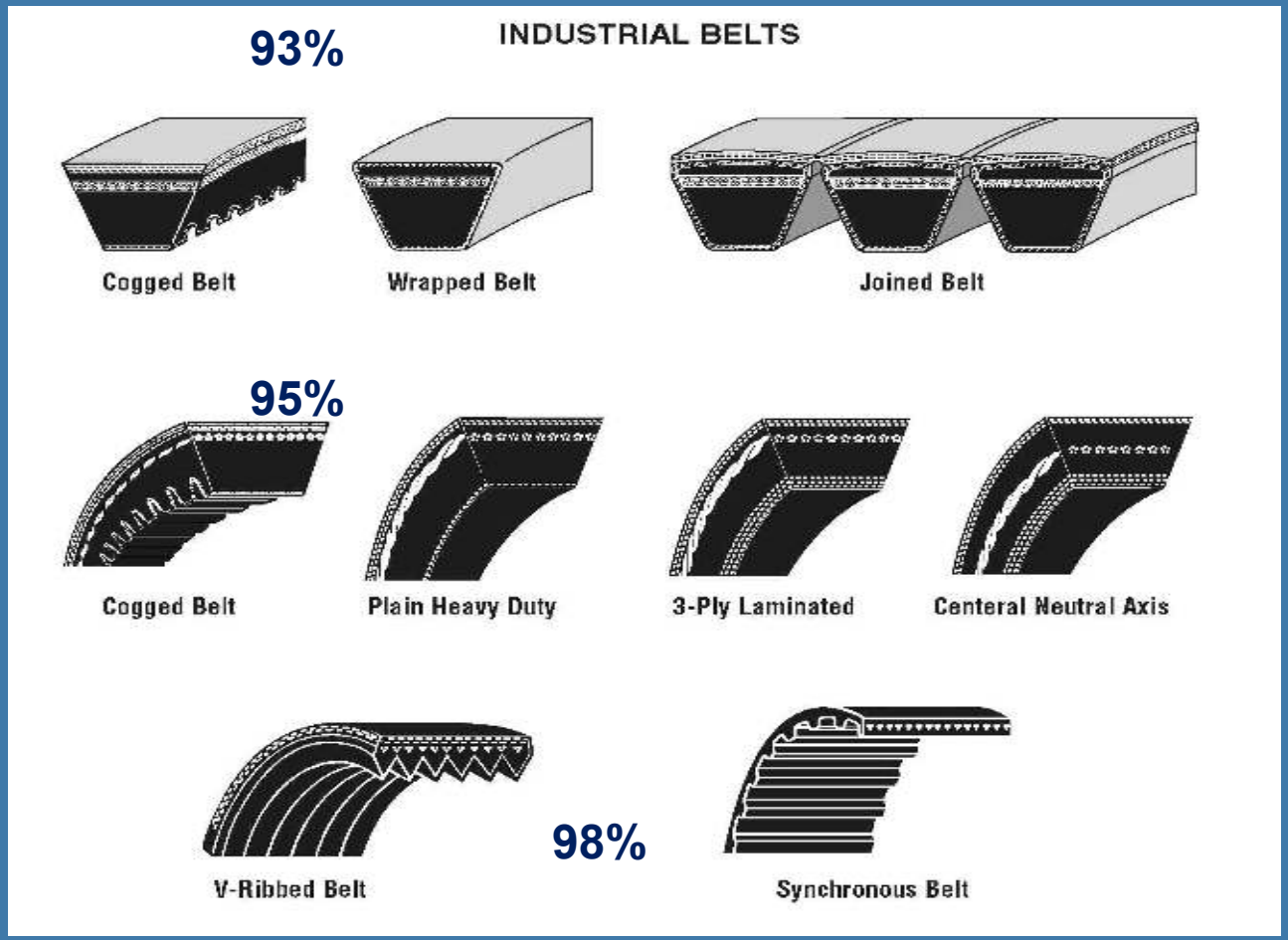
DC Equipment Power



DC loads may be small but some are easy and low cost to improve.

