October 2022 Volume 7 - Issue 2

# NJARNG Sustainability Newsletter

*In collaboration with Rowan University*

## Clean Cut Quarterly


*Image:* Green Planet

## *Winter is Coming!*

*Have a plan for scheduled maintenance & implementing temperature setbacks pgs. 2 & 3*


*Image*: Fire

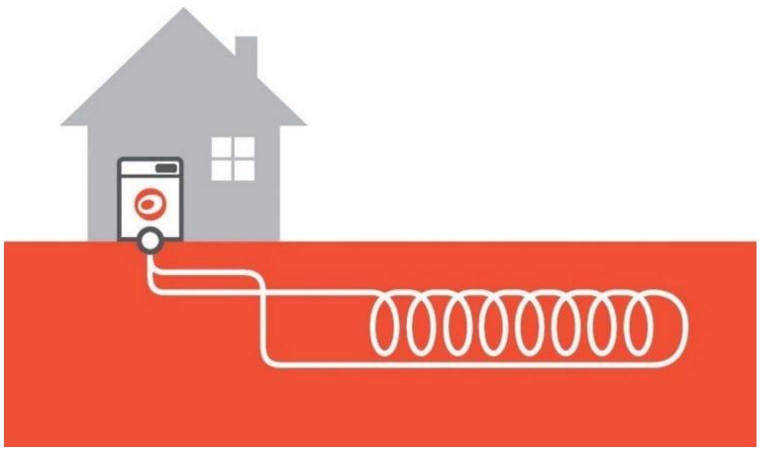


*Image:* GSHP

*Are You Burning Money? Pg. 4*

*Read How Ground Source Heat Pumps are Impacting Electrification on pg. 5*

# Savings with Setbacks

*By: Seth Steward, Jose Duran & Steven Lange*

HVAC systems are among the biggest energy users in residential and commercial buildings. According to the Department of Energy, about 117 million metric tons of carbon dioxide are released annually in the United States due to air conditioning systems. This use costs about $29 billion per year [1]. It is crucial to both the environment and the financial bottom line to keep these numbers low, so temperature setbacks are becoming more popular. Temperature setbacks involve setting the indoor temperature of a building closer to the outdoor temperature. This is done by lowering the output or even powering off equipment such as heaters and air conditioners. Temperature setbacks usually take place during times when the change in temperature will be less noticeable. For example, temperature setbacks can be programmed for a home during work and school hours, and overnight for an office building. Both situations allow for the savings of a temperature setback, while not imposing on the occupants of the building. Temperature setbacks can be an easy and effective way to save both electricity and money.

Temperature setbacks are usually implemented through programmable thermostats, with the help of devices called HOBO meters. HOBO meters are devices that log the temperature of the area they are set up in [2]. This temperature data can help armorers decide where and when to program these setbacks. These devices are currently being used by the Rowan University Sustainable Facilities Center audit teams during the audit process of the NJARNG readiness centers. During these audits, several HOBO meters are placed around different areas of the readiness centers. Several weeks after the meters are installed, the teams can collect temperature data of the building. Teams then use this data to determine when and where temperature setbacks should take place and offer more efficient solutions for the readiness centers.


*Photo courtesy of Jason Muermann*

***Figure 1. HOBO meter placed during the Somerset Readiness Center energy audit.***

Reducing the workload on different HVAC systems when occupants are not in the building will reduce the energy used by a building. According to the US Department of Energy, about 1% of HVAC related energy consumption can be saved for every one-degree setback for every eight-hour period [3]. So, if a building manager reduces the setpoint temperature by three degrees for an eight hour period per day during the heating season, they can expect to see a 3% savings on their energy bill due to HVAC usage. This temperature setback method must be practiced on a daily basis. Schools, hospitals, businesses, and offices can all implement setbacks to save some money and help preserve the environment.

