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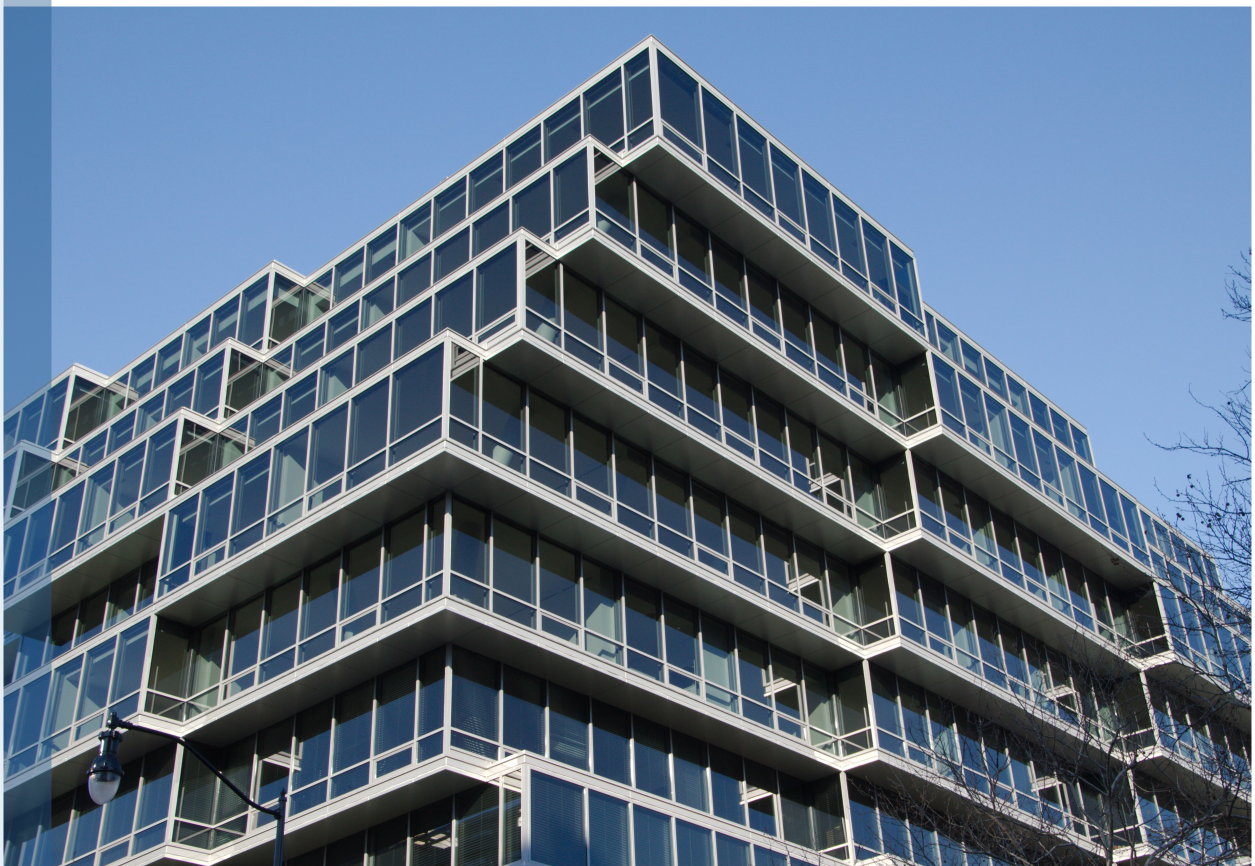

Considerations for Grid-interactive Efficient Buildings (GEB) Pilot Projects

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Introduction

Grid-interactive Efficient Buildings (GEBs) are buildings that integrate and optimize distributed energy resources (DERs)—including energy efficiency, demand response (DR), onsite generation, energy storage, and electric vehicles (EVs)—in conjunction with the electric grid to provide benefits to building owners and occupants as well as to the operation of the electricity system.[1] GEBs are *energy efficient*, are *connected* to allow two-way communication of signals between buildings (and their operators and occupants) and the grid, are *smart*, and are *flexible* to allow rapid adjustment of loads and tapping of DERs to provide grid and building services.