DC Electric Loads:

Belts



Efficiency Varies by:

- Belt Type
- Tension
- Pulley Size

- Slippage decrease efficiency ~5%

Energy Loss and Efficiency of Power Transmission Belts, Third World Energy Engineering Congress, The Association of Energy Engineers

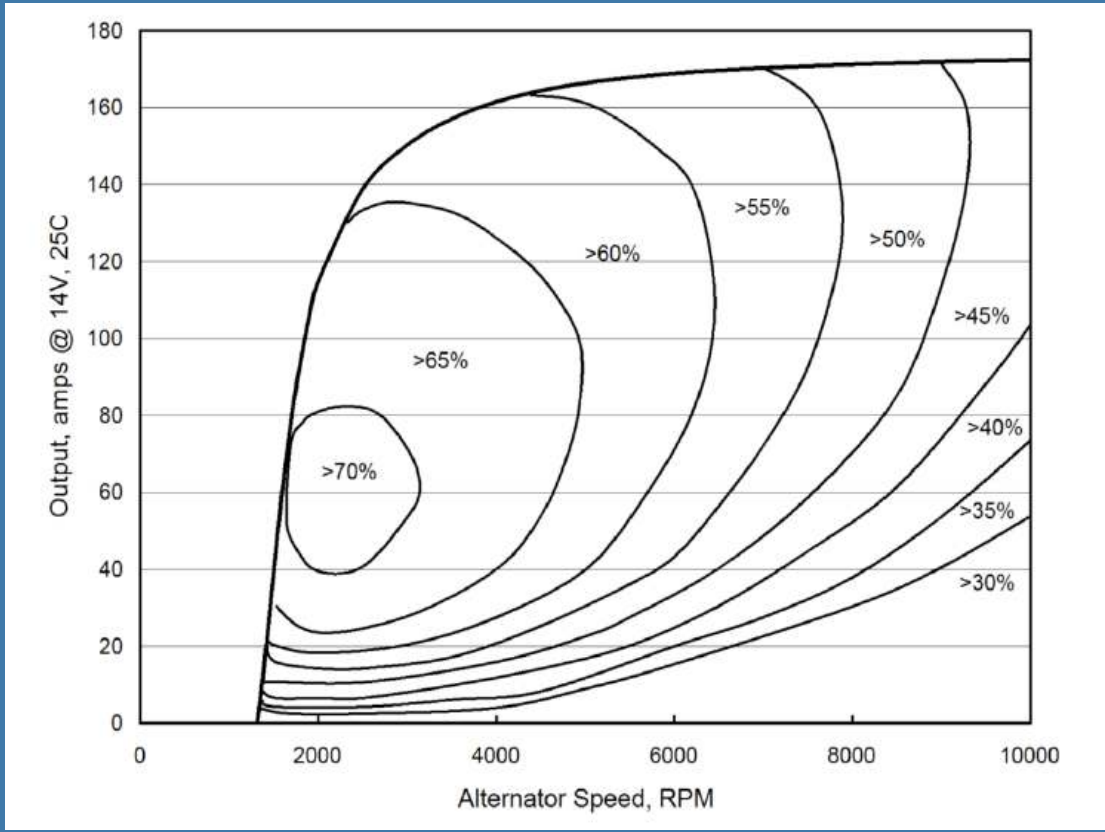
DC Electric Loads:

Premium Efficiency

DC System
Alternator Efficiency:
45% to 85%

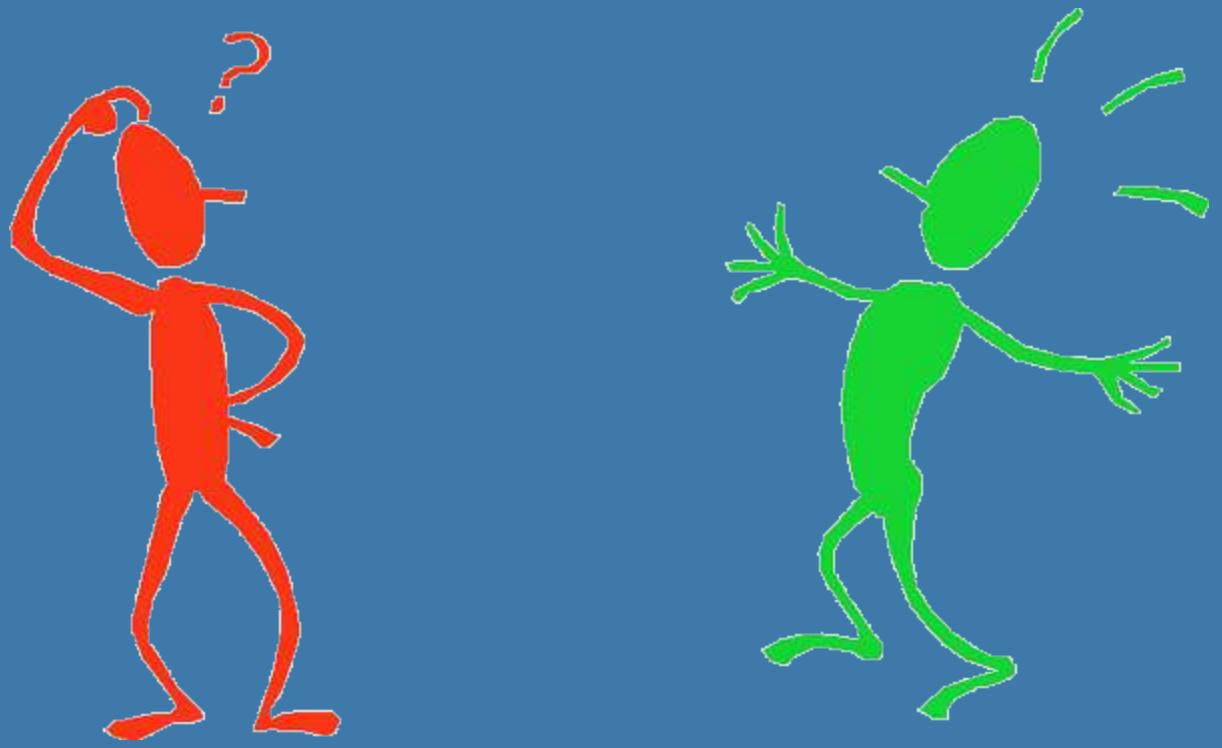
DC Electric Loads:

Alternator Sizing



White Paper: Improving Alternator Efficiency Measurably Reduces Fuel Cost:
Mike Bradfield, MSME, Remy Inc

Questions?