**'Setbacks' continued on page 2**

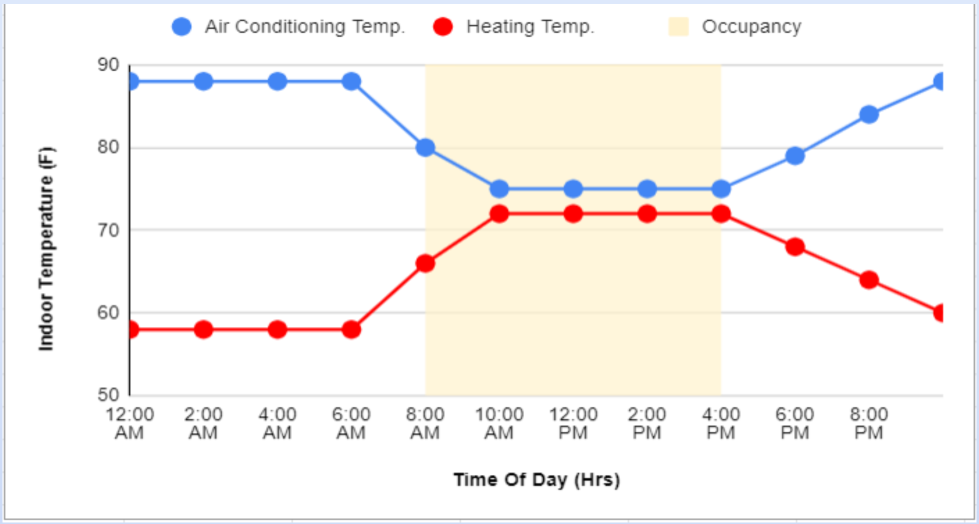



***Figure 2. Standard setback temperatures for heating and cooling seasons***

If temperature setbacks can save significant amounts of up to one percent per degree dropped, one may ask “Why don’t building managers implement double-digit temperature setbacks?” Significant temperature setbacks can lead to more harm than good to a company. On one hand, if a temperature setback is too significant in the winter months, condensation can begin to form because of the substantial change in temperature. On the other hand, if temperatures increase too much in the summer months, one can expect an increase in humidity inside the building. Both of these elevations in moisture can lead to mold and other unwanted water damage in a building [4].

In order to gain the benefits of temperature setbacks while avoiding unwanted damage, some standard recommendations have been developed. According to the Army Regulation Temperature Standards, an occupied office should be around 72 degrees in the winter and around 74 degrees in the summer [5]. Figure 2 represents what temperature setbacks should look like following these guidelines. While the building is occupied, temperatures are set to their preferred settings. While unoccupied, the temperatures either drop or rise depending on the weather.

# A Plan to Maintain is a Plan to Stay Sane

*By: Dan Corrigan & Tyler Hubbs*

## What is Planned Maintenance?

Students at the Sustainable Facilities Center (SFC) engage with real clients and assist their ongoing projects. One project at the SFC gives students the opportunity to assist NJDMAVA with planned maintenance.

There are two main types of maintenance, reactive and planned. Reactive, or corrective, maintenance refers to fixing systems as they fail, which could quickly lead to problems if multiple systems fail simultaneously. Planned maintenance instead plans for these eventualities, and uses scheduled maintenance to keep systems in repair and extend their overall lifetime. A combination of both reactive and planned maintenance can improve facility resiliency, and has been proven to lead to decreased costs [2].

The greatest strength of planned maintenance is sustainability. With planned maintenance comes increased reliability, as well as an expanded time between equipment breakdowns [1]. Not only is cost decreased, but so is waste. As systems are cared for, their lifespan is increased greatly, reducing the need to have them replaced.

**‘Maintain’ continued on page 3**

A fully functioning planned maintenance system requires accurate inventories and careful scheduling of maintenance. This is both to determine the frequency of care needed for each item, and to eliminate possible redundancies [3], such as an item being maintained by multiple people working at different times. This is especially important, as unnecessary maintenance could outweigh the benefits of efficiency normally gained from such a system.

Facility systems that are specifically prioritized by the SFC are HVAC, plumbing, electrical, fire suppression, and miscellaneous equipment such as tractors, or snow plows. Each of these systems is incredibly important and unique, requiring careful planning and observation to conduct a properly planned maintenance schedule.

