



**CHESAPEAKE ENVIRONMENTAL PROTECTION ASSOCIATION, INC.**  
 P.O. Box 117, Galesville, Maryland 20765

**NEWSLETTER**

**Winter 2021-2022**

**PRESIDENT/TRUSTEE MESSAGE**

*By Al Tucker & Mike Lofton*



In 2007 CEPA accepted a community benefit grant from Anne Arundel County to monitor the environmental impact on the surrounding community of the closed PST-Harwood Landfill (PST) on Sands Road in Harwood, MD. This landfill, classified as a "Rubble Landfill", operated in the 1990s, before the State and the County adopted strict engineering design principles for this type of landfill. It is one of approximately 10 legacy landfills in the State that have no bottom liner to prevent groundwater intrusion into rubble within the landfill.

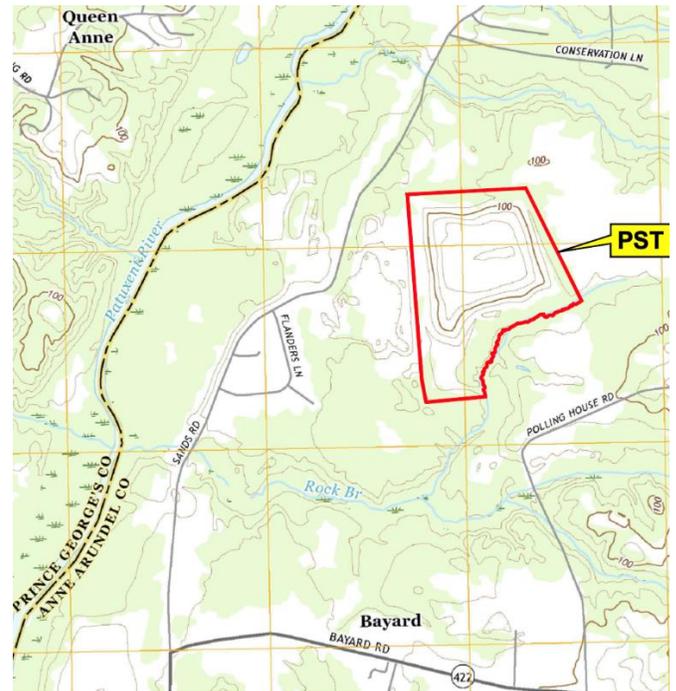


To understand why the PST Landfill presents a danger to the surrounding

neighborhoods and also a threat to a major aquifer in southern Anne Arundel, we need to consider how it is constructed. Up until the 1990s, the US EPA and its predecessor organizations developed guidelines for keeping water from infiltrating the trash within a landfill. Impermeable caps were required, and water diversion trenches were required if groundwater could penetrate from beneath. As a result, landfills would then require considerable annual maintenance. Trees are not allowed to grow on the landfill, since their roots would penetrate the impermeable caps and pumps must run 24/7 to divert groundwater from penetrating below. The site location was not a consideration. Hence, these landfills discharge significant amounts of water into nearby streams. As a result, these landfills require a surface water discharge permit from EPA. The water discharged must not have contaminant levels that exceed the maximum contaminant levels set by the EPA. If it does exceed these levels, it must be treated at a hazardous waste disposal site.

So what does a rubble landfill in Maryland contain? It accepts waste derived from construction debris such as wood, metal, bricks and masonry, concrete, glass, shingles, and roofing material. It may also contain interior structures and materials such as carpets, floor and wall tile, asphalt, insulation material, pipes, and even appliances. Additionally, debris derived from land clearing operations such as tree stumps, brush and limbs, logs, topsoil, vegetation, and rock. Paper and cardboard

packaging or building materials are accepted if they do not exceed 10% of the waste by volume. Empty paint containers and empty caulk or glaze containers are accepted, provided they do not exceed 1% of the waste accepted at the rubble landfill by volume. Wood and paper products are primarily organic materials that produce methane as they decompose. Appliances, paint, asphalt materials for example can be the sources of volatile organic compounds and some heavy metals.



Since July 1, 2001, the EPA guidelines have required all landfills to have liners and leachate collection systems. In addition, the liner system must be impermeable and located entirely above the composite high-water table. Landfills must now be sited to have a buffer distance between the liner and the maximum expected groundwater elevation at that location. More simply stated, the landfill must be constructed to prevent water infiltration from any direction at any time.

