

SEDAC ENERGY SMART TIPS



New Construction: Owner's Guide

New Construction EST Series 1 of 4



Owner's
Guide



Envelope



HVAC



Lighting

Let's assume you want to end up with a functional, attractive, cost-effective, and comfortable building. It's relatively easy to get a building that has some of these qualities – most buildings are designed around function and looks. Incorporating high performance energy efficiency and visual/thermal comfort is an additional challenge, but well worth it.

A savvy owner can get an energy-efficient building without paying a premium. Many energy-smart, no-cost, and low-cost design decisions can have a big impact on reducing a building's lifetime energy use. The opportunity to realize a building's potential for efficient operation is never greater than at the start of project planning. Reductions of 50% or more, compared to national average energy consumption for your building type, are readily achievable, if you make it a stated goal of your project from the start.

SEDAC's 4-part *Energy Smart Tips for New Construction* series provides practical information for the building owner's involvement in the design process, as well as high-level explanations of the major energy-using building systems.

This Owner's Guide (part 1) focuses on the overall process of pursuing energy efficiency, and outlines five key times when the owner can act:

1. **Setting initial energy goals**
2. **Selecting a design team**
3. **Promoting efficiency during design**
4. **Verifying goals were achieved**
5. **Planning for maintenance**

See the other Energy Smart Tips in this series (Envelope, HVAC, and Lighting) for more detail on each major system of your building. This series will give you the basics you need to push your design team in the right direction.

Energy efficiency: *get it right, from the start.*

1. Best opportunity for energy savings
2. Efficiency leads to comfort
3. Energy prices will rise

Remember, while the cost of construction seems high, the long-term operational costs of a building are much higher. A smart, efficient design means long-term energy cost savings, plus many other benefits, for you and your tenants. It has a positive impact on the bottom line for decades to come.

SEDAC is here to help. We provide New Construction design review services. Architects and engineers are on staff to assess the plans for your building, work with your design team, and find incentive funds for efficiency features in your new building. Apply at sedac.org.

The Smart Energy Design Assistance Center performs energy assessments on various building types. Each building type has different energy requirements. SEDAC's Energy Smart Tips help building operators identify energy cost reduction measures.

SMART ENERGY DESIGN ASSISTANCE CENTER
PROVIDING EFFECTIVE ENERGY STRATEGIES FOR PUBLIC AND PRIVATE BUILDINGS IN ILLINOIS

#1: SETTING PRELIMINARY GOALS

TWO KINDS OF ENERGY GOALS

The vision is an efficient building. You need two goals to get there: a **design goal** and a **performance goal**.

Think about these goals *before* you assemble your design team. Communicate your goals as you interview prospective architects, engineers, and contractors. Preliminary energy goals help you find a design team that is knowledgeable and enthusiastic about achieving efficiency. Your team will fine-tune energy goals during pre-design discussions.

PICK A DESIGN GOAL

For your design goal, SEDAC recommends you target a percentage better than the current code requirements – 15% to 30% is a reasonable range.

A design goal is a simple percentage in relation to code requirements, but will help your design team set the insulating values of the envelope, the efficiency levels of HVAC equipment, and the amount of power dedicated to lighting. By default, a new design must meet the current energy code, but the owner can decide to go 'beyond code', to get a better performing building. Designing beyond code can be cost-neutral with a knowledgeable design team. It can also make your project eligible for energy efficiency incentive funding.

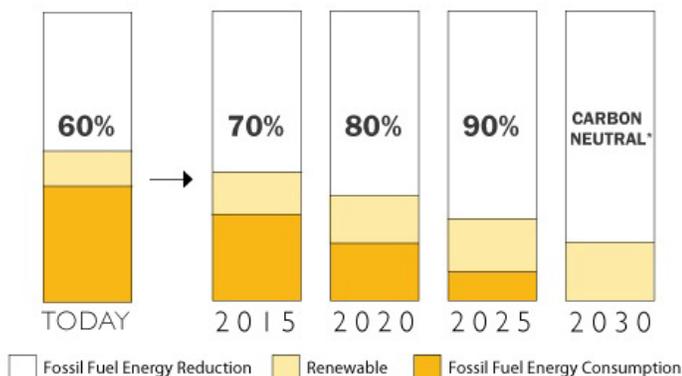
PICK A PERFORMANCE GOAL

You should also set a performance goal for your future building. A performance goal sets a target for your future building's benchmark Energy Use Intensity (EUI). [See box on upper right for more on EUI.] There are a couple ways to set an EUI goal:

1. ENERGY STAR® score. Use ENERGY STAR Target Finder® to set a goal on a 1 to 100 scale, where 50 is average performance. A score of 75 will earn your building the ENERGY STAR certification. Target Finder will generate an EUI goal for you.



