2015 Green Communities Criteria: Incremental Cost Survey

Prepared by Bridgewire Consulting

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Author, Notes, and Acknowledgements

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I. Methodology

What do we mean by incremental cost?

The purpose of this guide is to provide users of the 2015 Criteria—owners, developers, design professionals, contractors, and others—with industry estimates for the costs of meeting the 2015 Enterprise Green Communities Criteria. For the purposes of this guide, the project team defined incremental cost as the added cost to exceed standard construction practice for the affordable housing industry. In some cases, these estimates reference specific building codes and provisions, such as the International Energy Conservation Code (IECC).

In many cases, interviewees confirmed that some of the Criteria were already standard industry practice in many markets, such as criterion 3.2: Erosion and Sedimentation Control. In other cases, interviewees provided their estimates for the range in costs to meet each criteria.

It should be noted that this resource is not a cost-benefit guide. **All users should consider the positive impacts of meeting the 2015 Criteria and weigh these against the costs estimated in this guide and by professionals working on your project.** Positive impacts as a result of high-performance or "green" construction accrue to tenants, owners, and investors in the form of reduced energy costs, improved marketability, tenant retention, lender terms, and other financial advantages.

Investigation Methodology

This cost survey relied on a range of investigation techniques to produce incremental cost estimates. The project team chiefly relied on interviews with contractors, architects, and consultants who have deep familiarity with the 2015 Criteria. These experts provided their estimates for the added cost of meeting the 2015 Criteria based on experiences with their own projects as well as internal staff and subcontractor surveys. The vast majority of interviewees provided cost estimates for the most common building types seeking Enterprise certification: 50-75 unit infill multifamily properties and garden apartment communities. Where appropriate, the guide identifies where incremental costs differ for single-family properties or across U.S. regions.

Additionally data was gathered from published construction cost resources. One of these resources is RS Means, widely recognized as one of the national leaders in construction cost estimating. RS Means provides overall estimates for the cost to deliver building types (such as 1 to 3 story apartment buildings) as well as individual unit assemblies, such as the cost of installing insulation, TPO roofing, or vapor barriers. RS Means was used in this guide to 1) confirm interviewee incremental cost estimates and 2) provide some granular estimates cited in this guide. [1]

Where possible, the team has sought to spotlight the in-depth work of well-regarded incremental cost analyses undertaken by other organizations. For instance, detailed information on the incremental cost of upgrading window U and SHGC factors is provided from a study commissioned by the Department of Energy's Pacific Northwest National Laboratory (PNNL). Where third party resources are available, they are hyperlinked within

each criteria entry and are reproduced in the Resources section beginning on page 37.

II. How to Use the Cost Survey

This guide is designed to be a starting point for estimating the incremental costs of various components of the 2015 Enterprise Green Communities Criteria. Users of this guide should not simply "add up" the costs of each criterion in this guide which they intend to apply for. Instead, users should carefully consider the possible range of incremental costs of implementing each criterion as well as the possible cost savings and synergies of undertaking related measures. For example, choosing to meet criterion 4.5 Water Reuse would also help satisfy criterion 3.6 Surface Stormwater Management. Furthermore, users should coordinate with their design professional, consultants, or contractor to determine what the local cost of achieving the 2015 Criteria will be for a specific project.

Where applicable, the guide calls attention to the cost differential between new construction and moderate to significant rehab. Similarly, the guide identifies where the incremental cost differs between multifamily and single-family homes. Many costs, such as criterion 6.11 Reduced Heat-Island Effect: Roofing, are likely to be the same for single and multifamily buildings while others such as criterion 2.10 Passive Solar Heating/Cooling may be easier to achieve for single-family homes than for multifamily projects.

The project team sought to identify regional variation in incremental costs but found few estimated cost differences between U.S. regions. In general, states (and jurisdictions) with more stringent codes, such as the 2015 IECC, are likely to have lower incremental costs because more of the criteria will be mandatory. Other variations from one jurisdiction to another, including land development requirements, stormwater management requirements, and possible rebates, can influence costs as well.

Soft Costs and Hard Costs

This guide presents both the soft and hard costs of meeting the 2015 Criteria. Soft costs, such as architect fees associated with additional documentation, are presented as estimates to meet each requirement, where applicable. Incremental soft costs are expected to vary more widely from project to project based on the expected scope of design services or the project owner's own capacity. For instance, for criterion 8.5 Project Data Collection and Monitoring System, a project owner may already be monitoring energy or water use in order to improve asset performance and thus no incremental costs would be incurred.

Hard costs are presented without contractor overhead and profit or "markup." The guide does not add contractor markups because they range significantly from one market (or firm) to another. Thus, when examining hard costs, consider adding an overhead and profit percentage that is appropriate for your project.

As an example, figure 1 below provides average square foot building costs from RS Means' 2015 Square Foot Cost Guide for major multifamily property types and includes contractor overhead and profit as a separate line item. Because these are national average estimates, you should consult with your local contractors on estimates for an appropriate markup, which may be significantly lower than estimates provided by RS Means.

Figure 1

- 1-3 story apartments
- 22,500 square feet average building size
  - Hard Costs: $127.76
  - Contractor Fees (25%) $31.96
  - Architect Fees (7%) $11.18
  - **Total: $170.90**

- 4-7 story apartments
- 60,000 square feet average building size
  - Hard Costs: $133.53
  - Contractor Fees (25%) $33.39
  - Architect Fees (7%) $11.68
  - **Total: $178.60**

- 8-24 story apartments
- 145,000 square feet average building size
  - Hard Costs: $173.72
  - Contractor Fees (25%) $43.40
  - Architect Fees (6%) $13.03
  - **Total: $230.15**

Process Changes and Synergies

Using the 2015 Criteria may require changes in common practices for real estate professionals and allied disciplines: architects, developers, owners, engineers, property managers, consultants, and others. In many cases, these changes represent best practices in how buildings should be designed and managed, but some users may have to update their design and development processes. For example, architects and engineers are encouraged by criteria such as criterion 4.4 Efficient Plumbing Layout and Design to design homes or residential units to minimize the length of hot water plumbing runs. As such, where a criterion requires changes to common practice, it is labeled as a “Process Change.”

Similarly, the guide notes the interrelationship of individual criteria. Under each applicable criterion, directly-related criteria with synergies are notated as a “Synergy” alongside the numbers of the applicable related criteria. Each synergy should be studied by the project team as decisions made for one criterion may influence others, resulting in efficiencies and cost savings.

III: Criteria Incremental Cost Estimates

Section 1: Integrative Design

1.1a Goal Setting

Cost: $1,000 - $5,000. Architects who are experienced with Enterprise Green Communities suggest in interviews that the process of setting goals for a new project or rehab is standard in new construction or rehabilitation. However, for this criterion there may be some incremental costs associated with preparing documentation, which are estimated to range from $1,000 to $4,000 of staff time (soft costs) on a typical rehab or new multifamily project (40-100 units). Documentation for a single-family home is expected to be less than $1,000. The costs of applying for certification is estimated at 10 to 30 hours of staff time, or $1,500 to $5,000 per project. Additional charrettes (for residents of existing buildings, for instance) may add additional cost depending on the scope. Estimates provided for the basic charrette are an additional $3,000 to $5,000. For moderate rehabs, one firm recommended an energy and resilience audit (which would also satisfy 1.3a) with an expected cost from $5,000 to $7,500 per project.

Synergy with: 1.2a, 1.3a, 5.1

1.1b Criteria Documentation

Cost: $0 - $3,000. Architects interviewed suggest that the necessary construction documentation to meet criterion 1.1b is standard practice for architects and should result in no incremental cost. For those architects who do not have this in their scope, estimates were approximately $3,000 for staff time to prepare documentation.

1.1c Designing for Project Performance

Cost: $300 - $2,000, annually per building in the owner's portfolio. Incremental costs would be lower for an owner who has already uploaded their buildings into an analytical software. The US Environmental Protection Agency (US EPA) offers a free online tool called Target Finder that allows for project partners to set a target for energy use in a project, or calculate relevant energy metrics such as Energy Use Intensity (EUI) if estimated energy use is available.[2] Actual energy performance of other projects can be monitored in US EPA's PORTFOLIO MANAGER Tool, which can also track greenhouse gas metrics and water consumption.[3] Energy services companies such as WegoWise and Bright Power's Energy Scorecards offer fee-based benchmarking tools to track energy and water use, which cost around $300 to $2,000 annually per building. Additional incremental soft costs to analyze proposed building performance may be necessary if they are not included in the architect's scope.

When tracking energy use in buildings, the initial challenge for owners will be setting up the data connection from the local utility – a process which varies depending on the interface offered by local utility providers. Once the link between the utility and the analytical software is set up, maintaining up-to-date project performance data for buildings is straightforward.

One excellent resource for additional information on benchmarking is the FAQ created by the District of Columbia's Department of Energy and Environment (DOEE).[4]

Process Change

Synergy with: 5.2b, 8.5, 8.6

1.2a Resident Health and Well-Being: Design for Health

Cost: $200 - $300. According to interviews, meeting 1.2a requires the project team lead to simply identify which public health strategy the project will pursue from the table of resident health campaigns in the 2015 Criteria corresponding with this section. The project team lead should then provide a paragraph-long explanation as to how the project will address this health challenge. Meeting this criteria is estimated to require 1 to 2 hours of staff time on the part of the project team lead, totaling no more than $300 according to estimates.

