Salisbury Readiness Center
Army National Guard
Maryland Department of Military
27822 Ocean Gateway, Salisbury 21801

Energy Survey Analysis Report

Prepared for:
Maryland Department of General Services (DGS)*

Department of
General Services

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Introduction

Project Team

The Smart and Small Thermal Systems (S2TS) group, led by Professor Dr. Michael Ohadi, within the Center for Environmental Energy Engineering at the University of Maryland, College Park (UMD), performed this project, which is managed by the Maryland Department of General Services (DGS) Office of Energy and Sustainability and collaborates with multiple state agencies. The principal investigator and project director is Prof. Michael Ohadi. The project Deputy Director is Dr. Amir Shooshtari. The UMD S2TS team members who contributed to the present building audit project included Chirag Naga (Team leader), Aditya Ramnarayan, and Dr. Roxana Family.

Acknowledgment

We would like to acknowledge the building manager Major Jason Yankee at the Salisbury Readiness Center, Army National Guard, as well as other staff members for their help and cooperation during the walkthroughs and for answering our questions. We would also like to thank the officers and the armory building management for their interaction and the overall support and guidance to accomplish this project. We are also grateful to Mr. Tony Myers, Mr. Lorenzo Taylor, and Mr. Olatunde Babalola for their diverse help, including coordinating the walkthroughs, assisting with gathering the relevant technical information for the buildings studied, and reviewing the reports and offering feedback to the energy audit team.

Overview

This energy audit supports Governor Hogan's Executive Order 01.01.2019.08 - Energy Savings Goals for the State of Maryland Government, which was issued in July 2019 to signal the administration's desire to improve the energy efficiency of state-owned buildings, reduce their environmental impact, and save taxpayers' money. The executive order sets the energy savings goal at 10% savings over a 2018 baseline by 2029. The executive order requires DGS to audit 2 million square feet of State facilities annually and to present the audit reports to each building's owner. The executive order goes on to state that:

> **Each unit of state government that occupies the space audited shall, to the fullest extent practicable, implement the measures identified in the audit.**

The UMD's S2TS group, led by Professor Michael Ohadi, in general, divides an energy audit project into three phases: Building Comprehension which includes comprehensive walkthroughs and energy survey notes, Energy Model Development (if applicable and necessary), and Energy Efficiency Measures/Opportunities Analysis. The team carried out a facility walkthrough, analyzed the utility data and building plans to evaluate the energy usage of the building, as well as summarized their findings in this report. Due to the smaller size and the energy consumption trends, energy modeling was not deemed necessary for this building. Based on our overall analysis, this report identifies actionable energy-saving opportunities to increase the building's energy efficiency. The DGS Office of Energy and Sustainability will coordinate with each building owner on financing and implementing the measures identified in this audit report.

Building Description

The Salisbury Readiness Center is located at 27822 Ocean Gateway, Salisbury 21801. This is a three-story building that was constructed in 1959 with an overall building floor area of 33,070 square feet according to the information provided by the facility manager. Fig. 1 shows an aerial view of the building.

Fig. 1: Aerial views of the Salisbury Readiness Center [1].

The building primarily houses one drill floor, approximately 20 office spaces, one mechanical room, storage spaces, locker rooms, one kitchen, and restrooms, as specified in the building plans. The equipment in the kitchen includes a freezer, refrigerators, an electric microwave unit, a natural gas commercial oven, and a natural gas stove. Plug-in device inventories in the building include computer systems, copier machines, and routers.

Based on the questionnaire, the building occupancy schedule is from 9 AM to 5 PM on weekdays. The building has a daily occupancy of 15 people. However, this number increases during the drills, which usually take place one weekend a month, typically on Saturday and Sunday.

The building consumes energy from three primary energy sources – electricity, natural gas, and oil. The electricity consumption is metered and supplied by Constellation New Energy and Delmarva Power. The natural gas consumption is metered and supplied by Chesapeake utilities.

Mansfield Oil supplies the diesel fuel and roughly 785 gallons are ordered every year. In addition, water is supplied from the City of Salisbury. The Building has plenty of open space around it, which can be utilized to maximize the usage of renewable natural resources such as solar energy utilization.

