Clean Cut Quarterly

NJARNG Sustainability Newsletter

In collaboration with Rowan University

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IMAGE: Tim Boyle, USACE

Engineering the Coast

Learn about the fight to preserve the Jersey Shore amidst storms and the rising sea level on **page 1**.

IMAGE: NJDMAVA

In the fall, a new rain garden was installed at the NGTC. Learn all about the benefits of rain gardens on **page 2**.

Ditching fossil fuels: it's not just cars, buildings can be electric too. Read all about it on **pages 3 and 4**.

Photo courtesy of **RU-SFC**

New Jersey's Battle Plan Against the Rising Sea Level

By: *Jake Bohn*

The Jersey Shore, a popular tourist destination for people all over the country, brings in billions of dollars for the state each year. This money is extremely important for the local economy, but it is highly dependent on the appeal of nice beaches. Unfortunately for NJ, sea levels are rising, which has both short- and long-term impacts on the coastline. Every inch the sea level rises will have an increasingly severe impact on coastal communities. Flooding becomes more frequent there is an increasing number of powerful storm events that deplete the beaches.

Studies from the NJ Department of Environmental Protection (DEP) show that the sea level could rise as much as 1.1ft by 2030 and up to 6.3 feet by 2100 (relative to 2000 levels) [1]. To help preserve New Jersey's shoreline, the United States Army Corps of Engineers (USACE) have teamed up with DEP's Division of Coastal Engineering to restore these lost beaches.

NASA

Images of NASA's Wallop Facility on the eastern shore of Virginia before (left) and after (right) Hurricane Sandy.

The Devastation of Coastal Storms

New Jersey is located in a very susceptible region to coastal storms from both the north and the south. It is not uncommon for hurricanes and nor'easters to wreak havoc across the shorelines every few years, which can prove to be a major problem for not only the beaches, but the coastal channels as well. These powerful storms can generate extremely large waves and storm surges.

In 2012, Hurricane Sandy was accompanied by a storm surge of approximately 9 feet. The superstorm event impacted a wide region and caused many governors in Atlantic coastal states to declare a state of emergency. The figure, before and after photos taken of the Virginia coastline, illustrates just how significant an effect a single storm can have on the surrounding area and the aquatic ecosystem. While the two aerial images were captured months apart, when the storm hit, the shoreline was depleted in a matter of hours.

The Uphill Battle of Beach Restoration

To counteract the erosion caused by coastal storms and rising sea levels, the USACE and the Division of Coastal Engineering work to dredge channels and restore beaches. Unfortunately, the constant pressure of rising sea levels and coastal storms create a perpetual cycle of erosion of New Jersey's beaches. The eroded sand eventually finds its way into sand bars off the coast in channels that are used by shipping and fishing boats alike.

To maintain these channels, sand is constantly being removed by the tons and is placed back onto the beaches. These man-made beaches create a barrier between a shore town's infrastructure and the ocean tides, preserving the beaches that New Jersey relies so heavily on. ■

[1] "NJDEP," Dramatic Increase in Sea Level Rise. https://nj.gov/dep

Living Up to the Name, “The Garden State”

By: Karl Hauck

Throughout the country, and here in NJ, communities are starting to recognize the importance of adopting elements of sustainable design. One current trend is installing rain gardens to improve local water quality and reduce the volume of runoff flowing into the sewer system. These gardens also remove chemicals and nutrients from the runoff, acting as a natural water purifier.

Catching Water...

A rain garden is constructed to retain runoff that flows from hard surfaces—rooftops, paved roads, sidewalks, and parking lots—after storms. When natural surfaces are covered by human development, rain water is no longer absorbed into the ground, and in dense areas, this can easily overwhelm the sewer systems or contribute to flooding. Rain gardens are often built at the bottom of a natural slope or hill so that they can easily catch this water.

