Clean Cut Quarterly

NJARNG Sustainability Newsletter

In collaboration with Rowan University

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Click HERE to learn more about Rowan's journey to Washington D.C. to accept the 2019 Army - Community Partnership Award.

Gas-powered vehicles are out, electric vehicles (EVs) are in. Read all about it in our EV series on **pages 2-4**.

New Jersey has set goals for offshore wind energy generation. Check out why it could be an option for the NJARNG's energy on **page 5**.

Lithium-ion batteries for solar arrays are becoming more affordable. Learn how this technology can increase the resiliency of NJARNG facilities on **pages 9-10**.

Electric Vehicles Drive the Future

By Michael D'Orazio

With the prices of electric vehicles (EVs) shrinking every year, soon, a sea of these green vehicles will flood roads across the world. According to Bloomberg New Energy Finance's *EV Outlook 2019*, "Over 2 million electric vehicles were sold in 2018, up from just a few thousand in 2010." It is projected that the annual sales of EVs will be "10 million in 2025, 28 million in 2030 and 56 million by 2040."[1]

Although, currently, traditional vehicles still outnumber EVs on the road, there are numerous environmental and economic benefits of driving an EV.

JENGTINGCHEN / WIKIMEDIA COMMONS

The 2019 Tesla Model 3, a popular EV model.

Save Money on Fuel

Of the many economic benefits associated with the purchase of an EV, for many buyers, saving money on fuel can make their investment worthwhile. Drivers who switch from a gas-powered vehicle to an EV can expect to spend about half as much to power their vehicle.

The U.S. Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy defines eGallon as "the cost of fueling a vehicle with electricity compared to a similar vehicle that runs on gasoline." In November 2019, the average cost of one gallon of gasoline in the United States was $2.62, while the costs associated with one eGallon were only $1.21[2]. When paired with the high mileage that most electric cars inherently possess, EV owners can expect to see significant savings from driving an EV.

Lower Emissions

Traditional vehicles have internal combustion engines that burn gasoline and as a result, emit pollutants that decrease air quality and threaten human health. For instance, particulate matter emitted from tailpipes contributes to smog and can cause respiratory system symptoms. Also, volatile organic compounds (VOCs) emitted from tailpipes react with sunlight to form dangerous ground-level ozone. When the levels of these pollutants are too high, a warning may be issued to advise people to stay inside during certain hours of the day (to see the air quality in your area, visit *airnow.gov*).

A benefit of EVs is that because they do not have internal combustion engines, they do not directly generate air pollutants and greenhouse gases (GHGs). Using EVs instead of gas-powered vehicles in highly populated cities will improve local air quality. However, it's important to note that any device that you plug in, that consumes electricity from the electrical grid, likely uses some amount of energy produced from fossil fuel-burning power plants. Unlike renewable energy sources, these plants emit air pollutants and GHGs as they generate electricity.■

[1] Bloomberg NEF. (2019). *Electric Vehicle Outlook 2019*. Retrieved from https://about.bnef.com/electric-vehicle-outlook/
[2] "EGallon." *Energy.gov*, 16 Nov. 2019, https://www.energy.gov/maps/egallon.

Charging Stations Power the Drive

By Michael D'Orazio

EVs are not powered by gasoline like traditional vehicles. Instead, they have rechargeable batteries that are charged using electricity. Like other vehicles, EVs require periodic refueling. Across the country, there is a large network of gas stations, and you're rarely more than a few miles away from one. However, the network of publicly accessible EV charging stations is much smaller. Therefore, residential and commercial EV owners should consider installing a charging station at home or at the workplace.

Residential vs. Commercial Charging

There are different types of chargers—Level 1, Level 2, and Level 3 (also known as DC Fast Charging)— that can charge an EV battery at different speeds.

KONRAD ROEDER / WIKIMEDIA COMMONS

An EV charging station in Skykomish, Washington.

If you own a personal vehicle, Level 1 or 2 charging stations are recommended for installation at home. Level 1 charging is popular because it utilizes a standard 120-volt outlet, requiring no special installation. However, Level 1 charging is slow, adding only 2-5 miles of range per hour. This is not the most convenient, but, if you plan ahead, you can charge overnight and have a full battery by the next morning. Level 2 charging can add 10-20 miles of range per hour, and requires the use of a 240-volt plug.