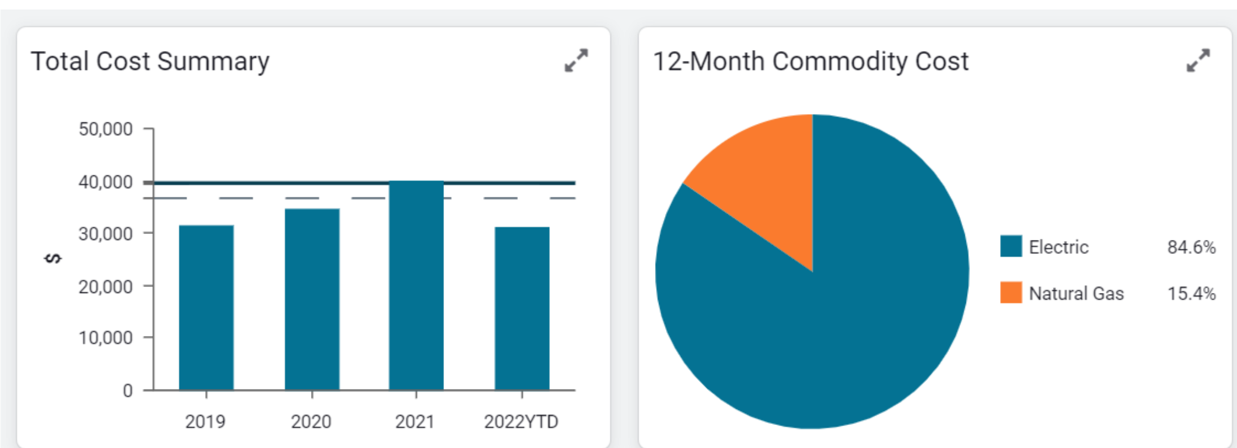
EUI Analysis

Table 1 shows the Energy Use Intensity (EUI) analysis of the Salisbury Readiness Center and its comparison with the widely known EnergyStar reference. The EUI for the building was averaged over 2018 through 2019 data found in EnergyCap. This calculation considered the electricity and the natural gas consumption. Comparing such a figure to the EnergyStar reference for a similarly sized and equipped building is valid and it was found that the Salisbury Armory had a better/lower EUI. This can be viewed as a valid representation due to two likely factors: the geothermal heat pump implemented in the building's HVAC system and the relatively good condition of the general building envelope thanks to recent renovations. Equally important factor is the fact that 2020 and 2021 were pandemic-imposed years and the buildings typically consumed some ~20% less energy due to lack of the normal occupancy.

Table 1: EUI analysis of the Salisbury Readiness Center.

Building name	2018-2019 EUI (E-cap) (kWh/sq. ft.)	Ref. EUI (Energy Star) (kWh/ sq. ft.) [2]
Salisbury Readiness Center	11.98 (40.90 kBTU/sq. ft.)	15.50 (52.9 kBTU/sq. ft.)

Energy Spend Analysis



Daily Cost

4.6%

$ 109
Previous Year
Apr 2020–Mar 2021

$ 104
Current Year
Apr 2021–Mar 2022

Time period	Cost
Apr 2020–Mar 2021	$ 109
Apr 2021–Mar 2022	$ 104

Fig. 2: Energy use and cost for Salisbury Readiness Center.

Building Observations

- Office 118 (Family Office) was found to be very humid.
    - Roof was actively leaking and the container collecting the water had to be replaced every day
    - Occupant kept their room at 68°F, but they claimed that it generally feels warmer than the set temperature.
- The GSHP utilizes 2 water pumps and both pumps were on at all times.
- Condensation and water stains were found in a few office spaces.
- Main lobby doors were found to have air gaps.
- Refrigerator in the kitchen was found to be operating at 65°F.
    - Likely missing most or all of its charge.
- The heating cabinet in the kitchen was found to be left on at 188°F.
- Roof (replaced in 2013) was found to be poor shape
- HVAC Systems:
    - Two RTUs providing heating and cooling
        - AARON (8 TON) RN-Series and AARON (20 TON)
        - 8 TON RTU has an Energy Recovery Wheel
        - 20 TON RTU has ERW, but not working
- Facility equipped with Solar Skylights for daylighting.
- Bathrooms and other spaces are equipped with occupancy sensors for lighting.
- Fluorescent lamps were utilized throughout the armory

Combined/Comprehensive EEMs

EEM 1 – Windows and doors Upgrade

- Appropriately close any gaps in the doors to reduce infiltration

Approximately 30% (or greater in certain cases) of the energy loss occurs through windows and doors [3]. At the moment, the Salisbury Armory has tinted double pane windows that proved to be in good condition.

Additionally, the doorways are also blue tinted, reducing the solar heat input during hot months. That said, there were visible gaps found where the doors met, which could be attributed to the door seal deteriorating or improper installation. This represents a low-cost solution scenario where sealing the entryways of the building properly can work to reduce both heating and cooling loads.

Fig. 3: Visible gaps for possible infiltration in main lobbies of Salisbury Readiness center.

