Note: This proposal is the work of an independent advisory committee to GSA, and as such, may or may not be consistent with current GSA or other Federal Policy. Mention of any product, service or program herein does not constitute endorsement.

GSA Green Building Advisory Committee Advice Letter on Building & Grid Integration

December 13, 2018

Kevin Kampschroer
Chief Sustainability Officer and Director,
Office of Federal High-Performance Buildings
U.S. General Services Administration (GSA)

RE: Recommendations for the Adoption of Grid-Integrated Building Policy Provisions

Dear Mr. Kampschroer:

This letter summarizes recommendations of the Green Building Advisory Committee (the Committee), based on the work of its Building-Grid Integration Task Group (BGI TG). (Please see list of Task Group members and observers below.) This task group was formed to identify opportunities to advance grid-integrated federal buildings that leverage technologies and strategies to dynamically shape energy loads, enhancing resilience and providing valuable services to the power grid while saving taxpayer money. This report of the BGI TG was accepted (pending revisions) by the full Committee at its fall 2018 meeting on September 27th, 2018.

Background:

The traditionally centralized, one-way electrical grid does not provide the optimal environment for managing many of the new and emerging energy challenges and opportunities of the 21st century. The vision of a smart, two-way grid interacting with smart, grid-responsive buildings provides the promise of fortifying the system to deal with economic, security, supply and demand disruptions while leveraging new opportunities for efficiency, cost savings, resilience, and distributed energy generation. Buildings and utilities separately incorporate many high-performance innovations; however the plans for and progress of these industries are insufficiently integrated to take full advantage of the new range of opportunities. Federal agencies are in a unique position to take the lead in demonstrating the benefits of building-grid-integration for the commercial and public buildings sectors. This proposal goes beyond previous efforts that have focused on individual solutions (e.g. demand response) to create integrative solutions with significant savings over time.

The Case for Enhancing Federal Building-Grid Integration:

By setting policies that improve the quality of building-grid integration in federal facilities, GSA can reap benefits in several ways. Better grid-integrated buildings may unlock lower electric utility bills and save taxpayer money by minimizing demand and capacity charges and allowing the agency to take advantage of time varying pricing (e.g. time of use) rate structures. Federal facilities may increase their own energy security and resilience, as well as the energy security and resilience of the grid itself. And these strategies can help advance a variety of federal energy and environmental goals, including minimizing energy consumption, diversifying energy supplies, minimizing emissions, and maximizing utilization of distributed and renewable generation assets, in a coherent and integrated manner, while supporting the missions of federal agencies.

Key Policy Recommendations:

Federal facilities and campuses should be designed and operated to maximize the benefits of building-grid interactions:

1. **All Buildings:** Adopt best practices as shown in the policies below for existing operations and maintenance efforts and building retrofit programs to move toward building-grid integration (which includes investment in deep energy efficiency, distributed energy generation, energy storage, and load flexibility).
2. **New Buildings:** Adopt policies that will enable all new buildings to strategically integrate with the grid, by optimizing investments in energy efficiency, distributed energy generation, energy storage and load flexibility (including smart controls). This can save taxpayers money over time and increase resilience immediately.
3. **Collaborating With Utilities and Grid Operators:** Work with utilities to pilot and implement rate structures and other efforts and programs that are mutually beneficial – thereby supporting utilities to balance supply and demand, increase resilience and reduce the need for infrastructure investment, while aligning incentives and saving money for federal (and commercial) building owners. This would allow investments in grid-interactive technologies to decrease the federal government's utility bills and increase financial benefits on both sides. Also, consistently request information about location and time of use-specific energy cost and emissions factors from every utility serving a Federal facility.

- **Short-term action:** Propose policies based on these topics.
- **Mid-term action:** Undertake pilot projects.
- **Long-term action:** Build these recommendations consistently into implementation and management plans.

A total of 13 specific policy recommendations are set forth in the detailed Summary of Task Group Results below, color coded to indicate the highest priorities. A wide range of enabling technologies and strategies are available for buildings today that can improve efficiency, minimize peak demand, improve flexibility, and provide specific grid services (such as generation capacity reduction, reduced generation operating costs, frequency regulation, deferring transmission and/or distribution costs, etc.) . Two case studies are included to demonstrate specific instances in which buildings or campuses have taken an integrated approach to enhancing grid interactivity, and have reaped the benefits of these practices.

Building-grid integration is a rapidly evolving field. New technologies and strategies with the potential to drive new electric supply business models and grid operational paradigms are emerging continually. The GSA is in a unique position, as the largest landlord in the nation, to help shape the future of buildings and the grid, and to harvest a wide variety of financial, security, and environmental benefits in the process.

Thank you for your careful consideration of this package and for the opportunity to recommend these important policies to the GSA. On behalf of the Green Building Advisory Committee, I respectfully submit these recommendations for your consideration.