As the National Association of State Energy Official's (NASEO) Grid-interactive Efficient Buildings: State Briefing Paper describes, there are technical opportunities and challenges as well as policy, regulatory, and administrative drivers and impediments to implementation of GEBs.[2, 3] Pilot projects to demonstrate and validate new technologies and approaches, including GEBs and related applications of load flexibility, can be used to collect real-world data and develop experience associated with the technologies and approaches.

Pilots can physically demonstrate and generate technical and economic performance data from GEBs. There can also be policy and regulatory elements to pilots which try at a limited scale new or altered policy, administrative, or regulatory approaches. Regulatory "sandboxes" can allow low-risk experimentation under conditions of reduced legal uncertainty.[4] Pilots of new processes and approaches as well as technologies can apply to consumer-owned rural electric cooperatives and municipal/public power utilities as well as investor-owned utilities. Limited-scale pilot projects permit trials of new technologies with modest risk should the projects underperform.

Both physical performance and policy and regulatory matters need to be addressed if GEBs are to be implemented at scale. Building owners (and occupants) need to be assured that implementing grid-interactive functions will be cost-effective and will enhance (including through potential energy resilience benefits) building function and comfort. Likewise, utilities and other grid operators (such as Independent System Operators [ISOs] and Regional Transmission Organizations [RTOs]) need to derive value from and be assured of the reliability of grid services that GEBs could provide.

Also, beyond the physical performance of grid-interactive technologies, the policy, market, and regulatory regimes matter. Do building owners have financial incentives through rate structures, demand response (DR) markets, or other mechanisms for GEB technologies to pay off? Do utilities have

[1] U.S. DOE, 2019, "Grid-interactive Efficient Buildings: Overview" along with a summary GEB factsheet, U.S. DOE, 2019, "Grid-interactive Efficient Buildings: Factsheet" provide overviews of GEBs. NASEO, 2019, "Grid-interactive Efficient Buildings: State Briefing Paper" discusses of GEBs and related flexible load management topics to help states and other stakeholders discern benefits of and challenges to load flexibility to meet such state objectives.

[2] NASEO, 2019, "Grid-interactive Efficient Buildings: State Briefing Paper," op cit.

[3] This document, the NASEO briefing paper, and other resources were developed under the aegis of the NASEO-NARUC Grid-interactive Efficient Buildings Working Group, a U.S. Department of Energy and Pacific Northwest National Laboratory-supported partnership of NASEO and the National Association of Regulatory Utility Commissioners that includes 14 states. See https://naseo.org/issues/buildings/naseo-naruc-geb-working-group for more information.

[4] B. Sheahan and J. Zhang, 2019, "Experiment without penalty: Can regulatory 'sandboxes' foster utility innovation?," *Utility Dive* https://www.utilitydive.com/news/experiment-without-penalty-can-regulatory-sandboxes-foster-utility-innov/550950/.

financial incentive to invest in and rely on non-utility-owned assets to provide services? Many of these issues are discussed in the NASEO briefing paper.

This paper outlines some factors and issues that states, localities, utilities, building owners, energy service providers, and other stakeholders should consider in contemplating pilot project development. This paper does not offer a full-fledged scoping for particular pilot projects. Such scoping would require extensive technical, business, administrative, and regulatory details specific to the project.

State and Local Government Piloting Roles

There are many activities that states and, sometimes, localities can take to advance load flexibility and the implementation of GEBs.[5] Key options include supporting GEB pilots. States can support physical, policy, administrative, and regulatory pilots in multiple ways.

