GREEN BOATS AND PORTS FOR BLUE WATERS

UNIVERSITY OF RHODE ISLAND
GRADUATE SCHOOL OF OCEANOGRAPHY

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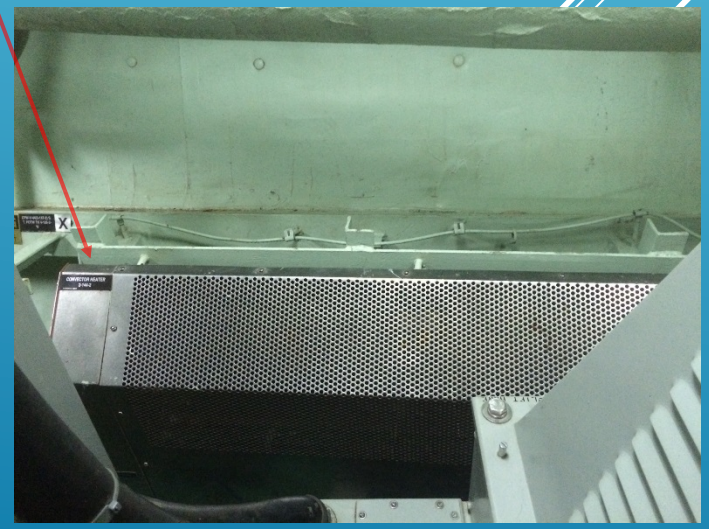
NAVIS
ENERGY MANAGEMENT SOLUTIONS LLC

PRESENTATION TOPICS

- Energy Efficiency (Cultural and Technical)
- Fishing Vessel Energy Efficiency Project
  - Alaska Fisheries Development Foundation (AFDF)
  - Alaska Longline Fishermen's Association (ALFA)
  - Energy Analysis Tool (EAT): Baseline Energy Consumption and Cost
- ECMs
  - Refrigeration and HVAC
  - Hydraulics

ENERGY EFFICIENCY: CULTURAL

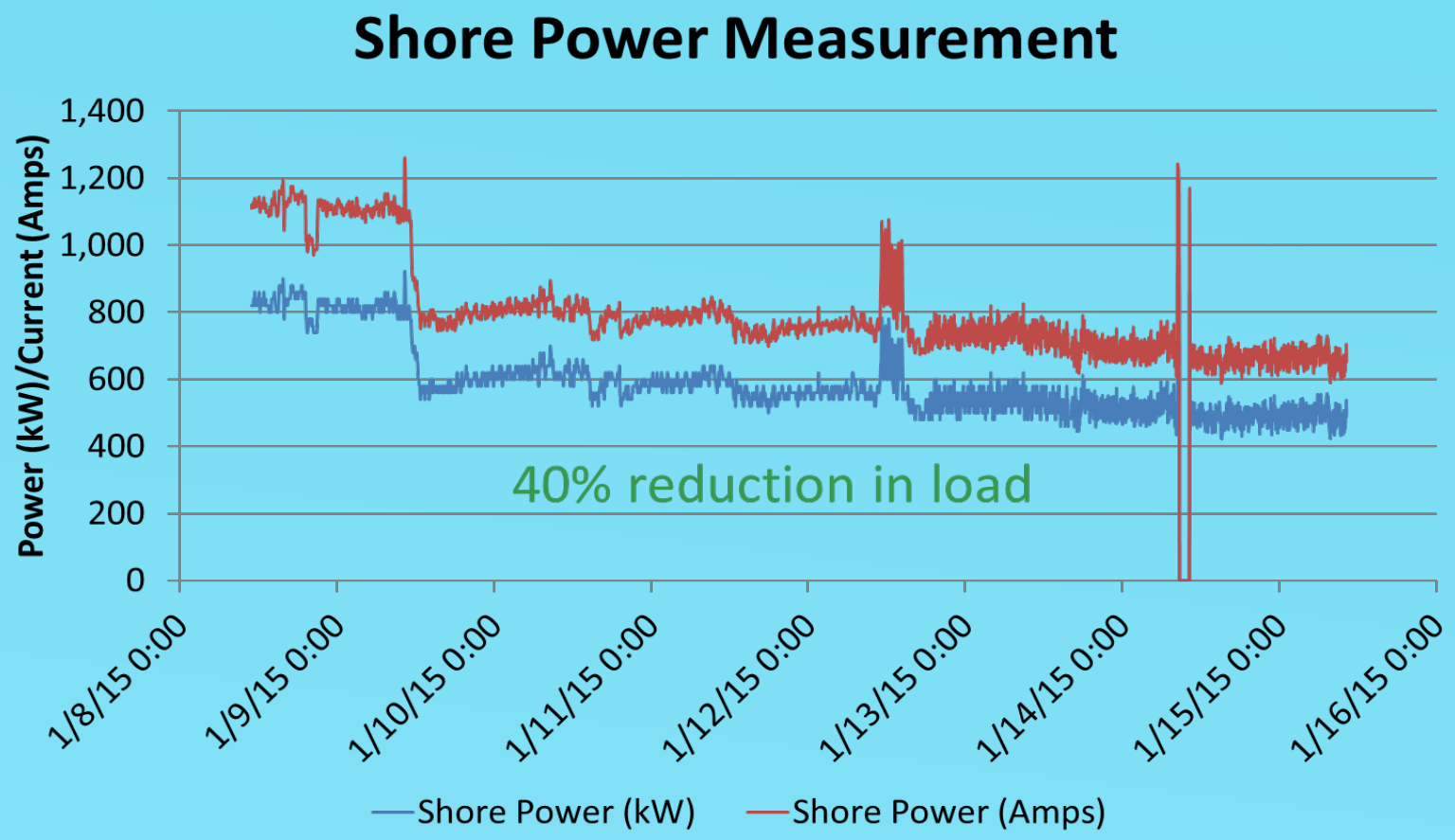
Same Space:
A/C set to 40°F
Electric Heater On



Cultural ECMs Typically have the greatest return on investment but most difficult to implement

