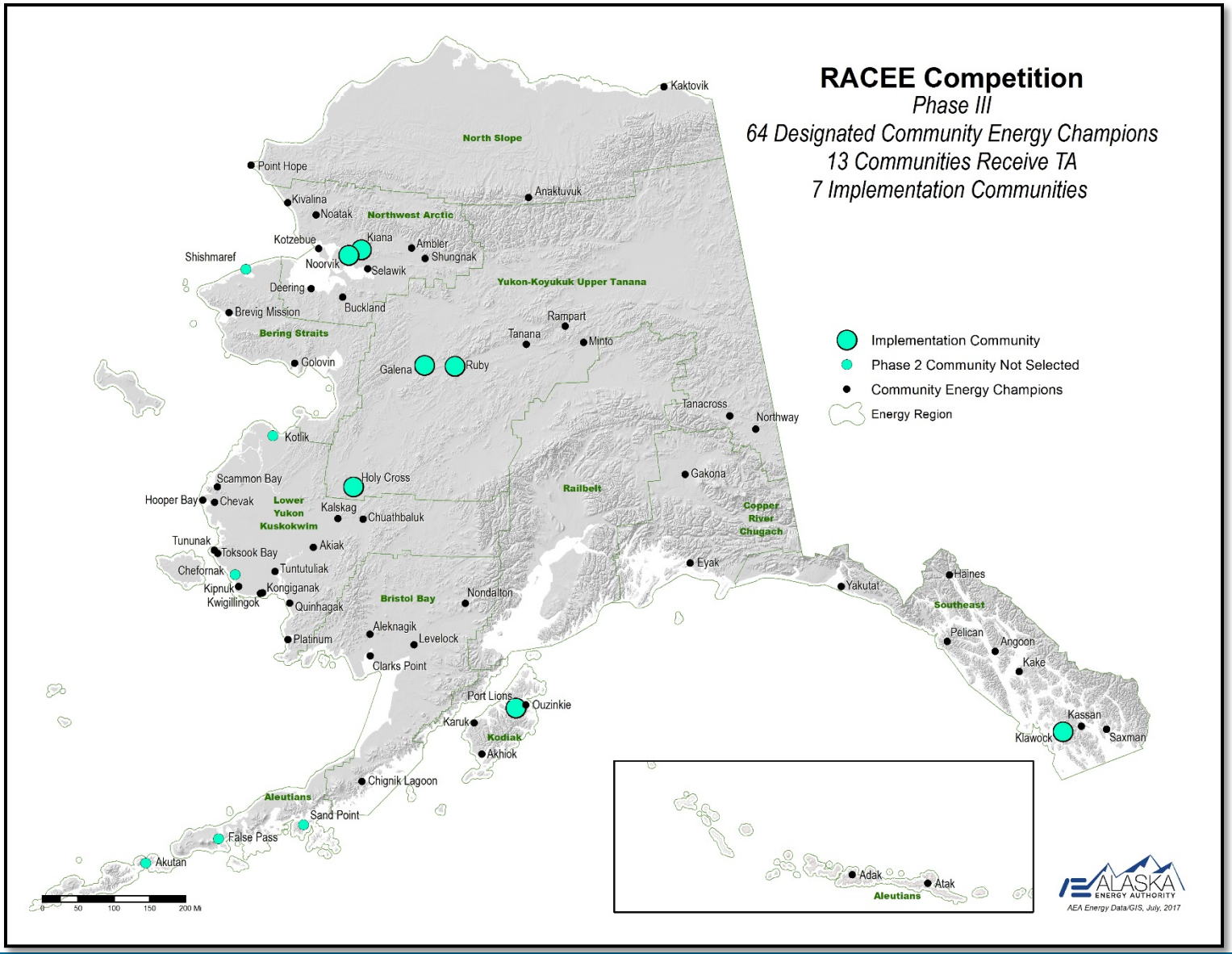
Remote Alaska Communities Energy Efficiency Peer Network

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Webinar Operations

- All participants have been automatically muted.
- If you have a question during the presentation, please type it into the Question panel on the right side of your computer screen. We will pose the question at the end.
- Please check the RACEE website after 11/15/17 for a link to the recording and transcription of this webinar.

http://energy.gov/eere/racee-competition-peer-exchange-network

- DOE plans to collect information for announcement on the next Peer Network call.
  - This can include useful information on funding and project ideas and opportunities
  - Email your input to Fletcher.Souba@ee.doe.gov for June's Webinar.

Welcome to the RACEE Peer Network

- The RACEE Peer Exchange Network is intended to provide a fundamental benefit to the 64 communities that pledged to reduce per capita energy usage by 15% by 2020.

- It will consist of three components:
  - RACEE website
  - Monthly technical webinars
  - In-person meetings
    - For, example, the RACEE Competition Summit at end of RACEE Phase 3

- For more details, see the RACEE Website:

http://energy.gov/eere/racee-competition-peer-exchange-network

RACEE Peer Exchange

- The goal of the network is to empower Alaskan communities and native Alaskan villages to develop effective tools to advance the use of reliable, affordable, and energy efficient solutions that are replicable throughout Alaska and other Arctic regions.

- The Department leverages the existing convening power of the AEA and other regional energy efficiency organizations to form the Peer Exchange Network to build a community of energy efficiency information sharing and action by peer exchange through webinars, and events.

Future Webinar Topics

- **Update on Rural Alaska Diesel Genset Specification, Performance, and Efficiency – David Lockard (AEA), Alan Fetters (AEA)**
- **Diesel Part 2**
- **Line Loss Mitigation**
- **AKEnergySmart - More about Renewable Energy in Alaska**

Rural Alaska Diesel Gensets:

- Specifications
- Performance
- Efficiency

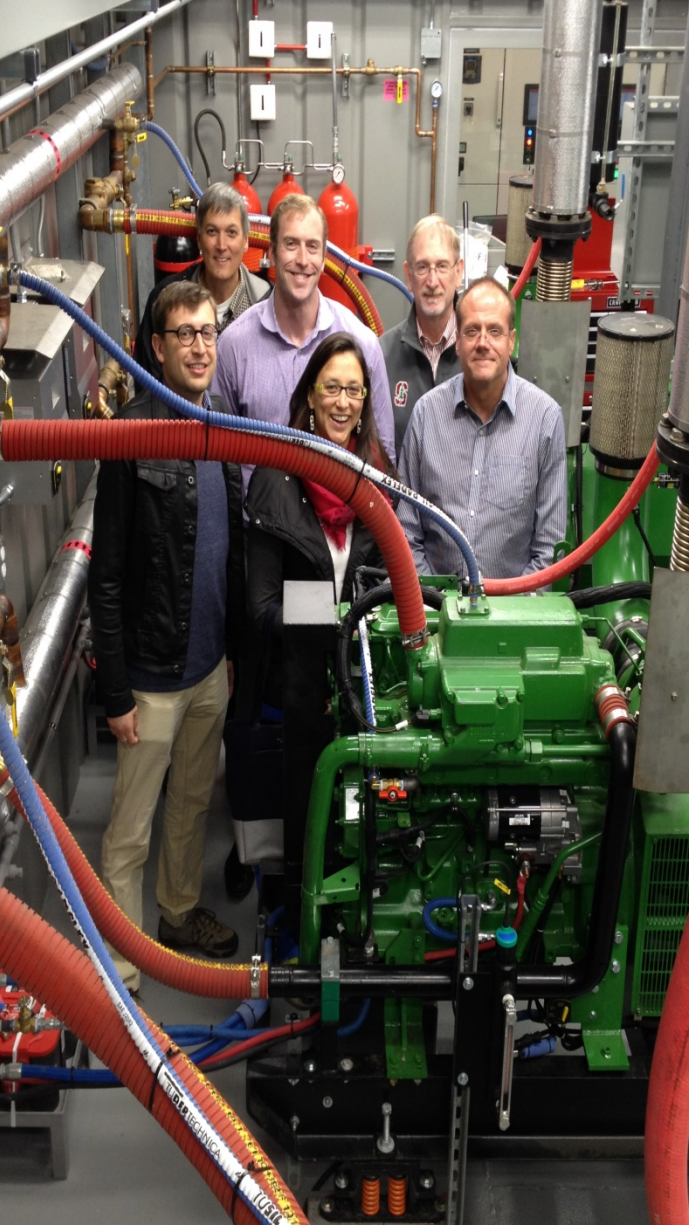
Alan Fetters, Rural Assistance Manager

David Lockard, Lead Engineer

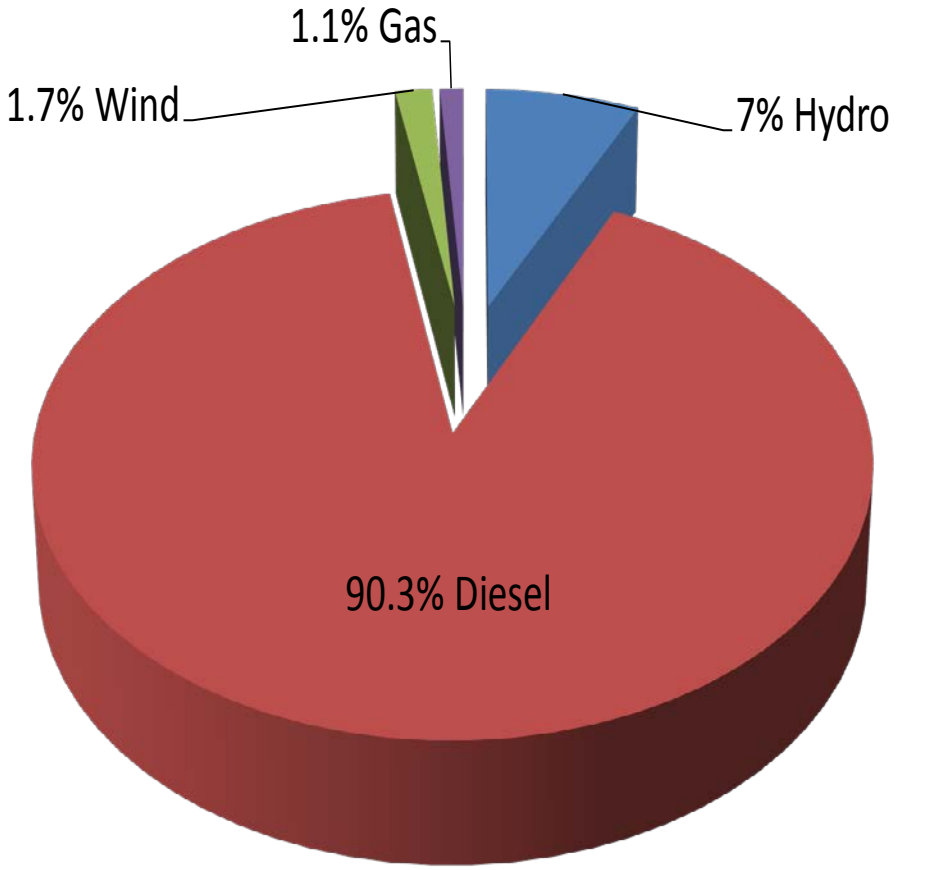
Alaska Energy Authority

RACEE Peer Exchange Network

October 26th, 2017



AEA's mission is to reduce the cost of energy in Alaska



- Hydro - 7% at 31,690,926 kWh - Up .7%
- Diesel - 90.3% at 410,317,350 kWh - Dn .8%
- Wind - 1.7% at 7,607,563 kWh - Up .3%
- Nat. Gas (Nuiqsut) - 1.1% at 4,856,852 kWh - Dn .1%

Koyuk uk

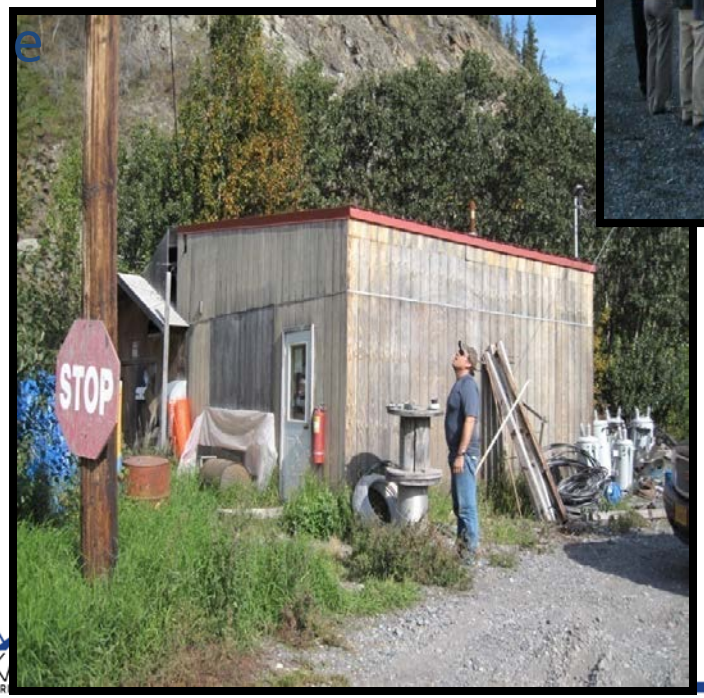
Befor

Afte r

Powerhouse Project

Chitina

Before



After

Engine Selection in 2000

- Fuel was cheap
- Engines were simple and reliable:
  - Brand Preference
  - Load Capacity
  - Fuel Efficiency

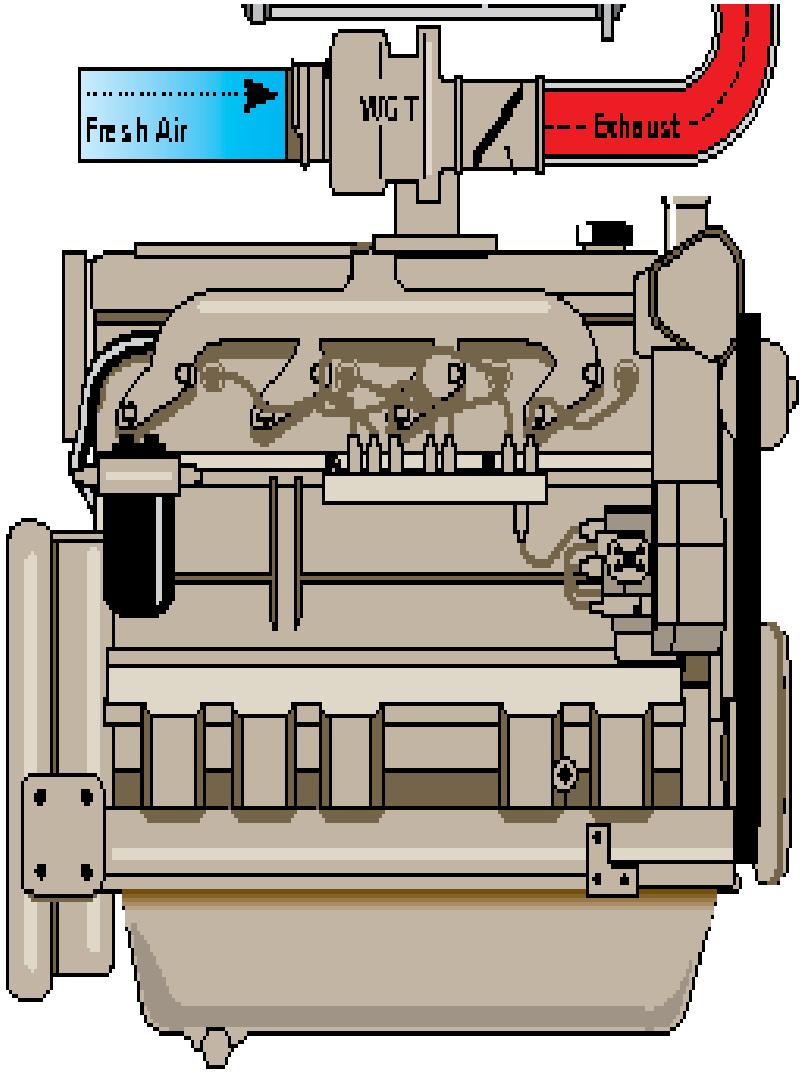
Engine Selection in 2006

- Fuel Prices more than Doubled
- Electronic Fuel Injection
- Separately Cooled Aftercooler
  - Fuel Efficiency
  - Load Capacity
  - Recoverable Heat
  - Brand Preference