Sincerely,

Projjal Dutta, Chair
Green Building Advisory Committee

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Green Building Advisory Committee Building-Grid Integration Task Group (TG)

Policy Recommendations for Accelerating Adoption of Grid Integrated Federal Buildings

Contents

Part I:
Introduction, Mission, Vision and Problem Statement

Introduction:

This document represents the work of the Building and Grid Integration Task Group (BGI TG) – a subcommittee of the General Services Administration (GSA)'s Green Building Advisory Committee (the Committee) that was formed after the Committee's Spring 2018 Web meeting to develop findings and recommendations on this issue. The BGI TG met on a biweekly basis between June and September 2018 to investigate and help build a common understanding regarding the opportunities for federal building and grid integration, and draft this policy framework of building and grid integration actions for the federal government to consider. The BGI TG consisted of the members and observers listed in the letter preceding this report. This report of the BGI TG was accepted (pending revisions) by the full Committee at its fall 2018 meeting on September 27th, 2018.

This document provides a general introduction to the concept of building and grid integration (BGI) and introduces the task group's vision of the opportunity for GSA and other federal buildings. The group's general findings are described below, and most importantly, policy recommendations are provided for accelerating the adoption of technologies that promote grid integration of the federal building portfolio. These policy recommendations are followed by a description of existing grid-integration technologies and case studies demonstrating aspects of BGI.

These recommendations are intended to complement and coordinate with other ongoing grid modernization and integration programs[1] underway in the public and private sectors. This set of recommendations is targeted at opportunities that federal buildings can undertake, based on the BGI TG's initial analyses, and as such, excluded topics and tasks beyond the group's present scope, or which may duplicate other initiatives. Some of these activities are recommended as next steps for the second phase of this group, which the Committee authorized at its Fall 2018 meeting: e.g., describing a detailed business case for federal grid-integrated buildings, defining implementation strategies, outlining standards and guidance revisions, creating a 'How-to' guide for BGI, exploring links with emerging metrics and standards or identifying possible federal BGI pilot projects. These are all important areas for potential future exploration.

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1 A few examples of programs with relevant grid modernization/building-grid integration elements include the U.S. Department of Energy's Buildings-to-Grid Initiative (and broader Grid Modernization Initiative and related activities at the National Labs), the New Building Institute's and U.S. Green Building Council's GridOptimal Initiative, the Rocky Mountain Institute's eLab, and the work of the Gridwise Architecture Council and Smart Electric Power Alliance.

BGI TG Mission Statement:

To advance grid-integrated federal buildings that leverage technologies and strategies to dynamically shape energy loads, help agencies meet their missions, provide resilience and valuable services to the power grid while saving money for the taxpayer.

BGI TG Vision Statement:

Federal buildings are designed, built, retrofitted, and operated to be smart, connected, and responsive assets that optimize interactions with the power grid in order to achieve agency missions reliably and cost-effectively. These solutions provide a compelling business case for GSA through operational cost savings and increased property value, while also reinforcing national priorities like a more resilient power grid. Fully integrated solutions (i.e., a balanced solution of energy efficiency, distributed energy generation, energy storage, and load flexibility) become standard such that the whole strategy is greater than the sum of the parts.

Problem statement:

The traditionally centralized, one-way electrical grid does not provide the optimal environment for managing many of the new and emerging energy challenges and opportunities of the 21st century. The vision of a smart, two-way grid interacting with smart, responsive buildings provides the promise of fortifying the system to deal with economic, security, supply and demand disruptions while leveraging new opportunities for efficiency, cost savings, resilience and distributed energy generation. Currently, buildings and utilities separately pursue many high-performance energy innovations; however, these efforts are insufficiently integrated to take full advantage of the new range of opportunities. Building owners need to understand the value proposition to integrate their buildings with the needs of the grid. Utilities, operators, and others in the electricity space need to properly value the services that buildings can provide to the grid and align their pricing models with grid health and emissions intensity.

