Net Zero Energy Through Adaptive Reuse

Master of Architectural Thesis by Ashley Brenner

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Architecture in The Lawrence Technological University. May 2015

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Abstract

From academic papers to the popular press, it is clear that the increasing world population is resulting in an unsustainable acceleration of energy consumption and material extraction. In architecture, one impact of this growth has been the need for more housing with its associated environmental burdens including the energy required to extract and transport raw building materials, and to construct and maintain these homes. In an attempt to reduce these costs, the green building movement emerged in the 1990s to promote resource-efficiency throughout a building's life-cycle.

Today, two of the most important design strategies for achieving sustainable goals are adaptive reuse and net zero energy. Although adaptive reuse projects are not a new phenomenon and have historically embraced design economy, utility, and durability, those including net zero energy objectives account for fewer than 25% of these projects. Clearly the potential of net zero reuse is not being realized. Through the analysis of case studies in adaptive reuse and net zero building, this thesis seeks to evaluate best practices in sustainable architecture that will inform a set of design development guidelines. The goal of this research is that these principles will assist in removing existing barriers to the successful implementation of net zero reuse.

Research Objectives

QUESTIONS:

What metrics are used to evaluate a building's sustainable potential?
How do you determine the best sustainable methods for the building?
How does cost impact the level of sustainability achieved?
Why net zero energy instead of various sustainable methods?
What does a successful net zero energy reuse entail and how does it achieve success?
How can net zero energy projects be more effectively promoted and used int he field of architecture?
What does a net zero reuse project give back to its context?
What are the financial savings from this net zero reuse?

PROPOSITION:

Adaptive reuse projects need to become more common and implement net zero energy strategies to achieve true sustainability. The more conventional these types of design interventions become, the more the cost is reduced to achieve them.

Purpose / Motivator

To collect / produce research to confirm that net zero energy and adaptive reuse projects are practical and achievable. The primary objective from this research is to develop a new set of guidelines to enhance the process of reusing existing buildings while maximizing their environmentally sensitive building practices by achieving the highest form of sustainability, Net Zero Reuse.

The thesis research, findings, and my contributions through guidelines, strives to help Researchers, Process Planners, and Architecture Policymakers on a theoretical level as well as Architects, Designers, Contractors, Architectural Students and Developers on a practical level, to pursue and successfully achieve net zero reuse projects.

Research Methods

This thesis is involves both theoretical and practical areas of focus. With the goal outcome of a set of guidelines to help various audiences, the need to gain clear understanding of both data were necessary.

In order to achieve data in both technical and practical aspects, I focused around three methods of research: analysis of existing design methods, analysis of case studies, and analysis of existing guidelines and written documents.

Throughout the thesis process, these three methods started to overlap and became incorporated within each other. Once successful methods were extracted; passive design, internal load reduction, and renewable energy, I used these methods as a parameter when analyzing the case studies. Each case explores the techniques used to achieve these three methods of design. The design methods and cases were then used to create the variables for the guidelines produced to achieve net zero reuse.

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Terminology

Adaptive Reuse: the process of reusing an old site or building for a purpose other than which it was built or designed for. A key factor land conservation and reduction of urban sprawl.

Net Zero Energy: a building that produces more energy that it consumes on an annual basis using only renewable energy.

Net Zero Reuse: the process of reusing an existing site or building for a purpose other than which it was originally intended for while incorporating high efficient systems and design ideas so that the building produces more energy than it consumes on an annual basis using only renewable energy.

True Sustainability: Projects that use the least amount of energy, water, and material as possible.

Greyfields: Blighted urban areas.

Guideline: is a statement by which to determine a course of action. A guideline aims to streamline a particular process according to a set routine or sound practice. By definition, following a guideline is never mandatory. Guidelines are not binding and are not enforced. (US Dept. of Veterans Affairs)

Land Recycling: reuse of land that is unused or under-utilized whether or not it is contaminated.

Reuse: returns materials to active use in the same or a related capacity as their original use, thus extending the lifetime of materials that would otherwise be disregarded.

Reclaimed Materials: materials that are being reused, but have not been significantly altered from their physical form in a previous application.

Daylighting: is the controlled entry of natural light into a space, used to reduce or eliminate electric lighting.

Terminology

Integrated Design: a collaborative method for designing buildings which emphasizes the development of a holistic design. Conventional building design usually involves a series of hand-offs from owner to architect, from builder to occupant.

Natural, or Passive, Ventilation: is provided by thermal, wind, or diffusion effects openings in the building façade, roof, or other components for the purpose of creating low-energy air movement.

Passive Design: employs the buildings geometry, orientation and mass to condition the structure using natural and climatologic features such as the sites solar insolation, thermal chimney effects, prevailing winds, local topography, microclimate and landscaping.

Thermal Mass: a material that is selected and / or used based upon its ability to store heat; good thermal mass will have high thermal capacity (density multiplied by specific heat).

Renewable Energy: energy produced by a source that is rapidly replaceable by a natural process (examples include wood, biofuels, wind and solar radiation).

Grid-Connected: an on-site power generation system that is linked to the local utility system.

Net Metering: is a metering arrangement that allows on-site generators to send excess electricity flows to the regional power grid. These electricity flows offset all or a portion of those drawn from the grid.

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1. Introduction

Background

As a human population, we are consuming more than the earth can sustain. "Our way of life is threatening all living systems. The solution is simple: lower CO2 and end our addiction to fossil fuels."1.1 In order to achieve this, one must occur with the other. Once we create a method to lower CO2 emissions, we will in turn develop a way to become less reliant on fossil fuels. It is as simple as biking to work or walking to the store instead of getting in our car every time we leave our doorstep.

Human dependence on fossil fuels has not always been this intense. "Energy use per person has grown as we have evolved… As energy has become relatively easier to find and use, more people were fed with less effort, driving population growth and providing other human conveniences." 1.2 Due to our increase in technology, we are able to generate more powered making it more available and cheaper. Thus making it easier to participate in habits and over use available energy, something the American society is very well accustomed to.

Fossil fuels have been our only means of energy for many years, however now they are depleting due to the increase in population and our consumption rates. "Fossil-fuel sources have finite reserves, and they will all peak – as oil already has."1.3 We must act now, our society and technology are capable of the shift it is now a matter of getting people educated and on board. We know we need to take action, so what are we waiting for?

While we are accustomed to a certain lifestyle of over using energy, technology may also be the answer to getting our energy usage back on track. Instead of fossil fuel emissions, we can enjoy fresh air and clear skies through sustainable practices of adaptive reuse and net zero energy, reusing what we have while minimizing the amount of energy used.

1.1 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. X.

1.2 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 3.

1.3 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 7.

Renewable energy has become easier to access as technology evolves and people become more aware of the success from this technology. Similar with most products, as time passes they become more available and reduce in cost, however this is not so with oil for example. Oil has become more expensive and harder to obtain in recent years therefore raising in price. We are at a time where renewable energy is cheaper, easily accessible and in abundance. This availability could not come at a more perfect time as our resources are peaking. This peak can control an economy's stability because of our dependence on fossil fuels, just as America has been this past decade.

Since oil has already peaked, what about the rest of earth's resources? When will those peak? Or be eliminated? "Experts fluctuate on just how long we have before we encounter runaway climate change and its catastrophic results, but most agree that we have just four or so decades to make serious change."[1.4] How long has it taken to fall into this slump that is causing climate change? Will four decades be enough to get back out of it? How much longer will it take to accept this issue and react?

Some countries already have a head start on making a sustainable change, where America is still stuck in the rut, if not making it deeper. Renewable energy is a simple answer that is right in front of our face. We just need to reach out and touch accept it. "Experience in Europe indicates that it is likely that renewable energy provides up to 50 or 60 percent of the grid's power, probably higher with a smart grid."[1.5] A grid is simply an on-site power generation system that is linked to the local utility system. The United States needs to consider updating to a grid system to not only reduce our fossil fuel consumption but make renewable energy consumption easier and more available.

1.4 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 7.

1.5 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 14.

Potential

Sustainability has a high importance within architecture due to the high potential within buildings. Buildings in America use roughly 40% of the energy produced and are the largest contributor to landfill waste. The first step to reducing our impact on this planet and creating a healthier environment is to reduce the largest contributing factor.

This is possible by reusing the existing building stock instead of demolishing them. Reuse of a building is an essential key to achieving sustainability, not only is it preventing waste from entering the landfill it is also lowering the need for and cost of new materials that are needed to construct new building. While renovation may raise or lower the cost, it is due to the condition the building is in and what is required to revitalize the building. Renovation adds and/or removes materials from the existing structure to serve the function of the new use of the space. This method, adaptive reuse, is a more environmentally friendly option than starting a new project.

Factors such as cost and time greatly impact whether a project is designed to be sustainable or not, however technology and knowledge has increased a buildings ability to achieve sustainable methods efficiently and with reduced costs. Why are we still not doing designing to true sustainability? True sustainability being a building that uses the least amount of energy, water, and material as possible. A way a building can achieve true sustainability is through adaptive reuse, as stated above, and by achieving net zero energy. These buildings that create the same amount if not more energy than they consume. "Net zero building design indicates that energy consumption in buildings can be cut by 70 to 80 percent with improved occupant comfort and satisfaction and increased building durability." **1.6** Meaning net zero energy buildings alone can reduce the 40 % of energy consumption by 70 to 80 %.

1.6 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 7.

This is a huge step in reducing our reliance on fossil fuels. However, “These efficiencies, combined with renewables, currently raise building costs between 5 and 15 percent.”**1.7** While the initial cost is 5 to 15 percent higher than typical buildings, the key is to determine how much this initial cost will end up saving over the life of the project.

There is a great quote in the *The New Net Zero* by Wiliam McClay that states “As Albert Einstein once said, ‘the problems that exist in the world today cannot be solved by the level of thinking that created them’”**1.8** Therefore new net zero energy architecture would not contain the solution to the large issue we are currently in. It is up to architects, designers, and urban planners to implement solutions into our current architecture. We know what the problem is with the existing architecture, we now need to make changes to fit those needs instead of trying to recreate or reinvent the wheel.

“Transitioning from one energy source to another is and has been part of human evolution,”**1.9** So why is it so hard to transition to renewable energy today? Have we not learned from our past? What is stopping us from transitioning to the next level, net zero energy? Many have wrote about how “Significant societal pressures and temporary additional costs.”**1.10** are to blame. The initial costs is hard to overcome because it is current and tends to be as far as some people see when funding a project. It is critical that owners/developers look at the big picture of the project and resist to get distracted by onetime initial costs.

1.7 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 7.

1.8 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 1.

1.9 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. X.

1.10 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 3.

Why?

As stated earlier, the cost for net zero buildings is not as expensive as it once was. “The cost of all renewable energy sources including solar are decreasing as cheaper, more efficient technologies are being developed.”1.11 It is time to take action and start pushing the need for change. We have the potential, technology, and knowledge to make the change, however we are lacking the will to change. When will this take affect, months, years, decades?

Not only has the cost to achieve next zero energy buildings been reduced, the energy itself is endless and free! “Researchers estimate that there is enough energy in the deserts of North Africa alone to provide forty times the global electric energy demand in 2006.”1.12 With this availability we need to take action and grasp the potential of renewable energy. It is a change that must be made and it is important to educate people and in order to start to make a change.

Not only does net zero energy prove viable because of availability, it also has a positive effect on the environment. While achieving net zero energy, we are reducing the pollution put into the air from fossil fuels. While many people do not understand the effects of fossil fuels because they are unable to see change immediately, the effects are costly. “If we add the true cost of fossil-fuel and nuclear-power use and subtract for the value lost through destruction of ecosystems, our societal balance sheet and profit and loss statements would look very different.”1.13

While net zero energy is a leading trend in architecture, we must also think of how we can achieve true sustainability. The greenest building is the one that has already been built. Existing buildings contain a large amount of embodied energy which is why it is necessary to pursue adaptive reuse.

