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An Overview of the U.S. Better Buildings Initiative as a Model for Other Countries

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Key Acronyms and Definition

Better Buildings Initiative (BB Initiative): The BB Initiative is a six-year-old initiative with four main pillars: Market Leadership, Better Information, Federal & Community Leadership and Workforce Development, aimed at reducing energy intensity in the commercial, residential and industrial sector by 20% by 2020, is one of the national leadership initiatives that help achieve this goal.

Better Buildings Challenge (BBC): BBC is a voluntary public-private partnership that invites organizations to commit to a 20% improvement in their buildings' energy intensity over a decade.

Better Buildings Alliance (BBA): BBA is another key partnership under the BB Initiative. BBA offers peer networking and technical assistance to commercial building owners, managers, and tenants, including BBC participants.

Better Communities Alliance (BCA): The BCA is a partnership that brings together local government leaders, businesses and institutions to deliver energy efficiency, sustainable transportation, and renewable energy solutions to communities.

Better Buildings Accelerators (BB Accelerators): BB Accelerators are collaborative peer-to-peer networks designed to demonstrate innovative policies and approaches, which fosters learning and leadership opportunities that result in new strategies and more investment in clean energy deployment and energy efficiency.

Better Buildings Summit (BB Summit): The U.S. Department of Energy hosts an annual Better Buildings Summit where partners convene to share best practices, market and technology solutions and future opportunities for energy efficiency. High-level DOE leadership typically attends the event.

1. Introduction

In the United States, residential and commercial buildings consumed about 27% and 19% of total primary energy in 2016, respectively [1]. Improving the energy efficiency of buildings is of great importance in creating jobs, saving money, reducing dependence on foreign oil and improving air quality [2]. The Better Buildings (BB) Initiative, aimed at reducing energy intensity in the commercial, residential and industrial sectors by 20% by 2020, is one of the national leadership initiatives that help achieve this goal.

This report offers a comprehensive overview of the U.S. BB Initiative, including the program structure, management and implementation. The report also summarizes lessons learned for a U.S. audience and offers approaches that might be replicated in China and elsewhere.

The BB Initiative is a six-year-old initiative with four main pillars: Market Leadership, Better Information, Federal & Community Leadership and Workforce Development (Figure 1). Within the market leadership pillar, there are three key programs: Better Buildings Challenge, Better Buildings Alliance, and Better Buildings Accelerators. Each of these programs complements each other, BB's successes, along with its evolution over time, offer an example of how, with the right tools, the government can partner with businesses to achieve significant strides in energy efficiency.

Figure 1. Program Structure of the U.S. Better Buildings Program [3]

2. Better Buildings Initiative

2.1. Overview

The Better Buildings program uses a multi-pronged approach to drive improvements in energy efficiency across the residential, commercial and industrial sectors. Launched in 2011, the program targets a 20% improvement in energy efficiency across different types of buildings over a 10-year period. BB recruits building owners and managers, along with other key stakeholders such as utility and corporate executives, with the targets of lower energy bills, upgraded property, a lower carbon footprint and the chance to create more jobs. A U.S. Department of Energy (DOE) program, BB promotes energy efficiency at sites ranging from universities to manufacturing facilities to office complexes. In 2013, it was expanded to include multifamily residential housing, while targeted accelerators were created to overcome challenges in areas such as data management and outdoor lighting.

To understand the premise of Better Buildings, DOE outlined four core areas of focus in accelerating energy efficiency in the U.S.:

(1) Develop innovative and replicable market solutions: DOE works with leading organizations across diverse market sectors, including public, private, commercial, industrial, multifamily housing, financial and utilities. Market leaders showcase energy efficiency solutions and share their experience in achieving deep savings.

(2) Make energy efficiency investment easier: DOE provides information critical to accelerating investment and access to financing. DOE aims to provide building owners access to existing financing mechanisms, helping building owners and financial institutions to make smart energy efficiency investment decisions.

(3) Develop a skilled clean energy workforce: DOE supports development of guidelines for accrediting organizations that provide training and certification programs for energy efficiency professionals including energy auditors, building operations technicians, commissioning professionals and energy managers. Training programs that meet these accreditation requirements can apply to use a Better Buildings recognized training logo, a stamp of approval.

(4) Lead by example in the federal government: The U.S operates a total of 360,000 federal buildings. An executive order in March 2015 directed federal agencies to reduce energy use in federal buildings by 25% and reduce water intensity by 20% through 2025 [4]. The federal government set a target to invest $4 billion in federal building energy efficiency by 2016, with no cost to taxpayers, through energy savings performance contracts (ESPC), which apply long-term energy savings to pay for upfront project implementation costs [5].

2.2. Managerial Structure

DOE runs the Better Buildings Initiative. It relies on various contractors to carry out strategic, sometimes technical tasks. The government contracts with firms with expertise in building energy efficiency and program deployment across a broad array of sectors.

Contract staff support Better Buildings in several primary areas: partner account management, communication and branding, and data analytics and program evaluation. Each category has a few subcategories, which are supported by different DOE contractors. Figure 2 shows the structure of the support.

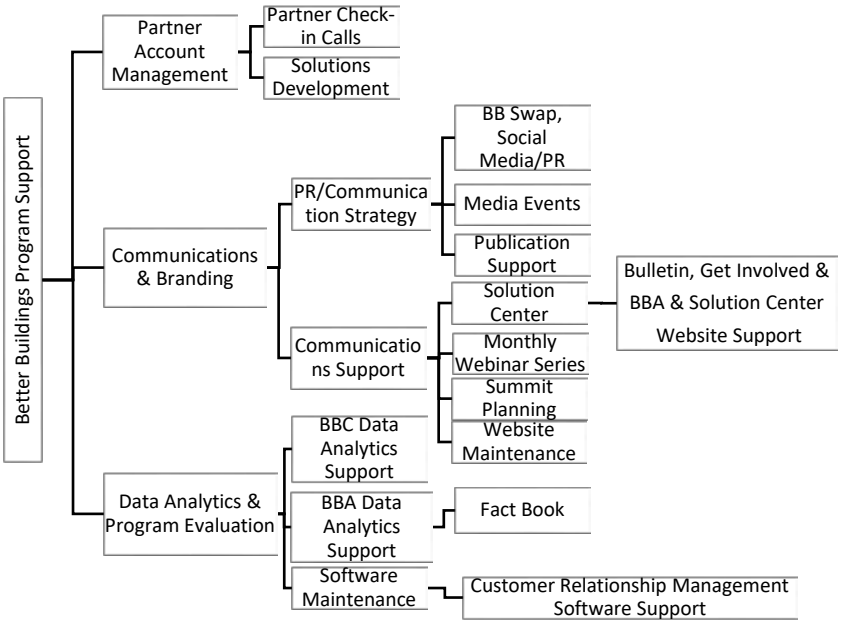

Figure 2. Structure of Better Buildings Program Support

2.3. Financial Support

DOE funds the implementation of the Better Buildings program. ***DOE does not pay for partners' building energy efficiency upgrades.*** Partner support and technical expertise accounts for roughly half of the Better Buildings annual budget. The remaining 50% is allocated roughly equally between communications, the annual Better Buildings Summit, program management and the Better Buildings Solution Center[1].

[1] DOE hosts the Better Buildings Summit every year to provide a platform for partners to share best practices and future opportunities for energy efficiency. For more information,

DOE funds a small number of scientists at the national labs to provide technical expertise to Better Buildings Alliance partners participating in Technology Research Teams focused on various building systems (e.g. refrigeration, energy management information systems, or lighting and electrical). This support typically takes the form of peer calls and webinars with partners focused on relevant technology topics, resource development (such as technology performance specifications), and in-person presentations and one-on-one consultations at the annual Better Buildings Summit. (*Also see 3.2.2. Better Buildings Alliance and 3.2.3. BBA Technology Campaigns*)

3. Better Buildings Initiative Key Programs

3.1. Better Buildings Challenge

3.1.1. Overview

The Better Buildings Challenge (BBC) is a voluntary public-private partnership that invites organizations to commit to a 20% improvement in their buildings' energy intensity over a decade. This establishes participants as market leaders in energy efficiency, earning them recognition from DOE and access to technical assistance. The Better Buildings Challenge is the initiative's "leadership circle," which calls on organization leaders to sign a pledge to reduce energy consumption in buildings that they own.