## Working with NJDMAVA

The Sustainable Facilities Center at Rowan University works hand in hand with NJDMAVA to sustainably manage facilities through the development of planned maintenance plans. To do so, SFC clinic students visit NJDMAVA facilities to inventory equipment and discuss maintenance with armorers and repairers. Back on campus, they collect information on the proper maintenance of each item. The team spoke with Justin Costa, Energy Manager for NJDMAVA, regarding the role of Rowan's sustainable facility management clinic in improving maintenance plans at NJ National Guard facilities. Justin commented on the importance of planned maintenance saying, "Planned maintenance is 100% essential because we need to operate facilities for occupant comfort, safety, and [financial] payback."

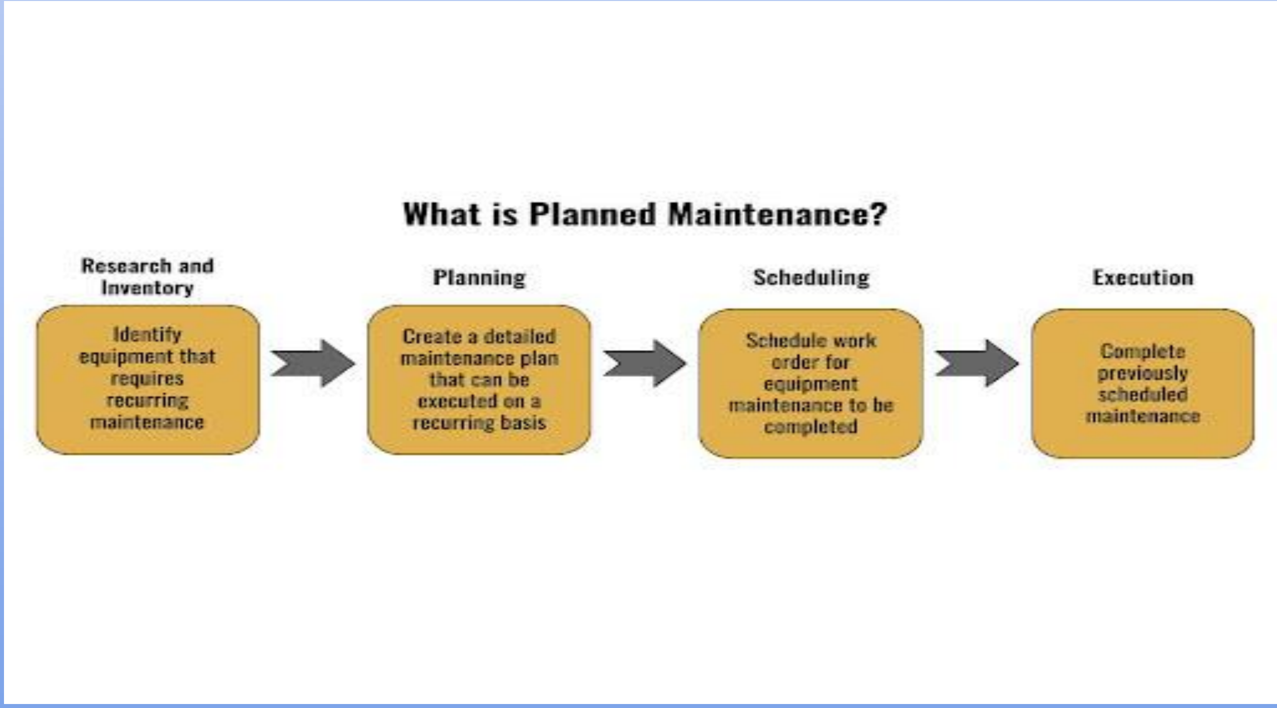



*Figure 3 . A flow chart displaying various stages of planned maintenance*

**'Maintain' continued on page 5**

Without proper planning, equipment will require more reactive maintenance, which translates to longer equipment downtime. According to Justin, NJDMAVA needs to, "...make maintenance as proactive as possible to avoid catastrophic issues." For larger facilities, like the NJARNG buildings, planned maintenance is absolutely necessary, mainly because of the high volume of equipment. If any vital equipment goes down unexpectedly, it can negatively affect everyone at the facility. Everything needs to be properly maintained in order to keep the facility running as intended.

In the future, NJDMAVA and NJARNG plan to switch to completely electric systems, such as air or ground source heat pumps. One reason for this is that it will be healthier for the environment, but also, it will make planned maintenance far simpler.