Commercial fleet owners should choose between Level 2 or Level 3 charging stations. Level 3 charging can add 60-80 miles of range in only 20 minutes, making it a great choice for commercial fleets with many vehicles that need to be charged quickly [1].

Costs

The price of residential EV charging stations depends on the station's level. According to Home Advisor, Level 1 stations cost an average of $450 and Level 2 stations cost an average of $600. Level 3 stations are expensive, costing an average of $1,500. The expenses associated with at-home installation should also be considered, which will vary with the cost of labor.

Prices for commercial charging stations are greater than for residential stations. Level 1 stations cost approximately $3,000, Level 2 stations cost approximately $6,000, and Level 3 stations cost approximately $50,000. The costs for ancillary hardware and installation rates are also typically greater than residential costs. Despite the costs of commercial stations, the investment is still worthwhile if a company or community adopts fleets of EVs that require a convenient, consistent location to charge. ■

[1] "Vehicle Charging." *Energy.gov*, 23 Dec. 2019, https://www.energy.gov/eere/electricvehicles/vehicle-charging.

Rotterdam: City of Electric Vehicles

By Michael D'Orazio

An excellent example of a city phasing out conventional vehicles and converting to fleets of EVs is Rotterdam, the second largest city in the Netherlands. In 2014, Rotterdam set a goal to achieve a share of 25% electric or hybrid vehicles in their municipal fleet [1]. Since then, the Rotterdam city government easily achieved this goal, and has set even more ambitious goals.

A Goal for 2030

Rotterdam now plans to increase the number of EVs used for individual motorized transportation to at least 30% of the total number of vehicles in the city by 2030. Rotterdam's objectives in increasing the number of EVs on the road are to reduce air pollution, GHG emissions, noise pollution, and fossil fuel consumption.

Currently, Rotterdam has an operational fleet of EVs in use by municipal sectors of both government and privately-owned enterprises. These vehicles are mainly used for waste collection, local municipal services, and street cleaning. The city is planning to increase the number of EVs in its municipal fleet to demonstrate to businesses and city residents that clean vehicles can have practical uses.

Better Air Quality

Through collaboration with two private companies that function as grid operators and energy suppliers, Rotterdam has been able to make substantial progress in sustainability research since beginning the preliminary trials for EV fleets in 2012. According to the research conducted by the city of Rotterdam, since adopting the EV initiative, the impact made through switching from traditional vehicles to EVs in the municipal sector has reduced the levels of vehicle emitted CO_2 by 67%, a reduction of total particulate matter by 10%, and an almost complete reduction of nitrogen oxides (NO_x) emissions. Through this study, Rotterdam has shown that EV fleets can have a positive effect on air quality, a key component in safeguarding human health.

By taking the initiative in promoting EVs in the municipal sector, Rotterdam has proven that utilizing EV fleets can improve the world that we all inhabit. ■

MUNICIPALITY OF ROTTERDAM

Rotterdam is among the first cities in the world to use electric garbage trucks for municipal waste collection

[1] "Rotterdam's Municipal EV Fleet: Lessons for Utilities and Cities." *TDWorld.com*, 1 Dec. 2019, https://www.tdworld.com/electrification/article/21112387/rotterdams-municipal-ev-fleet-lessons-for-utilities-and-cities.

Offshore Wind Power Coming to New Jersey

By Emily Twining

In the modern world, technology is constantly changing and updating, which can lead to an improved quality of life for many people. While fossil fuels are still a common source of energy, the production of renewable energy from solar, hydropower, and wind is becoming more widespread.

One of the newest advancements in renewable energy technology is offshore wind power, i.e., wind power at sea. Offshore wind farms can be installed along the coasts of the U.S.— and tapping into such a large energy resource may lead to reduced costs of electricity for consumers. Wind power (both terrestrial and offshore) does not directly generate any CO_2 emissions. Making the switch to carbon-free energy will lead to an overall decrease in the amount of emissions and air pollutants from our energy sources.