There are two groups of participants in BBC. The first group includes organizations that pledge to save energy, such as building owners, municipalities, and manufacturing firms. They will (1) pledge an organization-wide energy savings goal; (2) share their successful strategies via showcase projects and implementation models and (3) track progress toward the goal by sharing building-level energy data of their portfolio annually. For an example, please see Appendix A.

The second group of participants is "allies," which include financial institutions and utilities. Financial institution allies each make a private capital commitment of $25 million to energy efficiency projects in the United States. Together, financial allies have made a combined public commitment of $5.5 billion. Utility allies

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please see section 3.3.5. The online Better Buildings Solution Center is a very important component of the BB Initiative. The Solution Center collects case studies of retrofits that building owners can find based on the needs of their own properties. For more information, please see section 3.3.2.

provide energy usage data access to building owners and energy efficiency programs for commercial customers [6].

3.1.2. How BBC was Established

DOE staff reached out to executives whose organizations were involved in energy efficiency efforts to engage them on the program idea. With an initial email briefly describing the BBC, DOE staff offered the opportunity to discuss by phone with potential BBC candidates more details on the program's history, partnerships, and benefits. A key initial benefit of participating in the Better Buildings Challenge was being featured in a White House press release when the program was officially launched. The opportunity to attract positive public attention and the chance to reduce energy costs greatly incentivized energy managers within corporations to encourage their executives to join the BBC [7].

After assembling the first group of leaders, DOE announced the launch of the Challenge. While this is a U.S. Department of Energy program, the kick-off was held at the White House and attended by the President and CEOs of organizations that joined as initial partners. Fourteen initial partners committed more than 260 million square feet of floor area to the program when it was formally announced in June 2011 [8]. After the public announcement, DOE continued to recruit new partners. By the end of 2016, leaders from more than 345 organizations have committed to BBC, representing more than 4.4 billion square feet of commercial and industrial real estate [6].

3.1.3. Managerial Structure

In the Better Buildings Challenge program, partners are categorized and supported by the BBC administrative team based on their sectors. There are 10 program sectors:

- Commercial real estate
- Hospitality
- Healthcare
- Retail
- Food service and grocery
- Multifamily
- K-12 (primary and secondary education) schools and higher education
- State, city and local governments
- Data centers
- Financial allies

Each sector is managed by a DOE lead, a subject matter expert (SME), and account managers [9]. Account managers and SMEs are staff from DOE contractors. Account managers support DOE leads to assist with recruitment, tracking partners progress, drafting case studies, check-in calls with partners, and other services. Figure 3 shows the structure of Better Buildings Challenge partners' support system.

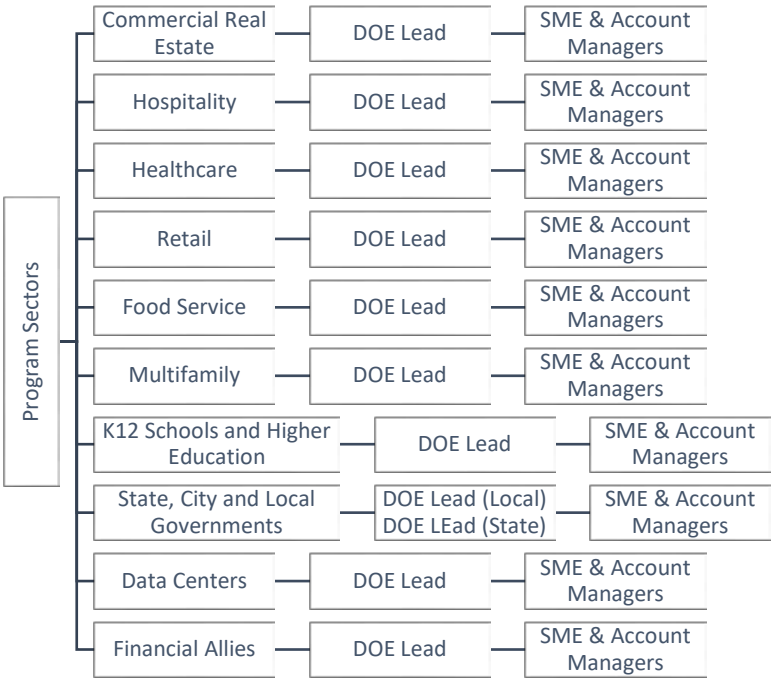

Figure 3. Structure of Better Buildings Challenge Partners' Support System

Account management is key to maintaining partner relationships and tracking achievements. The program administrative team uses customer relationship management (CRM) software to track interactions with Better Buildings partners. The CRM software helps the management team organize detailed information about program partners. DOE Leads and/or the account managers check in with partners by phone two to four times per year to learn about their success and challenges in energy efficiency and understand how DOE can better support progress toward their goals. The CRM software helps the management team organize detailed information about program partners.

In addition to the administrative team, participation from DOE leadership also ensures that the program is running smoothly. DOE leadership participation includes traveling to media events with partners, speaking at the Better Buildings Summit and other events.

3.1.4. Communication and Recognition

The Better Buildings Solution Center[2] is the main portal for BB partners to access information, as well as for the public to gain insights on how BBC partners participate in the program and what they have achieved (Figure 4). The website is also the hub to all aspects of the BB Initiative, including the Better Buildings Alliance, Better Buildings Accelerators, and Better Buildings Summit. *(Also see 3.3.2 Better Buildings Solution Center)*

The website has a map showing BBC partners across the U.S. that have made a pledge. Each partner has its own profile page showcasing its company information, challenge commitment, and portfolio energy performance progress. These online data displays are posted when partners share building-level energy data, which must pass quality checks, and include data for at least 80% of their square footage commitment.

Figure 4. A Screenshot of the Better Buildings Homepage[3]

In addition to the partner profile, the website spotlights success stories through showcase projects and implementation models. Over 180 showcase projects highlight individual buildings achieving 20% or greater energy savings. Each showcase project page includes detailed information on the project such as

[2] The Better Buildings Solution Center website: http://betterbuildingssolutioncenter.energy.gov
[3] Accessed date: June 26, 2017

project name, location, building type, square footage of building impacted; specific measures and solutions implemented and their associated costs and savings; annual energy use and savings; and annual energy cost. DOE provides a showcase project template to collect information from partners or account managers use this template to collect information from partners by phone.

Implementation models describe partners' organizational changes to promote energy efficiency and replicable pathways for energy efficiency deployment. The solution identified in the implementation models is expected to address a key barrier to energy or water efficiency within the organization or the public sector. Implementation models usually do not focus on technology but rather new project financing methods, standard operating procedures, or engagement with staff or customers, which facilitate energy savings. DOE provides a template to help partners define and develop implementation models. This helps DOE collect detailed information on the approach that the partner took to create the sustainable solution. The template fields include:

- The organization's goal or desired outcome and their associated barriers
- Solutions to improve energy or water efficiency
- Policies, process and outreach efforts developed
- Planning, partnerships, financing and data management developed to execute those efforts
- Key metrics to measure success
- Expected annual cost savings once the implementation is complete
- Materials and tools used or created to achieve energy saving goals

Gaining national-level recognition is one of the key benefits partners can enjoy by participating in the BBC. Partners are recognized at the annual Better Buildings Summit, as well as through media outreach and press releases, annual reports, articles in publications when reaching savings milestones and achieving the ultimate 20% goal. For example, in August 2016, DOE published a press release recognizing the fast food company Wendy's and a franchisee for leadership in energy performance[4]. Partners also receive recognition through organized media events onsite at their facilities, speaking engagements with DOE at conferences,

[4] For the press release, please visit: https://betterbuildingsinitiative.energy.gov/sites/default/files/news/attachments/US%20Department%20of%20Energy%20Recognizes%20the%20Wendy%27s%20Company%20-%20Press%20Release.pdf

Better Buildings blog[5] and social media posts. Partner media stories are also collected on the BB newsroom, on the program website[6].

