Net Zero Energy Buildings: An Introduction for Valuation Professionals

by Timothy P. Runde, MAI

Abstract

This article introduces key characteristics of net zero energy (NZE) buildings, how they differ from conventional buildings, and what that means for the appraiser and the appraisal process.

The term *net zero energy* (NZE) may be familiar to appraisers, but what does it really mean? What differences in building design and operation constitute NZE, and how do they affect the appraisal process? While many appraisers may not yet have encountered NZE buildings in their practice, this is increasingly likely to change. A confluence of market and non-market forces, together with shifting consumer preferences, is changing how owners and occupants of real estate view building energy use.

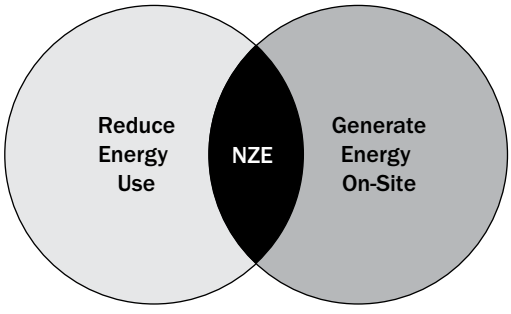
Buildings use more energy than any other sector. According to the US Energy Information Administration (EIA), residential and commercial buildings account for 40% of energy use in the United States and 74% of the electricity use.[1] Since energy is often the largest single controllable operating expense in a building, a structure designed and operated to eliminate this expense impacts the valuation process, whether the owner is an investor or the occupant.

This article discusses key characteristics of NZE buildings, how they differ from conventional buildings, and what that means for the appraiser and the appraisal process.

What Is NZE?

At its most basic level, an NZE building uses no more energy over the course of a year than it generates on-site from a renewable source. There are a variety of definitions, but as shown in Figure 1, NZE buildings typically combine two important characteristics: significantly reduced energy use by 30% to 50% as compared to a conventional building of similar type, with annual net energy use supplied by an on-site, renewable energy source like solar photovoltaics (solar PV).

Figure 1 NZE Buildings Combine Significantly Reduced Energy Use with On-Site Renewable Energy Generation



1. *EIA Annual Energy Outlook*, Table A2, available at http://www.eia.gov/forecasts/aeo/er/early_consumption.cfm, and EIA Table 7.6, available at http://www.eia.gov/totalenergy/data/annual/index.cfm#electricity.

Most NZE buildings currently remain connected to the local electrical grid and are therefore referred to as grid-tied. They operate interactively with the grid, sending electricity back to the grid when generating capacity exceeds on-site demand and drawing energy from the grid when demand exceeds supply. The grid connection improves the economics of on-site energy generation in two important ways: it allows the energy-generating system to be sized for average annual demand, rather than peak demand; and it also obviates the need for on-site energy storage, such as a battery.

NZE buildings may also be referred to as *zero net energy* (ZNE), *zero energy buildings* (ZEB), and in the residential sector, *zero energy homes* (ZEH). Zero electric homes are marketed in some areas, and are easy to confuse with zero energy homes. Zero electric homes typically retain a natural gas connection for space heating and cooking, and therefore, are not true net zero energy buildings. *Zero Energy Ready Homes* is a term used by the Department of Energy to describe houses with significantly reduced energy use relative to a code-built home, such that achieving NZE is feasible simply by adding solar PV.[2] NZE buildings may also be "net zero" on a cost basis, that is, the energy cost (not the energy use) is balanced against the energy generated. From a valuation perspective, the distinctions and nuances may or may not be relevant for a given property type or market. It is up to the appraiser to examine to what degree the building meets the basic definition of NZE and the response of the local market.

Factors Driving NZE

The market push towards NZE comes from both owner-users and investors. As energy use is often the largest controllable operating expense for most buildings, property owners have a compelling economic incentive to eliminate this expense. With the precipitous drop in the price of rooftop solar PV, an increasing number of residential and commercial owners have found generating their own electricity to be cost-competitive with conventionally generated electricity. Likewise, corporations have found economic benefits in focusing on energy cost reductions, and sustainability mandates that were initially compliance-based are now increasingly viewed as market differentiators. Apple, for example, recently committed to an $848 million solar energy contract, joining other companies such as Google, Microsoft, and Walmart, which have already invested heavily in renewable energy sources.