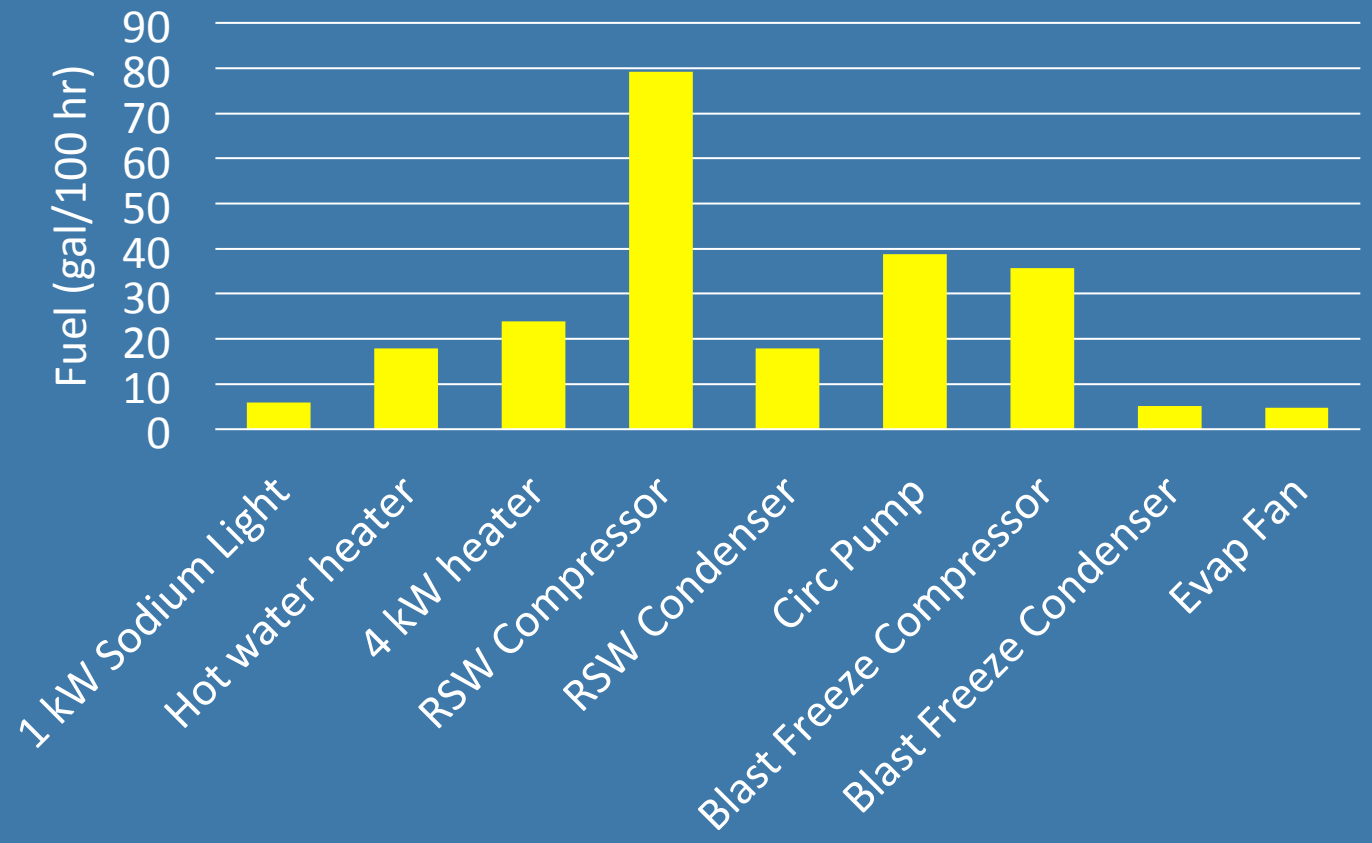


AC Electric Loads:

- Right size gen sets
- Inverters
- Premium efficiency motors

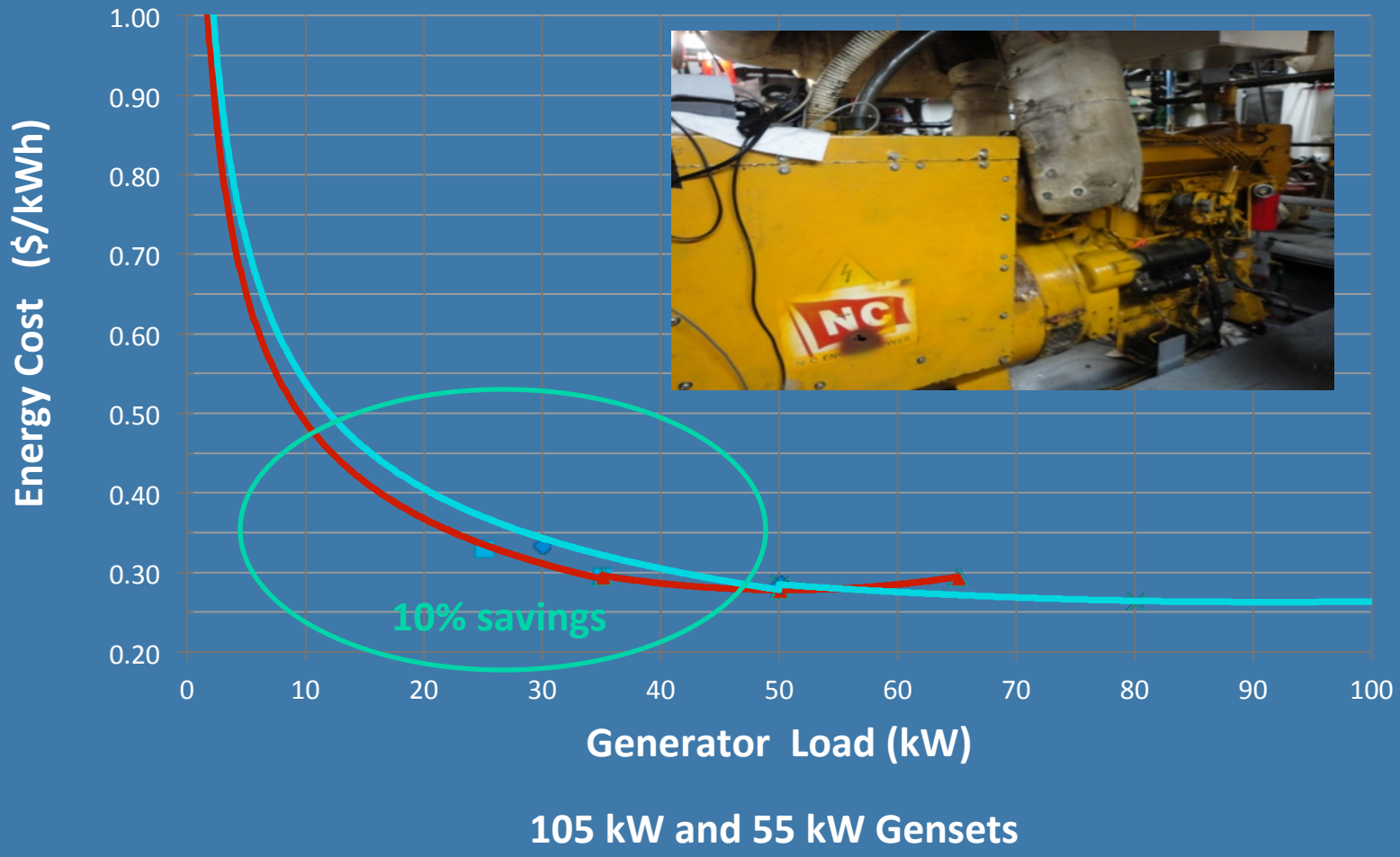
AC Electric Loads:

Measured Loads



AC Electric Loads:

Right Size Gen-Sets



105 kW and 55 kW Gensets

AC Electric Loads:

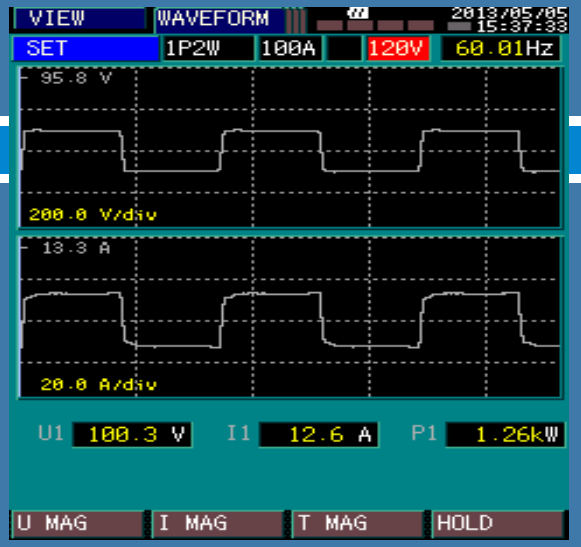
Right Size Gen-Sets

Load (kW)	Annual hours	Cost with 105 kW Engine	Cost with 55 kW Engine	Cost with 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