Since the PST Landfill occupies an exhausted gravel mine site that operated until 1999 when it was closed, it does not meet these requirements. As a result, it is grandfathered under regulations that existed prior to 2001. The geotechnical analysis for PST shows that its unprotected bottom lies within a few feet of the Aquia aquifer, a major drinking water aquifer for South County. In this area, the Aquia is semi-confined, which means that its water can mix with the surficial water aquifer. Thus, the diversion trenches at PST must intercept the natural groundwater flow and be pumped to the surface. At PST these trenches intercept about 250 gallons per minute, in other words, more than a small stream. A trench on the western side of the landfill monitors the effectiveness of the natural groundwater

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diversion. This trench then captures any leachate and groundwater seepage. It is within this trench that violations have been observed. Over the years, cadmium, barium, volatile organic compounds, and iron found in this trench have exceeded the EPA limits.

In 2013 the Maryland Department of Environment (MDE) entered into a consent decree with Waste Management Inc. (WMI), the current owner of the landfill, to remediate and limit these contaminant exceedances. The solution agreed to by MDE combined the discharges from the trenches into a single pond. Here, the leachate is diluted with fresh water from the primary diversion trench. The levels of contaminants in the surface water discharged from this pond are below the levels proscribed by the EPA.

In the meantime, the surface water discharge permit for PST has expired, and WMI has applied for renewal. Rubble landfills are required to maintain these permits until such time as the MDE determines that a regulated discharge is no longer occurring. That begs the question, what happens if they make this determination? This landfill has mechanical systems that must operate 24/7. If they fail, water may enter the facility, and the leachate may contaminate the groundwater. One of CEPA's primary interests is the contamination of aquifers, and leachates from the landfill have the potential to expose the aquifer to toxic chemicals. CEPA accepted the community benefit grant to act as a third-party observer and to continue groundwater monitoring in the event that the landfill is considered permanently closed.

Currently, WMI is responsible for maintaining the integrity of the landfill and for guaranteeing that any discharge from it is safe. Any landfill that has a remote possibility of groundwater intrusion should require monitoring in perpetuity.

In order to protect the drinking water supply to area residents and the Aquia aquifer, CEPA recommends that MDE:

1. Establish a rigorous monitoring program that recognizes the unique conditions associated with PST and other unlined landfills in Maryland.
2. Create a class of discharge permits that establish requirements to address the extended time periods and other conditions such landfills warrant to assure protection of drinking water sources.
3. Identify and test drinking water wells downgradient from the landfill.
4. Ensure that the closure bond is sufficient to remediate future contamination.

CEPA will encourage appropriate State and County officials to create new or to amend existing laws/regulations to minimize threats to public health.

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**THE VALUE OF GREEN INFRASTRUCTURE MUST BE PROTECTED**

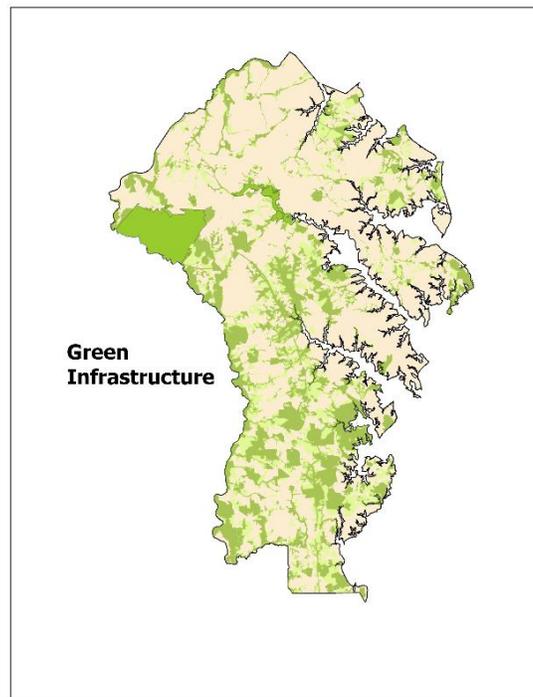
By Paul Christensen



Anne Arundel County's new Green Infrastructure Master Plan is a guide to conserving an interconnected network of the most significant remaining natural lands in Anne Arundel County. The lands identified in the Green Infrastructure Network help protect water quality and air quality, provide habitat for plants and wildlife, create opportunities for recreation, and support mitigation of, and adaptation to, climate change. All of these services are known as Ecosystem Services, and they bring valuable additions to the quality of life of everyone in our County.