In the past few years, offshore wind power has become increasingly popular. Many countries including the United Kingdom, Germany, and China are generating electricity from offshore wind turbines. Offshore wind power will not only benefit the environment, but the new industry can stimulate economic growth.

Offshore wind turbines

NJ Governor Sets Offshore Wind Goals

New Jersey is now working to implement offshore wind energy. In January 2018, Governor Phil Murphy signed Executive Order No. 8. This order directs the state to generate 3,500 megawatts (MW) of offshore wind energy by the year 2030. This action will allow the state to progress towards its goal of converting to 100% clean energy by 2050. Implementing offshore wind power is especially beneficial in New Jersey, the most densely populated state in the U.S., because it won't take up any land that could be used for other purposes. With 130 miles of coastline, New Jersey has ample space for wind turbines to be built offshore.

Benefits of Offshore Wind

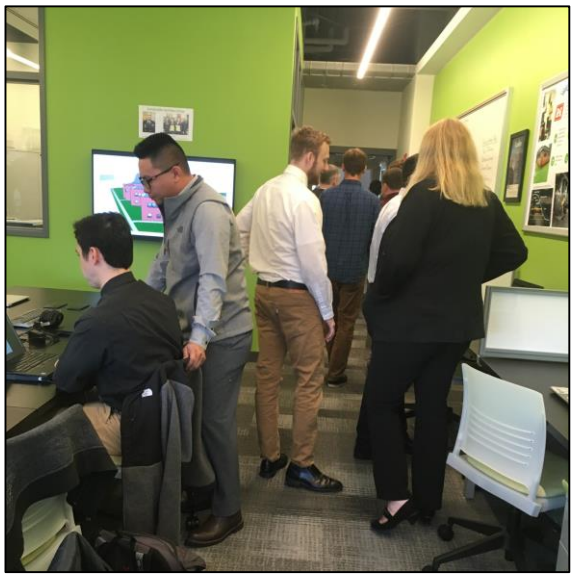
One of the benefits of having offshore wind power is that it can create job opportunities for thousands of workers. It takes time, energy, and money to build turbines in the ocean.

Another benefit of offshore wind power is that the amount of energy these turbines produce is superior to terrestrial turbines, because of the stronger and more consistent winds at sea compared to wind over land. The energy that is generated from offshore wind power can be transmitted and utilized in homes and buildings throughout the state, providing increased reliability for New Jersey's electric grid. ■

Rowan, NJARNG, and NJDMAVA Celebrate Sustainable Facilities Center

By Samuel J. Ramos

Rowan University and the New Jersey Army National Guard (NJARNG) have always stood by their mission to invest in the research and use of renewable energy and sustainable technology, and their latest milestone reinforces that mission. With the help of the NJARNG and the New Jersey Department of Military and Veterans Affairs (NJDMAVA), Rowan recently held a ribbon-cutting ceremony to commemorate its newest multi-functional research laboratory, the Sustainable Facilities Center (SFC). This lab is dedicated to researching sustainable technologies, conducting feasibility studies, and performing facility audits. On November 19th, NJDMAVA personnel, including Planning and Programming Bureau Chief Major Jeanne Falchek, and Rowan faculty, including Dr. Jess Everett, Dr. Benna Sukumaran and Dr. Kauser Jahan, were present at the ceremony. According to Major Falchek,



***Left to Right**: Dr. Everett, Major Falchek, Dr. Sukumaran, Dr. Sean Fischer, and Steve Weinstein*

"The partnerships between the NJARNG and Rowan University are extremely effective at reducing or avoiding costs of projects and deliverables that would otherwise require costly A&E services and contracts." Major Falchek continued to highlight the success of the SFC by stating, "The energy audits conducted by the Rowan University SFC…. cost less than $0.14/SF vs. the typical industry cost of $0.25/SF. Many of the technical studies, documents, and formal reports developed could cost from $100,000 to $150,000…. but the Rowan University SFC is completing these projects within the constraints of their established funding."

The SFC has not only made noteworthy contributions to NJDMAVA by reducing costs and providing new project ideas, but it has also allowed students to broaden their knowledge and work on real-world projects. Major Falchek ended her address by saying, "This is a proud and joyous moment for all parties and we look forward to the continued success of the Center and our partnership with Rowan University."