Meanwhile, policy and regulatory changes at both the federal and state levels, such as the Energy Independence and Security Act (EISA) of 2007 and California Assembly Bill 32 (AB32) of 2006, are affecting new construction and retrofits. In addition, increasingly stringent building energy codes are progressively lowering the energy use threshold of new and existing buildings while renewable portfolio standards (RPS) require utilities to expand renewable energy sources.

NZE vs "Green" vs Energy Efficient

NZE buildings are often presumed to be green buildings, but the terms are not synonymous. While the term "green building" lacks a precise and universally accepted definition, it is generally taken to mean buildings that address six key metrics: site selection, material/resource use, water use, interior environmental quality, energy use, and operations and maintenance. While NZE buildings will often have characteristics associated with green buildings, NZE measures only the energy component of the green building profile. Thus, an NZE building may or may not be a green building, depending what other factors it addresses beyond energy use. Likewise, a green building may or not be an NZE building as green buildings may or may not balance net energy use with on-site renewable energy sources.

Interestingly, while net zero energy buildings typically are considered energy efficient, this is not a requirement for NZE. Current market practice is to design a new building to use 50% or less energy compared to a comparable new, code-compliant building. For renovations, the target is 30% to 50% less energy use. However, current definitions do not specify an absolute or relative energy use for NZE buildings. So, at least theoretically, a very energy-inefficient building could be NZE, so long as there is adequate space for on-site energy generation.

Energy-efficient rating systems, such as the Home Energy Rating System (HERS) for residential or ENERGY STAR for commercial buildings, remain relevant. For example, a home with a very low HERS score may have a low threshold to overcome to

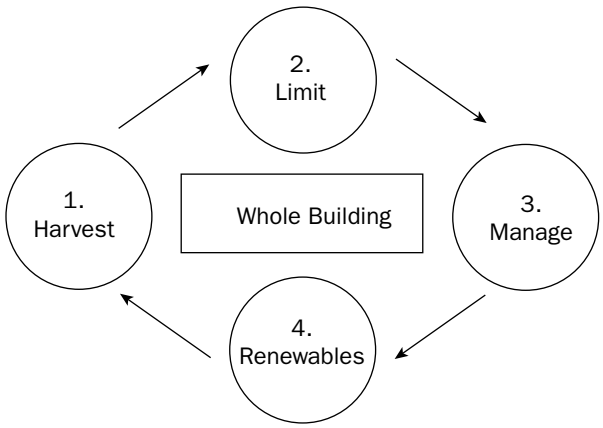
2. The Department of Energy states, "A DOE Zero Energy Ready Home is a high performance home which is so energy efficient, that a renewable energy system can offset all or most of its annual energy consumption," http://energy.gov/eere/buildings/zero-energy-ready-home.

achieve net zero status, which could be a relevant factor when considering market standards or adjusting comparable properties.

NZE vs. Conventional Building Design and Operation

Unlike conventional buildings, where energy use is a byproduct of the design process, energy use is typically a core element of an integrated design and construction process that creates a successful NZE building. To achieve that goal, the positive and negative energy impacts of each design element—the building siting, building type, amount and orientation of the glazing, the heat load of the lighting, occupant load, etc.—are all considered in an integrated manner in the design process. This approach to design and operation is referred to as the *whole building approach*. This approach brings together the aspects of the integrated NZE design hierarchy, illustrated in Figure 2, in order to produce the most cost-effective combination of active and passive heating, cooling, and lighting systems.

Figure 2 Integrated NZE Design Hierarchy



In NZE design, the focus is first placed on harvesting available passive resources, such as passive solar, shading, thermal mass, night flushing, stack effect, and the insulation/integrity of the building envelope. Second, NZE buildings seek to limit the use of active energy sources through daylighting, natural ventilation, advanced lighting controls, building automation and the limited use of fans and pumps typical of conventional HVAC systems. Third, plug load, which is largely the result of occupant behavior, is actively managed via occupancy sensors, low energy use equipment, dashboards and other feedback mechanisms. Landlords can also use lease language to control energy use. So-called "green leases" may include limits on the occupant's energy use through HVAC set points, specified types of lighting and office equipment as well as other energy management strategies designed to align the cost and benefits of energy efficiency measures. Once energy use is reduced to the lowest level possible, remaining energy requirements are supplied by an on-site, renewable source like solar PV.