Process Change

Synergy with: 1.1a

1.2b Resident Health and Well-Being: Health Action Plan

Cost: Varies. Interviews with public health professionals and property managers indicate that 1.2b requires significantly more investment from the project team than 1.2a. Optional criterion 1.2b builds upon the above requirements for 1.2a and calls for the developer, at pre-design and continuing throughout the project life cycle, to collaborate with public health professionals and community stakeholders to assess, identify, implement, and monitor achievable actions to enhance health-promoting features of the project and minimize features that could present risks to health. As compared to satisfying the requirements of criterion 1.2a, compliance with this criterion requires a more rigorous association with public health professionals and more robust follow-up action.

Specifically, developers will need to:

- Create a Health Action Plan based on additional research on the resident health factors identified in criterion 1.2a. Using public health data and community input, the Health Action Plan will characterize how the project may impact—both positively and negatively—social, environmental, and economic outcomes for residents and, in turn, promote or produce unintended negative consequences for health.

- Develop a project implementation and monitoring plan that includes a summary of the modifications made; performance metrics to be monitored; and specific information on indicators, data sources, frequency, and roles and responsibilities for monitoring different information. The plan will enable the developer to evaluate the project's impact on resident health throughout the project life cycle.

Efforts to meet 1.2b may include a survey for building residents. For those owners undertaking a survey of residents, interviewees indicate that the survey design must be careful not to raise privacy concerns. For example, surveys can ask about whether residents exercise more or how many days they were sick or stayed home from work or school, but can't inquire about specific health metrics. The cost of this survey could range depending on the sophistication of the survey and whether the work can be undertaken by property managers as part of business-

as-usual practice. Hiring a third-party to manage a resident survey would result in a range of costs based on the sophistication of the survey and associated research.

Creation of a health action plan can also take advantage of other resources, including a local health department (who may have a program that can assist at no-cost). In addition, the project owners can utilize Community Health Assessments prepared by local hospitals (which the IRS requires hospitals to publish every 3 years).

Process Change

1.3a Resilient Communities: Design for Resilience

Cost: $1,000. Design professionals interviewed suggested documentation of resilience strategies would result in approximately $1,000 of additional staff time per project.

Synergy with: 1.1a

1.3b Resilient Communities: Multi-Hazard Risk/Vulnerability Assessment

Cost: $5,000 - $10,000. Architects and consultants interviewed suggested a range of costs for the preparation of a vulnerability/risk assessment. The incremental cost is estimated to be $5,000 to $10,000 depending on the number of charrettes and the level of evaluation and detail undertaken. Interviewees indicated that undertaking a well-designed charrette could address both this criterion and 1.1a for approximately $5,000. One architect indicated the cost of commissioning a flood elevation certification from a surveyor would be $1,000, which would be required by code for projects in flood-prone or coastal areas.

Process Change

Synergy with: 1.1a

Section 2: Location + Neighborhood Fabric

2.1 Sensitive Site Protection

No cost. Architects interviewed indicated that avoiding sensitive sites is typically done as a standard practice. Many Green Communities-eligible projects are located on urban or redevelopment sites where wetlands and unique soil types are less prevalent.

2.2 Connections to Existing Development and Infrastructure

Cost: Varies. Enhancements to existing infrastructure can be achieved via a variety of low-cost measures. Building sidewalks, for instance, can connect new and existing developments at a relatively low cost. The addition of 4" thick sidewalks (with gravel base) are estimated by contracting firms to cost $2.00 to $3.50 per square foot, installed. Other pedestrian improvements are similarly low cost. For instance, the cost to upgrade to stamped concrete is estimated to add $2 per square foot, per a contracting firm, while crosswalk markings average $7 per square foot, according to the Pedestrian and Bicycle Information Center (PBIC). PBIC provides a cost report and an in-depth excel database of pedestrian and bike infrastructure

improvements which can be a resource to project designers as they plan additional infrastructure improvements.[5]

2.3 Compact Development

Cost: Negligible. Meeting criterion 2.3 requires approximately 15 minutes of effort on the part of the project architect or owner that should add no appreciable cost. Simply typing the project address into the Center for Neighborhood Technology's "Residential Density of a Location" Calculator produces the neighboring block group density instantly (in households per acre). [6] The project architect, owner, or developer can determine the proposed project density by dividing the number of proposed units by the acreage of the project site.

2.4 Compact Development

Cost: Negligible in most markets. As in criteria 2.3, criterion 2.4 can be easily assessed using an online tool within 15 minutes using the Center for Neighborhood Technology's "Residential Density of a Location" Calculator.[6] In many growing urban markets, building higher density structures is common building practice, where the high cost of land may encourage developers to exceed the surrounding density as part of their effort to cost-effectively deliver projects. In other cases, relatively dense development may be required by the local planning department or regulating authority. Costs are only likely to occur in the unlikely event that a density increase requires a change to a new structural system. For example, on tight urban sites, the need to increase from 4 to 5 stories might necessitate a move from a wood frame (type V construction) to a so-called "podium and stick" construction type. Please see the "How to Use the Cost Survey" section on page 5 for background on the average building costs per square foot for common construction types.

While no costs are likely to occur in many markets, incremental costs are likely to occur in "shrinking" cities where land costs are lower and as a result lower-rise construction is more cost-effective. In these cities, project owners and developers would incur costs to produce a denser project.

2.5 Proximity to Services

Cost: Negligible. Design professionals or the project owner/developer can easily produce an exhibit demonstrating the proximity of the project to services using free online mapping tools. This is ideally documented on a Context Map. See "Supplemental Document Instructions" found on Enterprise's website.[7] Additionally, in new construction, the project owner can deliver retail shell space to attract these amenities. In the latter, the project owner may actually create value through the creation of on-site retail spaces, depending on prevailing market rents and tenant creditworthiness. Costs to deliver new retail space include the cost to build retail shell space, a tenant upfit allowance (if required), and a possible retail broker fee, which ranges from 3–5% of the lease value.

Synergy with: 2.14

2.6 Preservation of and Access to Open Space for Rural/Tribal Communities/Small Towns

No cost. For most new developments in rural/tribal/small town settings, preservation of open space on a project site can be delivered at no-cost if prioritized early in the site planning process. This is ideally documented on a Context Map. See "Supplemental Document Instructions" found on Enterprise's website.[7] Any costs associated with meeting this requirement would only be incurred on constrained infill sites if the project site is not within one-quarter mile of a dedicated public park. In these cases, the architect will have to creatively locate buildings on the development site to ensure the open space target is met.

2.7 Preservation of Open Space

Cost: Varies. This feature should be demonstrated on the site plan and should have minimal impact on cost, most likely just toggling layers on/off in CAD. As in criterion 2.6, meeting these optional open space targets will depend on the project site and desired project density. For constrained sites, a more compact development pattern that clusters residential units can increase the amount of open space for residents. Green roofs are another alternative for urban sites, and can be delivered for an incremental cost of $10 to $20 per square foot installed. The costs of green roofs may be offset in some markets by incentives, grants, or the reduction in stormwater fees. A green roof also lengthens the life expectancy of the underlying roofing membrane, creating long-term savings opportunities.

Synergy with: 6.11

2.8 Access to Public Transportation

Cost: Negligible. Providing documentation of project distance to transit services can be easily accomplished by the project architect or owner using online tools such as Google Maps or Walkscore.com. This is ideally documented on a Context Map. See "Supplemental Document Instructions" found on Enterprise's website.[7]

2.9 Improving Connectivity to the Community

Cost: Varies.

Improving Access to Transit: Discounted transit passes range in cost by jurisdiction, but a representative example, Atlanta's MARTA system, offers unlimited monthly passes for $95.

Improving Auto Access: A space for a car sharing service can usually be delivered at no cost via an existing or planned parking space. In fact, some car sharing companies may pay to rent these spots from property owners. Subsidized car sharing memberships would vary based on baseline fees charged by each company, but most popular car sharing services offer annual memberships for less than $75 per year, with additional fees for use. Although owners may incur additional costs by employing these measures, costs can be more than offset if the number of parking spaces is reduced. The cost of avoided parking spaces is significant, ranging from $5,000 for surface spots to $30,000 and up for spaces in structured parking facilities.

Incentivize Biking Mobility: Bike racks can range in price from $200 to $300 apiece, while individual bike lockers are more expensive, estimated at approximately $500 per bike in a report issued the Pedestrian and Bicycle Information Center.[4] Dedicated bike rooms may be more easily integrated into new developments and may be located in unfinished space interior to buildings or in parking decks in space that is not otherwise usable. Costs to provide bikes and bike equipment may run from $200 to $300 per bike purchased and $60 to $100 per bike for annual tune-ups. Additional guidance on bike parking design is available in a guide published by the Association of Pedestrian and Bicycle Professionals (APBP).[8] Bike-sharing memberships vary in price but usually are available for less than $100 per year. For example, Chicago's popular Divvy service charges $75 per year, New York's CitiBike $149 per year, and Minneapolis' Nice Ride MN $65 per year. In many markets, there are discounts offered for riders below income thresholds. For instance, Denver offers $10 annual memberships for users at lower income levels. An additional resource for owners and property managers is Enterprise's Best Practice report in design of Green Transportation Systems.[9]

2.10 Passive Solar Heating/Cooling

Cost: Low to no cost.

Building Orientation and Glazing: Architects interviewed suggest that the cost of adjusting a building's solar orientation can be accomplished at no cost if begun early during design. Architects confirm that passive design principals are easier to achieve in single-family construction than multifamily. For multifamily buildings built on constrained urban sites, elongation of a building on an east-west axis (maximizing southern exposure) is sometimes infeasible due to the site's dimensions or neighboring buildings.