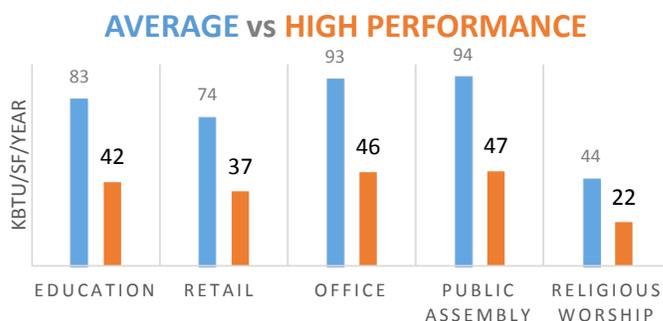
2. % better than the median EUI. The Architecture 2030 Challenge has 60% reduction in energy use as the goal for buildings being built today, with 70% reduction by 2015.



HOW MUCH ENERGY SHOULD A BUILDING USE?

Benchmarking, like comparing MPG in cars, is a great way to gain perspective. Benchmarking is done by calculating a building's Energy Use Intensity (EUI), or how much energy is used per square foot per year. The unit kBtu is used as a common unit for energy. Both kWh (electricity) and therms (natural gas) can be converted to kBtu.

A nationwide survey of buildings (CBECS) lists average EUIs for existing buildings, which gives an idea of typical building performance. An efficient design can easily result in an EUI for your new building that is less than half an average building's EUI. A highly efficient design with renewable energy can even bring those numbers down to net zero.



WHAT ABOUT NET ZERO?

You may have heard about net zero energy buildings or net zero emissions (aka carbon neutral) buildings. There are several ways to define each term, but the basic ideas are:

- a **net zero energy building** generates as much energy as it uses on an annual basis; and
- a **net zero emissions building** generates (or purchases) enough emissions-free energy to offset emissions from all energy used by the building annually.

The first goal focuses on energy use alone, the second is a more stringent goal aimed at minimizing the greenhouse gas footprint of a building. Some buildings achieve both.

The underlying approach for both goals is straightforward: reduce energy needs down to a level that can be met cost-effectively using emissions-free renewable energy. Of course, there is a practical limit to energy consumption reduction on every project. Finding the lowest total cost for energy systems is an iterative process. You start by setting a very low energy use goal and maximizing the potential for using renewable energy (like PV panels or wind turbines). Then you compare costs and look for balance points in a cost-benefit analysis.

You can also design for *future* net-zero performance by building in the right level of efficiency now, and planning for the later installation of renewables. See the SEDAC web page at NCTips.sedac.org for resources on designing a net zero building.

#2: SELECTING YOUR TEAM

Putting together your design and construction team is the next step toward making your energy-efficient facility a reality.



ENERGY COSTS...WHAT IS REASONABLE?

You don't want a nasty surprise when those first electric and gas bills arrive for your new building, whether bills are paid by you or your tenants. But what are reasonable energy costs to expect? SEDAC has analyzed nearly 1500 buildings in Illinois, and can provide both general and personalized context for energy costs in Illinois. [Apply to sedac.org for personalized help.]

As a general rule of thumb (when looking at existing buildings in Illinois) SEDAC considers most commercial building types* with combined energy costs under \$1 per square foot per year to be performing well. Between \$1 and \$2 is typical for buildings we have analyzed. Above \$2 per square foot, we assume something is wrong with the design of the envelope, the HVAC & lighting systems, or the way the building is run. *Industrial buildings, hospitals, and laboratory facilities may have higher costs. Keep this rule-of-thumb in mind during your preliminary goal-setting, and use it to sanity-check energy modeling results that your design team generates in schematic design.



GET THE RIGHT PEOPLE ON BOARD

Look for these qualities:

1. Firms that use a fully integrated design process
2. Prior experience designing for high performance
3. Energy modeling ability
4. Enthusiasm about energy efficiency and sustainability
5. Buy-in on your energy goals

Ask architects and contractors how they know if their building will be energy efficient. Professionals that understand high-performance methods will have ready answers to this question.