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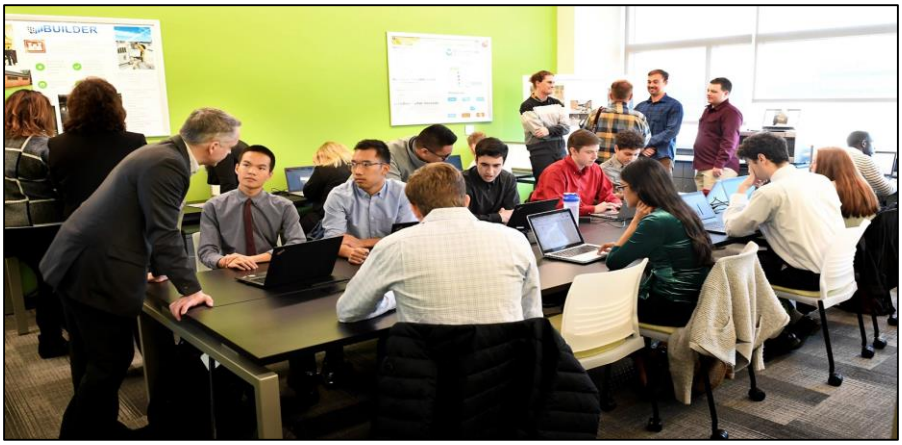
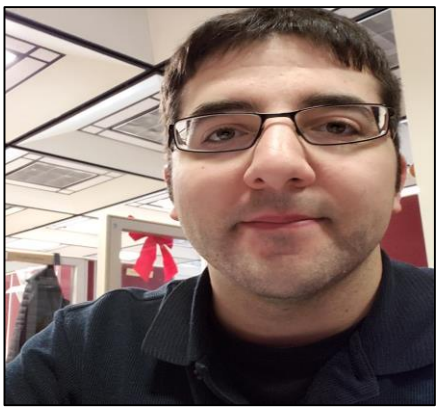
NJDMAVA Energy Manager Justin Costa was also at the ribbon-cutting ceremony. He is a Rowan alumnus who has worked at NJDMAVA since January 2019. While attending Rowan, Justin worked with project teams conducting energy audits of NJDMAVA facilities in 2011, before the formation of the SFC. He shared Major Falchek's positive outlook on the work being conducted by Rowan students at the SFC. When asked how well Rowan's and NJDMAVA's missions for sustainability coincided, he responded, **"**Very well! NJDMAVA recently received the newest NJ Energy Master Plan from Governor Murphy's office, which outlined goals on how NJ state agencies will become sustainable, as well as timeframes to meet these goals. The Master Plan stated no fossil fuels or coal, limited carbon emissions and electrification of heating systems and transportation. From what I've seen at Rowan's campus, yes, I would say our interests line up well."



When asked about how excited he was about the future of the SFC, he said, **"**I'm very excited, seeing this program grow from its infancy when I was a student at Rowan to what it is now. It's obvious that the efforts of the program have increased in both volume and complexity. I'm excited to see the next steps and see what the students can produce with the resources and equipment the University provides for them.**"**

Additionally, Justin shared projects he personally wanted the SFC to work on. They included the modification of a former helicopter hangar in Picatinny and the creation of a government-owned EV fleet. The helicopter hangar at Picatinny Arsenal was repurposed into a 6-bay vehicle maintenance facility several years ago. Large sliding doors are located on either end of the hangar to allow for helicopter access. Since its conversion, the sliding doors no longer serve a practical purpose. During the winter months when vehicles need to enter or exit the facility, the doors are opened, and all the warm, conditioned air leaves the facility. The air then needs to be reheated to allow facility personnel to resume work. This results in excess heating costs as well as unnecessary downtime. NJDMAVA would like the SFC to determine the feasibility of replacing the hangar doors with an insulated wall and roll-up garage doors, both to save energy and reduce personnel downtime. Another project NJDMAVA would like the SFC to conduct is the implementation of EVs. As part of the NJ Energy Master Plan, state government agencies must phase out existing internal combustion engine vehicles in favor of EVs. EVs don't have emissions and are less expensive to own, operate and maintain. However, purchasing new vehicles is only part of the transition. NJDMAVA has been and will continue to invest in EV charging stations. These will provide convenience and allow the EVs to be charged at NJDMAVA facilities, and avoid extra costs from using third-party charging stations. NJDMAVA would like the SFC to determine the feasibility of the installation of charging stations throughout the state and the feasibility of purchasing American-made EVs, such as Tesla, Ford and Chevrolet.



