# The Case for Net-Zero Energy in the GSA's Owned Building Portfolio

**Presented by: Rocky Mountain Institute**
**Contacts: Matt Jungclaus (mjungclaus@rmi.org)**
**Victor Olgyay (volgyay@rmi.org)**
**Attention: GSA Public Buildings Service**
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## EXECUTIVE SUMMARY

This paper examines the case for the United States General Services Administration (GSA) to pursue net-zero energy (NZE) buildings and suggests several strategies that support the GSA's adoption of the Green Building Advisory Committee (GBAC)'s NZE policy recommendation.

- In September 2014, the GBAC recommended that the **GSA and the entire federal government achieve NZE in 50% of its building square footage by 2030**.
- Several federal directives are calling for **higher levels of energy efficiency, greater renewable energy penetration, and net-zero energy**.
- The GSA, through its current NZE leadership, its **commitment to "making a more sustainable government,"** and its **devotion to "delivering better value and savings" for the federal government**,[1] is well positioned to accept and **lead the government** in achieving the GBAC NZE recommendation.

**There is not a simple cost premium for a NZE-ready building when compared with market rate buildings,** and net-zero-energy-ready buildings can be developed at cost or at a low cost premium if the following strategies are employed:

- Develop a prioritized portfolio strategy and consider deep savings over time
- Construct all new buildings as NZE ready
- Use ESPCs and other alternative financing
- Employ the government's "Reduce the Footprint" initiative
- Utilize integrated project delivery (IPD)
- Participate in eco-districts and leverage state and local NZE laws

**Time is critical.** Waiting 10 years to implement the GBAC's NZE recommendation **could cost the government over $2 billion** in potential energy cost savings by 2050. The GSA could meet the GBAC NZE goals **at cost and/or without appropriated funding** (through financing), supporting the GSA's mission and solidifying the GSA as a leader in the high-performance buildings space.

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# INTRODUCTION

Net-zero energy (NZE) is an emerging trend for high-performance buildings across the world. Generally speaking, a net-zero energy building is a building that produces as much energy through renewable resources as it consumes on an annual basis. [i] [ii] This concept can also apply to net-zero energy campuses, portfolios, communities, or districts. Net-zero energy has been a growing market for high-performance buildings for years. According to the New Buildings Institute, net-zero energy "has transitioned from an impossible concept to a quite probable future" through increased adoption and more widespread notoriety.[2]

The growing presence of net-zero energy in the commercial building market can be compared to LEED during its early stages. While initially, LEED certification uptake was slow, the federal government and many of the largest corporate real estate companies in the world now demand it. One of the most significant drivers of widespread LEED adoption was early adoption of LEED goals by the GSA, the Navy, the Army, and other federal agencies.[3] With the support of the GSA and other agencies, LEED gained more legitimacy in the commercial building market, more organizations adopted LEED into their building standards, and building to LEED standards became cost-competitive with conventional building practices.

The GSA is in a similar position with NZE buildings and has an opportunity to lead by example. The GSA could adopt an NZE requirement for its building portfolio, draw attention to NZE, and create demand for NZE buildings. Federal, state, and local policies are trending toward NZE, and the GSA has received an explicit NZE recommendation from its Green Building Advisory Committee (GBAC). The GSA has an opportunity to preempt the growing body of NZE requirements, build the largest NZE portfolio in the world, and pave the way for government agencies and corporate real estate portfolios that seek examples and external leadership to move toward NZE.

# THE CALL TO ADDRESS NZE

A number of federal policies are currently steering the GSA and the entire federal government toward net-zero energy. The GSA has positioned itself as a leader in high-performance buildings, so many agencies will be looking to the GSA for guidance as policy deadlines approach and NZE becomes a requirement. The mission of GSA's Office of Federal High Performance Green Buildings aligns well with this sentiment:

"To catalyze and facilitate the Federal government to operate more efficiently and effectively, and lead the marketplace to sustainability, by minimizing the Federal footprint through efficient use of energy, water, and resources, and by creating healthy productive workspaces."[4]

**Now is the time for the GSA to embrace existing and forthcoming NZE requirements and further demonstrate its leadership by serving as a role model to the rest of the federal government.**

**Policies supporting GSA's pursuit of net-zero energy include:**

[i] The term "net-zero energy (NZE)" is interchangeable with the common term "zero net energy (ZNE)." The Department of Energy (DOE) formally uses the term "zero energy building" to indicate what this paper will refer to as a "net-zero energy building."

