Landmark Neighborhood

Energy and Resilience Plan

CDD #2020-00007 Condition #99A, 99B, 99C

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SUSTAINABLE BUILDING PARTNERS

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Purpose

Sustainable Building Partners, with the insight and guidance of Foulger Pratt, INOVA Hospital, and the larger project team, has studied strategies and opportunities to reduce energy consumption and enhance the resiliency of the Landmark Neighborhood project. The studies were anchored by three primary components:

- **Explore** strategies that mitigate the effects of climate change
- **Strive** to reduce energy and resource demand
- **Enhance** the resiliency of the community

This Energy and Resilience Plan addresses a CDD Condition #99A, 99B, 99Cwhich requires the development team to convey concepts, elements, metrics, and phasing for seven (7) energy and resilience strategies (Items A-G).

Coordinated Development District Conditions

1. The applicant shall prepare an *ENERGY and RESILIENCE PLAN* which delineates its proposed concepts, elements, metrics, and phasing for:
    a. Individual Building Efficiency and Site Wide Energy Demand
    b. On Site Renewable Energy
    c. On Site District Energy
    d. On Site Electrical Storage
    e. Off Site Renewable Energy
    f. Building and Grid Integration
    g. Resilience
2. The *ENERGY and RESILIENCE PLAN* shall be completed to the satisfaction of the Director of Planning and Zoning and submitted as a component of an *INFRASTRUCTURE Site Plan.*

Reference 1: CDD Condition #99A, 99B, 99C Requirements

The project team has also incorporated other measures to achieve its sustainability goals and requirements, including LEED for Neighborhood Development and the Alexandria Green Building Policy 2019, into the Plan to provide a comprehensive picture of key sustainability elements of this development.

The intent of this Energy and Resilience Plan is to describe the analysis and conclusions from each study relative to these strategies. The Plan is a report based on information available at the time of the analysis relative to building and site design and available technology. The Plan is not ever-evolving and will not be updated at points in time in the future.

Development Description

The Landmark Neighborhood project is a redevelopment of the Landmark Mall site located in Alexandria, VA. The site spans 54.88 acres that was previously developed with a now vacant mall and several out buildings. The mall and out buildings will be demolished and the entire site redeveloped with the exception of the existing parking facility fronting I-395 which will be reused to serve the project. The redevelopment will in include a new Inova Hospital Campus, several multifamily buildings, townhomes, other attached residences, a fire station, retail and other space totaling 4.2 million square feet plus open space, parks, a new transit center and other community amenities to support the proposed development as well as the surrounding community.
The existing and proposed condition of the site are shown in Figure 1 and 2 below.

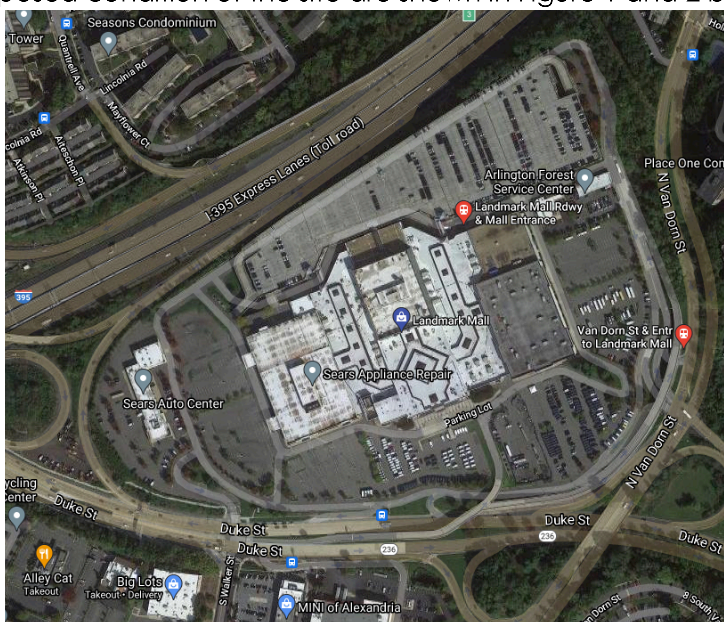


Figure 1: Existing Condition Aerial Map

Figure 2: Proposed Landmark Neighborhood

Key components and metrics of the new Landmark Neighborhood include:

- Up to 1,100,000 SF of medical space for the Inova Hospital campus.
- Mixed-use private development (Blocks D-M)
- Public Parks (Blocks F, N, R, P, Q)
- 54.88 acre development area
- 4.20 million total square feet of building area
- 3-story 377,065 sf footprint garage existing to remain

The existing site is under-utilized and has been identified as a key opportunity in the City of Alexandria for redevelopment into a vibrant, dense and mixed use community that is fully connected to the surrounding area. The City's Small Area Plan further defines this vision to include:

- A walkable mixed use community
- Reconstruction of the roads both on an adjacent to the development to meet contemporary standards associated with full multimodal transportation options
- The installation of an on-street Transit Center
- The provision for a fire station serving the site and the surrounding community
- The inclusion of a meaningful quantity of Affordable housing
- Open space and Parks to serve residents, visitors and the entire West End
- Enhanced storm water detention, including control of both the quantity and quality of runoff from the site where none exists today

The Inova Hospital campus, including a Level II Trama hospital, the Schar Cancer Center, and a Specialty Care Center, bring key services to the area. It's inclusion in the overall development plan introduces unique operational and regulatory requirements. Inova's mission, vision, and values noted below define the institution and guide decisions in the design of the Alexandria Hospital Campus at Landmark.

- People centered – our patients, our team members and our partners
- Commitment to serve Northern Virginia communities
- Not-for-profit stewardship of resources
- A unified, transforming health system – our drive for excellence

Inova's guiding Principles for Sustainability noted below apply the intent of the above mission to more specifically guide sustainability.

- We view our sustainability program as an essential means to live our Mission, Vision & Values
- As a citizen of the communities we serve, we must effectively address sustainability as a key partner in global and local solutions
- We work continuously to improve the health of our ecology, particularly our patients, team members and communities
- We embrace an evolution of improvement with flexibility for incorporating emerging sustainability approaches and technologies
- Our decisions must always ensure high quality, safe and continuous patient care without interruption to operations

Parking serving these three buildings is provided in one level below-grade and in an above grade multi-story parking garage to the north of the hospital.

In total, the IAH campus is expected to provide medical space ranging from 640,000 to 1,100,000 SF including future expansion and be the anchor of the Landmark development. The IAH campus will be designed in collaboration with Foulger Pratt to ensure compliance with the Small Area Plan and coordination with the LEED Neighborhood Development design, documentation and certification process. This coordination will ensure continuity of the public spaces and include vehicle, bicycle and pedestrian circulation, as well as paving and landscape materials.

It is important to understand that Hospital design requires continuous, uninterrupted, safe patient care, which in turn requires redundancy in equipment, resiliency in locations and design, emergency power, and an uninterrupted supply chain for necessities. The following are a number of the unique hospital design considerations required for this project.

Continuous 24/7 Operation – Patients must be provided a continuous controlled environment including building systems, and hospital operations. The hospital requires a 5 MW electrical service which in turn requires robust and independent emergency power and building system controls protected by Uninterrupted Power Supply (UPS).

Infection Control Zones – In order to limit the impact of infectious disease contamination within the hospital, the patient bed floors and the air handling units (AHU) serving them are zoned to serve limited areas. This enables contaminated spaces to be isolated while being decontaminated without impact to the ongoing hospital activities.

Acuity Adaptable Patient Rooms – This converts a standard patient room to have the size and capabilities of an ICU room so that the hospital can adapt as needed to better address mass casualty or pandemic events. This includes additional electrical circuits and outlets, medical gases, 100% fresh air capability, additional air changes per hour, and room pressurization control.

Mass Casualty and Decontamination Planning – The hospital must have a plan to address an emergency room surge beyond normal capacity, and provisions to set-up decontamination showers outside of the building in order to shower and scrub contaminated patients before they are admitted into the hospital.

Medical Gases – The hospital requires delivery of medial gases and the storage of bulk oxygen on site. The bulk oxygen tank and components require rated separation and/or a minimum distance from other services and occupied spaces. The oxygen tank and its components require a blue-sky location and access by crane for installation and replacement if needed without interruption of the hospital's services.

Resilient Design – All mission critical building systems are raised up and protected from potential harm including water and waste accumulation due to flooding, an undetected leak, or an infrastructure failure. This applies to numerous support systems including electrical switchgear, IT closets, boilers, chillers, pumps, and emergency generators.

Redundancy – The building systems providing heating, heat recovery, cooling, and power all incorporate redundancy in their design so that their operation is not compromised by periodic servicing, equipment failure and/or repairs.

Emergency Power – Emergency generators are provided with redundancy to run continuously for a minimum of 96 hours. The location of the generators is challenging as they require crane access to install and replace as needed in the future. The generator exhaust must be separated from all the fresh air intakes of the air handlers for the surrounding buildings and the vibration of the motors must be isolated from the structure and in turn the building occupants and equipment. The generators must also have an acoustical cladding or enclosure.

Water Supply Plan – Should the water service to the site become compromised the hospital must have on-site storage tanks or a contract with a local water supplier to provide tanker trucks of water when needed or equivalent support.

LEED for Neighborhood Development

LEED Neighborhood Development (LEED ND) was engineered to inspire and help create better, more sustainable, well-connected neighborhoods. It looks beyond the scale of individual buildings to consider entire communities and applies to new land development projects or redevelopment projects containing both residential and nonresidential uses. Since the rating system considers a district-wide development comprised of multiple buildings, it results in a well-balanced community that energizes itself from within and a cohesive sustainability strategy for the development and site. Strategies are grouped under three primary credit categories, with opportunity for demonstrating innovative strategies or pursuing regionally-preferred credits in a fourth credit category. The categories and their predominant themes are noted below:

- (**SLL**) Smart Location and Linkage – Smart, Conserve, Housing, Jobs, Site, Habitat
- (**NPD**) Neighborhood Pattern and Design – Walk, Connect, Public, Mixed-Use, Educate
- (**GIB**) Green Infrastructure and Building – Buildings, Energy, Water, Historic, Resource
- Innovation & Regional Priority – Exemplary Performance

Projects can be at any stage of the development process, from conceptual planning to construction, when in pursuit of LEED ND certification. LEED v4 ND offers projects two paths, certification of the design (Plan) or certification of the completed project (Built Project) based on the development milestone. The project intends to pursue LEED ND v4: Plan certification at this time.

CDD Condition #99 indicates that the entire CDD plan area shall achieve LEED for Neighborhood Development certification or comparable certification. The project team has evaluated the feasibility of LEED ND certification, identifying key contributing and limiting factors on a path to certification.

Contributing Factors

- Infill and previously-developed site
- Planned block length, building height, and ROW dimensions
- Landscape design: street trees, open space
- Planned density
- Proximity to jobs
- LEED-certified buildings onsite

Limiting Factors

- Proximity to mass transit options, uses, schools outside the development area
- Limited habitat restoration opportunities
- considerations relative to water use thresholds & district energy solutions

Based on this analysis, the project team is committed to achieving LEED ND v4 certification at a minimum of the Certified level.

Alexandria Green Building Policy 2019

The City of Alexandria's Green Building Policy 2019 identifies the City's green building goals, with a focus on energy performance. The requirements of the Policy are outlined below:

2019 GREEN BUILDING POLICY | Leadership in Energy and Environmental Design (LEED)											
RATING SYSTEM	MINIMUM LEVEL OF CERTIFICATION		PERFORMANCE POINTS								
			ENERGY USE REDUCTION			WATER EFFICIENCY			INDOOR ENVIRONMENTAL QUALITY		
	Private	Public	POINTS		CREDIT	POINTS		CREDIT	POINTS		CREDIT
			Private	Public		Private	Public		Private	Public	
LEED BUILDING DESIGN AND CONSTRUCTION (BD+C)	Silver	Gold	5	7	Optimize Energy Performance	4	4	Indoor Water Use Reduction	1	1	Low-Emitting Materials
			2	3	Renewable Energy Production				1	1	Construction Indoor Air Quality Management Plan
			1	1	Advanced Energy Metering[2]	1	1	Outdoor Water Use Reduction	1	1	Thermal Comfort
			Optional	3	Enhanced Commissioning				Optional	2	Daylight
									Optional	1	Indoor Air Quality Assessment

Reference 2: Alexandria Green Building Policy 2019 Requirements

CDD Condition #102 for the hospital campus and CDD Condition #103 for development blocks outside of the hospital campus require compliance with the Green Building Policy as follows:

Hospital Campus: **(CDD#102):** "Phase 1 as depicted in the CDD Final Site Plan shall comply with the City's Green Building Policy […], with the exception of the water reduction points

Inova's sustainability program is focused on pursuing the following major priorities and initiatives, some of which will contribute to LEED Silver certification in compliance with the City's 2019 Green Building Policy.