Glazing Type and Shading: For areas where the 2012 IECC has not been adopted, any increases in cost associated with improvements to shading or glazing to meet the 2012 IECC should be minimal. Most window manufacturers have developed cost-effective methods of providing windows that meet 2012 IECC requirements. A study created for the Department of Energy's Pacific Northwest National Laboratory (PNNL) estimated the incremental costs of upgrading to the 2012 IECC from prior codes per square foot of area of window for various U and SHGC factors.[10] The study is three years old but is still in use by the Department of Energy. As a result of ongoing improvements in manufacturing processes, these values should be considered an upper-bound for the incremental costs of windows used in single and multifamily settings.

Process Change

Table 5.2.1 Fenestration Costs by U-Factor per Square Foot by Climate Zone

Fenestration U -Factor	2006 IECC		2009 IECC		2012 IECC	
	U-Factor	$/sf	U-Factor	$/sf	U-Factor	$/sf
Climate Zone #1	1.20	$ 29.84	1.20	$ 29.84	NR	$ -
Climate Zone #2	0.75	$ 32.53	0.65	$ 33.12	0.40	$ 34.62
Climate Zone #3	0.65	$ 33.12	0.50	$ 34.02	0.35	$ 34.91
Climate Zone #4 except Marine	0.40	$ 34.62	0.35	$ 34.91	0.35	$ 34.91
Climate Zone #5 and Marine 4	0.35	$ 34.91	0.35	$ 34.91	0.32	$ 35.09
Climate Zone #6	0.35	$ 34.91	0.35	$ 34.91	0.32	$ 35.09
Climate Zone #7 and 8	0.35	$ 34.91	0.35	$ 34.91	0.32	$ 35.09

- Fenestration costs per square foot are based upon an average cost of Jeld-Wen premium vinyl casement window sizes ranging from 24"x42" to 72"x60"
- Cost estimates include for purchase and installation
- The costs for the IECC U-factor of 0.32 are based upon a component product with a U-factor of 0.30

Table 5.2.2 Fenestration Costs by SHGC per Square Foot by Climate Zone

Glazed Fenestration SHGC	2006 IECC		2009 IECC		2012 IECC	
	SHGC	$/sf	SHGC	$/sf	SHGC	$/sf
Climate Zone #1	0.40	$ 27.62	0.30	$ 30.39	0.25	$ 31.77
Climate Zone #2	0.40	$ 27.62	0.30	$ 30.39	0.25	$ 31.77
Climate Zone #3	0.40	$ 27.62	0.30	$ 30.39	0.25	$ 31.77
Climate Zone #4 except Marine	NR	$ -	NR	$ -	0.40	$ 27.62
Climate Zone #5 and Marine 4	NR	$ -	NR	$ -	NR	$ -
Climate Zone #6	NR	$ -	NR	$ -	NR	$ -
Climate Zone #7 and 8	NR	$ -	NR	$ -	NR	$ -

- Estimated costs are based upon interpolation of a quote containing multiple efficiency values and scenarios of various vinyl casement windows

2.11 Brownfield Site or Adaptive Reuse Building

Cost: Varies.

Adaptive Re-use: Adaptive re-use projects may have additional costs associated with upgrading buildings to meet new codes and regulations, but federal and local historic tax credits and grants are often available to offset these costs.

Brownfields: An environmental engineer interviewed reported that brownfield site cleanups vary widely in cost depending on the amount of mitigation action required. According to a 2014 paper which aggregated data from sites applying for funding from the US EPA's Brownfields Program, the average cost of cleaning up a brownfield site participating in the program was $602,000. The study included 51 brownfields with an average area of 10.83 acres per site and $55,583 in cleanup costs per acre. Fortunately for developers and local jurisdictions who undertake these cleanups, there are many federal and local grants available for all steps of the clean-up process to offset added costs.[11]

Process Change

2.12 Access to Fresh, Local Foods

Cost: Varies. The cost of garden materials and supplies depends on the size and type of available land, desired plant output, and ability of residents to participate in upkeep. Per contractor estimates, raised garden beds cost approximately $8 per square foot of cultivated area, which includes associated fencing and gravel or mulch between the beds. Greenhouses were estimated to cost approximately $25 per square foot. Establishing a Community-Supported Agriculture (CSA) pick-up point onsite requires minimal staff time to assist in accepting the produce from farmers during each growing period depending on the frequency of drop-off. Some farms collect a nominal fee ($3 to $5) per drop-off. Utilizing Option 3 for proximity to a farmers market will require minimal staff time. This portion of the submittal is ideally documented on a Context Map. See "Supplemental Document Instructions" found on Enterprise's website.[7]

2.13 LEED for Neighborhood Development Certification

Cost: Varies. Achieving LEED for Neighborhood Development (LEED ND) certification will require some incremental costs for project owners, including: certification fees collected through the U.S. Green Building Council (USGBC), additional documentation costs on the part of the project architect, and possibly additional hard costs which will range depending on project details. Registering a project for potential LEED ND certification costs $1,500.[12] Projects that are 20 acres and under incur flat fees of $18,000 and $10,000 for the Initial Stage and Subsequent Stage reviews respectively, and prices increase by $350 per additional acre. Separate fees may be added for additional services such as expedited review, appeals for specific credits after a final decision, and for Smart Location and Linkage Prerequisite Review. Preparing documentation for LEED ND certification on the part of the project architect or consultant will require additional soft costs, estimated at $10,000 by one interviewee. In addition to certification and documentation costs, meeting LEED ND for a project will require the project owner to meet selected LEED ND standards, the costs for which will differ by project. No study has provided incremental hard costs for LEED ND, but recent studies of individual buildings examining the cost to meet LEED for New Construction have shown modest cost premiums, from 0.4% in the case of a campus redevelopment in Cape Cod, Massachusetts to 4% in the case of branch banks in western Colorado.[13,14]

Process Change

2.14 Economic Development and Community Wealth Creation

Cost: Varies.

Local Hiring and Local Hiring Preference: Local hiring, when already mandated by city funding requirements (such as New York's Local Law 83) would not represent an incremental cost. Where no local hiring is required by the local jurisdiction, the cost of hiring locally (within a 10-mile radius) will vary by location, and may be nearly impossible in rural areas.

Physical Space for Business, Nonprofits, and/or Skill and Workforce Education: The cost to provide amenity space for use by non-profits and other local entities can be relatively low if

resident activity space is planned as part of the project's amenity package. Similarly, costs to administer this space may be handled by the property manager with a negligible investment of time. For delivery of additional space, either for flexible use by the community or for a dedicated tenant that would not otherwise be part of the development program, the added costs will range based on the construction type from $100 to $200 per square foot. In some cases, the delivery of space for lease to permanent tenants may create income that offsets this incremental cost. The offset would be based on local market rents, the relative discount provided to the tenant, and space upfit costs provided by the owner.

Synergy with: 2.5

Section 3: Site Improvements

3.1: Environmental Remediation

Cost: $1,500 - $2,500. Typical Phase I Environmental Assessments cost between $1,500 and $2,500. The cost for a Phase II Environmental Assessment varies greatly depending on the size and complexity of the development site, proximity to potentially hazardous sites such as gas stations and landfills, and the types of hazards that may need to be included in the assessment. Project owners should engage an environmental firm early in the development process to anticipate the types of hazards that may need to be reviewed in a Phase II Assessment.

3.2 Erosion and Sediment Control

No cost. Most design and construction professionals report that basic erosion control measures are standard practice in all jurisdictions. Contractors report that baseline erosion control for multifamily sites is $5,000 to $12,000 depending on size, which usually includes silt fences and storm drain protection as well as $2,000 for each stabilized construction entrance.

3.3 Low-Impact Development

Cost: Varies. Costs will vary depending on local jurisdiction requirements and underlying site hydrology. Reducing road widths to permitted minimums should reduce hard costs, while locating roads along topographic contours and ridgelines can also be achieved at no cost if anticipated early in design. Additional low-impact development techniques, such as the use of swales and removal of curb and gutter systems can be accomplished at no cost or result in construction cost savings.

Techniques for retaining, harvesting, or infiltrating the first 1.0 inch of rainfall over a 24 hour period will vary greatly depending on the project site's constraints, underlying hydrology, and local government requirements, many of which may require the first 1.0 inches or rainfall to be retained under current law. For larger projects, the most cost-effective stormwater management devices are typically water retention/detention ponds. These can double as community amenities if they are integrated into the project's landscape plan. Per one contractor interviewed, the hard costs of installing surface stormwater management with ponds has averaged approximately $130,000 per acre, which includes all the subsurface infrastructure required to route stormwater to the pond site. For more constrained sites, other stormwater management devices can be used, including rain gardens, cisterns, pervious

pavement, and other measures. The costs of pervious pavements can range from $2 to $10 depending on type. Rain gardens usually cost $10 to $15 per square foot. If thoughtfully integrated within the landscape plan, these measures can also contribute to satisfying open space requirements (criterion 2.7).

Synergy with: 2.7, 3.6

3.4 Landscaping

No cost. Interviewees confirm that native plants are widely available at nurseries and are no more expensive than conventional non-native plantings. The 2015 Criteria provides resources on where native plants can be sourced by contractors.

Synergy with 3.6

3.5a Efficient Irrigation and Water Reuse

Cost: Low to no Cost. Interviewees indicated that efficient irrigation systems are now common practice for new installations. Market demand for efficient systems is increasing due to the rising cost of water as an operating expense. In some markets water conservation measures are required by the local jurisdiction.