- Training
- Energy Management Program
- Energy Surveys/Retro-commissioning

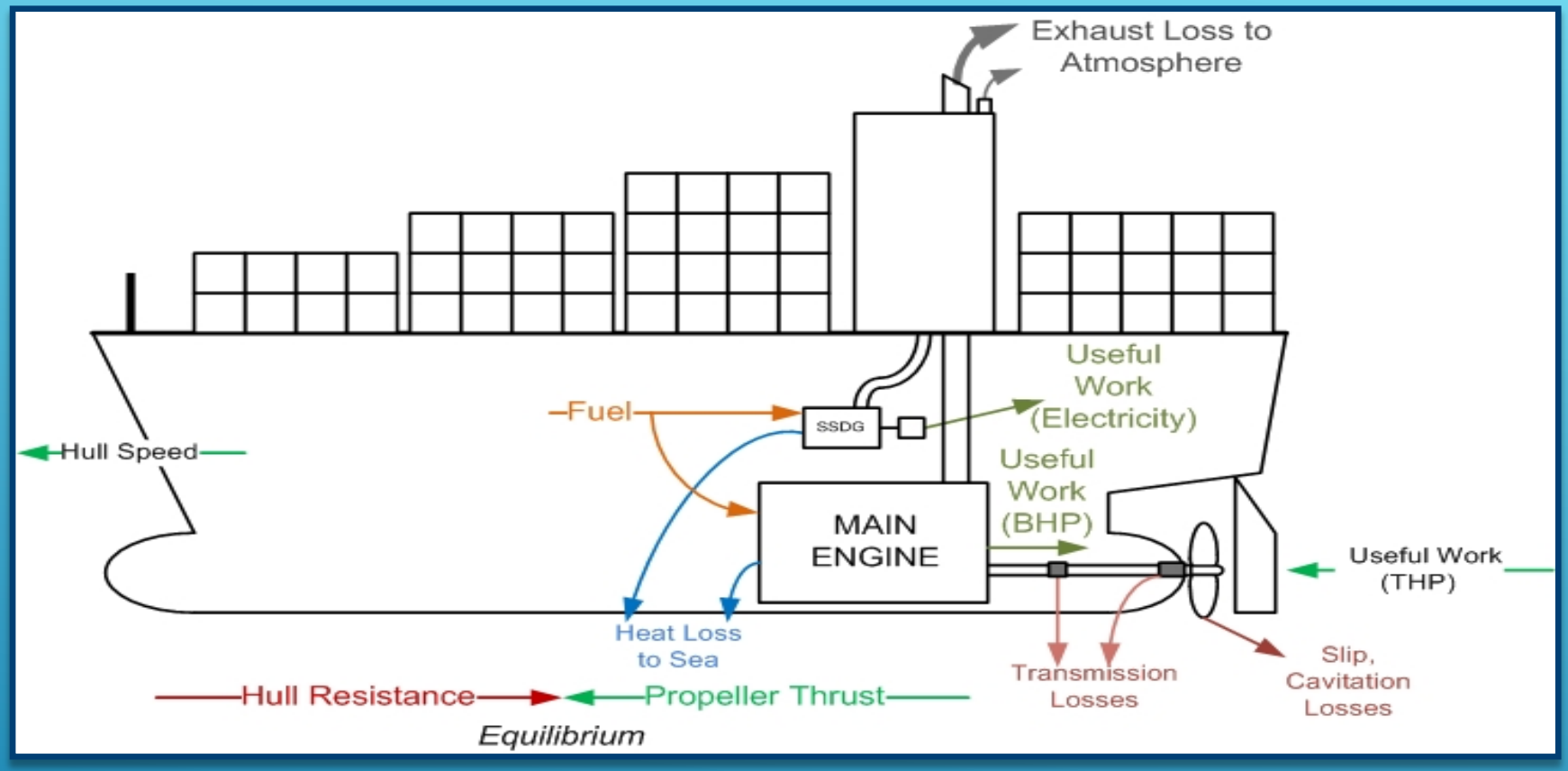
ENERGY EFFICIENCY: CULTURAL, RETRO-COMMISSIONING



Reduction in Energy from:

- Turning off equipment that is not required
- Operating running equipment more efficiently
- Modifying operating procedures

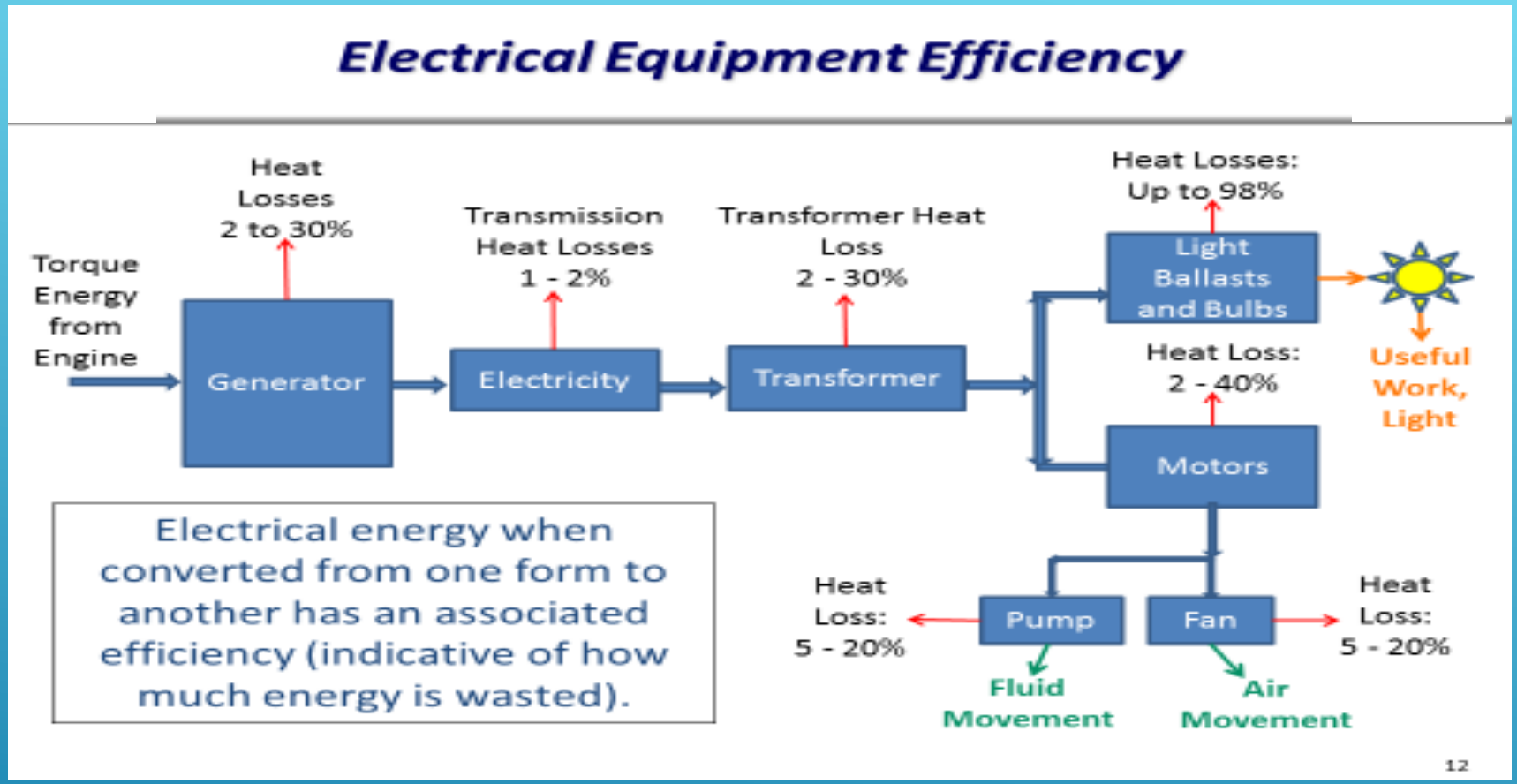
ENERGY EFFICIENCY: TECHNICAL



Minimize losses in conversion of chemical fuel energy to rotational torque energy from engine

- Improve engine efficiency
- Utilize waste energy from conversion process

ENERGY EFFICIENCY TECHNICAL



Improve Electrical Conversion Process:

- **Use high efficiency equipment: Motors, Transformers, Lights, Inverters**
- **Do NOT oversize equipment**

Fishing Vessel Energy Efficiency Project

Phase 1 complete, Phase 2 ongoing

Collaboration

Sea Grant Alaska

Alaska Longline Fishermen's Association

AFDE

NAVIS Energy Management Solutions LLC

akenergyefficiency.org Solutions For Alaska

Performed Energy Audits on 12 Fishing Vessels Phase 1 and 6 vessels so far in Phase 2

AFDE
Alaska Fisheries Development Foundation, Inc.

Fishing Vessel Energy Audit Project

4 Step Approach

1) Develop an operational profile for the vessel
2) Establish baseline energy loads for each profile
3) Identify high energy consumers
4) Research ECM appropriate for the vessel
   - Implement during upgrades

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

Mike Gaffney

Fishing Vessel Energy Efficiency Project
Energy Analysis Tool (EAT)

Beta Version – Microsoft Excel Spreadsheet

Instructions:
Fill in the green cells with the appropriate information specific to your vessel. Then assign a name to each "operational mode" or fishery you participate in. When you are done, click on the "Maintenance Costs" link or use the tabs below to begin filling in information specific to that operational mode.

Maintenance Costs | Operating Mode 1 | Operating Mode 2 | Operating Mode 3 | Operating Mode 4

Vessel Summary

Vessel Name	McCrea	
Type	displacement hull/ Skookum	
Length	38	feet
Fuel Cost /gallon	$4.00	$/gallon
Shore power cost $/kWh	$0.12	$/kWh
Propulsion Engine #1 Size	180	Horsepower
Propulsion Engine #1 Type	2 cycle	
Propulsion Engine #2 Size	0	HP
Propulsion Engine #2 Type		
Auxiliary Engine #1 size	8	HP
Auxiliary Engine #1 Type	4 cycle non-turbo	dive compressor
Aux Generator Engine #2 Size	8	HP
Aux Generator Engine #2 Type	4 cycle non-turbo	