3.1.5. BBC Components

3.1.5.1. Goal Setting

Better Buildings Challenge partners commit to an energy reduction goal of at least a 20% (energy use per square foot) over 10 years across their U.S. building portfolio. Partners can choose a baseline year up to three years before joining the program and provide their energy savings data and energy efficiency strategies. The minimum 20% reduction goal was set by DOE under the principle that the goal should be challenging but achievable with a reasonable payback.

Many of the participants have surpassed their goals within the 10-year period, and continue to strive for further improvements. BBC partners are asked to commit their entire U.S. building portfolio, but may exclude up to 5% of the square footage, though exclusion is very rare and addressed on a case-by-case basis. If partners cannot perform energy efficiency upgrades in certain facilities or have no access to energy data in a building, then DOE may allow them to exclude that square footage from the commitment.

3.1.5.2. Data Gathering, Reporting, Verifying and Sharing

The BB Initiative trusts partners to provide quality data to the best of their ability. Partners share monthly building level energy use for their full portfolio with DOE on an annual basis. The BB Initiative conducts checks for anomalies (extremely high, low or missing energy use intensity for building types) and returns a report to partners so they can make corrections if needed, which is a value-add to partners to help them improve data quality.

The Better Buildings Challenge has a detailed energy data tracking manual describing how partners' data are collected, analyzed, and published. Additionally, the BBC's data manual addresses issues regarding changes in a building portfolio, such as new construction property sales, and weather normalization of energy use data [10]. DOE is very careful to get partner permission before posting any information about a partner online. To ensure partners' privacy, detailed building-specific data is not on the Better Buildings website.

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[5] Better Buildings blog website: https://betterbuildingsinitiative.energy.gov/beat-blog

[6] Better Buildings newsroom website: https://betterbuildingsinitiative.energy.gov/newsroom

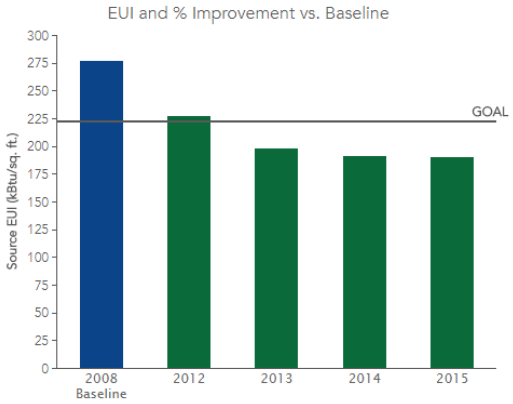

Figure 5. Aggregated Data of Best Buy's Energy-saving Effort

As seen in Figure 5, specific building energy data is not depicted, but changes in portfolio-wide energy use intensity (EUI) are shown on the website. In this way, the BBC protects partners' privacy while acknowledging their achievements. All data published on the Better Buildings website must be approved by partners.

DOE encourages partners to use ENERGY STAR® Portfolio Manager (Portfolio Manager thereafter), a free online interactive tool created by the U.S. Environmental Protection Agency (EPA) for the U.S. market. The tool determines a building's total energy performance score and allows users to track and assess energy consumption. Portfolio Manager can be used to (1) track energy and water (voluntary) consumption of a building; (2) set energy use priorities; (3) monitor progress; (4) verify energy improvements; and (5) compare energy use against other similar buildings.

The Portfolio Manager performs weather normalization and adjusted energy calculations to account for changes in operation over time, and allows for easy sharing of data with DOE. If a partner is not using Portfolio Manager, DOE can provide support to establish a Portfolio Manager account, upload property and energy use data, and share access with DOE. Data can be entered manually, through a spreadsheet upload option, or automatically through web services that exchange data directly. If a partner is using an alternative software tool for tracking energy data, DOE will work with the partner to review the tool to determine whether it provides the required information and consistency in calculations for tracking progress. Once DOE has approved the alternative tracking mechanism, the partner will submit energy consumption data every year

using the Better Buildings Challenge Data Collection Template (a Microsoft Excel spreadsheet template), available from DOE on request [10].

Data verification is very important to ensure the energy consumption reduction is valid and allows DOE to provide appropriate recognition for partners, publicize program-wide accomplishments and ensure program integrity. The primary verification approach is a data review to check for anomalies in property energy intensity and its components, such as square footage and current energy consumption for all fuels. If key data elements fall outside established error bands, DOE will follow up with partners and ask them to correct or explain anomalies in the data.

Anomalies often take the form of missing energy consumption data, unit conversion errors, incorrect hours of operation, and occupancy levels. DOE prepares a document that summarizes “flagged” property and data fields requiring completion or verification for each partner submitting the required level of data. Partners complete or update any missing data, as well as edit or confirm any other questionable data before results are shared publically.

3.1.5.3. Benchmarking

Benchmarking is an essential part of the Better Buildings Challenge. Partners receive data comparing their own facilities to one another and identify how they could improve on their energy efficiency performance. There are five important benchmarking indicators: (1) site EUI, (2) site total energy use (kBtu), (3) site electricity use (kWh/quarter), (4) site natural gas use (therms) and (5) weather-normalized source change from a baseline percentage.

Better Buildings Challenge partners strive to decrease portfolio-wide source EUI and to increase the percent improvement compared to a set baseline. For commercial buildings, EUI is generally measured in terms of energy use per square foot (kBtu/sq. ft). Energy use is tracked at a facility level [10]. Industrial and food service partners have the option to track kBtu per widget or transaction. EUI can be useful in comparing the energy use of facilities of different sizes and are commonly adjusted to account for changes in weather or operating conditions over time. Each facility has its own EUI baseline from which a company can easily identify possible future energy efficiency improvement opportunities.

A typical benchmarking process includes assessing the effectiveness of current operations, policies and practices; identifying and prioritizing energy efficiency opportunities; verifying and monitoring pre- and post-project energy use through

changes in operations and equipment; and tracking greenhouse gas (GHG) emissions and energy costs.

Many cities, states and counties have passed laws or policies to require energy benchmarking and transparency for large buildings (Figure 6). For example, California state law (Assembly Bill 1103), effective since July 1, 2013, requires buildings over 5,000 square feet to be energy benchmarked using a tool such as Portfolio Manager when an entire building is sold, leased or refinanced [11].