The economic value of Ecosystem Services has been extensively studied throughout the world, and the Maryland Department of Natural Resources, has calculated and mapped their estimated value for much of AA county. (see <https://dnr.maryland.gov/ccs/Pages/Ecosystem-Services.aspx>)

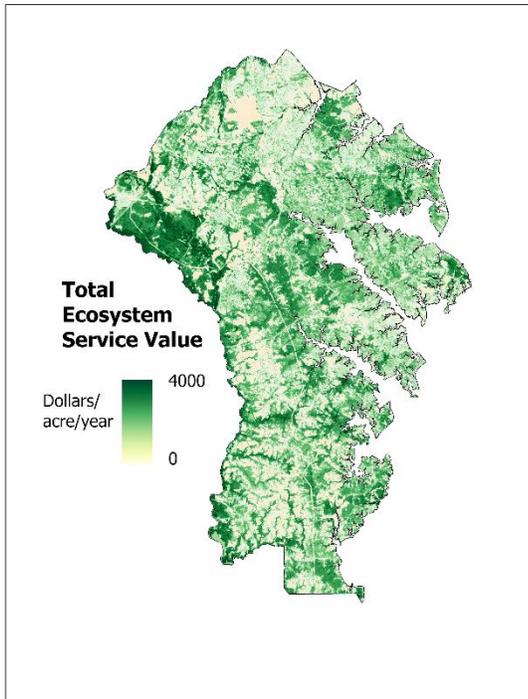
The maps below (this pg. and next pg.) show the locations of Green Infrastructure (GI) in the Plan and the areas in the County that provide highly valued ecosystem services. It is clear that designated Green Infrastructure in the map is typically associated with a high level of ecosystem services



The Green Infrastructure Network comprises 107,000 acres. Development of Green Infrastructure areas dramatically reduces the ecosystem services provided. Fortunately, about 65% of the GI Network is protected from development by various types of easements and County acquisitions. About 35% of the Network, however, is privately owned and subject to the land use choices of the owner. The landowner thus controls an asset that has value both to himself and the general public.

Owners' perspectives on their property often change over time. There is risk of an owner choosing to convert some or all of his

equity in the land into a more liquid asset and destroying many of its ecosystem services in the process.



The coming "Regional Area Plans (RAPs)" should prioritize protection of Green Infrastructure and avoid land use or zoning changes that will allow more intensive development of areas in the GI Network. The RAPs are supposed to be consistent with the general guidance provided by Plan2040 (the County's General Development Plan), but on issues like land use, they will be able to recommend amendments to Plan2040 and thus override it. RAPs are intended to be more powerful than the Small Area Plans (SAPs) were for the last GDP.

Up-zoning of these properties or conversion from residential to multiuse or commercial zoning is clearly not in the public interest. However, GI property owners in search of an exit strategy have the options of conservation/preservation easements or possible outright fee simple sale to the County.

The GI Plan targets protection of an additional 5,000 acres of the GI Network by 2030 through conservation easements administered by the County or private land trusts or through fee simple acquisition of properties by the County using County, State, and Federal funds. Because property values, easement costs, and available State and Federal funding can vary widely over time, the cost of protecting 5,000 acres is difficult to accurately estimate. However, the GI Plan states that \$40 million of funds were expended over the past decade for fee simple acquisition of 1,800 acres. Per acre costs for conservation easements are usually lower since the landowner retains use of the property.

Ultimately, achieving the objective of protection of an additional 5,000 acres will depend on the political will of the Administration and County Council to allocate the necessary funding to the project. County taxpayers should be prepared to strongly encourage their elected representatives to budget sufficient funds to assure protection of Green Infrastructure and its valuable ecosystem services. In a County with a \$1.7 billion annual budget, allocation of a few million dollars per year for Green Infrastructure preservation should be easily manageable.