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

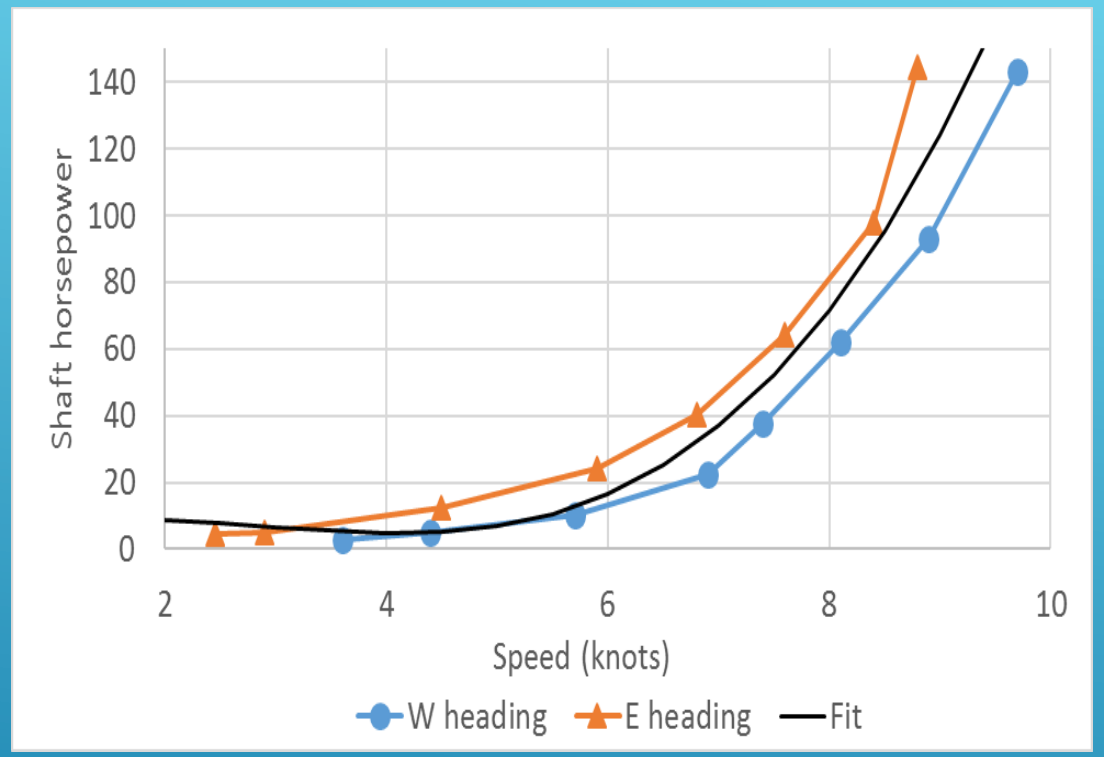
Use this calculator to help attain the hrs per year values if you know how many hours per day and how many days per year you fish.

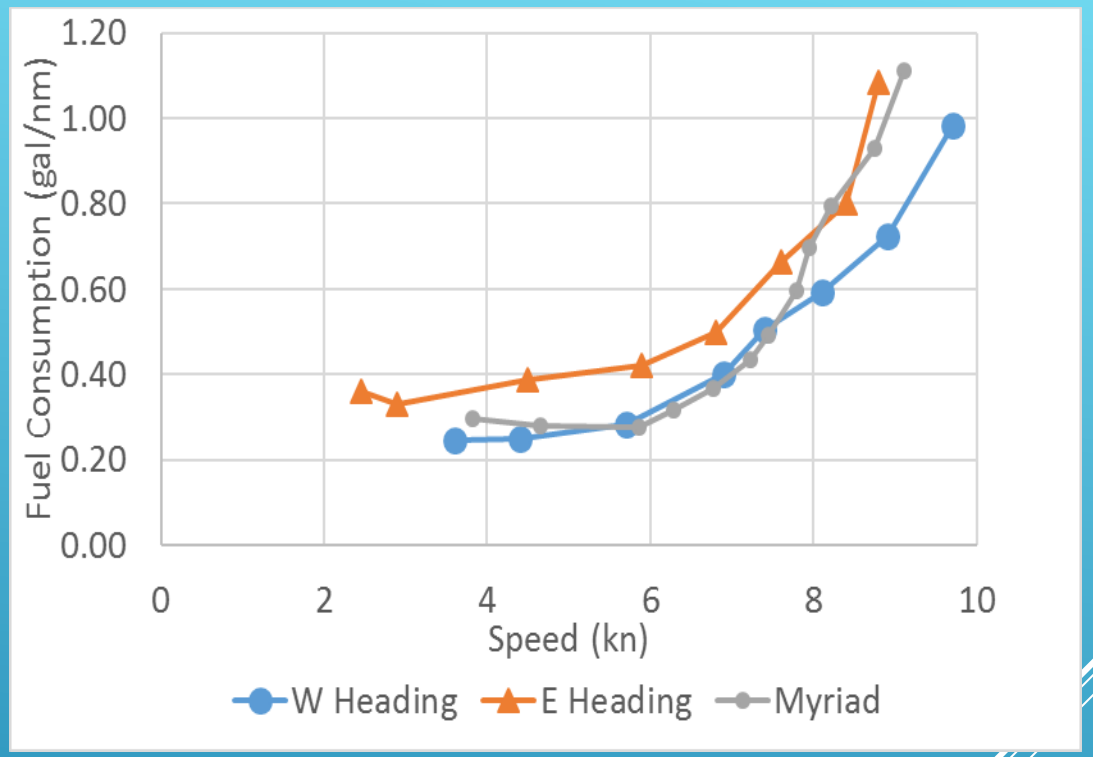
Hrs per day	Days per year	Hrs per year
		0

Operating Mode	Name	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	gillnet	200	1152	0	0	0	1
2	dive fishery	120	27	0	0	24	1
3	family outings	30	20	0	0	2	0
4		0	0	0	0	0	0
Total		350	1199	0	0	26	2
		Total hrs	1549	Total hrs	0		

Fishermen enter vessel and equipment particulars as well as operational profile into tool. The tool uses this data to create a baseline of energy cost and consumption.

