

Reducing Workboat & Rail Emissions in Ports with Clean Diesel Technology

BACKGROUND:
ENGINE
REPLACEMENTS IN
TEXAS

COST EFFECTIVE
RESEARCH: MARINE
AND RAIL REPOWERS

NEXT STEPS IN
RESEARCH

CASE STUDIES

SWITCHER IN
TACOMA

PUGET SOUND
WORKBOAT REPOWER

Leaders in Clean Diesel Technology

MISSION

To contribute to the greater awareness of clean diesel technology.

Collect and commission research examining the economic and environmental benefits of clean diesel technology



Environmental Defense Fund creates transformational solutions to the most serious environmental problems. **EDF links science, economics, law and innovative private-sector partnerships.**

Engagement
with Ports

- Port of Charleston
- Georgia Ports Authority
- Virginia Ports Authority
- Port of Houston Authority
- Port of Seattle
- Port of Oakland
- Prince Rupert Port Authority
- Port Freeport
- Port of New York/New Jersey
- Port of Baltimore
- Port of Los Angeles
- Port of Long Beach
- Port of Jacksonville
- Port of New Orleans

Background: TERP and Switcher and Marine Repowers

Diesel Emissions Reduction Incentive (DERI) Program

Projects by Emission Source¹

2001 through August 31, 2017

EMISSION SOURCE	NUMBER OF PROJECTS	NUMBER OF ACTIVITIES	TOTAL NO _x REDUCED (TONS)	GRANT AMOUNT	COST PER TON OF NO _x REDUCED
Locomotive	50	305	50,460	\$215,387,077	\$4,268
Marine	87	513	15,257	\$49,199,790	\$3,225
Non-Road	6,518	9,162	49,176	\$383,758,275	\$7,804
On-Road	4,874	8,898	60,219	\$426,655,420	\$7,085
Stationary	78	123	4,315	\$13,390,304	\$3,103
GRAND TOTAL	11,607	19,001	179,427	\$1,088,390,866	\$6,066

¹Does not include projects funded and subsequently canceled.

Large Engine Repowers Eligible for “VW Funds”

\$2.9 Billion to Reduce NOx Emissions with New Technology

- ▶ Class 8 Local Freight Trucks
- ▶ Buses (school, transit or shuttle)
- ▶ Dray Trucks
- ▶ Class 4-7 Freight Trucks
- ▶ Airport Ground Support
- ▶ Forklifts & Cargo-Handling Equipment
- ▶ Tugs & Switch Locomotives

Eligible Tug & Locomotive Activities

- ▶ Tugs
 - ▶ Replaced: Unregulated to Tier 2 Engines
 - ▶ Repowered with: Tier 3 or Tier 4 engines
- ▶ Locomotives
 - ▶ Replaced: Unregulated to Tier 2 Engines
 - ▶ Repowered or Replaced with: Tier 3, Tier 4 or cleaner engines

NOx Emission Reductions From Tugs and Switchers Matter

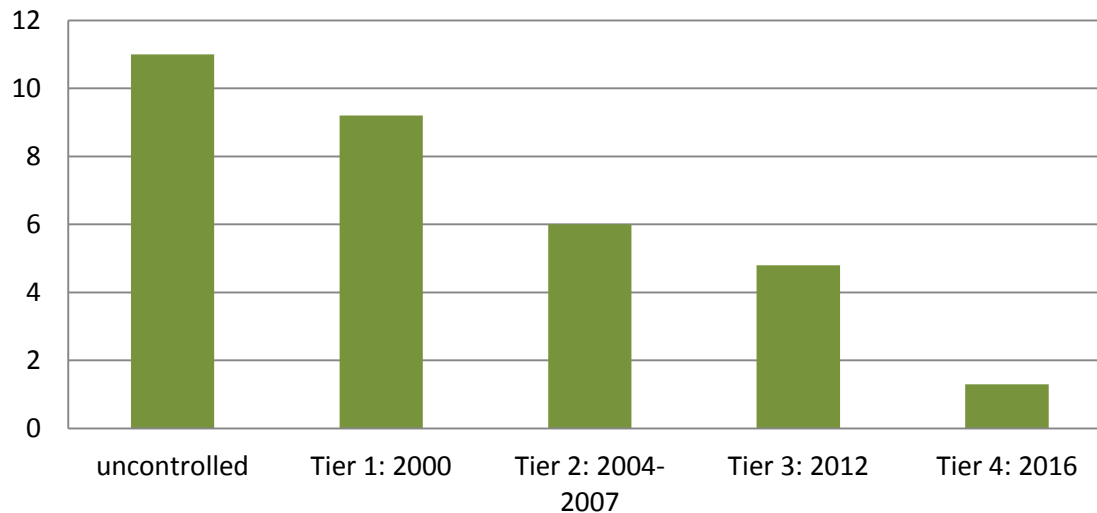
“According to the Puget Sound Maritime Emission Inventory for 2011, harbor craft account for approximately 25 to 30 percent of major maritime sector pollutants including the most common pollutants of concern: nitrogen oxides (NOX), PM, and carbon dioxide (CO2).