…And Filtering It

Rainwater runoff can be extremely contaminated, especially in urban areas. When it rains, the water picks up bacteria, chemicals, oil, garbage and other various particles that sit on the street and rooftops. This water then flows into local water sources, polluting those waterways. The great part about rain gardens is that they catch this dirty water and clean it.

The cleaning occurs because plants love nitrates. Nitrates are extremely concentrated in the first inch of runoff and the plants thrive off of absorbing these chemicals. This prevents the contaminated water mixing with ponds and lakes and instead allows a cleaner version of that water into the water sources.

The New Rain Garden at Sea Girt

Cleaning rainwater is not the only benefit rain gardens have to the community. Having a bountiful garden in a neighborhood, park, or center of town will make the area look livelier and brighten it up. Rain gardens also preserve the native flora. The garden is made up of only plants that reside in the area, so they add to the ecosystem that is already existing. Not only do native plants thrive with almost no maintenance, but they can attract birds, insects and small mammals to make the rain garden their home. Pollinator species serve an essential role in plant reproduction.

NJDMAVA

Photo of the rain garden at the Sea Girt National Guard Training Center.

Communities in New Jersey are already acting and creating rain gardens. This past October, at the entrance of the Sea Girt National Guard Training Center, a rain garden was constructed with the help of DMAVA staff and students from Stockton University. This garden, located in the median of Camp Drive, includes native plants, stones and signs that educate visitors about what rain gardens are and their purpose. ■

It's Electric!

By: Hannah Cioffi

Sustainability is the capacity of an entity to provide an environmentally, socially, and economically healthy community today, without compromising the ability of future generations to experience the same. Resiliency is the ability to adapt to and absorb future shocks and stresses an entities built and natural systems. As a global climate crisis looms, in the state of New Jersey, there has been a push for the implementation of more sustainable and resilient technologies. For NJ's Department of Military and Veteran's Affairs, the challenge is to decrease the environmental footprint of the millions of square feet of building space across the state, and also ensure that the NJARNG facilities are mission-ready.

Cutting the Carbon

NJ's Energy Master Plan (EMP) outlines a plan for the state to achieve 100% clean energy by 2050. When he announced the plan in early 2020, Governor Murphy said, "successfully implementing the strategies outlined in the Energy Master Plan will drastically reduce New Jersey's demand for fossil fuels, reduce our carbon emissions, greatly improve local air quality, and related health impacts." Achieving the goals will require cooperation from stakeholders from multiple sectors, including state agencies like DMAVA.

DOE

Electric transmission lines carry electricity to homes and buildings.

There are seven key strategies in the EMP that outline a plan of action and the proposed timeline to make this goal a reality. Strategy 4 focuses on reducing energy consumption and emissions from the building sector. One critical step is the electrification of buildings, another is the adoption of building codes that require net zero carbon in new construction [1].

Heating Things Up

In the fall, engineering students in Rowan University's Sustainable Facilities Center (RU-SFC) spent time researching how the NJARNG could electrify their facilities. Space heating is a very energy intensive process, and most NJARNG buildings burn fossil fuels on site for this purpose.

Natural gas and heating oil are both fossil fuels that emit carbon dioxide and other greenhouse gases as a product of their combustion. Swapping out old, inefficient technologies that use fossil fuels with new, fully electric, or even solar systems will increase the sustainability and resiliency of these buildings.

Electrification technology is not new, but there is a challenge in retrofitting buildings that were originally built with systems that rely on fossil fuels. Here, we describe the electric and solar technologies that could potentially replace the gas- or oil-burning space and water heating systems at NJARNG facilities.

