Deep Energy Retrofit Request for Proposal (RFP) Guidelines

The American Institute of Architects

Rocky Mountain Institute

BOMA International

Introduction

The following guide was developed to help building owners get the most value out of a deep retrofit in the RFP process.

OVERVIEW: In the 2013 publication "Deep Energy Retrofits, An Emerging Opportunity" the American Institute of Architects and Rocky Mountain Institute established that it is possible to leverage much greater energy savings from a building retrofit project by optimizing the interactions of the building's systems. These deep energy retrofits can help owners cut their building's energy use by 50%, sometimes more. In addition to saving energy, deep retrofits update buildings with state of the art systems, making them better able to address today's business needs (more density, more equipment per square foot than ever before) and thus creating additional value for real estate owners and occupiers.

PURPOSE OF THIS GUIDELINE: This document provides language to incorporate with an existing RFP specifically requesting a deep retrofit. It can easily integrate within an organization's existing RFP documents and processes. While an owner can generally request a "deep" retrofit or request that a team uses integrative design, the definition of what this actually means varies widely in industry. Therefore, it is crucial to use measurable targets and lay out process requirements to ensure a deep retrofit is actually provided. It will also make comparing each bidder's submittal more uniform to help in the selection process.

Each section and table below focuses on a component of the deep analysis process. It is recommended that the RFP include these overarching goals along with the applicable requirements in the table. When evaluating responses, this information can be used to ensure bidders are demonstrating knowledge and experience with each process step, in addition to allocating reasonable time to properly complete the goal.

While this RFP guideline is focused on existing commercial buildings, the process is applicable for multiple ownership structures (public, investors, owner occupied) and building uses (offices, schools, and hospitals). Typical RFP submittal requirements such as detailed engineering design and drawings, such as layouts and distribution sizing, installation requirements and team selection are not addressed in the guideline. This guideline also does not address contractor qualifications (i.e. it's not an RFQ).

WHAT IS A DEEP RETROFIT? A deep retrofit commonly targets 50% or more energy savings, but more importantly, a deep retrofit uses an integrative design and analysis process to achieve all cost effective energy savings. In practice, this means the team looks at all building systems, not just a primary system being affected, to find all possible efficiency savings and opportunities for synergies between building systems. A uniform solution to deep retrofit analysis does not and cannot exist. Unique combinations of deep retrofit measures are required for each project, depending on the individual needs of the project. Therefore it is critical to require an integrative design process and to fully understand each RFP respondent's approach. Two critical themes for undertaking a deep retrofit are further explained in Appendix A of the document:

- Retrofit Triggers: How you as an owner can pick the right building at the right time for a deep retrofit.
- Integrative design: Including integrative energy modeling, Life Cycle Cost Analysis (LCCA), tunneling through the cost barrier and requiring the right process to ensure a deep retrofit approach is delivered.

WHEN SHOULD THIS GUIDE BE USED? A perfect opportunity for a deep retrofit is when a building experiences a *retrofit trigger.* A retrofit trigger is an opportunity to provide efficiency improvements to a building in coordination with another event, such as tenant turnover, equipment failure, aesthetic upgrade, required code upgrade, or refinancing. Retrofit triggers occur infrequently in the building's lifetime and it is critical that these opportunities are used to ensure the building evolves and remains competitive with newer facilities.

WHY ARE DEEP RETROFITS IMPORTANT? Deep retrofits provide greater energy savings, greater value, and a better overall retrofit than conventional energy retrofits. The comprehensive analysis involved in a deep retrofit results in a superior building, with greater occupant comfort and satisfaction. The RFP process can be used to leverage necessary building component (i.e. windows, chiller) replacements to reduce energy costs and increase asset value.

SCALING THIS DOCUMENT TO VARYING SCOPES AND BUILDING SIZES. This guide was written to reflect a scope equivalent to a major retrofit of a large building. However, the intention and requirements can be translated across to smaller retrofit scopes and small buildings. The same overarching process goals detailed with each table below apply, but the number and scale of the process steps outlined in the tables will vary.

For instance, it is still crucial that the current building performance from an energy and occupant satisfaction perspective is considered. However, instead of requiring the contractor perform all items in the table, it may be sufficient to only review the building automation system (BAS) performance and talk with the facilities team. Larger projects will require an in-depth calibrated energy model, while smaller scopes may only need a simplified model. The RFP creator must use their judgment to decide which specific requirements will best meet the process goals while balancing realistic costs and time considerations in accordance with the project scope.

IMPACT ON PROJECT SCOPE, BUDGET, AND SCHEDULE. Modifying an RFP to initiate a deep retrofit analysis may expand the scope, budget, and schedule of the current project. The RFP will no longer include just the piece of equipment needing to be replaced immediately, but will consider building systems more holistically, providing a much greater value overall. Although the budget and schedule will likely expand in the short-term, using an integrative design process often reduces facility costs over time with better economic returns.

A good integrative design process is rooted in a calibrated energy model to evaluate system interactions. Bundles of energy conservation measures (ECMs) are then evaluated to determine synergistic effects between the ECMs. The energy model allows a large number of ECM bundles to be evaluated.