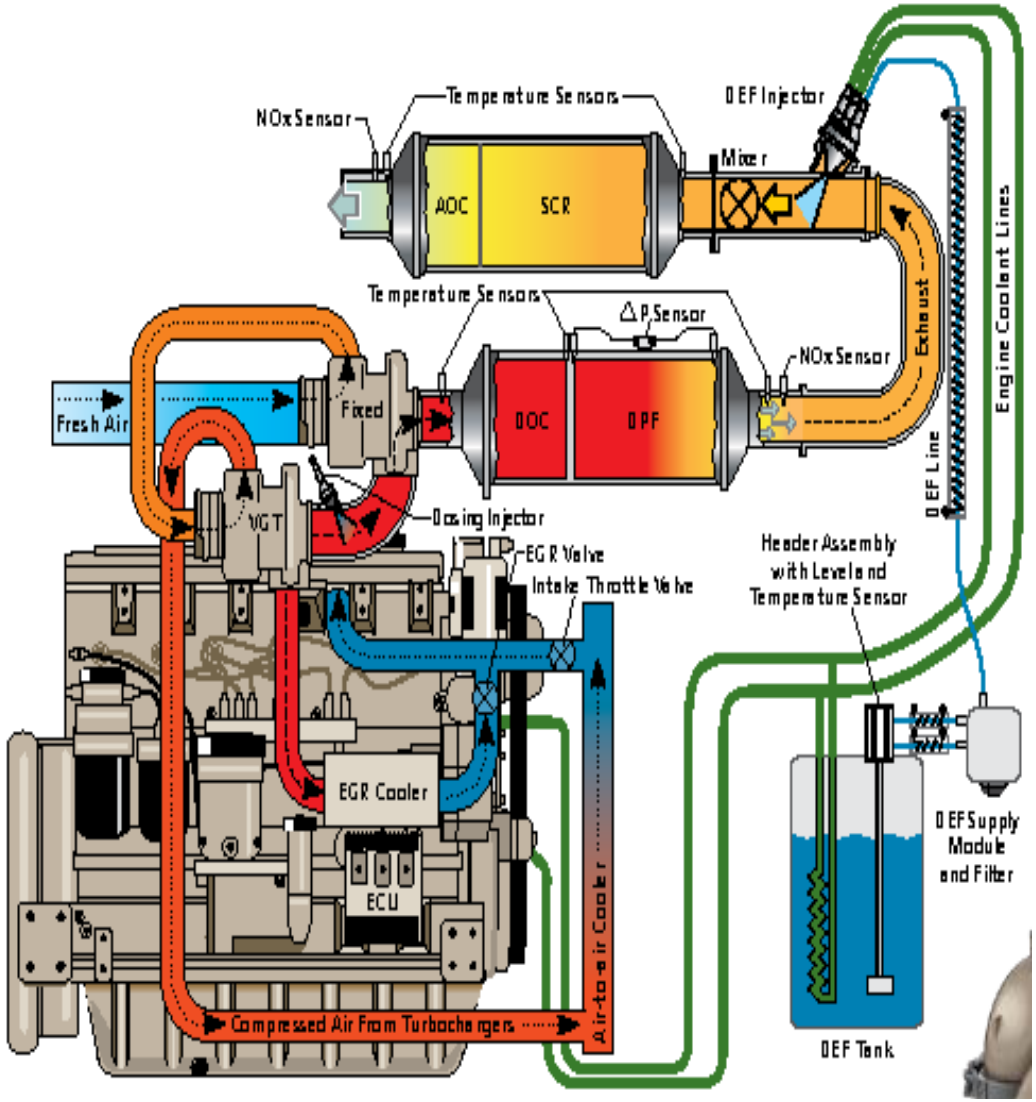
Engine Selection in 2017

- Reliability
- Regulatory Compliance
- Fuel Efficiency
- Load Capacity
- Recoverable Heat
- Brand Preference

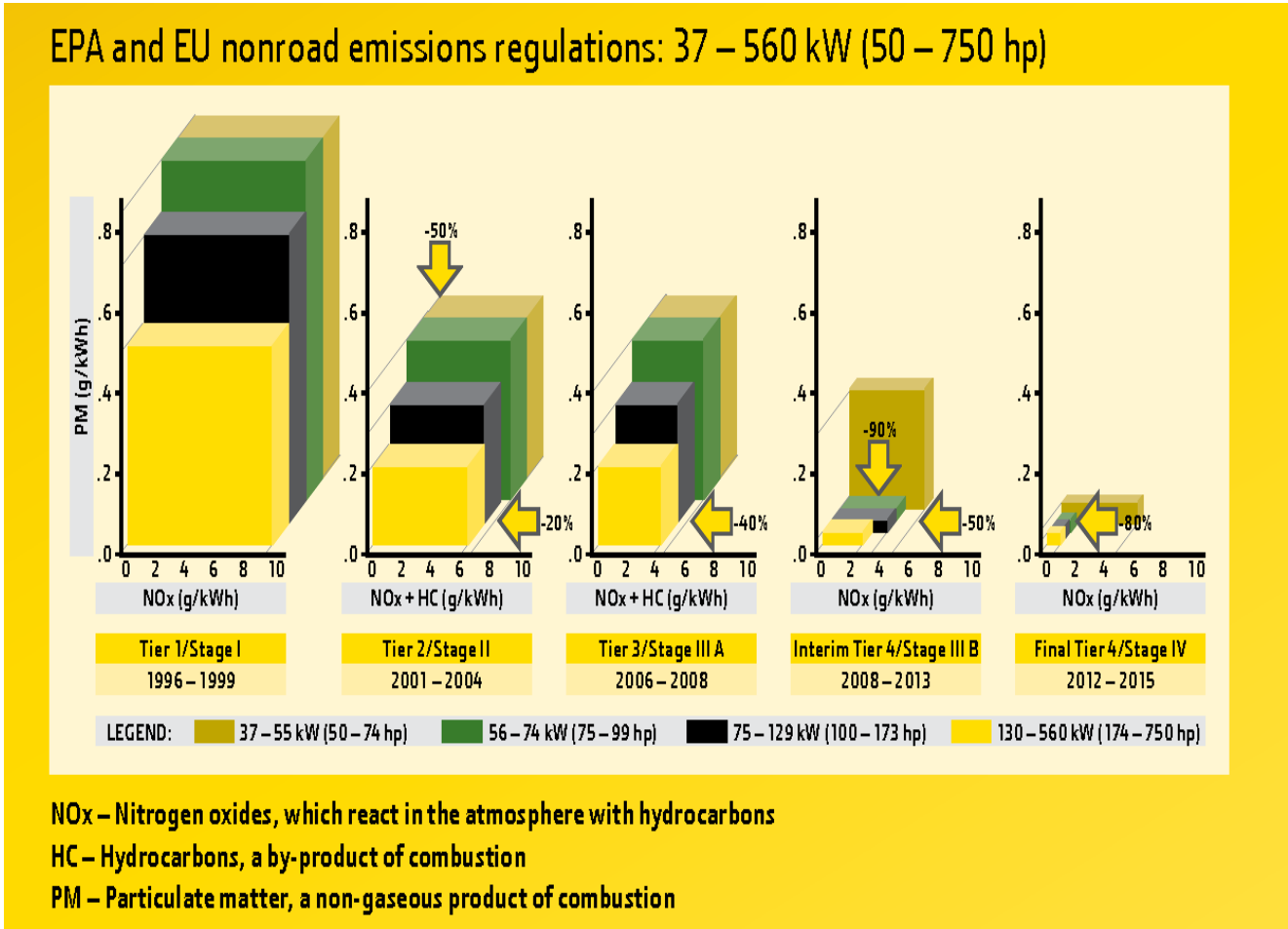
2006 Diesel Engine



2017 Diesel Engine



Tier Emissions Levels



NOx – Nitrogen oxides, which react in the atmosphere with hydrocarbons

HC – Hydrocarbons, a by-product of combustion

PM – Particulate matter, a non-gaseous product of combustion

NSPS - New Source Performance Standards

- The EPA agreed that the circumstances in remote Alaska require special rules:
- Removed requirement to use after treatment devices for NOX, in particular, SCR, for engines used in remote Alaska;
- Allowed the blending of used lubricating oil, in volumes of up to 1.75 percent of the total fuel, if the sulfur content of the used lubricating oil is less than 200 ppm and the used lubricating oil is “on-spec”
- Exempted all pre-2014 model year engines from diesel fuel sulfur requirements (no ULSD);
- Allowed use of engines certified to marine engine standards and Tier 3 nonroad industrial engine standards; but
- Requires PM after treatment devices for 2014 and later model year

What are the Options?