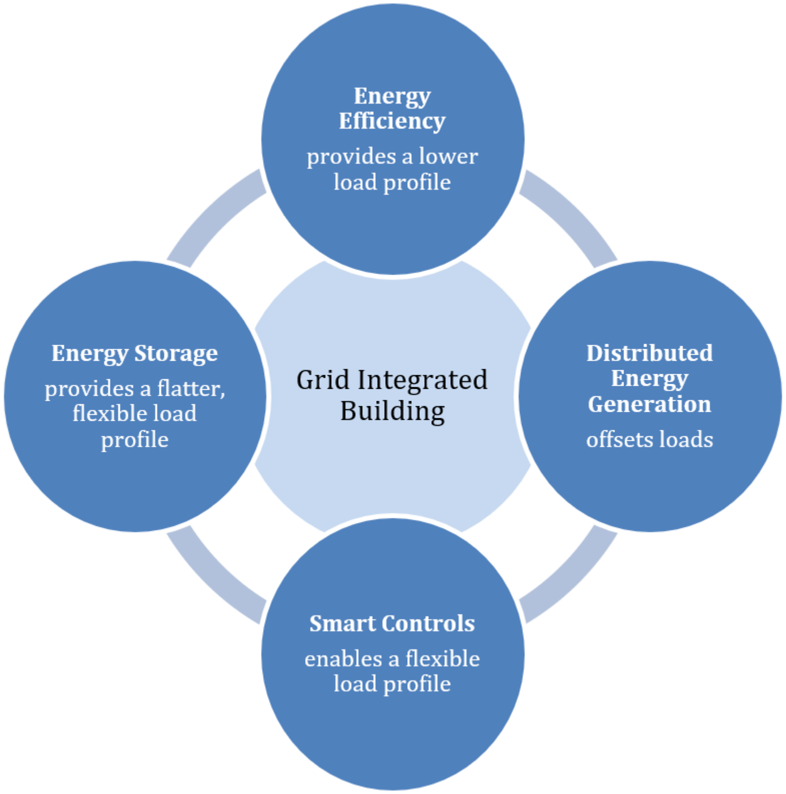


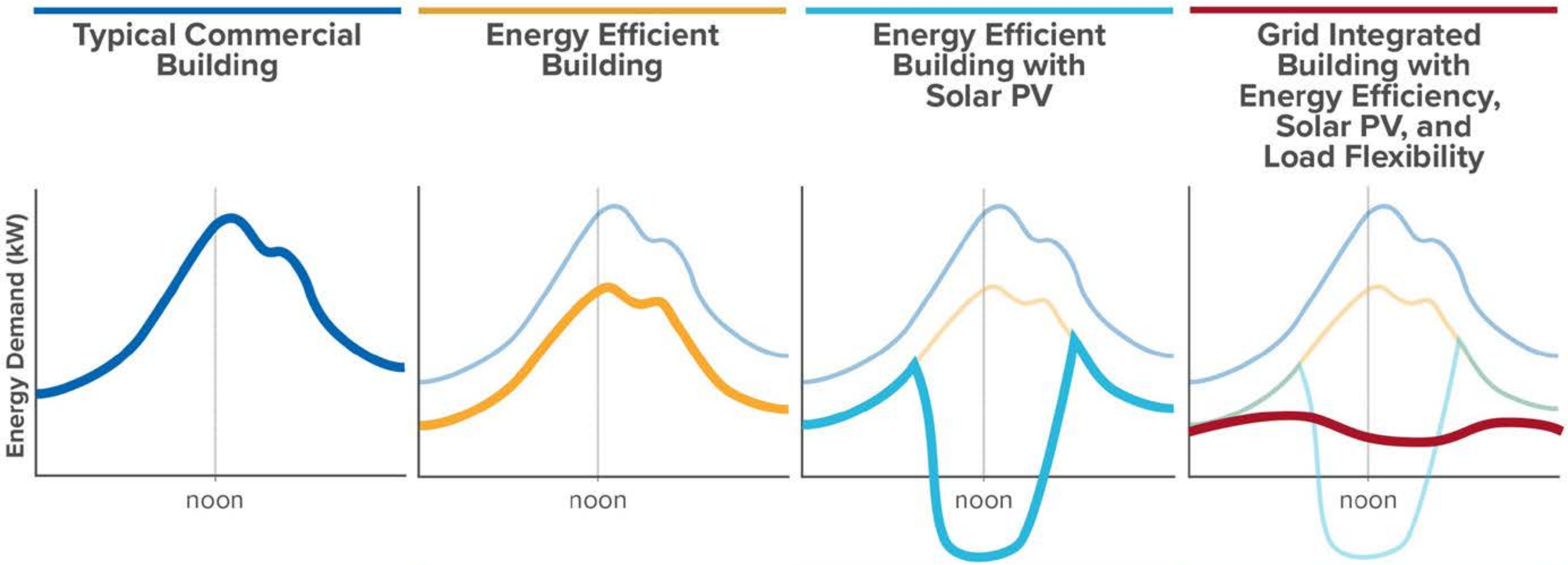
Figure 1: Grid Integrated Buildings have a holistically optimized blend of energy efficiency, energy storage, distributed energy generation, and load flexible technologies/smart controls. This results in a lower, "flatter", more flexible energy load profile which in turn delivers a more resilient and productive building, optimizes capital investments, reduces operating costs and provides access to new revenue. At the campus or community scale, additional strategies such as microgrids and district energy systems may also be advantageous.

The GSA is in a unique position to take the lead in demonstrating the benefits of BGI for the public and commercial building sectors. GSA has proven that it can lead by example, as it has by adopting standards and best practices like the Guiding Principles for Sustainable Federal Buildings, Green Lease Policies and Key Sustainable Products Initiative.

This proposal recommends going beyond individual grid-integration approaches (e.g. demand response) to develop integrative solutions that drive substantial savings to building owners, grid operators, utilities, and other players over time.

The following graphs show representative daily building load profiles for an office building. The first shows a typical commercial building load profile with a mid-day peak demand. The second scenario shows the benefit that energy efficiency provides by lowering the load profile overall and reducing energy use and demand. Energy efficiency is almost always the highest value and most reliable load profile influencer and should be the foundation of any solution. The third scenario is an efficient building with onsite solar PV generation. A building which balances energy use and generation over the course of the year may have such a daily profile; however, such a building still may have dramatic peak demands (e.g., when cloud cover reduces PV production). The under-recognized consequences of solar PV on the utility side include steep ramping up or down of generation and curtailment when the PV is overproducing. The last scenario shows an optimized blend of energy efficiency, solar PV, energy storage and load flexibility, which delivers a much lower and flatter load profile. With battery or thermal storage and load flexing smart controls, it enables the building to respond to grid signals. This can provide revenue potential under current rate structures, and enable buildings to adjust to future rate structures so buildings can continue to provide grid benefits and financial return to building owners.