USE SEDAC DESIGN ASSISTANCE SERVICES

SEDAC can be a part of your support team at no cost to you or your project. We are here to help you find specific ways to improve the energy efficiency of your building for new construction designs as well as other buildings already in your portfolio. We also identify incentive funding to lower the initial cost of high-efficiency choices. Involve SEDAC early in the project for best results.

Apply when you start a project, and we can provide energy-related guidance for early design decisions. Later in the design process, SEDAC will analyze elements of the design to identify weaknesses, and suggest ways to fix the problems.

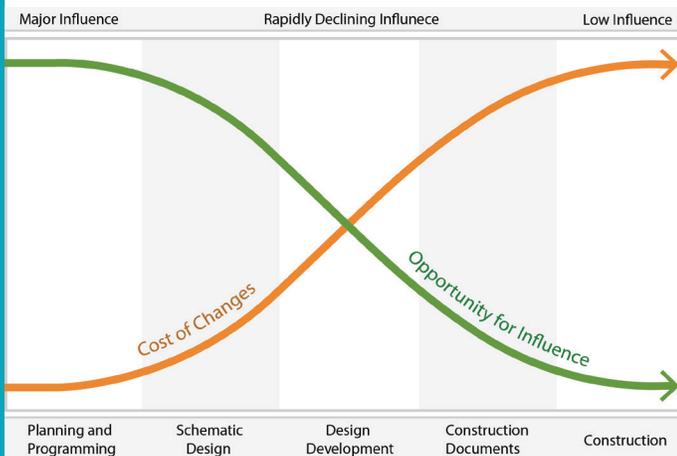
HIRE A COMMISSIONING AGENT

Commissioning is one of the best choices you can make to ensure energy goals are met. A commissioning agent should be brought on at the start of design and carry through to post-construction verification. See the sections later in this brochure for more details on commissioning.

USE ENERGY MODELING TO MEET GOALS

To know if your building design is likely to meet your **design and performance goals** [see left], your team must use **whole-building energy modeling** early in the schematic design phase, and actively use modeling to refine the design. Schematic design is the easiest and most economical time to optimize the performance of your building using energy modeling, based on goals set during pre-design.

This conceptual graph shows the inverse relationship of opportunity and cost of change over the life of a building project. Pursuing energy efficiency from the beginning gives the best results for the lowest cost.



A NOTE ON CERTIFICATIONS

Consider using a certification program to help guide your team in sustainable thinking during the design process. LEED, ENERGY STAR, and Green Globes are the most commonly used point-based certification programs. These certifications broadly address sustainability of your building. Don't assume that certification alone will result in an energy efficient building. Attention to the process suggested in this brochure is still needed to ensure your energy goals are met!

#3: PROMOTING EFFICIENCY DURING DESIGN

IDENTIFY AN ENERGY CHAMPION

Once you have a team assembled, find that one person who is really enthusiastic about energy and appoint them as the *Energy Champion*. This advocate will promote your energy goals throughout the design and construction process. The EC will coordinate efficiency priorities between all parties and persist in asking questions about how decisions will impact the building's future energy usage.

The EC can answer directly to the owner, be a member of the architecture or engineering design team, or be a third-party professional (i.e. commissioning agent). Most importantly, this person's primary responsibility is the coordination of energy and efficiency issues. Make sure the EC does not have conflicting interests in other project areas. This individual must be empowered to ask the necessary--and often, difficult--questions.



One of SEDAC's Energy Champions

REQUIRE SUBMETERING & PULSE METERS

Your building should absolutely have a main meter for each primary service: natural gas, electricity, and water. If you are developing a complex of buildings, there should be a campus-wide main meter for each service and a submeter on each building. Make sure the meters are digital 'pulse-enabled' meters for future real-time usage tracking.

Submeters can also be installed to track specific equipment or individual parts of a building. Think about what you'd like to know about the energy use of your building. Submetering is cheap and easy when added in the design process and will furnish highly valuable information downstream.

BE CAREFUL WITH VALUE ENGINEERING

Value engineering is often seen as a necessary evil. It is typically a cost-cutting exercise to bring a project back in line with its construction budget. It can mean scaling back on finishes, hardware, and other aesthetic choices of the design where expensive items can be swapped out for less pricey ones. Unfortunately, value engineering can be the death knell for items considered 'sustainability features' like solar shading, renewable energy arrays, and energy-saving features hidden in the walls of the building.