1.11 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 6.

1.12 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 7.

1.13 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 7-8.

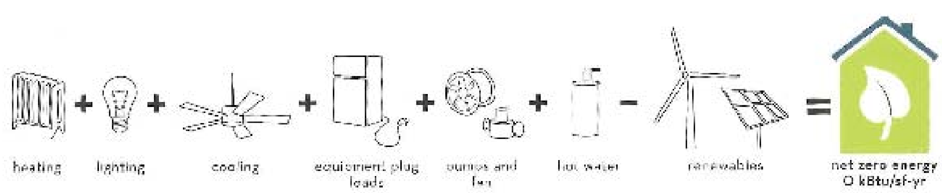
By reusing our existing architecture, we are reducing the energy required for demolition, raw materials, transportation, and assembly of a new building. Not taking advantage of existing buildings is wasting a lot of energy, we need to take advantage of what we already have.

Adaptive reuse is also helpful within the environment and local economy by redeveloping downtown and avoiding sprawl and new land consumption. Brownfield redevelopment, reuse of a currently developed site, is one of the most environmentally satisfying methods of design.

Not only can adaptive reuse limit sprawl and production of new raw materials, it also creates new social spaces. Reuse of familiar materials in creative ways is refreshing, inspiring, and interesting. Reuse spaces are created from existing space and materials that had various original uses to create something new that they were not design for, making it unique and intriguing. We as humans crave a more personal connection to the places we experience, adaptive reuse gives us that.

Adaptive reuse is also important in downtown areas because of the turnover rate with local businesses. New businesses are constantly starting and there is a need to fill the existing spaces. However there are times when zoning laws do not permit specific uses in those existing buildings. Zoning codes may be revised to permit a new use for that area. This is essential to revival and success of a downtown area. When buildings sit abandoned it is usually a result of economic and social downturn in that area. However these spaces provide the most potential for success since there is existing infrastructure. It is essential to reuse these buildings and make sure they become and stay populated for a thriving “place” where people want to be.

Figure 1.1



There are many existing processes in place for adaptive reuse and have incentives for projects that pursue this method. Some cities specifically have their own incentives and even the LEED system allows credits for adaptive reuse. Not only does the new LEED version award credits for adaptive reuse, the credits are available in most of the categories.

Achieving net zero energy through adaptive reuse is true sustainability. It is using our current infrastructure instead of creating waste and using mass amounts of new raw materials. Net zero reuse reduces the amount of energy needed by reusing an existing building while providing renewable energy to meet the needs of the building instead of relying one energy from fossil fuels. This true sustainability, using what we have, reducing what we use, and providing enough energy to supply our needs is what we must strive for. We can achieve this through net zero reuse.

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2. Design Objectives

Summary

In this chapter about design objectives, focus will be on designing for net zero energy and adaptive reuse aspects. As we know an objective is simply a goal, an intention or a purpose. Objectives are important in order to achieve both aspects of net zero reuse through providing a base or standard to follow.

When we think about how do design to suite net zero energy and adaptive reuse, three aspects are important to consider. Environmental, Social and Economical are three highly impactive aspects in design. Each of these three areas are directly related, impact on one results on impact on the others. The ideal objective is to get each of these areas, Environmental, Social and Economical to benefit each other.

Throughout this chapter, each one will be touched on in how it effects architecture, and achieving net zero energy though adaptive reuse.

Net Zero Energy Objectives

Environmental

The main objective to peruse net zero energy rather than various other sustainable methods is due to the conservation and preservation of Earth's resources. Through net zero energy, we are seeking out the highest potential a building can have other then creating more energy than it uses, which many net zero energy buildings can do from time to time.

By achieving net zero energy, we will achieve multiple positive objectives. The most current and straining objective is reducing and potentially eliminating the dependence on fossil fuels and other resources. This is done through renewable energy that is applied and implemented to net zero energy projects. In order to achieve net zero energy, the building must produce more renewable energy than it consumes. In-turn, by achieving net zero energy, we no longer rely on fossil fuels for building energy,

Another objective of net zero energy is reducing CO2 emissions. Due to net zero energy buildings producing and consuming only renewable energy, they are eliminating all of their emissions. The more buildings we can create that achieve net zero energy, the larger impact we can have on lowering of the overall building CO2 contribution of 40%.

By creating a net zero structure means that we are doing enough to balance our needs. That we are not taking anything from the environment that we are unable to replace.

Renewable energy is energy produced by a source that is rapidly replaceable by a natural process (examples include wood, biofuels, wind and solar radiation). Renewable energy can also consist of reusing materials that we already have, materials that consist of embodied energy. By reusing these materials we are saving from future labor and energy required for production.

Net Zero Energy Objectives

Social

Sustainability has been around for quite some time now, we have been conscious of our impact on the human population and our earth. Within the last few decades, net zero energy has become stronger, not only due to its benefits on the environment but also to our community.

The main social objective of net zero energy is to help preserve and clean our air and water for the public. This is possible through net zero energy because of reduction of energy while providing renewable energy. We no longer need fossil fuels to create our energy, the sun can generate more than enough for the entire population of the earth. Unlike fossil fuels, renewable energy does not give off any CO_2 emissions.

Communities are now more aware of what net zero energy is as it has become more common in our cities today. The increased popularity and knowledge of net zero energy is because of its impacts on our current surroundings. Net zero techniques allow for those interacting with the architecture to understand the power of nature and how it is not being used to its advantage.

Another way to look at the importance of net zero energy on a social level is to ask yourself, when do we ever constantly take and without giving something back? While this may occur in our current society from time to time on small scales, the majority of responses to this answer are never. So why are we taking resources from the environment when we can not give anything back to the earth to sustain itself, all we do is make our environment work harder to fight off our harmful effects.

How would we feel if the role was flipped and the environment constantly took resources from us and left us with nothing? Net zero energy allows us to safely use natural renewable resources, while creating no harmful effects, creating a balance, no harm to our human race.

Net Zero Energy Objectives

Economic

A key word in net zero energy is zero. Meaning that while it may cost a premium to achieve net zero energy status, once achieved, both the amount of energy and the cost are balanced at zero. This may sound crazy, but if you are producing equal to, if not more energy than you are consuming, they there is nothing to pay for.

As for the initial premium to achieve net zero energy, while this is higher than normal building practices, the difference is that over the span of a few years after construction, net zero energy repays for its initial start up cost from savings you would not have otherwise. Even the start up cost has decreased allowing for more implementation. “The cost of all renewable energy sources including solar are decreasing as cheaper, more efficient technologies are being developed.” **2.1**

The economic objective of net zero energy is to reduce the initial cost in order to achieve a balance of sustainability. This being that we as a population produce as much renewable energy as we use, creating a balance. In order for this balance to occur, the cost to achieve net zero energy needs to be reduced, making it more available in the market.

The cost to achieve net zero energy is the only variable that is preventing more projects to achieve status. Net zero energy is a small cost to pay when normal building practices cost us so much more with their damage, however it is harder for people to see the effect they are having on the environment. If this effect was more visible, this initial cost would finally be realized as the best economic answer.

2.1 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 6.

Adaptive Reuse Objectives

Environmental

"One of the main environmental benefits of reusing buildings is the retention of the original building's 'embodied energy.'" 2.2 Embodied energy is the sum of all the energy required / consumed in the acquisition and processing of raw materials, including manufacturing, transportation and final installment.

Today it is a part of current sustainable processes such as LEED and the Living Building Challenge (LBC) to require a lower embodied energy of materials for new construction. However, while this is helping new construction, we could be achieving far better objectives if we seek to reuse the current building stock that contains an unbelievable amount of embodied energy.

"New buildings have much higher embodied energy costs than buildings that are adaptively reused. In 2001, new building accounted for about 40 percent of annual energy and raw materials, 25 percent of wood harvest, 16 percent of fresh water supplies, 44 percent of landfill, 45 percent of carbon dioxide production and up to half of the total greenhouse emissions from industrialized countries" 2.3

We have evidence of how drastic our existing conditions are and that our current method of design and construction is having a negative effect to the environment. To think of the millions of existing residential and commercial buildings that can be reused versus creating new is promising in hopes to shift our environmental crisis. Reducing embodied energy is the largest and most necessary step in hopes to achieve a healthier environment.

"The Australian Greenhouse Office notes that he reuse of building materials usually involves a saving of approximately of 95 percent of embodied energy that would otherwise be wasted" 2.4 With a higher effective capability than the current processes in place today, LEED and LBC, adaptive reuse is the number one objective in hopes to improve our environment.

2.2 Australian Government Department of Environmental Heritage, "Adaptive Reuse: Pre serving our Part, Building our Future" (2004) pdf. 4.

2.3 Australian Government Department of Environmental Heritage, "Adaptive Reuse: Pre serving our Part, Building our Future" (2004) pdf. 4.

2.4 Australian Government Department of Environmental Heritage, "Adaptive Reuse: Pre serving our Part, Building our Future" (2004) pdf. 4.

Adaptive Reuse Objectives

Social

On a social level, adaptive reuse has the ability to create and define a place, this is known as Place-making. "Place-making is how we collectively shape our public realm to maximize shared value. Rooted in community-based participation, Place-making involves the planning, design, management and programming of public spaces." **2.5** Through place-making, adaptive reuse can revitalize and maintain the spaces in which we live.

As of lately, reuse of existing infrastructure has been considered ideal and a preferred method of design due to many successful implications, One of the case studies discussed later in this book is an adaptive reuse of a building constructed in 1908. This case study is of a historical building that has a strong presence within the city. Though adaptive reuse, this building has been able to strengthen the community and maintain its history.

This building sat vacant until the being renovated it into the Ferris State University Kendall College of Art and Design. This building created and environment where students are able to learn about adaptive reuse and history while experiencing a successful example. This space is not only used by students, it is also a central meeting and gallery space for architecture firms and events within the city. By providing places that meets the needs of local inhabitants is essential to achieve success.

A few of the social aspects that make this project achieve successful place-making was its strong consideration to preserve its existing character. By reusing a large majority of materials that were existing in the building and uncovering its original daylighting qualities, gives the sense of time allowing the occupants to capture the essence of the building's past.

Figure 2.1

2.5 "What If We Built Our Public Spaces Streets & Transit Markets Waterfronts Public Buildings Campuses Downtowns Squares Parks through Placemaking?" Project for Public Spaces. Web. 05 May 2015. <http://www.pps.org/>.

Location within the city is another major social objective. While not all adaptive reuse projects can allow for this due to current urban sprawl issues, it is important to start with those that are located within accessible reach of public transportation. Access and public transportation is a major attraction for developers, preferred by the majority of people and is a major aid in to achieving the objective of true sustainability, net zero energy. As mentioned, buildings within viable distance to public transit is ideal but not required, however it is a major contributor in achieving the social objective and be considered when ever possible.

The effect of neglecting to consider urban sprawl, buildings located out of considerable reach of public transportation, has left holes within our cities weakening its urban fabric, and has increased the amount of co2 emissions. To improve our social environment, we need to focus on strengthening the center of our city. When urban sprawl became an issue, neglected areas withing the city became blighted and abandoned.