- Purchase 2014 Final Tier 4 Engine
- Purchase 2014 Tier 3 Industrial Engine
  - Must install Particulate Filter
- Purchase 2014 Tier 3 Marine Engine
  - Must install Particulate Filter
- Particulate filters are problematic
  - Not OEM equipment – must be engineered
  - Costly to install
  - May reduce fuel efficiency
  - Higher maintenance costs
  - Unproven Reliability

What's the Solution?

- Re-use of pre-2014 engines
  - "new" unused engine
  - Low-hour used / rebuilt engines
  - Remanufactured used engines
    - Not same as "OEM Repower" program
    - Must be pre-2014 block
    - Must not exceed 50/75% of new engine cost
    - May upgrade engine to cleaner emissions standard

Marine manifold captures additional heat from exhaust and transfers it to cooling system antifreeze. 50-100% increase in energy capture for heating purposes, as well as a 5-10degF increase in temperature .

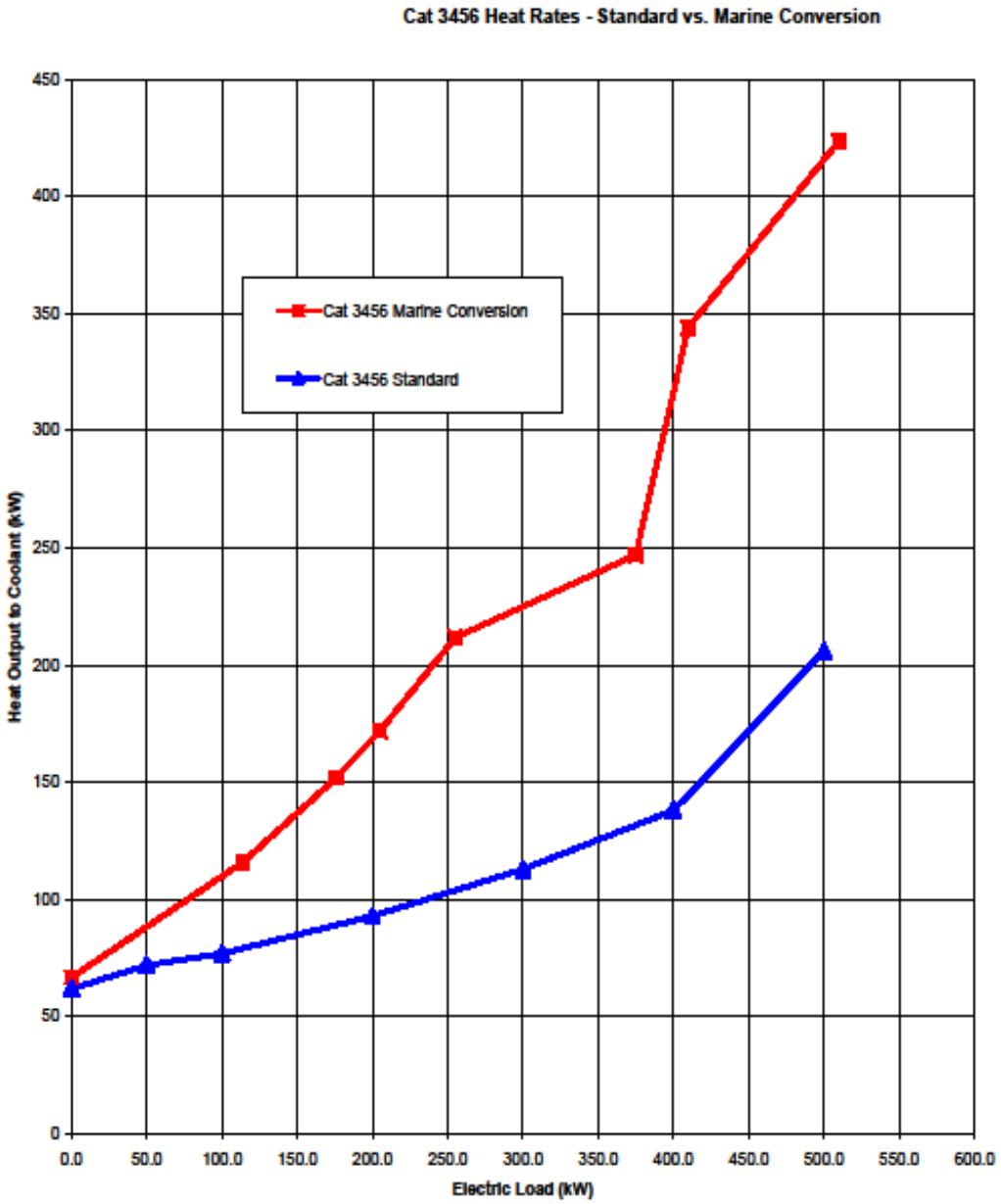
Top: Caterpillar 3456 exhaust manifold and turbocharger before marine conversion

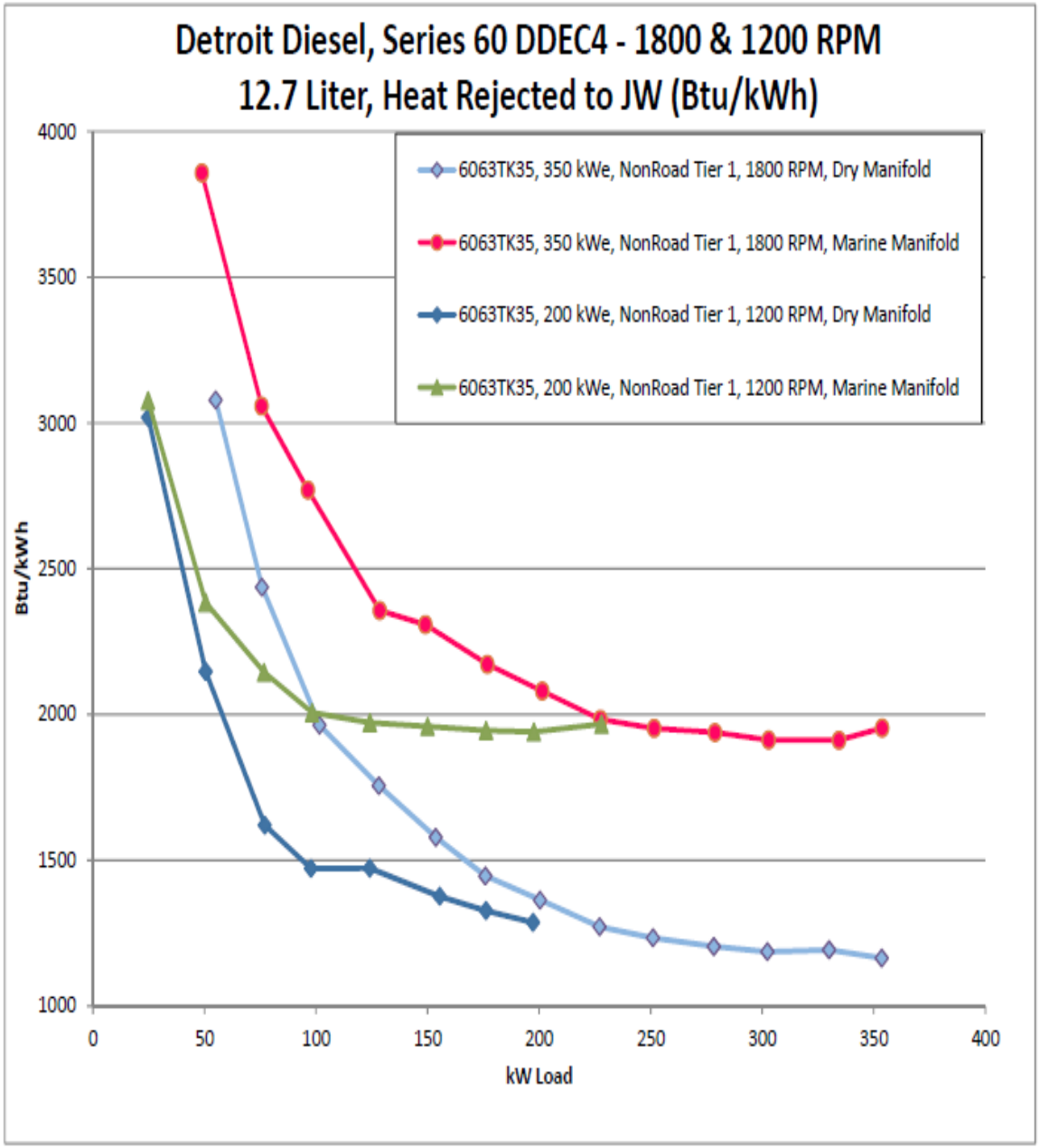
Bottom: same engine after marine conversion