An example: Your team designs a building with excellent daylighting and low solar gain in the summer. They accomplish this by designing south-facing windows combined with exterior solar shading. Then, the exterior shades are 'value-engineered' out of the project and the windows are left unshaded. The result? Higher cooling costs for the life of the building, along with uncomfortable glare and heat inside the spaces next to the windows. The removal of the shades saves a little money up front, but undermines the whole design.

You only get one chance (during design) to optimize the interactions of the structure, envelope, and systems. Understand that energy efficiency features become integral parts of the design and promote them as such. Your design team will appreciate you defending those items from cuts. Careful estimating minimizes the need for value engineering so encourage diligence in your estimating team.

BEWARE OF THE WEAK LINK

Be aware that energy efficiency features must work together to be effective. If one component is left out, or improperly designed, the whole building's performance can suffer. For example, a building with well-insulated walls, appropriately-sized windows, optimized passive solar orientation, and efficient HVAC is primed for substantial savings. If that building has an inefficient lighting design, however, the lighting will not only directly consume more energy than it should, but add extra heat to the building and increase the cooling load.



APPLY FOR INCENTIVES

Incentives are available for beyond-code design! Go to <http://smartenergy.illinois.edu/energy-incentives.html>

COMMISSIONING DURING THE DESIGN PROCESS

A commissioning agent can help you refine and document your goals related to specific areas of the building (most commonly, building control systems and the envelope) through the creation of two documents:

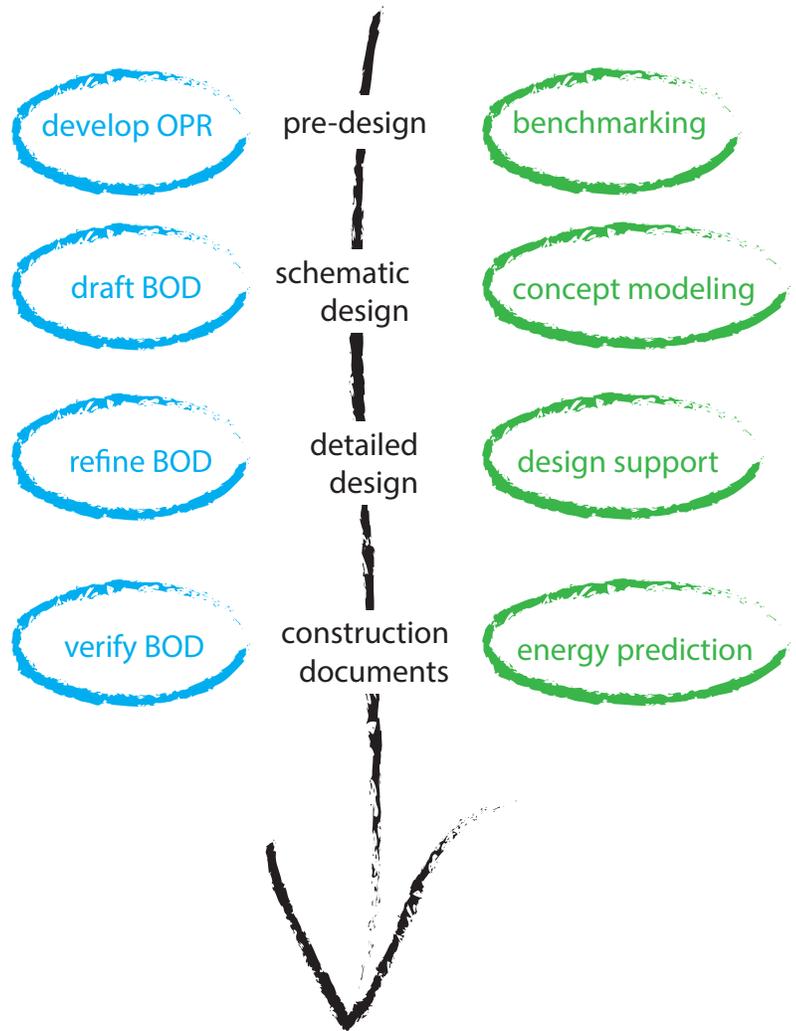
1. Owners Project Requirements (OPR) – This document records the functional requirements of the facility, and expectations of how it will be used and operated. Each objective in the OPR should have associated performance criteria, such as percent-beyond-code for energy efficiency. The OPR can include directives from the owner to the design team, such as expectations that the team will perform whole-building energy modeling periodically during design to optimize choices for energy efficiency.