However, these abandoned and blighted options provide a perfect canvas for adaptive reuse. “The challenge of tackling urban blight in the United States does not necessarily mean tearing down miles of building’s and replacing them with thirty-story concrete slaps… Inhabitants would be happier if they simply have their old neighborhood homes and streets spruced up with some pleasant open spaces added” **2.6**

Figure 2.2

2.6 Young, R. A.,. (2012). Stewardship of the built environment sustainability, preservation, and reuse. 42

Adaptive Reuse Objectives

Economic

As similar to the environmental objective, embodied energy is not only better for the environment, it also is an economical objective. Embodied energy reduces the cost of construction due to less labor and materials that are needed for a project. “Embodied energy savings from not demolishing a building will only increase with the predicted rise of energy costs in the future.” **2.7** The embodied energy of existing buildings consists of the labor and materials that were originally produced, by reusing them, we do not need to spend money demolishing, extracting raw materials and constructing a new building.

Adaptive reuse adds value to buildings. While this is less definitive, people are simply attracted to reuse of spaces. Whether it is a historic, contemporary or modern building, our society is intrigued by reuse. Not only is reuse gaining in popularity because of saving on materials and labor, it is also driving in business and is a major contributing factor to creating place-making, therefore increasing economical value to both the space and its context. “While there is no definitive research on the market appeal of reused heritage buildings, they have anecdotally been popular because of their originality and historic authenticity.” **2.8**

Another economical contribution is tax and financial incentives to pursue Adaptive reuse. Certain cities in the United States such as Portland, OR, allow tax or other financial incentives for adaptive reuse projects due to their ability to increase the market and economy in that area. “Portland has many aging buildings ripe for adaptive reuse. The trouble is that many retrofits would trigger costly improvements, like seismic upgrades, that can outweigh a building’s potential for future revenue.” **2.9**

Instead of allowing adaptive reuse to be overcome by cost, cities such as

2.7 Australian Government Department of Environmental Heritage, “Adaptive Reuse: Pre serving our Part, Building our Future” (2004) pdf. 5.

2.8 Australian Government Department of Environmental Heritage, “Adaptive Reuse: Pre serving our Part, Building our Future” (2004) pdf. 5.

2.9 “The High Cost of Adaptive Reuse in Portland.” Daily Journal of Commerce. Web. 05 May 2015.

Adaptive Reuse Objectives

Economic

Portland, OR are creating incentives to pursue adaptive reuse. The intent behind incentives is to allow projects to overcome the added cost (if any) to achieve adaptive reuse of an existing building. One of the most costly methods of adaptive reuse is structural upgrades, these incentives help offset that cost.

Incentives are not only financial, as they impact the economy, they equally impact the environment and society. Environmentally, adaptive reuse is a better method, "10 to 80 years are needed for a new building 30 percent more efficient than an average-performing existing one to overcome the negative climate change impacts related to construction." **2.10** **Our existing building stock has been design to last and withstand the elements. Simple upgrades are far more feasible and easier to correct than starting with new construction and hoping this net construction is successful and efficient.**

In Portland, OR, offers more than one tax incentive depending on the type of project. "The federal government offers a 20 percent tax credit for rehabilitation of historic income-producing buildings and a 10 percent tax credit for non-historic buildings. The Portland Development Commission offers grants through a storefront improvement program and the city of Portland waives or reduces building permit fees for certain renovations." **2.11** This allows for a larger number of projects to achieve tax incentives by providing each project with funding based on its economic needs.

Adaptive reuse "is a community asset and it brings so much more vitality to the neighborhood by adapting old buildings." **2.12** While this value is added, adaptive reuse can cost more to update outdated structures, tax incentives help remove this barrier by providing economical aid to projects.

2.10 "The High Cost of Adaptive Reuse in Portland." Daily Journal of Commerce. Web. 05 May 2015.

2.11 "The High Cost of Adaptive Reuse in Portland." Daily Journal of Commerce. Web. 05 May 2015.

2.12 "The High Cost of Adaptive Reuse in Portland." Daily Journal of Commerce. Web. 05 May 2015.

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3. Design Methods

Summary

Now that the objectives of Net Zero Reuse are established on all three areas, environmental, social and economic, we can look at techniques in which we achieve those goals. The the firs and main part of this research is to analyze the method's needed in order to achieve net zero and adaptive reuse.

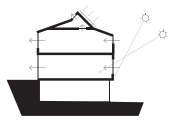
This chapter about design methods will discuss techniques currently used to achieve success in all three main areas; environmental, economical, and economic.

At the start of this research, there were tons of various techniques to achieve success. After analysis of these, many fit into similar categories. For ease of the end goal being guidelines, as well as these similarities, three main methods with various techniques within each were formed; Passive Design, Internal Load Reduction, and Renewable Energy.

While these three methods are divided into three focus areas, they are to be incorporated collaboratively and holistically. Techniques of each of these methods must be incorporated in order to achieve a net zero reuse project. "We see buildings as organisms that must function not just individually but also within their larger ecosystem of office buildings, homes, institutions, communities and natural systems." **3.1**

3.1 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. ix.

Passive Design Method



While passive design is easier to implement in new construction, it was also a past method of design. A majority of existing buildings were designed before electricity was the main method of lighting and ventilating spaces. When selecting existing projects for adaptive reuse, it is essential to look for characteristics within the building that show signs of passive design.

Even if the building does not incorporate passive design, the techniques listed below can be incorporated to achieve successful results.

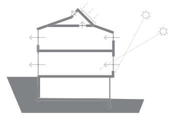
Intent: To develop buildings that use nature to their advantage through reducing environmental impact and passive design methods reduce the energy consumption of buildings.

Techniques:

Operable Windows
Placement Of Windows
Daylight
Solar Orientation
Roof Overhang
Thermal Mass
Light Reflectance
Geometry
Cross And Stack Ventilation
Context
Solar Heat Gain
Reuse Of Material
Composition
Historic / Original Style
Building Interaction
Diversity / Originality
Holistic Design
Performance
Natural And Recyclable Materials
Gardens
Views
Aesthetics
Contrast

Techniques:

Operable Windows



A main technique to improving thermal comfort of building occupants is through providing operable windows which open to allow for the building to be naturally ventilated. Natural ventilation is a free and (when the climate is right) unlimited resource to take advantage of. This is a simple technique to implement as it only requires to select an operable window instead of a fixed window. However the placement of operable windows is important.

Placement Of Windows

Whether the windows are operable or fixed, placement is essential. While windows can be placed anywhere along the building envelope, fenestration on all facades is ideal to allow for maximum day light and natural ventilation. While fixed windows can be placed anywhere on the building exterior, operable windows are usually placed in areas of occupation. This is due to allowing natural ventilation to the occupants as well as the ability to control their thermal comfort.

An essential note along with placement of windows is to specify the correct Solar Heat Gain Coefficient (SHGC) with the window based on the location. Windows located on the south wall require a higher SHGC than northern windows due to their direct sunlight on the glass. Another method for windows located on the south facade is to provide louvers to allow shade to the glass, this lowers heat gain within the building.

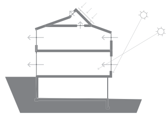
Daylight

Allowing the maximum amount of natural light to enter the building through placement of windows, orientation of the building and site context. Daylight is a free and abundant form of lighting that has been unused in some designs. Allowing light to enter the spaces allows occupants to relate with their surroundings and have a sense of time as the day passes. Daylight also allows for views out of the building.

Solar Orientation

The orientation of a building is essential for many reasons, first being to design and location of spaces in relative to the sun. Depending on the use of the space, its exposure to the exterior of the building is different. Another reason solar orientation is essential is due to on site production of renewable energy. Ideal angle and orientation for solar arrays are necessary for efficient and successful production of energy. Southern facing facades will collect the most direct sunlight.

Roof Overhang



Design of roof overhangs are essential to reducing energy and providing comfort for the occupants. Windows on the south facade get direct sunlight, needing the overhand to protect the windows during the summer months but allowing the sun to penetrate the windows during the winter months.

Thermal Mass

Many older buildings contain thermal mass, due to simpler construction methods. Thermal mass is a mass; concrete, brick, etc, that collects heat and stores it. Due to its materiality and size, stored heat is able to then radiant heat throughout the day warming a space very efficiently.

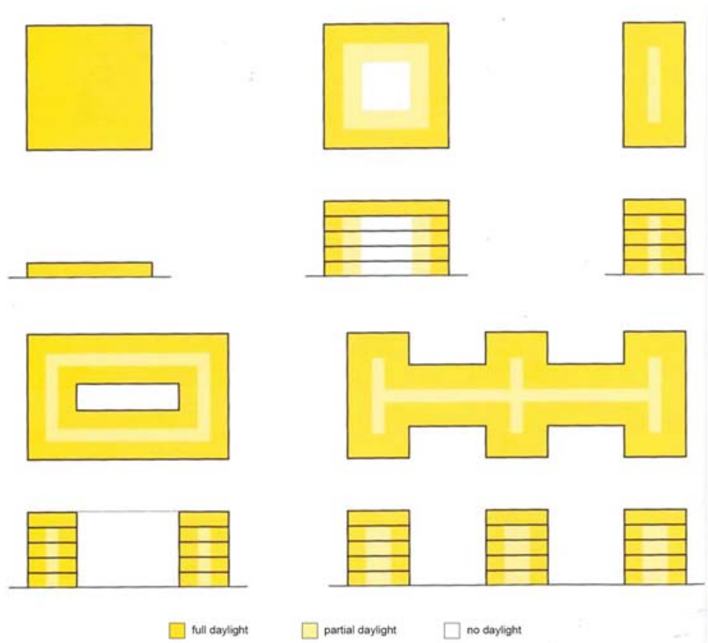
Light Reflectance

A technique used to extend natural daylight deeper into a space. This involves use of walls and vertical shelves that contain highly reflective material, can be as simple as white paint, that allows light to bounce from surface to surface.

Geometry

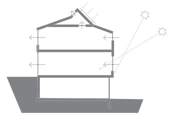
The massing of the building is key for efficiency. By allowing a longer thinner building mass, natural light is able to penetrate the building reducing the need for artificial lighting. Other building geometries such as a u-shape also allow natural light to reach all interior areas.

Figure 3.1



Cross And Stack Ventilation

A natural method of ventilation that is achieved through location of operable windows and openings throughout the building. Cross ventilation can be achieved by placing operable windows on opposite sides of the building, Allowing air to move through the space as natural pressures draw air out at one end and in through the other. Stack ventilation can be achieved by placing operable windows ant the lower and upper edge of a spaces, allowing cool air to be drawing into the space and warm air to be drawn out from the upper area where heat has risen over time.



Context

The surrounding infrastructure or lack there of around a building effects its energy usage. If the building is located within a city surrounding buildings can block sunlight from reaching into the space possibly hindering daylight capabilities as well as buildings creating a heat island effect requiring an adjustment for passive design methods. If there is no surrounding infrastructure and the building is surrounded by nature, allows for ample use of solar energy production, natural ventilation and views to nature.

Solar Heat Gain

To reduce solar heat gain, transmittance of heat from the sun through the exterior of the building both orientation and materials are involved. The most solar heat gain will be through the souther facade due to direct sunlight. Use of proper SHGC on windows based on the project location as well as proper insulation on the souther facade are important to reduce transmittance of solar heat into the building.

Site conditions

Depending on the location of the project, drought tolerant and native species are a great way to reduce energy through natural systems. Drought tolerant plants do not need extensive amounts of irrigation, they are able to strive off little water allowing for reduced means of irrigation. Native species are those which grow naturally in that local area. These species will also require less maintenance and irrigation allowing them to strive in the natural elements. Reducing irrigation and maintenance are easy ways to reduce energy consumption for a project.

Another option depending on the site location of the project is its ability to collect and recycle rain water or waste water. This is helpful for locations that both have scarce or ample amounts of water supply. Rain water can be used for irrigation as well as non potable uses within buildings.