At high loads the heat output from the marine version is twice as high as from the standard version

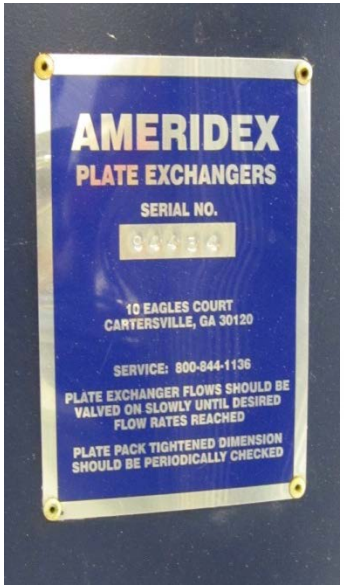
There are also benefits from the higher temperature of the output if the energy is used for space heating purposes

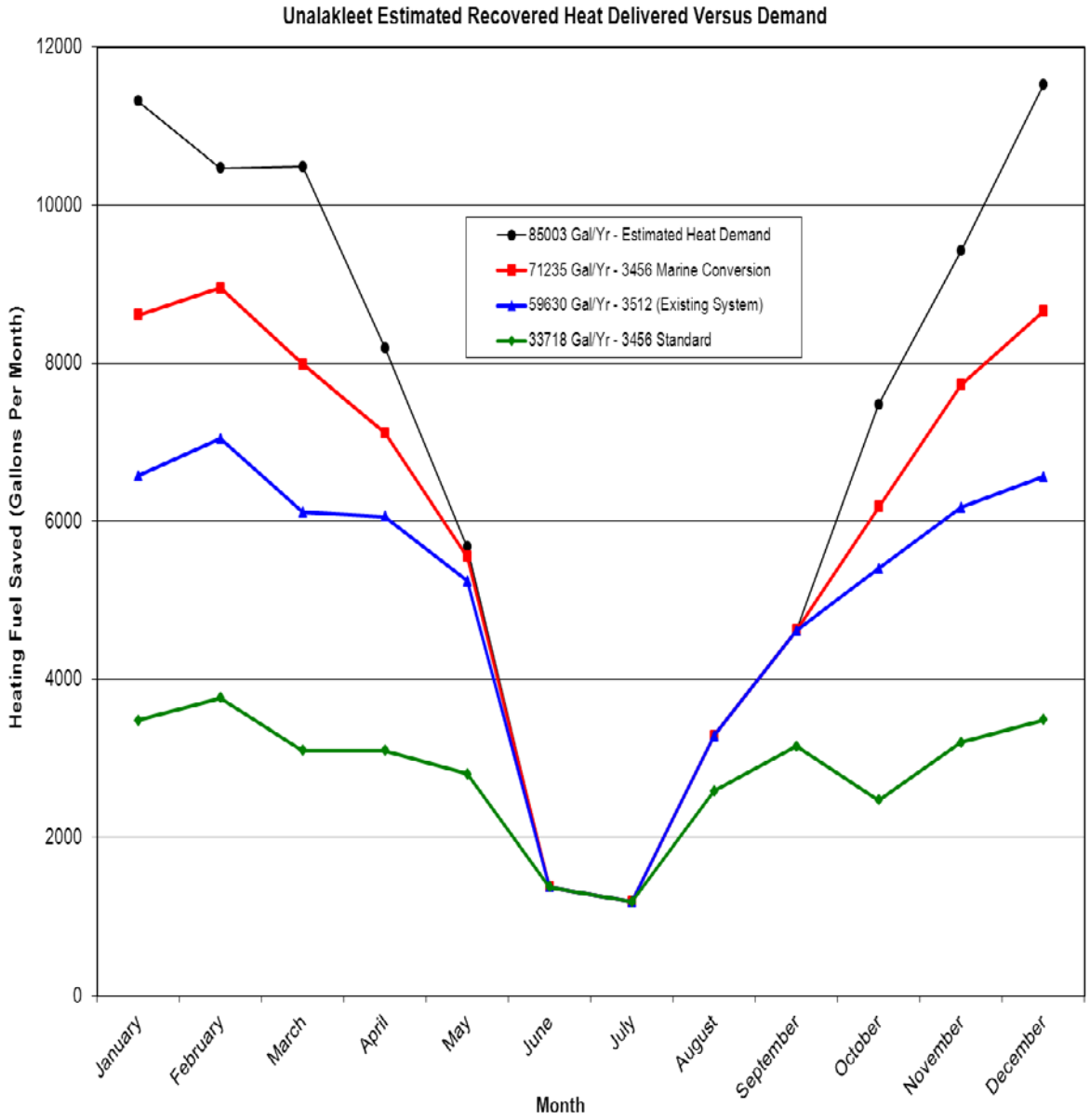
These heat recovery systems result in less electricity required for radiator fan cooling as well


Cat 3456 Heat Rates - Standard vs. Marine Conversion
Cat 3456 Marine Conversion
Cat 3456 Standard
Heat Output to Coolant (kW)
Electric Load (kW)
0
50
100
150
200
250
300
350
400
450
0.0
50.0
100.0
150.0
200.0
250.0
300.0
350.0
400.0
450.0
500.0
550.0
600.0


Detroit Diesel, Series 60 DDEC4 - 1800 & 1200 RPM
12.7 Liter, Heat Rejected to JW (Btu/kWh)
6063TK35, 350 kWe, NonRoad Tier 1, 1800 RPM, Dry Manifold
6063TK35, 350 kWe, NonRoad Tier 1, 1800 RPM, Marine Manifold
6063TK35, 200 kWe, NonRoad Tier 1, 1200 RPM, Dry Manifold
6063TK35, 200 kWe, NonRoad Tier 1, 1200 RPM, Marine Manifold
Btu/kWh
4000
3500
3000
2500
2000
1500
1000
0
50
100
150
200
250
300
350
400
kW Load