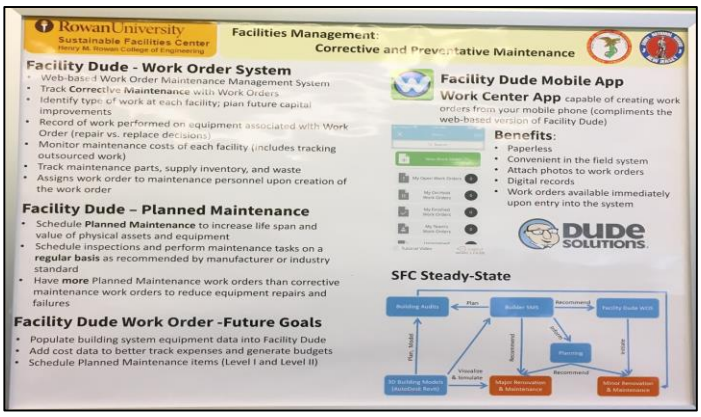
NJDMAVA Energy Manager Justin Costa

Continued on page 8

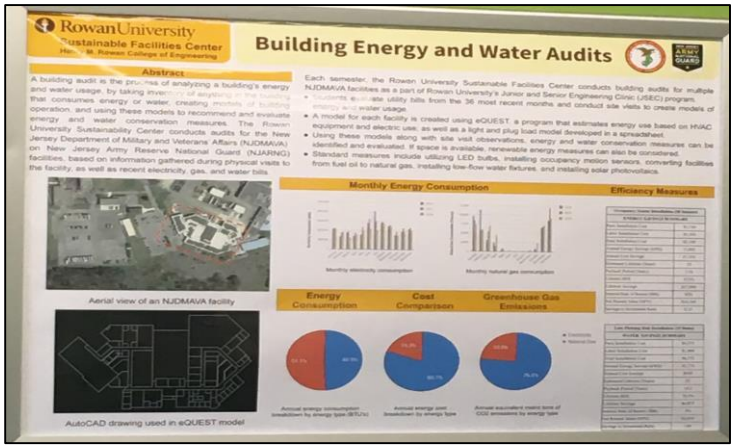
This semester, the Sustainable Facilities Center was used by four student teams to assist the NJARNG with improving sustainability at their facilities.

Sustainable Facilities Team

This team's goal was to determine how well the current work order system, FacilityDude, operates, identify ways to evaluate the software, and define metrics that provide information about how well the armories are being maintained.



Poster explaining FacilityDude



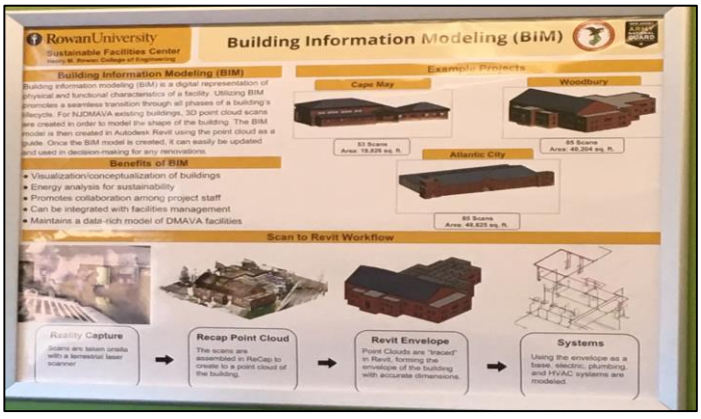
Poster detailing building energy and water audits

Building Energy and Water Audit Team

This team's mission was to evaluate building energy and water consumption by conducting site visits and creating models of energy and water usage. The team was broken into two groups, one that evaluated the Dover Readiness Center and one that evaluated the Woodstown Readiness Center.