- ***Air-source heat pumps*** operate by transferring the heat absorbed from the outside air to an indoor space. Air-source heat pumps work similarly to a refrigerator: they absorb heat and transfer it to another medium, and can also work inversely to provide cool air.
- ***Ground source heat pumps***, also known as "geothermal heat pumps", transfer heat between the building and the earth, and can also provide both heating and cooling to a building.
- ***Evacuated tube solar collectors*** are a set of many double-walled, glass tubes and reflectors that collect solar radiation to heat fluid inside of the tubes. Evacuated tube collectors use the liquid–vapor phase change in a heat pipe to transfer heat effectively from the collector to then heat water.
- ***Flat plate solar collectors*** consist of copper tubing and other heat-absorbing materials inside an insulated frame or housing, covered with clear glazing. The dark materials inside the collector absorb solar energy, while a clear glass or plastic casing traps heat that would otherwise radiate out—this process is similar to the way a greenhouse traps heat inside. Then, cold water circulates through the collector, becoming heated.

The first two technologies could potentially replace traditional boilers for space heating that are powered by either oil or natural gas. The second two are passive solar designs, which do not involve substantial use of mechanical and electrical devices, such as pumps, fans, or electrical controls to move the solar energy. This makes them very efficient and completely renewable. Solar collectors can supplement or replace traditional domestic hot water heaters, and provide a sustainable and resilient option for electric, natural gas, or oil-fired hot water heaters for domestic hot water supplies.

Clockwise from top left: Air source heat pump, ground source heat pump, evacuated tube solar collector for hot water heating, and flat plate solar collector for hot water heating

The implementation of any of these technologies will help the state to achieve the EMP goal of 100% clean energy by 2050. However, the goal will only be realized in combination with upgrades to the utility grid to include more renewable energy sources. This is because the electric grid is still powered by a large percentage of fossil fuels. Another strategy is to increase the on-site renewable energy generation at NJARNG facilities to ensure the increased energy demand from the electrification of buildings is fulfilled with clean energy sources. Together, these efforts will contribute to a safer and healthier community and environment, for generations of New Jerseyans. ■

[1] "The State of New Jersey Office of the Governor," Energy Master Plan Announced. https://www.nj.gov/governor/news/news/562020/approved/20200127a.shtml

The Coolest Roof in Town

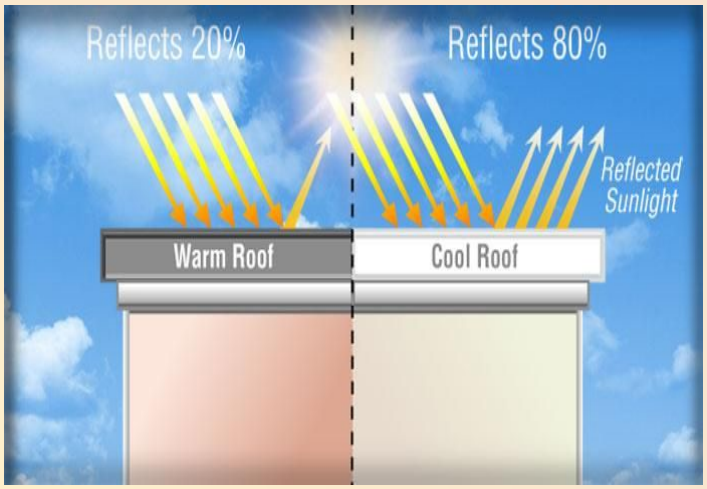
By: Victoria Santanello

For decades, researchers and engineers have been trying to develop strategies to increase the efficiency of cooling and heating buildings. One challenge of space cooling is that the heat of the sun beating down on the roof, walls, and windows of a building can raise the ambient temperature inside of that building. While many buildings are insulated in an effort to moderate fluctuations in temperature, this effect persists.

Color Impacts Temperature

If a roof stays cooler, it reduces the amount of heat conducted to the building below. The concept of a warm or cool roof is similar to wearing a white or black T-shirt on a hot day. When wearing the white T-shirt, you will feel cooler than if you wore a black T-shirt because it reflects more sunlight and therefore absorbs less heat.