PERFORMANCE CONTRACTING FOR DEEP RETROFITS. Terms like "deep retrofit" can be somewhat ambiguous. Measured energy reductions are not. Consider complimenting the project goals with specific contractual requirements for achieving the energy savings. Energy Performance Contracting can be used to repay the cost of a project with guaranteed energy cost savings. For more guidance on EPC, refer to industry vetted, best practice energy performance contract templates from Building Owners and Managers Association International (BOMA), which produces the BOMA Energy Performance Contract (BEPC) model. It is free to the public and contains sample contract and RFP templates. (http://www.boma.org/sustainability/info-resources/Pages/boma-energy.aspx). Another helpful EPC reference is an Owners Guide to Deep Energy Retrofits Using Energy Savings Performance Contracting (http://www.rmi.org/gsaretrofits), a jointly published guide from GSA and RMI.

Modifying an Existing RFP to Promote a Deep Retrofit

Information to be collected prior to distributing a deep retrofit RFP

Gathering information for a deep retrofit is an important step for the owner to do prior to issuing the RFP. Having all the pieces in Table A can save significant time and fee from the consultants. This information can be included directly in the RFP or provided upon request to interested bidders.

Information to Request from RFP Respondents

Several matrices are provided below that suggest integrative design steps to be included in the analysis. Each matrix is preceded by a goal statement outlining the overarching goal or mindset these requirements aim to demonstrate. These matrices should be customized for the project at hand and be included in the RFP. The process steps include tasks associated with energy modeling as well as energy auditing and retro-commissioning to ensure accurate and comprehensive results. It is recommended that respondents be instructed to reply to the RFP in the same matrix format to allow **side-by-side comparisons** of the proposals. In addition to completing the matrices each respondent should provide prior integrative design experience for each team member.

The process steps, deliverables, and time required will vary depending on the size and complexity of the project. Several of the tasks may be completed by internal staff, if capacity is available, which can reduce project cost and streamline the process.

To easily insert this information into your RFP, follow the instructions and sample in Figure 1.

TABLE A: Information an owner needs to gather (as much of the following as possible).

SUMMARY	ADDITIONAL DETAILS
Facility overview and drawings	Overview should include total size, date originally constructed. Site plan, floor plans, elevations and a few pictures.
Retrofit project background	A description of why the retrofit is being considered (the triggers) and timeline.
Deep retrofit objectives	– Specific energy use savings (typically > 50% reduction from current use) – Energy cost reduction ($ saved) – Energy Use Intensity target (i.e. 20 kBtu/SF) – Rating system achievement (i.e. Energy Star or LEED) – Occupant comfort (>90% satisfaction) – Renewable energy targets (ie 75% of energy supplied by onsite solar) – Stabilize utility expense through a variety of utility programs and technologies. – Evaluate, develop and document best practice strategies as it relates to energy management, building automation, infrastructure operations and maintenance, and where appropriate, site facilities services.
Utility bills	Collect 12–24 months of the most recent utility bills (showing both energy use and costs) for each energy stream consumed by the facility (i.e. electricity, natural gas, chilled water, steam). Also, work with your utility to provide a release so the selected contractor can obtain all utility nuance billing information directly from the utility.
Previous retrofit and retro-commissioning activities	Dates of upgrades or retro-commissioning and a description of scope. Also include any prior energy studies.
Mechanical equipment nameplate info and controls sequences	Create an inventory of equipment names, capacities, efficiencies and preferably cut sheets. Also list the date the equipment was installed and provide any maintenance records. Provide any sequences of operations from the controls equipment.
Operating conditions	Hours of operation, list of all functions, number of occupants and any existing operations and maintenance contract summaries.
Occupant survey data	Employee salaries are the biggest operational cost by far, it is important to keep the occupants productive, happy, healthy and engaged. Conduct an occupant satisfaction survey that examines the buildings influence on occupants. The Center for the Built Environment from of UC Berkeley has an Occupant Indoor Environmental Quality survey which also provides comparative data against thousands of other commercial buildings. http://www.cbe.berkeley.edu/research/survey.htm)

FIGURE 1: Guidance on developing RFP information request matrices.

STEP 2: Request these details for each process step.

STEP 1: Insert the list of process steps into your RFP.

PROCESS STEP	DETAILS ON HOW PROCESS STEP WILL BE COMPLETED	DELIVERABLES	ESTIMATED AMOUNT OF TIME	TEAM MEMBERS INCLUDED
Kick off meeting	Contractor to lead discussion on project goals (as described in the Owners Project Requirements document), how the goals will be met, costs, process, and communications protocol.	Agenda, facilitation meeting minutes	2 hrs	All key stakeholders
Technical potential design charrette	Develop a retrofit scenario focused on maximum energy savings using currently available technologies. Constraints (financial, time, process) can be layered in once a technical potential is achieved. More details provided in the appendix.	Preread (if needed), facilitation, meeting minutes	4 hrs	All key stakeholders (i.e. finance, occupants, maintenance, owner, design and construction team)
Project Team Meetings	Contractor to schedule and lead regular project team meetings to keep owner up-to-date on design and construction progress and get input as needed. At a minimum meetings will occur at project milestones.	Meeting agendas, attendance, meeting minutes	2 hour/ month	Project manager, owner at a minimum

STEP 3: Use the information provided in the table to help evaluate responses. Consider providing the 'Details on how the process step will be accomplished' so the contractors can respond with exactly what you're asking for.