[ii] The definition of net-zero energy can vary. This paper aligns with the DOE definition, which is similar to the GBAC NZE policy recommendation definition and more specific than the definition in Executive Order 13693. The DOE definition states that a zero energy building is "An energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy."

## THE GBAC NZE POLICY RECOMMENDATION

- The GSA and the entire federal government should verify 50% of their building square footage to achieve net-zero energy by 2030.
    - Interim targets include 1% verified NZE by 2020 and 10% verified NZE by 2025.

## "PLANNING FOR FEDERAL SUSTAINABILITY IN THE NEXT DECADE" - EXECUTIVE ORDER 13693

This executive order calls for expanded and updated federal environmental performance goals.

- NZE will be required for all new federal buildings that enter the planning process after 2020.
- Federal agencies are required to reduce energy consumption 2.5% per square foot per year through fiscal year 2025.
    - The GSA could attain this goal with fewer projects that deliver higher impact if it is met with NZE buildings.
- 30% of an agency's total building energy consumption should be supplied by renewable energy sources by 2025.
    - Renewable resources used to achieve NZE would likely count toward this target.

## THE ENERGY EFFICIENCY IMPROVEMENT ACT OF 2015

Within 180 days of enactment, the GSA must develop model commercial leasing provisions that "align the interests of building owners and tenants with regards to investments in cost-effective energy efficiency measures and cost-effective water efficiency measures."

- While this paper does not directly make recommendations for the GSA's leased buildings, incentivizing net-zero energy and other high-performance leased buildings would support this policy.

## THE CLEAN POWER PLAN AND SIMILAR

The Clean Power Plan and other similar policies call for increased levels of renewable energy and energy efficiency to cut carbon emissions. A shift toward net-zero energy also indicates a shift toward greater energy efficiency and renewable energy penetration.

## GROWING POLICIES OUTSIDE OF THE FEDERAL GOVERNMENT

- States like California, Massachusetts, New York, and Hawaii have shown immense support for NZE projects, studies, and policies.
- California's Energy Efficiency Strategic Plan states that 50 percent of all existing commercial buildings in in the state will need to reach NZE by 2030.[5]
- Municipalities like Fort Collins, Colorado have sought aggressive carbon neutrality plans that will result in a number of NZE buildings and communities.
- Campuses like Arizona State University have unveiled a full carbon neutrality plan, which goes beyond buildings and renewables to incorporate transportation and waste among other operational concerns.[6]
- States, municipalities, and districts that support NZE would serve as great testing grounds for GSA NZE buildings, even if local NZE policies do not apply to GSA buildings
    - Building or renovating to NZE in these locations would likely draw support from local governments, result in better economics, and further exemplify the GSA as a transformational leader in this space.

## BENEFITS BEYOND ENERGY AND COST

Beyond energy and energy cost savings, net-zero energy buildings provide a number of other benefits, including resilience to natural disasters, value as a grid asset, improved property values, higher rent costs, improved comfort, occupant happiness and productivity benefits, and a number of other common values

shared by high-performance green buildings. For a list of more benefits, please refer to RMI's report, "*How to Calculate and Present Deep Retrofit Value: A Guide for Owner-Occupants*."[7]

## SUPPORTING THE GSA'S MISSION

Support of net-zero energy can help support the GSA's mission in a number of ways.[8] As the GSA already knows, "to deliver the best value in real estate" incorporates much more than the first cost of real estate, acquired goods, or services. Rather, something that is delivered with the "best value" would provide the GSA with the greatest value and financial return over the life of a given building (or service provided by the GSA). The operating budget reductions, potential capital cost reductions, values beyond energy cost savings, and other values outlined below illustrate that net-zero energy will deliver the best value in the long term.

A move to net-zero energy also stands to benefit the GSA's stated priorities:

- Delivering better value and savings
- Making a more sustainable government
- Leading with innovation.

## THE GSA IS WELL POSITIONED AND EXPERIENCED WITH NZE

The GSA is a federal leader in delivering net-zero energy buildings, and has the power to expand this NZE leadership. To date, the GSA has:

- Retrofit the historic Wayne N. Aspinall Federal Building and U.S. Courthouse to achieve NZE and become one of the most energy efficient historic buildings in the country.
- Developed an energy savings performance contract (ESPC) program that is focused on delivering deeper energy savings.
    - This program will achieve the first NZE building through an ESPC (pending year 1 verification) with the Almeric L. Christian Federal Building.
    - The GSA's ESPC projects have achieved approximately double the percent energy savings of typical federal projects during the same time period.[9]
- Achieved several AIA Top Ten Green Buildings, an AIA Top Ten+ building, and garnered significant attention at conferences like GreenBuild, the GreenGov Symposium, and the Energy Exchange.