They can *host pilot demonstrations* in state and other public buildings. Multiple NASEO-NARUC Grid-interactive Efficient Buildings Working Group state participants are interested in GEBs for state and public buildings. State and local public facilities could have GEB-related technologies incorporated in the building at the time of construction or during significant retrofit. Energy savings performance contracting and energy-as-a-service models can serve as financing mechanisms. Some states are primarily interested in cost reductions that GEBs may offer. Many pointed to energy resilience benefits of GEBs (especially in critical facilities) that include power generation, energy storage and microgrid features. Others have "lead-by-example" goals to improve energy efficiency, reduce energy-related emissions, and improve clean energy implementation in state and public buildings. These interests suggest options for using public buildings as demonstration test beds for GEBs and other building energy technologies. This can be analogous to federal facility technology demonstration and validation projects performed through the U.S. General Services Administration's (GSA) Proving Ground (GPG) program and the Department of Defense's Environmental Security Technology Certification Program (ESTCP).[6, 7]

Indeed, opportunities for federal-state-private collaboration in pilot demonstrations can offer great benefits. As of this writing the GSA and U.S. DOE issued a joint request-for-information (RFI) soliciting load flexibility building technologies and energy services for potential demonstration in federal, non-federal public, and private buildings under the GPG, the U.S. DOE High Impact Technology Catalyst program, or both.[8]

States can *support private and public sector pilot demonstrations* through incentive programs. For example, the New York State Energy Research and Development Authority (NYSERDA) operates a Real Time Energy Management (RTEM) program that offers cost-share incentives for smart energy management system upgrades that enhance energy efficiency and include grid-interactive capabilities

[5] NASEO, 2019, "Grid-interactive Efficient Buildings: State Briefing Paper," op cit. and NASEO, 2019, "Roadmapping: A Tool for States to Advance Load Flexibility and Grid-interactive Efficient Buildings."
[6] U.S. General Services Administration, 2019, "About GSA's Proving Ground (GPG)," https://www.gsa.gov/governmentwide-initiatives/sustainability/emerging-building-technologies/about-gsa%E2%80%99s-proving-ground-gpg.
[7] U.S. Department of Defense, nd, "About ESTCP," https://www.serdp-estcp.org/About-SERDP-and-ESTCP/About-ESTCP.
[8] U.S. GSA, 2019, Request for Information https://www.gsa.gov/governmentwide-initiatives/sustainability/emerging-building-technologies/request-for-information.

supporting DR.[9] Building on RTEM, NYSERDA is developing a Grid-responsive Energy Management (GEM) program to enable buildings to act as virtual batteries, using controls and intelligent automation to rapidly shed and shift loads.[10]

States can also *create policy, market, and regulatory conditions that are conducive to allowing GEB pilot projects*. As noted, a regulatory "sandbox" can allow low-risk experimentation under conditions of reduced legal uncertainty.[11] The process and opportunity for piloting new administrative and regulatory procedures, rate structures, compensation mechanisms, and other matters will likely vary not only across states but also within a given state depending on whether the electric utility serving a proposed pilot project is investor-owned, municipal or other public power, or a rural cooperative. In most states, investor-owned utility regulation is under Public Utility Commission (PUC) jurisdiction.[12] Municipal utilities are under local government control while electric cooperatives are governed by a Board of their member-owners. The utility type, its governance, and its regulatory and rate structures can be important factors affecting pilot project viability.

In some cases, PUCs may have authority to approve or even require innovative, non-traditional approaches which can serve as pilots. One example is the New York Public Service Commission's approval of Consolidated Edison's Brooklyn Queens Demand Management (BQDM) Program as a "non-wires solution" (also called "non-wires alternative") to a local distribution system congestion problem.[13] In other cases, there may be funding to support pilot projects. For instance, the Colorado PUC approved Xcel Energy's establishment of an Innovative Clean Technology (ICT) program in 2009 to test emerging technologies.[14] The ICT is now supporting two Xcel Energy demonstration projects focused on GEB-relevant battery applications for peak reduction, solar integration, backup power, load shifting, and ancillary services.[15] Southern Company's Alabama Power and Georgia Power are implementing two Smart Neighborhood Initiative projects under pertinent utility commission authority.[16]

Other state policies that impinge on electric power markets are also salient considerations for pilot project design and implementation. Multiple DERs interacting in GEB pilots should be considered for their impacts on wholesale power markets where those exist. Pilot GEB and flexible load management

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[9] NYSERDA, nd, "Real Time Energy Management (RTEM) Program," https://www.nyserda.ny.gov/All-Programs/Programs/Real-Time-Energy-Management.