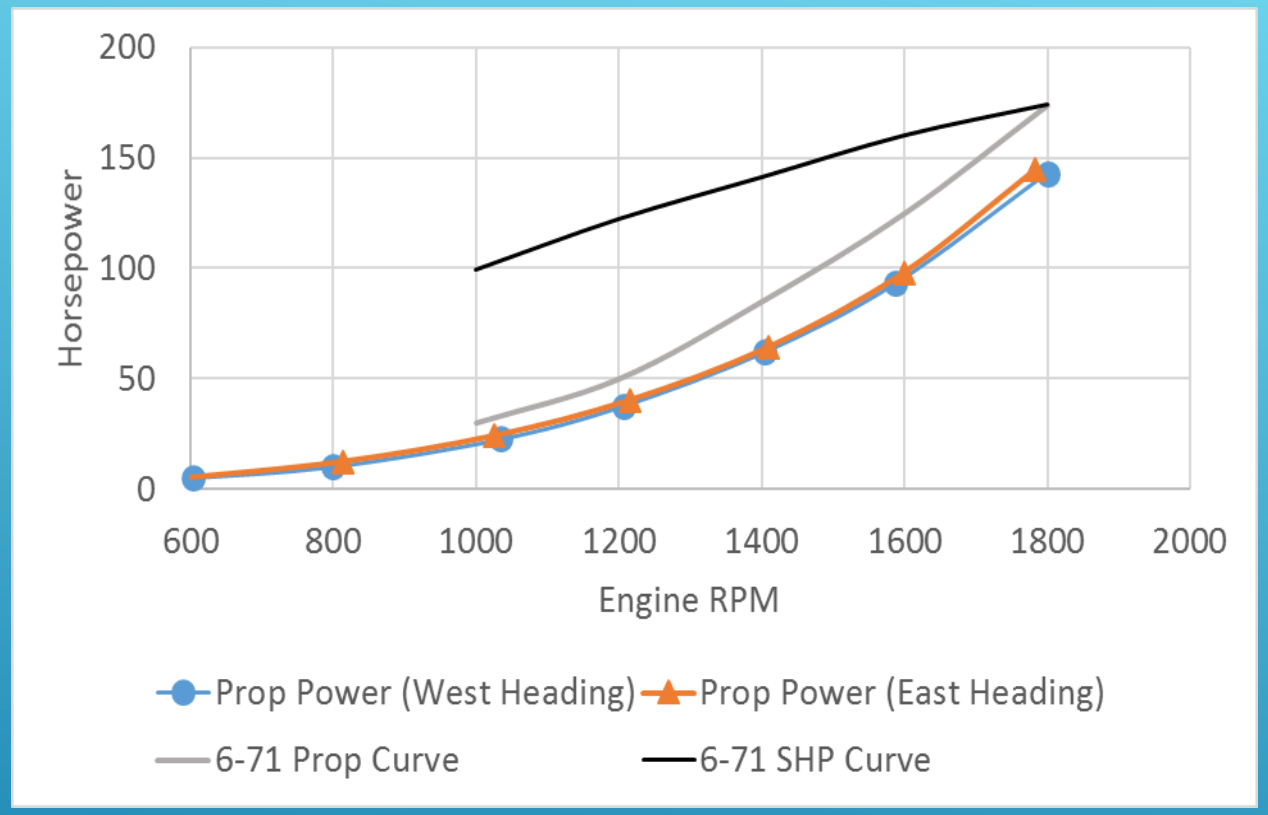
FISHING VESSEL ENERGY EFFICIENCY PROJECT

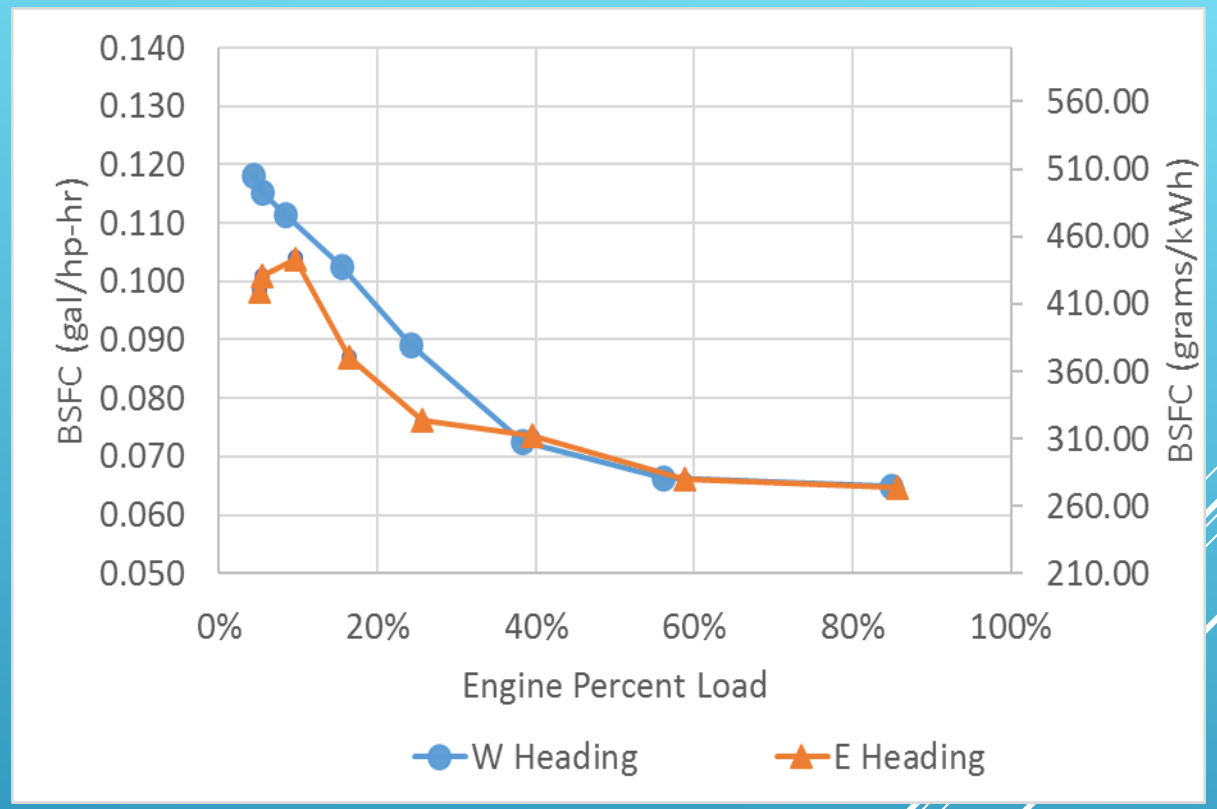




Operate at most fuel efficient speed when possible

FISHING VESSEL ENERGY EFFICIENCY PROJECT





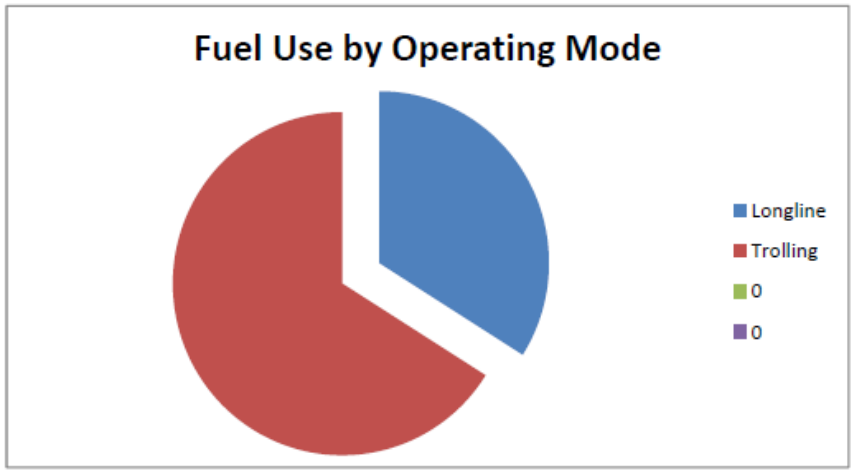
Properly sized engines increase fuel efficiency

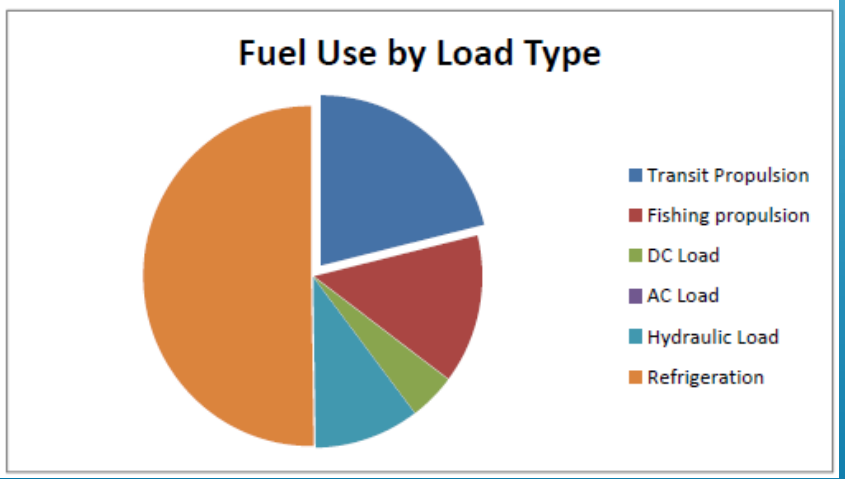
Fishing Vessel Energy Efficiency Project
Energy Analysis Tool
Beta Version – Microsoft Excel Spreadsheet

Vessel Summary: This tab displays the overall fuel consumption of your vessel. The table shows the gallons of fuel consumed by each load type in each operating mode.
The pie chart on the left shows which operating mode uses the most and the least fuel. The pie chart on the right shows how much fuel is used by each load type comparatively.

Cost Summary

(Hours)	765	819	0	0		
Fuel Use	**Longline**	**Trolling**	**0**	**0**		**Totals**
Transit Propulsion	500	199	0	0		699
Fishing propulsion	266	202	0	0		468
DC Load	93	53	0	0		146
AC Load	0	0	0	0		0
Hydraulic Load	265	68	0	0		333
Refrigeration	0	1,661	0	0		1,661
Total	1,123	2,183	0	0		3,307