1. Project Management Information Requests

GOAL: An effective deep retrofit is dependent on a true integrative design approach. This can only be achieved through specific process steps outlined in table 1. Without these meetings and charrettes, a team cannot bring together all parties and find creative solutions. A design process that does not include these steps cannot ensure all parties will be included in the final design. (See Table 1.)

TABLE 1: Project Management Information Requests

PROCESS STEP	DETAILS ON HOW PROCESS STEP WILL BE COMPLETED	DELIVERABLES	ESTIMATED AMOUNT OF TIME	TEAM MEMBERS INCLUDED
Kick off meeting	Contractor to lead discussion on project goals (as described in the Owners Project Requirements document), how the goals will be met, costs, process, and communications protocol.	Agenda, facilitation meeting minutes	2 hrs	All key stakeholders
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2. Utility Data Analysis Requests

GOAL: Analyzing the building's utility data allows the contractor to ascertain if the building is operating efficiently, as well as provide a baseline for performance. At a minimum, the utility billing data should be evaluated. (See Table 2.)

TABLE 2: Utility Data Analysis Requests

PROCESS STEP	DETAILS ON HOW PROCESS STEP WILL BE COMPLETED	DELIVERABLES	ESTIMATED AMOUNT OF TIME	TEAM MEMBERS INCLUDED
Review historic utility billing data	Review and analyze utility data provided by the owner. Ensure the data set is complete, energy use falls within an expected range, and that all energy is being metered.	Memo or presentation outlining current utility costs, usage, and demand. Section in final report.	2 hrs	Analyst
Granular energy use data (if available)	Request more granular utility data. Utility data collected on a tighter interval than monthly (i.e. 15 minutes, 1 hour) can provide insight on building operations such as scheduling. The tighter interval can also help evaluate the potential for cost savings associated with demand control efforts. Submeter data can also be helpful for identifying energy conservation measures and calibrating the energy model.	Memo or presentation outlining current utility costs, usage, and demand. Section in final report.	8 hrs	Analyst
Calculation of marginal utility costs	Calculate cost per unit of energy for each energy stream. In many cases utility rates are more complex than a fixed rate. Many accounts have time-of-use rate changes or demand charges. Rates should be modeled as accurately as possible to ensure ECMs are accurately evaluated. Rates can be determined by evaluating utility bills and cross referencing utility rate schedules. Sensitivity analysis should be conducted to determine the relative impacts of utility price increase or if a different rate class is achieved.	Memo or presentation outlining current utility costs, usage, and demand. Section in final report.	2 hrs	Analyst

3. Site Assessment Information Requests

GOAL: It is crucial the design team understands the current building's operation and any outstanding issues, even in areas not directly related to the primary retrofit scope. By understanding the whole building's operation, the team can look for whole systems solutions. (See Table 3.)

TABLE 3: Site Assessment Information Requests

PROCESS STEP	DETAILS ON HOW PROCESS STEP WILL BE COMPLETED	DELIVERABLES	ESTIMATED AMOUNT OF TIME	TEAM MEMBERS INCLUDED
Review drawings	Determine accuracy of most recent drawing set. If drawing have not been regularly updated the site assessment should include updating drawing or redlining drawings critical to the analysis, such as mechanical schedules and lighting layouts.	Site assessment memo or presentation with recommended operational improvements. Section in final report.	4 hrs	Project manager, analyst(s), energy auditor
Review sequence of operations	Determine if building controls sequences of operation have been documented. If not, use building automation system (BAS) trending, data logging, and facility staff interviews to document sequences (i.e. scheduling, temperature resets, setpoints). If so, spot check for accuracy since this information is critical for energy model accuracy.	Site assessment memo or presentation with recommended operational improvements. Section in final report.	8 hrs	Project manager, analyst, energy auditor
Inventory of existing equipment	If drawings are not up to date, inventory equipment (mechanical, electrical) and collect pertinent information for the energy model (i.e. motor horsepower).	Site assessment memo or presentation with recommended operational improvements. Section in final report.	8 hrs	Energy auditor, commissioning agent
Audit of plug loads	Inspections and surveys should log each piece of equipment plugged into an outlet. Any specialized equipment without specifications showing peak demand should be submetered for a short period to determine schedules, demand and energy use.	Site assessment memo or presentation with recommended operational improvements. Section in final report.	8 hrs	Energy auditor, commissioning agent
IR envelope evaluation	Use an infrared camera to evaluate the envelope. Identify acute issues to be resolved quickly such as uninsulated portions of a wall, but also evaluate envelope components to be evaluated by energy model.	Site assessment memo or presentation with recommended operational improvements. Section in final report.	8 hrs	Energy auditor, commissioning agent, envelope IR specialist

TABLE 3: Site Assessment Information Requests (continued)

