Vessel Electrification Investigation for the NCDOT Ferry Division Fleet

Background

Today more than 15 ferry systems in the United States operate or plan to soon operate either fully electric or hybrid electric ferries. With the passage of the Bipartisan Infrastructure Law (BIL) in 2021, the U.S. federal government is dedicating $500 million toward alternative fuel ferries from 2022 to 2026. North Carolina's Clean Transportation Plan and Clean Energy Plan, written in accordance with Executive Order 80 , outline strategies to reduce greenhouse gas emissions by 40% in 2025 compared to 2005 levels and to achieve a 60% to 70% reduction in emissions from the electric power sector by 2030 compared to 2005 levels—reaching zero emissions by 2050. With this context, the North Carolina Department of Transportation (NCDOT) is interested in exploring the feasibility of electrifying portions of its ferry system—a system that includes 22 ferries along eight routes, serving over 700,000 vehicles and 1.5 million passengers annually.

Purpose

This study examines the techno-economic feasibility of electrifying four ferry routes in NCDOT's Ferry System. For each of the four routes, the lifecycle cost, emissions, and health impacts of plug-in electric hybrid ferry vessels were compared to diesel mechanical and diesel hybrid vessels (see reverse for definitions). Plug-in hybrid vessels provide for operation in times of emergency response, and for vessels to periodically travel to Manns Harbor for required inspections and repairs. Vessel charging configurations considered include: one-side charging and two-sided charging and with and without shoreside energy storage systems (ESS).

Impact of Plug-in Hybrid Vessels

$97.5M
SAVINGS

190,000 Metric Tons
ANNUAL CO_2e REDUCTION

$2.3-$6.8M
ANNUAL HUMAN HEALTH BENEFIT

NCDOT Ferry Routes Studied for Electrification

	Pamlico River	Currituck Sound	Cape Fear River	Neuse River
Distance (One-Way)	4 miles	5 Miles	4 miles	2 miles
Duration (One-Way)	30 minutes	40 minutes	35 minutes	20 minutes
No. of Vessels Typically Operating	1	1	2	2
Crossings per Day (One-Way)	14	10	28 or 32 (season dependent)	56
Time in Port between Crossings	15 minutes	20 minutes	10 minutes	10 minutes
Age of Vessel(s) (Vessel Name)	31 years (Governor Daniel Russell)	39 years (Governor James Baxter Hunt Jr)	27 (Southport) & 23 (Fort Fisher) years	25 (Neuse) & 23 (Lupton) years
Electric Utilities	Tideland EMC	Dominion	Duke Energy & Brunswick EMC	Carteret-Craven & Tideland EMC

Electric Vessel Configurations

Plug-in hybrid. Electrically powered vessels primarily utilizing an onboard battery system regularly charged by a shoreside charging system. Onboard diesel generator sets utilized for range extension and/or emergency operations.

Diesel hybrid. Electrically powered vessels primarily utilizing diesel generator sets. Peak power requirements are met by a relatively small onboard battery system.

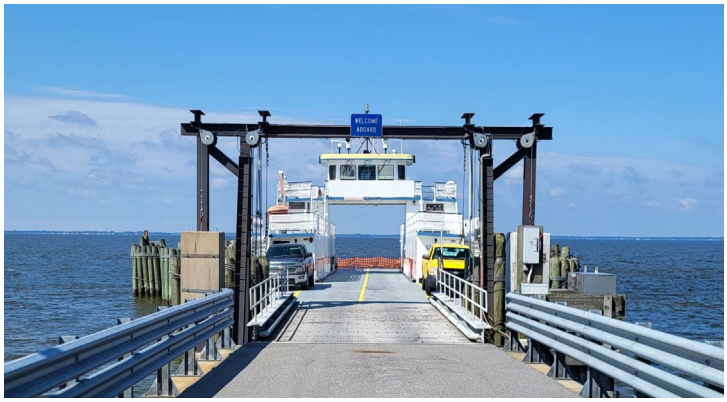
Diesel mechanical. Vessels utilizing a traditional mechanical powertrain configuration with diesel-powered main engines. Onboard generator sets provide power to electrical equipment.

Shoreside Electric Charging Configurations

No shoreside battery (no shore ESS). Plug-in hybrid vessel charges directly from the grid.

Battery used by ferry operator only (shore ESS). Plug-in hybrid vessel rapid charges from a shoreside battery that is slow charged from the grid. Only ferry system access to energy stored in shoreside battery.

Battery shared between utility and the ferry operator (shore ESS (shared)). Plug-in vessel rapid charges from a shoreside battery that is slow charged from the grid. The shoreside battery periodically serves as a grid asset for demand response, as both ferry system and utility share access to energy stored in shoreside battery.



Findings

For all analyzed routes, plug-in electric ferries have the lowest lifecycle costs, greenhouse gas emissions, local air pollutant emissions, and human health impacts. These findings were robust across most reasonable cost and financing assumptions. The estimated lifetime savings, reduction in annual greenhouse gas emissions, and annual human health benefit from electrifying the vessel(s) on each route are shown below. At every route evaluated in this study, the configuration with the lowest lifecycle cost, greenhouse gas emissions, and local air pollutant emissions emissions is a plug-in hybrid vessel charging on one side and utilizing a shoreside energy storage system.

Impact of Plug-in Hybrid Vessels vs. Diesel Mechanical Vessels

Route	Lifetime Savings	Annual CO_2e Reduction	Annual Human Health Benefit
Pamlico River	$12.4M	2,700 metric tons	$317,000-$718,000
Currituck Sound	$13.3M	2,300 metric tons	$292,000-656,000
Cape Fear River	$17.6M	5,600 metric tons	$1,016,000-$2,295,000
Neuse River	$54.2M	8,400 metric tons	$1,175,000-$2,645,000

Implementation Planning

Based on the potential for cost, emission, and health benefits, the recommendation is to pursue electrification on all four of the routes analyzed in this study, prioritizing electrification of the vessel(s) at Currituck Sound, followed by Pamlico River, Neuse River, and finally Cape Fear. The recommended configuration at all four routes is a plug-in hybrid vessel, charging on one side and utilizing a shoreside ESS that is accessible by the utility if applicable. This prioritization is based on lifecycle cost, emissions, vessel age, and potential grid infrastructure improvement requirements. Additionally, prioritization considered the number of vessels operated at each route and the number of crossings per vessel per day. Phasing these projects allows the NCDOT to gain experience in the funding, financing, and operations of the electric ferries prior to moving to the next project.