This whole building approach may be difficult to discern from visual inspection alone, particularly to someone unfamiliar with this newer approach to building design and construction. Many of the design elements that NZE buildings utilize do not look unusual, and it can be very easy to miss these characteristics during an inspection. In addition, this integrated design can result in construction features that might seem odd or counterintuitive to those more familiar with conventional building design. For example, in an NZE building, insulation may be placed on the outside—rather than on the inside—of a concrete wall in order to take advantage of the concrete's thermal mass properties to stabilize the internal temperature of the building. Other design elements may be subtle, yet produce substantial, discernable results, such as the use of operable windows and roof monitors that leverage the ambient exterior climate with the stack effect, thereby cooling a building, without the use of fans and compressors typical of conventional HVAC systems.

Verification and Certification: How Do I Know the Building Is Operating at NZE?

Because NZE is performance-based by definition, buildings have to be operating at least a year at stabilized occupancy before they can be verified as NZE. Verification can be performed by simply examining the net energy usage (total consumption vs. on-site energy generation) for the property for a 12-month period. Unlike the requirements of green building certification programs like Leadership in Energy and Environmental Design (LEED), no specialized training is needed to determine whether the energy use was positive or negative over the course of the year.

While independent verification/certification may not be required, two organizations offer independent verification of NZE buildings: the International

Living Future Institute (ILFI) and the New Buildings Institute (NBI).

The ILFI certifies NZE buildings as part of its "Energy Petal," one of seven performance areas of its sustainable building certification system, known as the Living Building Challenge. Certification requires third-party verification of the performance of a building at net zero energy for one year as well as the building meeting certain other prerequisites.

The New Buildings Institute (NBI) tracks and verifies—but does not provide a third-party certification of—low energy use and NZE buildings (which NBI refers to as *zero net energy* or ZNE) and began publishing its biannual report in 2012. The most recent NBI data include properties located in 39 US states, representing virtually all climate zones, and a variety of building types including office, retail, industrial, multifamily, educational, healthcare and government buildings.

Valuation Considerations

Appraisers face a unique set of challenges when valuing NZE buildings. As discussed previously, the design features may be new technology unfamiliar to most appraisers, old technologies used in new ways, or combinations to reduce energy use. Additionally, some of these features may not be discernible upon inspection. While appraisers will use the same appraisal methodology to analyze NZE buildings, determining the value impact (or lack thereof) may require the appraiser to gather new types of information, such as energy use data on the subject and the comparables, or to pay closer attention to market participant behavior in order to properly assess marketability, risk and uptake.

Identifying NZE Properties and Low-Energy Features

As with any appraisal assignment, proper identification and description of a property's physical characteristics are essential components of the valuation process. Aside from reporting requirements, the key to NZE properties, in particular, is the identification of all critical building features because one cannot value what has not been identified.

How can you tell if a property is NZE? Since NZE is performance-based, it is impossible to determine if a building is operating at NZE purely by physical inspection. However, there are certain clues that should trigger further research or investigation into the energy use profile of the building, even if the property has not been previously identified as being NZE.

Most notably, an NZE building has to have an on-site source of energy. This commonly consists of a roof-mounted solar PV array. While visible on a pitched roof typical of a residence or small commercial building, it may be completely obscured on a flat roof typical of a large office or industrial building, unless access to the roof is provided. Solar PV can also be integrated into building components such as shingles, or mounted on parking-lot carport canopies, or ground-mounted away from the building.

The NZE building elements that reduce energy use can be easy to miss during a typical appraisal inspection. Many of these elements are also common to green building design and construction, so appraisers working with NZE should expect to understand green building design and construction, even if the NZE property is not identified as a green building. Some of these elements are more obvious than others, and specific components used will vary by project, property type, and climate.

For example, operable windows in a newly built office building suggest the design team is using natural ventilation to supplement or replace mechanical air movement and thermal conditioning. Similarly, roof monitors—essentially vertical protrusions through the roof with glazing and sometimes air vents—provide natural light while utilizing the stack (chimney) effect to enhance natural ventilation. Large-format ceiling-mounted fans, over-standard insulation, exposed concrete walls and floors that leverage the thermal mass of the building, and solar tubes that bring natural light into the interior of the building are all elements common in NZE buildings.