Several building projects, including the Almeric L. Christian Federal Building, the Wayne N. Aspinall Federal Building and U.S. Courthouse, and the 435 Indio Way project make compelling cases for NZE economics (see Appendix A).

The GSA could lead the federal government in establishing aggressive net-zero energy goals, exceeding federal energy goals, and disseminating lessons learned to accelerate its progress and prepare other agencies. Many agencies already look to the GSA for green building guidance, and they could be influenced to act sooner and approach net-zero energy from a practical long-term perspective now rather than a rushed, short-term perspective as NZE mandates rapidly approach. The GSA is in a unique position and should leverage its status as a leader in the federal building world to drive NZE forward.

# THE COST OF NET-ZERO-ENERGY-READY BUILDINGS FOR THE GSA

This section focuses on the core question that this white paper seeks to answer: What is the cost premium associated with building or renovating to net-zero energy ready for the GSA's owned building portfolio?[iii]

## WHAT IS NET-ZERO ENERGY READY?

This paper suggests strategies and analyzes the GSA's portfolio to achieve net-zero energy ready. A net-zero-energy-ready building is an ultra-high-performance building that achieves high levels of efficiency and could be readily converted to net-zero energy with the addition of renewable energy resources (like rooftop solar PV). The cost of rooftop solar PV was not examined in depth in this paper, as the cost of renewable energy systems has been steadily declining and can be highly variable based on financing structure, geographic location, state and local incentives, and other factors. The impact of solar PV pricing should impact general portfolio prioritization (as addressed below), but we have decided not to analyze the economics of solar PV installations for net-zero energy GSA sites.

Generally, we do recommend that solar PV or other renewable energy systems be procured as financed on-site or community/campus-wide systems. This will limit upfront capital costs and avoid the use of appropriated funding. Aside from this general advice, we recommend that solar PV installations be analyzed on a case-by-case basis to adequately incorporate all incentives and other location-specific characteristics (see Appendix C for more information about RMI's Solar PV recommendations).

## THE COST OF NET-ZERO ENERGY READY

After reading numerous reports and contacting several industry experts, RMI concludes that **there is not a simple cost premium for an NZE-ready building when compared with market rate buildings**, and net-zero-energy-ready buildings can be developed at cost or at a low cost premium. While many studies and reports point to different cost premiums, there is a lack of consistency, and a clear message that while NZE-ready buildings can cost more than traditional buildings, in some circumstances they may cost the same, or even less than a standard construction building of similar qualities.
Even where a cost premium is unavoidable for a net-zero energy project that has employed adequate cost-control strategies, that project is typically lifecycle cost-effective, meaning that the long-term cost savings associated with lower operating costs and O&M expenses should pay for any additional up-front capital cost.
Sources that discuss the cost-premium of net-zero energy can be summarized as follows: [iv]

- "Green, LEED, and/or zero net energy buildings can be achieved within the range of other like-type buildings. When total construction costs for these buildings are analyzed against control groups they are comparable to conventional building costs."
- The cost-premium for a net-zero-energy-ready building is generally between 0–15% over market rates for new construction and major renovation projects (as evidenced by the studies referenced in Appendix D).
- Many projects that include significant elements of integrative design, are properly planned, or employ advanced contracting structures have industry-competitive payback periods and a lower cost premium (0–5%).
- Project budgets are very specific, and can vary widely based on many factors, including: location, building condition, building type and use, project timing, use of integrative design principles, and availability of financing and incentives.
- Net-zero energy is becoming a cheaper achievement over time (from a project budget standpoint), as the cost of high-performance building technologies and solar PV are declining over time AND high-performance building design techniques are becoming more widely adopted.

[iii] This paper does not consider the costs associated with renovating GSA's leased buildings to NZE. GSA's leased buildings offer more complicated ownership structures, so this subject should be examined in more detail. RMI does recommend prioritizing NZE and high-performance buildings in the GSA leasing provision revision required under the Energy Efficiency Improvement Act of 2015.
[iv] Based on sources listed in Appendix D, conversations with NREL, and conversations with Integral Group

- Construction project budgets typically fluctuate by 0–5%.
- A table in Appendix D summarizes the discrete cost premiums stated by various sources.