## AMMONIA AS A FUEL

By Gary Antonides



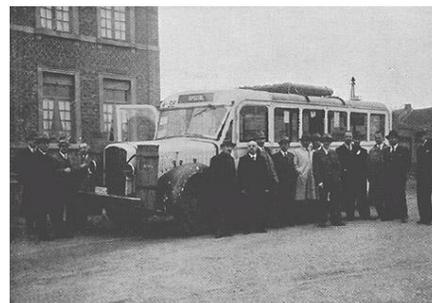
Anhydrous ammonia (ammonia without water) can be a substitute for petroleum as a transportation or power generation fuel. Combustion of ammonia yields water and nitrogen. Ammonia is manufactured using heat and pressure, and the heat and pressure can come from almost any energy source, so production can

use the cheapest, cleanest and/or greenest source. Ammonia can be used in internal combustion engines with minor modifications. It can be used in gas turbines, and improved ammonia fuel cells are being developed. Substantial ammonia distribution infrastructure already exists in the Midwest, mostly for the fertilizer industry. In addition, existing fuel dispensing infrastructure can be converted to ammonia. Safety issues with ammonia are no more severe than those with gasoline and diesel fuel. (See "Ammonia as a Transportation Fuel," AgMRC Renewable Energy Newsletter, May 2009, by Don Hofstrand, <https://www.agmrc.org/renewable-energy/renewable-energy-climate-change-report/renewable-energy-climate-change-report/may-2009-newsletter/ammonia-as-a-transportation-fuel>)



**Background** - An ammonia molecule is composed of one atom of nitrogen and three atoms of hydrogen (NH<sub>3</sub>). Most of the ammonia in the environment comes from the natural breakdown of manure and dead plants and animals. When ammonia

combusts it produces nitrogen (N<sub>2</sub>) and water vapor (H<sub>2</sub>O). Similar to propane or liquid petroleum gas (LPG), ammonia is a gas at normal temperature and atmospheric pressure but a liquid at higher pressures (about 150 psi at 75 degrees F). It can be stored and transported as a liquid but used as a gas.



Both gasoline and diesel engines can be converted to run on ammonia. The first utilization of liquid anhydrous ammonia as a fuel for motor-buses took place in Belgium in 1943 when diesel fuel was scarce. The

motor-bus fleet went thousands of miles on a mixture of ammonia with a small amount of coal gas during WWII.

In the 1960s, NASA's X-15 rocket-powered airplane used liquid ammonia and liquid oxygen, and achieved a world record for the highest manned flight Mach number of 6.7.

Ammonia has not been pursued as a fuel for combustion systems for many years, but has been researched to improve the technology. The 1990s saw renewed interest in the utilization of ammonia as an energy source to address global warming, and research into using ammonia for reciprocating engines and gas turbines has resumed.

Ammonia has a high octane rating (about 120), so it does not need an octane enhancer and can be used in high compression engines. However, it has a relatively low energy density per gallon. It's about half that of gasoline, so, in a vehicle, the fuel

mileage of ammonia is about half that of gasoline. As with hydrogen, ammonia has no carbon emission when combusted because it doesn't contain carbon. In internal combustion engines, ammonia needs very high pressures to compression ignite, so a small amount of another fuel such as hydrogen, LNG, diesel or biodiesel must be used in diesel engines.

Since WWII, research on ammonia engines has come in fits and starts, even as ammonia supplies soared. In the 1930s, worldwide annual production of ammonia was about 300,000 metric tons. Today, the world produces about 150 million metric tons of ammonia every year, but the transportation sector has had little incentive to use it since petroleum has a higher energy density and is easier and cheaper to produce.

Half of the hydrogen produced in the chemical industry is used for ammonia production. In addition to ammonia, hydrogen can be stored in other light chemicals such as methanol and ethanol. Ammonia has an advantage over those in that it does not contain carbon and will not release CO<sub>2</sub> when used as fuel. It is much less expensive to produce, store, and deliver hydrogen as ammonia rather than as compressed and/or liquid hydrogen.

#### Ammonia and fuel cells –

<https://www.frontiersin.org/articles/10.3389/fenrg.2014.00035/full>, "Ammonia as a suitable fuel for fuel cells," by Rong Lan and Shanwen Tao, University of Strathclyde, Glasgow, UK advocates the use of ammonia in fuel cells.