[10] NYSERDA, 2019, slide deck provided to NASEO https://annualmeeting2019.naseo.org/data/energymeetings/presentations/NYSERDA--RTEM-GEM.pdf

[11] Sheahan and Zhang, op cit.

[12] The term Public Utility Commission is used also to refer to Public Service Commissions, State Corporation Commissions, Utilities Boards, and similar bodies.

[13] While not a GEB project, BQDM is notable for the New York PSC's first ever requirement for a utility to address growth through means other than traditional utility investment. AEE Institute, Rocky Mountain Institute, America's Power Plan, nd, "Case Study: Navigating Utility Business Model Reform, Brooklyn Queens Demand Management Program—Employing Innovative Non-wires Alternatives," https://info.aee.net/navigating-utility-business-model-reform-case-studies.

[1414] Xcel Energy, 2016, "Innovative Clean Technology Program," https://www.xcelenergy.com/staticfiles/xe/PDF/Marketing/CO-Innovative-Clean-Technology-Info-Sheet.pdf

[15] E. Maurer and N Cowan, 2019, NASEO-NARUC Grid-interactive Efficient Buildings Working Group webinar presentation, Xcel Energy, https://naseo.org/event?EventID=6945.

[16] J. Leverette and J. Hill, Southern Company, 2019, "Southern Company's Smart Neighborhood Initiatives," NASEO-NARUC Grid-interactive Efficient Buildings Working Group webinar presentation, https://naseo.org/event?EventID=6945. Note that these projects included *shareholder* investment expenditures.

project effects on energy savings, renewable generation, emissions, and peak demand can be evaluated as compliance approaches for energy efficiency resource standards (EERS), renewable portfolio standards (RPSs), clean energy goals, and emerging peak mitigation policies such as Massachusetts' new Clean Peak Standard. Pilots may be able to inform development or alteration of such policies, programs, and regulations too, perhaps helping to better align and integrate what are now often unaligned programs.

Pilot Project Scoping Considerations

Pilot project developers need to consider numerous technical, economic, business, policy, administrative, and regulatory factors in designing projects. Policymakers and regulators also need to be cognizant of these if they wish to have support for pilot projects that advance GEBs and the use of load flexibility. Successful pilot project development requires the participation and cooperation of various stakeholders with differing perspectives, interests, and incentives. "Buy-in" of these varied stakeholders is critical.

Also, there can be high-level policy drivers such as Governors' Executive Orders or legislation supportive of GEBs and use of load flexibility to enhance electricity system operations, economics, reliability and resilience, and environmental performance. For example, Executive Orders establishing public building goals could provide impetus for public sector pilots. State energy plans, roadmaps, and action plans developed under executive branch or legislative authority could also instigate and channel pilot project development.

Building Owner Financial Compensation, Rates, and Markets

Building or facility owners generally will require a financial benefit to justify investment in load flexibility capabilities and providing load flexibility as a grid service.

Utility rates and their structures

Time-of-use rates or other time-differentiated charges provide an opportunity for financial savings from shifting demand from times when power is more expensive to when it is less expensive. *Demand charges* based on a facility's peak demand during a billing period also provides a financial incentive to schedule loads to reduce peaks. Adjustment of load through staging and scheduling of energy uses, precooling of buildings, thermal and electrical energy storage, and onsite power generation can all play roles to reduce utility costs, providing motivation to building owners and potential business opportunities for energy service companies (ESCOs) and other firms.

Current opportunities may be limited but future rate structures could become more dynamic to accommodate and provide compensation for a range of grid services provided by customer-side DERs.

Demand response program incentives

Utilities and other grid operators (e.g., ISOs/RTOs) may offer demand response (DR) programs under which participants can receive payments or bill credits for reducing demand in response to utility or grid operator signals. Some utilities offer "critical peak pricing" programs too that can provide additional load management incentive.[17] The availability of such programs can provide financial benefit to GEBs.

[17] Under critical peak pricing, participating customers can save additional money by curtailing or shifting away load during critical periods that are identified a day ahead by the utility.

Wholesale power markets

Some areas of the United States, such as those covered by the ISOs PJM and ISO-New England, allow DR and energy efficiency to be bid into capacity markets. The availability of a market and ability of a building owner (or ESCOs and energy service aggregators) to participate provide a cash flow that can encourage load flexibility.