Less obvious are advanced technologies like electro-chromic glass that darkens when an electrical current is passed through it to control solar heat gain and glare. With concealed wiring and wireless controls, these high-tech windows may not look any different than conventional glazing. Dimmable LED lighting with occupancy sensors may be impossible to differentiate from conventional fluorescent lighting, and advanced building/energy management systems (BMS/EMS) to coordinate and monitor the integrated mechanical and passive systems may consist of visually obscure sensors that are connected to software residing on a remote server and controlled by the property manager from

a mobile device. Identifying and understanding these behind-the-scene systems requires additional input from the owner, designer, and/or engineer.

Obtaining the Relevant Data

One of the biggest obstacles an appraiser may face when valuing an NZE building is obtaining the necessary information from the client and/or property owner. Unlike green building certification programs like LEED, NZE projects typically lack a project checklist identifying the design elements employed. At least at this point in the evolution of NZE, each building is considered to be unique. NZE buildings will also require the appraiser to interact with individuals not typically consulted for a conventionally built building. For example, understanding the features of a typical commercial NZE building requires the appraiser to engage with the project architect to understand the intent of the design, and with the NZE engineer to understand how those design decisions impacted the mechanical and electrical systems.

The inspection, therefore, becomes particularly crucial for NZE properties, and the appraiser should be sure that the person most knowledgeable about the NZE features is present for the inspection. In some cases, this person may be the property owner, but ideally, a member of the design team such as the architect or engineer should accompany the appraiser for the inspection. An appraiser will naturally have many questions about how a particular feature works: "how does that roof monitor actually work to cool the space without mechanical fans?" Having the right person available on the inspection to explain how the feature operates is key for the appraiser to be able to assess whether that feature may or may not impact value.

In addition to the information gleaned from the inspection, the appraiser will need to obtain documentation about the building's energy use and energy generation. Commissioning reports by a third-party engineer to assess the building performance can be a valuable resource in evaluating the overall building system's performance as well as that of the individual components such as the HVAC or solar PV system. For energy use data, the specific documentation required will depend on the type of property appraised and may include a HERS report to assess the energy performance of an NZE residence or an energy modeling report for a more complex NZE commercial building.

For an existing property that has been operating at least a year, review of the energy use over that time frame should reveal whether the property is operating at, above, or below a net zero energy use level. However, simply getting the utility bills from the property owner can often be difficult, either because the owner does not realize the appraiser needs such information or because the appraiser does not make it clear why the information is needed. Even when the utility bill information is available, it may not contain the level of detail necessary. For example, the utility bill for NZE buildings and others connected to the grid that are also generating electricity may be in the form of a year-end "true up" or reconciliation bill that only shows net energy use (total energy use less energy produced on-site) but does not show actual energy use. From a valuation perspective, whether the reduced energy cost is derived from efficiency or generation may affect the property risk profile, and thus impact the valuation process.

For on-site energy generation data, useful documentation includes a copy of the original installation contract for the solar PV or other on-site energy generator, which will provide important performance metrics needed to value this component of the property. Access to any commissioning reports for the solar PV system as well as access to the energy production monitoring system is helpful in assessing system performance.

Identifying Potential Impacts on Value, Marketability, and Risk

The design and construction elements as well as the on-site energy source impact the development and reporting of each of the three approaches to value. As with green building valuation, valuing NZE properties is less about developing a new approach to valuation, and more about integrating a new market fundamental and new property characteristics into existing appraisal theory and practice.

Cost Approach

Cost may not always equal value, but it is one indicator. At this point in the evolution of NZE design and construction, an NZE building may result in slightly to significantly higher initial construction costs relative to conventional construction, even before the cost of the on-site energy source is considered. Much depends on the type and complexity of the systems and the experience of the design team. Due

to the nascent nature of this building sector, costs are likely to decline with time and wider market adoption. Current replacement cost, rather than historical cost, is therefore the more reliable indicator of market value. The declining cost environment typical of emerging technologies like NZE may place limitations on the reliability of the cost approach.

Cost estimator resources such as Marshall Valuation Service (MVS) provide a dedicated "Green" costing section that can be useful in assessing the reasonability of developer-reported cost budgets for certain components of NZE buildings. However, in municipalities that have adopted green building codes, it is likely the base building costs already include elevated code-mandated energy efficiency requirements, so care should be taken not to double-count costs for components that reduce energy use in these cases.