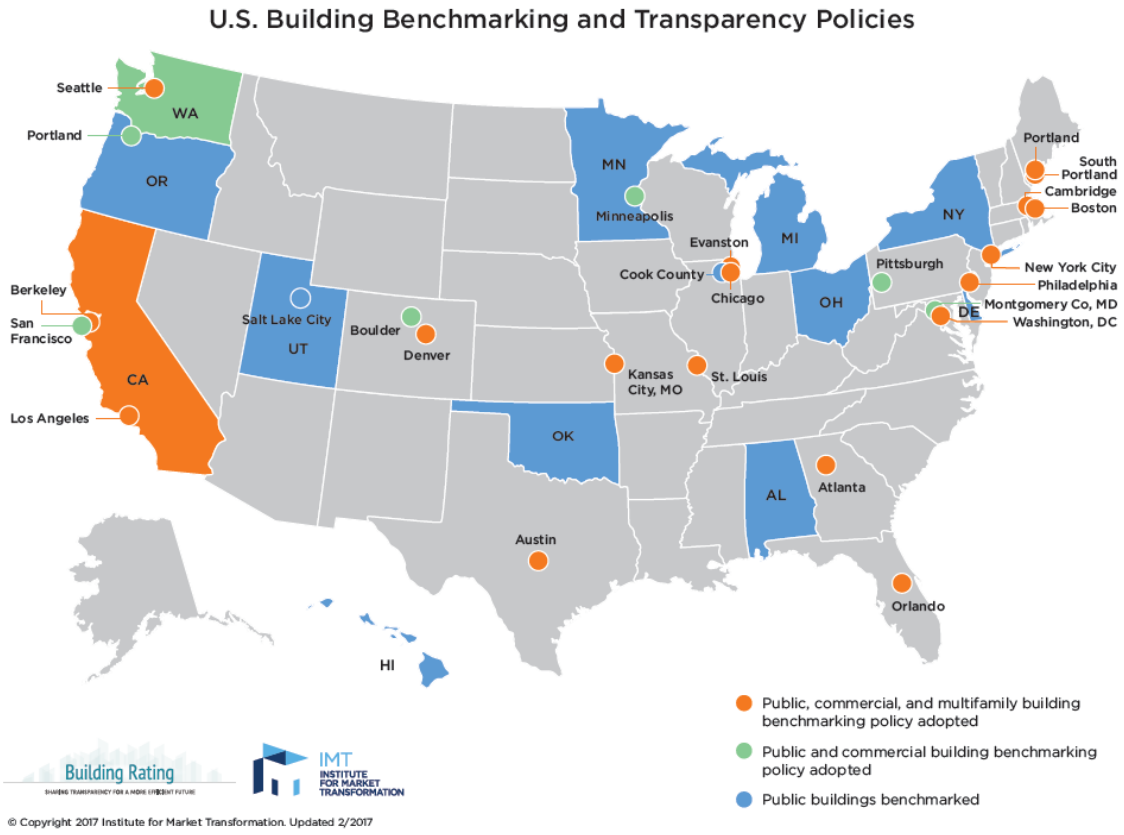

Figure 6. U.S. Building Benchmarking and Transparency Policies [12]

As mentioned in 3.1.5.2, Portfolio Manager not only helps partners collect and report data, but also helps them compare energy use with similar buildings at a national level. Based on the building information that is entered into Portfolio Manager, such as size, location, and number of occupants, a participant's actual energy data is compared to similar buildings using EPA's ENERGY STAR energy performance scale, and a percentile score (1-100) is generated to show where their building(s) ranks [13, 14].

A detailed example of a benchmarking practice is included in Appendix B.

3.1.5.4. Accessing Financing options

The Better Buildings program does not provide direct funding to partners for building upgrades. Partners use various financing methods to implement building energy retrofits. Many partners utilize innovative strategies to finance energy efficiency projects, such as revolving funds, energy savings performance contracts (ESPCs), grants, or green bonds. For example, BB Partner the Commonwealth of Massachusetts, created the Clean Energy Investment Program (CEIP) in 2010. The program invests in clean energy projects using state bonds, which are repaid from the energy savings generated by the projects. This innovative financing model not only addresses the barriers of limited access to financing for clean energy projects, but also ensures capital spending on energy projects without hitting the state debt limit. In four years, CEIP has financed more than $136 million of energy efficiency upgrades in 15 million square feet of state buildings space. These projects are expected to save $14.3 million annually over the life of the bond terms, typically 20 years or more [15]. Developing case studies of projects that have worked is important and the online Better Buildings Solution Center has case studies describing ways that partners have applied to access financing for building energy efficiency improvements.

In 2016, DOE launched the Better Buildings Financing Navigator, an online tool that helps public and private sector organizations find financing solutions for non-residential energy efficiency projects. The Financing Navigator provides information on traditional financing options, such as leases and loans, and specialized financing options, such as on-bill financing, property assessed clean energy (PACE), energy services agreements and energy performance contracts.

In addition, the tool can help users explore different financing choices and identify relevant financing options based on the project information provided by users. Moreover, the tool helps users connect to Better Buildings Financial Allies, which are committed to making financial investments in energy efficiency projects. The Financing Navigator is not only designed for those who want to access financing for their energy efficiency projects, but also of interest to those who want to learn more about the marketplace in general.

3.2. Alliances and Technology Campaigns

3.2.1. Better Communities Alliance

Many local governments are taking action to improve energy efficiency of buildings and infrastructure and expand renewable energy and sustainable transportation options for their residents and businesses. The Better Communities Alliance (BCA) is a BB Initiative partnership with municipal or county governments who wish to deepen their clean energy impact [16]. Local governments who participate or commit to participate in a Better Building Accelerator or another DOE qualifying leadership initiative are eligible to be part of BCA. The Better Communities Alliance was established to address a lack of resources made centrally available and facilitate dialogue to reduce energy, invest in renewable energy, and harness innovative technologies. The goals of BCA are to support local governments in achieving their energy and economic goals; advance integrated clean energy planning, and recognize leaders achieving inovative impacts in communities. Thus, BCA is a platform to transfer innovation and best practices to communities nationwide. Companies, foundations, and nonprofit organizations who make commitments in support of BCA objectives are BCA Affiliates.

BCA Partners receive customized technical assistance, a portfolio of curated DOE tools and program offerings, opportunities to apply for resources from BCA Affiliates, peer networking and expert dialogue, and federal recognition of their achievements. BCA Affiliates receive visibility for their local clean energy support, are able to leverage efforts and enhance the impact of their work, and federal recognition of their contributions.

3.2.2. Better Buildings Alliance

The Better Buildings Alliance (BBA) is another key partnership, which offers peer networking and technical assistance to commercial building owners, managers, and tenants.

The BBA was re-branded from the Commercial Building Energy Alliance, which was established by DOE in 2009 to further increase energy efficiency in commercial buildings. The BBA is a broader group of participants, which may or may not have committed to the BBC. The Better Buildings Alliance is a network of partners and technical experts who come together to develop and deploy innovative and cost-effective energy-saving solutions. By 2017, more than 230 members had joined as BBA partners, representing over 11 billion square feet of commercial real estate across five key market sectors: retail, food service and grocery; commercial real estate; healthcare; higher education, and hospitality.

Working together with DOE's experts, partners in different market sectors share energy-saving ideas that can be cost-effectively deployed and support development of publically available resources, including technical specifications, case studies, and decision guides. The Alliance has seven Technology Research Teams focused on lighting, space conditioning, plug & process loads, refrigeration, energy information systems, envelope, and renewables integration. Each subject area is led by a national lab or an expert consultant (Table 4). The Market Solutions Team addresses market-based challenges to energy efficiency including project financing, appraisal & valuation, leasing & tenant engagement, workforce training and data access.

Table 4. Research Areas and Solution Leads [9]

Technology Research Team	**Team Lead**
Lighting	Pacific Northwest National Laboratory (PNNL)
Space conditioning	National Renewable Energy Laboratory (NREL)
Plug & process loads	NREL
Refrigeration	Navigant
Energy info & systems	Lawrence Berkeley National Laboratory (LBNL)
Renewable integration	Navigant
Envelope & fenestration	Oak Ridge National Laboratory (ORNL)

To include non-governmental or trade organizations in the Better Buildings Alliance, DOE established the Better Buildings Affiliate role. Non-governmental organizations and trade organizations that represent sectors covered by the Better Buildings Alliance can join as an Affiliate. Affiliates promote BB programs and resources to their membership and help them advance energy efficiency.

3.2.3. BBA Technology Campaigns

DOE establishes technology campaigns through the Better Buildings Alliance Technology Research Teams to offer resources and recognition to encourage deployment of specific technologies and practices with high energy savings potential. By the end of 2017, BBA has issued two technology challenges (high-efficiency rooftop units and low-cost wireless sub-meters), five adoption campaigns (rooftop units, interior LEDs, exterior LEDs, energy management

information systems, and green leasing), and ten procurement specifications, which are designed to help companies select technologies [17].

Below provides a brief summary of four Better Buildings Alliance Technology Campaigns:

Advanced Roof Top Unit (RTU) Campaign (ARC): The Advanced Roof Top Unit Campaign encourages commercial building owners and operators to replace or retrofit their old RTUs with more efficient units with advanced controls.

