FOSS

THE HYBRID TUG SOLUTION

EPA VERIFIED TECHNOLOGY

REDUCING EMISSIONS FOR CLEANER AIR AT OUR NATION'S PORTS


HYBRID
CAROLYN DOROTHY
FOSS
HYBRID
CAMPBELL FOSS
FOSS

The world's first hybrid tug was introduced in San Pedro Bay in January of 2009 as an innovative approach to reducing air pollution. Foss' tug was designed to retain the power and maneuverability of her sister tugs, while dramatically reducing emissions, noise and fuel consumption.

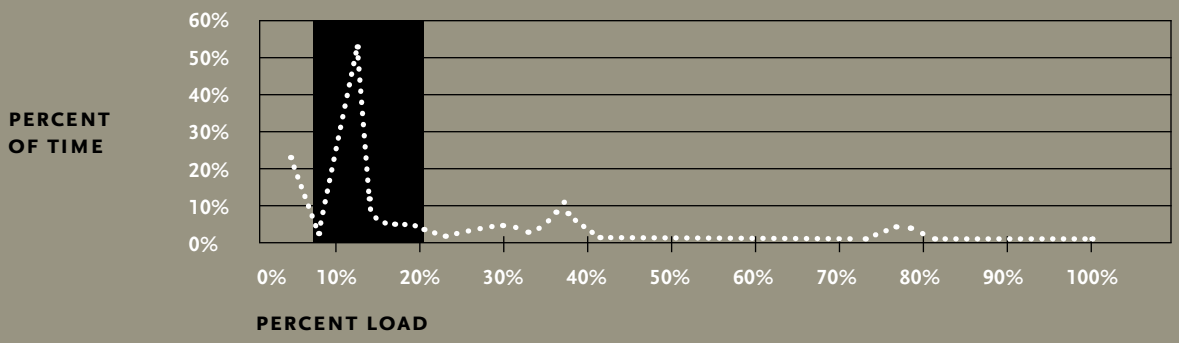
After independent third-party testing of the hybrid validated its significant emissions reductions, Foss decided to retrofit an existing tug to create a second hybrid. This EPA verified technology used on these hybrid tugs can be used to convert harbor tugs—and other types of workboats—to hybrid vessels with lower emissions, improved fuel economy, and lower maintenance costs.

THE CASE FOR THE HYBRID TUG

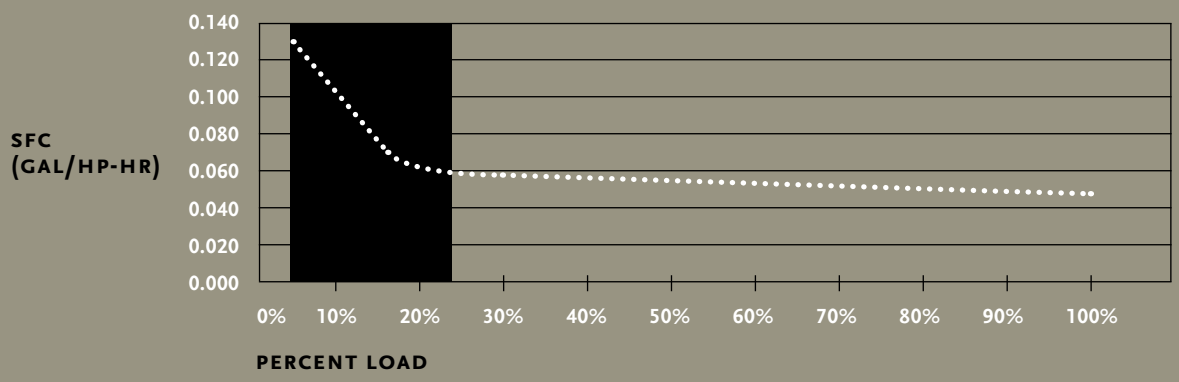
Traditional Harbor Tugs

The current fleet of over 500 harbor tugs is inherently inefficient. They have high power requirements, but only for short bursts of time. The highly variable power demands mean that harbor tugs end up using large diesel engines at low power most of the time, which results in higher fuel consumption, inefficient combustion and therefore higher emissions. In fact, today, in ports across the United States, harbor tugs are consistently using less than 68% of their available horsepower about 99% of the time.