- Promote Human Health
  - Maximizing Daylight & Views
  - Restoration of Landscape
  - Healthy Food
  - Thermal comfort
  - Indoor Air Quality
  - Chemicals of Concern
  - Acoustical Performance
- Improve the Environment
  - Renewable Energy Purchase (100% by 2045)
  - Future Conversion Capability to All-Electric
  - Reduced Green-House-Gas Emissions
  - High Performance building Enclosures and Systems
  - Exterior Solar Shading Devices
  - Advanced Energy Metering
  - LED Lighting, Occupancy Sensors, Localized Controls
  - Water Conservation 2030 Goal (40 Gal/SF)

  - Enhanced Commissioning
  - Rainwater Management
- Protect our Community
  - Resilient System Designs
  - Zoning of Systems for Containment & Infection Control
  - Emergency Power
  - Potable Water Back-up
  - Acuity Adaptability – Pandemic Mode
  - Emergency Management Plans
- Shape Culture and Practice
  - Walkable District / Bike Facilities
  - Alternative Transportation Program / Transit Access
  - Electric Vehicle Charging
  - Green Cleaning & Pest Management
  - Comprehensive Composting Innovation Program
  - Sustainable Culture within the Inova Ethos
  - Recycling Program
  - Patient Education / Outreach programs

Please note that due to the unique hospital water demand requirements, including the number of toilet rooms serving each patient room, the Hospital Campus is unable to achieve the water reduction points but will strive to achieve a 30% reduction in indoor water use.

Multifamily Residential & other Office Buildings: **(CDD#103):** "All buildings shall comply with the City's Green Building Policy at time of DSUP."

The elements of the Green Building Policy 2019 and the project's approach are outlined below:

- **LEED BD+C Certification (Silver):** The buildings will certify under the LEED BD+C rating system which may include but are not necessarily limited to New Construction, Core & Shell, and/or Multifamily Mid-rise. The project team will pick the rating system most appropriate for the building type while also meeting LEED Performance Point Requirements. In cases where the points-saving thresholds identified in the Green Building Policy do not align between rating systems, the percent thresholds will be achieved, except in the case of Optimize Energy Performance. This ensures comparable performance between building types and rating systems.

  LEED v4 is the current version of the rating system and a sunset date for this version has not been released. As such, the projects will register under the LEED v4 rating system at time of first DSUP submission and certify under the LEED v4 rating system as long as the version has not sunset and the project meets all sunset guidance which will be published by USGBC in the future.

- **Indoor Water Use Reduction (4 pts):** Under LEED v4, four (4) points corresponds to a 40% water use reduction of potable water use for indoor plumbing fixtures which includes water closets, urinals, showerheads, lavatory faucets, and kitchen sinks. Strategies typically include but are not limited to selecting low-flow fixtures and comparing them to LEED baseline values.

- **Outdoor Water Use Reduction (1 pt):** Under LEED v4, one (1) point corresponds to a 50% water use reduction of potable water use for irrigation. Strategies may include but are not limited to drought-tolerant plants, drip irrigation, moisture sensors and efficient water controllers, collection and re-use of rainwater.

- **Optimize Energy Performance (5 pts)**: Under LEED v4, five (5) points corresponds to the following energy cost savings relative to ASHRAE 90.1-2010:
    - New Construction (NC): 14%
    - Core and Shell (CS): 11%
    - Multifamily Mid-rise (MFMR): 10%
    - Healthcare (HC): 10%

  Project teams will complete iterative energy models throughout design development to document compliance with LEED requirements. Energy efficiency opportunities (EEOs) and measures will be evaluated and explored during this process and integrated into the design of each building.

- **Renewable Energy Production (2 pts)**: Under LEED v4, two (2) points corresponds to installing on-site renewables that offsets 5% (New Construction and Healthcare) or 3% (Core & Shell) of the annual energy use of the project.

  USGBC allows a v4.1 credit substitution which restructures the credit and provides 3 pathways to achieving two (2) points:
    - Purchase green power (RECs) and carbon offsets for 70% of total annual energy use for a period of 10 years
    - Purchase off-site renewable energy from an asset built within the last 5 years (RECs) for 20% of the total annual energy use for a period of 10 years
    - Install on-site renewables that generate power to offset 5% of the total annual energy use

  The LEED v4.1 credit substitution recognizes the limitations and challenges energy dense projects with a small footprint encounter when attempting to offset energy use with purely on-site renewable energy. Specifically, these project types are typically managing competing priorities for rooftop space including mechanical equipment placement, vegetated roof and stormwater management, and amenity space which can make it challenging to locate enough photovoltaic (PV) to reach the first point threshold under LEED v4 credit Renewable Energy Production. As a result, these projects often rely on REC purchases and Power Purchase Agreements (PPA) to meet their renewable energy goals. This pathway is important to the industry as a whole since off-site renewable energy purchases and agreements moves the industry to introduce more renewable energy sources into the grid which further encourages decarbonization of the utility.

  The new v4.1 credit structure offers project teams options to achieving the full 5 points available under the rating system for renewable energy. The project team will explore the available options under the LEED v4.1 credit in concert and recognition of the City of Alexandria's carbon neutrality goals and Energy Action Plan 2040.

- **Advanced Energy Metering (1 pt)**: The LEED v4 credit for one (1) point requires the project to install advanced energy metering for whole-building energy uses and any end-use energy uses that represent more than 10% of the total annual consumption of the building. The advanced energy metering equipment must:
    - Record consumption, demand, and power factor at ≤1 hour intervals
    - Use a local area network to transmit data that is available remotely
    - Store data for ≥36 months
    - Be capable of reporting hourly, daily, monthly, and annual energy use

Note that the 2019 Green Building Policy only requires non-residential projects achieve this point. But if a residential (multifamily project) elects to pursue this credit, common area and back-of-house end uses only need to be submetered per LEED requirements.

The project team recognizes the value of advanced energy metering to ensure as-designed performance carries through to operations by allowing property management to understand energy usage at a more granular level. This provides real-time decision making opportunities to its staff that have a pronounced impact on overall building energy performance.

- **Enhanced Commissioning (Optional)**: Under LEED v4, the Enhanced Commissioning credit has three options:
    - Enhanced Commissioning (3 pts)
    - Monitoring-Based Commissioning (1 pts)
    - Envelope Commissioning (2 pt)

  The commissioning process provides significant value to projects, acting as the bookends to the design and construction activity. The LEED v4 credit has moved much of the design activity of the mechanical, electrical, plumbing, and renewable (MEP&R) commissioning activities to the Fundamental Commissioning prerequisite. The Fundamental Commissioning prerequisite also includes the actual on-site commissioning activities. Therefore the Enhanced Commissioning activity now mostly addresses end-of-construction close-out documentation.

  The other two Enhanced Commissioning activities expand upon traditional MEP&R commissioning activities adding monitoring points to the equipment and reviewing and testing envelope conditions.

  The Foulger Pratt project team intends to consider Enhanced Commissioning activities on a building-by-building basis.

- **Low-emitting Materials (1 pt):** The LEED v4 credit for one (1) point corresponds to two product categories that meet the CDPH v1.1-2010 emissions requirements. If one of the product categories is adhesives and sealants or paints and coatings the products must also meet VOC limit thresholds.

  USGBC allows a v4.1 credit substitution which restructures the product categories and point thresholds and updates the emissions standard to CDPH v1.2-2017. One (1) point under LEED v4.1 also corresponds to two compliant product categories.

- **Construction Indoor Air Quality Management Plan (1 pt):** The LEED v4 credit requires the Contractor to develop a Plan for implementing the SMACNA measures and prohibiting smoking on site during construction.

- **Thermal Comfort (1 pt):** The LEED v4 credit requires all space types to meet ASHRAE 55-2010 thermal comfort requirements and 100% of multi-occupant and 50% of single-occupant spaces to be installed with a thermal comfort control that can modify temperature, humidity, and/or air speed.

  The project team has identified one key challenge in the feasibility of the the credit requirements, specifically for office buildings. The credit as written would require half of all single-occupant desks to have a thermal comfort control. Single-occupant spaces like workstations and private offices typically are not designed with their own HVAC units and doing so would require significantly more equipment that may not be cost effective. The project team plans to deviate from the 2019 Green Building Policy for office and commercial buildings and does not plan to pursue this credit.

- **Daylight (Optional):** The LEED v4 credit provides three options for compliance, one for simulating spatial daylight autonomy, another for simulating illuminance, and the last for measuring illuminance. The credit also requires manual or automatic glare-control devices

  USGBC allows a v4.1 credit substitution which restructures the options and provides more thresholds for achievement.

- **Indoor Air Quality Assessment (Optional):** The LEED v4 credit provides two options for compliance, one for flush-out of the building using outdoor air systems (1 pt) and the other for air testing which includes particulate matter, organic compounds, and inorganic compounds (1 pt).

  USGBC allows a v4.1 credit substitution which separates out the air testing option into two paths, one for particulate matter and inorganic gases and the other for inorganic gases.

Energy and Resilience Plan

A.Building Efficiency and Site Wide Energy Demand

Concepts and Elements: Analyzing and understanding whole building energy performance is critical to identifying and evolving strategies that reduce total energy use and energy demand. Furthermore, reducing total energy use and energy demand should be prioritized in concert with carbon neutrality goals to ensure project strategies do not have unintended impacts, such as on increasing source energy use and placing a larger energy demand on the utility such that it makes it challenging for the utility to convert to renewables.

Whole building energy modeling evaluates architectural, mechanical, electrical, plumbing, and renewable energy concepts. The process is iterative and can be used as a design tool, allowing the project team to make better informed decisions that are more comprehensive and consider the energy performance impacts. All projects within the development intend to complete a whole building or whole home energy analysis in support of these efforts. Energy efficiency opportunities will be explored throughout the design process with a heightened focus around enclosure optimization, internal load optimization, ventilation control and design, and occupancy conditions where there is still significant opportunity for fine-tuning designs based on current industry practice and available technology. Strategies include, but are not limited to, the following:

Enclosure: Passive solar, assembly performance, glazing performance (U-value, SHGC, overhangs, light shelves, coatings), etc.

Internal loads: Lighting power density, lighting controls, plug-load controls, smart controls, appliance performance, end use metering, etc.

Ventilation control: Decoupled ventilation air and space conditioning, occupancy or CO2-controlled outdoor air systems, energy recovery, heating-cooling set points, etc.

Occupancy conditions: Zone isolation, real-time zone control, etc.

Metrics: Industry standards for understanding and comparing building energy performance have included the use of ASHRAE 90.1 energy cost savings, energy use intensity (EUI), and ENERGY STAR Scores. These metrics are used by government agencies, jurisdictions, green building rating systems, and other entities and institutions. The industry is starting to incorporate a carbon metric (mTCO2e) to measure performance in response to and support of industry and jurisdictional carbon neutrality goals to mitigate climate change. However, the use of this metric is in its infancy and is not currently used interchangeably with other metrics or as the standard for measuring energy performance.

ASHRAE 90.1 energy cost savings: ASHRAE 90.1 has been a benchmark for the development of building energy codes and entitlement conditions, much like the International Energy Conversation Code (IECC), within the United States. It sets minimum energy efficiency requirements that evolve and are updated every three years. It is typically referenced in green building rating systems, like LEED, and within surrounding jurisdiction policies, codes, and conditions. As such, a comparison against ASHRAE 90.1 throughout design provides the design team a reference point that can inform design decisions to ensure the project will hit anticipated targets. The City of Alexandria requires 14% energy costs savings for New Construction projects, in alignment with the Green Building Policy 2019.

Energy Use Intensity (EUI): ENERGY STAR Portfolio Manager allows properties to benchmark their operational energy use relative to the energy use of similar properties within the nation. The *Energy Use Intensity by Property Type* technical reference lists national median site and source energy use intensities (EUI). Although source EUI is the recommended benchmark, normalizing on-site combustion and on-site electric use, site EUI is typically referred to. The national median site EUIs for anticipated property types are listed in Table 2 for comparison.

ENERGY STAR Score: Using the benchmark data in ENERGY STAR Portfolio Manager, projects can achieve an ENERGY STAR Score. This score is based on real energy usage data and is calculated by an algorithm that estimates the energy use of the actual building if it was a high-performer, average-performer, or worst-performer based on the building's peers. A minimum Score of 75 (or 75th percentile) must be achieved.

Operational Carbon (mTCO2e, metric tons of carbon dioxide equivalent): Operational carbon is calculated by converting the total energy use of the building (kWh, therms, kBtu) into a carbon equivalency. The conversion factor is based on the emissions associated with the combustion and transfer of energy, which can be either directly on site or from the utility to the project site. As a result, it takes into account the energy make-up of the grid and decarbonization of the utility.

The analysis uses EUI as the main reference point for energy performance, with the goal of reducing energy intensity and demand first. Other reference points, like ASHRAE energy costs savings, are useful in evaluating the same goal; however, considering these blocks are at concept level, EUI allows us to calculate relative performance and impact in advance of having complete building information.

Analysis: The development team has set EUI targets for each building type. These targets are based on data from SBP's large portfolio of completed energy models and verified operational performance results within the DC-Maryland-Virginia region. The targets take into account opportunities and limitations of technology currently available on the market, best practices and opportunities for fine-tuning the design, and real-world occupancy and operational characteristics. Our approach was additive, meaning the target EUIs were derived adding building energy consumption up from a zero condition, to include all owner and tenant-controlled elements.