Interior Lighting Campaign (ILC): The Interior Lighting Campaign is a recognition and guidance program with an initial focus on troffer lighting. The goal of the campaign is to help facility owners and managers achieve energy savings through implementing high efficiency interior lighting solutions.

Lighting Energy Efficiency in Parking (LEEP) Campaign: The Lighting Energy Efficiency in Parking Campaign is a recognition and guidance program to enable facility owners and managers to leverage high-efficiency lighting solutions in their parking lots and parking garages to achieve energy savings.

Smart Energy Analytics (SEA) Campaign: The Smart Energy Analytics Campaign encourages the application of commercially available Energy Management and Information Systems (EMIS) technologies and ongoing monitoring practices to help achieve energy savings and improve building performance.

3.3. Better Buildings Accelerators and Other Key Support

3.3.1. Better Buildings Accelerators

BB Accelerators are collaborative peer-to-peer networks designed to demonstrate innovative policies and approaches. This fosters learning and leadership opportunities that result in new strategies and more investment in clean energy deployment and energy efficiency. BB Accelerators aim to advance investment in energy efficiency by overcoming market and institutional barriers, paving the path for BBC partners. BB Accelerators are short-term (one and a half to two years) focused efforts to address a specific barrier to energy efficiency. Some examples include building owner access to data in multi-tenant buildings, data center efficiency, laboratory efficiency.

Since 2013, DOE has worked with over 170 organizations across 13 BB Accelerators that focus on persistent barriers to clean energy. Those areas, which are identified by partners, include energy-saving performance contracting, energy data, industrial superior energy performance and outdoor lighting.

The Sustainable Wastewater Infrastructure of the Future (SWIFt) Accelerator, for example, works with state, regional, and local agencies to accelerate a pathway toward a sustainable infrastructure for water resource recovery facilities in their jurisdiction. This Accelerator aims to catalyze the adoption of innovative approaches and best practices in infrastructure improvement, such as data management, technologies, and financing. The goals of the partners are improving the energy efficiency of their participating water resource recovery facilities by at least 30 percent and integrating at least one resource recovery measure [18].

3.3.2. Better Buildings Solution Center

A very important component of the BB Initiative is the online Better Buildings Solution Center. The website benefits partners with links to resources developed by expert-led technology and market solutions teams. The Better Buildings Solution Center addresses many kinds of potential challenges that building owners might face when conducting retrofits. One can search for potential barriers in the Solution Center and find examples on how other building owners overcame those challenges.

The Solution Center collects case studies of retrofits that building owners can find based on the needs of their own properties. Solutions can be searched through a variety of filters, including barriers, building size, building type, location, partner, sector, content type and technology. Another way to query solutions is through barriers. Eleven barriers are included in the Solution Center, such as financing, energy use measuring, data access, stakeholder engagement, capacity building and acquiring outside expertise. BBA produces technology solutions that can also be found on the website. Top partner solutions are also summarized and published regularly. Please see Appendix C for a list of example solutions for different building types.

3.3.3. Better Buildings Challenge SWAP

In addition to the Solution Center, the Better Buildings Challenge SWAP is another way the BB showcases solutions in building energy efficiency. The Better Buildings Challenge SWAP is a special reality-style web series where DOE invites two teams of energy efficiency leaders to visit one another’s buildings, find new energy saving opportunities and share best practices. Its three seasons have featured SWAPs between the hotel and retail sector, U.S. armed forces, and cities. The process is recorded and made into professional and engaging videos. This approach publicizes partner organizations’ effort on energy through friendly competition. The videos greatly demonstrate how BB partners can make efforts to improve energy efficiency in buildings.

3.3.4. Webinars

The Better Buildings Initiative also hosts interactive webinars to help building owners learn about best practices and discuss lessons learned about integrating energy savings into daily building operations. The webinar schedule can be found at the Better Buildings website[7]. The webinars cover a broad range of topics that leading businesses and governments commonly face, and they routinely attract hundreds of participants.

3.3.5. Better Buildings Summit

DOE hosts an annual Better Buildings Summit where partners convene to share best practices, market and technology solutions and future opportunities for energy efficiency. High-level DOE leadership typically attends the event. Featuring over 900 participants, the Summit also highlights success stories backed by real data. It is a way to raise the profile of partners who are leading on energy efficiency [19]. In providing this yearly update and a forum for recognition of results, the program solidifies a platform that BBC partners can continue to build on for years to come [20]. Presentations from Better Buildings Summit are available to download after the event.

4. Achievements of the Better Buildings Initiative

4.1. Better Buildings Initiative 2017 Update

Through years of progress, the Better Buildings Initiative is on track to build a mature energy efficiency market in the United States. Key achievements in the four key areas as of 2017 include [3]:

(1) **Developing innovative and replicable market solutions with market leaders.** More than 345 organizations representing over 4.4 billion square feet of building space have taken the Better Buildings Challenge of helping lead the country toward 20% energy savings by 2020. More than 230 organizations spanning more than 11 billion square feet of building space have joined the Better Buildings Alliance to collaborate on effective technical and market energy efficiency solutions in commercial buildings. Since 2013, the BB Initiative has launched 13 Better Building Accelerators with the participation of over 100 organizations to overcome common challenges to energy efficiency.

(2) **Making energy efficiency investment easier.** There are over 1,000 technical and market solutions available publicly in the online Better Buildings Solution Center, which makes it easy to access proven energy and

[7] Link: https://betterbuildingssolutioncenter.energy.gov/webinars-list

water strategies. The Financing Navigator was launched in 2016 as an online tool for building owners to compare options for financing energy efficiency projects. Data consistency and access was also improved through DOE's Building Performance Database (BPD) and Building Energy Data Exchange Specification (BEDES). BPD helps building owners with better energy efficiency decision-making by providing building performance data from more than 10,000 users representing over 870,000 buildings. BPD also provides benchmarking for building owners to compare their energy usage with similar buildings. BEDES defines 600 term and concepts, ensuring a common language to describe building characteristics and energy use.

(3) Developing a skilled clean energy workforce.DOE has developed Better Buildings Workforce Guidelines to recognize programs that meet its standards. For example, the Association of Energy Engineers' Certified Energy Manager was the first commercial building certification program to be recognized. Superior Energy Performance (SEP) certified practitioners in energy management systems are qualified to help companies implement ISO 50001 and SEP.

(4) Leading by example in the federal government. Federal government agencies have invested $4.2 billion in energy efficiency of federal buildings via energy savings performance contracts (ESPCs), surpassing the government's $4 billion performance contracting goal. DOE has demonstrated its leadership by reducing its greenhouse gas emissions 33% compared to 2008 levels.

4.2. Better Buildings Challenge 2017 Update

Participants in the Better Buildings Challenge have shown steady progress, achieving more than 2% energy savings annually and staying on track toward a 20% target within 10 years. At least 35 partners and four financial allies had met their goals ahead of schedule by May 2016. DOE estimates that the program has delivered 240 trillion Btus of energy savings and $1.9 billion in avoided energy costs in the six years since its inception [3].

As the program accumulates successes, it is also building a portfolio of shareable real-world solutions. There are performance results for every state, with 200 partners representing over 38,000 properties sharing solutions as of 2016. Of those, 5,500 properties have achieved 20% or greater energy savings, and 12,600 properties have demonstrated 10% or more [3].