Thus, the actual cost premium of net-zero energy can be within the margin of budget uncertainty for construction projects, and using cost-control tools is key to delivering a high-performance building at a low cost premium.

- Proper portfolio planning and prioritization can make a net-zero energy project possible within a standard project budget—that is, with a low or negative cost premium.
- A net-zero energy project CAN have a very large cost premium if portfolio-planning strategies are not implemented to control costs and incorporate integrative design strategies.

Even if net-zero energy projects are pursued at a cost premium, they can still be designed to be lifecycle cost-effective, and to provide a high return on investment (and hedge against high future utility rates).

- For example, the Integral Group's 435 Indio Way project, a 30,000 $ft^2$ office building in Sunnyvale, CA, was retrofitted to net-zero energy with a $1.6 million cost premium (including a $345,000 solar PV system) that was paid back in under 6 years. This resulted in a $240,000 increase in net operating income, representing $3.2 million in net present value.

# STRATEGIES TO LEVERAGE RIPE NZE OPPORTUNITIES AND CONTROL COSTS

A thoughtful portfolio plan can allow the GSA to effectively upgrade its entire portfolio of buildings to net-zero energy over time, with minimal or no cost premium. Portfolio planning strategies are key to efficiently and cost-effectively "ramping up" net-zero energy within the GSA's building portfolio. Over time, the GSA will tailor its portfolio planning to more seamlessly, efficiently, and cost-effectively deliver NZE projects.

The GSA can learn from current best practices and develop new practices to make NZE more cost-effective and accessible. Best practices and ongoing projects from the GSA will help to educate other agencies, contractors, and external parties and to prepare them for NZE requirements down the road. If the GSA demonstrates demand for NZE buildings, the private sector will provide more buildings and services to help achieve this. While select best practices from individual projects exist, the GSA will become a thought leader in large-scale NZE. This will allow the GSA to fulfill the Office of Federal High Performance Green Buildings' mission: "*To catalyze and facilitate the Federal government to operate more efficiently and effectively, and lead the marketplace to sustainability.*"

The following six strategies should be employed to achieve the GSA's NZE goals:

## 1. DEVELOP A PRIORITIZED PORTFOLIO STRATEGY AND CONSIDER DEEP SAVINGS OVER TIME FOR EXISTING BUILDINGS

This strategy prioritizes the best opportunities for cost-effective energy upgrades across a portfolio as they become most cost-effective. It considers the age of buildings, maintenance schedules, building upgrade schedules to align planned renovations (key intervention points) with new NZE projects, local utility costs, available incentives, and other cost considerations.

Given the large number of buildings in the GSA's portfolio, many buildings would be eligible for energy upgrades under a "deep savings over time" portfolio plan each year. The first NZE renovation projects would be:

- Buildings planned for renovation within the next 5 years
- Buildings in locations with expensive utility rates, good rebates, and good renewable resources
- Buildings with immediate resilience or renewable energy goals

The favorable economics of such a project would allow for more flexibility and creativity as the GSA and its contractor teams build proficiency in this space. The GSA can also apply technical and cost-control lessons from the initial projects to future projects with less ideal economics. And other buildings could be receiving short-payback energy conservation measures to begin saving energy immediately while waiting for a key intervention.

Key intervention points will be prime opportunities to employ integrative design principles:

- New equipment can be properly sized to meet building loads.
- Energy upgrades can be designed to leverage positive interactive effects (synergies) between building systems.

Misalignment of NZE projects and key intervention points can increase project cost and complexity significantly, while potentially compromising energy goals.

Energy upgrade budgets can also be combined with other renovation budgets under performance contracts or other mechanisms to employ larger, more synchronized, and more effective upgrade projects. Developing a portfolio prioritization plan affords the GSA an opportunity to perform benchmarking or other portfolio analysis tasks simultaneously.

## 2. CONSTRUCT ALL NEW BUILDINGS AS NZE READY

Any new buildings will be constructed to an ultra-efficient standard to be NZE ready. Where beneficial, projects will use financing, design, and construction tools that can reduce costs or avoid budgetary constraints. Renewable resources will be added immediately in locations that allow renewable energy to be financed at or below grid parity. Renewable resources will be directly purchased where economically feasible. Over time, all buildings will transition from NZE ready to NZE.