PROCESS STEP	DETAILS ON HOW PROCESS STEP WILL BE COMPLETED	DELIVERABLES	ESTIMATED AMOUNT OF TIME	TEAM MEMBERS INCLUDED
Building Automation System (BAS) trending	If interval data for pertinent variables isn't already being collected initiate trending. Archive trends so data is not overwritten. Trend variables critical to characterizing significant energy consuming equipment for both short-term operational improvements as well as baseline energy model calibration.	Site assessment memo or presentation with recommended operational improvements. Section in final report.	16 hrs	Energy auditor, commissioning agent
Data logging	For equipment not connected to the BAS or with untrustworthy sensors use temporary or permanent data loggers to collect operational and energy data.	Site assessment memo or presentation with recommended operational improvements. Section in final report.	16 hrs	energy auditor, commissioning agent, electrician
Interview facilities team about comfort issues	Determine history of comfort issues in building and areas/systems tied to the issues; ideally in the form of daily logs instead of anecdotally.	Site assessment memo or presentation with recommended operational improvements. Section in final report.	1 hr	Project manager, energy auditor, commissioning agent
Interview facilities team about operations and maintenance issues	Determine history of equipment operation and maintenance issues in building and areas/systems tied to the issues; ideally in the form of daily logs and historical maintenance costs instead of anecdotally.	Site assessment memo or presentation with recommended operational improvements. Section in final report.	1 hr	Project manager, energy auditor, commissioning agent
Interview with facilities team to supplement building controls characterization	When documented sequence of operations, trending and data logging, do not fully define a facility's sequence of operations, interview facilities staff to complete the characterization. Example: analysis occurs in winter and doesn't allow summer operation to be characterized.	Site assessment memo or presentation with recommended operational improvements. Section in final report.	2 hrs	Project manager, energy auditor, commissioning agent
Functional testing of equipment	Identify equipment that consumes significant amounts of energy and will impact the accuracy of the energy model if current sequences of operation (SOO) are not accurately understood. If trend data is not available or isn't for relevant weather conditions functionally test equipment to confirm SOO.	Site assessment memo or presentation with recommended operational improvements. Section in final report.	8 hrs	Energy auditor, commissioning agent

4. Baseline Energy Model Information Request

GOAL: A model is required to evaluate the potential savings for multiple design options and accurately predict the savings. The complexity of this model will vary on the project scope, but all models should include enough detail to allow the team to investigate packages of options and evaluate interactions between systems. (See Table 4.)

TABLE 4: Baseline Energy Model Information Request

PROCESS STEP	DETAILS ON HOW PROCESS STEP WILL BE COMPLETED	DELIVERABLES	ESTIMATED AMOUNT OF TIME	TEAM MEMBERS INCLUDED
Model Quality Control	A peer review with a series of quality control checks focused on both model inputs and outputs should be incorporated into the development of the baseline energy model.	Baseline energy model memo or presentation. Section in final report.	4 hrs	The owner or consultant could suggest third party peer reviewers. Project manager, department manager, engineer, third party
Weather data used to calibrate model	TMY weather data should be used for design scenario evaluation. Actual weather data corresponding to the same time period as the utility data should be used for model calibration.	Baseline energy model memo or presentation. Section in final report.	2 hrs	Analyst
Acceptable model calibration error	Calibration should be evaluated per ASHRAE Guideline 14.	Baseline energy model memo or presentation. Section in final report.	6 hrs	Analyst
Compare model output to facility data	Monthly and daily profiles from the energy model will be compared with historic energy use to verify control sequences and schedules.	Baseline energy model memo or presentation. Section in final report.	6 hrs	Analyst, energy auditor, commissioning agent
Facility data used to calibrate model	Facility data collected during the site assessment using BAS trending and data loggers should be compared against hourly equipment-level model output for high energy consuming equipment.	Baseline energy model memo or presentation. Section in final report.	6 hrs	Analyst, energy auditor, commissioning agent

5. Energy Reduction Evaluation Requests

GOAL: Depending on the scope of the project, RFP respondents should provide a rough estimate of the number of ECMs they will evaluate, to demonstrate the overall scale and whole systems approach they intend on taking. In addition, the process to analyze and evaluate these ECMs is crucial to ensure all synergies will be considered. The primary goal of this section is to ensure the team will look beyond the standard, low hanging fruit, single system ECMs and instead focus on wider, holistic options. (See Figure 5.)