Building Information Modeling (BIM) Team

This team used BIM software to create digital representations of physical and functional characteristics of NJARNG facilities. The resulting digital representations can aid in quick and efficient decision-making for any possible planned maintenance and renovations.



Poster illustrating modeling in BIM

Energy and Water Resiliency Team

Each member of this team worked on separate projects that will make NJARNG facilities more efficient and resilient. The team members highlighted their research in the articles in this issue on EVs (page 2-4), offshore wind power (page 5), solar power (page 9-10) , and boilers (page 11). ■

How Batteries are Changing Solar Arrays

By Samuel Ramos

Across the United States, solar power has become a large component our electricity portfolio. Solar generates energy without releasing any emissions into the atmosphere—meaning that it isn't polluting our air or contributing to climate change. Another benefit of solar power is that it generates energy from an essentially limitless source: the sun.

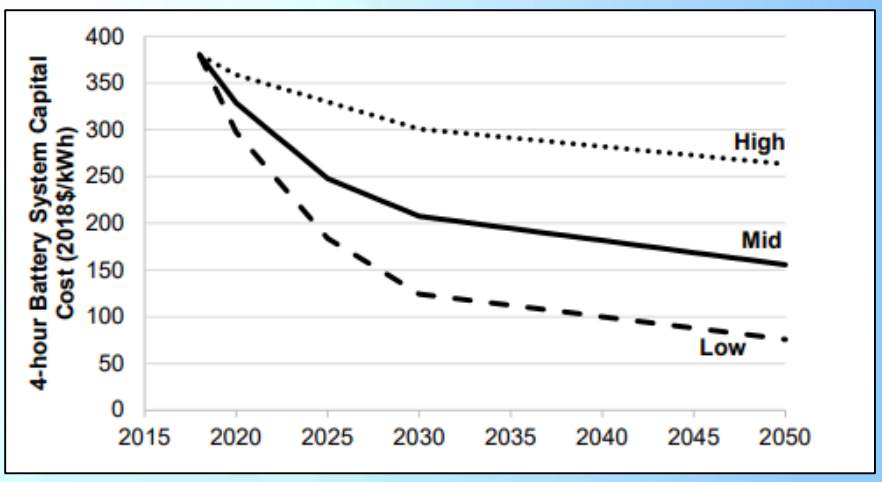
PUNJANAK / WIKIMEDIA COMMONS

Solar panels on a roof of a home

Here we discuss batteries, and how they are changing solar arrays. Lithium-ion (LI) batteries are capable of storing very large quantities of electricity that is produced from solar arrays for future use. This will allow facilities that rely only on solar to operate even during times when the sun isn't shining. Battery storage would also increase the resiliency of NJARNG facilities. If a power plant providing energy were to go offline, the stored energy and solar panels could supply a facility with the power it needs to remain operational.

Batteries are Getting Cheaper

While LI batteries are not a new technology, their affordability has increased significantly in the past few years. According to a 2018 study by the National Renewable Energy Laboratory (NREL), the total cost of a 4-hour LI battery system is $380/kWh. Costs are expected to fall even further, with the low cost projection dipping below $100/kWh by 2040 [1] .



NREL

Low, mid, and high cost projections for a 4-hour LI battery system

Additionally, solar panel prices have never been lower. Another NREL study showed that the current price for commercial-scale solar panels is now about $1.45/Watt Direct Current (DC). In 2014, this value was around $2.27/Watt DC. The savings add up for the type of large arrays that could be installed on NJARNG facilities

[1] Cole, Wesley, and A. Will Frazier. 2019. *Cost Projections for Utility-Scale Battery Storage*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-73222. https://www.nrel.gov/docs/fy19osti/73222.pdf.