Table 1 summarizes the target EUIs for each building type within the Landmark Neighborhood development and compares them to median regional and the median US EUIs.

- *Median regional EUIs* are based on the Building Energy Performance Standard (BEPS) program in the District of Columbia. This program is a database of actual reported energy use of buildings in DC, grouped by building type. It is comprised of 18,750 buildings.

- *Median US EUIs* are derived from ENERGY STAR Portfolio Manager's *U.S. Energy Use Intensity by Property Type* Technical Reference which uses nationally representative data that is primarily derived from the Commercial Building Energy Consumption Survey (CBECS) data source.

Table 1: Site EUI Summary by Building Type*

Building Type	Target EUI	Median Regional EUI	Median US EUI
Office	40 -60		
	(14% less)	47	
	(24% less)		53
Medical Office	60		
	(24% less)	66	
	(1% less)		51
Multifamily**	40		
	(28% less)	56	
	(33% less)		60
Hotel***	60		
	(3% less)	62	
	(4% less)		63
Retail****	75		
	(-7% less)	70	
	(27% less)		104
Fire Station	50		
	(44% less)	90	
	(21% less)		64
Hospital	160-180		
	(2% less)	184	
	(23% less)		234

*Traditional Townhomes are not included in the Table since Median US EUI information is not available. Target EUIs don't include EV charging stations.

**Multifamily excludes retail.

***Simple motels or small hotels consisting primarily of guest rooms can achieve very low EUIs more easily than larger hotels with banquet/conference space which have significant additional loads. The Target EUI accounts for this.

****Retail energy intensity can vary greatly based on the type of business which is apparent in the Median US EUI.

Our approach is further detailed below, using a multifamily residential construction building as an example. The project team has identified a site EUI goal of **40 kBtu/sf-yr for multifmamily buildings**. The EUI includes related garage areas but excludes EV charging capacity and stations as well as retail and/or restaurant areas. The goal is based on the following design elements and end-uses that are anticipated for a multifamily building in this development. Some items are required by current code and/or LEED.

Table 2: Estimated Energy Demands for Multifamily Buildings

End-Use	EUI kBtu/sf-yr	Basis of Design
Owner Controlled		
DOAS Ventilation Dedicated outside air system	15.4	Direct to unit, dehumidified neutral temp air, DX cooling, electric heat
Common Area HVAC	2.81	Variable Frequency Drive System; *includes impact of enclosure performance*
Common Area Lighting	1.15	All LED
Garage Lights	0.33	LED with occupancy sensors
Garage Ventilation	0.28	CO/NOx control with VFD
Elevator	0.17	Typical high efficiency elevator
SUBTOTAL	20.14 kBtu/sf	
Tenant/Occupant Controlled		
Hot Water	5.97	Electric water heater with low flow fixtures
Apartment HVAC	4.10	VRF System with cycling fans; *includes impact of enclosure performance*
Plug Loads	3.07	Typical, not under influence of project team
Stove	2.06	Electric
Clothes Dryer	2.05	Energy Star, electric
Unit Lights	1.40	All LED
Refrigerator	1.28	Energy Star
Dishwasher	0.87	Energy Star, includes water heating,
Clothes Washer	0.43	Energy Star, includes water heating
SUBTOTAL	21.23 kBtu/sf	
TOTAL	41.4 kBtu/sf	

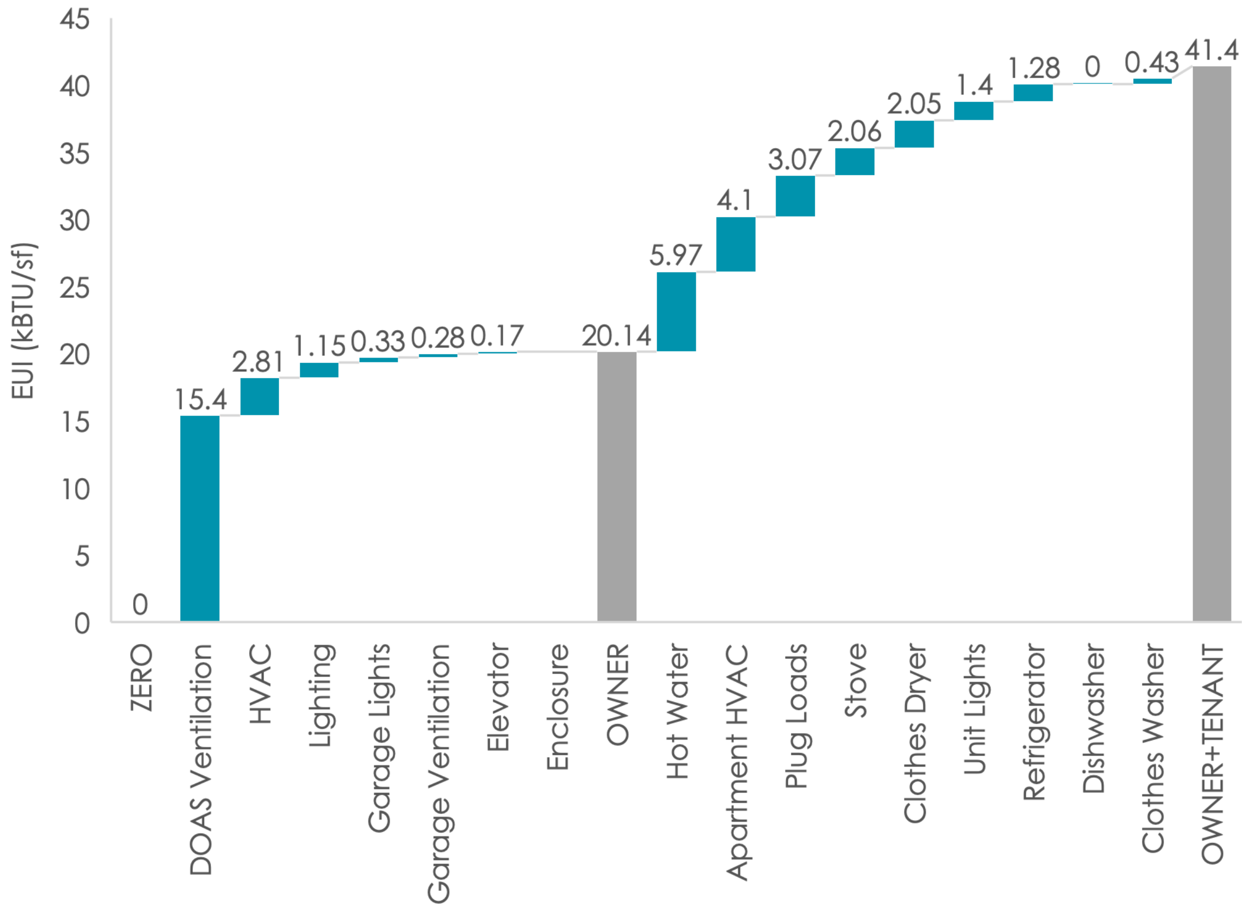


Figure 3: Estimated Energy Demands for Multifamily Buildings

Key **conclusions and points of note** from the analysis that have informed the target EUIs are listed below. These points emphasize the level of accuracy and likelihood that operational performance will be realized that corresponds to modeled performance.

Hospital Campus:

Hospital Loads – The evaluation process for pursuing Individual building efficiency is addressed in the same manner for the buildings on the Inova hospital campus, but there are differences in the programmatic needs of each building that make it advisable to treat the MOB separately.

Conceptually the individual buildings will take advantage of passive solar considerations including solar shading where viable, and endeavor to reduce heat transmission, thermal bridging, air and water infiltration, condensation, and solar heat gain. We will use Therm models of the wall sections and energy models of the typical rooms and overall buildings to test the performance of our design including the impact on thermal comfort and energy efficiency. We will measure our energy use reduction using the LEED - Optimize Energy Performance credit. In addition, we will have LEED - Advanced Energy Metering which will enable energy to be effectively managed, and we will have LEED Enhanced Commissioning for the building systems and envelope to ensure the systems are operating as designed and the building envelope insulation, air barriers and vapor barriers are installed in a complete and continuous manner. This addresses our conceptual approach and metrics.

To increase operational and energy efficiencies we have centralized the Hospital and Cancer Center chillers, boilers, and cooling towers into one system in the hospital, and gathered the emergency generators on the roof of the Cancer Center to ensure crane access for future growth or unit replacement, and separation from the hospital air handler unit intakes.

The MOB program areas do not require high humidity levels, 24/7 systems operation, or 96 hours of emergency power, so the MOB systems are not as robust and located within the MOB.

The building systems all reduce green-house-gas omissions, limit the use of fossil fuels in the initial buildings on site, and are designed to accommodate conversion to all electrical in the future to the extent viable. The maximum Energy Use Index (EUI) goal for the hospital is an EUI of 180 and for the MOB an EUI of 60.

The Hospital, Cancer Center and MOB buildings are to be completed in Phase I of construction. There is a hospital expansion plan, but the schedule and scope for the expansion will be determined by the future needs of the hospital.

Multifamily Residential & other Office Buildings:

1. Ventilation Loads – Ventilation loads represent a significant portion of the overall building loads. Ventilation is required under building code and the LEED rating system, ensuring that high quality air is provided throughout the space for the health and wellbeing of the occupants, typically specified by the percentage of outside air that is delivered to the occupied space. Our region is also unique in that we see a wide range and high variability of temperature and high humidity levels that requires sufficient amount of energy to take that air from an outdoor to neutral condition before it enters the space. This ensures buildings do not experience moisture issues that could lead to indoor air quality issues. There are strategies available to mitigate the high energy use of ventilation systems through set point controls, etc but the ventilation load cannot be completely removed from the building.

2. Ventilation strategy – A centralized apartment ventilation strategy was included as part of this analysis, which decouples the apartment ventilation and HVAC equipment. There is an option to ventilate apartments locally, ducting outdoor air horizontally to the HVAC unit. HVAC equipment energy use for the apartments would increase under this scenario if the fan operates continuously. To mitigate fan energy use a time-averaged or occupancy-based control of the HVAC equipment is suggested.

3. Owner vs Tenant Loads – The owner has the ability to influence the energy usage of a select number of system and elements within the building. There are many end uses that are directly under the influence of the tenant. For example, residential unit level plug loads, lighting, hot water, and appliances (all of which are assumed to use high efficiency technology) are occupant driven and require approximately 15-20+ kBtu/sf-yr, approximately half of the total energy consumption, before adding in additional energy end uses like ventilation and heating/cooling in the multifamily example above. One strategy to incentive tenants to reduce occupant driven energy consumption is through tenant metering.

4. Variability in Energy Use by Project Type – A wide range of retail and hotel project types exist that can result in a wide range of reported EUIs. Simple motels or small hotels consisting primarily of guest rooms can achieve very low EUIs. Larger hotels with banquet/conference space have significant additional loads. It is anticipated that a hotel within this development would have banquet/conference space; therefore, the target EUI reported herein is approximately the same as the median US EUI. Retail energy intensity can also vary greatly based on the type of business which is apparent in the Median US EUI. Considering anticipated location and size of retail in the development (multiple spaces on the 1st floor) and scope of retail fit-out (mechanical, electrical, plumbing by retail tenant), maintaining flexibility in setting target EUIs is appropriate.

Phasing: The team will study additional energy savings opportunities throughout design with the goal of meeting or reducing the EUI listed for each building type where feasible.

B.On Site Renewable Energy

Concepts and Elements: On site renewable energy reduces the energy demand of the building and on the utility. Several renewable energy strategies were considered:

- Solar Photovoltaic (PV) – PVs convert the sun's energy into electrical energy using semiconductor materials. Solar PV technology continues to advance, decreasing the price point of traditional roof-top mounted solar PV allowing for widespread adoption of the technology. Unique funding mechanisms, tax incentives, and other opportunities exist that may be attractive to projects. The future of PV is bright, and new technology is expected to come to market, like building-integrated PV. Due to the competing needs for rooftop space throughout the Medical Campus, PV panels are not feasible. A more detailed discussion of the feasibility of using PV panels on Multifamily residential and other non Hospital Campus buildings is below.

- Solar Thermal – Solar thermal harnesses solar energy to generate thermal energy. Low and medium temperature collectors can be used to heat pools, ventilation air, and water and air respectively. These type of collectors are predominantly used for generating hot water on small scale projects and therefore not suitable due to the scale of this development

- Wind – Wind energy converts mechanical energy into electrical energy using a wind turbine. The typical application is at a utility-scale where several wind turbines are placed on a large area of land (or water) to reduce and offset fossil fuel use at a power plant. The requirement for turbines that are several hundred feet tall and the limited site area eliminate this as a viable power source.

- Hydropower – Also known as water power, converts the kinetic energy of water into electric energy. It is often generated by damming rivers. Lack of proximity to a moving water source eliminates this from consideration

- Geothermal – although sometimes termed a renewable energy source, geothermal does not actually generate energy unless there is access to the earth's magma near the surface, typically in active seismic areas. Geothermal wells can serve as a heat source/sink where they can be feasibly used to improve the efficiency of certain types of mechanical systems. This too is discussed further below.