Gardens

By providing a space to grow produce as well as other plant species is both great for the environment and increases the social aspect providing a place for occupants to relax and enjoy nature. Providing produce no mater the location of the project is an essential key in our society today. Local produce reduces the cost and energy for transportation of healthy foods.

Views

Connection to nature is a easy and effective way to provide comfort to occupants. Allowing a visual of the outside environment while within the building allows the occupants to stay connected with natural process of time. Being able to see and connect with the outside world provides a space for happier occupants and allows them to work more efficiently.

Reuse Of Material

Within adaptive reuse projects, reuse of material is a successful technique that benefits the environment. Materials can be reused for the same or new function than which they were originally used for. Through reuse we are maintaining the character of our history as well as reducing our impact on the environment through needs of new materials for construction.

Composition

Composition relates to the geometry of the building. Through forming and placement of uses withing the project efficiency can be achieved. Highly trafficked spaces should be located near the entry and on lower levels. Allowing daylight can reduce energy needs, correct use of fenestration on the building envelope can control the need for HVAC systems.

Historic / Original Style

The move to renovate an existing structure is a technique of passive design, using what is already available to us to utilize for future use. When renovating existing buildings a majority of these buildings have historic presence within the city but are not necessarily considered historic. These buildings create a strong presence within the city and should remain.

Building Interaction

Designing to allow occupants to interact with the building allows for a strong definition of place. People are able to feel a sense of pride and ownership of the spaces they inhabit through control of their environment as well as knowing and understanding how the building functions.

Diversity / Originality

A majority of older buildings are very diverse and unique, all the while other used buildings are very similar and are from a cookie cutter design. Through reuse of these spaces we can either maintain the diversity of the space or create diversity in the space by incorporating a new use. While reusing the space and maintaining parts of its original character while incorporating the new use allows occupants to connect to the building create a sense of place.

Holistic Design

Holistic design means to consider all aspects of the design and treat them as whole. All aspects of the building, HVAC, function, aesthetics, energy consumption, etc. are all interconnected and must be designed to work together. Correct sizing of fixtures and systems is essential when seeing efficiency as a whole for the building.

Performance

In order to create a healthier environment, building performance needs to be improved. Through use of passive design methods and seeing more efficient performance in buildings energy consumption can be reduced therefore reducing a buildings impact on the environment.

Natural And Recyclable Materials

Use of natural materials such as wood and stone not only reduce the energy required to produce the material but cause less harm to the environment at the end of their life cycle. Allowing these produces to be recycled easily and reused. Other materials that are manufactured are chemically bound and can not be recycled as well as cause harm to the environment when they are disposed due to their inability to decompose.

Internal Load Reduction Method

A major issue in existing building today is that they are using extreme amounts of energy. This is the number one issue of buildings in our environment today. Now that we know this it is essential that we reduce the amount of energy we consume. If we can lower energy usage we therefore can lower both CO2 emissions into our environment as well as reduce cost of energy in buildings. Being the most essential method we must implement, it helps that it is also the easiest to implement, to reduce loads within buildings.

Intent:

To reduce energy in buildings though use of efficient systems, passive design, updates to the building envelope, efficient appliances, and sensors. Reduction of building energy consumption reduces buildings environmental impact to CO2 contributions as well as allows minimal renewable energy to be provided on site.

Techniques:

Roof Top Light Monitors
Led Or Fluorescent Light Fixtures
Energy Efficient Appliances
Reuse Of Materials
Smart Controls
Maximize Daylight To Reduce Artificial Lighting
Duel Operation Outlets
Rain-Screens
Laptops Vs. Desktops
Eliminate Phantom Loads
Window Selection
Highly Insulated Building Envelope
Minimize Thermal Bridging
Double Envelope System
Radiant Heating
Heat Recovery Unit
Electric Panel System
Energy Management System
Ground Source Heat Pump
Efficient Systems (ERV & Indoor Air Handling Unit)
Solar Hot Water Heater

Techniques:

Roof Top Light Monitors

A roof top light monitor consists of a raised portion of the roof along its ridge to allow for windows to bring daylight into the center of a building. This is an great source to allow daylight to enter deep buildings or even to allow diffuse lighting throughout a space. This technique greatly reduces energy by reducing the need for artificial lighting.

Led Or Fluorescent Light Fixtures

A simple step to reducing energy is to replace light fixtures. Old light fixtures and bulbs are both inefficient and hazardous to the environment. Updating the light fixture along with the light bulbs will give the best results however you can also upgrade just the light bulbs and see energy reduction.

Energy Efficient Appliances

Appliances are another simple fix, while efficient appliances can be a bit costly, updating them can have a great savings on the energy consumption. Energy star certified appliances are a good start to selecting appliances to reduce energy in buildings.

Reuse Of Materials

An obvious technique to reducing energy is to reuse what we currently have. This comes in two ways, first through reuse of the building itself to reduce demolition, raw material and construction energy and second on a smaller level with saving or re-purposing materials for use on that project or others. Materials that can be reused are endless and this also plays into the creativity and uniqueness of adaptive reuse projects.

Smart Controls

There are various smart controls in buildings today to help manage mechanical and electrical systems such as thermostats, occupancy sensors, daylight sensors, carbon monoxide, etc. Thermostats are an efficient due to their ability to program the temperature for various times of the day, week and even year. This allows for the system to save energy by shutting down when its services are not need, such as at night or when you are out of town.

Occupancy sensors are another great control to have and are more common in commercial buildings. These sensors track motion for when a spaces is occupied. These sensors can be used to control artificial lighting and mechanical systems. Use of one in every room, can often save over 50% on energy bills.

Daylighting sensors are another essential control to have to reduce energy, similar to occupancy sensors, they control artificial lighting and shut it off when adequate daylight is provided or turn them on when natural lighting is low. Infrared sensor, humidity sensors and CO2 sensors are other sensors that can have a great impact to the efficiency of a building.

Maximize Daylight to Reduce Artificial Lighting

This is where passive design shows its effects, through the techniques stated earlier to achieve maximum daylighting as well as the rooftop light monitor technique, natural daylight reduces the need for artificial light. With this technique, task lighting is usually provided to allow specific occupants to add additional lighting if needed. Providing daylight with the option for task lighting is efficient and ideal for many office settings.

Dual Operation Outlets

A way to reduce plug load within the building is by installing dual operation outlets, meaning the outlets can shut off when the building is not in use. The outlets can be tied to the occupancy sensor so when the building and its appliances are not in use, the power is shut off to eliminate phantom plug loads, energy that is used even when we do not realize it.

Rain-Screens

Two functions can be served by incorporating rain screens into a design, first being that they use natural irrigation to water landscaping as well as the plantings on the rain screen itself reducing storm water runoff. The second function they serve is cooling the building and reducing heat island effect. By providing plantings the suns energy is used for them to grow instead of heating the glass or brick mass of the building.

Laptops Vs. Desktops

A technique that is overlooked is reducing the size of equipment that we use. A simple switch from desktops to laptops can save over 50% of energy consumption. While this technique depends on the use of the spaces it is an easy and effective energy saver. Specific uses such as architecture, engineering, Scientology, etc. that rely heavily on computer speed and processing are exceptions, but many other uses are able to reduce the size of computer needed.

Eliminate Phantom Loads

Phantom loads consist of energy that is being consumed while systems or appliances are not being used. Many appliances continue to use energy even while they are in sleep mode or even shut down. There is constantly energy running in the background and is raising those energy bills. Ways to eliminate phantom loads consist of unplugging certain appliances when not in use, use of dual outlets which shut off when spaces are unoccupied or use of a kill switch. A kill switch is basically a way to shut down the entire building systems so that all of those plugs loads that we are unaware of are eliminated when the switch (more like a push button) is used.

Figure 3.2

Window Selection

As discussed earlier window location is essential for passive design strategies, however it is directly related to energy reduction. The type of window used can also impact energy consumption, double pane windows with wood framing allow for minimal thermal bridging due to their insulation capabilities and the materials low conductive rates.

Highly Insulated Building Envelope

Proper insulation of the building envelope is essential to reduce energy. Heat loss is high among older buildings due to improper insulation and sealing of the building envelope. When renovating and existing building check all exterior walls for adequate insulation. Other areas to check is the roof, as warm air rises, and uninsulated roof can let heat rise right out of the building making the HVAC system work constantly to maintain a warm temperature.

Minimize Thermal Bridging

To reduce thermal bridging, use of non conductive materials is the easiest step. Materials such as wood, rubber and vinyl serve as good exterior materials as to not transfer heat or cold through the building.

Double Envelope System

A double envelop system is a newer technique that is used for buildings with majority of glass facades. This system allows for two layers of curtain wall with a one to two foot gap in-between. This gap allows for reduction of solar heat gain directly on the glass into the occupied space. The cavity in-between the curtain walls is used to place louvers as well as collects the warm or cold air to be reused where needed in the building. Double envelope systems can allow for operable windows allowing natural ventilation through the space.

Radiant Heating

Radiant heating is a good source of heat due to it radiating through the floor and naturally heat the spaces as heat rises. Geothermal heating is a great way to use the earths stored energy from underground. Radiant heating consists of pipes the run underground and connect to the building allowing that energy to run through the building slab transferring heat from the water flowing through the tubes to the thermal mass. Once a mass contains stored energy it slowly radiates that energy warming or cooling the space.

Heat Recovery Unit

A heat recovery unit allows for incoming and out going air to cross flow allowing outgoing warm air to precondition incoming cold air, as well as cool outgoing air to precondition warm incoming air. This allows for reduced energy needed to heat or cool air as it enters the building by reusing energy already produced.

Energy Management System

In order to control and maintain reduced energy consumption, awareness of how much energy is being used is essential. Through an energy management system, real time results of energy produced and consumed is tracked and displayed for the occupants. This allows people to see what their impact is and how to reduce energy when available. These systems also allow for people to learn how buildings function and aware of their impacts on the environment.

Ground Source Heat Pump

A ground source heat pump is used to pump water through underground tubing to provide energy for radiant heating. This pump can be ran off electricity allowing it to be powered by renewable energy.

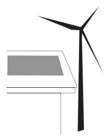
Efficient Systems (Energy Recovery Ventilators (ERV) & Indoor Air Handling Unit)

Similar to the heat recovery unit, an ERV and indoor air handling unit reuse waste energy and reuse it to allow for reduced energy loads to create warm and cool air for the building.

Solar Hot Water Heater

A solar hot water heater is similar to a normal hot water heather other than it is powered by a solar array. This allows for a major reduction in energy needed to heat water for the occupants.

Renewable Energy Method



Renewable energy is an essential method in seeking net zero reuse. While both passive design and internal load reduction make a great contribution to the energy consumption of buildings, in order to balance our on energy consumption we must produce as much energy as we are consuming. With out this method, one can not achieve net zero reuse.

Renewable energy is achieved through means of solar, wind, hydro and geothermal. These means use nature to create energy, natural sources which are unlimited. By using these methods instead of fossil fuels, we are no longer take resources from the earth at a faster pace than she can sustain, but we are utilizing unlimited resources and allowing for reduced energy costs.

Techniques:

Phovoltaics
Hot Water Photovoltaic System
Grid Connection
Solar Collector
Collection / Reuse of rainwater
BIPV (Building Integrated Photovoltaics
Skylights For Daylighting
Energy Management System

Techniques:

Photovoltaics

Photovoltaics are referenced to many different names, solar panels solar array, solar energy are to name a few. “Solar energy is the most abundant renewable resource, solar is available to some degree almost everywhere on the planet, and solar domestic hot water and photovoltaic (PV) systems are feasible options for local energy needs in most locations.” **3.2**

Photovoltaics are a form of technology that converts the suns energy into energy. While this technology is newer the cost has been high. However now that the technology is proven to work and methods of constructing and fabricating photovoltaics are well known, cost of photovoltaics have reduced. “The cost of all renewable energy sources including solar are decreasing as cheaper, more efficient technologies are being developed.” **3.3**

Solar energy is one of the easies and most common forms of renewable energy. Photovoltaic panels can be installed in almost any climatic location and be able to produce energy. However solar panels provide the best results when located in sunny climates and at the correct angle to achieve the maximum about of direct sunlight.