Like the white T-shirt, lighter colored roofs reflect more sunlight, thus absorbing less heat. A lighter colored roof can reflect up to 80% of visible light, compared to about 20% of light reflected from a darker roof. A lighter colored roof can significantly reduce the amount of energy a building uses to cool the space because the building ambient temperature is more moderate.



LBL

A schematic of sunlight reflecting from a traditional roof and a cool roof. Four times the amount of sunlight is reflected from a cool roof.

A Special Paint

Researchers at Columbia University have been able to develop a paint that reflects a whopping 99.6% of light. This polymer-based paint contains acetone, which evaporates as the paint dries, leaving behind a network of small air pockets. It is the presence of these “voids” that make the paint more strongly reflective than even the brightest, whitest paint.

When highly reflective paint is used, it creates what is referred to as a *cool roof*. The more light (in the visible, infrared, and UV parts of the spectrum) that is reflected away from a building, the less solar energy is absorbed into the structure’s interior. The increased reflectivity of roofs leads to lower surface temperatures, and reduced cooling costs. Cool roofs also can thermally emit which means they have the ability to release absorbed heat. A high thermal emittance is preferable in warmer areas so that the heat is not held within the roof and, therefore, the building.

Lowering Global Emissions

The use of cool roofs can lead to less heat penetration which can lower cooling energy demand in some areas. In climates that experience cold winters and hot summers (like New Jersey), lowering the heat penetration will somewhat increase the heating cost for the building in the colder months. For this reason, cool roofs are typically the most effective in warmer climate zones.

Cool roofs are efficient in lowering cooling energy demand and have been identified as part of an effective mitigation strategy to reduce global carbon emissions. According to the Environmental and Energy Study Institute (EESI), buildings account for 40% of the carbon dioxide emissions in the United States [1]. Decreasing the energy required for cooling buildings can, in turn, lower emissions. Additionally, cool roofs can reduce the local air temperature in denser urban settings, which contributes to lowering the peak electricity demand, which could help prevent power outages and increase grid reliability. ■

[1] “EESI,” Buildings & Built Infrastructure. https://www.eesi.org/topics/built-infrastructure/description

Hydrogen Fuel Cells: A Piece of the Clean Energy Future

By: Alex Salazar

Hydrogen fuel cells (HFCs) have gotten a lot of buzz, with Toyota and Hyundai recently announcing their plans to expand their green vehicle offerings to include electric models built with HFCs. Here we explore hydrogen—the most abundant element in the universe —and its potential as a versatile fuel source.

Harnessing the Power of Hydrogen

HFCs use the chemical energy of hydrogen as a fuel to cleanly and efficiently produce electricity [1]. HFCs generate energy as a byproduct of combining hydrogen and oxygen atoms. Hydrogen reacts with oxygen across an electrochemical cell, which operates similarly to a battery, to produce electricity, water, and heat.

HFC technology has a long history. In fact, NASA was using HFCs in the 1950s to power the electrical systems on spacecrafts. Today, there are many different applications for HFCs, from small cells that power laptop computers, to larger ones that can power remote buildings that are not connected to the electric grid or serve as a backup energy system.

One of the most promising uses of hydrogen fuels cells is in the transportation sector. Zero-emission fuel cell electric vehicles (FCEVs) use fuel very efficiently. In fact, 2.2 pounds of hydrogen fuel is as efficient as 1 gallon of gasoline. Meaning, hydrogen-fueled vehicles can drive the same distances as gas-powered vehicles can cover with about a four pound reduction in fuel! With about half of the U.S. population living in areas where pollution levels pose a problem for their health, adopting cleaner modes of transportation is critical. FCEVs do not emit any of the pollutants a gasoline powered vehicle does including carbon monoxide and particulate matter. The only emission is water vapor and warm air.