- Nuclear – Not considered appropriate at this site.

Metrics:
Total installed PV capacity is measured in Watts and is influenced by orientation, tilt, shading, and panel efficiency. Most commercially available PVs are 15-20% efficient when oriented optimally. The overall performance of the system is typically compared to and measured by calculating the percent of on-site energy use (kilowatt-hours, kWH) offset by on-site renewable energy. The LEED rating system structures EA credit v4.1 Renewable Energy as such, awarding points for offsetting a percentage of the on-site annual energy use.

> LEED v4.1 EA credit Renewable Energy – Percent annual energy use offset with on-site renewables and corresponding points awarded:
> 2% (1 pt), 5% (2 pts), 10% (3 pts), 15% (4 pts), 20% (5 pts)

For energy dense projects with a small building footprint, achieving the first threshold can be challenging as these projects are typically managing competing priorities for rooftop space.

Analysis:

Hospital Campus:

The Inova hospital campus team has considered several alternatives for on-site renewable energy. The limited site area of 10 acres, compounded by the extensive programmatic and building system requirements of the hospital campus buildings totaling between 640,000 to 1,100,000 SF of conditioned space severely limit on site renewable energy options as the functional needs of the hospital and service to patients is Inova's priority. Photovoltaic panels serving the Hospital and Cancer Center were estimated to require a minimum of 80,600 SF of active panel area to provide 5% of the estimated energy demand.

Inova has looked at all the potential locations for solar panels and found the ventilation requirements of the mechanical systems, the clearance requirements of the helipad, and the zoning requirements for open space take priority. The location over the parking garage to the north is in the shadow of the towers, which limits the performance of the panels, and the area is significantly short of the area required to support 5% of the estimated energy demand. Given these limitations, and the availability of different off-site renewable power sources, Inova has chosen to pursue renewable power from off-site sources.

Multifamily Residential & other Office Buildings:

The analysis and results from the "Energy Efficiency and Site Wide Energy Demand" Section were used to inform the "On Site Renewable Energy" section. Specifically, the target EUIs set in *Table 1: Site EUI Summary by Building Type* were converted into an average EUI for the development that, when multiplied by the development gross square footage, quantifies the total anticipated annual energy use of the development. Using this value, potential percent offsets and corresponding panel area, system power, annual generation, cost, and carbon reductions were calculated. These scenarios are summarized in Table 3. Note that for this analysis, the hospital campus was excluded.

Table 3: On-site PV System Power and Cost

Offset	Area Required	System Power (kW)	Annual Generation (kWh)	Cost Range *		mT CO2 Reduction
2%	33,000	780	930,000	$1.95 - $3.12M	$0.46-$0.74/sf	314
5%	82,500	1,950	2,325,000	$4.9 – $7.8M	$1.15-$1.84/sf	784
10%	165,000	3,900	4,650,000	$9.75 - $15.6M	$2.30-$3.68/sf	1,568
20%	330,000	7,800	9,300,000	$19.5 - $31.2M	$4.60-$7.37/sf	3,135
50%	825,000	19,500	23,250,000	$48.8 - $78M	$11.51-18.42/sf	7,838
75%	1,237,500	29,250	34,875,000	$73.2 - $117M	$17.27-27.63/sf	11,758
100%	1,650,000	39,000	46,500,000	$97.5 - $156M	$23.02-36.84/sf	15,677

**Rule of thumb cost used is $2 - $4 per Watt. This cost is turnkey; specialty products (like racks on the garage) would be on the higher end of this range.*

The design team spent considerable effort investigating the feasibility of using the existing garage structure as a location for PV panel arrays with the hope that it could meet a 5% Offset for its buildings. A fundamental premise of the redevelopment and a key to reducing the required subsidy from the City, was to reuse all of the parking in the existing structure to serve the new development. 550 of those spaces are serving the City owned land that will be leased to Inova for the Hospital Campus. In addition, a shading study of the garage was done to determine what portions of the garage might be suitable for PV arrays due to shading.

Shading of Garage
The garage's location at the north end of the site will result in considerable shading as a result of other buildings on the site. The figures below illustrate shading in both summer in winter conditions.

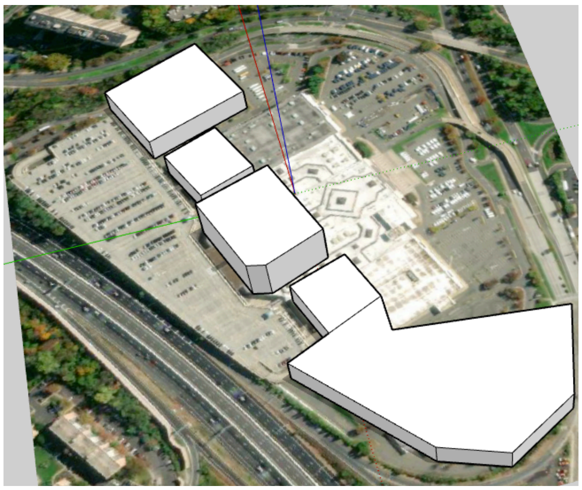


Figure 4: Summer Shading

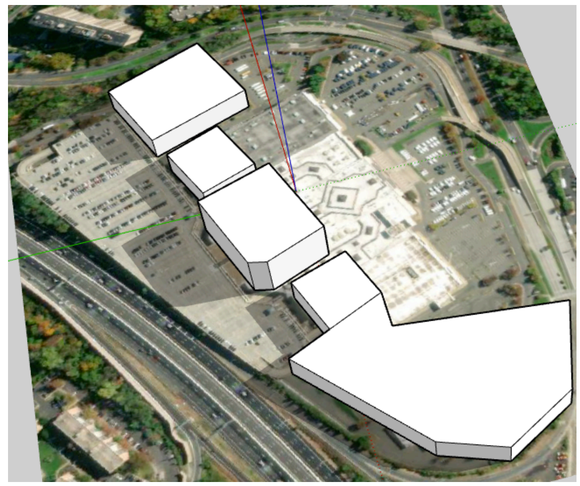


Figure 25 Winter Shading

In order to avoid shading that can have a significant impact on panel output and cause the power to be more expensive to produce, it is ideal to locate panels in areas that are rarely shaded. The figure below illustrates a 100,000 sf area of the garage that theoretically could be considered for PV. This is diminished by approximately 50% due to the structural limitations outlined above.

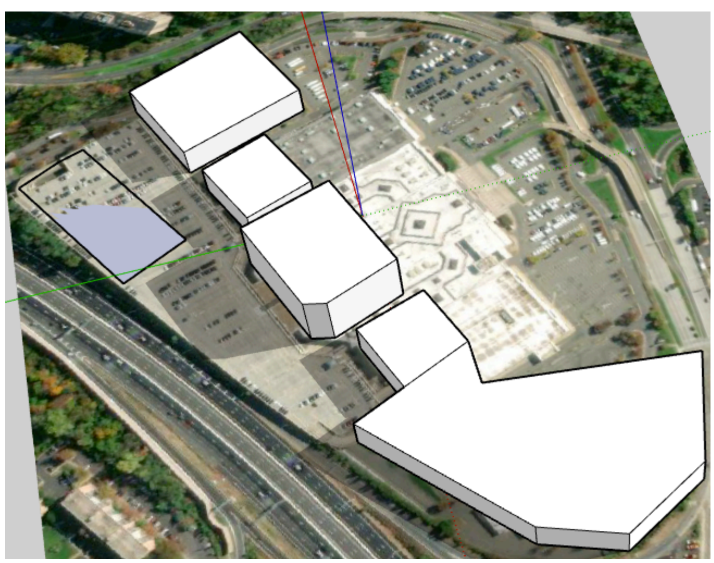
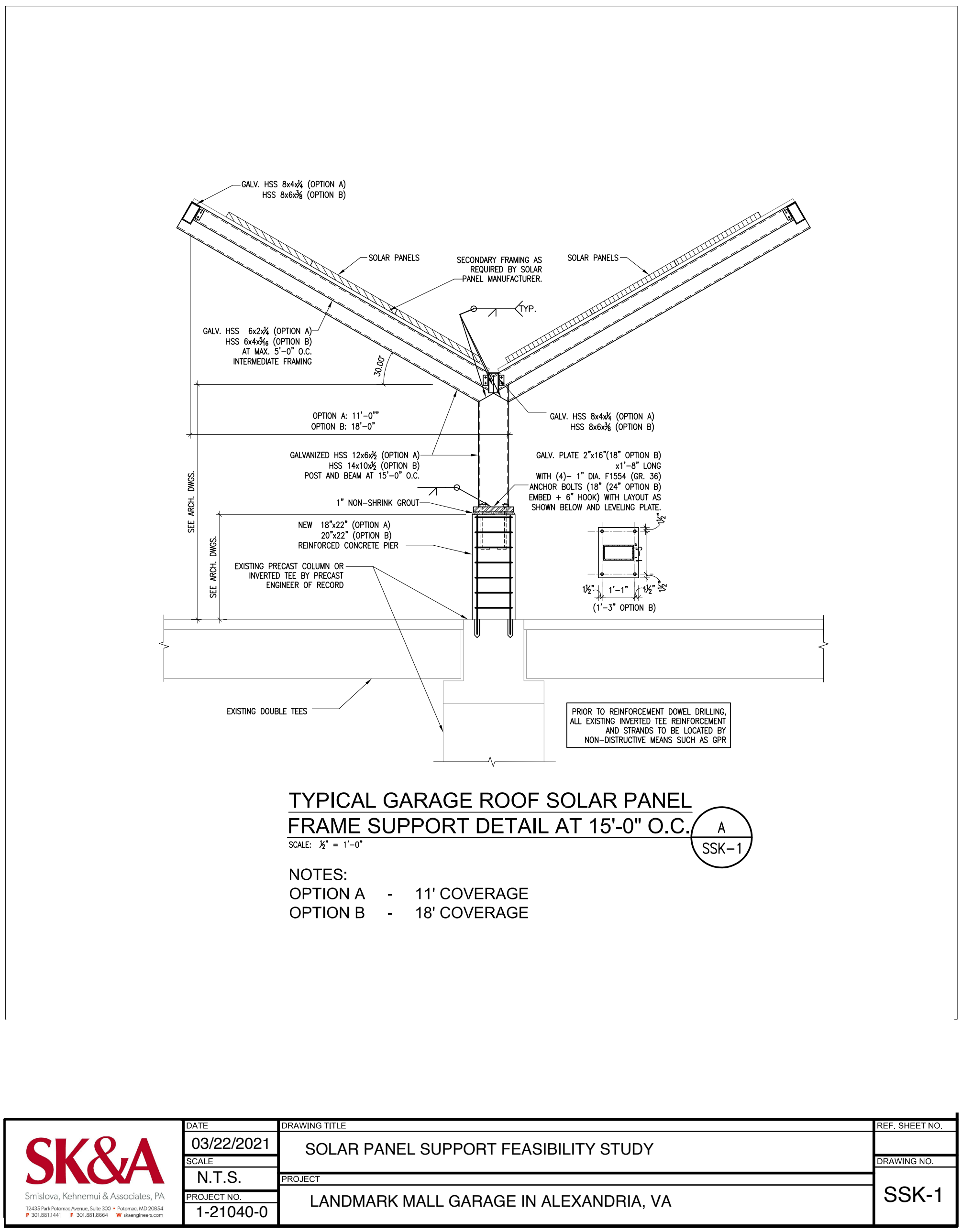


Figure 6: Year-round unshaded garage area

Structural capacity of the Garage: Foulger Pratt has investigated the existing garage's ability to support additional load, such as a PV System, with the support of a third party engineer. As mentioned above, the top deck of the garage needs to be retained for parking uses. Consequently, the PV arrays would need to be installed on a new layer of structure built atop the existing garage. After significant study by the structural engineer, it was determined that it was infeasible to install PV arrays over any of the travel aisles as they were too far from the structural columns. Accordingly, the following detail was developed for further investigation:



These limitations on the added structure further reduced the potential available area for PV panel installation on the garage by an additional 50%.

Additional analysis of the existing precast double tee parking structure was undertaken to determine whether or not the existing structure could support the installation of the added structure and PV panels. This analysis revealed that the existing foundations were insufficient to accommodate the impact of the additional lateral loads that needed to be taken into account. There is no feasible way to increase the capacity of the foundation system to accommodate the installation of PV panels atop the garage.

Relative to geothermal, the project team determined that sufficient site area is not available to support the projects heating and cooling capacity. Key analysis includes:

- The average geothermal well supplements the efficiency of 1 - 2 tons of cooling or heating capacity and requires approximately 100 square feet of accessible site area.
- Wells cannot be located in parks or other public open space due to maintenance requirements and park use restrictions.
- The average multifamily building requires about 400 tons of cooling capacity and there is insufficient available land to support the ±1 acre that this type of system would require.
- For lower density townhomes, the increased cost of providing the two wells needed by these systems ($20 - 25,000/unit) make this approach infeasible.