Grid Integrated Building: Load Profiles



Efficiency improves curve (lowers and flattens)

+ Reduces energy consumption and demand charges

Adding solar offsets significant loads, often coincident with utility peak loads

+ Reduces energy consumption and demand charges
- BUT...can cause steep ramping of loads and utility issues

Grid integration combined with the other strategies shifts building loads to match generation, further reducing peaks

+ Optimizes energy consumption and demand charge savings while supporting grid stability and resilience
+ Demand response capability during grid peak scenarios provides additional revenue

Part II: Findings

The BGI TG's core findings center on: (1) the benefits of closer building-grid integration and (2) the challenges to achieving greater building-grid integration.

Benefits of greater building-grid integration:

The following list includes a subset of the potential benefits that the federal government (and most building or portfolio owners) can see from a greater degree of building-grid integration. Simply put, building owners can optimize their energy use, save money directly and do it in a way that also helps grid owners and operators save money and support a stable, flexible, resilient and smart grid:

1. Lower federal energy bills, which will save money for the taxpayer. The federal government, which presently pays over $6 billion a year in facility site energy costs[2], can decrease these costs through:
   a. Decreased demand charges (including grid operator, Regional Transmission Organization (RTO) or Independent System Operator (ISO) capacity charges).
   b. Greater opportunities for time varying pricing (TVP) (including time of use (TOU) rates and dynamic pricing), relevant utility incentives, and similar programs.
   c. Enabling utilities to reduce capital, operating, transmission and distribution expenditures, which can help keep future utility rates low. This can result from reducing grid capacity constraints, which in turn reduces the need for costly investments in grid capacity infrastructure.

2. Greater energy security and resilience at the following scales:
   a. Buildings, campuses, and installations: by providing alternatives, such as energy storage paired with distributed energy generation and island-able microgrids, which can ultimately increase utilization, reduce risk and downtime if configured to operate in a grid independent mode.
   b. The grid: by increasing stability with more flexible options for transmission, storage, and distributed generation, including the integration of distributed energy resources and storage as non-wires alternatives.

3. Advancing federal energy and environmental goals[3], by:
   a. Reducing energy use.
   b. Enhancing diversification of the U.S. energy supply with more distributed and renewable energy options.
   c. Decreasing emissions.

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2 U.S. Department of Energy, Federal Energy Management Program. (2017). *Site-Delivered Energy Use, Costs, and Gross Square Footage of Federal Facilities by Agency, FY 2017 (in Adjusted Constant FY 2017 Dollars).* https://ctsedwweb.ee.doe.gov/Annual/Report/SiteDeliveredEnergyUseCostsAndGrossSquareFootageByAgency.aspx

3 Primary sources of these goals and mandates are: Energy Independence & Security Act of 2007 (EISA), Energy Policy Act of 2005 (EPAct), and Executive Order 13834, Efficient Federal Operations. The U.S. Department of Energy's Federal Energy Management Program (FEMP) provides detailed information on these sources at https://www4.eere.energy.gov/femp/requirements/requirements_filtering/buildings_energy_use.

   d. Balancing grid supply and demand.
   e. Maximizing the utilization of existing distributed and renewable generation assets and infrastructure.

Challenges to Building-Grid Integration:

Challenges to BGI from the perspectives of federal building stakeholders (many of which are relevant to private sector building owners as well) and power grid stakeholders (including utilities, grid operators, and other key players) are outlined below. Understanding these sometimes disparate perspectives is critical to driving greater building-grid integration in the future, as building owners will not invest in grid-integrated technologies if the incentive structure doesn't exist, and the power sector will not create the incentive structure if building owners do not invest in the proper technologies. The best way to proceed beyond these challenges is for the buildings sector and the power sector to work through them together.

Electricity sector challenges:

1. Inflexible Central Generation and Distribution Systems Not Responsive to Current Trends.
   a. Inflexibility of central generation and the legacy grid create disincentives for integration.
   b. Many systems are optimized for simple rate structures without time of use pricing.
   c. Geographic fragmentation of power markets lead to different sets of incentives and challenges in different locations.
   d. Lack of information access at various levels, e.g., substation distribution level, leads to unclear market signals.

2. Integrating Growing Distributed Energy Resources (DERs).
   a. Renewable Portfolio Standards (RPS) and renewable system development can lead to negative pricing, renewable energy curtailment and grid congestion.
   b. Standardized architecture, planning tools and techniques for DERs are lagging behind.
   c. DERs applied under current business models can result in lost customers and revenue for utilities.
   d. The shift away from centralized baseload power sources creates concerns about reliability and resiliency.
   e. Lack of infrastructure to identify and use DERs in real time energy management.

3. Dynamic Grid Load Profile.
   a. Load profiles vary by state, utility and geographic/NERC (North American Electric Reliability Corporation) region, i.e., by Regional Transmission Organization (RTO) or Independent System Operator (ISO) which require different solutions under different conditions.
   b. Load profiles are subject to change due to climatic shifts.

4. Power Grid Resilience.
   a. The traditional power grid is increasingly susceptible to natural hazards and tampering.

b. Resilience/recovery are needs not prioritized within the most critical areas.
c. Infrastructure vulnerabilities are changing with climatic shifts.