### 3. USE ESPCS AND OTHER ALTERNATIVE FINANCING

ESPCs are a useful vehicle for performing energy upgrade projects without appropriated funding. ESPCs can be combined with several of these strategies, especially a "deep savings over time" portfolio plan, to accomplish energy upgrades without the use of appropriated funding. Appropriated project funding can be incorporated with ESPCs to help them drive deeper savings or provide non-energy benefits. Power purchase agreements (PPAs) are also powerful tools for procuring renewable energy without incurring the up-front capital costs (see Appendix C for more information about PPAs).

Examples:

- The GSA has used ESPCs to drive 38% energy savings per project on average (double the federal average for a similar time period).[10]
- The Almeric Christian Federal Building, a GSA building in St. Croix, is expected to be the first federal building to achieve NZE under an ESPC.[v]

### 4. EMPLOY THE "REDUCE THE FOOTPRINT" INITIATIVE

The government's "Reduce the Footprint" initiative calls for building consolidation where there are large, underutilized sites that are consuming energy but not serving agency needs efficiently. By employing "Reduce the Footprint," the GSA can save money on unneeded leases and apply that saved funding to ESPC projects in the buildings that are being properly utilized.

### 5. UTILIZE INTEGRATED PROJECT DELIVERY (IPD)

IPD is a contracting mechanism that aligns the incentives of the client and the design/construction team. Contractors are financially incentivized to meet several energy and cost goals set out from the start of the project. The strategy is particularly effective for new construction projects or renovation projects that are not financed as performance contracts. It is critical that the contractors and owners agree upon the performance targets before the project begins.

Examples:

- NREL used IPD to deliver their NZE Research Support Facility at no cost premium over market rates.
- RMI is using IPD to deliver a cost-competitive net-zero energy office as its new headquarters in Basalt, CO.

### 6. PARTICIPATE IN ECO-DISTRICTS AND LEVERAGE STATE AND LOCAL NZE LAWS

GSA should further demonstrate its leadership by participating in NZE, carbon-neutrality, or other high-performance building initiatives that align with state and local policies. If GSA has buildings located in a city or region with a prominent eco-district, it may consider converting nearby buildings to NZE to make a public statement of leadership, show their commitment to local interests, and drive closer to their NZE goals.

Other key solutions are highlighted in the official GBAC net-zero energy recommendation.[vi]

## PROJECTED SAVINGS FOR ATTAINING NZE GOALS

[v] Detailed in Appendix A

[vi] The office GBAC net-zero energy recommendation can be found at http://www.gsa.gov/portal/getMediaData?mediaId=196947

This section provides a high-level summary of the energy and cost savings that the GSA would gain if it complied with the GBAC NZE recommendations outlined above. More importantly, this section quantifies the **substantial energy and energy cost penalty** that the GSA (and taxpayers) would incur by waiting 10 years to implement this policy (all assumptions for this section are documented in Appendix B).

Table 1 highlights the estimated energy and energy cost savings associated with attaining NZE-ready buildings for 1%, 10%, 50%, and 100% of the GSA's building portfolio. Ultimately, this assumes that buildings are converted to become ultra-high-performance buildings, but do not include renewable resources to attain NZE. For the purposes of our calculations, we assume a building energy use intensity reduction of 60%, to reach approximately 34 kBtu/sqft/yr.

Table 1: Estimated annual energy and energy cost savings for the GSA to attain NZE-ready buildings

| | Annual Energy Savings (Billion BTU) | Annual Energy Cost Savings |
|---|---|---|
| **NZE-ready 1%** | 64 | $1,000,000 |
| **NZE-ready 10%** | 636 | $13,000,000 |
| **NZE-ready 50%** | 3,180 | $67,000,000 |
| **NZE-ready 100%** | 6,360 | $134,000,000 |

Table 2 shows the estimated energy and energy cost savings associated with achieving the GBAC NZE recommendations, with the addition of 100% NZE (which is not part of the GBAC NZE recommendations, but is an assumed ultimate trajectory). The difference between this table and the table above is that this table includes the additional energy savings associated with employing renewable energy to achieve net-zero energy (while the previous table highlights a net-zero-energy-ready approach).

Table 2: Estimated annual energy and energy cost savings for the GSA to comply with the GBAC NZE recommendations

| | Annual Energy Savings (Billion BTU) | Annual Energy Cost Savings |
|---|---|---|
| **1% NZE (2020)** | 106 | $2,000,000 |
| **10% NZE (2025)** | 1,060 | $22,000,000 |
| **50% NZE (2030)** | 5,300 | $111,000,000 |
| **100% NZE (est. 2045)** | 10,600 | $223,000,000 |

As the title indicates, Table 3 represents the energy and energy cost savings that would be "lost" if the GSA were to delay the GBAC NZE recommendation by 10 years. We consider this loss as a cost to the GSA and the taxpayer that could be avoided. With NZE buildings that could be built with little to no cost premium, renewable energy resources that could be financed, and substantial operational cost savings on the table, waiting to employ NZE could cost the government over $2 billion by 2050.