Hot Water Photovoltaic System

Another form of solar energy is though solar hot water heaters. These function similar to normal photovoltaics in that they use a solar array to produce energy to heat water for use by the occupants.

“Technological advances in PV, with associated rapid cost decreases, continue at an accelerating pace. By 2020 the US Department of Energy’s SunShot Initiative hopes to reduce PV costs to around $1 per watt, the equivalent of six cents per kilowatt-hour, which is lower than coal.” **3.4** As solar energy becomes cheaper, new systems become achievable.

3.2 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 10.

3.3 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 6.

3.4 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 10.

Grid Connection

With producing solar energy, a project can connect to the local grid when available. A grid is simply a system that connects multiple buildings onto a network. This network can control the amount of energy that goes in and out of all buildings. “The smart grid delivers power to individual addresses as well, allowing power to be turned on and off at every user location to control grid power loads.” **3.5**

The beauty of the grid is that when a building produces more or less energy than is required each month to achieve net zero energy, the building can use energy from the grid. While this is a good opportunity, the building must maintain producing more energy in the course of a year than it consumes to be considered net zero. The grid comes in handy for buildings during time of the year when sun is less prominent and allows the building to provide others with renewable energy when the building has produced more than is needed.

In other counties where the grid and buildings that incorporate renewable energy are more prominent, set a great example that we should learn from. “Experience in Europe indicates that it is likely that renewables provide up to 50 or 60 percent of the grid’s power, probably higher with a smart grid.” **3.6**

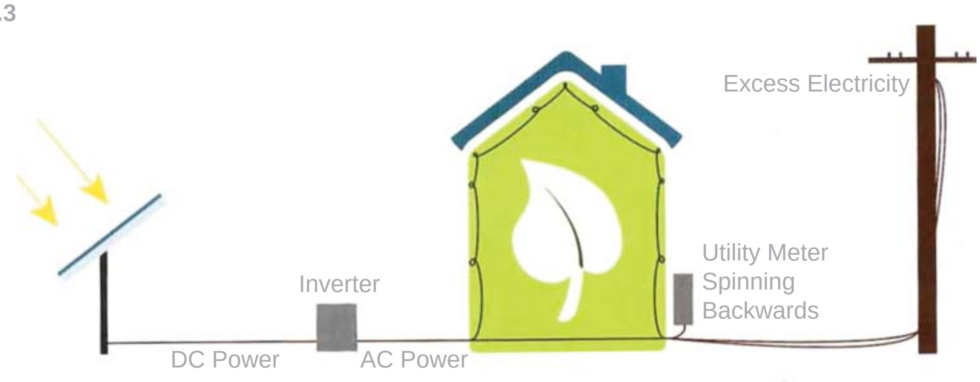
Through use of a grid, net metering is used to track the amount of energy that is going in and out of the building. “Net metering allows individual customers who generate their own power at their site, or on other sites within the same utility service area, to access power from the grid when they need it and sell their own power back to the grid, at the same price, earning a credit on their utility bill for the energy they produce.” **3.7**

3.5 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 14.

3.6 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 14.

3.7 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 14.

Figure 3.3



Solar Collector

A solar collector in another term for solar array. It is a series of Photovoltaic panels that are used to collect energy from the sun and produce energy.

Collection / Reuse of rainwater

Another form of resources that can be collected and rused. Rain water within cities usually gets passed into storm water systems due to the solid infrastructure implemented. Collection of that rainwater allows the resource to be used instead of being wasted down the street and becoming contaminated by chemicals in our streets and sweers. Rainwater can be used for both irrigation and toilets within the building.

Another form of reuse of water can be done thorough waste water, toilet water can be reused thorugh the process of a living machine. A living machine collects both waste water and rainwater and uses natural plants to cleanse the water and use for toilet water withing buildings.

Figure 3.4

LEGEND
1 odor - scrubbing biofilter
2 closed - aerobic reactor
3 open-top, aerobic Eco-Machine cells
4 vertical, upflow constructed wetland
5 collection sump for purified water

BIPV (Building Integrated Photovoltaics

This is another form of using photovoltaics other than the standard array system as already discussed. This technique allows for photovoltaics to be incorporated directly into building products, such as roof panels, siding, signs, etc, to help gain solar energy. These surfaces are are exposed to the sun on a continuous basis and are able to gain energy since they have prime real estate.

While these methods do cost a bit more due to manufacturing and change in production process, they are a great source in order to achieve renewable energy. New technology is being produced daily and new foms of collecting solar energy are being developed. Investment in this technique is valuable because it produces a great return for the amount invested. BIPV makes sense and is a leading technique for renewable energy.

Skylights For Daylighting

Skylights are another way for natural sunlight to enter the building. Daylighting is another form of renewable energy in that it provides lighting needs within buildings without cost. Skylights allow diffuse lighting to enter deep into the building. Skylights are ideal for buildings with larger footprints where windows along the facades do not provide adequate lighting.

Energy Management System

An energy management system is a computer program that is connected to the buildings energy usage. This system records the amount of energy that is consumed within the building. This system records and tracks usage patterns to allows occupants to view the consumption within the building.

Energy management can also allow occupants to engage with the building. Specific systems can use lighting throughout the building to signal users when there are ideal conditions to open the building for natural ventilation.

When occupants can visually see the impact they are having within a building they are able to adjust their methods and become aware of how to reduce their energy usage. High electricity usage could signal users to turn off the lights when they are not needed, or shutting down their computer as they leave for the day.

Overall energy management systems are key in achieving reduced energy with a building. The ability to learn from the building as well as see how a buildings energy functions allows people to engage and participate in reducing energy consumption.

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4. Case Studies

Summary

This chapter provides analysis on eight case studies. These eight case studies were selected due to their location within the United States. As discussed in the first chapter, the United states is behind the curb on designing for net zero energy. By focusing on projects here in the states, we are able to see what is achievable and successful in our country and how to learn from them as an example. Local exemplars are easier to understand and grasp than what is currently being done in other countries.

Each of these case studies are analyzed based on the three design methods discussed in the previous chapter; Passive Design, Internal Load Reduction and Renewable Energy. The cases will state what was implemented in each method to aid in its success to achieve net zero through/or adaptive reuse. These cases bring a diverse look at how one can achieve true sustainability.

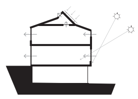
Figure 4.1

1 Mission Zero House - Ann Arbor, MI
2 Zero Cottage - San Francisco, CA
3 Willowborrk House - Austin, TX
4 Hood River Middle School Music & Science Building - Hood River, OR
5 IDeAs Z2 Design Facility - San Jose, CA
6 DPR Construction Regional Office - Phoenix, AZ
7 FSU / Kendall College of Art & Design - Grand Rapids, MI
8 David & Lucile Packard Foundation Headquarters - Los Altos, CA

Case Study Overview

Within each case study, the list of methods below were used as parameters to gather data for successful techniques on how to implement each method. The list of methods is based off those stated earlier in chapter three. Each case will discuss the techniques based on passive design, internal load reduction, and renewable energy. Three of the case studies will focus on areas of environmental, social and economic impacts.

Passive Design



Operable Windows
Daylight
Roof Overhang
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Solar Heat Gain
Reuse Of Material
Historic / Original Style
Building Interaction
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Views
Placement Of Windows
Solar Orientation
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Aesthetics
Composition
Contrast
Diversity / Originality
Performance
Gardens

Internal Load Reduction

Roof Top Light Monitors
Led Or Fluorescent Light Fixtures
Energy Efficient Appliances
Efficient Systems (ERV And Indoor Air Handling Unit)
Smart Controls
Maximize Daylight To Reduce Artificial Lighting
Duel Operation Outlets
Reuse Of Materials
Laptops Vs. Desktops
Eliminate Phantom Loads
Window Selection
Highly Insulated Building Envelope
Minimize Thermal Bridging
Double Envelope System
Radiant Heating
Heat Recovery Unit
Electric Panel System
Energy Management System
Ground Source Heat Pump
Solar Hot Water Heater
Rain-Screens

Renewable Energy

Phovoltaics
Hot Water Photovoltaic System
Grid Connection
Solar Collector
BIPV (Building Integrated Photovoltaics)
Skylights For Daylighting
Energy Management System

Figure 4.2

Case Study 1

Mission Zero House

Ann Arbor, MI

Net Zero Reuse
House: 1500 SF living space (870 sf building footprint)
Single Family Residential
Reuse / Revitalization of Existing Structure
7 years from start of construction to occupancy

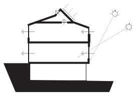
For more information see: http://living-future.org/case-study/missionzero

Process:

Goal of the project was to restore a neglected old home and preserve the heritage, story of place and the beauty of the home without expanding its footprint.

Strategies:

Passive Design



Seeking great meaning in the popular “the greenest building is the one that already exists”, the owner was seeking to achieve the highest standards of energy efficiency from an existing building. When the owner was selecting this home, he was thinking about its historic character and the fact that it did not look like a typical green building. This home is over 100 years old and is on the Ann Arbor National Registrar of Historic Places. The building contains a small narrow footprint, allowing for a compact design and daylight to penetrate the building.

The orientation for the building was ideal, the pitched roof now has solar panel arrays at an optimal angle. The south facade also contained operable windows on both upper levels as well as the basement to allow for maximum daylighting. Updated windows throughout the structure prevent solar heat gain and aids to the natural passive stack ventilation.

Figure 4.3

Figure 4.4

Internal Load Reduction

Replacement of weather stripping and hardware of the original single pane windows greatly effected the energy savings for this home. Another are of the home that was extremely in efficient was the exterior walls and the attic. The exterior walls were opened and blown in with R-13 dense-pack blown cellulose insulation. The attic was updated from being an uninsulated space to achieve a rating of R-29. A energy recovery ventilator was also used in this project.

Renewable Energy

The roof contains a 8.1kW solar panel array system that provides more energy than the house consumes. This array consists of thirty-six panels spanning from edge to edge of the south sloped roof. These panels needed to be flush to the roof so as to not diminish or destroy the historic character of the home. The design also consisted of taking up the entire roof surface for visual needs, providing more energy being generated than the project needed. Due to the strict historic preservation requirements, the renovation did not alter any of the structure or interior wall layout of the home.

Figure 4.5

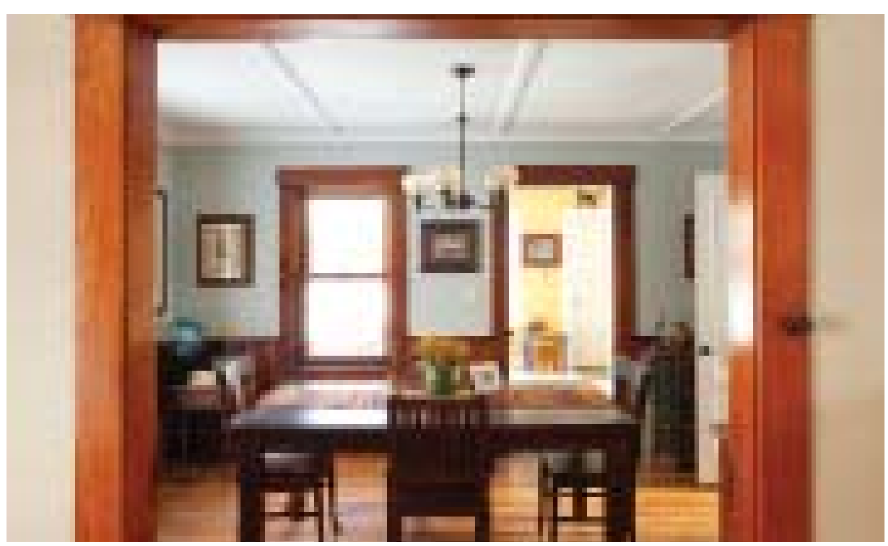


Figure 4.6

Case Study 2

Zero Cottage

San Francisco, CA

Net Zero Reuse
Townhouse: 710 SF, Workshop: 430 SF
Mixed Use
Urban Infill, Previously Developed
20 Month Renovation

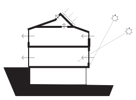
For more information see: http://living-future.org/case-study/zero-cottage

Process:

Through refinement and continuous improvements throughout the design and construction phase, they were able to achieve baseline net zero energy and succeed to net positive energy.