TABLE 5: Energy Reduction Evaluation Requests

PROCESS STEP	DETAILS ON HOW PROCESS STEP WILL BE COMPLETED	DELIVERABLES	ESTIMATED AMOUNT OF TIME	TEAM MEMBERS INCLUDED
Quantity of ECMs	The evaluation should start with a large list of energy conservation measures (ECMs). Not all ECMs have to be evaluated with the energy model. The list can be shortened using a rough order of magnitude analysis early in the design process using estimated energy reductions and pricing. System interactions should be considered when evaluating ECMs. Fifty or more ECMs is appropriate for most projects.	Provide in proposal.	1 hr	Project Manager
Types of ECMs	Even if the retrofit trigger that initiates the project is focused on a specific building area such as HVAC, lighting, or envelope the analysis should evaluate the facility more broadly to take advantage of interactive effects between systems.	Provide in proposal.	1 hr	Project Manager
Process for developing ECM list	An extensive ECM list should be developed during the technical potential charrette. If a technical potential charrette is not planned for the project a list should be brainstormed between a group of key stakeholders including the design team, building owners, facility team, occupant representatives and financial decision makers.	Provide in proposal.	1 hr	Project Manager
Individual ECM evaluation	Investment decisions should be evaluated using economic analysis of bundled measures (to take advantage of synergies). It is best practice to begin with individual ECM evaluation to help with bundling measures and to ensure that lower performing ECMs do not get bundled unless they provided a synergistic benefit (i.e. wall insulation reducing HVAC capacity).	Design scenario presentation. Section in final report.	24 hrs	Analyst
Bundling process	ECM bundling should be guided based on individual ECM results as well as preliminary pricing. Bundling is an iterative process typically requiring parametric energy modeling analysis paired with life cycle cost analysis. At least three bundles should be considered, with varying degrees of savings, investments, risks and levels of intervention.	Design scenario presentation. Section in final report.	16 hrs	Analyst
Equipment capacity reduction evaluation	Tunneling through the cost barrier commonly relies on reducing equipment capacities when loads in a building are reduced. Analysis should include equipment sizing using the baseline model as well as each modeled design scenario. This evaluation varies from annual energy use modeling, because equipment sizing uses worst case conditions on peak design days.	Design scenario presentation. Section in final report.	2 hrs	Analyst

6. Economic Analysis Requests

GOAL: A different mindset than a standard simple payback approach is crucial when discussing deep retrofits. Many other factors must be considered for the owner to make an informed decision. Most of these steps apply for all project scales. (See Figure 6.)

TABLE 6: Economic Analysis Requests

PROCESS STEP	DETAILS ON HOW PROCESS STEP WILL BE COMPLETED	DELIVERABLES	ESTIMATED AMOUNT OF TIME	TEAM MEMBERS INCLUDED
ECM pricing	Initial phases of the analysis can rely on standard pricing references, but before final bundling occurs project specific pricing should be collected from vendors. Additional costs associated with working during non-business hours, renting heavy equipment such as a crane, or removing a wall to remove and install new equipment should all be included in the project cost. Pricing should be as comprehensive and accurate as possible.	Design scenario presentation. Section in final report.	16 hrs	Cost estimator, project manager, analyst
Business-as-usual scenario	Calculate the NPV for the business as usual scenario (assuming no improvements were made, what are the operating costs and standard equipment replacement costs?). Clearly state and get buy in from all stakeholders on this scenario. The business-as-usual NPV calculation should include replacement costs of equipment that has or will reach the end of its useful life during the analysis period. The business-as-usual NPV calculation should include anticipated facility renovation and upgrade costs during the analysis period. The design scenarios should also include these costs as well as any incremental increases such as increased insulation or skylights.	Design scenario presentation. Section in final report.	8 hrs	Analyst
Economic analysis methodology	Life cycle cost analysis is preferred. The net present value (NPV) of the business-as-usual scenario should be calculated as well as the NPV for each of the bundled ECM scenarios.	Design scenario presentation. Section in final report.	16 hrs	Analyst

TABLE 6: Economic Analysis Requests (continued)

PROCESS STEP	DETAILS ON HOW PROCESS STEP WILL BE COMPLETED	DELIVERABLES	ESTIMATED AMOUNT OF TIME	TEAM MEMBERS INCLUDED
Operations and maintenance impact on economics	Operations and maintenance costs should be included in all scenarios.	Design scenario presentation. Section in final report.	2 hrs	Analyst
Rebates and incentives impact on economics. What sources of rebates and incentives will be included?	All potential grants, rebates, and other financial subsidies should be included in the economic analysis. Sources may include federal, state, and local governments as well as utilities.	Design scenario presentation. Section in final report.	2 hrs	Analyst
Deep retrofit value impact on economics (i.e. IEQ, occupant experience, asset value)	Not all deep retrofit project value is tied to energy cost savings. A better performing building can also result in increased asset value, lease rates, sales, worker productivity, and a host of other benefits that can exceed the energy cost savings. Understanding deep retrofit value can have a significant impact on project investment decision making. A guideline for calculating deep retrofit values can be down loaded from RMI's website at http://www.rmi.org/retrofit_depot_deepretrofitvalue.	Design scenario presentation. Section in final report.	8 hrs	Project manager, analyst

Appendix A: When to Use a Deep Retrofit RFP

Not all facilities are "ripe" for a deep retrofit. This appendix provides a quick explanation of the integrative design process and illustrates how these concepts typically apply to an existing building. Understanding where your facility is in the life cycle of infrastructure investments as they relate to integrative design will help define the level of effort appropriate for a given project.

Integrative Design

Integrative design and whole systems thinking provide the foundation for a successful deep retrofit. Designers tend to disassemble design problems into their individual pieces. This reductionism, common in Western science, can be useful for developing topical expertise, but optimizing individual parts with little thought to their interactions yields inferior results.