Table 3: Estimated energy and energy cost "loss" for delaying the GBAC NZE recommendation by 10 years[vii]

| | Energy savings "lost" as a result of goal delay (Billion Btu) | Energy cost savings "lost" as a result of goal delay |
|---|---|---|
| **Cumulative Cost (2030)** | 19,291 | $405,000,000 |
| **Cumulative Cost (2050)** | 105,360 | $2,212,000,000 |

[vii] Table 3 represents cumulative energy and cost figures, while Tables 1 and 2 represent annual figures.

## CONCLUSION

The GSA is in an unprecedented position to lead the movement toward high-performance, net-zero energy buildings in the United States. The GSA has already demonstrated that it is ready, willing, and capable to deliver NZE buildings, and it has the expertise, scale, and motivation to be the biggest player in this space. Catalyzing a new generation of NZE buildings aligns well with the mission of the GSA. With a detailed portfolio prioritization plan and the use of several other tools, the GSA could readily begin meeting the GBAC NZE goals at no cost premium in the coming years.

Moving forward with the GBAC's recommended net-zero energy policy will position the GSA to lead the federal government in net-zero energy process, attain the largest net-zero energy portfolio in the world, exceed its federal energy mandates, and set an example for the federal and corporate markets to follow.

# APPENDIX A: CASE STUDIES RELEVANT TO NZE EFFORTS

A number of existing NZE projects have demonstrated that NZE is viable today within market economic thresholds. The information below is a summary of some of the top, most relevant NZE case studies to the NZE opportunity available to the GSA.

## 435 INDIO WAY RETROFIT[11]

The NZE retrofit of the 30,000 square foot Indio office building in California demonstrated a payback of less than 6 years when financial gains from energy, operations, and improved leasing price were taken into account. The project was focused on incorporating as many sustainability measures as possible within the developer budget. The developer realized that incorporating sustainability measures would make a more appealing space for building occupants, and in doing so upgraded the building from real estate Class C- to Class B+.

The result is a world-class building that is in high-demand from a leasing perspective. The developer created a unique leasing structure that incentivizes the tenant, owner, and landlord to work together to achieve energy efficient building operation. Such provisions reduce plug loads, allow the building to shut down at night, and keep the overall operating costs to a minimum. The developer is also working to show appraisers firsthand why it is profitable to retrofit to net-zero energy, and why developers should be able to borrow more to achieve aggressive energy reduction goals like net-zero energy.

KEY FEATURES:

- LED lighting with skylights, daylight controls, and occupant tracking
- Natural ventilation with night purge cooling
- Advanced automation system to control light, airflow, and temperature
- HVAC equipment downsized by 80%, leading to energy and maintenance cost savings
- Dynamic windows and other building envelope upgrades
- Rooftop solar PV to achieve NZE

## WAYNE N. ASPINALL BUILDING AND U.S. COURTHOUSE NZE RETROFIT[12]

The 2013 NZE retrofit of the Wayne N. Aspinall Building and U.S. Courthouse was recognized as an AIA Top Ten Project in 2014. The combination of historic restoration and net-zero energy are two goals that are typically seen as incompatible due to the complexity and detail required for each. The Aspinall building retrofit represents the GSA's first net-zero energy building and first net-zero energy retrofit, and can serve as a stepping stone for the GSA to break into the net-zero energy space.

The Aspinall building included a number of energy conservation measures that were all life-cycle cost-effective. The building was retrofit to achieve an energy use reduction of 68%, with the remainder offset by a 123 kW solar PV system. The cost of renovation for the Aspinall building fell within average energy renovation costs for similar building types.