Phasing:
The Multifamily buildings are expected to have a combination of podium-level roof, occupied rooftops, and unoccupied rooftops. Green roof and mechanical equipment will also exist on the various roof surfaces. With this in mind and in combination with shading impacts from structure above, mechanical air flow requirements, stormwater management and green roof needs, the available area for PV is further reduced.

Notwithstanding the current infeasibility of providing significant PV arrays on the project site, the Multifamily buildings will be made “solar ready” so that PV panels can be easily added to these structures should technology and costs advance so that it becomes feasible in the future.

C.On Site District Energy

Concepts and Elements: On-site district energy typically uses a central plant to generate hot water, steam, and/or chilled water to buildings through a network of pipes. Sources of thermal energy may include combined heat and power plants, waste heat from processes and equipment, and natural heat sources/sinks (like geothermal). District energy solutions can achieve efficiencies 10-30% more than separated services. They are typically found in dense business districts, university campuses, hospitals, airports, and military bases and other areas that feature either significant amounts of waste energy or common ownership.

Key considerations for on site district energy solutions include:

<u>Available site area</u> – District energy solutions required dedicated site area to locate a central plant, renewable energy sources, and natural heat sources/sinks.

<u>Fuel use type</u> – In locations where there is not abundant available waste energy, the predominant fuel type for modern district energy plants is natural gas which conflicts with electrification and carbon neutrality goals.

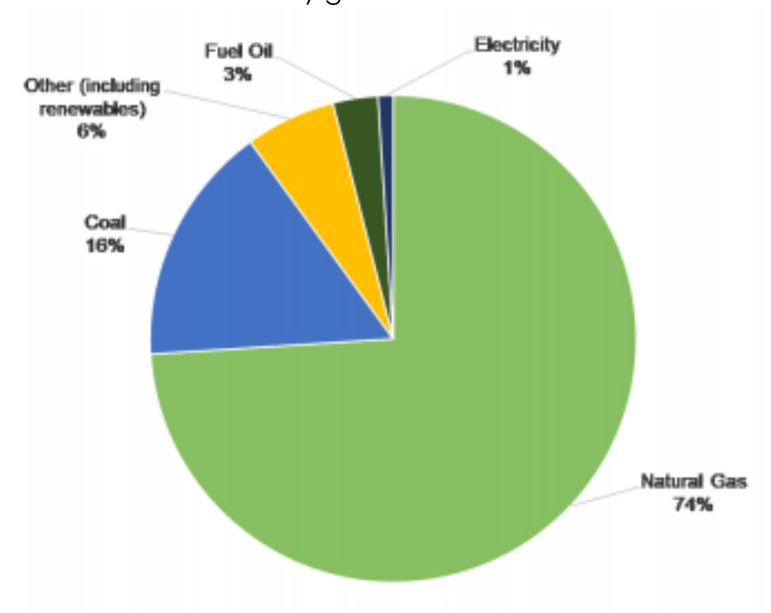


Figure 4. Fuel use in district energy systems (2012 data).

Figure 7: From U.S. Department of Energy: Combined Heat and Power Technology Fact Sheet Series

Analysis: A key consideration to the viability of an on-site district energy plan is available land area. The development scheme for the Landmark Neighborhood occupies 95% of the total site area leaving little space for an on-site district energy plant at a scale that could support the energy demands of the development.

57.88 acres (2,521,400 sf) total site area
54.88 acres (2,390,510 sf) total development area comprised of:
- 29.41 acres (1,281,117 sf) development block area
- 9.57 acres (416,676 sf) hospital campus area
- 11.25 acres (489,843 sf) non building area (roads, easements, existing garage)
- 4.66 acres (202,877 sf) open space

Figure 8: Landmark Neighborhood Development Scheme

Hospital Campus:
For the hospital campus, the limited site area of 10 acres compounded by the extensive programmatic and building system requirements of the hospital campus buildings totaling between 640,000 and 1,100,000 SF of conditioned space leaves no available space to contribute to a central energy plant. The redundancy requirements, 24/7 operations, and a 5 MW electrical service associated with the Hospital Campus are also unique and present a significant load for an on-site energy district to address.

Multifamily Residential & other Office Buildings:
Each of the blocks outside the Hospital Campus will ultimately be owned and managed independently making District Energy solutions and the associated metering difficult. In addition, there is no space onsite to accommodate a central plant and the phasing of the development makes individual, appropriately sized mechanical plants only feasible approach. Furthermore, Dominion Energy's current tariff structure does not permit the sale of power across public rights of way.

For these reasons, District Energy solutions are not feasible for this redevelopment.

Metrics and Phasing: Since this option is not feasible in the Landmark Neighborhood, metrics and phasing are not covered.

D.On Site Electrical Storage

Concepts and Elements: Electricity can be stored in a variety ways including hydro, thermal, and electrochemical (battery) and used to address peak demand and power factor management, short and sustained electric grid outages, and renewable energy generation impacts. Recently, battery storage has become a predominant form of electrical storage due to the technological advancements and reductions in cost in lithion-ion batteries.

Electrical storage may make sense when the follow conditions or needs exist:

- Significant onsite energy generation is feasible.
- Demand management including using electrical storage to reduce utility demand charges paying for and storing electricity at a lower price point during off-peak hours and using that electricity during peak hours.
- Periods of sustained electric grid interruptions are anticipated due to reliability issues or predictable events and electric storage can be used to meet critical loads or requirements.
- Net metering of PV is a concern, where the PV overgenerates electricity and the utility does not allow for this electricity to be transferred to the grid.
- To shift and smooth out PV generation such that it aligns with peak energy demands.

Key considerations when deploying electrical storage technology such as lithion-ion batteries include:

- Power conversion
- Thermal management
- Software and controls
- Other load reduction strategies

Analysis:

Hospital Campus:

On Site Electrical Storage - The Hospital's MOB can use battery packs for emergency lighting. Emergency power is required to serve the hospital and logistics make it logical to also provide emergency power to the Cancer Center. Uninterrupted Power Source (UPS) units will be used in all buildings to provide continuous power for critical systems including the imaging systems and OR equipment. The UPS equipment may be consolidated in areas or zones to increase their resiliency and efficiency.

Peak Shaving – A large battery installation could be used to shave peak energy loads, but it would require a significant number of batteries and conditioned space to impact the energy demand of the 5 MW hospital campus. In addition, consideration of the environmental footprint of batteries compared to off-site renewable energy is relevant. This is not a viable option.

Multifamily Residential & other Office Buildings:

For the same reasons outlined in the Hospital Campus section above, onsite electrical storage is not feasible.

Metrics/Phasing: Since this option is not feasible in the Landmark Neighborhood, metrics and phasing are not covered.

E.Off Site Renewable Energy

Concepts and Elements: Off-site renewable energy installations and purchases are a key element in a resilient and decarbonized future. These mechanisms allow renewable energy projects to be deployed and financed at scale, avoiding typical boundaries to on-site PV for urban-based projects. Off-site renewable energy falls into two categories – mandatory compliance typically directed at power producers as part of their service agreements and tariff structure agreements with individual government jurisdictions and purchasing agreements typically entered into by consumers of power. . Purchase agreements typically utilize . mechanisms like Renewable Energy Certificates (RECs), power purchase agreements (PPAs), and community choice aggregations (CCAs). Voluntary based purchasing is covered within this section.

Renewable Energy Certificates (RECs) represent one megawatt-hour (MWh) of electricity generated by a renewable energy source connected to the grid. A REC does not represent a direct purchase of renewable energy or the physical delivery of renewable energy to the building. It may also not represent a renewable energy source tied to the project's grid. Instead it is a market commodity and instrument to verify renewable electricity use claims and fuel renewable energy projects by tracking and assigning ownership to renewable energy generation. Green-e certified RECs are strongly encouraged since Green-e acts as a third-party that ensures the purchaser receives verified clean energy and gets what they paid for.

The price of a REC is based on supply and demand. From 2010-2020 the price for RECs fluctuated around $0.50 - $1.00/REC. This is based on a study by NREL and SBP's history purchasing RECs for LEED projects. Over the course of 2021, SBP's typical vendors have indicated that the REC market is highly volatile. We have seen prices increase and fluctuate between $5 - $10/REC making it challenging to reasonably project cost and associated impacts to future project budgets.

Power Purchase Agreements (PPAs) represent a contract with a renewable energy generator. In the case of Virginia, it sits in both the retail and PJM unregulated markets. Most buildings and projects would be required to purchase their electricity through the retail market, which is comprised of Dominion and Appalachian Power, but would have access to the unregulated market to contract off-site renewable energy sources. There are two types of PPAs:

- A Direct PPA is a direct purchase of renewable energy and the physical delivery of renewable energy to the project through the grid. Since the delivery is through the grid, the full electricity demand of the building may be met by both renewable and non-renewable energy sources.

- A Virtual PPA is a financial instrument whereby renewable energy output and RECs are purchased at a set price but then sold into the wholesale market. The buyer is subject to the fluctuations in wholesale price of electricity on a daily basis and therefore may earn or pay money, also known as a "contract for differences".

Virtual PPAs have gained significant traction in the industry due to the financial component of the contract structure. As a result, it has spurred significant growth of off-site renewable projects in the United States. Buyers benefit from economies of scale and therefore PPAs are more attractive to both the buyer and seller for large-scale projects, typically comprised of non-residential buildings and large corporations. The market is responding and a buyer aggregation contract structure is starting to develop, but the contract structure still typically includes one large commercial buyer coupled with smaller commercial buyers representing at least 10 MW of energy.

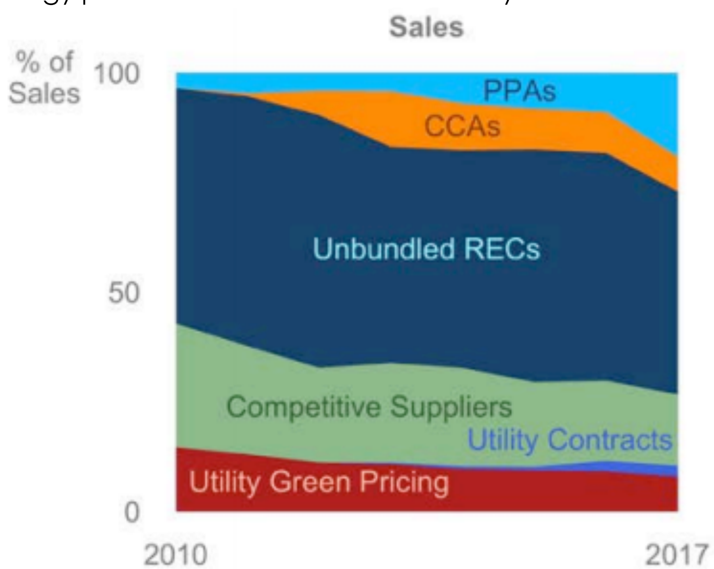
Electric Provider Programs include various options where the customer purchases or participates in a program through their utility including but not necessarily limited to:

- REC purchase
- Renewable attribute purchase
- Shared solar subscription

These programs are valuable options for small businesses, multifamily residential buildings, and single family homeowners who don't have the economies of scale to participate in a PPA. Of note, the Virginia Assembly enacted new sections under the Code that allows Dominion Energy Virginia customers to participate in shared solar projects by purchasing subscriptions to a shared solar facility. This option is very new and interested customers can only now start registering to participate (as of July 1, 2021).

Community Choice Aggregations (CCAs) allow communities to aggregate their loads collectively to procure green power as a single bulk purchase. This mechanism addresses the issues of PPAs for residential customers. However, it is limited to states with an investor-owned utility such as Illinois, California, Ohio, Massachusetts, and New York.

For reference, the image below shows the change and growth in off-site renewable energy purchase mechanisms in recent years.



Reference 3: from NREL: Status and Trends in the U.S. Voluntary Green Power market (2017 Data)

Carbon Offsets *are sometimes referenced in the same context as RECs and PPAs;* however, they are fundamentally different. REC and PPA purchases drive new renewable energy sources onto the market and can offset Scope 2 emissions and decarbonize purchased electricity whereas a carbon offset purchase secures a reduction of carbon emissions someplace to neutralize or offset carbon emissions on site.

Metrics: RECs and PPAs offset a percent of on-site energy use considering the purchase is based on a unit of energy (megawatt-hour, MWh). Relative to the LEED Rating System and the Green

Building Policy 2019, EA credit v4.1 Renewable Energy awards points for offsetting a percentage of the on-site annual energy use through off-site renewable purchases.

> LEED v4.1 EA credit Renewable Energy – Percent annual energy use offset with off-site renewables corresponding and points awarded are separate into Tier II and Tier III. The key distinction is that Tier II purchases are from renewable energy sources built within the past 5 years. The purchase must represent 10 years of operational energy use.
> 10% (1 pt), 20% (2 pts), 30% (3 pts), 40% (4 pts), 50% (5 pts) – Tier II
> 35% (1 pt), 70% (2 pts), 100% (3 pts) – Tier III

REC and PPA purchases indirectly reduce the total carbon emissions of a building or project by considering the carbon emissions associated with the electric grid and converting a unit of energy (megawatt-hour, MWh) to a unit of carbon (metric tons of CO2, mTCO2). RECs and PPAs can contribute significantly to the overall goals of the Energy Action Plan 2040 which calls for a 50% reduction in greenhouse gas emissions by 2030 and an 80-100% reduction by 2050. These mechanisms can overcome barriers to on-site renewables, technological limitations, and operational considerations which are detailed in the sections above.