Ammonia can be used in fuel cells, but we more often hear that hydrogen is our ultimate renewable and green fuel source. Hydrogen fuel cells take in hydrogen (H<sub>2</sub>) and oxygen (O<sub>2</sub>), produce electrical power, and emit water (H<sub>2</sub>O). Hydrogen is the most abundant element in the world but it is relatively rare in its elemental (H<sub>2</sub>) form. Although hydrogen has high energy density by weight, it is the lightest of all elements and requires large volumes for motor vehicles or power generation. Hydrogen is difficult to store and transport. Hydrogen can be compressed as either a compressed gas or liquid hydrogen, but the pressures required to do either are substantial and create a potential safety hazard.

Ammonia is sometimes called the "other hydrogen" due to its high content of three hydrogen atoms in a molecule of ammonia. The ability of ammonia gas to become a liquid at low pressures means that it is a good "carrier" of hydrogen. Liquid ammonia contains more hydrogen by volume than liquid hydrogen, and is over 50% more energy dense per gallon. Since ammonia can be stored and distributed much easier than hydrogen, fueling stations are much easier to convert to dispensing ammonia rather than hydrogen.

To use ammonia with a hydrogen fuel cell, it is necessary to separate the ammonia into its hydrogen and nitrogen elements before it is used. Alternatively, there are several fuel cells designed to use ammonia directly, enabling high efficiency conversion of ammonia to electric power.

**Safety** - Ammonia is safer than propane and comparable to the safety of gasoline when used as a transportation fuel. Ammonia vapors cause irritation to humans at low concentrations and is life threatening at high concentrations. However, ammonia can easily be detected by its strong odor. It is lighter than air and rapidly dissipates in the atmosphere. Regardless, safety precautions need to be implemented for handling ammonia.

Unfortunately, when burned at high temperatures, ammonia produces nitrogen dioxide, which contributes to smog and acid rain. Combustion also yields some nitrous oxide—a greenhouse

gas that's significantly more potent than CO<sub>2</sub> and methane. But technologies such as selective catalytic reduction can be used to avoid these.

In some respects, ammonia is safer than gasoline. Gasoline vapors are carcinogenic but ammonia vapors are not. Ammonia does not burn readily or sustain combustion except with fuel-to-air mixtures of 15-25% air. Explosions and fire are less likely with a ruptured ammonia tank than with gasoline. Also, gasoline can produce hazardous carbon soot particles, but ammonia contains no carbon and does not produce soot.

**Ammonia production and distribution** - Currently ammonia is primarily produced from natural gas and coal. China is the number one producer. In the U.S., ammonia is made primarily from natural gas. Hydrogen is taken from the natural gas and nitrogen comes from the atmosphere. Although ammonia used in the U.S. has traditionally been produced domestically, imports of ammonia have increased substantially in recent years.

Although ammonia does not produce CO<sub>2</sub> during combustion, the production of ammonia from natural gas does emit CO<sub>2</sub>. Carbon sequestration at the point of production could greatly reduce these emissions.

Better yet, instead of using fossil fuels, ammonia can be produced using a renewable energy source. For example, electricity from wind energy can be used to create hydrogen through the electrolysis of water into hydrogen and oxygen. The electricity could also be produced from solar energy, nuclear power, geothermal energy, ocean and tidal energy and others.



Carl Bosch (chemical engineer)



Fritz Haber (chemist)

Regardless of the energy source for the hydrogen, nitrogen is taken from the atmosphere (78% of earth's atmosphere is nitrogen) and hydrogen and nitrogen are converted to ammonia through the Haber-Bosch process, which was invented over 100 years ago by F. Haber and C. Bosch. The process uses an iron-based catalyst at high pressure (100–300 atmospheres) and high temperature (750–930°F) to combine hydrogen and nitrogen.

Prior to the 20th century, the most common fertilizer used to grow food was manure. And one of the most important sources of that manure was bird and bat guano, which was found in remote tropical locations. With the global population rapidly expanding at the beginning of the 20th century, it became clear the world's guano reserves would not be enough.