Other Markets

The presence or absence of other market opportunities should also be considered in developing pilot projects. A GEB pilot could be useful for evaluating GEBs to help meet state clean energy standards or RPSs, Clean Peak Standards, or other energy and environmental requirements. For example, onsite photovoltaics at a GEB may generate renewable energy certificates (RECs) that the utility might purchase for compliance purposes while providing cash flow to the GEB owner. Also, a GEB may be managed to improve grid-scale renewable power utilization and reduce curtailment events, again supporting RPS or clean energy standard compliance. The Massachusetts Clean Peak Standard will offer opportunities for GEBs incorporating qualifying renewable generation and energy storage to earn REC-like Clean Peak Energy Certificates.[18]

Energy Reliability and Resilience Benefits

Potential energy reliability and resilience benefits can also be a driver of GEBs and be a consideration for siting and designing GEB pilot projects. Reliability (including of power quality) and resilience against potential disruptions can work on at least two levels—at the building or facility and on the broader grid.

Energy efficiency, smart load management, onsite generation (solar, fossil, or others), and energy storage can also be combined and configured as a microgrid to provide energy resilience to buildings, campuses, and communities, allowing them to operate (especially critical functions) during grid outages. Microgrid-equipped facilities need not necessarily include GEBs. However, load flexibility found in GEBs can optimize building performance both when grid-connected and when operating off the grid in "islanded" mode, thus supporting facility resilience.[19] Critical facilities, such as hospitals, public safety and security facilities, military installations, and water and wastewater facilities, can be considered for demonstration and validation of microgrid, load flexibility, and GEB functions. Those considering such applications should look at existing cases, whether fully grid-interactive or not, to learn from past experience. The aforementioned ESTCP program has demonstrated relevant technologies and there are a growing number of civilian facility examples.[20]

Also, there are relevant grid-interactive pilots in residential communities that can inform additional demonstrations in other states and contexts. One example is Alabama Power's Reynolds Landing Smart

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[18] Massachusetts Department of Energy Resources, 2019, "The Clean Peak Energy Standard: Draft Regulation Summary," https://www.mass.gov/files/documents/2019/08/07/Draft%20CPS%20Reg%20Summary%20Presentation%208.6.pdf.

[19] With constrained onsite energy storage and power generation, which may also be variable (e.g., solar), load flexibility to balance generation and consumption, including assuring power quality, may be more critical when islanded than when grid-connected. Load flexibility may also allow better prioritization of loads during an extended outage.

[20] Though having limited grid interaction, Montgomery County's (MD) microgrid projects provide an example of a civilian application at its Public Safety Headquarters and a correctional facility, https://www.montgomerycountymd.gov/dgs-oes/Microgrids.html.

Neighborhood project where a community microgrid enables islanded operations in the event of a grid outage, [21] Another example, from Vermont, is Green Mountain Power's Grid Transformation Pilot, designed to allow utility control of home-sited batteries for peak demand management that enabled 1,100 homes to remain powered during a weather-induced blackout on October 2019.[22]

GEBs provide grid services such as load shedding, shifting, and modulation that can alleviate local distribution level grid congestion stresses.[23] Pilot location decisions could consider existing or expected (due to predicted load growth) areas of congestion and stress where a GEB can become part of a non-wires solution. Non-wires solutions provide a lower cost alternative to conventional utility distribution system investments for enhancing power reliability and quality.

Utility Type, Governance, and Motivation

As noted, the electric utility type—investor-owned, public power/municipal, or cooperative—can affect the context for a pilot because of different governance, regulatory oversight, and compensation structures. These can affect a utility's motivation toward piloting new approaches, including reliance on GEBs and DERs generally, and approval processes enabling the projects to occur.

PUC engagement and approval will generally be required for investor-owned utility projects. Consumer advocates including the state's Office of Consumer Counsel or similar body should also be engaged to assure that consumer/ratepayer interests are well represented. The governing bodies of public power utilities or Boards of Directors for cooperative utilities would need to approve pilots performed by their utilities.