Analysis: The development team has explored the potential cost associated with purchasing RECs or entering into a virtual PPA with the following requirements, goals, and policies in mind:

> 20% offset for 10 years (Green Building Policy 2019, 2 pts under EAc Renewable Energy)
> 100% offset by 2050 (Energy Action Plan 2040, for community greenhouse gas emissions)
> 100% offset by 2045 (Virginia Clean Economy Act, Dominion Power)

Hospital Campus:

Inova will purchase renewable off site power through Dominion's Renewable Power program to meet their commitment to a 50% reduction in emissions by 2030 and 80 to 100% reduction in emissions by 2050. Refer to the attached graph titled Inova Alexandria Hospital – Path to Reduce Carbon, and dated September 7, 2021.

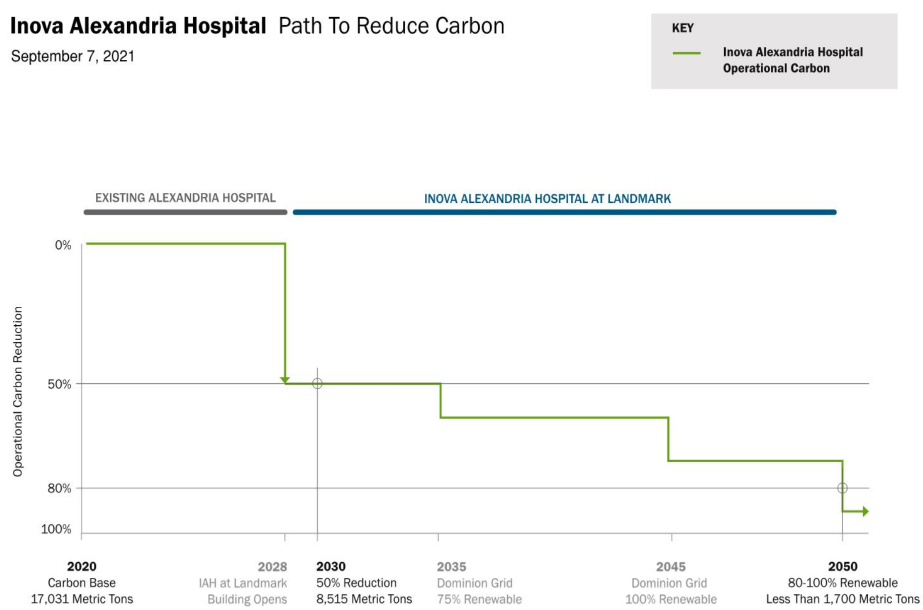


Figure 9: Inova Path to Reduce Carbon

Multifamily Residential & other Office Buildings:
An analysis for the Foulger Pratt development is summarized in Table 5 and represents offsets for 15 years' worth of estimated operational energy use based on an average site EUI calculated for the development, excluding the hospital campus. A fifteen year timeframe was used in anticipation that the development would be substantially built out by 2030 and the electric grid and Dominion Energy will be fully decarbonized by 2045 in alignment with the Virginia Clean Economy Act. The information shown in Table 5 is point in time and should not be considered fixed or viewed with a high level of confidence due to the recent volatility of REC prices and limited information on the contract structure and pricing of PPAs. As a result and for the purpose of this analysis, the price for RECs through a third party vendor or as part of the PPA is valued at $10/MWh.

Table 4: 15 Years' worth of RECs for Landmark Neighborhood, excluding the Hospital Campus

% Offset	Cost	MWh	mT CO2
20%	$1,442,000	144,000	49,000
50%	$3,605,000	366,000	122,000
100%	$7,209,000	721,000	243,000

The cost of off-site renewable energy purchases is significant to the overall development and operational costs. However, the development team recognizes the importance of a decarbonized future and continues to evaluate the feasibility and impact of REC purchases and PPA mechanisms. Of note, PPAs for multifamily buildings are more complex as RECs are typically owned by the building owner not the resident. The market is working to overcome these barriers which include co-ops and subscriptions, like Dominion Energy Virginia's new shared solar program, These techniques will be a considered option to meet the Renewable Energy Production requirements of the Green Building Policy.

Phasing: The off-site renewable energy market and mechanisms for participating and purchasing off-site renewables continues to evolve and grow rapidly. In tandem, the electric utilities continue to decarbonize their energy generation sources such that they are comprised of 100% renewable energy. The operational energy use and associated carbon emissions between Year 0 of building operations (assumed as 2030) and a decarbonized utility (assumed as 2045) can be met through off-site renewable energy purchases, contracts, and subscriptions. The pricing, contract structure, and availability of such mechanisms will need to be evaluated on an on-going basis and considered in combination with operational and maintenance expenses.

F.Building and Grid Integration

Concepts and Elements: This section focuses on the reliability and performance of the electric grid relative to overall energy, decarbonization, and resiliency goals of the Landmark Neighborhood development.

Reliability: The reliability of our energy sources and responsiveness of our providers is important to the overall success and security of developments. This is especially important as the built environment and industry works toward decarbonization of fuel sources via electrification of all on-site energy-using equipment and appliances, increasing the demands on our electric grid. The North American Electric Reliability Corporation (NERC) completes annual and seasonal risk assessments of the power systems reporting on performance trends, reliability risks, overall system health, and the success of migration activities. Key findings from NERC's most recent 2019 report indicate:

- Highly reliable power system (overall interruptions 0.005% of time)
- Advanced deployment of inverter-based resources (PV, wind, battery storage)
- Stable to increased performance and availability of energy resources, transmission systems, generation fleet, and disturbance protection measures
- Consistent decrease in misoperations rate (7.95%)

Electrification: Electrification of demand-side assets is a key component to the overall decarbonization of the built environment. This transfers consumption and emissions from the demand sectors to the power sectors. NREL's *Electrification Futures Study: Scenarios of Power System Evolution and Infrastructure Development for the United States* indicates that electrification will result in system-wide energy and carbon emission reductions in both sectors, with key contributors including the following:

- Sustained deployment of renewable energy sources to meet generation demand
- Reduced emissions within the power sector using low-emitting generation sources
- Increased energy storage at power generation site to meet peak demands
- Flexible load strategies to ensure electrification decarbonizes the power sector
- Increased demand-side flexibility technologies that avoid infrastructure needs
- Avoided fossil fuel consumption in demand sector via transfer of power generation
- Increase in equipment and appliance efficiencies reducing generation demand

The overall impact and contribution of electrification to decarbonization goals is highly dependent on market conditions, technology advancement, and policy implementation. A combined approach will yield the best results in a shorter timeline. Considerations relative to these three driving forces include:

Non-electric resistance solutions: The overall demand on the power sector will influence its ability to deploy power generating solutions that do not emit carbon. Specifically, equipment and appliances that use electric resistance to heat air and water is an extremely inefficient use of a unit of energy (kW), using three times more energy than it's natural gas counterpart. The overall impact on the utility is apparent and heightened if the industry relies on electric resistance technology to decarbonize the built environment. As such, technological advances and alternative solutions to electric resistance that can be implemented for both small and large-scale projects ensures the grid can react and scale to meet an increase in energy demands using non-carbon emitting power generating sources. In short, relying on electric resistance equipment and appliances to meet electrification goals is a very inefficient use of energy requiring more generating capacity at the utility which could impact its ability to deploy carbon free power generating sources.

Decarbonization through policy: Specific to Virginia, The Virginia Clean Economy Act (VCEA) was passed April 2020 which promotes and requires energy efficiency standards and clean energy solutions. Notably, the law requires Dominion Energy Virginia to be 100% carbon-free by 2045 by retiring facilities that emit carbon to produce electricity and constructing, acquiring, or entering into agreements to purchase generating facilities that use renewable energy. As such, the law implements a mandatory Renewable Portfolio Standard (RPS) program within the Commonwealth. Other notable requirements and provisions include:

- Construct or acquire 2,700 MW of energy storage capacity
- Achieve incremental annual energy efficiency savings at 1.25% starting 2022
- Develop offshore wind with rated capacity of 5,200 MW by Jan 2034
- Amended net metering energy program increasing max capacity of on-site renewable generation on nonresidential projects from 1 – 3 MW and increasing cap of generation capacity to 150%
- Increase cap on third party PPAs to 500 MW

Metrics: The power sector generates electricity using a combination of fuel sources, each with their own level of reliability and carbon emissions metric. Relative to this analysis, the reduction of carbon emissions (lb/MWh) over time is considered the key indicator of overall performance. This metric contributes to and recognizes the following goals and requirements:

- 50% carbon emissions reduction by 2030 (Energy Action Plan 2040)
- 80% to 100% carbon emissions reduction by 2050 (Energy Action Plan 2040)
- 100% renewable energy generation by utility by 2045 (Virginia Clean Economy Act)

Analysis: This section and analysis addresses reliability and electrification.

Hospital Campus:

The hospital is the primary building of concern relative to reliability. Inova is working with Dominion to address electrical demands and reliability on both the supplier and customer side as follows:

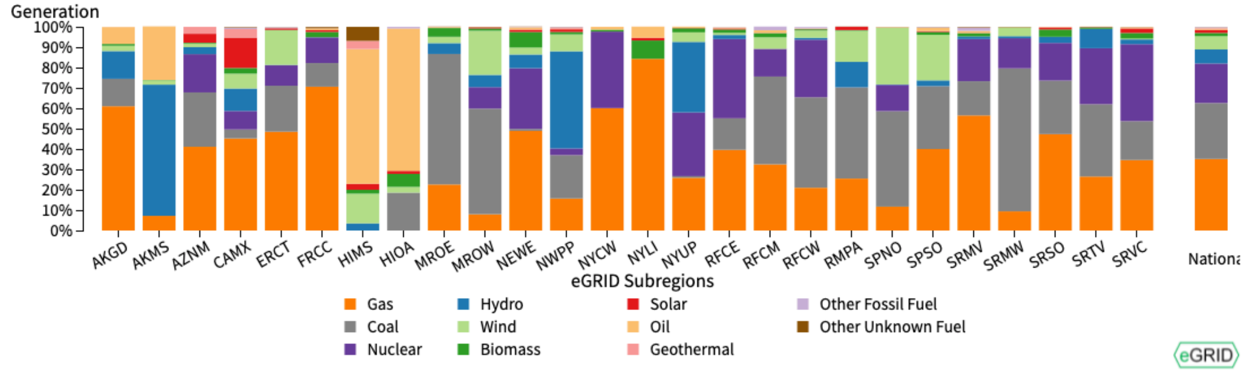
Electrical Source Circuiting – Inova has requested grid power be provided by Dominion to the hospital from two separate circuits to protect against a power outage due to a circuit failure.

Multifamily Residential & other Office Buildings:

Relative to electrification, the EPA quantifies and communicates the carbon emissions relative to grid electricity generation in the Emissions and Generation Resource Integrated Database (eGRID). eGRID breaks the United Stated into 26 subregions based on the unique make-up of fuel sources within the region, plant and parent company ownership and affiliations, and grid configurations in order to calculate emissions factors.

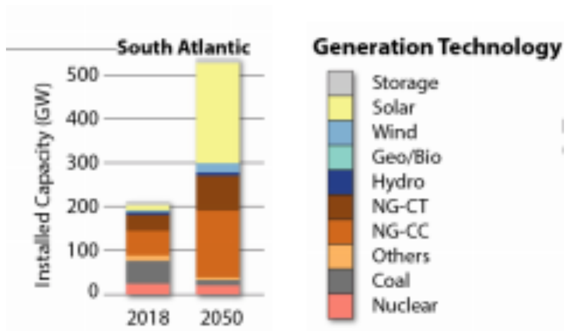
Virginia is located within the SRVC subregion. The predominant fuel types in 2018 within the SRVC subregion include gas, coal, and nuclear representing 91.5% of the total generation fuel sources.

In comparison, these fuel sources represent 82% of the total national generation types.