Federal building owner challenges:

1. Lack of Information and Resources.
   a. Lack of examples and case studies, particularly those demonstrating comprehensive integration (efficiency + solar + storage + load flexibility) as opposed to individual strategies (e.g., demand response).
   b. Lack of design guidance, education, and comprehensive approaches to integration for architects, engineers and building operators.
   c. Lack of understanding of how specific technologies and strategies enable grid-friendly design and performance outcomes.
   d. Modeling tools are not readily available to model interactive effects of technologies and strategies.
   e. Additional information is required on the relevant resource codes and standards and where they may support or conflict with integration goals.
   f. Lack of actionable, readily available information about real time energy costs and emissions factors.

2. Operational Knowledge Gaps and Lack of Control.
   a. Lack of building operator knowledge and education on how their building could and should respond to grid conditions.
   b. Grid flexibility is not integrated into building operations standards, procedures, incentives, and training programs.
   c. Lack of easy building interface with utility grid, e.g., to react to peak load predictions.
   d. Benchmarking and transparency requirements and resulting information are limited.
   e. Lack of smart controls.
   f. Lack of modeling tools.
   g. Takes time, effort & capital for building owners to implement what to do, when and how to do it.

3. Lack of Integration Among Strategies and Technologies.
   a. Cost-saving strategies may not always align with emissions reduction strategies – joint optimization requires clear goals and relevant price signals (e.g., price on emissions).
   b. Advanced metering infrastructure (AMI) not available everywhere (~50% across US).[4]
   c. Grid balancing strategies may sometimes conflict with other building objectives.
   d. Rapidly evolving infrastructure needs complicate integration (i.e., expanding EV charging demands).
   e. Different strategies and solutions should be used in various states/regions.

4 U.S. Energy Information Administration. (2017). *Nearly half of all U.S. electricity customers have smart meters.* https://www.eia.gov/todayinenergy/detail.php?id=34012

4. Price Incentives.
    a. Price signals and rate structures may change in the future, affecting the long term value proposition, positively or negatively.
    b. Lack of grid signals and if present, lack of agility to respond.
    c. Demand charge savings (while significant, on average 30-40% of utility costs) not yet catching owners' attention. Cost savings potential is risky (one strike and you're out each month) and not clearly illustrated and disseminated.
    d. Demand reduction induced price effects can provide broad benefits, but are not often understood or enabled.[5]
    e. Emission reduction incentives, where they exist, vary state to state. Federal sector contracts should be adjusted to take advantage of this.
    f. Utility incentive programs encourage some measures but do not recognize or incentivize grid-friendly buildings holistically.

5. Inadequate Financing/Contracting Models.
    a. Insufficient financial incentives for federal buildings to take advantage of grid integration opportunities (no high-level policy push and absence of savings retention for good load management practices.
    b. Value not understood or integrated into ESPCs, perhaps due in part to risk of missing pinpoint timing (e.g., for monthly demand peak or DR participation).
    c. Current performance contracting practices rarely utilize savings from demand charge reductions.

6. Security Concerns.
    a. Potential IT security concerns with automated response programs.

7. Lack of Supportive Policies.
    a. Concern over real or perceived regulatory barriers.
    b. Lack of policy models to effectively encourage/enable grid integration.
    c. Lack of relevant pricing for emissions and environmental impacts from time-of-use energy consumption.
    d. Current policy goals focus on energy savings. Some grid-integrated buildings measures could increase energy consumption, while decreasing cost and decreasing grid emissions. (For instance, battery storage is roughly 80% efficient in charge and discharge cycles; therefore, it uses 20% more energy to meet the same energy needs.) Policies should appropriately balance these opportunities and concerns.

5 State and Local Energy Efficiency Action Network (SEE Action). (2015). *State Approaches to Demand Reduction Induced Price Effects: Examining How Energy Efficiency Can Lower Prices.* https://www4.eere.energy.gov/seeaction/system/files/documents/DRIPE-finalv3_0.pdf

Part III: Recommendations

The following recommendations begin with an overarching proposed federal policy statement for all federal buildings. The table then provides more detailed, specific, prioritized policy recommendations that could benefit the entire federal government.

Policy Recommendation for Accelerating Adoption of Grid Integrated Federal Buildings

Federal facilities and campuses should be designed and operated to maximize the benefits of building-grid interactions;

4. **All Buildings:** Adopt best practices as shown in the policies below for existing operations and maintenance efforts and building retrofit programs to move toward building-grid integration (which includes investment in deep energy efficiency, distributed energy generation, energy storage, and load flexibility).
5. **New Buildings:** Adopt policies that will enable all new buildings to strategically integrate with the grid, by optimizing investments in energy efficiency, distributed energy generation, energy storage and load flexibility (including smart controls). This would save taxpayers money over time and increase resilience immediately.
6. **Collaborating With Utilities and Grid Operators:** Work with utilities to pilot and implement rate structures and other efforts and programs that are mutually beneficial – thereby supporting utilities to balance supply and demand, increase resilience and reduce the need for infrastructure investment while aligning incentives and saving money for federal (and commercial) building owners. This would allow investments in grid-interactive technologies to decrease the federal government's utility bills and increase financial benefits on both sides. Also, consistently request information about location and time of use-specific energy cost and emissions factors from every utility serving a Federal facility.

- **Short-term action:** Propose policies based on these topics.
- **Mid-term action:** Pilot projects.
- **Long-term action:** Build these recommendations consistently into implementation and management plans.