The SFC continues to develop planned maintenance reports, the first of which will be submitted to NJDMAVA headquarters for final review this year. However, all staff can and should be involved in proper maintenance planning by keeping armorers informed when spotting faulty or failing equipment. The Sustainable Facilities Center hopes to participate in this partnership, and assist NJDMAVA in planned maintenance for years to come.

# Combustion Efficiency Cuts Emission Costs

*By: Daniel Bindas, Michael Brown, and James Nguyen*

Boilers are a crucial component of any residential, commercial, or industrial building. Via the properties of flowing heat and water, boilers hold multiple useful functions. Boilers are closed pressure vessels fueled by either natural gas, electricity or heating oil [1]. The fuel is used to heat up the water, turning it into a gas state, and allowing a building to be heated up [2].

An overall measurement of how well a boiler is performing is called its combustion efficiency. It refers to the measurement of how much of the stored chemical energy in the fuel is being transformed into useful heat. Therefore, having a higher combustion efficiency means a boiler is working with less required energy [3]. Measurements of combustion efficiency can be taken as the first step in understanding boiler performance and recommending any upgrades to the boiler or its combustion chamber. A combustion chamber consists of the fuel source from the boiler being burned so that the water within the boiler begins to be boiled into steam. By refining the gas consumption inside the chamber of the boiler, the combustion efficiency can be improved.

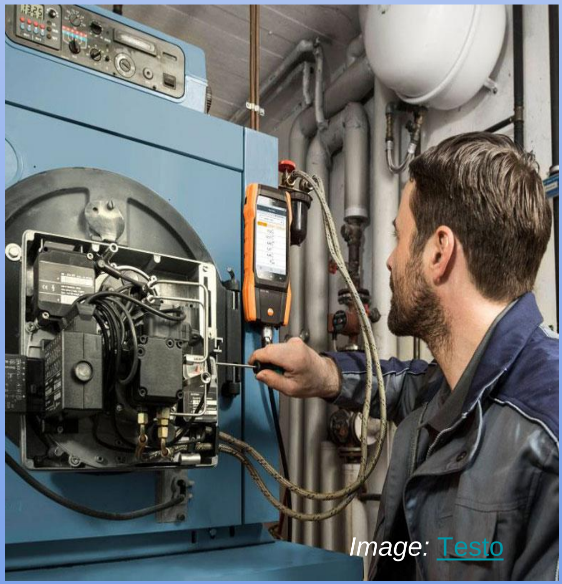



***Figure 4. Testo 300 being used to test the efficiency of a boiler***

**'Combustion' continued on page 5**

Combustion efficiency can be measured in a few ways. One method that the Rowan University audit teams are using for measuring combustion efficiency is a handheld device called the Testo 300. It is a top of the line tool that is very easy to work with and is able to wirelessly send collected data, such as temperature and gas concentration, to a computer for recording [4]. By using the Testo 300, Rowan University audit teams will be able to more accurately and efficiently investigate the components and performance for boiler systems during their site visits.

The Testo 300 can display the oxygen concentration of the air, the carbon monoxide concentration, $T_{stack}$, and $T_{amp}$ through its touch screen interface [4]. The $T_{stack}$ and $T_{amp}$ (flue gas temperature and combustion air temperature) are used to understand whether the boiler has too much or too little excess air. The amount of excess air within the boiler affects the combustion efficiency. When there is too much excess air, heat loss occurs, but if there is too little excess air, there will be signs of fuel, soot, smoke, and carbon monoxide.

Using this information, the amount of fuel energy used by a building can be reduced along with the costs associated with fuel usage. The boilers that should be replaced first can be determined from this. This allows for improved heating while lowering costs.

# Warming up to Ground Source Heating

*By: Walter Foard, Allison Garfield, Braden Garth, Moira Smith, Andrew Wilson*

A ground source heat pump (GSHP), also known as a geothermal heat pump, is a renewable-energy-based option to provide heating and cooling. GSHPs transfer thermal energy between the ground and the building. The ground temperature is cooler than the ambient air temperature during the warmer months, which is ideal for cooling buildings. Conversely, the ground temperature is warmer than the ambient air temperature during the colder months, which is ideal for heating buildings. As a result, GSHPs have the capacity to reduce cooling energy by 30-50% and heating energy by 20-40% compared to traditional HVAC systems.