EEM 2 – Roof Repair/Resealing

As seen below in Fig. 4, the roof over the majority of the building has degraded over the few years it's been in place, with the latest renovation being in 2013. The staff expressed concerns regarding the roof leaks in many areas of the building. A likely possibility would be that the roof is no longer waterproof in some areas and that the topography of the roof surface makes it difficult to determine the exact location of the original damage. The minimum recommendation is to reevaluate the condition of the roof by experts and to seal any obvious water entry points. Reducing the leaks can positively affect the HVAC system health as well its efficiency. This also will stabilize the humidity in some of the leakage prone areas, thus leading to an overall more efficient HVAC operation.

Fig. 4: Leaks throughout the armory.

Fig. 5: Roof condition in the Salisbury Readiness Center.

EEM 3 – Energy Star Certified Appliances

There are currently several different appliances being used throughout the building. For example, refrigerators, microwave ovens, heaters (Fig. 6). These appliances can be high energy consumers depending on their energy ratings and age. Replacing all appliances that are more than five years old and are also not Energy Star certified with new ones that are Energy Star certified will result in savings in electricity consumption [4], and savings may be shown in water consumption as well. The contractor shall locate all applicable appliances within the building and after careful and professional assessment provide replacement options with pricing to include installation costs and estimated payback periods.

For appliances where the Energy Star rating is unknown, replace these as necessary with products with energy efficiency ratings that are in the top 25% in their respective markets.

Fig. 6: Plug-in equipment throughout the Salisbury building.

EEM 4– Plug-in Process Load Reduction (PPL)

- Smart Power Strips - Smart power strips can reduce energy waste, prolong the life of electronics, and offer premium fireproof surge protection. It will be advantageous from an energy audit standpoint to replace all power strips in the building with smart power strips to reduce annual electricity consumption. The payback period of a smart power strip is estimated at about 1.1 years [5].

- All power strips in the building should be replaced with smart power strips, e.g., similar to the ones provided by Tricklestar or similar brands. The contractor shall provide pricing for the provision of smart power strips as well as for their installation by existing power connection setups for each room in the building.

EEM 5 – Water Conservation Measures

1) Bathroom Sink Faucets/Accessories
- Replace the older models with new WaterSense labeled faucets to reduce water usage.

2) Toilets and Waterless Urinals
- Many high-efficiency toilets are sold in two parts, with the tank and bowl sold separately. When components combine to make a WaterSense labeled product, tanks should include the words "When used in combination with [bowl model number/name]" in close proximity to the label, and similarly with bowl labeling.
- Waterless urinals are available in the market which use Eco-Trap technology and can last up to 1500 sanitary uses [6].

3) Showerheads
- With a WaterSense labeled showerhead, one can save a considerable amount of water. Water-saving showerheads that earn the WaterSense label must demonstrate that they use no more than 2.0 GPM. The WaterSense label also ensures that these products provide a satisfactory shower that is equal to or better than conventional showerheads on the market.

EEM 6 – Geothermal Water Pumps

On days where the HVAC load on the geothermal system is low, an additional improvement to the energy savings could be to reevaluate the VFDs on the geothermal water pumps to reduce the rotational speed of the motors. Due to the Cube Law of electrical motors, even a 5% reduction in motor RPM's can manifest an approximately 14% reduction in the motor energy consumption [11].

Summary Scope of Work

A summary scope of work is provided in the following table. The estimated payback periods are to be used as a general guide and otherwise represent average estimated costs offered in the open domain. With the current inflationary market prices, the cost/payback estimates will certainly need updating when the implementation of any/all of the respective EEMs is intended.

System Description	Current System/Issue	Proposed System/Solution	Comments
HVAC Equipment	No issues, equipment ~ 9 years old and operating fine	Replace the equipment as they get older to benefit from better energy efficiency	SEER (seasonal energy efficiency rating) of the new systems are ~50% or better higher than the older models

Non-HVAC Related Appliances	Some are old and not Energy Star certified.	Replace the more than 5-yr-old appliances that are not Energy Star certified with new Energy Star certified ones.	Energy Star-certified appliances can result in 10% to 25% of electricity savings compared to non-Energy Star certified appliances [7]. Payback periods vary with the appliance in question [12]
Roof Repair	Roof is in a very bad shape, leading to leaks	Reseal and repaint the roof	Humidity levels can impact the efficiency of HVAC systems, while can cause health and air quality issues as well
Plug-in Process Load Reduction	Identify and implement (PPL) opportunities.	Smart Power Strips. Energy Star rated vending machines and water coolers.	Plug-in and process loads (PPLs) can consume up to ~ 47% of the primary energy in U.S. commercial buildings. PPL efficiency has become pertinent in achieving aggressive energy targets [8]. The payback period of a smart power strip is estimated at about 1.1 years [5].
Water Conservation	Identify and implement WaterSense opportunities, including leak detection.	WaterSense rated sinks, faucets, urinals. Leak detection system.	Water-saving techniques can save budget and reduce water withdrawal from rivers, bays, and estuaries. WaterSense labeled products that have typically short payback periods of 2-3 years [13].
Renewable Energy	Domestic water heater	Solar water heater/ Solar PV panels	A typical 10-kW solar PV system can generate about 14,095 kWh/year of electricity [9]. The typical payback period of a Solar PV system in Maryland is ~11 years [14].