Key to Successful Policy Implementation: Pilot Projects

In support of the following specific recommendations, the federal government should pursue pilot projects. Pilot projects are a critical tool that allows the government to test these concepts and increase its comfort level with grid-integrated building approaches that haven't been considered before. Many of the concepts below have been implemented at least in part in a number of federal projects across several agencies, but they've seldom been carried out in combination, toward true building-grid integration. The key is forming a more holistic vision: finding the appropriate balance of energy efficiency, distributed energy generation, energy storage and controls that will reduce costs, provide resiliency, and cut emissions. This will require flexibility to meet unique regional grid needs and specific needs of building owners. These recommendations should be carried out in a comprehensive manner that encompasses new construction, renovation, and ongoing operations and maintenance.

Specific Policy Recommendations

The following table provides detailed policy recommendations for both new construction, major renovations, and existing buildings. The recommendations also drive toward optimal rate structures by working with utilities for mutually beneficial financial outcomes. Highest priority recommendations begin each list and are shaded light blue. GSA and other agencies participating in these activities should engage with organizations with deep technical skills (like National Institute of Building Sciences (NIBS), National Renewable Energy Laboratory (NREL) and National Institute of Standards and Technology (NIST)) to determine which policy mechanisms, technologies and strategies should be used for their portfolio. GSA, DOD and delegated agencies should also pool their utility-buying power when engaging with utilities, as utilities are much more likely to negotiate with entities that have larger, pooled loads. Pilots can be performed with the Department of Energy (DOE) and National Labs in conjunction with DOE's Grid Modernization Initiative, among other efforts.

Proposed Policy	Purpose/Intent	Policy Mechanisms	Difficulty	Impact
	Why is this important? What is the desired outcome?	Suggested mechanisms for policy makers	Once enacted, how easy is it to accomplish? Low-Med-High	How much cost/energy will this save the federal govt? Low-Med-High
A. Policies for All Buildings				
A-1: Modify federal energy goals that focus only on energy reduction (in energy use intensity (EUI), to also include targets pertaining to demand reduction (in kW), load factor, energy costs, and emissions reduction.	Reflect the benefits of strategies that reap greater emissions and cost savings than energy efficiency alone (e.g., battery storage or thermal storage)	Develop standardized metrics for buildings that include the following targets to build awareness: • Energy Use Intensity (EUI) • Peak Demand • Load Factor • Energy Costs Design a pathway that optimizes across these metrics.	Med	High
A-2: Plan grid integration improvements over time	GSA should pilot and implement in the short term, while enabling for future flexibility.	Plan capital planning improvements and operations and maintenance (O&M) projects to include grid integration strategies (see Part IV below) assuming technology upgrades and rate structure modifications over time.	Low	High

Proposed Policy	Purpose/Intent	Policy Mechanisms	Difficulty	Impact
A-3: Investigate how ESPC and UESC projects could better incorporate demand savings; consider and pilot promising approaches	Allow grid integrated building strategies to be part of ESPC/UESC projects	Energy Savings Performance Contract (ESPC)/Utility Energy Service Contract (UESC) projects are often executed without consideration of grid integration policies – e.g., based on energy savings only, i.e., excluding demand savings. These demand savings can further reduce emissions, as well. A study and potential pilots can identify use cases, investigate and test approaches to consider and change this as appropriate.	High	Med
A-4: Incorporate grid integration into building resilience	GSA and other agencies should enable buildings to operate even if the grid goes down.	Where appropriate, design and operate buildings and campuses to enable passive operation, islanding and microgrids, partial operation, uninterrupted power source (UPS), etc.	Med	Med
A-5: Investigate and promote greater use of distributed energy resources and onsite generation	GSA should provide site-based distributed energy resources in order to increase resilience and save cost.	Distributed generation can be used as a component of grid integration strategies to reduce usage of grid electricity (while ensuring that strategies do not increase pollution, which can be a concern depending on the fuel used). While some federal buildings already employ such systems, study of their value and policies to promote them could advance productive use of these technologies and strategies and provide case studies for others to follow.	Med	Med
A-6: Investigate, consider and pilot use of energy storage (including "storage-ready" facilities)	GSA should enable more participation in transactive energy programs and increase energy resilience.	Conduct necessary studies to determine federal policy to promote, facilitate and pilot installation and use of energy storage resources, including battery, thermal and other viable alternatives – with consideration of regulatory, financial and other challenges, opportunities and solutions.	Low	High