In contrast, whole-system thinking reveals and exploits connections between parts. Integrative design optimizes an entire system as a whole, rather than its parts in isolation. This can solve many problems at once, create multiple benefits from single expenditures, and yield more diverse and widely distributed benefits that help attract broader support for implementation.

However, the definition and interpretations of what makes a design integrative varies widely in the industry. At the core, an RFP is trying to determine which team will look at all systems holistically that could possibly influence the primary project systems, and not be constrained to a narrow view of a single system function. The easiest way to ensure a team will do this is by examining the process they use to approach design problem. Therefore, it is crucial the RFP uses the provided charts with process examples to define appropriate integrative design and ensure the contractor is able to meet the owner's definition.

Additional Resources

Much has been written on integrative design and deep retrofits and a good starting point for learning more is to visit:

http://energy.gov/eere/buildings/advanced-energy-retrofit-guides

http://www.wbdg.org/

http://www.rmi.org/retrofit_depot_101

http://www.rmi.org/retrofit_depot_download_the_guides

http://newbuildings.org/document-library

Developing a Roadmap

A deep retrofit is not always appropriate in a building's lifecycle. Therefore, it is crucial to determine where your building is in its lifecycle, relative to the description below. This will allow you to confidently move forward with a deep RFP or start planning for one in the future.

Implementing integrative designs is typically more straightforward with newly constructed buildings, or major retrofits, since all concepts will be executed at a single time. Economics will likely prevent this with many existing building retrofit projects. This is because it is likely not economically feasible to replace costly systems (e.g. air handling system) and building components (e.g. windows) on energy and maintenance savings alone. Energy efficiency upgrades will need to be timed with the end-of-useful life of the equipment to allow the owner to capitalize on the reduced equipment sizes resulting from those energy efficiency measures.

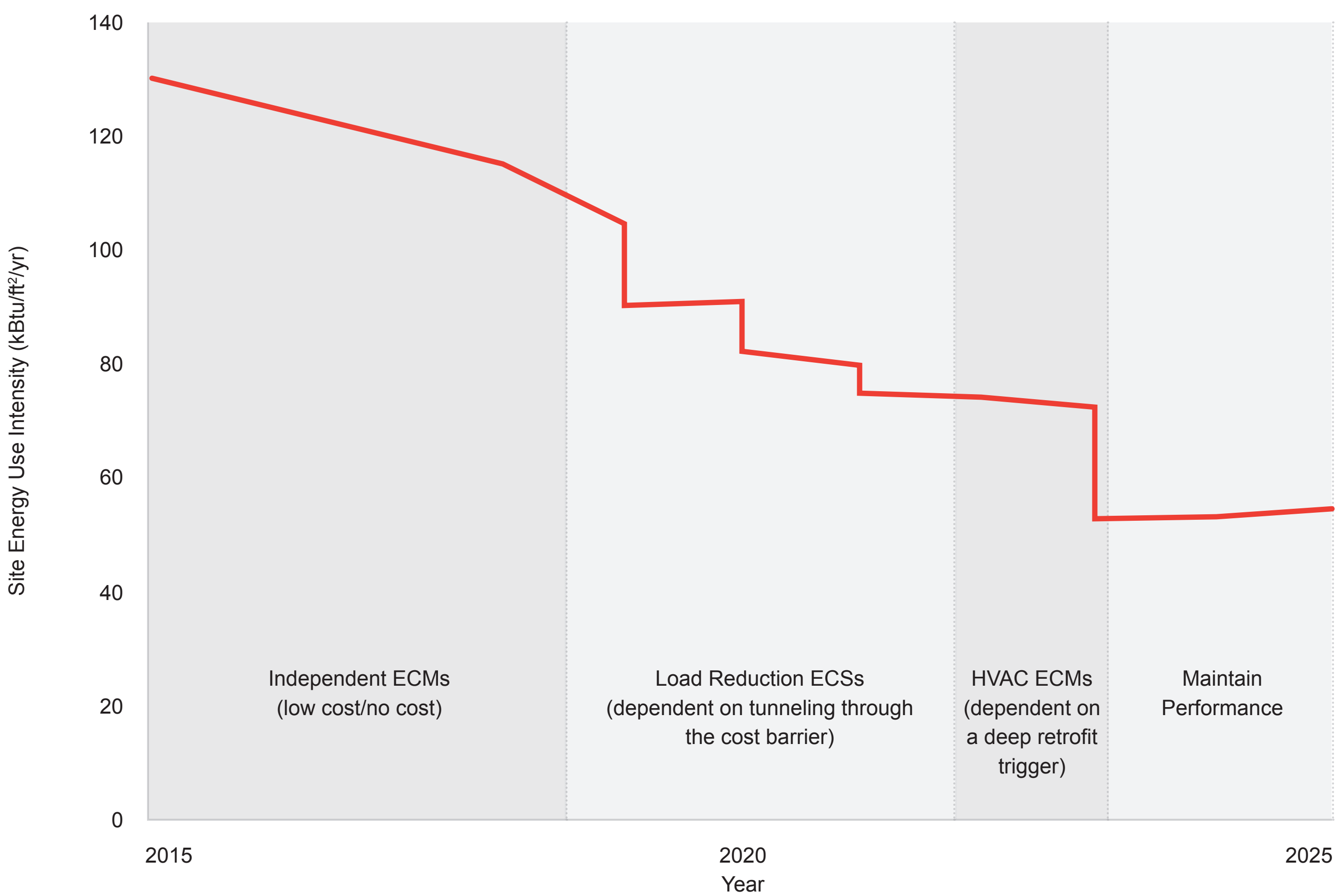
Figure 2 illustrates a common path throughout a buildings life cycle of achieving deep energy savings through integrative design in a cost effective way. Understanding the four phases in the cycle will help in developing an RFP and for planning for facility investments. Each of the four phases is further described in the sections below.