Extracting the Element

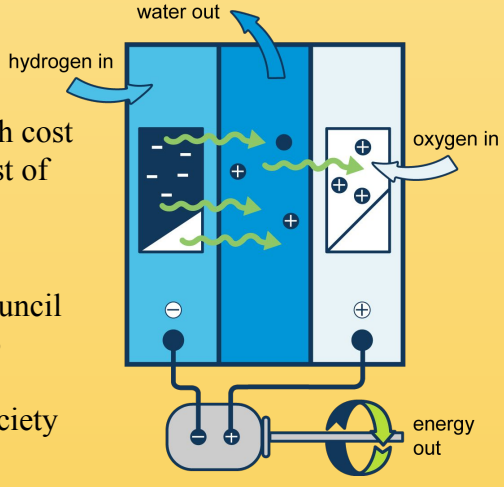
Hydrogen is naturally part of the composition of organic matter such as hydrocarbons (a major component of fossil fuels) and water. One of the most significant challenges of the wide-scale adoption of hydrogen as a fuel source is how to efficiently extract it from these compounds.

Currently the method of steam reforming, combining high temperature steam with natural gas to extract hydrogen, accounts for 95% of hydrogen production in the United States. There are other ways that hydrogen can also be produced using natural gas, however, it may be possible to derive hydrogen from renewable sources including wind and solar.

Costs

One of the challenges to the widespread adoption of HFCs in vehicles is the high cost of isolating and storing hydrogen. To be more competitive in the market, the cost of HFCs must be reduced substantially without compromising any performance.

In addition to the high manufacturing cost of the fuel cells, the construction and maintenance costs of hydrogen fueling stations is significant. The Hydrogen Council reports that the current cost to construct a hydrogen fueling station is one to two million dollars. While a lot of capital and resources are required to make more hydrogen fueling stations for FCEVs, the investment could be worthwhile as society must drastically decrease the amount of carbon dioxide we contribute to the atmosphere. ■



U.S. EIA

[1] "Office of Renewable Energy and Energy Efficiency," Fuel Cells. https://www.energy.gov/eere/fuelcells/fuel-cells

Meet the Editors

Karl Hauck

Civil & Environmental Engineering, Junior

This past summer Karl interned with the municipal engineers at the Lake Mohawk Country Club (LMCC). Karl's experience with the LMCC gave him a deeper understanding about how the processes of a down function and the importance of sustainability in a lake community. Karl plans to pursue his interest in environmental studies by entering graduate school for Environmental Engineering.

Jake Bohn

Civil & Environmental Engineering, Junior

Being the big outdoorsman he is, Jake always knew he wanted to make an impact helping the environment. In the RU-SFC's engineering clinic, Jake researches how the NJARNG could expand their on-site renewable energy generation. He hopes to one day be a part of large-scale environmental engineering projects that reduce pollution. In his free time, you may find him at a golf course or his local fishing pond.

Hannah Cioffi

Mechanical Engineering and Mathematics, Junior

Hannah is a lover of nature, health, and holistic living. She hopes to use her background in mathematics and engineering to make progress in the world of sustainability, and make day-to-day living healthier for both the environment and people. In the future, Hannah would like to work for a company that shares her same goals and beliefs, and eventually have a self-sustaining, off-grid home.

Meet the Editors

Alexander Salazar

Civil & Environmental Engineering, Junior

Alexander is interested in the transportation engineering sector, specifically rail. He has gained experience in this subfield, interning for NJ Transit for two summers in a row and has worked extensively on different train station projects. He also has an interest in environmental engineering as he is passionate about the well being of the environment, while catering to the needs of all consumers.

Victoria Santanello

Civil & Environmental Engineering, Senior

Victoria has a passion for indoor gardening and sustainable living practices. She hopes that her background in engineering and green practices can help to better educate the public. She is currently working on an NJARNG project to electrify DMAVA buildings. In the future, she hopes to work as an environmental engineer and help make the world more sustainable.

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Learn more about the Rowan University Sustainable Facilities Center **here** or scan our QR code!

SCAN ME

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