Reference 4: Fuel Source Breakdown by Subregion
(from https://www.epa.gov/egrid/power-profiler#/)

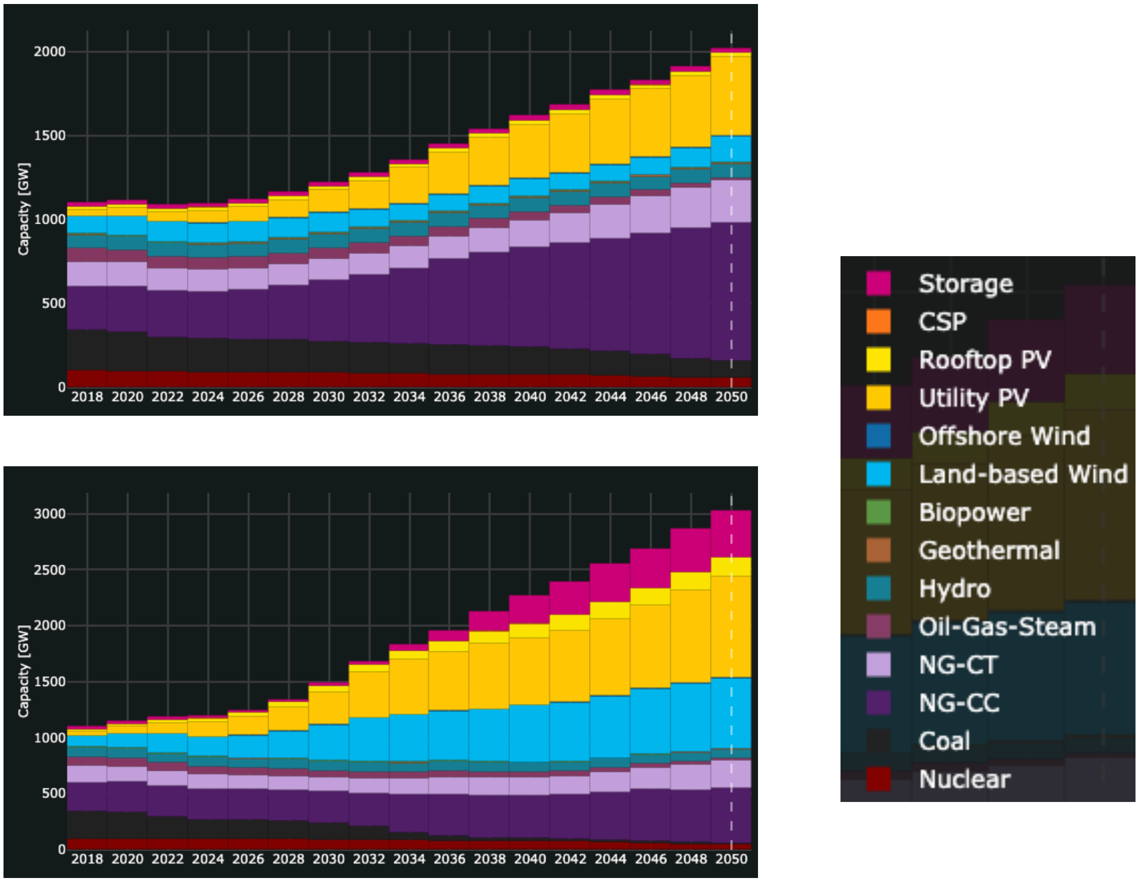
As part of NREL's Electrification Futures Studies, they anticipate generation capacity will double between 2018 and 2050 to meet anticipated demand. The studies also predict that electrification will further increase the deployment of renewable energy technologies, with solar representing the predominant energy source at almost half of the installed capacity for the South Atlantic region which includes Maryland, DC, Virginia, Delaware, West Virginia, North Carolina, South Carolina, Georgia, and Florida.



Reference 5: Predicted Generation Technology Breakdown by 2050
(from https://www.nrel.gov/docs/fy21osti/72330.pdf)

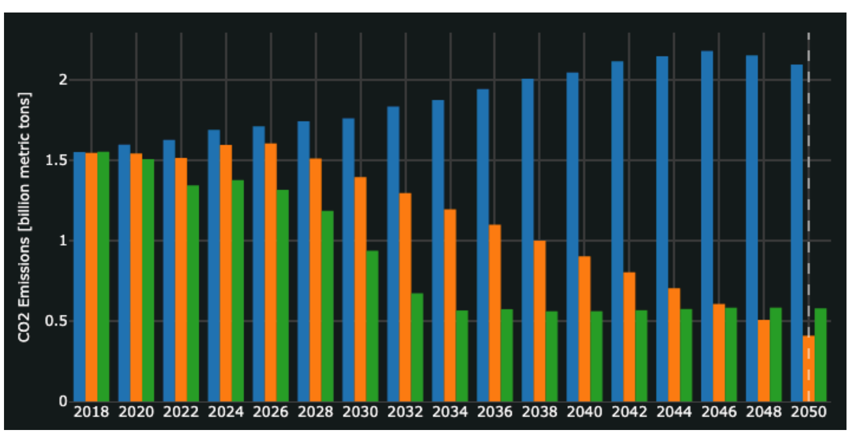
The positive impacts of electrification, including a reduction in total energy use and carbon emissions, and the timeline of realized positive impacts is influenced by the cost and efficiency of renewable energy technology as well as policy.

Reference 6 demonstrates the impact of renewable energy costs, often driven by technological advancement, on the overall generation breakdown of our national grid. This assumes transformational change and a high level of electrification in the United States based on technology, policy, and consumer demand. Constant renewable energy costs are shown on top and low renewable energy costs are shown on bottom.



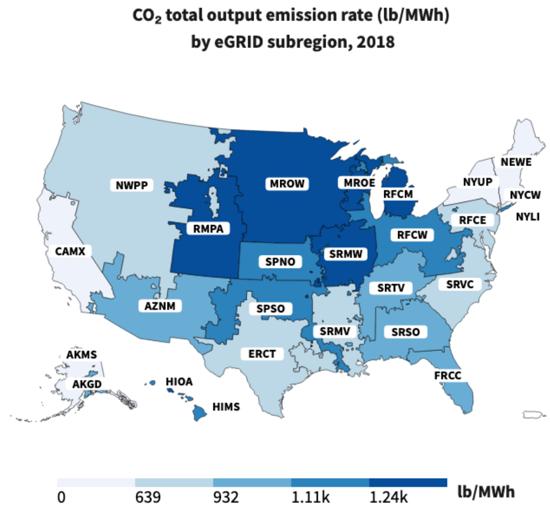
Reference 6: Impacts of Constant Renewable Energy Cost (top) vs Low Renewable Energy Cost (bottom) on Generation Technology Breakdown

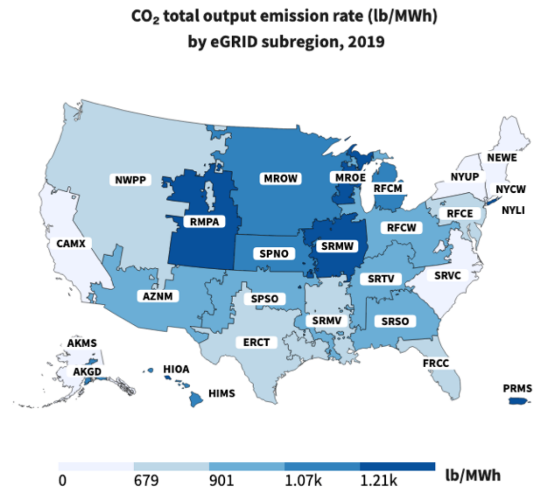
The generation technology profile shown above directly corresponds to anticipated carbon emissions from the grid, demonstrating the importance of <u>advancements in cost-effective technology, specifically renewables (green bars), and the impacts of policy on the decarbonization of the electric grid (orange bars) in reducing the total carbon emissions of the grid.</u>



Reference 7: Carbon Emissions of Constant Renewable Energy Costs (blue) vs Emissions Constraints (orange) vs Low Renewable Energy Costs (green) on the Generation Technology Portfolio

As a point of reference, the national and SRVC subregion have seen a decrease in total carbon emissions per MWh of energy produced from 2018 to 2019 based on eGRID data. Similar trends are occurring in the other subregions, visualized from a darker to lighter color in the Figure below.





2018 National Average: 947.18 lb/MWh
2018 SRVC: 743.33 lb/MWh

2019 National Average: 884.23 lb/MWh
2019 SRVC: 675.42 lb/Mwh

eGRID data exists for each subregion for previous years as well. For the SRVC subregion, the carbon emissions data for years reported between 2004 through 2019 have been trended by SBP to project future carbon emissions. The data points fit a linear regression model with a goodness-of-fit or R2 value of 0.9625, with 1 representing no variance from the regression model. This means the model and equation can be suitably used to predict future emissions of the SRVC grid.

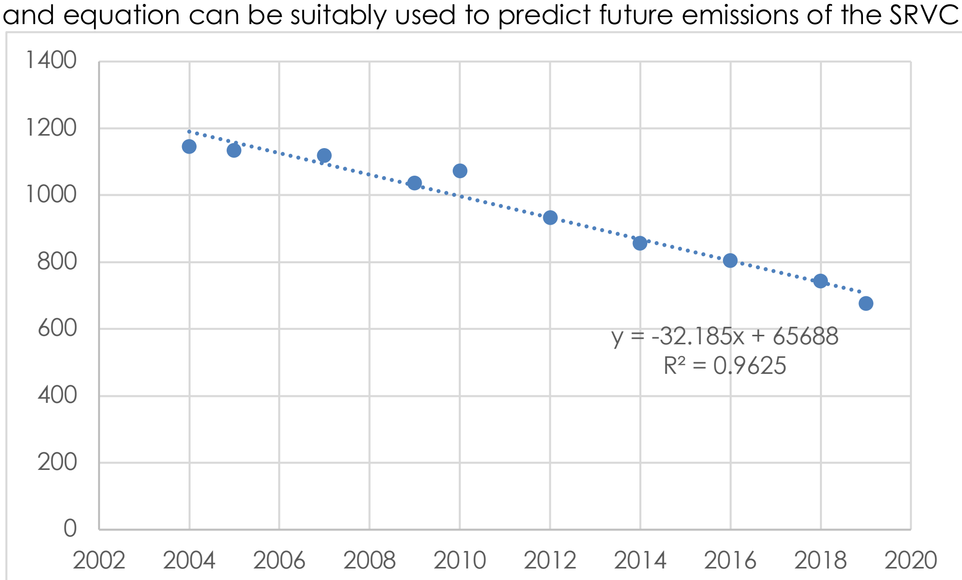


Figure 10: eGRID SRVC Subregion Carbon Emissions Data

Applying this equation in isolation, the SRVC grid is anticipated to generate zero carbon emissions by 2041. This aligns with the Virginia Clean Economy Act requirement for Dominion Energy Virginia to produce zero carbon emissions from electric generating technology by 2045.

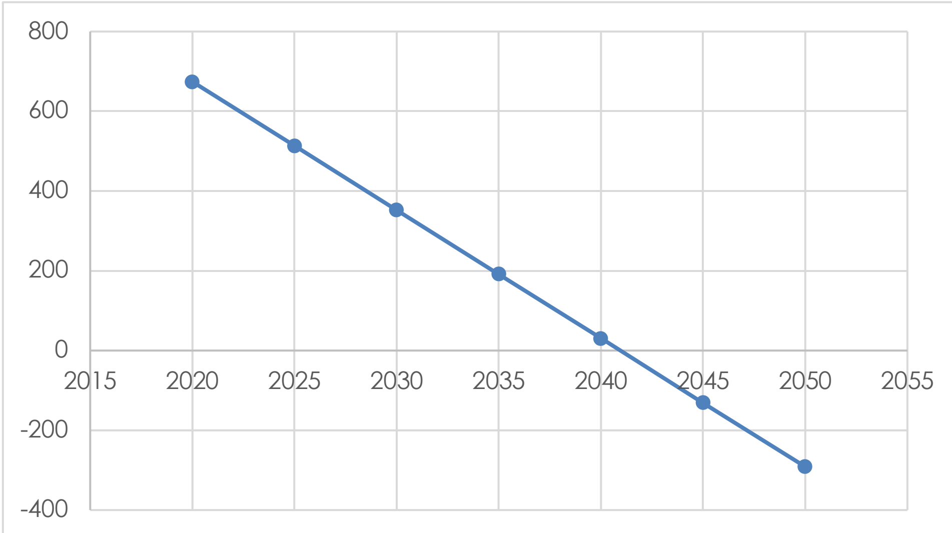
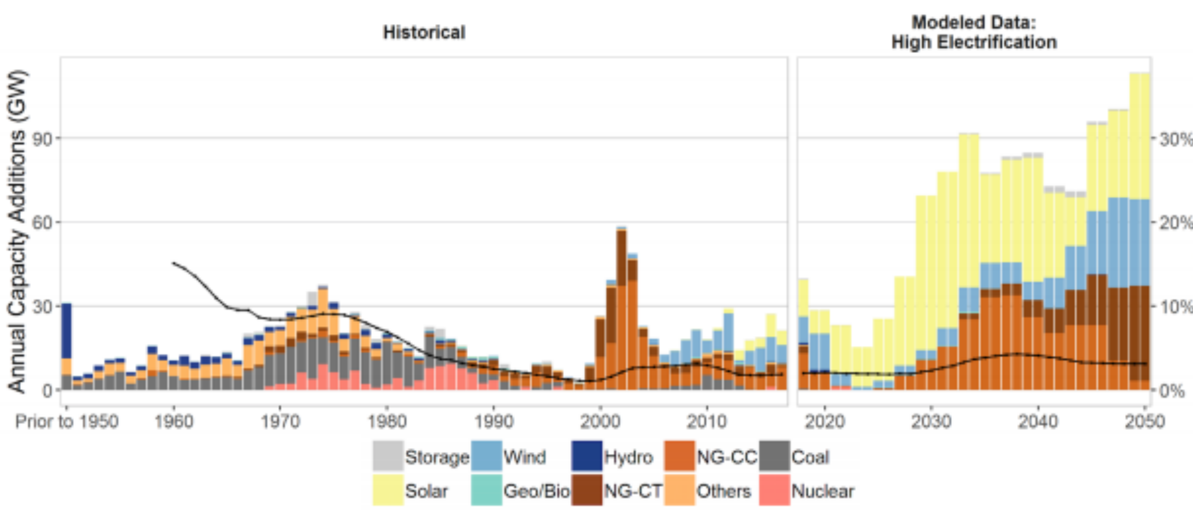


Figure 11: Projected Carbon Emissions of the SRVC Grid

The regression model shows favorable results for a zero carbon grid by 2045 based strictly on historical data such that it could be assumed that the current pace of renewable energy deployment, transitions to all-electric, and technology advancements would naturally decarbonize the grid. But, NREL's Electrification Futures Study reveal a significant increase in energy demands in the next 30 years, far exceeding the historical 5% capacity growth rate , placing pressure on utilities to meet these demands. Therefore, it is <u>anticipated that the rate of decarbonization will slow down over time</u> and the intersection will not occur at year 2043.