The harbor craft sector is the second largest emissions source sector in the Puget Sound maritime industry; ocean-going vessels are the largest emissions source sector. “

- “Harbor Craft Emissions Reduction and Fuel Efficiency Efforts”. Puget Sound Clean Air Agency. May 2017

Progress to Near-Zero Emissions with the Latest Clean Diesel Technologies in Workboats

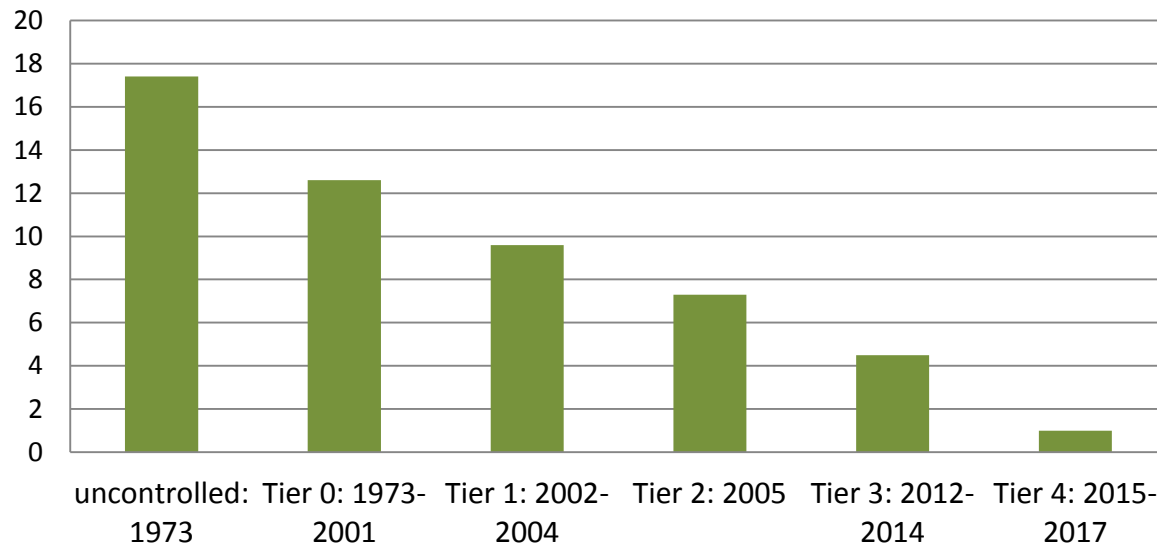
88% Reduction NOx Emissions for Marine Workboats [g/Kw-Hr]



Typically 2 propulsion engines with additional auxiliary engines

Progress to Near-Zero Emissions with the Latest Clean Diesel Technologies in Switch Locomotives

**94% Reduction NOx Emissions for Switchers
[g/bHp-Hr]**



New switchers typically use a single engine

Enormous Potential to Reduce Emissions Immediately



NATIONAL PORT STRATEGY
ASSESSMENT: Reducing Air
Pollution and Greenhouse Gases
at U.S. Ports



Switch Locomotive

Unregulated Engine with Tier 4 Engine

18.8 tons NOX per year

(replacing 29 pre-1991 port trucks)

Marine Workboats

Unregulated Engines with Tier 4 Engine

48.4 tons NOX per year

(replacing 75 pre-1991 port trucks)

Huge Benefits, But What Does It Cost?

Use existing grant data and anonymized cost data from manufacturers

What we learned

Replacing large engines is not like replacing a commercial vehicle. It's a custom project.

Will a new engine fit in the engine compartment?

Can aftertreatment technologies be incorporated?

Are there additional switchgear requirements?

Can upgrade kits be used?

Large Engine Upgrades Deliver the Most Cost Effective Emission Reductions

The most cost-effective upgrades make the biggest health impact

New Tier 4 engines for tug boats reduce NOx emissions by 91%

The \$2.9 billion VW Environmental Mitigation Trust provides funding to upgrade older vehicles and equipment to rapidly reduce nitrogen oxide (NOx) emissions, which contribute to hazardous smog pollution. Upgrading just one of the oldest, dirtiest tug boats is like taking tens of thousands

of passenger vehicles off the road per year, bringing substantial health benefits to at-risk communities. With states now deciding how to invest these funds, repowering these older vessels with cleaner Tier 4 engines is a game-changer for delivering immediate and cost-effective air quality benefits.