As with any other appraisal problem, the cost approach must consider to what degree the market will recognize the marginal cost of NZE, in light of the anticipated benefits. Put another way, the cost premium of NZE may reflect some level of either superadequacy or functional obsolescence. NZE can also be viewed as cost shifting, whereby increased construction costs are offset by reduced future operating and replacement costs. This dynamic is not yet widely appreciated in the appraisal world, but warrants attention and further study.

An example of this cost shift is evident in the reduced HVAC requirement for an NZE building. A smaller HVAC system made possible by leveraging the thermal mass of the building and the ambient environment via passive heating and ventilation results in lower maintenance costs and lower replacement reserve requirements. Further, dimmable LED lighting with occupancy and daylight sensors that last 20 years or more virtually eliminates routine light bulb replacement costs and the associated labor costs, in addition to the significant ongoing energy costs savings.

Importantly, however, not all NZE design and construction features cost more than conventional construction. In fact, some cost less. In many areas, exposed concrete floors and walls are a popular and attractive design element, lending a modern, high-tech feel to office space. Eliminating the cost of floor coverings and wall finishes has a positive impact on the construction budget. What may not be as obvious is that by exposing the concrete to the internal circulating air, the thermal mass of the concrete stabilizes the interior temperature, which reduces energy required to maintain thermal comfort.

In addition, NZE features can have synergistic benefits when combined with other features. The cooling system may be downsized due to the reduced heat load realized by the combination of daylighting that reduces artificial lighting, and the replacement of conventional lighting with LED lighting controlled by occupancy and daylight sensors. Combined heat and power (CHP) systems harvest waste heat from power generation to supplement space heating and domestic hot-water heating. Wood-frame construction with studs located at 24-inch intervals instead of conventional 16-inch intervals both reduces lumber cost and improves building envelope performance by reducing thermal bridging.

Sales Comparison Approach

With NZE, the challenge in the sales comparison approach is the same one an appraiser faces with any new property type or characteristic that impacts value. Market evidence of the value effect is often scarce or nonexistent. This situation is not unlike that confronting the appraiser who values the first house in the neighborhood with a pool, an extra garage space, or an in-law unit. There is clearly a cost and benefit to the owner, but the lack of comparables makes it difficult to quantify the value impact. Application of the sales comparison approach in valuing NZE properties when no NZE comparable sales are available requires using a cost-based or income-based adjustment to reflect the value added by the NZE components.

The challenges of a cost-based adjustment in the sales comparison approach are identical to those discussed in the previous section: Will the next buyer recognize the current costs required to achieve NZE? Is there an obsolescence adjustment to be considered? How reliable is a current replacement cost estimate if costs are likely to fall in the future?

Using an income-based adjustment for the NZE effect in the sales comparison approach requires the appraiser to accurately establish building energy use for a comparable conventional building, so that the marginal energy cost savings, net of any associated operating costs, can be appropriately estimated. This challenge is not insignificant, and the effort involved should not be discounted. Publicly available databases to benchmark energy costs for

conventional buildings are typically dated. Industry surveys, owner-reported operating expenses, and appraiser file data may not segregate energy from other utility costs such as water/sewer, and sometimes trash removal or data services. Energy use, and thus cost, can vary widely, based on the property type and use as well as the vintage of the building. Energy codes have generally become more stringent over time, so new and recently renovated buildings will often have a different energy use and cost profile than older, unrenovated buildings. Developing a credible income-based adjustment is beyond the scope of this article and will be the subject of future work.

Income Capitalization Approach

The income capitalization approach provides the most direct method of addressing the economic impact of NZE. Both the stabilized income statement and a discounted cash flow (DCF) provide line-item areas that explicitly address direct positive and negative impacts on the income and operating expenses.

In markets where tenants typically pay the energy costs, as in a triple-net lease structure, the market rent analysis should consider the effect the lack of energy cost might have on the market rent conclusion.

On the expense side, an NZE building should operate at no net energy use, but there likely will still be some fixed costs associated with maintaining a connection to the local electrical grid. Solar PV systems are relatively low maintenance with a typical economic life of 25 to 30 years, similar to that of a roof, though the inverter(s) typically require(s) replacement around year 15. While periodic cleaning and monitoring costs are nominal, the inverter replacement cost is significant and is sensitive to the size of the system, type and number of inverters, and the local market. Local market research is the appraiser's best resource for ongoing inverter maintenance and replacement costs. These capital costs could be considered in the replacement reserves allowance, or as explicit deductions at specified times, particularly if discounted cash flow analysis is used.