Reference 8: Capacity by Technology (from https://www.nrel.gov/docs/fy21osti/72330.pdf)

As such, our trajectory toward a zero carbon electric grid can be supported and advanced by technological advancements, policy, and demand-side electrification support. The Virginia Clean Economy Act coupled with project level electrification requirements will ensure the current trajectory of SRVC grid carbon emissions is maintained and zero carbon emissions from power generating sources on the electric grid are achieved by 2045.

The onsite components of the Dominion Power distribution system will be installed in underground conduit system with built in redundancy. It is anticipated that the development will be served by multiple Dominion circuits to enhance resiliency. Similarly, underground onsite conduit systems will be provided for telecommunications and high speed internet providers.

The Multifamily Residential & other Office Buildings will utilize the increasingly reliable Dominion Power grid, enhanced with Code required generator and/or battery backup to ensure continuity of operations of each of these buildings.

Phasing: The development team recognizes the importance of electrification in the decarbonization of the built environment. The development team also realizes the limitations of full electrification of buildings, which is captured in CDD Condition #106. CDD Condition #106 requires multifamily buildings to be limited to electric, except for limited accessory elements such as retail use, food and beverage uses, emergency generators, common areas system, and unit appliances. At this moment in time, these exceptions are necessary.

- Retail and food and beverage uses often include kitchens with gas cooking. The food and beverage industry and cooking equipment manufactures need to address this hurdle.
- Common area system, like central ventilation equipment and central domestic hot water heating, are currently gas-fired for projects of similar size and scope like those planned for Landmark Neighborhood. As mentioned in the Building Efficiency and Site Wide Energy Demand section, advancements in heat pump technology by the private sector are necessary before gas can reasonably be removed as a fuel source for common area systems on large commercial projects.

G.Resilience

Concepts and Elements: Environmental hazards can pose a severe risk to human life and create a devastating financial burden from property damage. Eleven risks are typically considered and analyzed including Sea Level Rise, Storm Surges, Flooding, High Winds from Hurricanes, Tornadoes, Earthquakes, Wildfires, Drought, Landslides, Extreme Heat, and Winter Storms.
Beyond environmental hazards, there is the occupant experience. A resilient neighborhood connects the community and creates a sense of place. This ensures a level of sustained vibrancy that stands the test of time.

Resilient buildings and developments respond to environmental hazards and risks as well as occupant and program needs. Predominant environmental hazards for this site include flooding, mostly from precipitating, as well as extreme heat and high winds. These events are predicted to be more frequent and more intense. Key resiliency strategies relative to these hazards which will be evaluated throughout design include:

- Foundation design and waterproofing
- Stormwater conveyance
- Generator capacity
- Vegetated roofs and roof materials
- Energy efficiency façade
- Solar ready design
- Regular audits
- Multi-purpose and flexible design

Metrics: Environmental hazards and associated risks are quantified differently. For the purpose of this section, an increase in frequency, quantity, or severity as compared to historical data coupled with a moderate to high level of vulnerability of the site is the key metric for which resiliency measures are evaluated.

Analysis: Information was collected from the local hazard mitigation plans and climate preparedness reports as well as from online government databases, such as FEMA, NOAA, and USGS. Based on analysis from the historical data and projected models, the major risks to the project site include:

Table 5: Hazard Assessment Summary

Hazard Category	Risk Summary	Vulnerability Summary
Sea Level Rise & Storm Surge	Moderate - Low	Moderate - Low
Flooding	High - Moderate	High - Moderate
Hurricane – High Winds	Moderate	Moderate
Tornado	Moderate - Low	Moderate - Low
Earthquake	Low	Low
Tsunami	None	None
Wild Fire	Low	Low
Drought	Low	Low
Landslide & Unstable Soils	Low	Low
Extreme Heat	Moderate	Moderate
Winter Storms	Moderate – Low	Moderate – Low

Three hazards were identified with moderate to high risks to the site including flooding, extreme heat, and high winds.

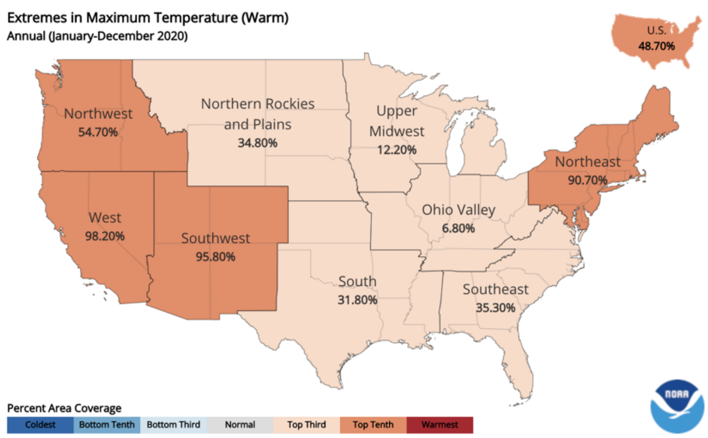
<u>Flooding</u> - As global temperatures rise, precipitation is projected to increase in the northern and eastern United States because a warmer atmosphere can hold greater quantities of moisture,

which will lead to higher-intensity rainfall events, like flash floods. While flooding related to sea level rise and storm surges is not a major risk to the project site, flooding from precipitation are.

Flooding in the City of Alexandria can occur at any time throughout the year but is more frequent during the fall and spring seasons. The most severe flooding events have been associated with intense rainfall from hurricanes and tropical storms. According to the Northern Virginia Hazard Mitigation Plan, there have been 36 flood events in the City of Alexandria from 1950 to 2015.[1] precipitation has been increasing in the northern and eastern United States and will continue to do so as the climate warms. Additionally, there is evidence of regional hurricane slowdowns in the North Atlantic by 6%.[2] This means that a hurricane will likely stay in an area for longer and release more precipitation to that area, which can result in more dangerous and destructive flash floods. Given the topography of the site and surrounding area, little flooding risk is anticipated even with an increase if the frequency of high precipitation events.

Extreme Heat - The number of days per year with a temperature greater than 95°F is expected to significantly increase. The Urban Heat Island effect can further intensify extreme heat events in areas of dense infrastructure. Heat emergencies will not only impact people by causing widespread health and food security consequences, but it will also place pressure on utility services to meet the demand of cooling that will be required.

The U.S. National Climate Assessment predicts increases in average temperature and extreme heat, as well as decreases in the frequency of extreme cold events. The U.S. Climate Extremes Index reported that on average 35.30% of days across the Southeastern region of the country in 2020 had higher than average temperatures.



Reference 9: NOAA U.S. Climate Extremes Index

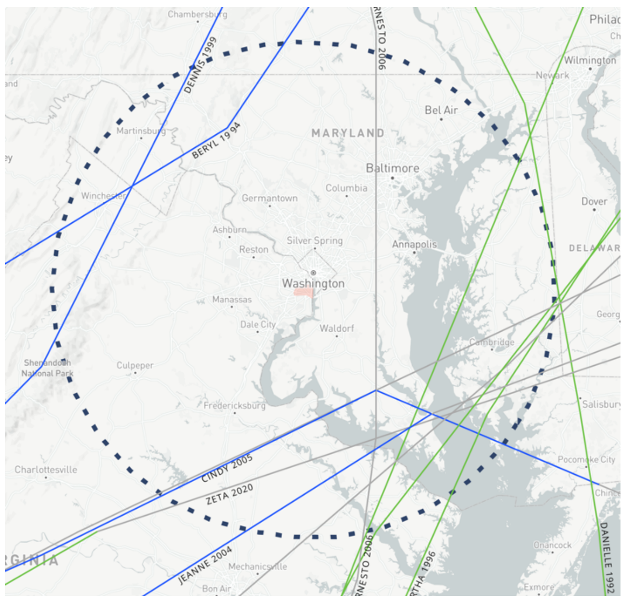
The DC Government of Homeland Security and Emergency Management Agency classifies any temperature 95°F or higher as a Heat Emergency. From 1990 to 2020, there has been an 81% increase in extreme heat events in Northern Virginia compared to the previous 30 years (1960 to 1990). Future projections expect significant increases in the number of days per year with extreme heat.

The impacts of extreme heat will be mitigated by focusing on the building's enclosure and building airtight construction, high insulation, low SGHC glass, and reflective roofing materials.

[1] Northern Virginia Hazard Mitigation Plan (2017)
[2] NOAA Tropical Cyclone Slowdown

High Winds - Hurricane season in the North Atlantic runs from June to November, with the peak season between August and October. The Atlantic basin produces an average of 6.2 hurricanes per year, with more than a third typically measuring Category 3 or above. While the region is somewhat protected from the full strength of a hurricane, a hurricanes expansive nature makes the region vulnerable to high winds, flooding, and tornadoes that often accompany these extreme weather events.

In Alexandria, the likelihood of a hurricane making direct contact with the area is rare, but other effects of hurricanes, such as high winds, can be felt from hundreds of miles away. The City of Alexandria has experienced ten hurricanes and two tropical storms to come within 70 miles of the region from 1991 to 2020 (Figure 6). While there is no evidence that hurricane intensity has changed in recent history, studies show that North Atlantic hurricanes have been increasing in frequency, making hurricanes and high winds a potentialhazard for this location. Compared to the previous 30-year period (1961-1990), only one hurricane and four tropical storms tracked within 70 miles of the Northern Virginia region, indicating that the frequency of high wind storms is increasing in the project site’s location.



Reference 10: Northern Virginia Historical Hurricane Tracks

High winds from hurricanes or other extreme weather events can cause utility interruptions. Current building codes require that exterior elements of the buildings withstand wind speeds of 111 mph in order to protect the building against the damage from high winds. Power outages are possible during one of these extreme events and can greatly impact the typical functioning of a building.

Hospital Campus:
The Inova campus is the most sensitive building and requires continuous, uninterrupted, safe patient care. The following outlines the aspects of the design that provide resiliency for the hospital campus buildings to mitigate the potential impacts of these three hazards:

Resilient Design – All mission critical building systems are raised up and protected from potential harm including water and waste accumulation due to flooding, an undetected leak, or an infrastructure failure. This applies to numerous support systems including electrical switchgear, IT closets, boilers, chillers, pumps, and emergency generators.

Redundancy – The building systems providing heating, cooling, and power all incorporate redundancy in their design so that an equipment failure or repair does not compromise services to the hospital.

Emergency Power – Emergency generators are provided with redundancy to run continuously for a minimum of 96 hours.

Water Supply Plan – Should the water service to the site become compromised the hospital must have on-site storage tanks or a contract with a local water supplier to provide tanker trucks of water or equivalent support.

Multifamily Residential & other Office Buildings:
The other buildings within the development will be designed considered the three key risks. Resiliency strategies relative to the following building elements will be reviewed during design:

- foundation waterproofing
- stormwater conveyance
- generator capacity to support additional load
- vegetated roof
- roof top materials
- energy efficient façade materials

Beyond building design and constructability strategies, the Parks currently planned address occupant experience. Studies show that people's ability to connect with nature increase the health and wellness of the individual which would translate to the overall neighborhood.

Phasing: The long-term resiliency of the neighborhood can be established by implementing key design elements that allow the building and operators to respond to environmental hazards, climate change, and program and occupancy needs. Key considerations for long term resiliency include the following items. These strategies will be evaluated on a building-by-building basis.

- solar ready design with consideration to the following design elements
    - location and aggregation of mechanical equipment/vents
    - davit placement and anchoring
    - location of roof sleeves for electrical conduit
    - roof, electrical room, and switchgear space for PV equipment
    - data placement
- electric panel design and generator capacity for additional select loads
- building audits to ensure materials, systems, and equipment are performing as intended
- multi-purpose and flexible space design