Independent Energy Conservation Measures (ECMs)

Often referred to as low cost or no cost ECMs, these improvements are economically feasible independent of integrative design. The energy and maintenance cost savings justify the investment independent of other factors. These measures should be implemented as soon as possible. Common examples of independent ECMs are retro-commissioning and building automation system upgrades. Two areas to approach with caution when investing in independent ECMs:

1. If additional retrofits are planned for the near-term ensure that the independent ECMs payback prior

FIGURE 2: Building Infrastructure Investment Phases



to implementation of any future ECMs that negate their benefit. For example, installing VFDs on fan motors when the air handling units will need to be replaced within a couple of years.

2. If there is a range of improvements possible for a given ECM, don't make a conservative investment based on independent analysis. For example, a range of upgrades are commonly available for lighting systems. This could range from a lamp and ballast retrofit to a full lighting redesign and controls upgrade. Analyzing only the energy cost savings associated with the lighting may suggest the 1-for-1 retrofit, but using integrative design concepts to also consider potential cooling capacity reductions (see Load Reduction ECM section below), deep retrofit triggers, and increased occupant productivity may suggest a larger investment in the lighting system.

If the only ECMs currently viable at a facility are truly independent it is likely not cost effective to perform an entire integrative design process at this time. A rough roadmap should be created based on equipment age and condition to estimate when the integrative design process should be initiated. This roadmap can either be created by the building owner, or provided by a consultant. If a RFP is issues for this scope, the table below provides details on required steps to create an effective roadmap.

TABLE 7: Future Roadmap Request

PROCESS STEP	DETAILS ON HOW PROCESS STEP WILL BE COMPLETED	DELIVERABLES	ESTIMATED AMOUNT OF TIME	TEAM MEMBERS INCLUDED
Identification of needed future retrofit triggers	It is likely that 100% of the selected design scenario will not be economically feasible to install immediately. Additional retrofit triggers may be required for a portion of the ECMs. For instance, if the air handling units have reached the end of their useful life and their replacement initiated the deep retrofit analysis it still may not be economically feasible to increase roof insulation until the membrane needs to be replaced. ECMs that cannot be economically justified immediately should have retrofit triggers identified in the roadmap.	Roadmap memo or presentation. Section in final report.	16 hrs	Project manager, analyst
Project phasing	If all ECMs are not being installed immediately the order of installation should be specified if the design is dependent on capacity reductions. Tunneling through the cost barrier relies on implementing ECMs in a specific order.	Roadmap memo or presentation. Section in final report.	8 hrs	Project manager, analyst
Occupant engagement strategy	How occupants interact with building has a huge impact on the total energy use (impacting up to 25% of energy costs). Include educational information (displays, feedback devices).	Section in final report.	8 hrs	Project manager, occupant behavior specialist

TABLE 8: Triggers and synergistic deep retrofit opportunities

RETROFIT TRIGGER	ENERGY OPPORTUNITIES RELATED TO TRIGGER	SECONDARY IMPACTS
Building Renovation due to change of use, upgrading or replacing finishes, etc.	– May trigger mechanical equipment replacement (see below) – Interior color and reflectances should be optimized for daylighting – Additional insulation in walls – Window replacement (see below) – Changes to room layout should consider potential for daylighting enhancement – Optimize space use	Reducing heating and cooling loads may enable smaller heating and cooling systems. Optimized daylighting will reduce lighting loads.
Mitigation of comfort issues	– May trigger equipment replacement (see below). – System and equipment retro-commissioning	Reducing heating and cooling loads may enable smaller heating and cooling systems
Upgrades required to meet building code	– May trigger equipment and envelope replacement (see below).	Reducing heating and cooling loads may enable smaller heating and cooling systems
Disaster recovery	– May trigger equipment and envelope replacements (see below).	Reducing heating and cooling loads may enable smaller mechanical systems.
Roof replacement	– Consider adding insulation – A lighter colored roof should be used in hot climates – May trigger equipment replacement – Consider adding skylights.	Reducing electric lighting loads and adding insulation may enable smaller heating and cooling systems
Window replacement	– High efficiency windows (U value, SHGC) – Shading devices – Operable windows and natural ventilation opportunity – System and equipment retro-commissioning	Optimization and load reduction measures (i.e. controls, VFD, lighting) and envelope measures can enable reduced cooling, heating, and fan capacities.
Facade to be replaced	– Consider adding wall insulation and/or a radiant barrier – Consider how to reduce infiltration through good sealing practices – Add thermal mass (where appropriate) – Optimize window and door placement for daylighting and natural ventilation – Add shading devices – Window replacement	Optimization and load reduction measures (i.e. controls, VFD, lighting) and envelope measures can enable reduced cooling, heating, and fan capacities.