Table 5. Better Buildings Challenge Achievements (Cumulative Results) [3,19]

Results	**2012**	**2013**	**2014**	**2015**	**2016**
Energy Saved (trillion Btus)			94	160	240
Dollar Saved (million $)			840	1300	1900
Avoided CO_2 Emissions (million tons)			5.8	10	15
Funding Committed (billion $)[8]			5.5	5.5	7
Funding Extended (billion $)			3	5.4	8.6
Water Savings (million gallons)			375	2300	4000
Solutions					
Partner Solutions Available Online	90+	117+	190+	400+	1000+
Partners					
Number of Partners and Allies	110+	195+	250+	310+	345+
Square Feet Represented (billion)			3.5	4.2	4.4

5. Better Buildings Initiative Lessons

5.1. Benefits of Joining the Better Buildings Challenge

The essence of the BBC program is 1) national recognition for companies, states and local government, and school districts that succeed in reducing their portfolio enegy use and 2) transparency of best practices and replicable solutions. DOE may include accolades before peers at relevant conferences, DOE media events held at partner properties, articles and presentations and press releases highlighting partner accomplishments. In turn, this encourages others to participate in BBC and gain recognition as well.

Beyond the public praise, companies that join BBC also benefit from improved management and, hence, reduced energy costs. Some partners have experienced that the public commitment and annual energy data tracking, helps to strengthen the internal commitments to energy efficiency. Support from executive leadership also elevates the importance of energy management in the

[8] Total funding committed includes DOE support and contributions from all partners and allies.

organization. Data review from DOE offers an added level of quality control for partners, with more accurate benchmarking and reporting.

5.2. Improving Program Design as Challenges Arise

During the initial implementation of the program, DOE encountered some challenges, especially in tracking and reporting. To address these challenges, DOE adjusted the program to streamline processes.

One of the challenges was balancing the level of effort required by partners with the level of data quality desired by DOE. For example, the program initially requested that participants submit data quarterly. To reduce the time burden on partners DOE now requests data annually. Another example is case study development. It was difficult for partners to devote time to developing case studies, so DOE took a proactive approach, conducting phone interviews with partners, then writing a first draft of the case studies. Partners edit and approve the drafts before publication. Additional best practices from the partners are gleaned and shared when DOE takes the lead in collecting information.

Another key challenge that DOE encountered was the inconsistency of data tracking systems that companies used. Initially, the Better Buildings Challenge encouraged partners to share data in Portfolio Manager. However, some partners track energy data in third-party systems, which made it difficult for those partners to report data in the way that DOE requested. To address this challenge, DOE developed a simple Excel spreadsheet that allows partners to import data from the systems they use and share the data in the generic spreadsheet format with DOE.

5.3. Addressing Existing Barriers for Building Energy Efficiency

The Better Buildings Challenge has successfully addressed many barriers that organization leaders encounter for their building energy efficiency upgrades. Table 6 provides a summary of key barriers that BBC has helped addressed.

Table 6. Summarized Key Barriers and BBC Solutions

Key Barriers	Key Solution
Lack of upfront funds for energy efficiency upgrades	◆ DOE brought financial institutions into the Challenge, committing $5.5 billion to finance energy efficiency upgrades.
Lack of technical knowledge about building retrofit approaches	◆ DOE established the publicly accessible online Better Buildings Solution Center that gathers existing energy efficiency upgrades from partners or previous case studies. ◆ Regular webinars, annual summits and other events provide opportunities for organizations to learn about technical approaches to reducing energy consumption. ◆ Benchmarking program helps building owners compare their building's energy usage with similar buildings. ◆ The BBA provides a platform for peer networking and resources development and serves as a channel for ongoing engagement with business and trade organizations and national laboratories on technology deployment. ◆ DOE established Technology Research Teams led by experts at the National Labs and third party consultants to examine barriers and solutions for energy efficiency upgrades. ◆ BBA technology adoption campaigns offer resources for implementation of specific technologies.
Lack of awareness about the benefits of improving building energy efficiency	◆ DOE makes an effort to establish partnerships (e.g. BBA Affiliates) and reach out to organization leaders to educate them on the benefits of implementing energy efficiency upgrades. ◆ The Better Communities Alliance connects local governments with broader DOE resources and information (e.g. distributed generation solar, and efficient vehicles) for communities and private resources to advance energy goals. ◆ In the Better Buildings Solution Center, organizations can find solutions that apply to their own buildings profile. Organizations can get a sense of how much energy and money they can potentially save.
Institutional barriers	◆ BB Accelerators address specific challenges and institutional barriers organization leaders face during energy efficiency upgrades.

6. Conclusions

This report offers a comprehensive overview of the U.S. Department of Energy's Better Buildings Initiative, including the program structure, management and implementation. The BB Initiative has four main pillars: Market Leadership, Better Information, Federal & Community Leadership and Workforce Development. This overview focuses on the three key programs under the market leadership pillar: Better Buildings Challenge, Better Buildings Alliance, and Better Buildings Accelerators. These programs are supported by technology campaigns, the Solution Center, and a variety of communications activities, such as partner media events, a webinar series, and the annual Better Buildings Summit.

The essence of the BB Initiative is national recognition and transparent information exchange. Recognition encourages continued progress within leadership organizations and can inspire other organizations to prioritize energy improvements and set new goals. Transparent information exchange validates partner progress toward their energy goals and reveals the best practices of leading organizations, which can be replicated by others. The BB Initiative helps address persistent technical and institutional barriers to building energy efficiency, including lack of upfront funds for energy efficiency upgrades, lack of technical knowledge about building retrofit approaches, and lack of awareness about the benefits of improving building energy efficiency.

Better Buildings' successes, along with its evolution over time, offer an example of how, with the right tools, government can partner with businesses to achieve significant strides in energy efficiency. China and elsewhere could learn lessons from the U.S. Better Buildings Initiative to develop similar programs.

Appendix A. Sprint, Turning Corporate Goals into Action

Pledging an Organization-Wide Saving Goal

Sprint is a communications company whose energy-consuming portfolio includes commercial office buildings, retail space, data centers and a nationwide data network.

In joining the Better Buildings Challenge in 2013, Sprint set a goal to cut electricity use 20% from a 2007 baseline across its building portfolio by 2017, a raise from earlier corporate sustainability goals of 15% [21].

Each business unit was tasked with reducing energy usage by 20% in order to contribute toward the overall corporate goal. This created momentum across the company to test out energy-saving strategies and share best practices.

Establishing an Implementation Model

The key idea of Sprint's implementation model is that an overarching goal can drive efficiency strategies across different types of assets.

DOE notes three key components of Sprint's solution [21]:

- A cross-functional energy management team and set standards for tracking and reporting progress
- A specific energy reduction strategy for each Sprint asset class, e.g. network, retail stores and commercial office buildings
- Accountability for energy goals via employee goals and vendor key performance indicators

Implementation Process

Creating a Cross-Functional Energy Management Team

The corporate social responsibility (CSR) team brought together representatives from office, retail, network and IT business units to form a cross-functional energy management team. Representatives came from finance, engineering, business, legal and facility management divisions. These units had previously operated independently of one another—now they had a common goal and a means of sharing strategies.

Energy Reduction Strategy by Asset Class

Commercial Office Buildings

Commercial buildings account for about 6% of Sprint's energy use. The office business unit conducted numerous retrofits, replacing old heating, ventilation and air conditioning (HVAC) equipment with smaller, more efficient models. A five-year energy plan was created for the company's approximately 8 million square feet of commercial office space, and the team is pursuing smart building and lighting controls. [21].

Retail Stores

At the retail level, Sprint focused on LED lighting upgrades and more efficient rooftop units across its portfolio of more than 1,100 stores nationwide. Retail stores account for approximately 3% of Sprint's total energy usage [21].

Network and Data Centers

Sprint's highest energy savings among its switch sites and cell towers came from streamlining the network, and from the installation of new, more efficient equipment. At its six data centers, Sprint evaluated whether new, more efficient equipment could allow for upgrades earlier than planned [21].

Tying Energy Efficiency to Job Performance

Sprint's teams added progress toward energy efficiency goals to job descriptions and performance management goals for manager-level employees. It also made efficiency part of the performance metrics for facility managers at their commercial properties. Tying energy performance to employee reviews and contract renewal decisions helped make energy efficiency a high priority [21].