Upgrading old engines means cleaner air for all

EPA estimates that by 2020, only 3% of tug boats will be replaced with cleaner Tier 4 engines. The VW Environmental Mitigation Trust provides a rare opportunity to retire the oldest diesel engines still in operation, which can last 50 years or longer. Tier 4 or Tier 3 engines will deliver cleaner, healthier air faster to at-risk communities. These new engines also improve fuel efficiency, which reduces CO₂ and black carbon emissions, two important greenhouse gas pollutants.

Tug projects are a better value

1 ton of NOx reduction costs



1. Barkdoll, 2018. Emission reductions and cost effectiveness for marine and locomotive projects
 2. EPA, 2016. National Fuel Efficiency Assessment
 3. Tier 2 rap idies, 10,000 miles per year
 4. EPA, 2016. National Fuel Efficiency Assessment. Report
 5. Tier 2 rap idies, 10,000 miles per year

The most cost-effective upgrades make the biggest health impact

New Tier 4 engines for switchers reduce NOx emissions by 95%

The \$2.9 billion VW Environmental Mitigation Trust provides funding to upgrade older vehicles and equipment to rapidly reduce nitrogen oxide (NOx) emissions, which contribute to hazardous smog pollution. Upgrading just one of the oldest, dirtiest switchers is like taking tens of thousands

of passenger vehicles off the road per year, bringing substantial health benefits to at-risk communities. With states now deciding how to invest these funds, repowering these older switchers with cleaner Tier 4 engines is a game-changer for delivering immediate and cost-effective air quality benefits.



Upgrading old engines means cleaner air for all

EPA estimates that by 2020, only 5% of switcher engines will be replaced with cleaner Tier 4 engines. The VW Environmental Mitigation Trust provides a rare opportunity to retire the oldest diesel engines still in operation, which can last 70 years or longer. Tier 4 engines will deliver cleaner, healthier air faster to at-risk communities. These new engines also improve fuel efficiency, which reduces CO₂ and black carbon emissions, two important greenhouse gas pollutants.

Switcher projects are a better value

1 ton of NOx reduction costs

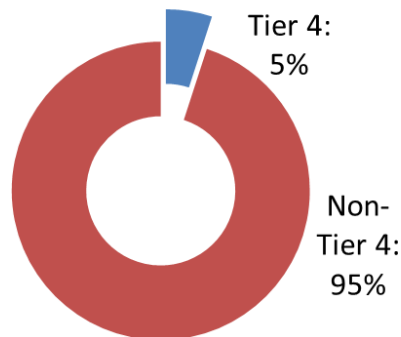


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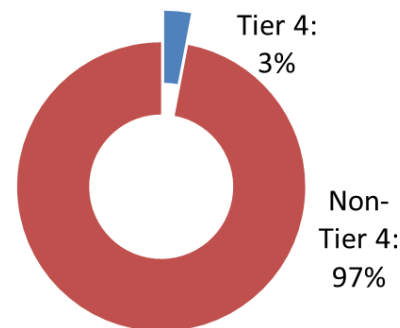
More Research to Come

- ▶ How long do these engines really last?
 - ▶ EPA assumes switchers last **70 years**
 - ▶ Are marine workboats as long lived?
- ▶ What would the air shed look like in select ports if more of this equipment were replaced sooner?

Population of Tier 4 Engines in
Switch Locomotives by 2020



Population of Tier 4 Engines in
Tug Boats by 2020



Case Study: 34 tons of NOx Reduced for Tacoma Residents



*Recent Diesel Emission
Reduction Act Grant*

\$2 million investment to replace 1950s era switcher with a Tier 3 engine

Benefits for communities

- Reduced 34 tons of NOx
- Eliminated almost 2,000 pounds of fine particles
- Saved the rail operator 19,000 gallons of fuel

Case Study: 3.2 tons of NOx Reduced in Puget Sound



***“Island Chief”* workboat engine replacement**

- 2 unregulated propulsion engines replaced with 2 Tier 3
- 1 unregulated auxiliary engine replaced with Tier 4

Cost: \$225,000

Benefits Provided

- Reduced 3.2 tons of NOx per year
- Eliminated 400 lbs of fine particles
- Saved the operator 45,000 gallons of fuel resulting in 1,000 tons of GHG emissions

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