Strategies:

Passive Design



This project used the Passive House Standard as a basis of energy design. One of the major techniques this project implemented in order to achieve success included upgrading to windows with a higher solar heat gain coefficient (SHGC) to reduce heat gain during the warmer months. Another advantage to updating all of the windows allowed for operable windows to allow comfort control by the occupant. Varying window location also allowed for framed views of nature as well as privacy.

Due to the restricted site area and tree canopy, a green roof and solar panel array's occupy the building's roof surface. Due to close adjacent buildings, the minimal space left available on the roof was used to bring in daylight. Window locations along the exterior walls also varied due to the adjacent buildings and site conditions allowed for disbursed daylighting.

The location of the project is also another important aspect to its success, this project utilized existing historic character and walkability to other buildings. The existing three story sapce allowed for flexibility with multi-level spaces and existing material allowed for contrast between new and reused materials. Parts of the existing building that could not be spared for their original use were re-purposed for new uses, such as old building framework was used as cabinetry and the exterior metal shingles were cut from scrap materials.

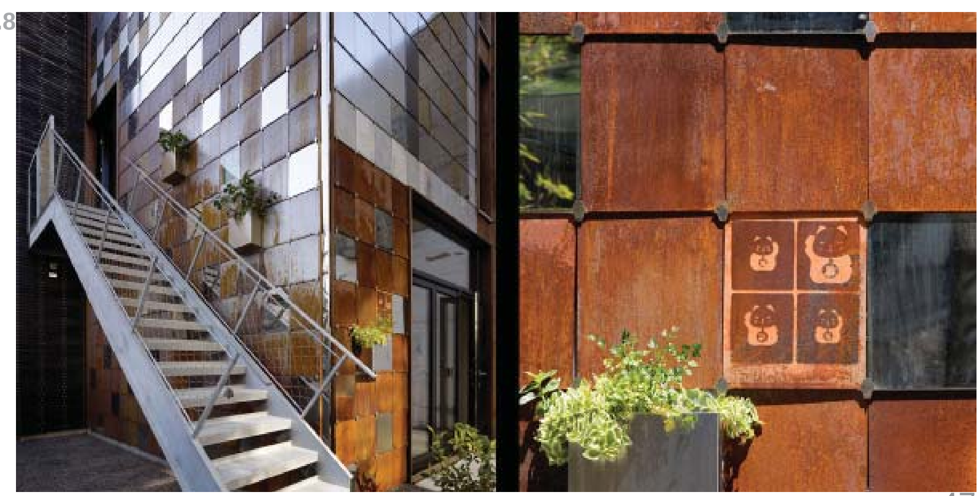
Figure 4.7


Internal Load Reduction ↓

Due to maximum use of daylight, artificial lighting was significantly reduced. The project also uses light monitors and dimming options for all light fixtures allowing for control of when artificial light is actually needed. By using efficient systems that run off electricity instead of gas, less energy is used and can be generated by renewable energy. Another easy plug load reduction this project applied is energy efficient appliances. Older appliances can use large amounts of energy because of inefficient designs, new appliances alone could save tremendously on energy bills.

In larger contributions, the mechanical and electrical systems use such as whole house ventilation systems with heat recovery units, which are 92% efficient, and light monitoring systems made a greater impact to this projects success. Use of a solar water heater combined thermal collection and storage in a single roof-mounted unit. They combined this with a tank-less water heater to ensure how water needs are met for the residence.

This project also incorporated a few innovative energy optimizations, a rain-screen system constructed of primarily reused materials covers the exterior walls and allows for plant boxes to be mounted onto the walls. The other by using reclaimed maple flooring material that is more durable and requires less maintenance than new wood flooring used today.

Figure 4.8


Renewable Energy

Renewable energy on this project is achieved through solar panel arrays and a solar hot water PV system located on the roof. Due to minimal roof space, the project design incorporated a cantilevered solar photovoltaic (PV) panel array in order to produce enough energy to cover the buildings consumption demands. Not only does this 3kW solar array meet the buildings energy needs, it provides 22 % more energy than consumed by the building, making it exceed net zero energy and progress to achieve net positive energy. This PV system contains a high efficiency inverter and does not require a fan, further improving its performance.

Another key to this building achieving net zero energy through adaptive reuse, is its energy management system. This allows the occupants of the building to see the direct impacts of energy usage and how to change their methods based on the real time energy consumption results.

Figure 4.9

Figure 4.10

Figure 4.11

Case Study 3

Willowbrook House

Austin, TX

Net Zero Reuse
House 2,100 SF
Residential
Previously developed site with existing building.
5 Month Renovation

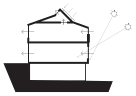
For more information see: http://living-future.org/case-study/willowbrook-house

Process:

Through renovation, the family wanted to change their lifestyle, they were dedicated to living healthier for the environment. Their goal was to achieve net zero energy and greatly reduce their water use.

Strategies:

Passive Design

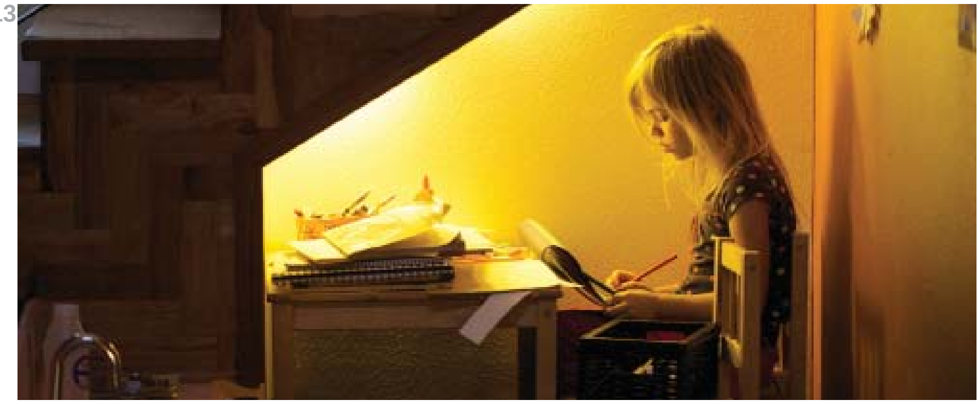


When selecting the home, the owner evaluated the established neighborhood as well as the character of the area. The home itself was at an ideal solar orientation, already had well designed overhangs, and thermal mass. Thermal mass being the concrete slab and its exposure to the exterior elements, in the summer months, the sun shades the slab keeping it cool, and allows sun during the winter months to allow the slab to store heat keeping the home warmer. Depending on the orientation of the house, different Low-E coated windows were selected.

The home was originally built 1948 post-war, the materials in this home consist of what was locally available at the time. The flooring was made from old warehouse flooring that was then sanded down to show its character.

Figure 4.12

Figure 4.13



Internal Load Reduction

The existing building had very poor performance, the exterior envelope consisted of a concrete block with no insulation, single pane steel frame windows, minimal insulation in the attic, poor duct work and placement, and outdated and inefficient systems. By analyzing these elements of the home they were able to detect poor condition and get an understanding for what renovation was needed. The exterior wall now consisting of the original concrete block (R-18), open cell spray foam (R-12.6), and SIP R-panels that function as a weather barrier (R-3.3) and then laminated the interior to breat the thermal bridge of the wood studs. This now gives the exterior wall a R-value of R-33.9. Also utilizing the existing thermal mass.

New systems were also updated including the fan, EFV and indoor air handling unit. Variable speed systems are ideal for the hot humid climate. While updating the systems, the house was reconfigured allowing the location of systems to be properly located for efficiency.

Renewable Energy

Atop the roof sits two solar hot water panels as well as the 4.5 kW solar panel array. The gas lines to the house were disconnected allowing for all electric systems to run off the renewable energy. As for the family living healthier and reducing their water use, a energy management system is located in the house tracking real time energy and water usage.

Figure 4.14

Figure 4.15

Case Study 4

Hood River Middle School

Hood River, OR

Net Zero Energy
42,754 SF
K-12 Education
Greyfield, site previously used by the school.
16 Month Renovation

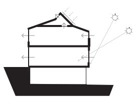
For more information see: http://living-future.org/case-study/hrmsmusicandsciencebuilding

Process:

The Hood River Middle School Music and Science building was designed around the principles of Permaculture, meaning the design was guided by 12 universal design principles ensuring that they were used ethically and appropriately in regards of the environment.

Strategies:

Passive Design



This buildings is naturally ventilated through use of varying heights of clear story windows along with rooftop ventilators that create cross and stack ventilation. There are lights located around the building to let occupants know when the outdoor air is adequate to open windows.

Ground source heating system is located just 10 feet under ground and is horizontally looped adjacent to the soccer fields allowing for a warming function for the water heater pumps that radiantly heat and cool the building slabs. The water is used by a nearby stream and pumped through the tubes in the slabs to cool the space during summer months and is then returned to the stream.

Figure 4.16

Figure 4.17

Permaculture, a creative design process based on building an understanding of the connection in all ecosystems and how humans can work with nature rather than against it. The goals of this project allowed for preservation of 21,000 sf of open site that consisted of native and instructional plants that need very little water. The building also contains greenhouses that further the ability for students to learn from the school's example.

On the interior of the building, maximum daylight is achieved and further enhanced through warm natural materials and colors to brighten up the space and increase personal comfort. Design techniques allow for seasonal shading and warming to aid in the buildings thermal comfort.

Internal Load Reduction ↓

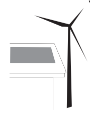
Due to large amount of daylight, occupancy sensors reduce the use of artificial lighting when not needed. All switches and outlets in the building are duel operation, meaning that the outlets can shut off when the building is not in use, which is determined by the occupancy sensor. There are also CO2 sensors that regulate the amount of fresh air intake.

Figure 4.18

Another major way this project reduced its energy comsumption is by energy smart appliances. For this project those appliances consisted of laptops instead of desktops. A laptop uses 1/3 the amount of energy a desktop uses, and depending on what those devices are used for, many times a laptop is easier and more convenient as it was for this school.

The school wanted to emphasize on the building being a tool to teach the students by incorporating a living machine in one of the greenhouses. This living machine recycles wastewater and reuses it for irrigation purposes. A living machine is a natural way to purify waste water though a series of cleaning stations that contain plants and other natural purifiers.

Renewable Energy



To meet the larger energy needs of the school, a 35kW photovoltaic array is mounted on the south facing roofs of the building and a few more that are mounted horizontally at the base of the roof. Another advantage of solar energy is to connect the solar array system to the grid to allow any energy that is produced over the amount consumed by the school can be offered to others that are connected to the grid. Through the use of net metering, the amount of energy that is added to the grid, or that is taken from the grid (if the building did not produce as much as it consumed it can also take energy from the grid that was generated by other renewable sources), is tracked and the owner of the building will be charged or more commonly refunded for that amount of energy.