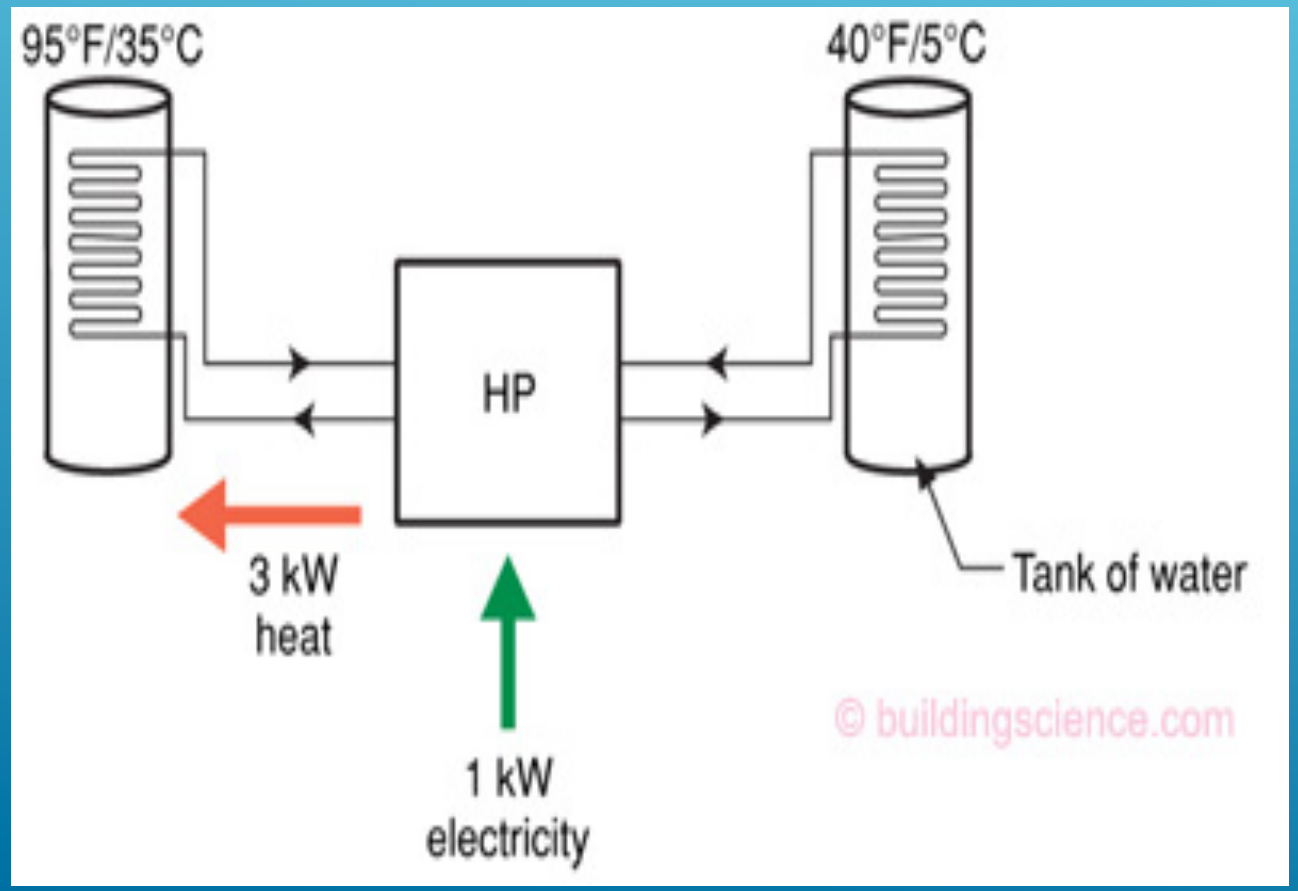


Baseline Enables ECM Analysis

AFDF
Alaska Fisheries Development Foundation, Inc.

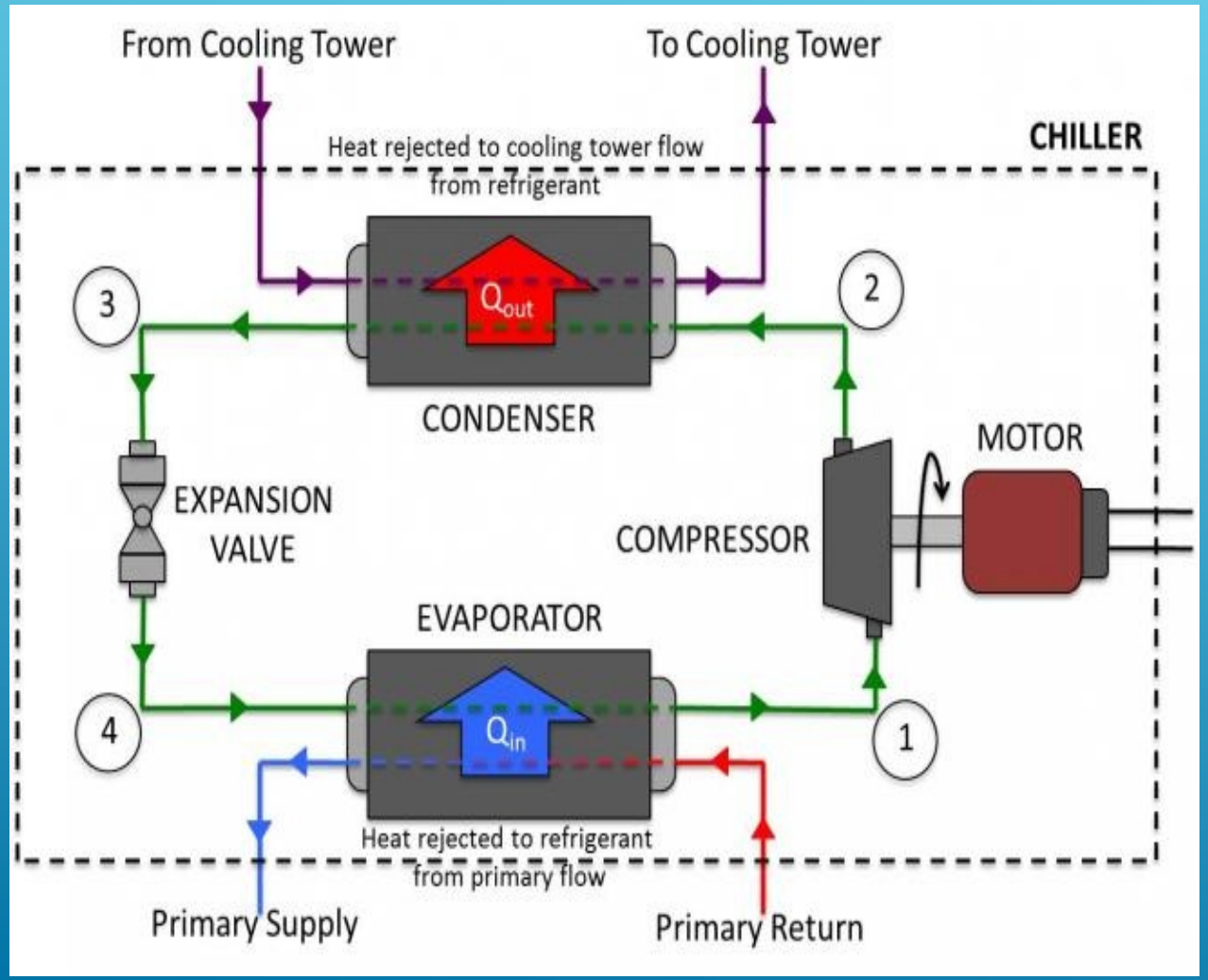
FISHING VESSEL ENERGY EFFICIENCY PROJECT
ECM: HVAC/ REFRIGERATION EFFICIENCY

Coefficient of Performance (C.O.P.)
= Q (heat moved) ÷ W (electrical energy used)



- C.O.P. = 3 kW ÷ 1 kW
- C.O.P. = 3
  - (Higher is more efficient)