Proposed Policy	Purpose/Intent	Policy Mechanisms	Difficulty	Impact
A-7: Investigate, consider and pilot use of Advanced Metering Infrastructure and OpenADR	GSA should enable OpenADR (or a similar protocol) for easy participation in demand response markets, streamlining revenue generation for federal buildings.	Specify lights and HVAC equipment with controls that are OpenADR compatible based upon the OpenADR Smart Grid Standard for communication between utilities and other energy sources. Enable successful integration by working with IT security and other IT processes to investigate opportunities and requirements for approval and implementation.	Specifying: Low Implementation: High	Med
B. Policies for New Buildings				
B-1: Design for Grid Interactivity	Provide for future load flexibility	Design facilities to meet specific design and operational standards related to grid interactivity (as noted in Part 4 below) These parameters will be quantitative and will define the capability of the building to modify its load shape. For example, a building could be required to be capable of shedding a certain percentage of its load for a certain number of hours, e.g., through use of targeted efficiency, storage, PV, cogeneration and/or other strategies.	High	High
B-2: Design to Zero Energy Buildings (or Zero Energy Ready)	GSA should set goals and design new construction projects to have low load shape/be highly efficient and enable solar PV generation and energy storage.	During the early design phase, analyze buildings for best-in-class energy use intensity target standards and provide necessary wiring, space and infrastructure for renewables and storage installation (either for installation immediately or in the future).[6]	Med	High
B-3: Incorporate grid integration into Lifecycle Cost Analysis (LCCA)	GSA should use lifecycle cost analysis to optimize integrative strategies and minimize long-term costs.	During the design phase, use life cycle cost analysis to determine the most cost-effective balance of energy efficiency, distributed energy generation, energy storage and load flexing technologies. Use standard efficiency, business-as-usual baselines for equipment selection factors in the incremental cost to upgrade facilities, including return on investment (ROI).[7]	Low	Med

6 Resources include: Architecture 2030, Zero Tool, and U.S. Department of Energy. Zero Energy Buildings. https://www.energy.gov/eere/buildings/zero-energy-buildings.

7 LCCA is a requirement for federal buildings per OMB Circular A-123, and is facilitated through NIST's Building Life Cycle Cost Programs. In theory, advanced energy systems should be installed if life cycle cost effective. However, advanced energy systems are often eliminated as part of value engineering or during construction phase due to budget issues for most major construction projects. LCCA is also challenging since utility rates will almost certainly change within the horizon of analysis, adding uncertainty.

Proposed Policy	Purpose/Intent	Policy Mechanisms	Difficulty	Impact
C. Collaborating with Utilities and Grid Operator Policies				
C-1: Analyze the Grid System	In partnership with each grid operator, GSA should understand regional grid load profiles and opportunities to support grid stabilization.	Prior to implementation of building approach, analyze and propose strategies to help mitigate capacity, generation and distribution constraints. This investigation should include the local and regional electric grids, utility and RTO/ISO current and forecasted plans. This analysis can be performed regionally (rather than building-by-building) and should be regularly updated as systems and rates evolve.	High	High
C-2: Understand and Take Advantage of Flexible Rate Structures	GSA should align building characteristics and performance (efficiency, storage, distributed generation, and controls or load flexing technologies) with rate structures to optimize financial returns.	Partner with utilities and RTOs/ISOs to conduct rate structure analysis, pilot projects, and participate in the most cost-optimal electric rate structures available which ideally reflect the variable cost of generating electricity (e.g., time-of-use, critical peak pricing, real-time pricing). Identify and install building-level infrastructure necessary to enable flexible load and participation in demand response markets and programs. As available in the future, participate in transactive energy markets.[8]	Med	High
C-3: Create incentives for load management transparency	GSA should consistently request information from the utility about location and time of use specific energy cost and emissions factors, to gain the benefits of greater understanding and transparency.[9]	Create structure and measurement and verification (M&V) rules that allow and encourage federal sites to pursue load management strategies (including those that take advantage of time-varying pricing (TVP) options), such that the benefits of these activities can be reaped by the entities that instituted them. Standardized information request for every utility serving a federal facility.	Updating M&V standards: Medium Implementation: Low	Medium

8 For a definition of transactive energy, see National Institute of Standards and Technology (NIST). (2017). *Transactive Energy: An Overview.* https://www.nist.gov/engineering-laboratory/smart-grid/transactive-energy-overview

9 GSA, DOD and delegated agencies can generally retain savings from participation in ISO/RTO- or utility-sponsored demand response programs, but not from “informal” load management efforts (e.g., to minimize demand and capacity charges or to take advantage of time-varying pricing, TVP).

Part IV: Existing Technologies, Implementation Strategies, and Case Studies

This section moves from the more conceptual recommendations of Part III to highlight: (1) the technologies and solutions that can drive these recommendations to fruition, (2) several implementation strategies that the government should explore, and (3) several case studies that highlight various elements of grid-integrated building solutions.

Technologies and Solutions:

The following building-grid integration technologies and solutions are being explored and implemented in the federal and commercial markets today:

Type of Program and Benefits	High Priority Technologies and Strategies
1. Energy Efficiency » Energy efficiency specifically targeted at baseloads lowers load curve all day and year-round » Some measures can specifically target peak demand » GSA can and should systematically coordinate the use of baseload- and peak-load targeted energy efficiency strategies	**Site Strategies:** • Passive solar orientation to control heat gain **Envelope Strategies:** • Super-insulation • Air-tight envelope to reduce infiltration/exfiltration • Thermal mass and phase change materials • Daylighting **Mechanical and Electrical Strategies:** • Efficient lighting and controls • High efficiency, right-sized equipment specification • Smart meters and controls • Natural ventilation • Ventilation optimization • Plug load management **Operational Strategies:** • Periodic recommissioning • Occupant behavior change through education and training