Large percent of time spent at very low power levels...



...where fuel consumed per horsepower produced is very high



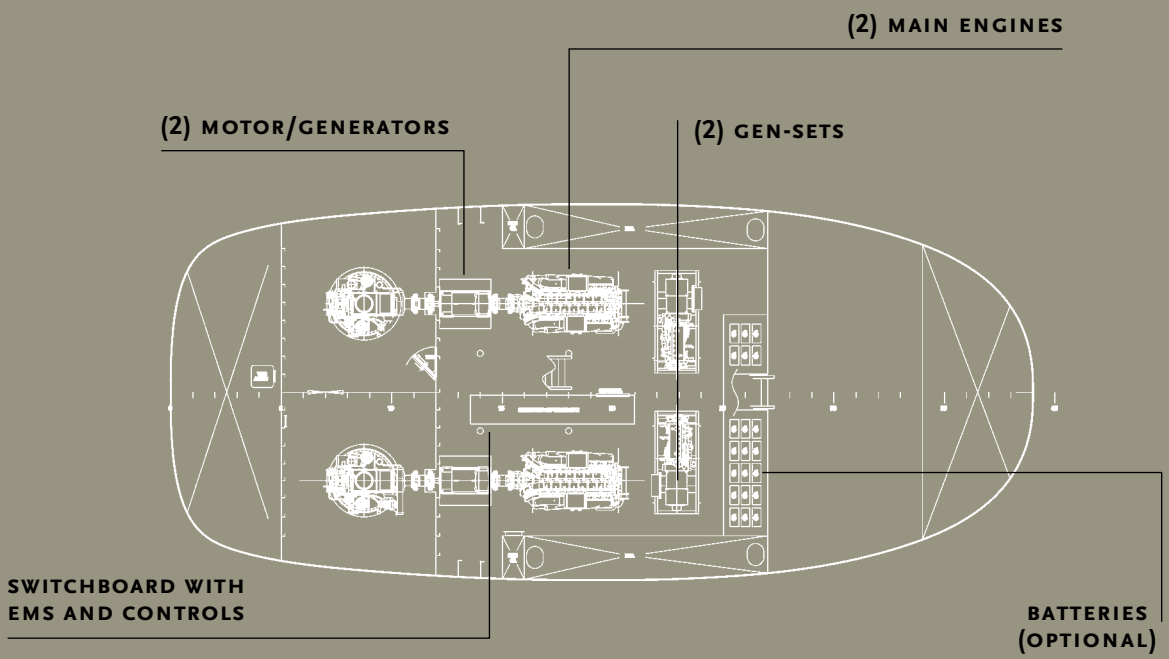
The Hybrid Tug

Proven hybrid technology solves the harbor tug dilemma by matching power sources to power requirements. With dozens of possible equipment configurations, the hybrid tug delivers only the power needed through the most efficient combination of power sources. For maximum efficiency, motor generators, diesel generators, diesel main engines and batteries (optional) run only when needed, and are controlled by an energy management system.

The hybrid tug achieves better fuel economy by sharing the propulsion load between the diesel and electrical sources with a significant reduction in unnecessary idling.

Since the main engines are operating less frequently, their lives are extended which means more time between engine overhauls. By reducing maintenance and repairs, fewer parts are used, reducing the carbon footprint and producing less waste to end up in landfills.

The system redundancies and multiple power sources also improve safety by nearly eliminating the chance of power loss. The hybrid tug always retains its ability to maneuver, no matter what.