Since ammonia can be used as the basic building block to make ammonium nitrate fertilizer, the Haber-Bosch process made it possible to replace manure. More than a century later, this process is still used to make the ammonia for most fertilizers and thus helps feed billions of people around the world. About 90% of all ammonia produced worldwide is used in fertilizer.

Mass production of ammonia began in 1913. In addition to being used for fertilizers, ammonia is also used for chemical raw materials and refrigerants. Even though the Haber-Bosch process is used to produce virtually all of the world's ammonia, it is energy intensive. And since fossil fuels normally provide the energy, it accounts for 1.8 percent of human-caused global CO<sub>2</sub> emissions each year.

The importance of the Haber-Bosch process cannot be overstated. Haber and Bosch were awarded Nobel prizes for their work. For the last 100 years, this process allowed us to have enough food to feed ourselves. It may now keep us from destroying the planet by providing a low-emissions fuel, provided we use renewable fuels for the energy source.



A modern ammonia production plant

Ammonia is now produced at 32 plants in 17 states and shipped around the country by pipeline, rail, barge, and truck. It is easy to store and deliver in large quantities and is already one of the most transported chemicals worldwide. In addition to the storage and delivery infrastructure that already exists for ammonia, the nearly two million miles of natural gas and petroleum pipelines can be cost-effectively converted to carry ammonia, making it available to nearly every community in the U.S. The ability to use one fuel source, ammonia, in a variety of engines, fuel cells, turbines, etc., is a huge advantage.



**Biomass Ammonia -**

Cellulosic ammonia may be more viable than cellulosic ethanol for a fuel. Biomass ammonia from renewable crops such as sweet sorghum (photo) has been shown in Iowa to supply enough hydrogen through anaerobic digestion or thermal gasification to produce a quantity of ammonia that contains more energy per acre than corn ethanol or cellulosic ethanol.

Crops like sweet sorghum thrive under drier and warmer conditions than many other crops, so marginal land can be used for energy production.

**Energy Storage -** Energy produced from most renewable energy sources, such as wind, wave, tidal and solar is typically intermittent, so storage of the energy in batteries, in chemical form, or in some other way, is necessary in order to cushion the effects of fluctuation in energy production. Chemical storage is more economical in comparison to batteries. Ammonia has 10 times the energy density of a lithium-ion battery and three times that of compressed hydrogen. Using ammonia for storage also allows for the replacement of fossil-based fuels with carbon-free fuels for use in existing engines or turbines to generate power.

Ammonia is already used as a chemical additive for selective catalytic reduction (SCR) of nitrogen oxides in thermal power generation, and most large-scale thermal power stations have ammonia tanks for that purpose. Since power stations already store, transport and use ammonia, it is a suitable candidate to replace fossil fuels for energy storage with minimal investment.

**Producing “Green” Ammonia -** Producing “green” ammonia starts with “green” hydrogen. Most commercial production of hydrogen uses “steam methane reforming.” It causes the methane in natural gas to react with steam and releases hydrogen, carbon monoxide, and a small amount of CO<sub>2</sub>. That process can be replaced with the electrolysis of water into hydrogen and oxygen using renewable energy. Electricity is also used to cool air to separate the nitrogen from other gases. The hydrogen is then reacted with the nitrogen using the Haber-Bosch process (with renewable energy) to produce ammonia.

Attempts to produce “green ammonia” using “green” hydrogen are beginning on a small scale in several regions:

- A trial plant at the Fukushima Renewable Energy Institute in Japan uses solar power to produce up to 110 lbs of green ammonia a day.
- A demonstration system at the Rutherford Appleton Laboratory in England is powered by a wind turbine and makes up to 66 lbs of green ammonia daily.
- A farmer in Iowa is using solar power to produce green ammonia.
- An inventor from Ontario is producing ammonia from air and water using renewable energy. His small machine takes the excess electricity from wind and solar systems to produce ammonia. When there’s no sun or wind, that ammonia is used in generators.

Larger initiatives are underway in Australia, Chile, and New Zealand. The Australian Renewable Energy Agency recently backed a feasibility project for a plant that could produce 20,000 metric tons of ammonia annually, using 208 gigawatt-hours (GWh) of renewable electricity.