2. Basis of Design (BOD) – This document responds to the OPR. It details the decision-making process and assumptions the design team is using to meet the requirements set out in the OPR. It also describes the systems and methods to meet those requirements.

These two documents are typically created through a multi-stage process. The Owner's Project Requirements does not usually change much after preliminary design. The Basis of Design, however, may change often as the various strategies to meet the OPR are finalized.

As the design reaches the milestones of schematic design, design development, and construction document production, the commissioning agent can provide third party design reviews to assure that the project is staying on track to meet the energy design and performance goals. The agent can also play a role in recognizing synergies across the scopes of work of various design disciplines (architect, engineers, lighting designers, interior designers, landscape designers, etc.). Synergy is critical on large projects with many consultant disciplines represented by different firms.

commissioning & energy modeling activities during the design process



ENERGY MODELING DURING THE DESIGN PROCESS

Whole-building energy modeling is done in computer programs like Trane TRACE, Carrier HAP, eQUEST, DesignBuilder, and Energy Plus. Energy modeling is the only way to get a good understanding of how much energy a building might require once it is built. Done early in the design process, modeling is of great value in evaluating early ideas of form, massing, orientation to the sun, and the amount of glass on the building.

Energy modeling can be used to estimate building energy consumption as well as create a code compliant baseline for use in analyzing expected energy and cost savings from implementation of certain energy saving features. Whole-building energy modeling is the best prediction tool for future performance currently available.

Above all, staying realistic about the performance of your new building will lead to satisfaction with the end results.



#4: VERIFYING BUILDING PERFORMANCE

The verification stage happens at the end of construction. It's a chance to make sure everything is working as expected. This is your chance to evaluate: Did you meet your goals?

POST-CONSTRUCTION COMMISSIONING

Once all systems are installed and tested individually by the installers, the commissioning agent will test the functionality of all building systems together. The agent will check that controls and schedules match the expected use of the building, meters and submeters are tracking usage, and everything is working as described in the Owner's Project Requirements.

INSTALL AN ENERGY DASHBOARD

An energy dashboard is a valuable tool to help you know if your building is functioning well. Typically, a dashboard uses a website to display information gathered from the pulse-enabled meters and submeters in your building. Dashboards reveal regular patterns of energy use, unusual spikes or drops, and can help your building operator and management know when something is not working right.

Dashboards are particularly valuable in comparing what the building automation system *thinks* is happening and what is *actually* happening. SEDAC saw a case where major water damage occurred from a frozen pipe because a boiler was shutting down at night in very cold weather - even when the building automation system was telling it to operate continuously. The energy data often reveals the truth.



SEDAC energy dashboard for former SEDAC office building

#5: PLANNING FOR BUILDING OPERATION

KEEP UP THE ENERGY SAVINGS

Plan to keep your building running smoothly and efficiently. A maintenance plan ideally has five parts:

1. Create and follow a maintenance schedule for HVAC equipment, lighting, and building envelope.
2. Offer training and continuing education for your building operators.
3. Perform ongoing commissioning, including annual benchmarking.
4. Use dashboard or utility billing information regularly to track if energy use is as expected.
5. Offer occasional social activities for building occupants to raise awareness. Celebrate energy efficiency accomplishments!



MAKE AN ALLY OF THE BUILDING OPERATOR

Once construction and post-construction commissioning is completed, the person you hire as your building operator has the greatest ability to impact energy consumption during the normal operation of the building. The building operator's outlook really matters. They have control of the building systems and have the power to override, change, or turn off energy efficiency features.

It is critical that the building operator is your ally in running the building in a comfortable **and** efficient manner.

THE IMPACT OF OCCUPANT BEHAVIOR

The people who use your building everyday also play a major role in how efficiently your building performs. If your building has features that users can manipulate (operable windows, multi-stage lighting switches, wall thermostats, etc), ask the contractors supplying those items to include simple, clear signage.

Users can easily become careless (in the case of closing windows or opening blinds), or frustrated (in the case of unlabeled scene lights), or creative (putting a heater or ice pack on the thermostat).

User thermal/visual comfort and energy efficiency go hand in hand. If your design team has created a building that is conditioned appropriately and free from glare, you won't have displeased occupants subverting the building's energy features.

YOUR BEST FRIEND: THE COMMISSIONING AGENT



WHAT IS COMMISSIONING?