Heat Recovery



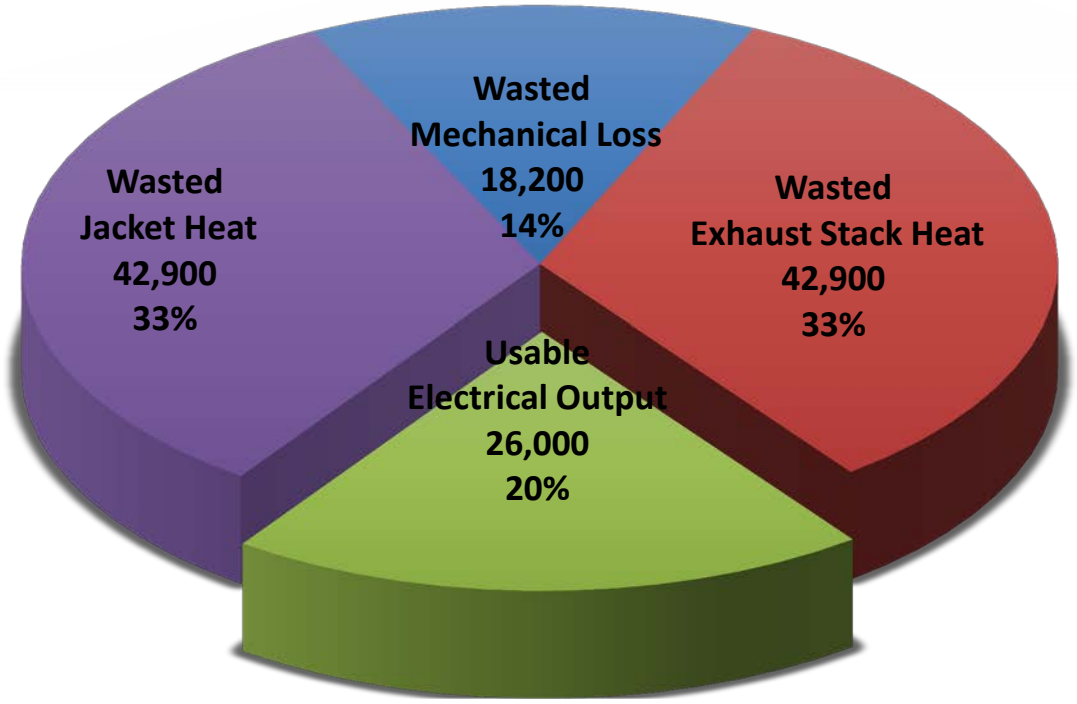

Unalakleet Estimated Recovered Heat Delivered Versus Demand
Heating Fuel Saved (Gallons Per Month)
12000
10000
8000
6000
4000
2000
0
85003 Gal/Yr - Estimated Heat Demand
71235 Gal/Yr - 3456 Marine Conversion
59630 Gal/Yr - 3512 (Existing System)
33718 Gal/Yr - 3456 Standard
January
February
March
April
May
June
July
August
September
October
November
December
Month