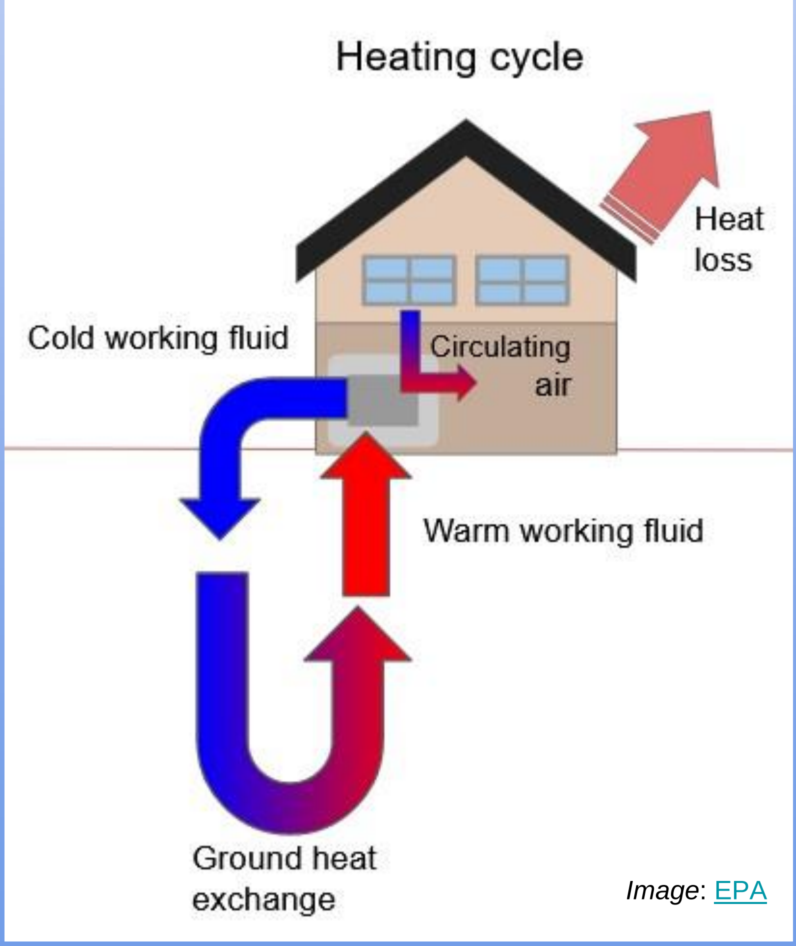



***Figure 5. GSHP heating cycle***

**'Warming' continued on page 7**

## Heat Transfer Process

GSHPs use electric pumps to move a working fluid through a system of pipes that are underground. To heat the structure, the working fluid inside the pipes absorbs heat from the warmer soil or rock that surrounds the pipes. The now-heated fluid continues its loop to inside the building, where a heat exchanger is used to extract the heat from the working fluid. The heat exchanger can transfer heat into the air and ventilation system or can be used to heat the water in the building. After the working fluid transfers its heat, it is returned to the ground loop to start the process over.

## Configurations

There are two main types of ground loop configurations for GSHPs: horizontal and vertical. Horizontal GSHPs can be more economical, but a large amount of land must be available for the installation. Vertical loops can be more efficient from a thermodynamics standpoint, but their deeper bore depth (at least 100 feet) can be costly.

## Thermodynamic Applications of GSHP

It is critical to take into account the laws of thermodynamics and their impact on the GSHP system. The first law of thermodynamics generally states that the change in energy of a system is equal to the difference between energy deposits and energy withdrawals. A simplification of the second law of thermodynamics says that it is impossible to spontaneously transfer heat from cold to hot; work must be put into a system to move heat from cold to hot. These laws apply to ground source heat pumps. During heating season, the transfer of heat from the warmer ground to the colder working fluid is passive. However, the heat exchanger uses energy to extract heat from the working fluid to the warmer air of the building. Despite the energy used by the heat exchanger and pumps to move the working fluid throughout the ground, GSHP are more efficient than resistance-based heaters because they are moving heat rather than generating heat.