Physical pilot projects may include policy and regulatory pilot components to try new administrative and regulatory approaches. Interest in or amenability to non-wires solutions, performance-based regulation and utility compensation, utility-customer shared savings approaches, and rate-basing of certain non-capital utility investments may provide utilities motivation to support GEB pilots. These topics, including some examples, are discussed in the NASEO GEB briefing paper.[24]

Business Models and Ownership and Control of DERs

Closely interacting with issues of utility incentives or hindrances to relying on GEB-provided grid services is the nature of ownership and control of the DERs in a GEB project.

In some pilot projects, many or all of the DERs are owned and directly operated by the utility. For example, in the Alabama Power Reynolds Landing development, the utility owns and operates a microgrid featuring solar and natural gas generation and battery storage while households own energy efficient appliances in their homes.[25] In the aforementioned Green Mountain Power Grid

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[21] J. Leverette and J. Hill, Southern Company, 2019, "Southern Company's Smart Neighborhood Initiatives," NASEO-NARUC Grid-interactive Efficient Buildings Working Group webinar presentation, https://naseo.org/event?EventID=6945.

[22] J. Spector, 2019, "Batteries vs. Blackouts: 1,100 Homes Powered Through Vermont Outage with Storage," Greentech Media (Nov. 7), Green Tech Media, https://www.greentechmedia.com/articles/read/green-mountain-power-kept-1100-homes-lit-up-during-storm-outage.

[23] GEBs can mitigate wider grid stresses but this paper focuses on individual pilot demonstrations that are unlikely to have wide scale system impact. However, data derived from individual pilots can be used to estimate aggregate impacts from implementation at scale.

[24] NASEO, 2019, "Grid-interactive Efficient Buildings: State Briefing Paper," op cit.

[25] Leverette and Hill, op cit.

Transformation Pilot, the utility owns and controls customer-sited batteries.[26] A similar New Hampshire residential battery pilot project is starting with utility-owned residential batteries but plans to provide opportunity for third-party companies to offer batteries and service.[27]

Third-party companies have served as DR aggregators and provide energy services through energy savings performance contracts (ESPCs), energy-as-a-service structures, and other arrangements. Through ESPCs, ESCOs provide billions of dollars annually in energy efficiency upgrades in U.S. federal, state, local government, and institutional (e.g., hospitals, schools, universities) markets. A pending advice letter to the GSA recommends options for using ESPCs to further federal building-grid integration.[28] Its advice is pertinent to non-federal public sector and institutional GEB pilot opportunities too.

Energy-as-a-service structures can be innovative. For example, though with limited grid-interaction, Montgomery County, MD installed microgrid projects at its Public Service Headquarters and a correctional facility to provide resilience to public safety and security critical facilities. The project, which includes photovoltaics, natural gas-fueled combined heat and power, electric vehicle charging stations, and associated controls and cyber-security features, was structured as a public-private partnership with Duke Energy Renewables, which is contracted to own and operate the system over its planned 25-year life, and Schneider Electric, an ESCO responsible for construction and maintenance.[29]

The point is that GEB pilot projects could be performed under various business models and project structures. Responsibilities, costs, and compensation details would likely need to be negotiated for each pilot project though existing cases can provide models. Project developers and hosts also need to carefully consider applicable state and local laws and regulations, including procurement requirements and procedures. States differ in their ESPC authorities and restrictions. In a given jurisdiction, laws may or may not allow a Montgomery County-type arrangement of a private firm owning components of a public facility.

Utilities may prefer direct ownership of DERs even if customer-sited, which may be easier to rate-base under traditional utility regulation. However, a building owner may prefer to own the DER assets directly or use third-party ownership arrangements.