Figure 4.19

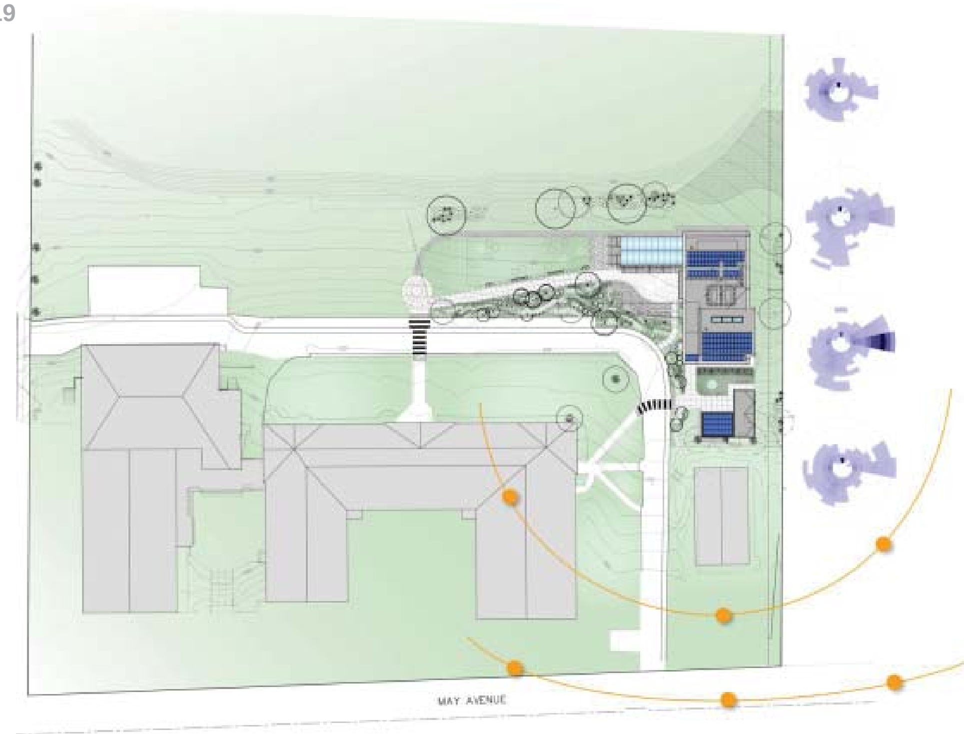


Figure 4.20

Case Study 5

IDeAs Z2 Design Facility

San Jose, CA

Net Zero Reuse
7,200 SF
Office
Renovation of an existing building
10 Month Construction

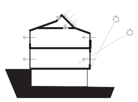
For more information see: http://living-future.org/case-study/ideasz2

Process:

IDeAs Z2 design facility was achieved through the integrated design approach. This approach focuses on all professionals associated with designing, building and occupying the building working collaboratively from the beginning to the end of the process. This office was one of the first to receive the Living Future Institutes's Net Zero Energy Building Certification and has set the bar for cutting edge design.

Strategies:

Passive Design



As like many other successful net zero energy projects, daylighting was a key strategy in achieving a comfortable and efficient space. By using oversized skylights daylight is disbursed throughout the building throughout the entire day. On the east facade, where the morning sun shines through contains an electro-chromatic glass system to disburse the daylight in the morning hours.

Operable windows and doors are used throughout the building to allow occupants to control their thermal comfort and allow fresh air into the building. The existing building was windowless, so through renovating the building both daylighting and the aesthetic qualities were enhanced. The windows expand higher along the wall to allow for views of the landscape for a more natural and joyful visual experience. Light also comes in though the skylights and casts a shadow on the wall allowing occupants to sense the passing of time and enjoy a beautiful light display.

The site incorporates native vegetation which captures most of the sites water rather than entering the storm drains. The site also uses gravel and stone as previous paving to allow rainwater to penetrate the surface and reduce rainwater runoff.

Figure 4.21

Internal Load Reduction

↓

The electro-chromatic glass system on the east wall not only controls the daylight into the space but also the heat that is transmitted. Due to having skylights on the project that no matter how advanced the glazing is always computerizes thermal insulation, use of high efficient ceiling insulation is used to help offset the drawback.

Daylighting and occupancy sensors are incorporated in the building to allow for efficient use of both the lights and temperature of the space. A step further from daylight and sensors, this project upgrade its lighting fixtures to T8 Fluorescent lamp fixtures. Fluorescent bulbs are more efficient by using less energy and producing less radiant heat while providing a bright and natural light.

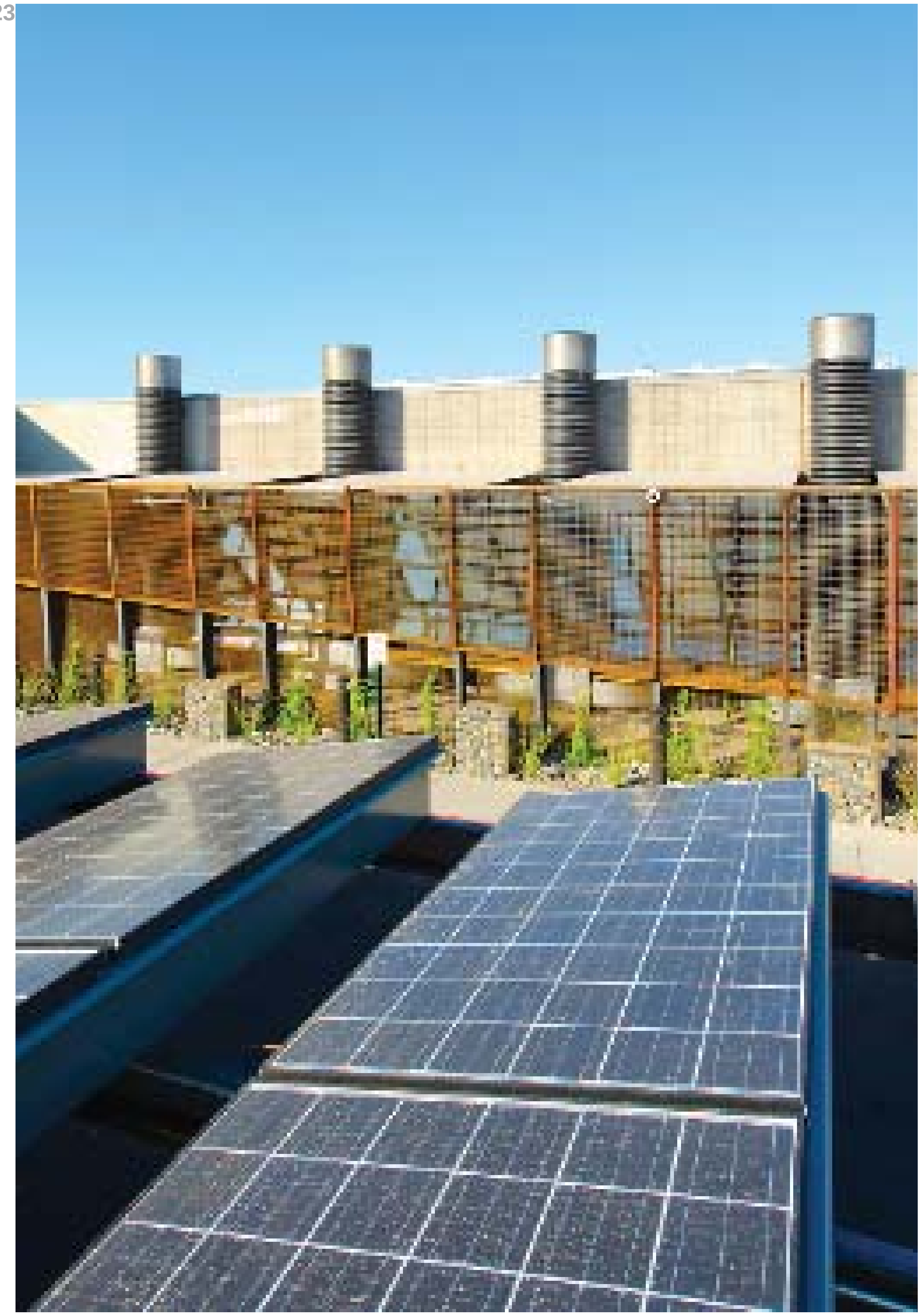
Incorporating energy efficient systems is necessary to achieve successful net zero status, this project uses radiant heating and cooling, ground source heat pump, and Building Integrated Photovoltaics (BIPV). The radiant heating uses less energy for the same amount of conditioning as a forced air system and the ground source heat pump both chills and heats water with very low energy use.

Renewable Energy

BIPV's are a new form of technology that as PV's become more popular and technology increases, PV's are able to be incorporated into everyday building products. This project uses the BIPV's in single ply PVC white waterproof roofing membrane with solar cells incorporated in the material.

Figure 4.22

Figure 4.23



Case Study 6

DPR Construction Regional Office

Phoenix, AZ

Net Zero Reuse
16,500 SF
Office
Renovation of an existing building
5 Month Renovation

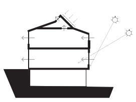
For more information see: http://living-future.org/case-study/dpr-phoenix

Process:

DPR Construction's new office was a renovation of a previously developed site. The existing building was a windowless bookstore and has now been revitalized to a new cutting edge design that expresses the company's core values: integrity, enjoyment, uniqueness, and ever forward.

Strategies:

Passive Design



An 87 foot Zinc clad Solar Chimney serves as the main design feature for the new use. It functions by capturing hot air rising in the office and letting it escape through operable louvers in the chimney to the outside which encourages a breeze across the workstations in the office as fresh air is drawn in through the buildings 87 operable windows. These new windows also allow for maximum daylighting along with the skylights that are scattered throughout the building.

This design technique allows occupants to connect to nature by observing the movement of the sun throughout the day, as well as reduce energy. Through the use of all the windows in the building, 100% of the lighting needs in the space are met by daylight (even closed wall rooms), reducing or even eliminating the need for artificial lighting. Natural lighting is the most significant energy saver and favorite feature considered by the occupants.

For passive cooling, the offices installed a Fan from Big Ass Fans which is located in open areas and are on during the summer nights to cause air movement and allow for thermal comfort during the day. The orientation of the building in relation to its context allows the building to achieve a desired energy efficiency level.

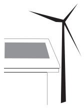
Figure 4.24

Internal Load Reduction

The existing structure was well constructed and was in good condition allowing for minimal updates necessary for efficiency of the building itself. The exterior walls is highly insulated masonry and areas were removed to allow for windows to bring in daylight. Minimal weather proofing was needed to seal the openings that were created.

The company was very aware of phantom loads that existed in buildings, in order to prevent this from happening in their office, they installed a kill switch, or as they call it, a vampire switch. When pushed (usually at the end of the day), this switch will shut off any non-critical plug loads that are still running unnoticed by many individuals. The results of this switch resulted in 37% reduction of the office's plug load energy.