**Ammonia and Ships -** The shipping industry is a major example of where ammonia could be used as a fuel, and this could result in one of the most significant reductions in our fossil fuel use. Ammonia can be used in existing marine engines. It would have to be produced with renewable sources rather than fossil fuels, and, while there are some pilot projects that do that, scaling up to the necessary volume will be a challenge. With today’s technology, the combustion of ammonia is the most effective way to use ammonia as an energy source, rather than fuel cells. (See <https://spectrum.ieee.org/why-the-shipping-industry-is-betting-big-on-ammonia>)

Maritime shipping contributes nearly 3% of the world’s annual CO<sub>2</sub> emissions, according to the International Maritime Organization (IMO). In 2018, IMO delegates agreed to reduce emissions by 50% from 2008 levels by 2050. A 2020 survey by the American Bureau of Shipping found that two-thirds of shipowners and operators had no decarbonization strategy. Even so, nearly 60% said they view hydrogen and ammonia as the most attractive fuels in the long term. No large vessels today are equipped to use ammonia. Even if they were, the supply of renewable (green) ammonia is virtually nonexistent

Regardless, a handful of projects are moving in that direction:

- Finland’s Wärtsilä plans to begin testing ammonia in a marine combustion engine in Stord, Norway.
- Germany’s MAN and Samsung are part of an initiative to develop the first ammonia-fueled oil tanker by 2024.
- The supply vessel Viking Energy is being retrofitted with a 2-megawatt ammonia fuel-cell system. Green ammonia will be produced at a plant in Norway.
- MAN is developing an ammonia engine for a medium-size container vessel.

Although other climate-friendly technologies are being considered for shipping (such as fuel cells, hydrogen-storage systems, large battery packs, spinning metal cylinders, and towing kites), it is expected that ammonia will dominate, and some say that nearly all newly built ships will use it by 2044.

For ammonia-fueled shipping to become common, though, ports must build the infrastructure to handle ammonia, and large investments in renewable-energy must be made to produce enough green ammonia for thousands of ships. The global shipping industry used the power equivalent of 3.05 million GWh in 2015. Producing green ammonia for all ships would take 5.5 million GWh of renewable electricity, according to the Korean Register of Shipping.

Fortunately, operators of chemical tankers already have experience handling ammonia. In addition to ammonia tankers, since the properties of ammonia are similar to propane, ships that transport propane can generally be used for ammonia.

To improve ignition, ammonia can be combined with diesel fuel, though that would not completely eliminate the ship's carbon footprint. But shipbuilders can use technologies like selective catalytic reduction to greatly reduce greenhouse gases.

Fuel cells do not have harmful emissions since they do not burn fuel. Unfortunately, existing fuel cells don't have adequate power for large ships, but experts believe they will eventually have a higher efficiency than internal combustion engines. A big container ship would need more than 60 MW of fuel-cell capacity

There have been a number of *hydrogen* fuel cells used in smaller vessels, and they could use ammonia as a source for the hydrogen. However, a "solid-oxide fuel cell," can use ammonia directly. This is what is being installed on the *Viking Energy* supply ship. And the Swiss line MSC Cruises is having a new vessel built with a 50-kW solid-oxide fuel cell system.

**PROFILE OF A TRUSTEE**  
**Jeffrey Short MD**



Jeff is a physician at Fort Meade, MD. He went to medical school in Buffalo, NY after which he was commissioned in the US Army. He received a Masters of Public Health in Health Policy and Management from Harvard and is board certified in Emergency Medicine and Aerospace Medicine.

Jeff spent 30 years active duty in the US Army retiring in 2015. He served as an aviation clinic commander, emergency department chief, chief medical officer (CMO) of a hospital, and Combat Support Hospital commander deployed to the combat zone. He spent time at McMurdo Station and South Pole Station in Antarctica. He has multiple combat tours. He spent 15 years working part time in a remote hospital emergency room in Bethel, Alaska serving Yupik Eskimos.

An avid sailor, Jeff races on the Bay with his 34 foot catamaran. He has held positions in the Chesapeake Multihull Association including treasurer, fleet captain and commodore. He is active in the Annapolis Sail and Power Squadron (ASPS) where he has served on the budget committee, the Executive Committee, and as Commander.

He became a CEPA Trustee in 2017 and is currently serving as the CEPA treasurer.



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