A GEB's interactive features could be directly under a utility's control or control may be mediated through a building energy management system or via a third-party operator to respond to a combination of grid signals (technical and price) and owner preferences. Utilities may prefer full control to assure the response it wants, in essence "dispatching" the GEB's DERs. However, an owner may want to retain control to allow options. For example, a facility may have a special event or circumstance and want to override a load shed or shift signal, or a household may need to charge an electric vehicle during

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[26] J. Spector, 2019, "Batteries vs. Blackouts: 1,100 Homes Powered Through Vermont Outage with Storage," op cit.
[27] J. Spector, 2019, "New Hampshire Approves Groundbreaking Home Battery Pilot to Fight System Peaks," (January 23) Green Tech Media, https://www.greentechmedia.com/articles/read/new-hampshire-approves-groundbreaking-home-battery-pilot .
[28] GSA Green Building Advisory Committee, 2019 (pending), "Federal Building and Grid Integration: Proposed Roadmap Advice Letter."
[29] Montgomery County (MD), Department of General Services, Office of Energy and Sustainability, nd, "Public Safety Headquarters Microgrid," https://www.montgomerycountymd.gov/dgs-oes/MGP-PSHQ.html.

a peak period; in both cases owners can make the decision though with a cost or foregone revenue/incentive.

These types of details should be considered in developing a GEB pilot project.

Grid-interactive DER Types and Combinations

The number and types of GEBs, and the grid services desired of them, will also influence the nature and scope of a GEB pilot. Some existing pilots cited in this document focus on batteries. Others include combinations of onsite generation (renewable and fossil) and storage. The degree of onsite load management can vary too, from residential smart thermostats to sophisticated building management and automation systems.

Simpler pilot projects may include only one DER type, limited grid-interaction, and simpler grid services (say, automated DR during peak periods). Such projects should be easier to design and run than projects demonstrating broader capabilities and deeper integration of grid-interactive resources. However, more complex demonstrations may better show the functionality and value of GEBs.

Sectors and Building or Facility Type

In targeting potential pilot locations and hosts, the building or facility type as well as the sector it serves and who the owners are matter. Different building types have different features and usages—including levels of electricity demand and load shapes—affecting GEB grid-service functionality and value. The choice of building or facility type should contemplate how the pilot results can inform the design of other buildings and renovation projects. Will the pilots provide results that are widely usable and applicable for furthering GEB implementation?

The sector served and ownership type can also be important for pilot project design, potential for success, and application of results. As discussed previously, public facilities can be attractive sites for GEB demonstrations based on state and public interests in monetary savings, resiliency, and achieving environmental goals. They are also attractive due to stable, long-term ownership relative to commercial properties. They can also be more amenable to ESPC, energy-as-a-service, and other business model approaches than commercially-owned facilities too.

A pilot project could be focused on individual buildings or on wider campuses and communities. An example of the former is the previously discussed NYSERDA RTEM program that will be enhanced to include greater grid-interactive functionality. Other projects serve campuses or other multi-building installations. Still others, like the Southern Company Alabama Power project and a related Georgia Power Smart Neighborhood project and the Colorado Residential Retrofit Energy District (CoRRED) led by the Colorado Energy Office cover communities.

Still another consideration is whether to target existing buildings or new construction. New construction pilots can incorporate GEB technologies and features from the beginning and can be designed to ease monitoring and measurement of performance. However, the greatest potential for GEBs and their grid and wider benefits lie with existing buildings. RTEM, previously cited residential battery pilots, and CoRRED serve as good examples of pilots for existing facilities.

Conclusion

Pilot projects to demonstrate and validate new technologies and approaches—including GEBs and related flexible load management—can be used to develop real-world datasets and experiences needed to give decision-makers confidence that the new approaches work and to inform further development and improvement if they underperform.

For GEBs, multiple stakeholders need to be assured that grid-interactive functions will deliver benefits and not adverse consequences. Owners and occupants need to perceive cost-effectiveness, improved function or service (including resilience sometimes), and improved (or at least not diminished) comfort and amenity. Utilities and sometimes other grid operators need to discern value through financial and operational improvements. Policymakers, utility regulators, and others also require assurances of benefits.

Pilots include physical demonstrations that generate technical and economic performance data. They can also include policy and regulatory pilots to try at a limited scale new or altered approaches, allowing policy and regulatory experimentation with low risk and reduced legal uncertainty.

This paper outlines factors and issues that multiple stakeholders—states, localities, utilities, building owners, energy service providers, and others—should contemplate in developing pilot projects. This paper does not offer a full-fledged scoping for particular pilot projects. Such scoping would require extensive technical, business, administrative, and regulatory details specific to the project.