NOTE: The rooftop HVAC systems were found to be 10 years old (nameplates were weather worn) and did not pose as a source of any issue according to the building manager.

We do recommend however, to upkeep strict maintenance schedules and to ensure that the energy recovery system is operational in the RTUs. Due to the relatively low EUI and the building manager's input, it makes sense to not replace the HVAC system as of now. That said, the system should be subject to a reevaluation in a few years as the system approaches the 15-year mark.

Future Renewable Energy Scope

The Climate Solutions Now Act of 2022 increases Maryland's target for reducing greenhouse gas emissions to 60 percent below 2006 levels by 2031 and sets a 2045 deadline for achieving net-zero greenhouse gas emissions across the state's economy.
It also creates a building energy performance standard for the state that will require most buildings over 35,000 square feet to start reporting their data in 2025 and achieve a 20% reduction in direct emissions (as compared to 2025 levels for average buildings of similar construction) by January 1, 2030, and net-zero direct emissions by January 1, 2040.

Building electrification is a critical part of the path to transition away from fossil fuels and to meet the state's aggressive climate goals. Based on DGS data on carbon emissions by the year 2029, the carbon emissions in lb/MWh from the electricity grid will be along the same level as the amount from natural gas sources. This downward trend would continue after 2029 with the CO_2 emissions from the electricity grid being less than that of natural gas sources.

Hot water heaters

- Hot water heaters could be replaced with Heat pump water heaters (HPWHs).

ENERGY STAR certified electric storage water heaters use a highly efficient heat pump – essentially a refrigerator run in reverse – to transfer heat from the surrounding air to the water, using less than half the energy of an electric resistance unit.

Transitioning towards an all-electric system for heating, cooling, and hot water needs, instead of burning natural gas or fuel oil can reduce overall energy use, reduce emissions, ensure that occupants have access to cleaner, healthier, more resilient buildings and enable the opportunity to deploy renewable energy options at the site to supplement the energy demands.

Solar PV panels can be installed at the site to provide supplemental electricity to the building. The solar system would need to be provided with a battery system to offset the intermittent availability of sunlight throughout the year at the location. Using the NREL PVWATTS Calculator, an assumption of the system parameters can be made [9]. For example, at the Salisbury Readiness Center, a 10-kW solar system can generate about 14,095 kWh/year of AC power. This system can be sized appropriately based on the available space at the site, preferably the roof. If the roof space is limited, further space can be explored near the site such as parking spaces or other open spaces.

Further opportunities include purchasing renewable electricity from utilities wherein the sourced renewable energy could go hand in hand with the site renewable energy implementation.

Rebate incentives can be claimed in the form of Solar Renewable Energy Credit (SRECs) [10], also called alternative energy credits in Maryland. SRECs are created for each 1,000 kWh of electricity produced by a qualified alternative energy source. There is no specific size limit, but the systems generally must be connected to the distribution system serving the State, for qualifying.

General Low cost-No cost Energy Efficiency Opportunities (General EnergyStar recommendations)

Following is a general list of low-cost/no-cost energy-saving opportunities that apply to most buildings in the areas of lighting, heating, cooling, and water heating consumption. It is offered as a supplementary piece of information for the report.

✔ Regularly change or clean HVAC filters, particularly during peak cooling or heating season, as dirty filters cost more to use, overwork the equipment, and result in lower indoor air quality.

✔ Calibrate thermostats to ensure that their ambient temperature readings are correct, and adjust temperature set points for seasonal changes.

✔ Maximize daylight harvesting by opening or closing blinds to make the best use of the natural daylight. Take advantage of skylights or other natural daylight sources to reduce lighting consumption during daytime hours.

✔ Program the lights so that they are off when not in use or when natural daylight is sufficient. This can reduce lighting energy consumption expenses by 10-40% [16].

Appendix

List of the Nomenclature used in the report:
BAS – Building Automation System
DGS – Department of General Services
DOAS – Dedicated Outdoor Air System
DHW – Domestic Hot Water
EEM – Energy Efficiency Measure
EUI - Energy Use Intensity
LED – Light-Emitting Diode
RTU – Roof Top Unit
S2TS – Smart and Small Thermal Systems
SCIF – Sensitive Compartmented Information Facility
SREC – Solar Renewable Energy Credit

VFD – Variable Frequency Drive
WGL – Washington Gas Limited

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