Results

Portfolio Energy Performance and Cost Savings

Since 2007, Sprint has decreased total energy use by 40% [22]. As of 2013, Sprint had reduced absolute energy usage by 33% in commercial offices, 24% in retail stores, 7% in data centers and 22% in networks. Spring saved over $60 million in energy costs from 2007 to 2015 [21,23].

Appendix B. Benchmarking in the State of Delaware

In 2010, Delaware Governor Jack Markell signed Executive Order 18 (EO 18), *Leading by Example Towards a Clean Energy Economy & Sustainable Natural Environment*, setting a goal of reducing energy consumption in state-owned or -leased facilities 30% by the end of 2015 based on 2008 levels.

The state lacked a centralized location where officials could see building energy performance and decide where retrofits would make sense. To overcome this barrier, Delaware used EPA's Portfolio Manager to benchmark state building energy use and prioritize upgrades. This profile provides a summary, based on DOE's findings, of how benchmarking helped Delaware reach its energy reduction goal.

Staffing and Training

To facilitate benchmarking, EO 18 directed each executive agency to designate a sustainability manager. Those managers comprised of the Sustainability Managers Workgroup (Workgroup thereafter), a central coordinating body for the initiative [24]. The sustainability managers were generally agency staff with responsibility over facilities, operations and/or contracts [25].

To benchmark, the first step was to collect energy data across agencies. The Workgroup used existing insurance reports, utility bills, state property lists and maintenance information to develop a detailed asset inventory that included specifications such as building age, condition, type, and square footage.

Sustainability managers reviewed their agencies' facilities to establish baseline energy use. The Workgroup then set database maintenance standards and agreed to review and update facility improvements on a quarterly basis.

Another important step before starting the benchmarking process was to train sustainability managers and their staff on using Portfolio Manager. The Workgroup set up basic training on the tool for sustainability managers and then offered group and one-on-one sessions on the details of data entry, making sure training was consistent across agencies.

Benchmarking Process

After energy data was collected and staff were trained, individual agencies started what DOE terms a "hub and spoke" benchmarking process. Individual agencies were the spokes, entering monthly energy performance data for their buildings into the Portfolio Manager, and the Workgroup served as a hub, analyzing the entire state's building portfolio.

Each agency had to report on at least 50% of its building square footage and include all buildings larger than 3,000 square feet. The Workgroup then reviewed the data for comprehensiveness and accuracy, flagging any trends, anomalies or significant changes in consumption so agencies could review and revise as needed.

The Workgroup analyzed the agency-collected data to plan ongoing operations, maintenance and opportunities for renewable energy deployment. After compiling a list of agency facilities needing energy audits, each sustainability manager applied a set of Workgroup-created criteria to prioritize the list. The criteria were based on facility characteristics such as building size and age [25]

Each agency maintained and updated its own priority list for upgrades. Individual agency lists were merged into one statewide audit roster. The Workgroup used this central priority list to begin authorizing energy-saving projects.

Working with the Delaware Sustainable Energy Utility (DESEU), a non-governmental organization created by the state in 2007 to help advance clean energy and efficiency, the Workgroup began making project schedules and locating funding sources such as tax-exempt bonds and the Regional Greenhouse Gas Initiative. The Workgroup partnered with DESEU through the organization's Energize Delaware initiative to establish audit schedules for the priority retrofit projects and identify funding sources to move them forward. DESEU leveraged multiple funding sources such as tax-exempt bonds and leases, Regional Greenhouse Gas Initiative (RGGI) funds, fees and interest on financing and fees for services [25].

Results

In five years, Delaware achieved a 17% reduction in its building energy use—short of the goal set in 2010, but still an impressive 3% annual improvement, on average. It has indexed 80 percent of its building portfolio in the Portfolio Manager tool, which helped the Workgroup identify about 40 retrofit projects [25].

Appendix C. Better Buildings Challenge Solution Examples

Table 1. Better Buildings Challenge Solution Examples for Different Building Types [26]

Organization	Type	Solution	Solution Type	Solution Overview	Outcome
TH Real Estate: 1001 Pennsylvania Avenue, Washington,D.C	Commercial	Low- or no-cost building energy efficiency measures	Showcase project	Working with their sustainability consultant and the Hines property team, BB Challenge partner TH Real Estate identified no-and low-cost strategies. Over the course of five years, TH upgraded the building's energy management system (EMS), installed carbon dioxide (CO_2) sensors throughout the building and improved the efficiency of the HVAC system.	When aggregated, the projects yielded an overall payback period of 3.5 years and an ROI of 29%.
The Tower Companies	Commercial Office and Residential Real Estate	Leveraging Green Leases	Implementation model	Inclusion of green appendix in standard lease agreement offered to new and renewing tenants [27].	More complete portfolio-wide energy benchmarking thanks to tenant energy use reporting; Reduced energy and water use in tenant spaces across commercial portfolio.

General Electric (GE)	Diversified technology and financial services	Operations Management Leadership Program (OMLP)	Implementation model	By design, the program accelerates the deployment of newly hired engineers that are trained in GE's energy and environmental management program and equipped with the necessary functional and leadership skills needed to help meet the company's near- and long-term operational challenges [28].	New engineers are quickly engaged in identifying energy savings opportunities throughout GE facilities around the world. Since the program was launched, these engineers have identified 572 projects totaling $6.4 million in savings.
Nevada's Douglas County School District (DCSD)	Education/K-12 School District	Energy savings performance contract (ESPC)	Implementation model	In 2008, DCSD implemented an energy savings performance contract (ESPC) to create operational efficiencies and cost-saving measures funded by a tax-exempt installment-purchase agreement (IPA) [29].	The $5.1 million ESPC project is paying for itself through $456,000 in guaranteed annual energy cost savings
Citi Bank Riverdale Data Center	Financial Institution	Energy Services Agreement (ESA)	Implementation model	Citi used a third-party energy services agreement (ESA) to innovatively finance and deliver efficient electricity and cooling at its London data center, and plans to implement the same model in US facilities in the future [30].	Total funds committed were about $8 million.
InterContinental Hotels Group (IHG)	Hospitality	IHG Green Engage System	Implementation model	The IHG Green Engage System is a comprehensive sustainability platform that allows hotels to track, measure and report on their carbon footprint and utility consumption [31].	IHG Green Engage can help hotels save up to 25%, or roughly $90,000 annually on energy. Since 2012, IHG's company managed hotels avoided

					over $185 million in energy costs through participation in the program.
Cummins: Jamestown Engine Plant (JEP)	Industrial	Energy Retrofit Project	Showcase project	Beginning in January 2012 through 2015, Cummins is implementing a phased, whole building energy and infrastructure improvement project, including $5.1 million in energy efficiency improvements. In 2014, the plant installed a new, 2-megawatt solar installation capable of generating about a third of the plant's power on the sunniest days. The plant has also installed three regenerative dynamometers that recover energy from engine testing and provide power to the facility [32].	The JEP project expects to save 33% in annual energy consumption and 30% in annual energy costs by 2016 compared to baseline year 2011.
City of Milwaukee	Local Government	Property Assessed Clean Energy (PACE) Program	Implementation model	The city created a PACE financing option that allows building owners to pay for energy improvements over time through a voluntary municipal special charge which is attached to the property, not the owner. If the owner sells the property before the end of the loan term, the new owner inherits the loan along with the energy improvements, which reduces the risk of financing to building owners [33].	Milwaukee closed its first PACE deal in September 2014 to retrofit the University Club of Milwaukee. Annual operating savings from the project are predicted to approach $60,000, roughly 30%.

LINC Housing and SEED Partners	Multifamily Affordable Housing Developer	Replicable and scalable near-zero net energy retrofit model	Implementation model	Developed a near-zero net energy retrofit model that is replicable and scalable [34].	This project serves as a model that documents the steps low-income multifamily property owners can take to make whole-building energy efficiency retrofits.
Kohl's	Retail	Energy Finance Strategy	Implementation model	Kohl's attempted to create a partnership between the Finance and the Energy teams. Despite a track record of successful projects, the Energy team was having trouble getting and defending sustained corporate funding for unbudgeted energy efficiency projects. In order to overcome this barrier, Kohl's strengthened the relationship between the Finance and the Energy teams by embedding members of the company's Finance Department into the Energy team. This expedited the communication of financial benefit and the approval of energy efficiency projects [35].	The Energy team has an annual "new technology" budget to test emerging technologies and a Financial Analyst liaison to expedite expense requests.