## GSHPs for NJDMAVA buildings

For NJDMAVA buildings, switching to a ground source heat pump from oil burning furnaces and gas boilers is more environmentally and economically efficient. The coefficient of performance (COP) is a common method of comparing the energy use of heat pumps. Typically, the COP for GSHPs range from 2.5 to 5.0. For example, a COP of 3 means that 3 units of heat energy are provided for every 1 unit of energy spent. Although ground source heat pumps have more expensive installation costs than boilers, the energy savings of GSPH allow payback periods of 5 to 10 years. Additionally, ground source heat pumps require little to no maintenance and do not require combustible sources of fuel. Ground source heat pumps are a reliable means to heat and cool buildings, especially for NJDMAVA buildings as they move forward toward electrification.

# Meet the Authors

## Steven Lange, Jose Duran, & Seth Steward

*Building Energy and Water Audit Clinic Team*

Steven is a junior studying civil engineering. He enjoys the outdoors and wants to own a construction firm someday.

Jose is a junior in the electrical and computer engineering program, who likes to work on cars and plans to work on weapon defense systems.

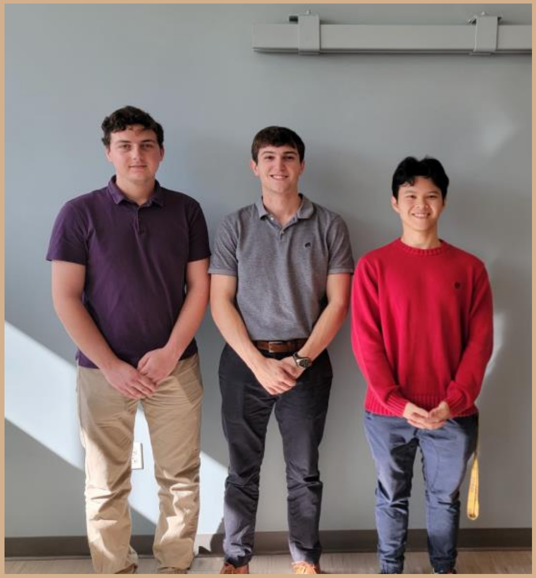
Seth is a junior studying mechanical engineering. Seth started Seth's Lawn Service to pay for college and he intends to be an industrial production manager for Lockheed Martin.

## Dan Corrigan & Tyler Hubbs

*Facilities Management Clinic Team*

Dan is a senior majoring in mechanical engineering. He likes to work out and stays fit. Dan hopes to work in the manufacturing field after college.

Tyler is studying civil engineering and is in his junior year. He has worked for Senate President Sweeney performing press releases and managing communications. Tyler is interested in pursuing politics or traffic engineering.



## Daniel Bindas, Michael Brown, & James Nguyen

*Building Energy and Water Clinic Team*

Daniel is in his junior year working towards an electrical and computer engineering degree.  He is into hiking and rock climbing. Daniel has a dream to step foot in all 50 states.

Michael is enjoying his junior year working towards a civil engineering degree. He enjoys skateboarding and appreciates art. He wants to pursue a career in construction management.

James is a junior in the mechanical engineering program. He enjoys small hikes and is interested in sustainability/maintenance engineering.

'Meet The Authors' continued on page 8

# Meet the Authors

**Allison Garfield, Moira Smith, Andrew Wilson, Walter Foard, & Braden Garth**

*Ground Source Heat Pump Clinic Team*

Allison is a junior in the mechanical engineering program. She is currently supporting the integrated product team at Lockheed Martin and serves on the Tutoring Advisory Committee.

Moira is a junior in the civil engineering program. She likes running and going to the beach. Moira would like to be a coastal engineer focusing on shore protection.

Andrew is in his junior year majoring in civil engineering. Andrew likes to work out and intends to be his own boss.

Walter is in his senior year and finishing a civil engineering degree. Walter is an avid archer.

Braden is in his junior year pursuing a civil engineering degree. Braden loves to golf.

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

SCAN ME

For more information, please contact:

Bill Johnson
*Clean Cut Quarterly Managing Editor*
*Rowan SFC Advisor*
johnson@rowan.edu

RowanUniversity
HENRY M. ROWAN
COLLEGE OF ENGINEERING