3.5b Efficient Irrigation and Water Reuse

Cost: $150 - $200. Interviewees and market resources suggest that WaterSense-labeled weather-based irrigation controllers can be a relatively low-cost addition to new or existing irrigation systems at about $200 per controller. Signal-based controllers, which receive data on local weather conditions from radio, web, or other means, are lower cost, and can be installed for as little as $150 per unit. By contrast, systems with on-site sensor-based controls require additional incremental costs to install sensors on site. A primer on WaterSense Weather-based controllers is available from the US EPA.[15]

3.6. Surface Stormwater Management

Cost: Varies. The cost will vary depending on local jurisdiction requirements and underlying hydrology. Techniques for retaining, harvesting, or infiltrating the first 1.0 inch of rainfall over a 24 hour period will vary greatly depending on the project site's constraints, underlying hydrology, and local government requirements, many of which may require the first 1.0 inches of rainfall to be retained under current law. For larger projects or greenfield sites, the most cost-effective stormwater management devices are typically water retention/detention ponds. These can double as community amenities if they are integrated into the project's landscape plan. Per one contractor interviewed, the hard costs of installing surface stormwater management with ponds has averaged approximately $130,000 per acre, which includes all the subsurface infrastructure required to route stormwater to the pond site. For more constrained sites, other stormwater management devices can be used, including rain gardens, cisterns, pervious pavement, and other measures. The costs of pervious pavements can range from $2 to $10 depending on type. Rain gardens usually cost $10 to $15 per square foot. If thoughtfully integrated within the landscape plan, these measures can also contribute to satisfying open space requirements (criterion 2.7).

Synergy with: 2.7, 3.3, 3.4, 4.5

3.7 Reduce Heat-Island Effect: Paving

Cost: Varies. Increasing the reflectivity of paving areas can be accomplished via the installation of concrete instead of asphalt. Concrete is more expensive to install than asphalt, however it offers lifecycle savings over less-durable asphalt. The albedo of asphalt can be increased via the installation of high-albedo “chipseals” or “sealcoats,” which, according to interviews, can be painted on conventional asphalt surfaces to improve reflectivity. These applications, which cost $0.10 to $0.25 per square foot, also improve the longevity of asphalt surfaces.

Installation of pervious, monolithic pavements may increase costs by 20–50% over traditionally-poured concrete products. Pervious paving options, from open grid geotextiles to monolithic pavements that simulate traditional surfaces, range from $2 to $10 per square foot. Interviews with architects and contractors indicated that these costs would decline as market penetration increases. One firm estimated the average annual maintenance costs of pervious pavement for small to medium sized parking areas to be $500.

Section 4: Water Conservation

4.1 Water-Conserving Fixtures

No cost. Contractors interviewed reported that the cost of ordering fixtures that meet criterion 4.1 (including required flow rates and WaterSense labeling) is negligible, as suppliers can provide fixtures with built-in aerators or sufficiently low flow rates at no additional cost.

4.2 Advanced Water Conservation

Cost: $150 per toilet. As in criterion 4.1, contractors report that the cost of providing faucets and showerheads that meet 4.2 adds no appreciable cost. However, upgrading to toilets that use 1.1 gallons on a baseline flush increases the cost of toilets by $150 per installed toilet.

4.3 Leaks and Water Metering

Cost: $400 - $1,500 per unit or riser. System testing to ensure water fixtures are operating properly is expected to be part of good building and property management practice. Contractors interviewed estimate that the installation of manually-read submeters in new construction and substantial renovations are $400 to $500 per unit, although installation of submeters is becoming standard for some owners. For retrofits where significant plumbing upgrades are not part of the project design and engineers intend to install one submeter per riser, some manufacturers provide meters that can be clamped around existing supply pipes. These meters cost on average $1,000 each and require additional installation costs, as well as ongoing wireless monitoring fees of $50 per month for the first meter and $20 per month for each additional.

In some markets, such as those with riser-fed multifamily stock, this criterion can be met by one submeter per riser, instead of in each unit. In these markets, where hot water must be delivered from a central boiler to individual units, the costs of water submetering would then require the installation of at least two submeters per riser – one for hot and cold water, respectively.

Process Change

4.4 Efficient Plumbing Design and Layout

Cost: $0 - $575 per unit or home. In the design phase for new and substantial rehab projects, plumbing design that creates shorter hot water runs can often be achieved at no cost. For situations where plumbing runs are too long, contractors estimate the cost of installing a recirculating pumps at the furthest fixture to be $575 per unit or home.

4.5 Water Reuse

Cost: Varies. Contractor interviews indicate that the cost of reusing rainwater or graywater varies depending on the system installed, with rainwater reuse considered to be much lower cost than greywater reuse.

Rainwater Reuse: For rainwater reuse, one contracting firm estimates that the most cost-efficient system they have installed uses cisterns which gather water from the gutter system and distribute it via a drip irrigation network. This system is estimated to cost $2,500 for each 100 gallon tank and associated distribution field. Depending on building size and rainfall expectations, larger buildings would require multiple cisterns.

Greywater Reuse, Irrigation: Greywater reuse is more costly and can vary depending on system design and intended reuse. One architect interviewed indicated that greywater systems which direct water to outdoor irrigation are more cost-effective than systems which redirect greywater to other sources, such as toilets. This architect reported that the cost to reuse laundry facility water (for a 70 unit building with 14 washing machines) for irrigation was $30,000. This included design costs, plumbing, a sand filter and controller, as well as connections to the outdoor irrigation field. For a small multifamily retrofit in California, one designer reported costs to reuse water from four washing machines for irrigation as follows:

Branched Drain System: $4,300 - $5,400

Pumped System: $5,250 - $6,500

Pumped to Drip Irrigation: $15,000 - $22,000

Greywater Use, Toilets: Installing greywater systems which reuse water from clothes washers and showers for flushing toilets or other domestic uses will incur greater costs. According to one designer, a rule of thumb used in new multifamily construction (50-75 units) where graywater is reused for toilet flushing is that a system will result in a 10% increase in plumbing costs (for dual plumbing), as well as $400 to $600 per toilet fixture, and $10 to $15,000 for the graywater treatment system. Expected payback for this system in California is 5 to 10 years.

At the University of Colorado-Boulder, a dormitory opened in 2011 with a greywater system that serves the 180 building residents. The system collects greywater from 65 sinks and 45 showers and treats and disinfects the water to be used to flush toilets. The system totaled $436,000 in capital costs and reduced consumption by 20%. [16]

Net Zero Water Use: Achieving net zero water use will incur significant incremental costs. A study commissioned by the District of Columbia's Department of Energy and the Environment

and undertaken by the New Buildings Institute (NBI), International Living Future Institute, and SKANSKA estimated the incremental costs of a Net Zero Water building in Washington, DC. In the study (which assumed a baseline of LEED Platinum) the incremental cost for a 12-story, 427,000 square foot building was estimated as $1.58 million in hard costs, or approximately 2.15% of hard costs above the LEED-Platinum baseline. [17]

Process Change

Synergy with: 3.6

4.6 Access to Potable Water during Emergencies

Cost: Varies. The cost to meet this criterion will vary depending on the strategy employed and the type of emergency experienced. For emergencies where an energy disruption interrupts access to water in units on a building's upper floors, potable water access can be ensured by providing a faucet in a common space, such as a laundry room, on a lower level of the property. This feature can be accomplished for no more than $500 to $1,000 for a sink and faucet combination.

For buildings in low-lying areas that may be at risk of public water contamination, interviewees recommend a water storage strategy. One architect recently commissioned an estimate for a system including a large storage tank, plumbing, pumps, a generator, and an enclosure to prevent freezing which totaled $100,000 for a 75 unit building.

Section 5: Energy Efficiency

The building performance standards in criteria 5.1a-d, below, offer a range of options for a project to achieve improved energy performance. For any performance standard chosen, a project will incur hard costs and soft costs – the latter including costs for both energy modeling/design and documentation. In the examples below, unless otherwise stated, the estimates assume projects contain at least 50-75 units, a scale which lowers the cost of energy modeling and field verification per unit. One important distinction between these standards is that criteria 5.1a and 5.1c relate to the performance of individual units, while criteria 5.1b and 5.1d relate to the performance of the entire building.

5.1a Building Performance Standard

Cost: $20,000 – $30,000 for soft costs. The cost to improve energy performance of a project to meet this criterion may include both soft and hard costs. Incremental costs will include soft costs for energy rating and project documentation as well as hard costs for building upgrades. As a general rule, these costs will be lower per unit for larger buildings, as scale is achieved across more units.

Soft Costs: According to architects interviewed, the cost of a HERS rater in a new 50-75 unit multifamily building is $20,000 to $25,000. In some markets, the required energy modeling ($10,000 to $12,000 of this total) can be reimbursed by the local utility. Another energy rating firm estimated $200 per unit for properties of 50 to 75 units to create an energy model and perform the required field verification and certification. Additional architectural detailing undertaken by the project architect is estimated at $5,000 to $10,000, depending on project

size. In a single family context, the cost of HERS rater to document home performance is estimated by an industry expert as $500 to $1,000 per home.

Hard Costs: Hard costs vary, according to interviews with contractors. According to a 2013 report by EPA, the additional hard costs for a project to build to the ENERGY STAR Certified Home program standard and perform verification measures is estimated to be between $0.88 and $1.17 per square foot of conditioned space, which will be at least partially offset by the resulting energy savings after construction.[18] The costs to certify a home through ENERGY STAR will vary based on region-specific requirements for the standard and the local market for HERS raters, though they can be minimized if the builder is experienced in construction practices that are above code-minimum requirements, or if the builder works in conjunction with a licensed HERS rater early in the design process.

Synergy with: 5.2, 5.3, 7.3, 7.4, 7.5, 7.6, 7.9

5.1b Building Performance Standard

Cost: $25,000 – $60,000.

Soft Costs: ENERGY STAR certification is expected to require additional work on the part of a licensed professional to show compliance. Consultants estimated the soft costs of an ASHRAE model to be $15,000 to $20,000 for a 50-75 unit building. Another energy rating firm estimated $300 per unit to create an energy model and perform the required field verification and testing for mid- and high-rise buildings. Project owners would also incur additional costs for construction documentation, estimated at $10,000 to $50,000, depending on project size.