Heat Recovery


DANGER

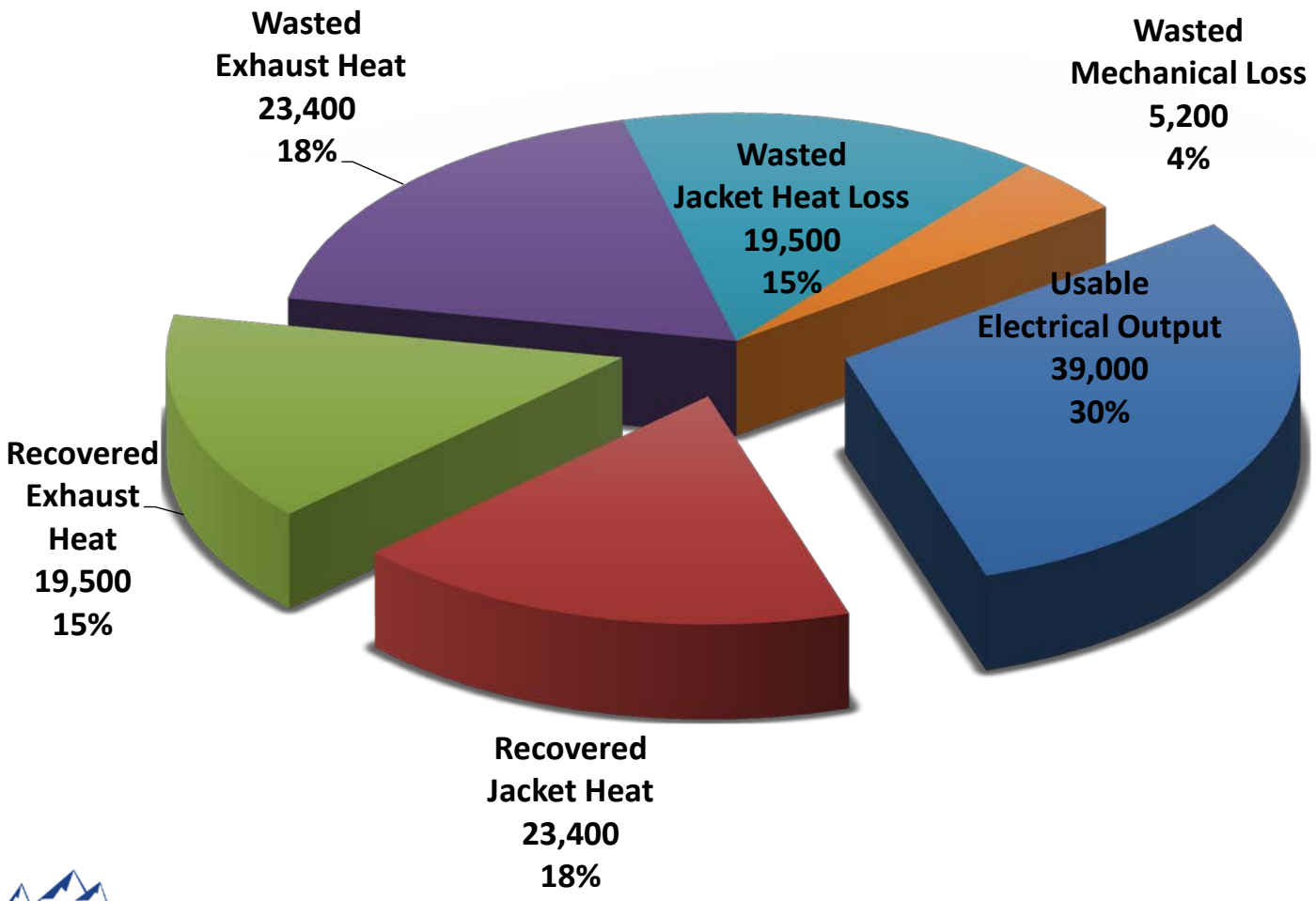
Diesel Generator Energy Outputs

Energy Allocation for Older Technology Diesel Generation

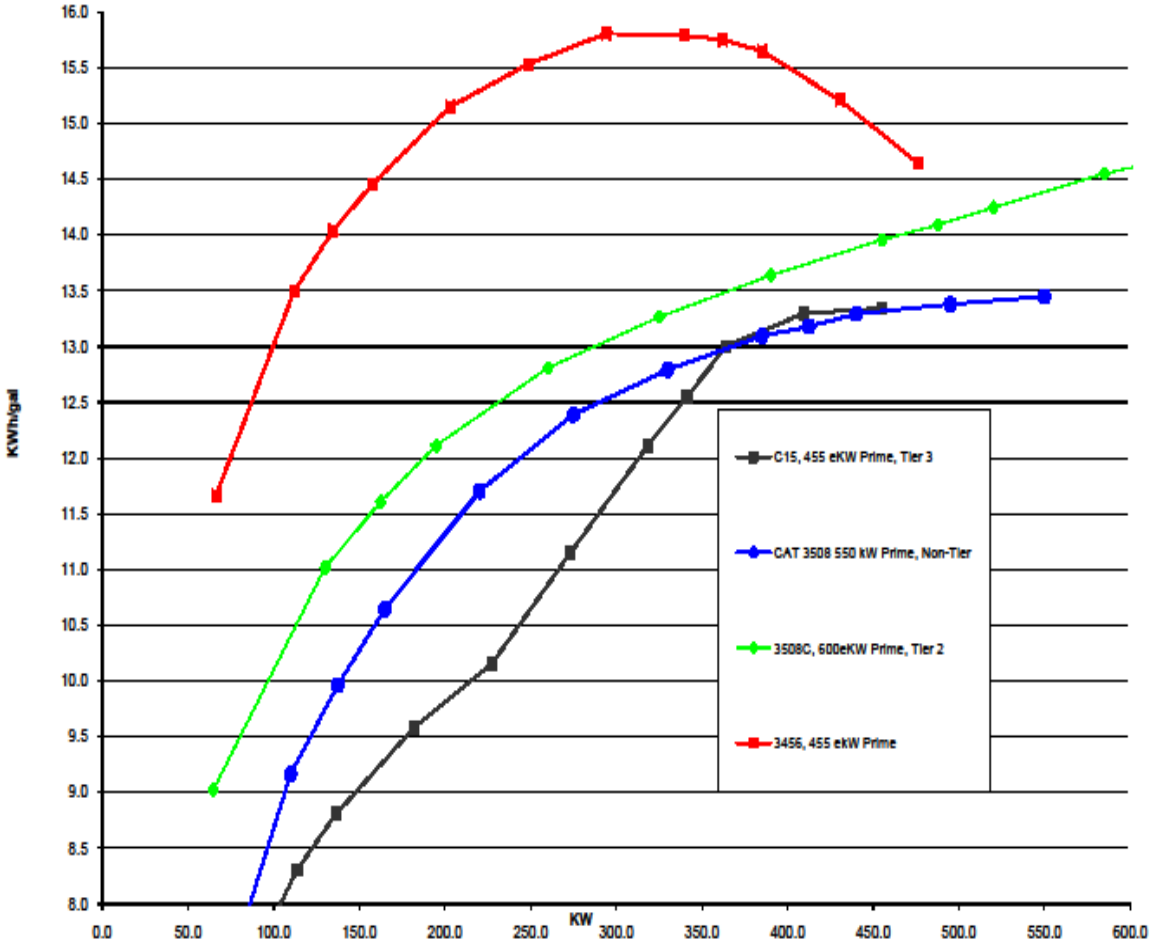


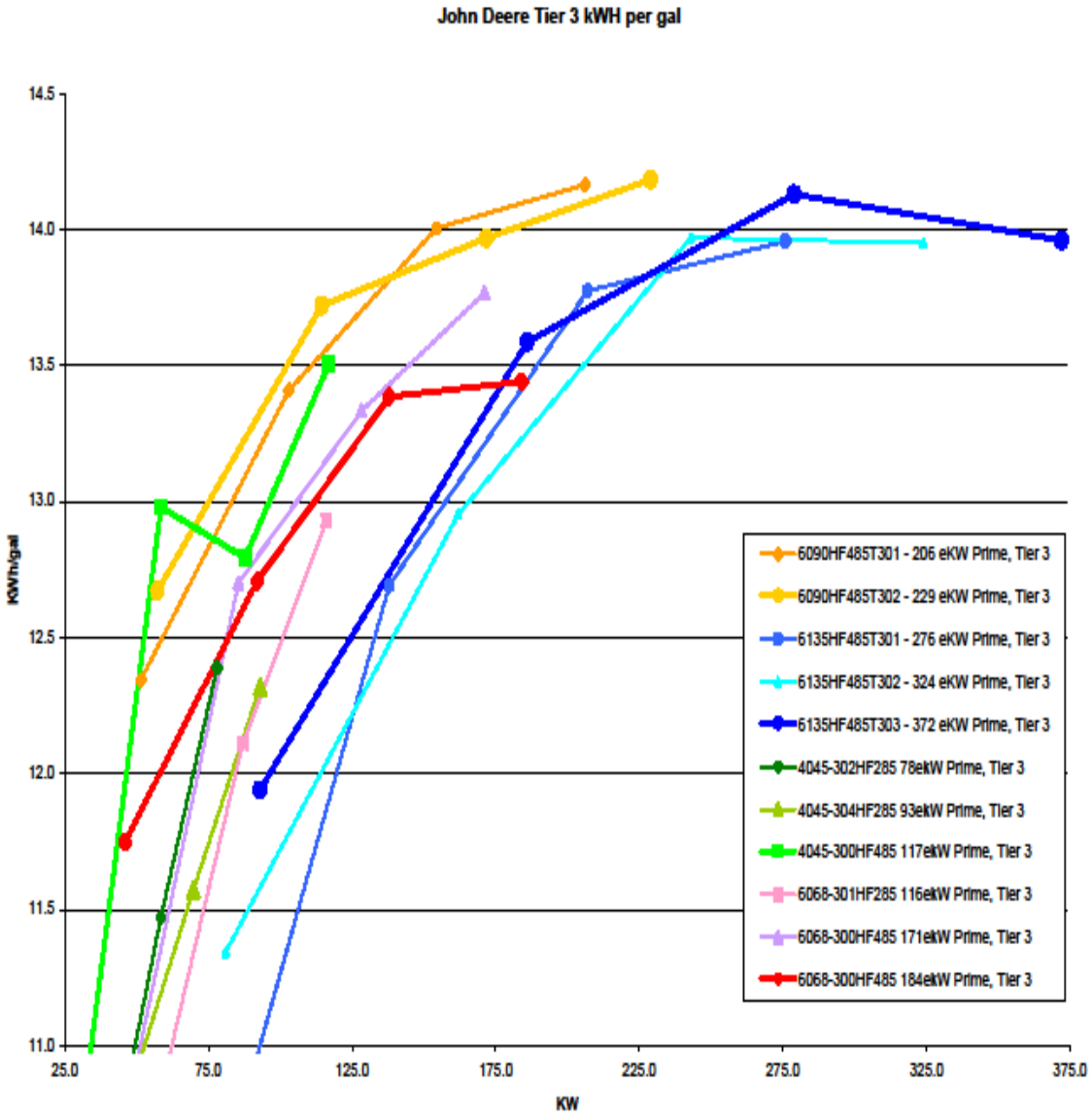
Diesel Generator Energy Outputs

Energy Allocation for New Technology Diesel Generation



Changing Diesel Technology




John Deere Tier 3 kWH per gal
14.5
14.0
13.5
13.0
12.5
12.0
11.5
11.0
KWh/gal
25.0
75.0
125.0
175.0
225.0
275.0
325.0
375.0
KW
6090HF485T301 - 206 eKW Prime, Tier 3
6090HF485T302 - 229 eKW Prime, Tier 3
6135HF485T301 - 276 eKW Prime, Tier 3
6135HF485T302 - 324 eKW Prime, Tier 3
6135HF485T303 - 372 eKW Prime, Tier 3
4045-302HF285 78ekW Prime, Tier 3
4045-304HF285 93ekW Prime, Tier 3
4045-300HF485 117ekW Prime, Tier 3
6068-301HF285 116ekW Prime, Tier 3
6068-300HF485 171ekW Prime, Tier 3
6068-300HF485 184ekW Prime, Tier 3