FISHING VESSEL ENERGY EFFICIENCY PROJECT
REFRIGERATION COMPRESSOR EFFICIENCY



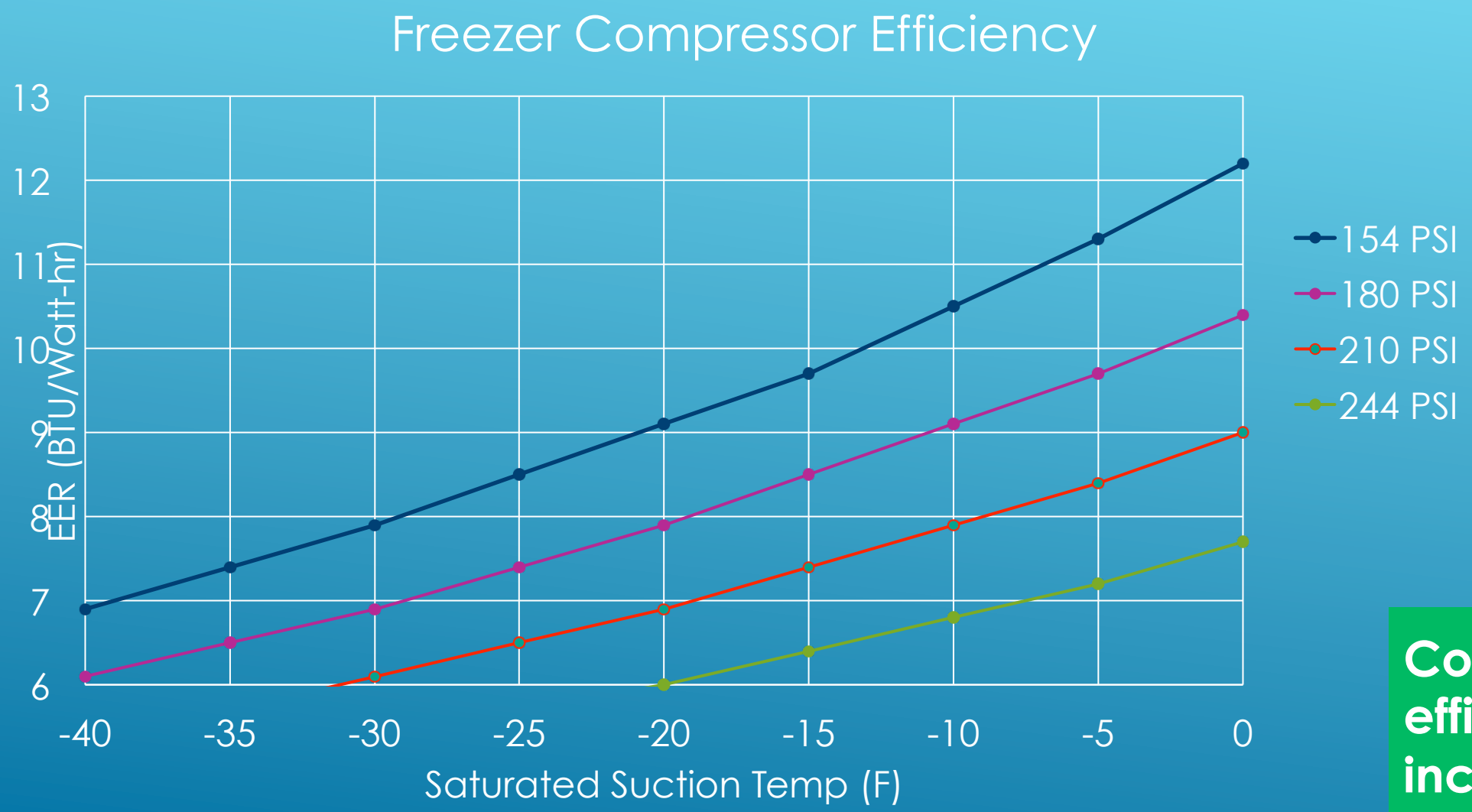
Discharge Pressure (Pd)
Condensing Water Temp

Total Lift (Pd - Ps)

Suction Pressure (Ps)
Chill Water Temp

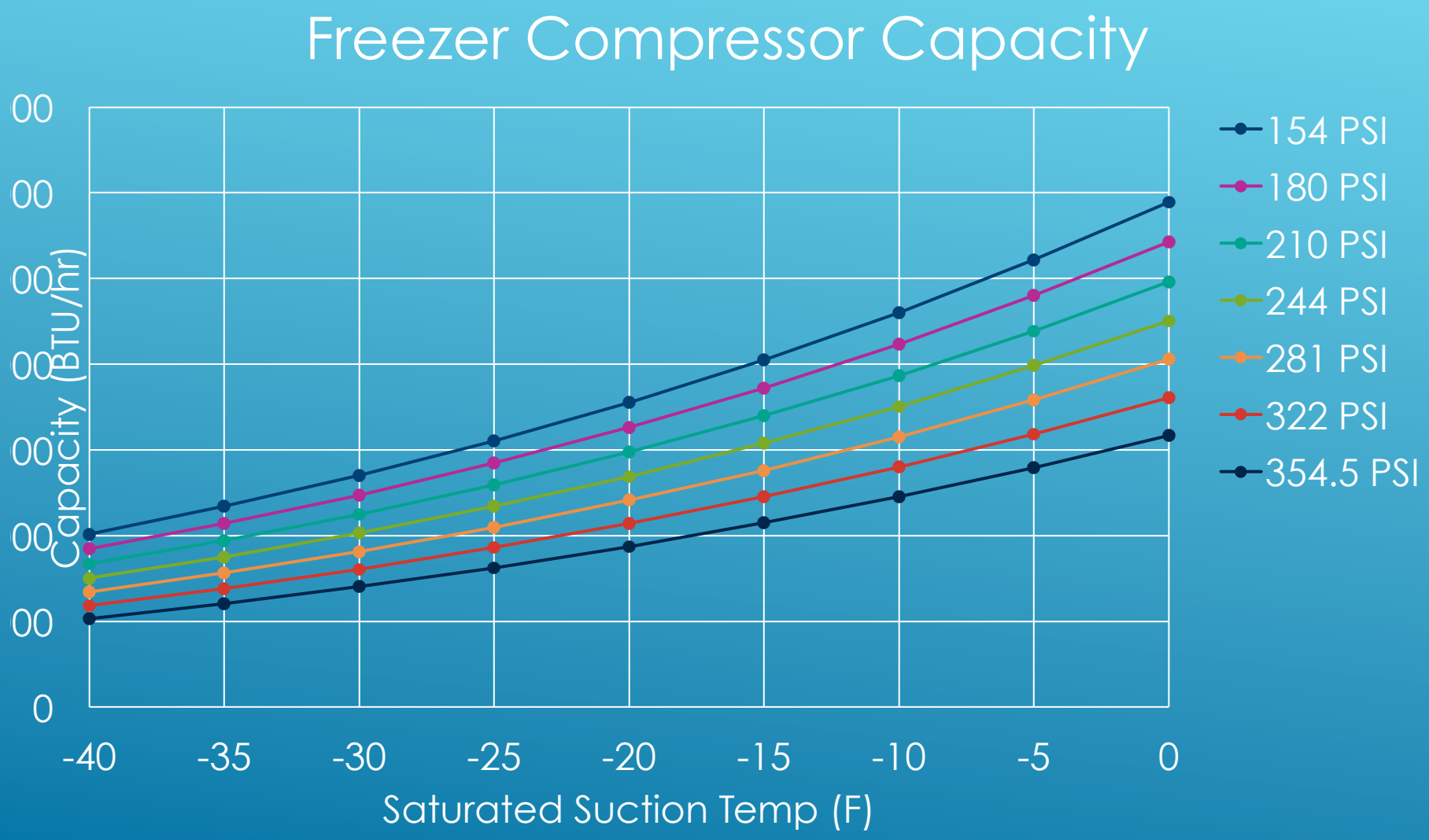
Efficiency increases as total lift decreases