THE BENEFITS OF HYBRID TECHNOLOGY

Reduces emissions for all pollutants associated with diesel engines, without sacrificing power or maneuverability. The hybrid shows a significant reduction* for pollutants related to combustion efficiency – 73% for particulate matter, 51% for nitrogen oxides, and reductions of 27% for fuel related pollutants (sulfur dioxide and CO2) when compared with a conventionally powered sister tug.

Reduces fuel consumption by an estimated 20-30% by reducing idling and increasing engine efficiency.

Reduces main engine maintenance costs by reducing the number of operating hours by approximately 50% on the main engines.

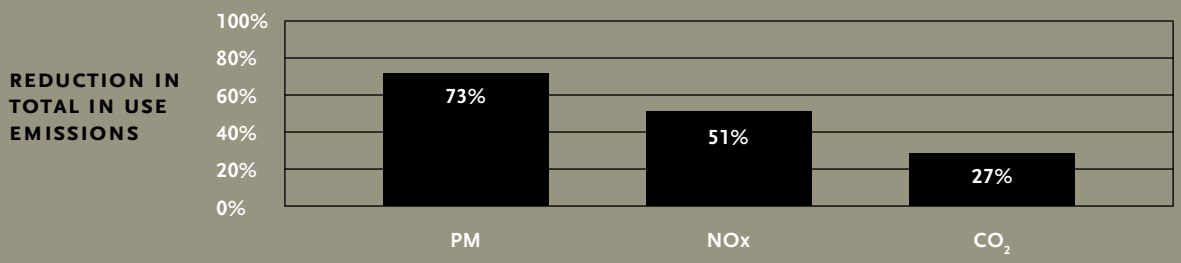
Reduces noise pollution by using quieter batteries and generators instead of large diesel engines.

Improves safety by effectively removing any chance of power loss with multiple system redundancies and configurations.

** From a California Air Resources Board 2010 report of independent, third-party testing performed by a team at the Center for Environmental Research and Technology (CE-CERT) at the University of California, Riverside (UCR). The testing program was conducted in the Ports of Los Angeles and Long Beach over a seven-month period from January to July, 2010.*

Overall Emissions Reductions

Testing compared emissions from the Carolyn Dorothy hybrid tug to those of a conventional sister tug



BUILDING THE WORLD'S FIRST HYBRID TUG

The hybrid tug was a collaborative effort. Foss built the tug in its Rainier-Oregon shipyard, based on the 78' x 34' x 14' Dolphin class tug, specifically designed to provide optimal power and positioning in confined waterways. The first hybrid, *Carolyn Dorothy*, was the tenth Dolphin tug constructed at the Foss Rainier shipyard. This same shipyard is also responsible for the retrofit of the second hybrid, *Campbell Foss*. While a hybrid tug looks identical to its sister tugs on the outside, the huge technological advances are readily apparent in the engine room.

Foss partnered with Aspin Kemp & Associates (AKA) (www.aka-group.net) for systems integration and design of the hybrid power system, which incorporates available technologies in a new application. The hybrid tug uses a sophisticated power management system that delivers power seamlessly from batteries (optional), generators and the main engines when necessary. The technology used in the hybrid design has already been proven and is well-understood in other applications. The tug's flexible design allows it to take advantage of emerging technologies such as improved battery and fuel advances, and afterburn treatment systems like diesel oxidation catalysts, selective catalytic reductions, and diesel particulate filters.

THE OPPORTUNITY

Hybrid technology is EPA verified and promises significant benefits both to ports by reducing a major source of air pollution, and to fleet operators by realizing cost savings from reduced fuel consumption.

All conventional harbor tugs working today in the U.S., regardless of their engine room configuration, are candidates for retrofitting to the hybrid system. Investment to overcome the capital cost of retrofitting conventional tugs could provide a substantial benefit to the public and help the many EPA non-attainment ports on either coast improve air quality.

ALWAYS SAFE. ALWAYS READY.

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Foss has a company-wide commitment to safety and environmental stewardship, and a long history of technological innovation. Our mission: to provide marine services without equal.



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