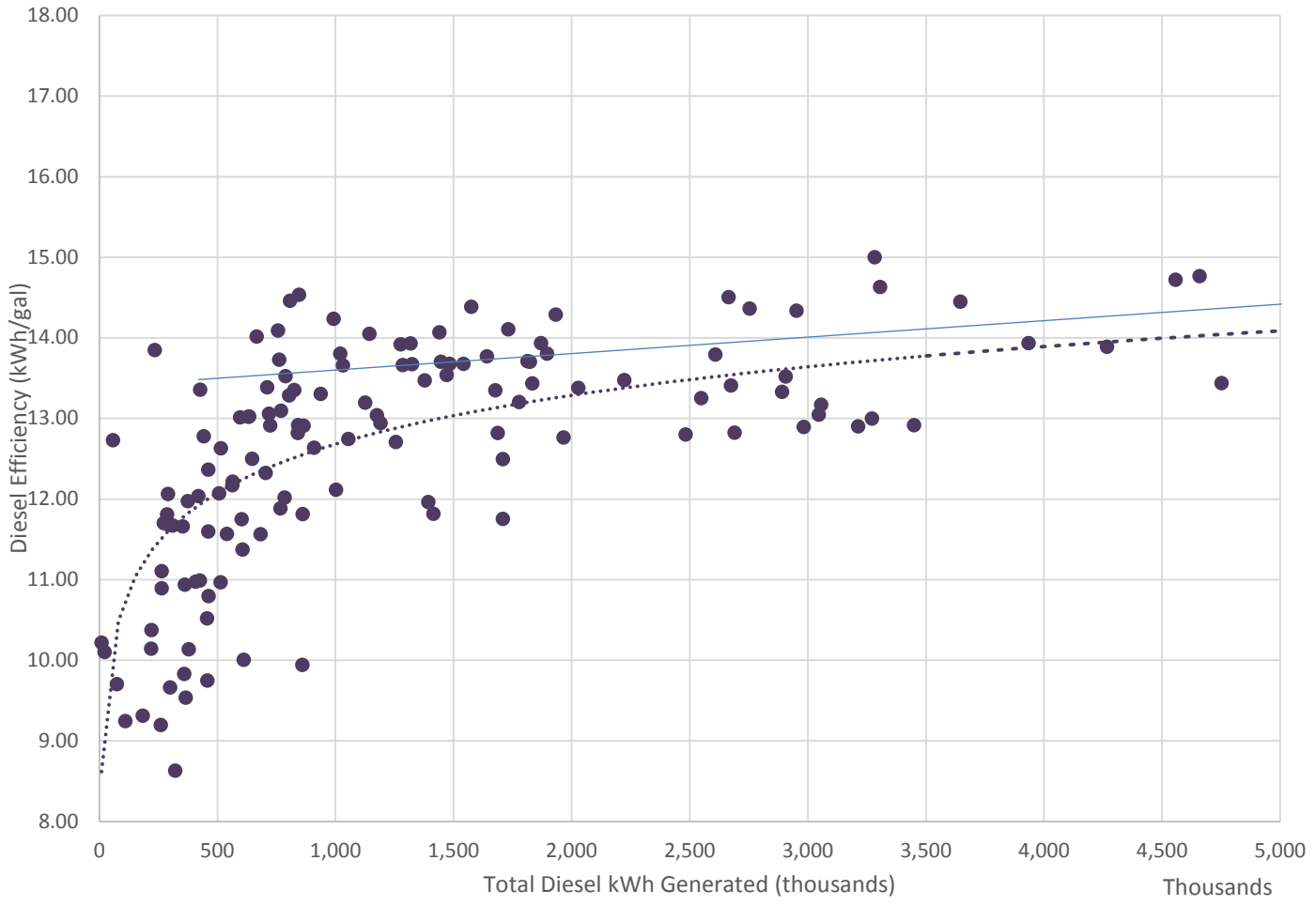
Fuel Cost Dominates Annual

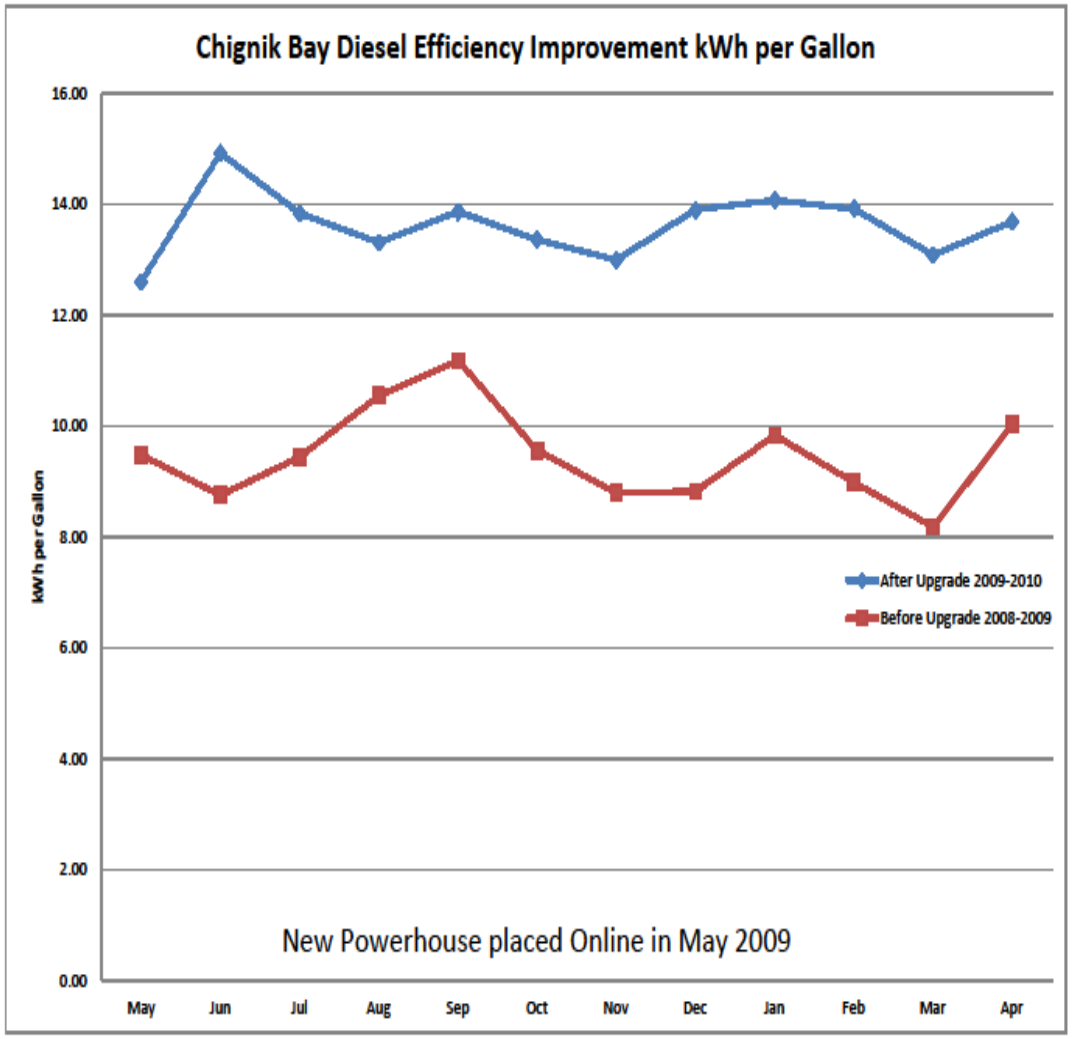
- 8760 hrs x 350 kW = 3,066,000 kWh/yr
- @13.0 kWh/gal = 235,000 gallons/yr
- @15.7 kWh/gal = 195,000 gallons/yr
- Fuel Savings = 40,000 gallons/yr
- $4.00/gallon = $160,000/yr
- 1-Year Payback Engine Replacement

Fuel Cost Dominates Lifetime

- 120 kW at 12 kWh/hr = 10 GPH
- 10 GPH x 50,000 Hr Life = 500,000 gallons
- $4.00/gallon = $2,000,000 over engine life
- 1% efficiency increase = $20,000 savings
- Engine Efficiency can vary more than 10%

FY13 PCE DATA: Diesel Eff. vs Total Diesel kWh Generated (in thousands)




Chignik Bay Diesel Efficiency Improvement kWh per Gallon
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
kWh per Gallon
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
After Upgrade 2009-2010
Before Upgrade 2008-2009
New Powerhouse placed Online in May 2009

Waste Oil Injection

Injection of waste engine oil back into the fuel

Power Generation Fuel

- #1 Diesel is most common for winter power generation use
- Blended #1/#2 used in some places to reduce cost, improve lubricity, increase Btu/gallon content
- Some utilities heat and/or insulate their fuel tanks and piping so they can use #2 year-round
- Benefits of using #2 year-round: higher lubricity, lower cost, more Btu/gallon

Questions ?