Type of Program and Benefits	High Priority Technologies and Strategies
2. Distributed Energy Generation » Offsets loads	• Solar photovoltaic (PV) • Campus scale wind • Biomass or biodiesel generators
3. Smart Controls and Technologies to Provide Load Flexibility » Understand and respond to outside signals requesting grid services across a variety of timescales » Meet occupant set points and preferences » Forecast and adapt operation based on exogenous and grid variables	• Appliances and plug load device controls with smart controls that can shift load based on signals from facility manager or the utility • Provide direct demand response capabilities • Dynamic glazing • Smart electric vehicle (EV) charging (varies based on time of day or cost of energy) • Cogeneration/combined heat and power provides load flexibility • Facility manager responsiveness to load signals
4. Energy Storage to Provide Load Shifting » Dynamic response to grid signals » Can include peak load shaving, load shifting, demand response, and other services	• Battery storage for demand charge reduction • Bi-directional energy flow between EV batteries • Thermal storage – (i.e. ice storage, heat pump water heaters, etc.)
5. Further Utility Integration » Additional measures that enable integration with the utility grid or otherwise benefit grid health	• Off-site green power purchasing programs and community solar • Automated demand response (ADR) • Ancillary and other grid services • Resilience-capable buildings and campuses with islanding technologies and microgrids • Time varying utility rate structures • Emissions intensity tracking of power based on real-time data (e.g., WattTime)

Grid Integrated Building Case Studies:

The Grid Integrated Building concept is new, and examples that fully exemplify this strategy, with elements of energy efficiency, distributed energy generation, storage, and load flexibility, are few and far between. Nevertheless, some leading project designers and owners have successfully implemented key elements of the vision described in this report. After reviewing numerous facility examples mentioned during BGI TG deliberations, the following two case studies have been selected to highlight here:

Case Study 1:
Marine Corps Base Albany

Size: 3,300 acres, 360 facilities

Location: Albany, New York

Key Grid Integration Features:

- First Navy Zero Energy Base, substantially increasing resilience.
- Energy efficiency: LED lighting, high efficiency transformers, lighting and boiler upgrades, controls and microgrid
- Renewable Energy: 44 MW Solar, 8.5 MW Biomass, 2.1 MW CHP using landfill gas (fully islandable)
- Load Flexibility: Peak shaving with diesel generators

Financial: $170 M, 23 year ESPC Project

More information: 2/25/2016 Albany Herald article, 11/8/2016 Buildings.com article, 8/15/2018 Energy Exchange Presentation

Case Study 2:
University of Arizona, Tucson Campus

Size: 378 acres, 216 buildings

Location: Tucson, Arizona

Key Grid Integration Features:

- Energy Efficiency: maximized chiller efficiency, reduced runtime, optimized combined heat and power (CHP) system
- Energy Storage: 205 thermal ice storage tanks totaling 30,750 ton-hours of storage
- Load Flexibility: Peak shaving by accelerating discharge of thermal storage tanks

Financial: $423,000 annual savings in energy costs (phase 1 only), plus maintenance and equipment life savings

More information: Case Study in Distributed Energy Magazine, March/April 2009

Part V: Conclusions and Next Steps

The policy recommendations in this document include a series of known and achievable actions that support grid-integrated buildings and lower costs for taxpayers, building owners, utilities, grid operators, and other key players. When considered as part of a holistic strategy that reflects regional grid needs, these actions can yield additional benefits in terms of reduced infrastructure investment, energy use and pollution.

Policy recommendations represent only the start of the process to drive the entire federal government toward adoption of grid-integrated buildings. In order to achieve success, the following implementation steps are needed:

Recommended actions for GSA, DOD and delegated agencies:

1. Increase transparency by creating and distributing information about load management opportunities and utility performance information at GSA facilities, critically including location and time of use specific energy costs and emissions factors.
2. Identify federal pilot projects. High level criteria for selecting pilot projects include criteria that identify the best business case for the federal government (e.g., high demand costs, battery storage incentives, etc.).
3. Continue coordinating with agencies and organizations involved in federal building-grid integration, including DOE's Building Technologies Office and Federal Energy Management Program, DOE labs including Lawrence Berkeley National Laboratory, Pacific Northwest National Laboratory and National Renewable Energy Laboratory, National Association of Energy Service Companies, National Institute for Standards and Technology, New Buildings Institute, Rocky Mountain Institute, US Green Building Council, GridOptimal Initiative, Northeast Energy Efficiency Partnerships, American Council for an Energy-Efficient Economy, International Energy Agency's Energy in Buildings and Communities Programme (Annex 67), ISOs/RTOs like PJM and California ISO, service aggregators, investor-owned or municipal utilities, merchant generators, and others.
4. Work to align grid integrated solutions with financing mechanisms including Energy Savings Performance Contracts (ESPCs), Utility Energy Service Contracts (UESCs), Enhanced Use Leases (EULs) and appropriated funding.
5. Use educational resources, such as GSA's SFTool (sftool.gov), to educate key federal audiences on grid integration strategies and solutions.

Next steps for BGI TG, Phase II:

1. Survey relevant work currently being done on building-grid integration.
2. Research existing federal policies into which these recommendations might be integrated and how.
3. Develop a discrete roadmap outlining how to proceed in carrying out this strategy, step by step.
4. Develop criteria for selecting pilots.
5. Consider mobility and storage challenges and opportunities.
6. Continue coordinating with agencies and organizations involved in federal grid integrated buildings efforts, listed above.