FISHING VESSEL ENERGY EFFICIENCY PROJECT



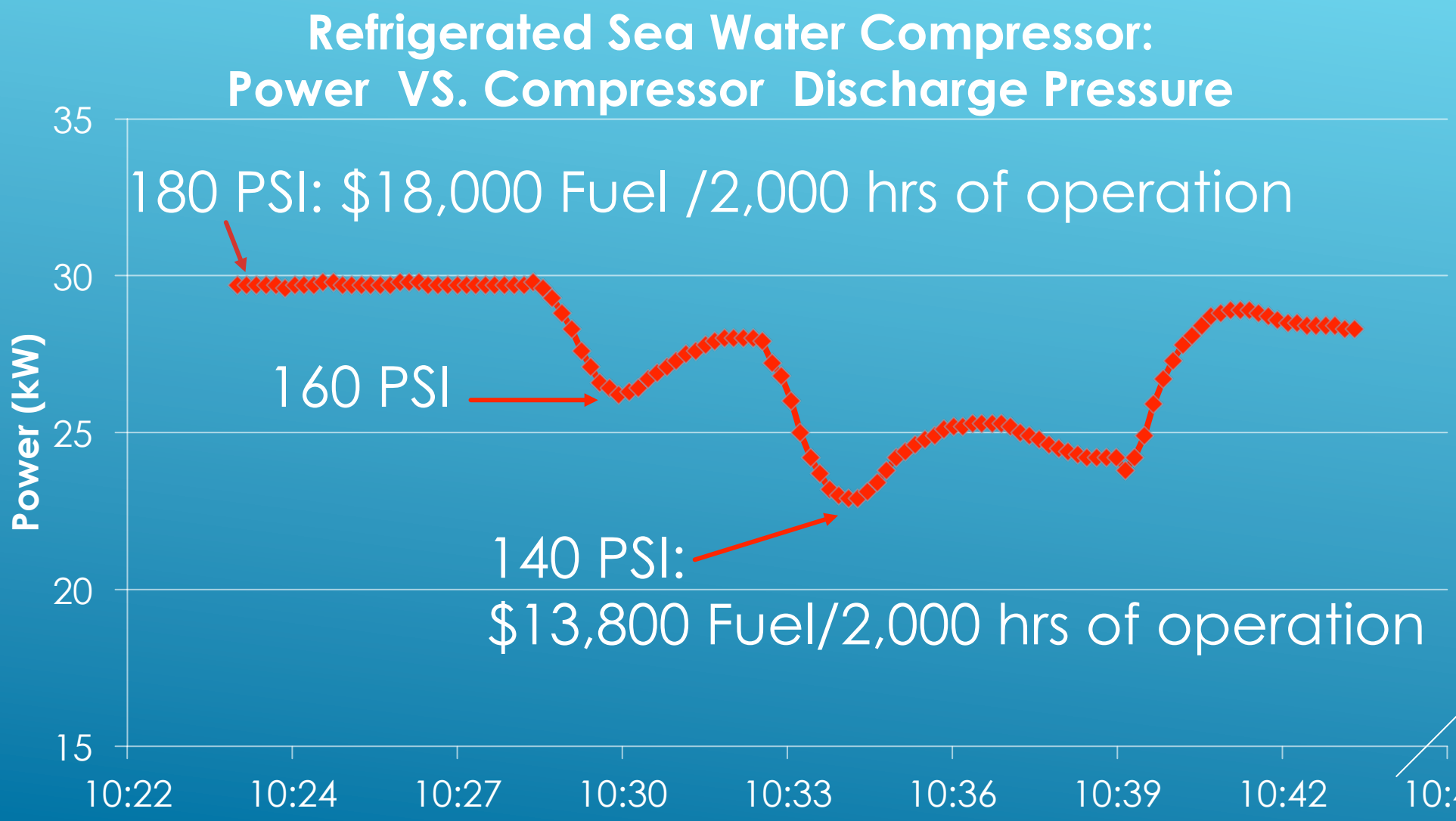
Compressor efficiency increases as lift decreases

FISHING VESSEL ENERGY EFFICIENCY PROJECT



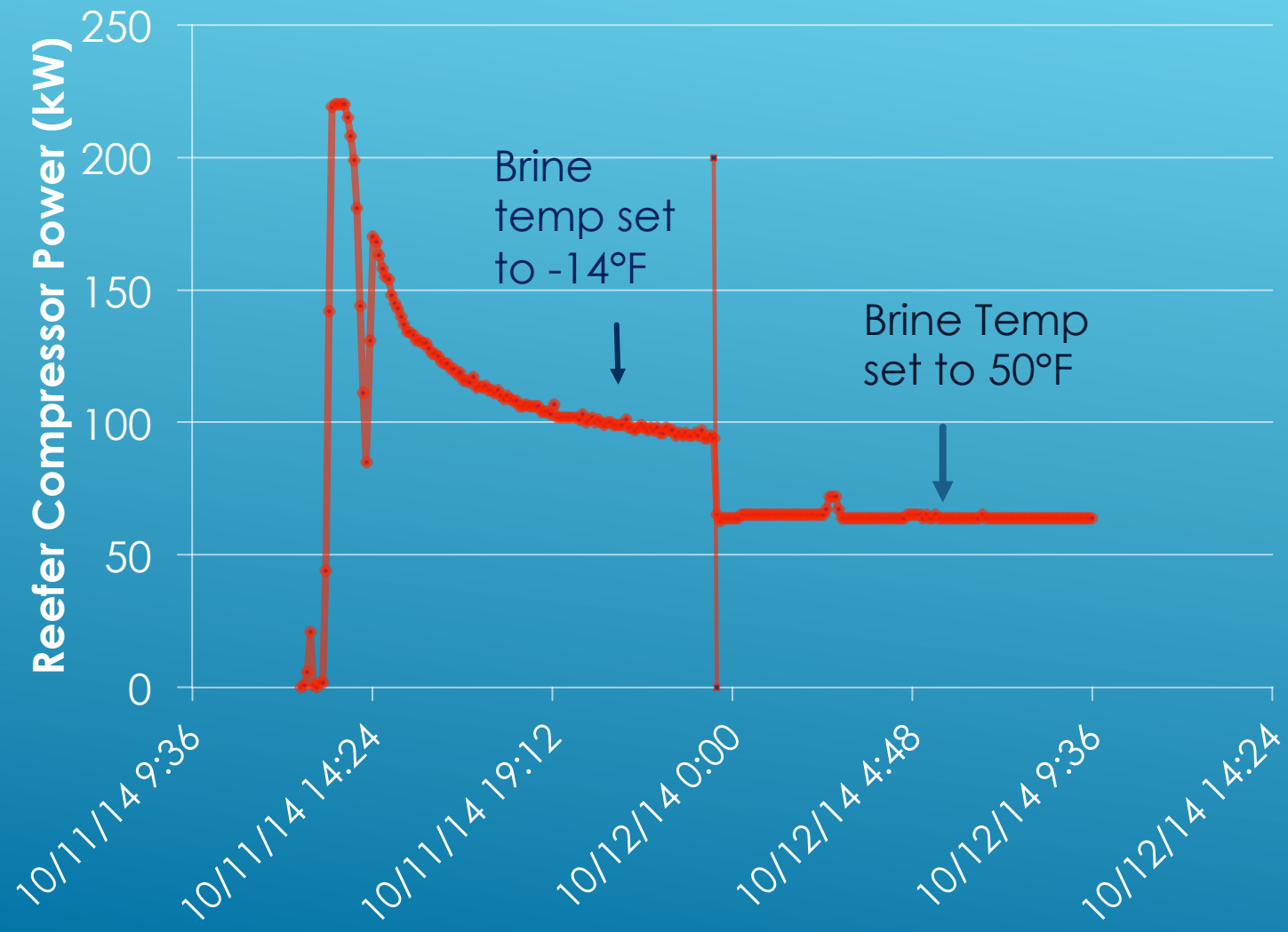
Refrigeration capacity increases as lift decreases

Refrigeration Compressor Efficiency



Profits increase as lift decreases

Refrigeration Efficiency (Ship System) Increase Suction Pressure to Reduce Lift



Ave P sum (kW)

(14°F to 50°F)

33% Power reduction with decrease in lift

Shipboard HVAC Cost
Maximize Compressor Efficiency

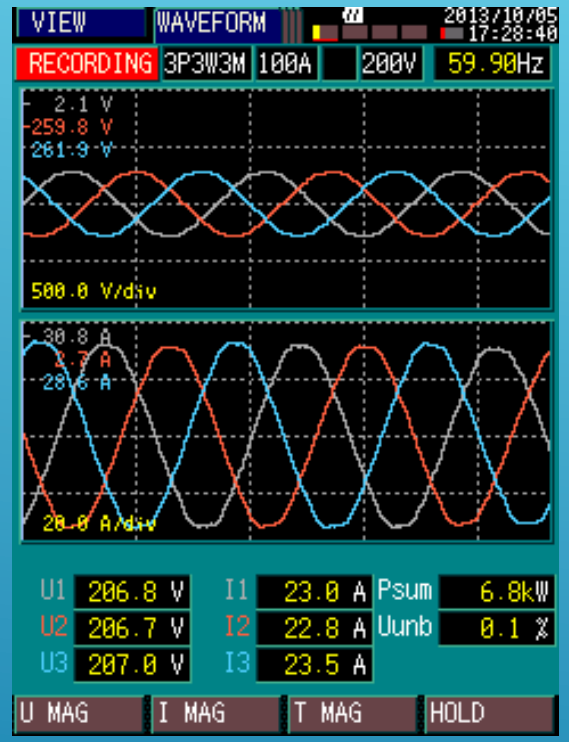
	Ship's power inport ($/yr)	Shore Power Inport ($/yr)	Total Inport Cost ($/yr)	At Sea Cost ($/yr)	Total Annual Energy cost ($/yr)	Total Fuel (gal/yr)
AC Motor COP 5.5	$228,774	$89,205	$317,979	$343,111	**$661,090**	142,971
AC Motor COP 4.5	$279,612	$109,029	$388,641	$419,358	$807,999	174,742
AC Motor COP 3.5	$359,501	$140,180	$499,681	$539,174	$1,038,856	224,669
AC Motor COP 2.5	$503,302	$196,252	$699,554	$754,844	**$1,454,398**	314,536