Hard Costs: One contractor who recently analyzed the cost of meeting the standard for a new building estimated achieving ENERGY STAR for multifamily to be an incremental cost of 4–7% of building hard costs. During the pilot phase of the ENERGY STAR Multifamily High-Rise program (completed in 2010), US EPA found the median incremental cost to achieve the standard to be $3.20 per square foot.

An analysis undertaken by NYSERDA for its Multifamily Performance Program yielded the following incremental soft costs (energy modeling) and hard costs for new and rehabbed buildings between 2011 and 2015.

NYSERDA Multifamily Performance Program: Costs 2011-2015

Metric	New Construction	Gut-Rehab	Whole Program (NC & GR)
Average # of Units	119	30	101
Average Total Project Square Feet	123,318	33,481	105,512
Average Incremental Cost for Scope of Work (Hard Costs)	$13,467.76	$8,993.59	$12,572.34
Average ERP Partner Fees (Soft Costs)	$19,502.24	$17,679.74	$19,055.21

Source: TRC Energy Services, NYSERDA Consultant

Process Change

Synergy with: 5.2, 5.3, 7.3, 7.4, 7.5, 7.6, 7.9

5.1c Building Performance Standard

Cost: $6,000-$8,000 per 50-75 unit building plus $1,000 to $1,500 per unit.

Soft Costs: As stated in the Enterprise Green Communities Criteria Manual, engaging a certified HERS rater early in the design process can help to optimize energy efficiency and minimize the cost of a retrofit. One energy modeling firm estimated the costs to undertake energy modeling for 50-75 units (distributed over six buildings in a garden apartment community) would total $6,000 to $8,000. Another energy rating firm estimated $200 per unit to create an energy model and perform any required field verification and testing for buildings with at least 50 units. These costs were expected to decline as the number of units increased.

Hard Costs: One contractor estimated the cost of achieving this standard in moderate and substantial rehabs to be an incremental cost of $1,000 to $1,500 per unit. This would include the addition of insulation in roof cavities, equipment replacement, and caulking of top and bottom plates for walls that were to be opened as part of the renovation. It is noteworthy that this estimated incremental cost assumes equipment updates, roof replacement, and insulation upgrades are already required as part of the retrofit to meet code requirements.

Many states already have codes in place that require compliance with the 2009 IECC or more stringent codes. Thus, in gut rehab projects where the 2009 IECC is in effect, no incremental hard costs may be required to meet this standard. However, in the case of moderate rehab projects, some incremental costs may be incurred in common spaces (beyond what is required by code within units) which are outside the scope of common renovations. See this code status map provided by the Building Codes Assistance Project to determine if your state or jurisdiction is at or above the 2009 IECC.[19] In all cases, the costs associated with a rehabilitation project to achieve an 85 HERS Index Score or better vary depending on the existing performance of the property and local market conditions.

As an example of hard cost requirements, below are ceiling R values required under the 2009 IECC for various climate zones and the associated cost of blown-in fiberglass cellulose insulation, per RS Means:

Required Ceiling R-Values, 2009 IECC

Climate Zones	Required R Value	Fiberglass Blown-in Insulation	Cellulose Blown-in Insulation
1, 2, 3	R-30	$1.81 / Square Foot	$1.37 / Square Foot
4, 5	R-38	$2.24 / Square Foot	$1.74 / Square Foot
6, 7	R-49	$2.84 / Square Foot	$2.24 / Square Foot

Synergy: 5.2

5.1d Building Performance Standard

Cost: $10,000 - $17,000 in soft costs for energy modeling plus $1,000 - $1,500 per unit in hard costs.

Soft Costs: Documenting performance with an energy model created by an energy services provider may add incremental soft costs compared to a standard demonstration of code compliance, which for most projects is achieved with a ComCheck report. An energy model created by a third party energy services provider was estimated by energy rating firms to add incremental costs of $10,000 to $17,000 for a 50-75 unit multifamily buildings. Another energy rating firm estimated $300 per unit to create an energy model and perform any required field verification and testing.

Hard Costs: For moderate or substantial multifamily rehab projects, the added cost of achieving compliance with ASHRAE 90.1-2010 will vary depending on the building's baseline energy use. For hard costs, one contractor estimated incremental costs of $1,000 to $1,500 per unit, which includes upgrading exterior insulation in floor cavities, attics, and rigid exterior insulation.

Synergy: 5.2

5.2a Additional Reductions in Energy Use

Cost: Varies. Architects and contractors interviewed indicated that estimating the incremental costs of increasing performance on the HERS scale is difficult to generalize from one project to another. Achieving a HERS rating of greater than 50 was generally seen as increasing hard costs by less than 3%, while projects aiming to reduce energy use below a HERS rating of 50 will begin to incur significant incremental costs, including those associated with super-insulated wall assemblies.

5.2b Nearing Net Zero

Cost: Varies. To achieve certified status for various programs, the project will incur incremental soft costs and may incur incremental hard costs. Since hard costs vary depending on the size of the project and type of construction, the added cost (if any) for nearing net zero energy will also vary. On smaller projects, such as single family homes, incremental hard cost as a percentage of the total hard costs is generally more than on larger apartment buildings.

There is more clarity around the incremental soft costs for nearing net zero energy, as project teams may have to hire additional technical expertise and also pay for the cost of certification. As noted in the 2015 Green Communities Criteria Manual, there are several options for certification: Passive House Certification, DOE Zero Energy Ready Home Program, and Living Building Challenge.

Passive House Certification: Passive House certification can be achieved through either Passive House Institute US (PHIUS) or through the international Passive House Institute (PHI). Both PHIUS and PHI standards require energy modeling and some thermal bridge analysis, documentation of construction practices and third-party verification of blower door test results, however PHIUS also requires third party quality assurance during construction through an independent PHIUS+ Rater, rather than self-documentation. Since September

2015, PHI and PHIUS are also different standards with different energy use and other requirements, so it makes sense to choose the certification method early in project design. Both PHI and PHIUS offer pre-construction certification, wherein construction documents and material specifications are reviewed against Passive House criteria, and corrections can be made to ensure a project is capable of meeting the requirement prior to the start of construction. Pre-certification is not required. When a project team opts to use pre-certification, the fee is split into pre- and post-certification reviews; little to no additional cost is incurred when choosing this path.

Cost of Passive House Certification for a Single-Family Home

Expense	PHI ($)	PHIUS ($)
Certification Fee*	2,250 to 2,950	1,080 to 1,850
Third-Party Construction Verification[+]	N/A	1,500 to 2,500
Third-Party Blower Door Test^	150 to 300	150 to 300
TOTAL	2,400 to 3,250	2,730 to 4,650

* Certification Fee range is due to size of home and project team affiliation with either program.
[+]PHIUS+ Raters set their own rates. Contact a Rater in your area to discuss your project.
^Third-party blower door tests are required to meet the 2015 IRC, and do not represent additional costs in jurisdictions where this version of the code is in place.

For multifamily projects, the fees for Passive House certification under both PHI and PHIUS scale with the size and complexity of the project. Additionally, PHIUS estimates that while the cost for the PHIUS+ Rater is roughly equal to the cost of certification for smaller projects, it can begin to diverge for larger and more complex projects.

In terms of the required energy modeling and thermal bridge analysis, the project architect can generally complete the proprietary Passive House Planning Package (PHPP) and perform THERM analysis on thermal bridges if they are familiar with PHPP and THERM. Otherwise, a separate Passive House Consultant can be hired to perform this job, with fees ranging depending on the size of the project.

An advantage of using the PHIUS Passive House rating system for single family homes is PHIUS has established relationships with the ENERGY STAR and DOE Zero Energy Ready Home programs. As such, all single family projects use the ENERGY STAR, Zero Energy Ready Home, and the PHIUS+ checklist items for their on-site Quality Assurance processes, and earn all three certifications as part of their certification fee.

The advantage of using the PHI rating system is that quality assurance can be self-documented, which reduces the incremental cost of certification, and the rating system is still driven by the energy modeling standards used for Passive House projects internationally.

DOE Zero Energy Ready Homes: DOE Zero Energy Ready Home certification can be achieved without achieving Passive House Certification. In these instances, soft costs for achieving certification are largely limited to the cost of a HERS rater to document home performance. The cost is estimated by an industry expert as $500 to $1,000 per home, with higher prices associated with single homes or more inexperienced builders who have not gathered data and documented their efforts. Engaging a HERS rater for multiple homes would

decrease the price to as low as $500 per home. The DOE Zero Energy Ready Home program allows for a RESNET-approved sampling protocol for the Indoor airPLUS Verification Checklist and the HVAC System Quality Installation Rater Checklist, but not the HVAC System Quality Installation Contractor Checklist. The ability to use sampling protocols greatly reduces the cost to achieve certification for larger projects.

Living Building Challenge: The Living Building Challenge provides the fees for certification in a table on their website.[20] Given the relative newness of Living Building Challenge, it may take substantial staff time to educate the project team on the requirements, as well as determine how to meet the requirements, the cost of which would range depending on experience with the standard.

In all cases, no additional consultants other than those mentioned above are required to achieve nearly net zero energy performance. Project owners can choose architects, mechanical engineers, and other consultants they would normally hire for their project that already have the capability to carry out their nearing net zero energy goal, rather than hire additional consultants to manage this part of the project.

Process Change

Synergy with: 1.1c, 4.5, 5.1, 6.10, 7.1

5.3 Sizing of Heating and Cooling Equipment

Varies. No added costs should be incurred for this criteria as mechanical engineers are required to perform proper sizing calculations while designing the HVAC system. However, in practice many systems are oversized by designers to compensate for poor construction and to avoid call-backs.