KEY FEATURES:

- Enhanced insulation (spray foam in walls, rigid insulation on roof)
- White "cool roof" shaded by solar PV
- High-performance storm panel windows over top of existing historic single pane windows
- LED and T-8 lighting
- Advanced metering and wireless controls for lighting and HVAC
- Water source geothermal variable refrigerant flow HVAC system, sized to meet reduced loads
- 40% water reduction
- 123 kW rooftop solar PV array to achieve NZE

## ALMERIC CHRISTIAN FEDERAL BUILDING NZE ESPC RETROFIT[13]

The Almeric Christian Federal Building represents another key milestone in the GSA's NZE journey as the first energy savings performance contract (ESPC) project expected to reach net-zero energy (NZE status is

pending year 1 verification). The site, located in St. Croix, U.S. Virgin Islands, has a high cost of electricity, which enables a more economical deep energy retrofit than most typical GSA sites. While this represents atypical economic conditions for a GSA retrofit project, it serves as a perfect case study for demonstrating the GSA's ability to prioritize ripe opportunities for NZE retrofits now.

High energy costs allowed the project team to pursue deep HVAC upgrades, building automation system upgrades, and lighting retrofits. Solar PV was also included within the project financing thresholds to bring the building to NZE. While it is not clear how much whole-building optimization was performed when designing the ECMs for this project, similar projects could be leveraged as test-beds for advanced whole-systems design and other innovative technologies.

KEY FEATURES:

- Developed using an ESPC
- Retrocommissioning and building automation system upgrades, which required key interactions with GSA's information technology personnel
- Major HVAC system upgrades (chillers, air handling units, and pumps)
- Window film
- Included added values of new security perimeter fencing and slab regrading as part of the ESPC (to support multiple ECMs)
- 462 kW solar PV array to achieve NZE

# APPENDIX B: ASSUMPTIONS FOR ENERGY AND ENERGY COST PROJECTIONS

This paper assumes that GSA's building portfolio consists of 377.9 million rentable square feet with 48% of this space, or 183.0 million square feet, owned by the GSA.[14]

While the GSA does not publicly post its energy consumption data, RMI estimates the site energy consumption of the GSA's owned building portfolio at 10.6 trillion BTU in 2013. This figure is extrapolated from the GSA's baseline energy consumption for its EISA 2007 goals, the agency's ratings on the 2013 OMB energy scorecard, and the square footage of owned buildings. Using average electricity costs for commercial facilities,[viii] this represents an estimated $222.5 million in annual energy costs.[ix]

Any economic analysis performed as part of this effort could be readily improved with additional energy and energy cost data from the GSA. This paper provides a relative estimate of expected impact to the GSA given the age and inconsistency of the available data.

For the purposes of this paper, we assume that the GSA's owned building portfolio will stay relatively constant in size. While initiatives like "Reduce the Footprint" encourage the GSA to continue consolidating and eliminating assets where possible, the rentable square feet and number of owned assets in the GSA portfolio during recent years has risen marginally (less than a 3% increase over 5 years).[15]

[viii] EIA 2014 data was used for the average cost per square foot of commercial facilities.

[ix] Most of the GSA energy or portfolio data was from FY2013, as it is the year with the most consistent data available. RMI does not expect this to lead to any major calculation errors in this report, as GSA's portfolio did not change substantially between FY2013 and FY2014.

# APPENDIX C: DEVELOPING A STRATEGY FOR SOLAR PV

The cost of solar PV installations is dependent on a number of moving variables, including the falling cost of installation per installed watt; rapidly changing federal, state, and local incentives; and the financing mechanisms used (if any), which may make solar PV more or less appealing based on local utility rates. For this reason, RMI does not attempt to estimate the cost of solar PV as part of this study. The GSA should consider these things before pricing solar PV to bring specific locations to net-zero energy. The next net-zero energy facilities that the GSA aims to develop could easily be in the areas with the best incentives, highest cost of electricity, and greatest solar resource.

The GSA should also consider all types of solar PV installations—including on-site and off-site community, campus, or district-wide systems. Community, campus, or district systems can be particularly helpful in reducing costs (due to larger scale) and balancing site loads properly.

While RMI does not wish to price solar PV as part of this study, we do recommend considering a power purchase agreement (PPA) structure to procure solar PV for net-zero energy facilities. We have also listed several sources for historical and current solar PV costs below.

## POWER PURCHASE AGREEMENTS

A power purchase agreement (PPA) is a financing strategy that allows owners to purchase renewable energy from on-site or off-site resources at no upfront capital cost. In this arrangement, a third-party owner-operator installs the renewable energy either on-site (on a building's rooftop, over parking spaces, in an adjacent field, etc.) or nearby. This third party owns, maintains, and operates the solar PV installation (much like a utility owns, maintains, and operates a power plant) and sells the renewable energy to the customer. Typically, the power is sold back to the customer at or below the cost of grid electricity. These contracts are typically amortized over a long term in order to make up for the cost of the renewable energy system installed.