FISHING VESSEL ENERGY EFFICIENCY PROJECT
REFRIGERATION VFD APPLICATION

VFD: Most efficient way to control compressor capacity

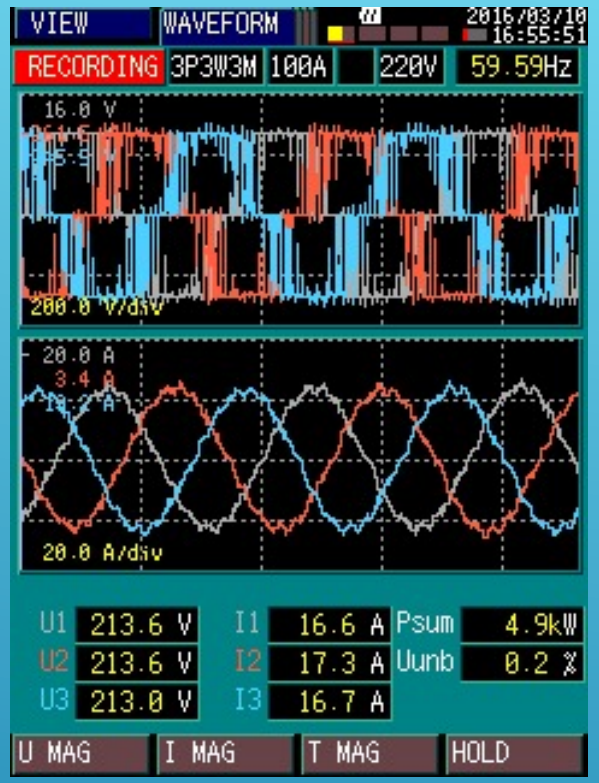
ALFA trials underway this fishing season with energy meters to document energy savings

FISHING VESSEL ENERGY EFFICIENCY PROJECT
REFRIGERATION VFD APPLICATION



Voltage and Current wave form without VFD

VFD: Introduce harmonics into the motor



Voltage and Current wave form with VFD

Ensure grounding and generator sizing is as per MFG guidelines

FISHING VESSEL ENERGY EFFICIENCY PROJECT
HYDRAULICS

- ALFA trials to measure actual hydraulic loads over the next few months
- Data collected will provide more accurate energy baseline

Hydraulic Systems: F/V Myriad

Activity	Measured Fuel (GPH)	Change (GPH)
Trolling with hydraulics OFF	1.47	
Trolling with hydraulics ON	1.68	-0.22
Trolling while Running Gear w Hydraulics	1.74	-0.27

Operating Mode	Name (ie. Ice troll, gillnet, family outing)	Propulsion Engine #1	
		Hrs Transit	Hrs Fishing
1	Longline	125	160
2	Ice troll	70	150
3	Freeze troll	160	480
4	family	40	20
Total		**395**	**810**

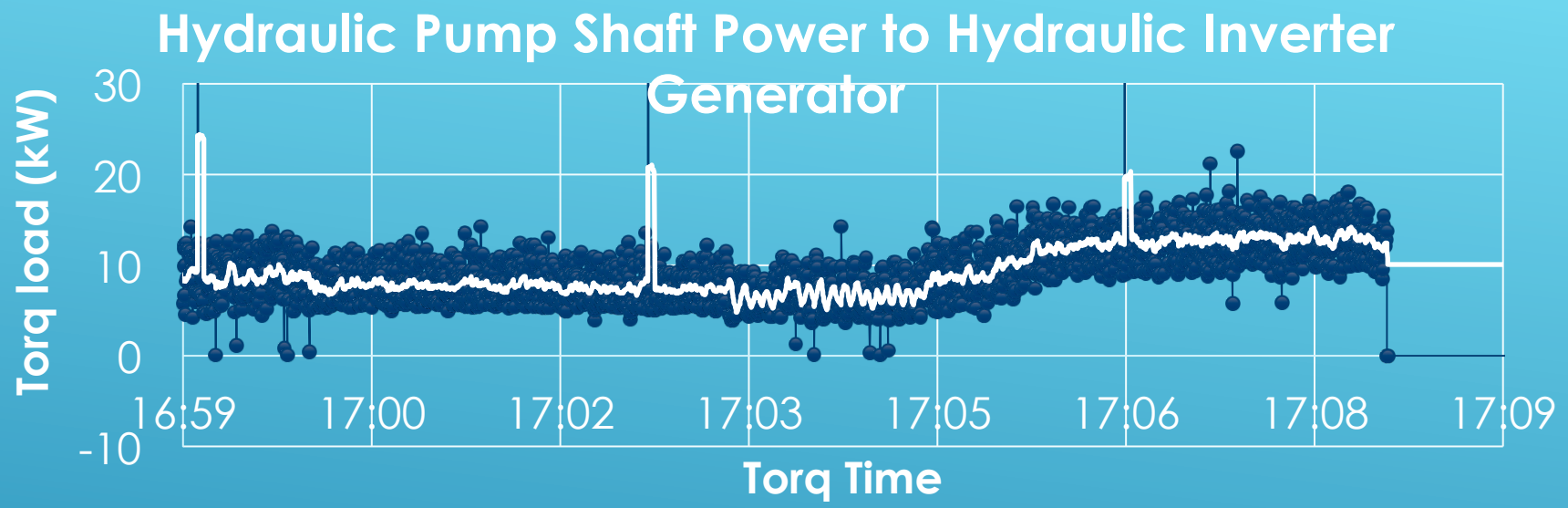
Energy Analysis Tool Vessel Profile Page

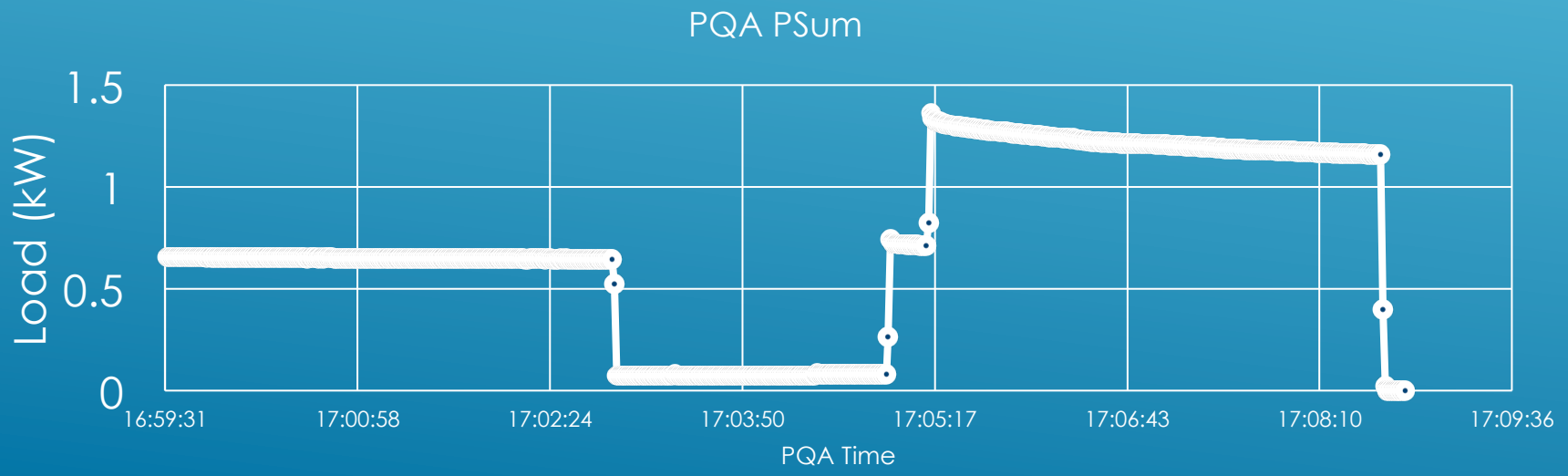
Ave Hourly Hydraulic Loss Cost: $1/hr

No Load Hydraulic Fuel Cost on All the Time (1,205 hrs): = $1,205

Only Engage Hydraulics When Needed for Useful Work

FISHING VESSEL ENERGY EFFICIENCY PROJECT





Losses in converting shaft power to hydraulic power to electrical power

Fishing Vessel Energy Efficiency Project

All About the Boats: Vessel Energy and Fuel consumption

THANK YOU!

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