When undertaken alongside quality construction, extra diligence in equipment sizing can produce opportunities to install right-sized (usually smaller) equipment that has lower up-front cost and will save energy during operation. To facilitate this, the project's architect can include right-sizing as a requirement in specifications provided to project's mechanical engineer.

Process Change

5.4 ENERGY STAR Appliances

Cost: Varies, but no more than $550 per dwelling unit or home. The incremental cost of purchasing an ENERGY STAR-certified appliance over a standard model ranges from no additional cost to $550 per unit. According to interviewees, refrigerators meeting the standard have an incremental cost of $350 per unit due to a recently revised performance requirement. Additionally, certified clothes washers may cost an additional $200.

These additional costs can be offset in some jurisdictions through utility rebates and incentives. Appliance rebate programs are numerous and vary by jurisdiction and local utility. For example, the City of Longmont, Colorado provides a rebate to customers of up to $100 for purchasing qualified ENERGY STAR-certified clothes washers.

5.5 Lighting

Cost: Varies. In the context of commercial-grade fixtures, contractors interviewed indicate that the cost to upgrade compact fluorescent (CFL) lighting to higher efficiency variants (T-12 to T-8 or T-5) during new construction or rehab (when fixtures are expected to be replaced) is minimal. The cost to upgrade to LED lamps will add incremental costs, though these will vary based on design selections. The upgrade to LED fixtures will also significantly lower lighting replacement and maintenance costs, as these bulbs are frequently rated for 50,000 hours of use.

Installation of occupancy sensors would add additional incremental costs, which are estimated in a report by LBNL to be $0.90 to $1.00 per square foot.[21]

For single-bulb applications, which are common in both multifamily and single-family residential, CFLs are now a market standard. LED bulbs can be installed at a modest cost of approximately $4.00 per bulb for a 60 Watt equivalent (9W), versus $2.00 for an equivalent 13W CFL – an incremental cost of only $2.00 per bulb.

For exterior parking lot and common space applications, the incremental costs of installing LED lights was estimated by one contractor to add incremental hard costs of $300 per fixture. By this contractor's estimate, two basic pole-mounted LED fixtures and lamps would cost $1,200, compared to $600 for two conventional metal halide lamps. Despite incremental costs of $600 in this example, the contractor pointed out that these LED lamps would be expected to produce significant energy and maintenance savings.

Synergy: 1.1c, 8.1, 8.3

5.6 Electricity Meters

Cost: $400 - $3,000 per unit. The cost per unit to install electricity submeters depends on the type of meter and services that are provided along with it, as well as the number of meters installed within a building. Individual submeter units can range in price from $400 to $3,000 without including software and installation, though in some jurisdictions the upfront costs can be offset through electric utility incentive programs.

5.7a Photovoltaic/Solar Hot Water Ready

Cost: Varies, but is significantly lower in new construction. The incremental costs of creating a solar-ready building varies depending on whether the building is a rehabilitation or new construction and the type of solar system. Building professionals interviewed indicate that the cost of making a new building solar PV ready are relatively low, while the cost to add these features to an existing building may require electrical conduit and equipment to be installed external to the building. To a make a new or renovated multifamily building that is 25-100 units in size PV ready, one contractor estimated $2,500 to $5,000 to run necessary conduit. For solar hot water, making a new or rehabilitated building solar hot water ready during construction requires additional plumbing to be designed and installed. One firm estimated the cost to complete a solar hot water design and run piping for multifamily projects to be $7,000 per project for hard and soft costs. Hard costs of installation will vary based on the length of plumbing runs. For single-family homes, interviewees estimated the cost to provide solar PV

readiness at $500 per home and the cost to provide solar hot water readiness at $1,000 per home.

Process Change

5.7b Renewable Energy

Cost: Varies. Installation of renewable energy systems requires integrative design on the part of the project architect. Southern-facing exposures and flat roofs are preferable for installation of solar photovoltaic (PV) and solar hot water generation. For new construction on most sites, the building orientation and roof shape can be adjusted to provide these exposures at low or no cost to the owner. To determine the size of the system needed to meet various percentages of overall energy use, the project architect may choose to create an energy model but may instead approximate the expected energy demand for the project. In many markets, solar can be installed at no cost or even save the property owner money via a power purchase agreement (PPA) or lease with a third party investor/owner. For owners electing to own their own system, costs vary based on system size, architectural constraints, and the availability of state rebates. The Department of Energy's Lawrence Berkeley National Lab publishes an annual report, "Tracking the Sun," that provides annual average installed prices per kWh for solar PV by state. [22]

Process Change

Synergy with: 2.10, 5.8b

5.8a Resilient Energy Systems: Floodproofing

Cost: Varies. Based on Enterprise's study of the issue in the New York City market, the prices for meeting this criterion range widely. Locating building systems during new construction so that they would not be severely impacted in the event of a flooding emergency would not result in additional soft costs if considered in the design phase. Some examples of improvements and their costs in a retrofit context for floodproofing are specifying smart floodwater vents at a cost of $250 to $300 per unit (without installation) and installing a sump pump which had an installed cost of $3,000. A retrofit project of a 71-unit multifamily building located in Queens, New York installed four floodgates and seven flood doors for a total project cost of $100,000.

Synergy with 1.3a, 1.3b

5.8b Resilient Energy Systems: Islandable Power

Cost: Varies. Islandable power requires the installation of specialty solar PV equipment along with the typical solar panels and inverter. In typical grid-tied solar PV systems, when there is a power outage, the home or building also loses power. In order to keep the building operating a special bi-directional inverter with a battery storage system must be installed. This specialized bi-directional inverter essentially creates a micro-grid within the house or building. Note that combination inverters that handle both the PV system and the battery back-up system are under development by leading solar system manufacturers.

There are two major types of islandable power configurations: systems that keep the building running while the sun is shining, and systems that power the building even overnight. In day-operation systems, only a small amount of battery storage is required to "jump start" the micro-grid, which can then run off the solar PV panels. In these systems, the PV array must be sized such that it can produce enough energy to equal the electrical load of the building. By contrast, in systems that keep either all of the building or critical loads powered overnight, the amount of battery storage must be sized to the electrical demands of the building. In this scenario, the PV system would have to be sized such that it could both power the building or critical loads during the day and also recharge the batteries for night time use.

As islandable power is an immature (though not new) market, it is difficult to compare cost per kWh across manufacturers. Each battery chemistry contains a different number of “cycles” or times the battery can be discharged, “usable” kWh despite the sticker kWh rating, percentage capacity degradation over time, and other factors. Adding to the confusion, systems are often quoted as cost per kW for the battery itself, which doesn’t take into account these critical factors that affect actual energy storage and use over time. As a result, prices for adding an islandable power system to an existing PV system will thus range significantly – from $0.12 to $0.25 per kWh, depending on system size, configuration, and equipment type. As a prerequisite to undertaking cost estimation, the project team should determine the project’s energy needs.

Process Change

Synergy with: 1.3a, 1.3b, 5.7b

Section 6: Materials

6.1 Low/No VOC Paints, Coatings and Primers

No cost. Contractors interviewed suggested that meeting criterion 6.1 results in no incremental cost because these measures are now an industry standard. Some contractors provided anecdotes that some no- or low-VOC paints provide less coverage than conventional equivalents, creating a need for additional coats of paint. Contractors indicated that testing different products is necessary to determine which provides proper coverage.

6.2 Low/No VOC Adhesives and Sealants

Cost: $0.10 - $0.15 per square foot. Interviews with contractors indicated that meeting criterion 6.2 results in an added hard cost of $0.10 to $0.15 per square foot of project area.

6.3 Recycled Content Material

Cost: Low or no cost. Contractors interviewed indicated that for some materials, such as sheathing (OSB), paving (concrete), and insulation (cellulose), meeting the 50% post-industrial or 25% post-consumer recycled content hurdles can be achieved at no cost. Aluminum framing can be cost-effective as well in some construction types. Achieving this standard for other materials, such as framing, siding, and roofing can be more costly. Some composite roofing products which mimic the appearance of historic materials (such as slate)

can cost $2.50 to $3.50 additional per square foot when compared to conventional asphalt shingles.

6.4 Regional Materials

Cost: Varies. In many cases there are no incremental costs to sourcing building materials from within 500 miles of a project, as building suppliers have an incentive to avoid transportation costs. These costs will thus vary by region across the U.S. In the Southeast, for instance, access to lumber from within a 500 mile radius will mean no incremental cost, whereas in the West other materials, like gypsum, are locally-produced. One contractor interviewed indicated that in some cases the cost premium of materials can rise to 10–40% versus conventional practice for materials that aren't historically sourced in the project region.

6.5 Certified, Salvaged and Engineered Wood Products

Cost: Varies. Interviewees indicated that the cost of meeting this criterion often is standard practice, based on the wide use of engineered wood products. Forest Stewardship Council (FSC) lumber is estimated to cost an additional 10–15%t more than conventional lumber. Meeting this criterion only requires 25% of lumber meet FSC standards, thus this criterion is expected to add approximately 2.5–3.75% or more in overall structural wood costs. Salvaged wood is expected to vary in price based on type and local availability while engineered framing materials are used in many projects as a standard practice.

6.6 Composite Wood Products that Emit Low/No Formaldehyde

No Cost. Interviewees agreed that there is no cost for installing composite wood products that emit low or no formaldehyde, as these products are now an industry standard.