There are several rulings that may limit whether solar PPAs can extend long enough for contracts to become fully amortized, and whether solar PV under a PPA can be included in an ESPC project. If these issues do still exist, RMI recommends the GSA continue to advocate strongly to any regulatory bodies that may be limiting the useful application of PPAs, and look into utilizing the effective structures that other agencies, including the DoD, have leveraged to institute longer-term PPAs (or directly contracting with these other agencies to implement PPAs if possible).

RMI recommends that GSA consider all possible avenues in financing solar PV, which is key to achieving NZE at this time.

## SOURCES FOR SOLAR PV COSTS

The following resources are helpful for assessing the historic and current installed costs of solar PV:

- *Tracking the Sun VII: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998–2013*, Lawrence Berkeley National Laboratory: http://emp.lbl.gov/publications/tracking-sun-vii-historical-summary-installed-price-photovoltaics-united-states-1998-20
- *Photovoltaic System Pricing Trends*, U.S. DOE SunShot: http://www.nrel.gov/docs/fy14osti/62558.pdf
- Open PV Project, National Renewable Energy Laboratory: https://openpv.nrel.gov/

# APPENDIX D: COST PREMIUMS FROM VARIOUS SOURCES

| Source | Cost Premium of NZE ready: New Construction | Cost Premium of NZE ready: Major Renovation |
|---|---|---|
| New Buildings Institute – 2012 Getting To Zero Update (2012)[16] | 0–10% for several case studies | |
| New Buildings Institute – Washington, DC Study (2014)[17] | 1–6% for new office buildings | 7–12% for office building retrofits |
| New Buildings Institute – 2014 Getting To Zero Update (2014)[18] | Energy efficiency costs not distinguishable from overall budget (assumed 0%) | |
| The Integral Group – The Power of Zero (2014)[19] | Energy efficiency costs not distinguishable from overall budget (assumed 0%) | |
| National Renewable Energy Laboratory – NREL Research Support Facility[20] | Below the average cost of newly-constructed office buildings designed to meet LEED ratings (assumed 0%) | |
| National Renewable Energy Laboratory – Wayne N. Aspinall Building (2014)[21] | | No significant difference (below the "national average for office buildings that include energy efficiency measures") (assumed 0%) |

[1] The GSA's Mission and Priorities. http://www.gsa.gov/portal/content/100735, accessed September 2015.
[2] *2014 Getting to Zero Status Update*, New Buildings Institute, January 2014. http://newbuildings.org/sites/default/files/2014_Getting_to_Zero_Update.pdf
[3] *The Federal Commitment to Green Building: Experiences and Expectations,* The Office of the Federal Environmental Executive, November 2003.
[4] GSA Office of Federal High-Performance Green Buildings. http://www.gsa.gov/portal/category/101107
[5] *CA Energy Efficiency Strategic Plan*, California Public Utilities Commission, January 2011. http://www.energy.ca.gov/ab758/documents/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf
[6] https://sustainability.asu.edu/resources/climate-neutrality-at-asu/
[7] http://www.rmi.org/retrofit_depot_deepretrofitvalue
[8] The GSA's Mission and Priorities
[9] http://www.gsa.gov/portal/mediaId/198447/fileName/NDEREnergySavingsReport5.action
[10] Ibid.
[11] http://www.integralgroup.com/indio-nze-retrofit-wins-best-rehab-award/ and http://www.integralgroup.com/blog/a-real-estate-developers-business-case-for-net-zero/
[12] http://energy.gov/sites/prod/files/2014/10/f19/aspinall_courthouse.pdf and http://www.nrel.gov/docs/fy15osti/62360.pdf and http://www.aiatopten.org/node/367
[13] http://www.rmi.org/Content/Files/Almeric_L_Christian_Federal_Building.pdf
[14] FY2013 State of the Portfolio, GSA
[15] Ibid.
[16] http://newbuildings.org/sites/default/files/GettingtoZeroReport_0.pdf
[17] http://newbuildings.org/sites/default/files/ZNECostComparisonBuildingsDC.pdf
[18] http://newbuildings.org/sites/default/files/2014_Getting_to_Zero_Update.pdf
[19] http://bnim.com/images/powerofzero/index.html
[20] http://www.nrel.gov/sustainable_nrel/pdfs/51742.pdf and http://www.nrel.gov/docs/fy12osti/51387.pdf
[21] http://www.nrel.gov/docs/fy15osti/62360.pdf