Reference

[1] Energy Information Administration (EIA). 2017. Monthly Energy Review. April 2017

[2] The White House Office of the Press Secretary. 2011. President Obama's Plan to Win the Future by Making American Businesses More Energy Efficient through the "Better Buildings Initiative. February 3, 2011. https://obamawhitehouse.archives.gov/the-press-office/2011/02/03/president-obama-s-plan-win-future-making-american-businesses-more-energy

[3] U.S. Department of Energy. 2017. *Better Buildings Successful Strategies Driving Innovation & Results, Progress Report 2017.* Department of Energy.

[4] The White House Office of the Press Secretary. 2015. Fact Sheet: Reducing Greenhouse Gas Emissions in the Federal Government and Across the Supply Chain. March 19, 2015. https://obamawhitehouse.archives.gov/the-press-office/2015/03/19/fact-sheet-reducing-greenhouse-gas-emissions-federal-government-and-acro

[5] The White House. Leading by Example to Reduce Carbon Pollution and Waste Less Energy. May 9, 2014. https://obamawhitehouse.archives.gov/blog/2014/05/09/leading-example-reduce-carbon-pollution-and-waste-less-energy. Accessed July 10, 2017.

[6] U.S. Department of Energy. 2017. Press Release: Better Buildings Challenge Partners Save $1.9 Billion, 18 Achieve their Portfolio-Wide Goal this year. https://betterbuildingssolutioncenter.energy.gov/sites/default/files/news/attachments/Summit%20-%20Press%20Release%20--%20Results%20of%20BBC%20and%20Progress%20Report%20-%20May%2016%20letterhead.pdf

[7] Zach Abrams, from ICF International. Interview with author on 10 Aug 2016.

[8] The White House Office of the Press Secretary. 2011. Obama Administration Announces 14 Initial Partners in the Better Buildings Challenge. June 30, 2011.

https://obamawhitehouse.archives.gov/the-press-office/2011/06/30/obama-administration-announces-14-initial-partners-better-buildings-chal.

[9] JDM, "DOE Better Buildings Organizational program support structure," 2015.

[10] U.S. Department of Energy. 2015. Energy Data Tracking Manual for Better Buildings Challenge Partners.

[11] U.S. Department of Energy. *Implementation Model: Mass Benchmarking*. Accessed July 20, 2016, from Better Buildings Solution Center. http://betterbuildingssolutioncenter.energy.gov/implementation-models/mass-benchmarking.

[12] BuildingRating.org. 2017. U.S. Building Benchmarking Policy Landscape. http://www.buildingrating.org/graphic/us-building-benchmarking-policy-landscape.

[13] U.S. Department of Energy. *Implementation Model: Energy Benchmarking Program*. Accessed July 20, 2016, from Better Buildings Solution Center. http://betterbuildingssolutioncenter.energy.gov/implementation-models/energy-benchmarking-program.

[14] EPA & DOE. (n.d.). *Use Portfolio Manager*. Accessed July 20, 2016, from ENERGY STAR Portfolio Manager. https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager.

[15] U.S. Department of Energy. *Implementation Model: Clean Energy Investment Program*. Accessed July 10, 2017, from Better Buildings Solution Center. https://betterbuildingssolutioncenter.energy.gov/implementation-models/clean-energy-investment-program

[16] Better Communities Alliance: Frequently Asked Questions. https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Better%20Communities%20FAQs.pdf. For more info on BCA, check out: https://betterbuildingssolutioncenter.energy.gov/bca

[17] M. T. Vargas. 2014. Better Buildings - A National Initiative Driving Greater Energy Efficiency in U.S. Buildings. *2014 ACEEE Summer Study on Energy Efficiency in Buildings , 6*, 299-310.

[18] U.S. Department of Energy. *Better Buildings Sustainable Wastewater Infrastructure of the Future (SWIFt) Accelerator Fact Sheet.* Accessed July 10, 2017. https://betterbuildingsinitiative.energy.gov/sites/default/files/attachments/SWIFt_Fact_Sheet-032017.pdf

[19] U.S. Department of Energy. 2016. *Better Buildings DOE 2016 Report-Moving Our Nation Forward, Faster.* US Department of Energy.

[20] U.S. Department of Energy. 2016. *Summit Home*. http://betterbuildingssolutioncenter.energy.gov/summit.

[21] U.S. Department of Energy. "Sprint Implementation Model." http://betterbuildingssolutioncenter.energy.gov/implementation-models/corporate-goal-catalyst-custom-efficiency-strategies-office-retail-and-data.

[22] U.S. Department of Energy. "Sprint Energy Data." http://betterbuildingssolutioncenter.energy.gov/energy-data/Sprint.

[23] U.S. Department of Energy. "Sprint Showcase Project." http://betterbuildingssolutioncenter.energy.gov/showcase-projects/core-switchregional-data-center.

[24] K. Field & M. Shah. 2014. Better Buildings Challenge Accelerator Support – 2014 Building Technologies Office Peer Review. Accessed July 12, 2016, from Office of Energy Efficiency & Renewable Energy, DOE. http://www.energy.gov/sites/prod/files/2014/11/f19/cbi24_shah_042314.pdf.

[25] U.S. Department of Energy. "Implementation Model: Centralized Benchmarking & Project Prioritization." Accessed July 2016. http://betterbuildingssolutioncenter.energy.gov/implementation-models/centralized-benchmarking-project-prioritization.

[26] U.S. Department of Energy. "Energy Solutions Center." http://betterbuildingssolutioncenter.energy.gov/.

[27] U.S. Department of Energy. "Implementation Model: Leveraging Green Leases To Reduce Energy And Water Use." Accessed July 2016. http://betterbuildingssolutioncenter.energy.gov/implementation-models/leveraging-green-leases-reduce-energy-and-water-use.

[28] U.S. Department of Energy. "Implementation Model: Operations Management Leadership Program." Accessed July 2016. http://betterbuildingssolutioncenter.energy.gov/implementation-models/operations-management-leadership-program.

[29] U.S. Department of Energy. "Implementation Model: A Lesson Plan in Financing K-12 Energy Efficiency." Accessed July 2016. http://betterbuildingssolutioncenter.energy.gov/implementation-models/a-lesson-plan-financing-k-12-energy-efficiency.

[30] U.S. Department of Energy. "Implementation Model: Citi Riverdale Data Center Energy Services Agreement (ESA)." Accessed July 2016. http://betterbuildingssolutioncenter.energy.gov/implementation-models/citi-riverdale-data-center-energy-services-agreement-esa.

[31] U.S. Department of Energy. "Implementation Model: Green Engage." Accessed July 2016. http://betterbuildingssolutioncenter.energy.gov/implementation-models/green-engage.

[32] U.S. Department of Energy. "Showcase Project: Jamestown Engine Plant." Accessed July 2016. http://betterbuildingssolutioncenter.energy.gov/showcase-projects/jamestown-engine-plant.

[33] U.S. Department of Energy. "Implementation Model: Property Assessed Clean Energy (PACE) Program." Accessed July 2016. http://betterbuildingssolutioncenter.energy.gov/implementation-models/property-assessed-clean-energy-pace-program.

[34] Near-Zero Net Energy Retrofits for Low-Income Housing." Accessed July 2016. http://betterbuildingssolutioncenter.energy.gov/implementation-models/replicable-and-scalable-near-zero-net-energy-retrofits-low-income-housing.

[35] U.S. Department of Energy. "Implementation Model: Energy Finance Strategy." Accessed July 2016. http://betterbuildingssolutioncenter.energy.gov/implementation-models/energy-finance-strategy.