TABLE 8: Triggers and synergistic deep retrofit opportunities (continued)

RETROFIT TRIGGER	ENERGY OPPORTUNITIES RELATED TO TRIGGER	SECONDARY IMPACTS
AHU or RTU to be replaced	– Select high efficiency units (AC, furnace, fans) – Optimize configuration (i.e. replacing multi-zone configuration) – Consider upgrading to a more efficient technology – Optimize controls – System and equipment retro-commissioning – Eliminate or reduce reheat – Optimize ductwork (big, straight ducts)	Optimization and load reduction measures (i.e. controls, VFD, lighting) and envelope measures can enable reduced cooling, heating, and fan capacities.
Chiller to be replaced	– Select high efficiency chiller – Consider upgrading to a more efficient technology – Optimize controls – System and equipment recommissioning, including cooling towers, piping configuration, valves, CHW and CW pumps, and VFDs	Optimization and load reduction measures (i.e. controls, VFD, lighting) and envelope measures can enable reduced cooling capacity.
Boiler to be replaced	– Select a high efficiency boiler – Consider upgrading to a more efficient technology – Optimize controls – System and equipment recommissioning, – Optimize piping configuration, valves, condensate return and make up water system – Explore heat recovery	Envelope improvements, optimization and load reduction can increase capacity.

Load Reduction Energy Conservation Measures (ECMs)

This phase of the roadmap includes ECMs that not only save energy, but also reduce the building's heating and/or cooling load. This is significant, because when HVAC equipment reaches the end of its useful life smaller capacity equipment can be purchased. This is commonly referred to as "tunneling through the cost barrier", which is a key component for making deep retrofits economically feasible (similar to retrofit triggers). A common example of tunneling is improving a building's envelope and reducing heat loads introduced into a building from the lighting system and plug loads and then reducing cooling, fan, and pump capacities. The reduced HVAC system capital cost offset the cost of other efficiency improvements (i.e. high performance windows, LEDs) that may not be economically feasible when each measure is evaluated in isolation.

Planned investment in load reduction ECMs should trigger a deep retrofit RFP since these investments should be considered within the context of the whole building design. The analysis cost may seem disproportionate relative to the size of the project, but the benefits will be reaped during future projects.

HVAC Energy Conservation Measures—Major HVAC Equipment Replacement

When a major piece of equipment is near the end of its useful life, this is the perfect time to upgrade other systems through a deep retrofit. Replacing equipment acts as a deep retrofit trigger (triggers can exist for load reduction ECMs as well). Table 11 provides common examples of deep retrofit triggers.

HVAC ECMs represent the chance to rethink entire systems. This is especially true for buildings with original systems that are inherently inefficient. For instance, constant volume multi-zone systems may be changed to a completely different air distribution system instead of just replacing the air handling unit and upgrading controls. A deep retrofit is appropriate at this stage.

Planned capital investment in HVAC ECM(s) should trigger a deep retrofit RFP since these investments should be considered within the context of the whole building design. The analysis may fast track independent and load reduction ECMs to ensure that capacity reductions in HVAC equipment is achieved prior to replacement. A deep retrofit is appropriate at this stage.

Maintain Performance

Implementing a deep retrofit does not ensure ongoing performance. Strategies for maintaining, and even increasing, performance should be considered within the deep retrofit roadmap. Common strategies include energy monitoring, fault detection and diagnostics, staff training, and facility management policy changes. The cost of the enhancements can typically be reduced when incorporated into the specification for retrofits instead of being implemented independently. For instance, ensuring the building automation system is properly trending and archiving data points when new equipment is installed can make implementing fault detection and diagnostics much more feasible.

If the only projects currently viable at a facility are focused on maintaining performance it is likely not cost effective to perform an entire integrative design process at this time.

Baseline and LCCA

When putting together a business case for an efficiency upgrade, big or little, the owner must consider the business-as-usual replacement or repair costs that will be incurred. If a building component must be replaced because it has reached the end of its useful life, this is a cost the project would incur, regardless of the efficiency motivations or benefits. The business-as-usual cost should be subtracted from the cost of installing a highly efficient system, dramatically improving the economics for the project.

For instance, if a chiller is 20 years old and is experiencing regular maintenance issues and has been earmarked for replacement, **the cost of installing a super-efficient chiller is only the incremental difference** between a standard code-compliant chiller and the super-efficient chiller instead of the total cost associated with purchasing a super-efficient chiller. Additionally, the operational costs and savings should be considered including operations and maintenance, repair and replacement and failure risk.

The optimal bundle is not determined based on simple payback analysis. Rather, the bundle to be implemented should be selected based on a combined, overall project return, including the cost reductions of having one project versus multiple and thus a more integrated life cycle economics using energy modeling to understand the interactive effects of measures. For further information on executing LCCA, refer to http://www.rmi.org/Knowledge-Center/Library/2010-24_LCCA.