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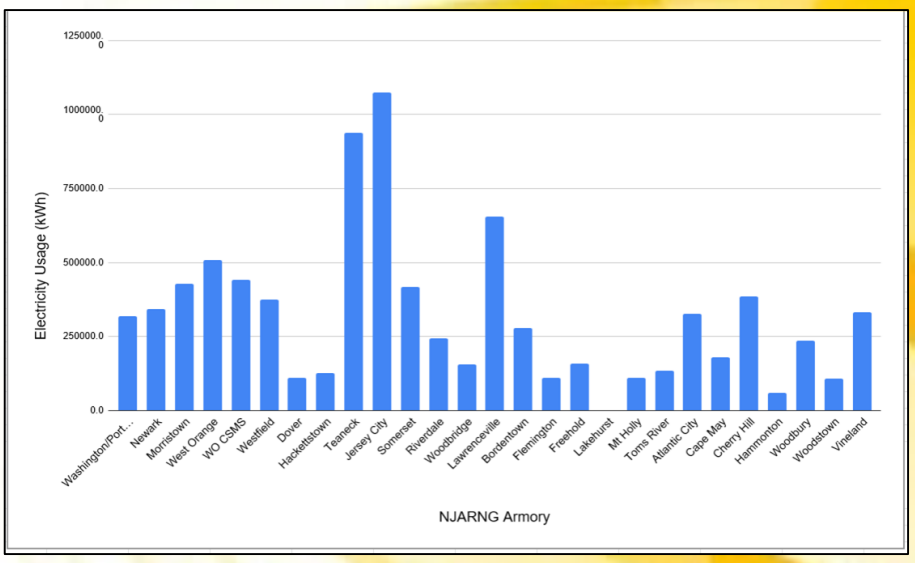
NJARNG Solar Assessment

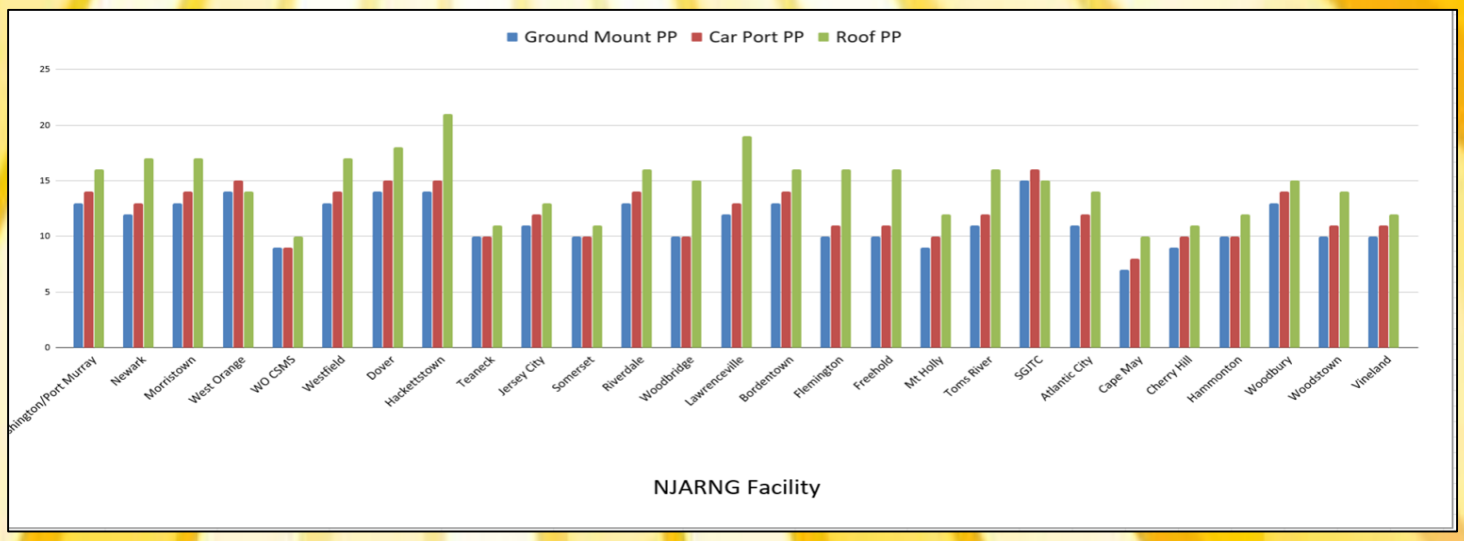
Part of the SFC's Energy and Water Resiliency Team's duties was to complete the NJARNG Solar Assessment for 2019. This entailed collecting energy usage data from all of the NJARNG facilities and researching prices for solar array installation. Then, payback periods were established for each facility. A payback period is the number of years that it takes for the savings from implementing solar to become greater than the initial capital cost.