Other components of the NZE building may also require adjustments to the repairs and maintenance or management expenses. The complexity of the NZE design features may require added expenses for monitoring, management, or periodic commissioning. Other NZE components may have the opposite effect of reducing operating costs, which should be considered as well. For example, reducing or eliminating the conventional HVAC system decreases annual maintenance costs as well as required replacement reserves.

The lease should be reviewed for any language governing operation of the NZE building to determine whether the marketability or functional utility of the space is affected. The lease may specify the proportion and location of private offices in order to facilitate natural air flow. Set points on the HVAC may be controlled by the landlord, and there may be limitations on the use of space heaters, electric car charging, and other energy-intensive activities. Careful market research into occupant reactions to these new property characteristics is critical as they may not always be what appraisers or property owners expect.

In addition to the direct impacts on the property cash flow, indirect impacts should also be considered. Does the NZE status of the subject affect its marketability to potential tenants? If so, positively or negatively? For example, natural ventilation, which can be seen as a positive feature, may be accompanied by unwanted outdoor noise or security concerns. Will the tenant satisfaction be affected? Will investors see the benefits of being first to market an NZE property, or just the downside risks of new technologies?

An example of how difficult it is to predict the market response to NZE properties involves a speculative NZE project that also included a variety of sustainable features but was not LEED-certified. This property leased faster than anticipated, and at a rent that significantly exceeded the developer's pro forma as a result of competitive bidding. The capitalized rent premium offset the marginal cost of the NZE and sustainable renovation components of the project by a ratio of 3 to 1. In this particular case, the project was able to attain rents similar to Class A buildings in its market, despite its Class B status. While this experience is anecdotal, it suggests a potentially untapped segment of demand, at a level that surpassed even the developer's projection.

Conclusion

Net zero energy buildings are likely to become more common, presenting both challenges and opportunities to appraisers unfamiliar with green building, building energy dynamics, and on-site renewable energy sources. The design and construction of these properties impacts all three approaches to value. Acquiring the necessary competency to credibly

complete NZE assignments requires advanced study and coursework in both green building and on-site energy source valuation. The concepts learned in valuing NZE buildings, however, are directly transferrable to any low-energy-use property, many green buildings, and a variety of on-site energy sources. This expanding field of practice offers a compelling incentive for appraisers to pursue this expertise.

Tim Runde, MAI, LEED AP, is a partner with Carneghi and Partners, Inc. in San Francisco. He has over twenty-five years of commercial real estate appraisal experience, encompassing a wide range of property types, including office, industrial, retail, and multifamily assignments. Besides an expertise in the valuation of green, high-performance and sustainable real estate, Runde specializes in addressing unusual and complex valuation assignments such as net zero energy buildings, ground leases and ground rent determinations and ad valorem tax assignments involving intangible components. He has also provided litigation support and served as an expert witness in a variety of settings. Runde received his master's of science in real estate appraisal and investment analysis from the University of Wisconsin under the direction of Dr. James Graaskamp. Runde is a frequent guest speaker across the country to appraisers and others in the commercial and residential real estate industry on the value impact of green and high-performance design/construction on both green buildings and existing building stock. He is an Appraisal Institute instructor, course reviewer, and webinar developer. **Contact: trunde@comcast.net**

Resources for Digging Deeper

Appraisal Institute, Green Building Resources
http://www.appraisalinstitute.org/education/education-resources/green-building-resources/

Appraisal Institute, *Residential Green Valuation Tools* by Sandra Adomatis, SRA, LEED Green Associate
http://www.appraisalinstitute.org/residential-green-valuation-tools/

Database for State Incentives for Renewables and Efficiency (DSIRE)
http://www.dsireusa.org/

International Living Future Institute (ILFI)
http://living-future.org/

Institute for Market Transformation (IMT), information on green leases
http://www.greenleaselibrary.com/

New Buildings Institute (NBI)
http://newbuildings.org/

US Department of Energy, Zero Energy Ready Home
http://energy.gov/eere/buildings/zero-energy-ready-home

US Energy Information Administration (EIA)
http://www.eia.gov/