6.7a and 6.7b Environmentally Preferable Flooring

Cost: Varies. For new and renovated buildings, carpets are rarely installed in common areas, although they are sometimes installed in units over a ground-level slab. Upgrading from carpet to other floor finishes in these areas will range in cost. Wood floors, ceramic tiles, and natural linoleum will run from $3.75 to $11 per square foot for materials and installation. Hardwood flooring, for instance, can be installed for $7 per square foot. Interviews with tile installers indicate that ceramic tiles can also be installed for $6 to $9 per foot. By contrast, carpet can be installed for as low as $2.50 per square foot. Natural linoleum can be installed for a slight premium (installed cost of $3.75) vs. conventional linoleum ($2.75 per square foot). For floors above a concrete slab, the concrete can be stained with low-VOC materials for $2 to $4 per square foot, with price driven by project size. In the latter case, depending on the expected quality of the baseline concrete installation, the concrete subcontractor may also increase their price to produce a smoother floor surface.

While carpet is less expensive than more environmentally-preferable products, it is typically replaced when units turn over, raising operating expenses.

6.8 Mold Prevention: Surfaces

No cost. Interviewees indicate that criterion 6.8 is a standard practice in new construction and renovation, including sealed grout.

6.9 Mold Prevention: Tub and Shower Enclosures

Cost: No cost for fiberglass shower enclosures, negligible cost for those using tile tub and shower surrounds. Interviewees indicate that standard construction practice increasingly has replaced "green" and "purple" board behind tub and shower enclosures with cement board. However, for those areas where cement board (or equivalent) is not common practice, contractors estimate the incremental cost of upgrading to be $0.15 per square foot due to material prices and the cement board's increased weight. In some cases the profile of the wall changes where drywall meets the cement board, although this can be mitigated with tiling. For the average 3 foot by 5 foot tub/shower enclosure (assuming 8 foot ceilings) with a square footage of 64 square feet, the incremental cost would be $1.20 per shower enclosure.

6.10 Asthmagen-Free Materials

Cost: Varies. Contractors interviewed indicated that meeting criterion 6.10 would require low incremental costs for many of the requirements under this criterion. Compliant insulation and wall coverings can be purchased at no additional cost and are considered an industry best practice. For vinyl flooring, an incremental cost of $1.00 per square foot is estimated to upgrade to natural linoleum. Ultra-Low Emitting Formaldehyde (ULEF) and No Added Formaldehyde (NAF) products for cabinetry and subflooring are standard in some markets but can also increase the cost of these materials by 5–10% depending on the product. One contractor interviewed indicated that ULEF or NAF cabinets might incur a 10% hard cost premium. Another contractor confirmed that painting the exposed wood edges in conventional cabinets can cost-effectively meet this requirement. This contractor indicated that cabinet installers can use a roller and paint to seal the exposed cabinet edges (on top and rear of cabinets) for approximately $50 per home (or unit) in added hard costs.

6.11 Reduced Heat-Island Effect: Roofing

Cost: Varies. ENERGY STAR-certified roofing products can be installed at similar price points to conventional roofing products. In many markets, white roofs, such as TPO, are an industry standard for flat roofs. In markets where EPDM is more common, the cost to coat this black material is estimated to add 3–7% to installed costs. The incremental costs of extensive green roofs (roofs with 6 inches or less of media) installed on flat roofs typically run from $10 to $20 per square foot installed, although prices vary based on project size, complexity (number of roof penetrations), and maturity of the local green roof market (installers). For green roofs, a significant percentage of cost is labor – extensive green roof materials usually run less than $5 per square foot.

Synergy with: 2.7

6.12 Construction Waste Management

Cost: $100 - $200 per unit. Interviewees suggest that reusing 50% of building waste can be accomplished at a fairly low cost of $100 per unit. Diverting 75% of waste from the landfill may double this cost to $200 per unit. Both of these estimates assume a hauling firm will sort the construction waste off-site at their facility. These estimates include offsets for reduced tipping fees, and assume the diversion of recyclable materials (cardboard, metal, etc.) by the third-party hauler.

In some cases, interviewees indicate that construction waste management costs could be lowered if recycling is done on the project site by contractors, but many projects do not have a sufficiently large staging areas for the 4 to 5 dumpsters that would be required to accomplish onsite sorting, especially on urban redevelopment sites.

Some users of the Green Communities Criteria report that no recycling haulers are available within 200 miles of their work sites. In these cases, construction waste management can become significantly more expensive or impractical.

Process Change

6.13 Recycling Storage

Cost: Negligible. The cost to provide recycling storage areas is minimal and varies depending on the building layout. The cost of individual recycling bins runs between $5 and $10 per receptacle, an amount which could be allotted for each unit. Larger bins for collection points run between $25 and $35 apiece, of which at least four are typically needed (metal, glass, plastic, paper). Collection points for multifamily buildings can typically be located in designated spaces for trash collection.

Synergy with: 1.1b, 8.1, 8.3

Section 7: Healthy Living Environment

7.1 Ventilation

Cost: Varies. Vented bathrooms and kitchens are considered a standard practice for new construction projects in many markets. According to interviewees, the cost of adding a bath (or kitchen) fan, vent, and an outlet to the building's exterior would add $200 to $250 in hard costs per kitchen or bathroom in both new construction and substantial renovations. In some building assemblies, a fire damper may be necessary, which will add an additional $45 to $50 in incremental costs. Whole-house ventilation via a bath-fan type ERV would add incremental costs of $250 per house (single-family) or per unit in multifamily to upgrade from a standard bath fan.

7.2 Clothes Dryer Exhaust

Cost: $200 per unit in retrofits only. The installation of galvanized steel ducts (i.e. hard-ducted) dryer vents represents a cost increase over flexible ducts. However, in many jurisdictions the fire code requires dryer vents be hard-ducted and thus it would be included in standard building practice. However, where retrofits are necessary, the cost to run 4" galvanized spiral steel ductwork is estimated as $200 per unit.

7.3 Combustion Equipment

Cost: $180 per unit. Meeting criterion 7.3 is expected to add incremental costs of $180 per installed hard-wired combination smoke alarm/carbon monoxide alarm. For jurisdictions requiring hard-wired smoke alarms under their current code, there should be no added cost.

Vented combustion appliances are now standard practice in conditioned space, and would result in no incremental cost. Where the addition of a powered or direct vent is necessary, one contractor estimated the cost to install an upgraded hot water heater would represent an incremental cost of $300 to $400 per water heater installed.

7.4 Elimination of Combustion within Conditioned Space

No cost, or cost savings. Removal of combustion from conditioned space can be achieved with no added construction costs. Within kitchens, electric ranges can be purchased and installed for comparable price points to gas ranges, and many electric appliances are lower-cost than their gas-fired equivalents. To meet heating and cooling loads in increasingly well-insulated homes, modern electric heat pumps (sometimes known as mini-splits) can deliver superior energy performance at comparable (or lower) price points than conventional forced air combustion systems. Minisplits can also be conventionally ducted, mounted in ceiling "cassettes" or wall-hung, with the latter two options eliminating the need for and expense of duct work.

Process Change

7.5 Vapor Retarder Strategies

No cost. Interviewees indicate that the installation of a vapor retarder under slabs is standard practice in new construction and rehabs when foundations are replaced as part of the project scope.

7.6 Water Drainage

Cost: Negligible.

Weather-Resistant Barriers: Weather-resistant barriers represent standard construction practice for frame walls in all new construction. The installed cost of weather resistant barriers is approximated as $0.30 per square foot. Proper detailing of the weather-resistant barrier can be achieved at no cost by trained installation crews. Providing a pathway for bulk water movement behind cladding systems is also standard in new construction for both traditional lap siding products and brick-clad structures. However, for an increasing number of projects with more highly-insulated envelopes, designers are suggesting installation of vertical furring strips between the weather-resistant barrier and cladding, resulting in a larger drainage plane. Interviewees suggest the cost to install these furring strips is minimal. Alternately, some products integrate grooves or a corrugated mesh as part of the weather-resistant barrier to improve the drainage plane and avoid the additional furring strip layer.

Roof Systems: Although installation of roof flashing is standard practice, the costs to install 6 inch metal flashing is estimated at approximately $1.50 per square foot. Drip edges can be installed at similar price points per linear foot and are also a common practice in many markets for new construction.

7.7 Mold Prevention: Water Heaters

Cost: $0 - $250. For new construction, drainage for water heaters is considered standard practice, while in rehabbed buildings, contractors estimate the cost of adding drains as $250 per unit.

7.8 Radon Mitigation

Cost: Varies. In new construction, radon mitigation measures are considered standard practice in Zone 1 Radon areas. In retrofits without mitigation measures in place, however, contractors estimate that the cost for single family home retrofits to be $2,000 to $3,000 per unit. This is significantly higher than the roughly $200 per dwelling unit for new single family construction.

Radon testing can be done on new construction sites and in existing homes for a baseline cost of approximately $150 per test. For larger multifamily sites, multiple tests will be needed. Each test will have the same price, but more tests will have to be undertaken to cover the larger area.

7.9 Garage Isolation

Cost: $200-$300 per garage. To isolate garages from homes or multifamily buildings, one contractor estimated that the most cost-effective solution would be adding a sheet-applied air barrier for an incremental cost of $200 to $300 per garage. Another interviewee suggested that using foam and caulk might alternatively be used but might incur the same or higher costs, depending on the materials. A technical resource on creating an air barrier between garages and homes is available from PNNL.[23] One contractor interviewed indicated that the cost to follow PNNL specifications to spray foam cavity walls with closed-cell spray foam would add incremental costs of $3 to $5 per square foot of frame wall for a 3.0 to 3.5 inch thick application of foam.

7.10 Integrated Pest Management

No Cost. Integrated pest management, including designing and sealing all areas to minimize pest entry is considered an industry standard with no incremental cost.