Average annual electricity consumption of NJARNG Armories (2015-2018)

The NJARNG prefers to only undergo projects that have payback periods of much less than 20 years. However, as previously mentioned, LI batteries have become significantly cheaper and their cost must also be factored into the capital cost. While this increases the capital cost of a given array, it can vastly increase a facility's resiliency while saving the facilities a large amount of money in the long run. We found that most facilities have payback periods of around 10 years with annual savings of around $30,000 to $40,000.

If more facilities could fully rely on an unlimited source of energy and never have to pay another electric bill, than that money could be used to further improve the facilities or even pursue more sustainable advancements. ■



Payback periods for NJARNG facilities for ground-mounted solar panels (blue), car port panels (red), and roof-mounted solar panels (green)

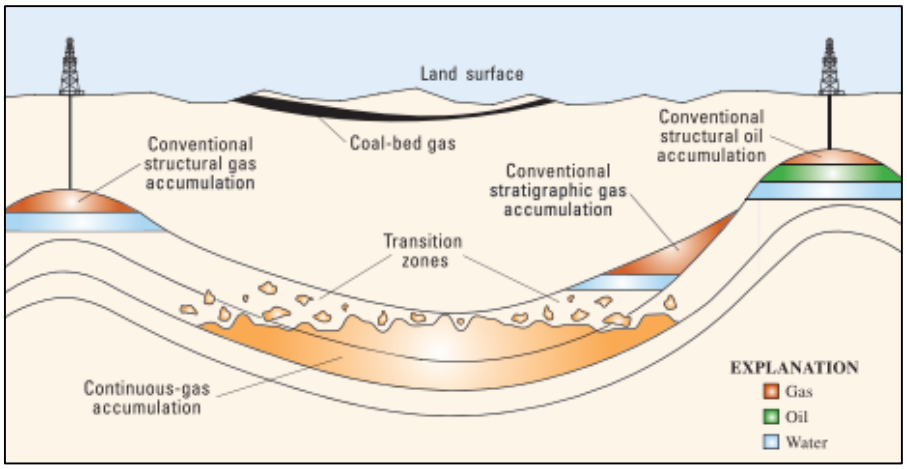
Why we Should Convert our Boilers from Oil to Natural Gas

By Esteban Vargas

Winter is here, and that means the heat will be turned on in almost every building across the country. Many buildings use boilers as their heat source. Boilers work by burning a fossil fuel to heat water. The water is then distributed to radiators or in floor pipe networks, which gives off heat to warm the room.While many boilers are powered by oil, existing systems can be converted to run on natural gas. Alternatively, the entire system can be replaced with a gas-burning unit if the boiler is towards the end of its useful life.

Natural Gas as a Fuel Source

Natural gas is a fossil fuel that is extracted along with oil. According to the U.S. Energy Information Administration, the U.S. produces almost all of the natural gas it uses. The increase in natural gas production since 2005 can be attributed to the popularity of hydraulic fracturing (i.e. fracking).



U.S. GEOLOGICAL SURVEY

Natural gas (shown in orange) and oil (shown in green) in the subsurface.

While burning natural gas to generate heat also emits CO_2, a GHG, into the atmosphere, it emits much less than from burning oil (117 pounds of CO_2 vs. 161.3 pounds of CO_2 per million British thermal units)[1]. If NJARNG facilities with boilers converted to gas-burning units, it would result in a significant decrease in CO_2 emissions across the state.

Thinking of Making the Switch?

While retrofitting a boiler of replacing an oil-fired unit with a gas-fired one may be expensive, making upgrades that increase efficiency may save you money on fuel in the long run. It is also a more environmentally-friendly option.

If replacing your unit, consider purchasing an EPA ENERGY STAR certified gas unit that has an annual fuel utilization efficiency (AFUE) rating of at least 90 percent. This means that the unit uses 90 percent or more of the energy it consumes into heat for your home. ■

[1] U.S. Energy Information Administration - EIA - Independent Statistics and Analysis. (n.d.). Retrieved from https://www.eia.gov/tools/faqs/faq.php?id=73&t=11.

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