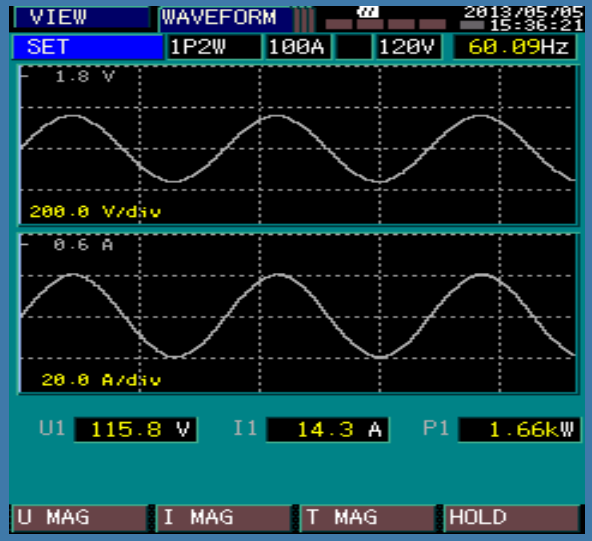
AC Electric Loads:

Inverters

- **Square Wave**
  - Issues with sensitive gear
  - Increases energy consumption
  - Lowest Cost
- **Modified Wave**
  - Less equipment sensitive
  - Better efficiency
  - Modest cost
- **True Sine Wave**
  - No issues with sensitive gear
  - Same or better than shore power
  - Best efficiency for gear
  - Highest Cost



Square Wave Inverter

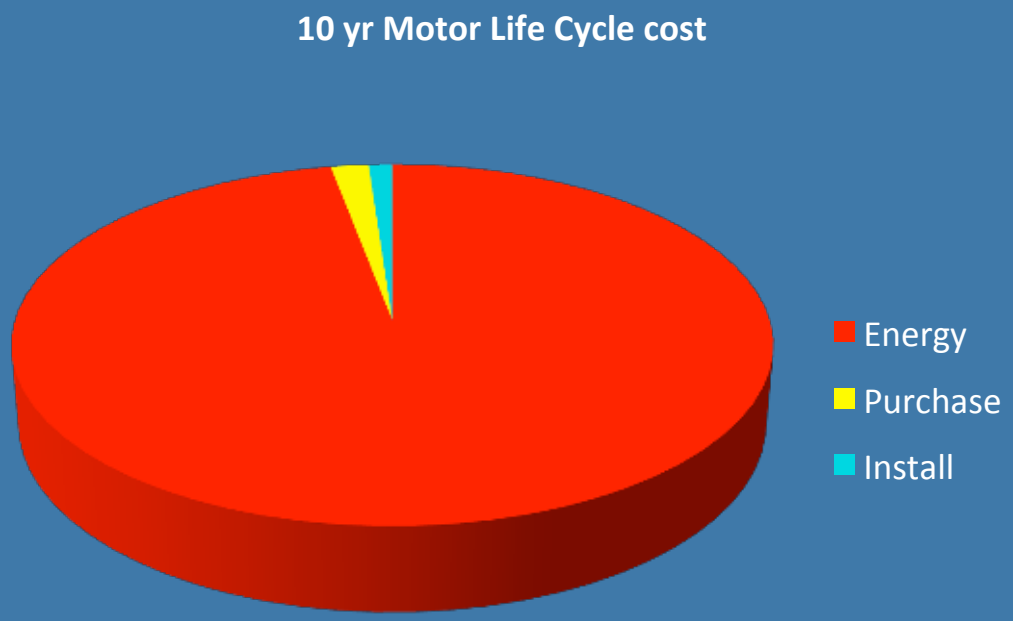


Shore Power

AC Electric Loads:

Premium Efficiency Motors

Purchase price: $321
Install cost: $100
Operating cost/yr.: $735



Motor life: 10 years
Total operating cost: $7,350
% operating costs: 95%
% purchase and install: 5%

AC Electric Loads:

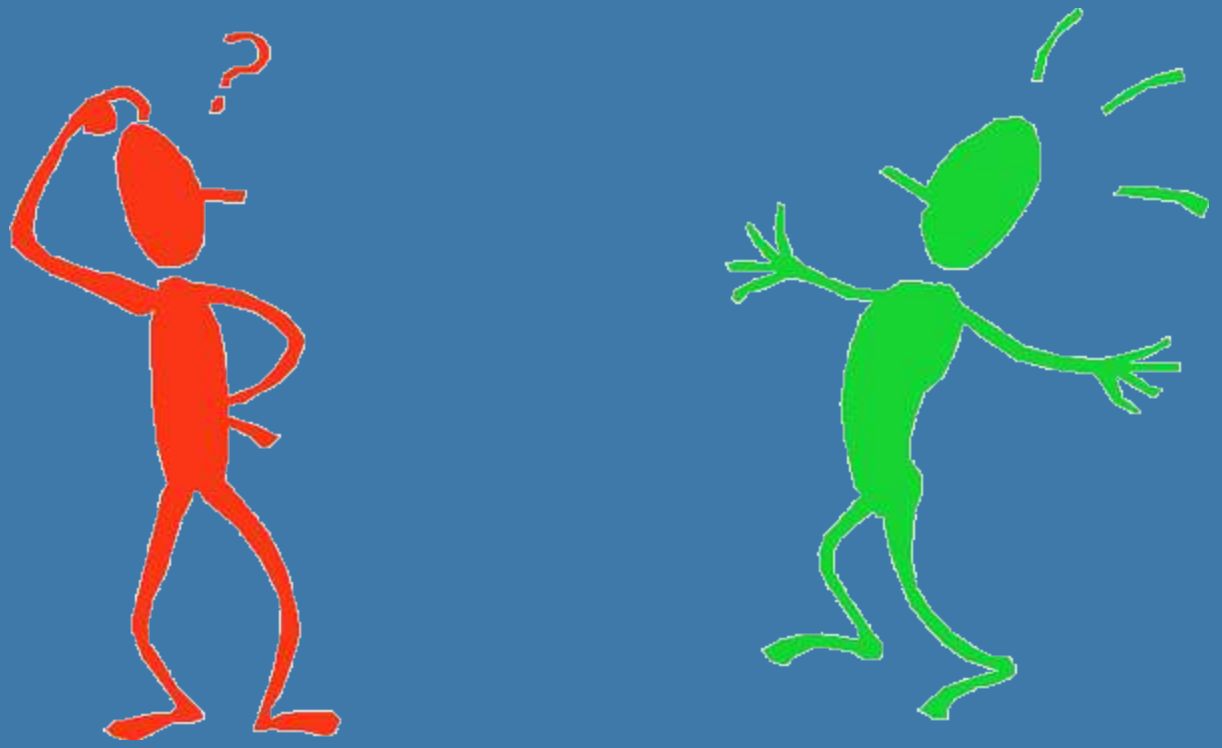
Premium Efficiency Motors

- **68% Standard Efficiency Motor** - 1 HP Circulating Pump
  - Input Power: 1.47 HP
  - Cost for 1000 hrs/yr operation @ $0.5/HP: $735
  - Purchase Price :$321
- **82.5% Premium Efficiency Motor** - 1 HP Circulating Pump
  - Input Power: 1.21 HP
  - Cost for 1000 hrs/yr operation @ $0.5/HP: $605
  - Purchase Price: $446

IE Class 3

Cost difference: $125
Annual savings: $130/year
Motor life: 10 years
Payback: 1 yr

Questions?



Funding for Implementation

USDA Rural Energy for America Program

Commercial Fishing Loan Program
(for energy efficiency upgrades)

Alaska Longline Fishermen's Association

REAP Renewable Energy Alaska Project

Sea Grant Alaska

AFDF Alaska Fisheries Development Foundation, Inc.

Southeast Conference

Module 3: Hydraulics

- Fishing vessel fuel efficiency project
- Propulsion
- **Hydraulics**
- Refrigeration
- DC Loads
- AC Loads