Commissioning is essentially a process of verification to check that the building's subsystems work together in an efficient manner. The subsystems include the building's HVAC system, plumbing, electrical, lighting, fire safety, building envelope, specialty interior systems, renewable energy systems, wastewater, security, controls, and metering.

The commissioning process ideally spans the whole life of a building, starting from the earliest moments of design, follows through the construction of the building, and continues to occur periodically throughout the building's occupancy.

Commissioning is performed by a commissioning agent, a highly-trained engineer with a very specialized skill set. The commissioning agent is generally the only person on a project with the technical capability to understand how the building systems should behave, how they actually are interacting with each other, and how to get them operating correctly.

The most important role of the commissioning agent is to verify that systems are functioning correctly when construction is complete, and to help train the building manager to properly control the building.

IS COMMISSIONING WORTH IT?

Paying for a third party commissioning agent is an upfront expense (now required by code for lighting) but it's money well spent. Commissioning is the best way to end up with an efficient and well-functioning building.

Today's buildings, like today's cars, have many electronic systems that are more technically demanding than their predecessors. Each system is typically installed by a subcontractor that specializes in a specific trade, and although the install may go smoothly and appear operational, chances are good that issues with overall system integration will arise. Individual contractors for the various trades generally will not have the high level knowledge needed to ensure your building performs as designed.

Involving a commissioning agent early on helps ensure a fully optimized building that is both efficient and comfortable.



EFFICIENCY IN TRADITIONAL DESIGN-BID-BUILD

A fully-integrated design process that involves contractors and building operators from the beginning is the best way to achieve an efficient building. However, many buildings (particularly public-sector projects) are still built using the traditional design-bid-build method. In this method, the hiring of a commissioning agent becomes even more important, to maintain continuity between major steps.

In projects where selection of the lowest bidder is required, on-site observation and contractor training should be built into the specifications for the project. Every contractor has a slightly different approach and not all understand how efficient features work, therefore the specifications must be used to give preference to those who do.

CASE STUDY: PRACTICAL HIGH-PERFORMANCE



Bousfield Residence Hall
University of Illinois
at Urbana Champaign

Size: 170,000 sf
Occupancy: 480 student residents
Opened: Fall 2013

Bousfield Residence Hall is the most recently completed building in the major resident hall replacement project currently underway at the University of Illinois. The project will seek LEED certification and the design includes many energy efficient features:

- High performance roof and wall construction with <40% glazing area
- Energy efficient lighting design using ≤ 0.7 W/sf (vs. code allowance 1.0)
- Heat recovery chiller, tied to the campus chilled water loop, providing primary heat for the building

Energy Code Basis:	ASHRAE 90.1 2007
% Beyond Code:	31%
Annual Energy Cost Savings:	\$106,000
Incremental Cost of Efficiency:	\$370,000
DCEO NC Incentives:	\$243,000*
Simple Payback:	< 3.5 year w/o incentives < 1.5 year w/ incentives

*Recommended Amount: Award Pending

A CASE FOR NET ZERO – RETAIL

The first U.S. net zero energy retail store opened in Evanston Illinois in 2013.



This Evanston store will produce energy equal to or greater than the amount it consumes by implementing energy-efficient and renewable energy technologies including: energy-efficient building materials, LED lighting, ultra-high-efficiency refrigeration, solar panels, wind turbines, and geothermal technology.

<https://www4.eere.energy.gov/challenge/showcase/walgreens/retail-pharmacy-evanston>

NEED HELP WITH AN EXISTING BUILDING IN YOUR PORTFOLIO?

Check out SEDAC's other Energy Smart Tips:
<http://smartenergy.illinois.edu/publications.html>

ENERGY SMART RESOURCES FOR NEW CONSTRUCTION

Visit the SEDAC New Construction Program website at NC.sedac.org
And for more resources and reading go to NCTips.sedac.org

SEDAC

WHO WE ARE

SEDAC is sponsored by the Illinois Department of Commerce and Economic Opportunity in partnership with investor-owned utilities to achieve energy efficiency savings in buildings throughout the State of Illinois.

SEDAC is an applied research program at the University of Illinois at Urbana-Champaign.

SEDAC works in collaboration with the 360 Energy Group.

SEDAC PROGRAMS

- Energy Assessment
- Public Sector Retro-Commissioning
- New Construction Design Assistance
- Public Sector New Construction Incentive Review
- Public Housing Efficient Living
- Training and Outreach
- Energy Incentive Guidance

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SXC.hu
energystar.gov
Architecture 2030 Challenge
University of Illinois
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