7.11a-b Beyond ADA: Universal Design

Cost: $2,000 - $3,000 per accessible unit to meet ADA or ANSI in new construction. Accessible units are common practice for many new developments. Architecture firms interviewed indicate that including accessible units would not incur additional design fees but may increase the square footage of some spaces, such as bathrooms, depending on unit sizes. For instance, in smaller units, bathrooms may need to increase in floor area by an estimated 10% to meet ADA requirements. In addition, the designer would add handrails and grab bars, an appropriate-height switch for the range hood, as well as emergency horns and strobe combinations. These additions were expected to add approximately $2,000 to $3,000 per accessible unit. These per-unit incremental costs would only be applicable to the 15% of units designed to this standard.

The costs to meet ANSI requirements are estimated to be higher than ADA in a retrofit context. Cost in substantial and moderate rehab projects (7.11b) was estimated at $3,000 and up. According to architects interviewed the cost of achieving ICC /ANSI A117.1, Type A, Fully Accessible guidelines can be the same as new construction if units are undergoing a gut-rehab. In more moderate rehabs where the owner intends to retain the original floor plan, the costs of achieving the ICC standard may rise in cost to $10,000 per accessible unit – which according to interviewees would be prohibitive for most owners.

7.12 Active Design: Promoting Physical Activity within the Building

Cost: $1,000 per stairwell. Interviewees suggest that the soft and hard costs of features designed to promote physical activity are minimal, as many of these features are common practice or can be integrated at no to low cost during the design phase. Some improvements to the stairs may be necessary, including improvement of the stair entry. According to one architect interviewed, on recent projects the costs have totaled $1,000 per stairwell, which is inclusive of adding maple or birch stair treads to the first riser, improving handrail details, and adding a door with a magnetic door-holder. According to interviewees, modern LED lights in all new stairwells would be sufficient to make the space inviting for daily use.

7.13 Active Design: Staircases and Building Circulation

No cost. There should be no cost to locate a stairwell for convenient access and use by residents. In the rare event an additional stairwell would need to be added to meet this requirement, the added cost of a four story interior stair is estimated to have a hard cost of $40,000.

7.14 Interior and Outdoor Activity Spaces for Children and Adults

Cost: $100 - $200 per square foot. In new or renovated multifamily buildings, gyms are often provided as part of the project scope. Where they are not included, contractor estimates range from $100 to $200 per square foot, depending on the size of the gym facility. This estimate excludes the cost of equipment. Exterior playgrounds for children can range significantly in price. Small “tot” parks can be installed for as little as $10,000 to $15,000, while more elaborate playgrounds may cost $75,000 or more, including equipment and installation.

7.15 Reduce Lead Hazards in Pre-1978 Buildings

No cost. As lead remediation is required by law, no incremental cost would result from this criterion. A lead risk assessment by an EPA-certified provider will typically cost from $400 to $700 for a single-family home. The results of this assessment will determine the amount of remediation measures necessary, if any at all, and these could include replacing windows that contain lead paint, removing lead paint from other interior or exterior spaces, and covering or removing soil that has been contaminated with lead. One contractor estimated the cost to reduce lead hazards in contaminated buildings as $1,200 to $5,000 per unit, depending on areas of contamination.

Windows: Window replacement may cost from $400 to $700 per window, with additional costs necessary for highly-efficient models (please refer to criterion 2.10).

Lead Paint Removal: Lead abatement processes for paint will range depending on the number of affected areas and the local market for certified lead containment practitioners, ranging in cost from $8 to $15 per square foot.

Soil: Soil can be covered with a tarp or protective sheeting for minimal cost to limit exposure to lead contaminants while remediation is taking place. Raised garden beds placed on top of protective sheeting to permanently cover contaminated soil range in cost from $9 to $30 per square foot depending on the desired source materials.

Synergy: 6.1, 6.2

7.16 Smoke-Free Building

Costs: Varies. For both new and existing buildings, there will be some costs for property owners associated with encouraging residents not to smoke inside buildings, including installation of no-smoking signs, or creation of a dedicated smoking area on the property away from the buildings themselves. No Smoking signs cost $15 to $30 apiece and can be posted in common areas at the discretion of the property owner or manager. Outdoor-rated ashtrays cost as little as $40 to $50 apiece, although property managers may also choose to install a dedicated outdoor pavilion.

Owners and property managers report that creating a smoke-free building is now standard practice in most markets for new buildings. Providing impetus for roll-out of smoke-free properties, the Department of Urban Development (HUD) issued a new rule in November 2015 requiring local housing authorities to make their properties smoke-free.

At present, in existing buildings, many owners are wary to evict tenants due to smoking, and there are costs to patrol and manage the policy. Not undertaking a smoke-free building policy also has costs, however, including the cost to abate smoke contamination affected units, estimated at $3,515 per unit by the National Center for Healthy Housing.[24] One interviewee estimated the cost might rise to as much as $6,000 per unit in highly-contaminated units.

Section 8: Operations, Maintenance + Resident Engagement

8.1 Building Operations & Maintenance (O&M) Plan

Cost: $2,500 - $10,000. For many contractors, providing an O&M manual is standard practice and a contractual obligation of their contract with the project owner. For those manuals that are not sufficient regarding sustainability features, building owners and owner's reps report that the cost to integrate green attributes throughout might add an additional cost of $2,500 to $10,000. This cost would be reduced if the project owner was able to utilize a preexisting manual provided by the company or a third-party. Some owners indicate that the adoption of Integrated Pest Management (IPM) standards require a process change to business-as-usual practices, though no incremental cost is incurred.

Process Change

Synergy with: 6.13

8.2 Emergency Management Manual

Cost: $1,000 - $3,000 per building. Project owners and owner's reps suggest that an emergency management manual should already be in place for well-managed properties but in the event one is not available, it can be prepared for $1,000 to $3,000 per property.

8.3 Resident Manual

Cost: $2,500 - $3,000. Interviews with project owners and consultants indicate that the cost to prepare a customized resident manual (using the Enterprise Green Communities template) to be $2,500 to $3,000. This guide could be prepared by the owner or developer's staff, the property manager, or a consultant.

Process Change

Synergy with: 6.13

8.4 Resident and Property Staff Orientation

Cost: $0 - $300. Interviews with property managers and owners indicate that building orientations are standard for new tenants and should incorporate green measures. However, in the event property management staff has to develop new materials for orientations, interviewees estimate an additional cost of no more than $300 in staff time.

8.5 and 8.6: Project Data Collection and Monitoring System

Cost: $0 - $2,000. Building energy performance can be monitored in EPA's PORTFOLIO MANAGER tool, which can also track greenhouse gas metrics and water consumption, and is available no cost. Additionally, energy service companies such as WegoWise and Bright Power’s Energy Scorecards offer fee-based benchmarking tools to track energy and water use, which cost around $300 to $2,000 annually per building.

Prior to entering energy data into PORTFOLIO MANAGER or a third-party software tool, work will be required on the part of the building staff to collect energy data. The degree of difficulty in assembling tenant energy use data will vary by jurisdiction and local utility. In some leading jurisdictions where buildings over a certain size are required to disclose energy use to the city government, buildings that contain a sufficient number of units are able to automatically upload energy data from their utility into PORTFOLIO MANAGER or a third-party program.

If your property is located in an area with a benchmarking ordinance, check with your local sustainability office or department of the environment for more info. The Institute for Market Transformation keeps a quick reference of jurisdictions with benchmarking ordinances and the requirements for each.[25]

In other jurisdictions without these disclosure ordinances or where utilities do not offer automatic data upload, additional staff time will be required to seek waivers from tenants to access their energy data, and to submit these waivers to the participating utilities to set-up automatic data upload to the online platform. This may require persistent effort by property owners and may be best accomplished by including energy disclosure forms and waivers when

new tenants sign leases. Once the link between the utility and the analytical software is set up, maintaining up-to-date project performance data for buildings is straightforward.

Synergy with: 1.1c, 5.6

IV. Resources

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3. EPA's PORTFOLIO MANAGER Tool; https://www.energystar.gov/buildings/facility-owners-andmanagers/existing-buildings/use-portfolio-manager
4. District Energy Benchmarking of Existing Buildings Frequently Asked Questions; http://ddoe.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/BenchmarkDC_FAQ_021113.pdf
5. Costs for Pedestrian and Bicycle Infrastructure Improvements; http://www.pedbikeinfo.org/data/library/details.cfm?id=4876
6. Center for Neighborhood Technology's "Residential Density of a Location" Calculator; http://apps.cnt.org/residential-density/
7. Enterprise Green Communities Supplemental Document Instructions; http://www.enterprisecommunity.com/solutions-and-innovation/enterprise-green-communities/certification-2015
8. Bicycle Parking Guidelines; http://c.ymcdn.com/sites/www.apbp.org/resource/resmgr/Bicycle_Parking/EssentialsofBikeParking_FINA.pdf
9. Green Transportation Systems to Support Transit Oriented Development in Very Low Income Urban Properties; http://www.enterprisecommunity.com/servlet/servlet.FileDownload?file=00P1400000eRplOEAS
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12. Neighborhood Development Fees; http://www.usgbc.org/cert-guide/fees#nd
13. The Cost of LEED: Case Study of Massachusetts Maritime; http://www.erland.com/assets/costleed_formatted.pdf
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17. Net Zero Energy and Living Building Challenge Financial Study, International Living Future Institute et al; https://newbuildings.org/sites/default/files/ZNECostComparison BuildingsDC.pdf
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21. Cost-effectiveness Analysis of Expanding use of Occupancy Sensors; https://www.energycodes.gov/sites/default/files/documents/iecc2018_C-6_analysis.pdf
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