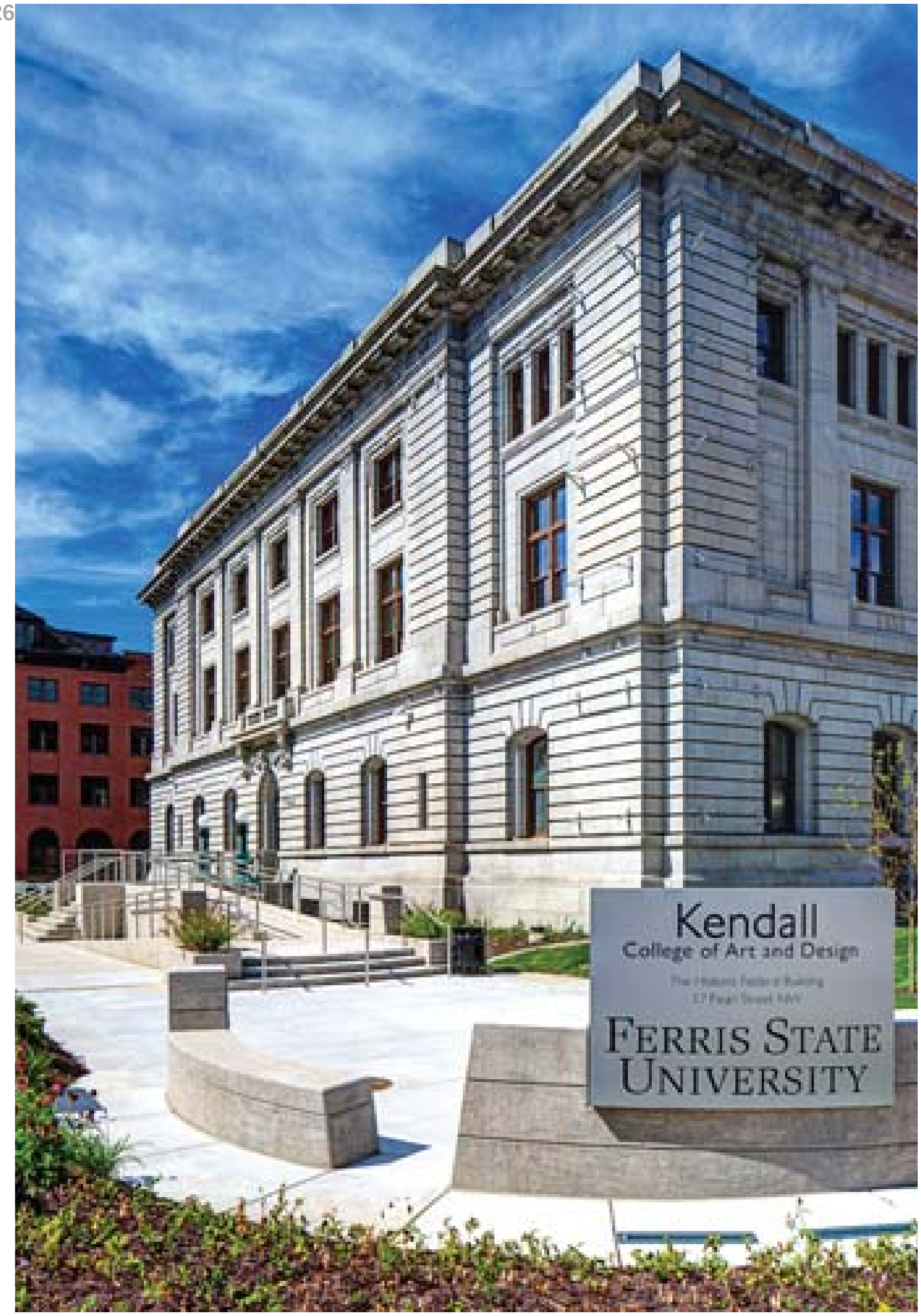
Renewable Energy



A 79kW photovoltaic array is mounted on the adjacent parking lot's canopy and produces the buildings energy on site. The panels are mounted at a 10 degree tilt which is optimal for the location of this project in relation to the sun. The use of the parking canopy provides shade for the vehicles while allowing energy to be created from the sun. This also advantaged the project by freeing up the roof of the building itself to allow for maximum skylights. This array is tied to the grid allowing for net metering. The net metering and energy usage is tracked on the Lucid Building Dashboard displayed on a monitor within the office. This allows the occupants and its clients real time energy production and usage.

Figure 4.25

Figure 4.26



Case Study 7

FSU / Kendall College of Art & Design

Grand Rapids, MI

Adaptive Reuse
92,000 SF
Higher Education / University
Renovation of an existing building

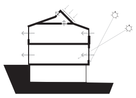
For more information see: http://towerpinkster.com/files/docs/reports/FSU_Kendall_College_of_Art_and_Design.pdf

Process:

The owner of this building was well aware of the historic quality of the building an sought to preserve its character and achieve LEED Gold while doing so.

Strategies:

Passive Design



The original design of this building was done in 1909. The building was originally the Grand rapids Federal Post office and Courts. Due to its age, the building contained design techniques that were ideal for passive design. There was maximum window fenestration on the souther facade allowing for both daylight to enter the building as well as views out to the heart of downtown Grand Rapids. The building also contained skylights along the upper most level that were covered, through the renovation, have sense been uncovered and allow beautiful daylight into the building.

With 91% of the material on this project being reused or recycled, there is a great sense of history and character that adds value to the project.

Figure 4.27

Figure 4.28

In regards to the urban site, through the use of natural vegetation and a rain storage system, 50% less irrigation is required due to reuse of rainwater.

Due to the flexibility of the design and opening up of spaces within the building, the project provides multi-use gathering spaces for both education ans well as professional with local firms.

Internal Load Reduction

Not only is irrigation reduced by 50%, the project has also been able to reduce their use of potable water & sewer usage through water efficient plumbing fixtures by 33%. This allowed the project to reduce as much water usage as possible.

Through preservation and renovation of the building, the design resulted in 17% less energy usage. This is possible through the extensive use of daylighting and efficient systems and appliances throughout the building allowing to reduce the plug loads. Due to building serving educational needs, allowing for a laptop friendly area also helped reduce plug loads.

Figure 4.29

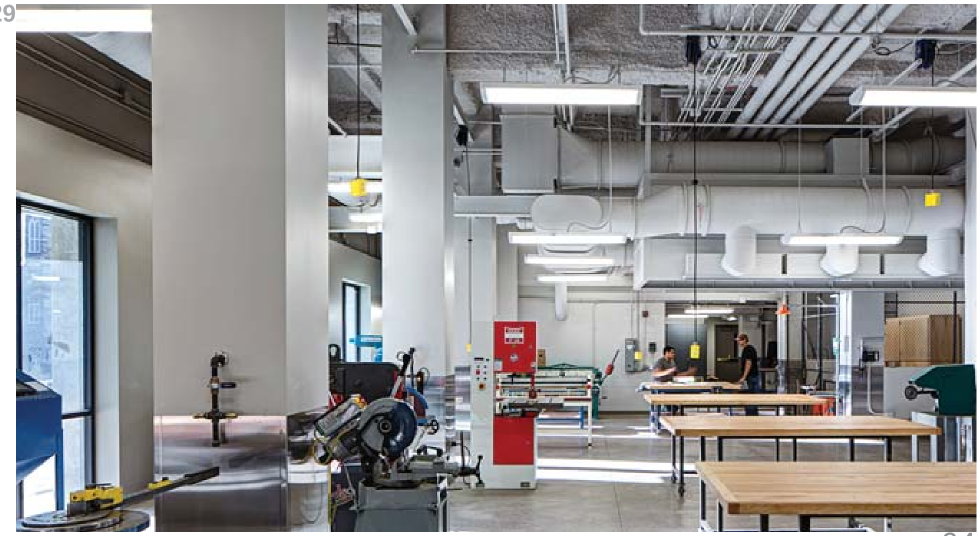


Figure 4.30

Renewable Energy

While this project did not incorporate any renewable energy strategies, the reuse of the existing building and materials impacted the buildings construction costs. During construction, 91% of all construction waste was reclaimed, recycled and used throughout the project. The recycled materials used on the project consisted of 24% of the total cost of materials for this project, a great energy saver.

Figure 4.31

Figure 4.32

Case Study 8

David & Lucile Packard Foundation

Los Altos, CA

Net Zero Energy
50,956 sf
Office Headquarters
Previously developed site
3 Year Construction

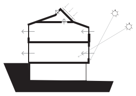
For more information see: http://living-future.org/case-study/packardfoundation

Process:

This project achieved LEED Platinum through passive and bioclamatic design strategies. This fits well withing the company goal of conserving and restoring the earth's natural systems. Though their headquarters building, they are demonstrating how an organization can make a difference.

Strategies:

Passive Design



This building is located on a previously developed site allowing for a lower impact on the environment. The building itself consists of two long narrow stretches allowing for daylight to penetrate the space. As a result of the building fenestration, orientation and shape, 30% of the energy was reduced due to availability of daylight rather than artificial lighting. The design was able to incorporate light shelves to allow the natural daylight to penetrate further into the space. Light shelves reflect natural light off the ceiling in order to diffuse the light through the space.

All windows and doors are operable and serve as natural ventilation for the space during ideal climatic conditions. The building utilizes a dashboard that tells the occupants when to utilize natural ventilation.

Figure 4.33

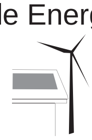
Figure 4.34


Internal Load Reduction

Through the use of the dashboard, the building can reduce its energy usage by not needing to run mechanicals systems when outdoor contritions are ideal. Other ways this project reduced its energy consumption was by upgrading to energy efficient T-8 fluorescent bulbs, LED task lighting, and occupancy sensors that turn off lights and put computers to sleep when the space is unoccupied.

A programmable thermostat controls the temperature throughout the day and the seasons. The building is set to a target temperature of 74 degrees Fahrenheit and is controlled by occupancy to take in consideration the buildings systems and appliances that give off heath throughout the day.

Renewable Energy



The building itself is not oriented ideally for solar collection, its panels face southwest / northeast and north. The production on these orientations is from 3-7% lower than southern orientation. Solar panels were mounted on the roof of the building as well as the parking lot area in order to produce enough energy that was estimated for he building.

Roof mounted PV panels produce 285kW to supply the building's energy consumption needs. By allowing for maximum daylight, operable windows help to control thermal comfort. Updated appliances and systems allow for the building to track their energy usage through energy monitoring.

Figure 4.35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5. Guidelines

Summary

While the techniques and case studies are helpful to guide someone with achieving net zero reuse, a formal set of guidelines will provide a structured system to follow.

A guidelines is a statement by which to determine a course of action. A guideline aims to streamline a particular process according to a set routine or sound practice. By definition, following a guideline is never mandatory. Guidelines are not binding and are not enforced. While what a guideline is can be defined, how do we define what makes a successful guideline?

Variables

Through research of existing guidelines and written documents, the following qualities were extracted. These qualities are proven successful and are common between multiple guidelines in our profession today.

The initial organization of guidelines should consist of the following:

Create a brief outline.
State clearly what should / should not be done.
Explain how to correct an action.
Include terms and provide definitions.
Specify any time constrains.

A general note to understand about guidelines is that the majority of readers will not read off the guidelines directly, they will use them as a reference and for understanding.

Once you have a layout framework for the guidelines, the next step is to write the guidelines. While writing, it is essential to write for the user / audience of the guidelines. A few key techniques when writing guidelines for the user consist of the following:

Make sure information is helpful
Be specific
Provide encouragement
Anticipate problems
Summarize
Review / Test to make sure they make sense
Provide overview / give context
State all things that are needed to achieve this (limit to each category,
    ex: green roof, rainwater collection, etc.)
Diagrams are good
Create breaks, allow people to track their progress
Small units are more successful, (break guidelines into categories, to
    achieve this: ex. Green roof, follow these guidelines)
Provide "landmarks" to allow reader to know if they are on the right track.
Landmarks could also be warnings
Use words like: "should" and "may", NOT "shall", "will", or "must".
Specify any legal requirements (requirements based on code, city
    ordinances, zoning, safety, etc.)

Getting Started

First thing first, the commitment to design a sustainable project. This initial decision is what gets you on the path to a healthier environment and a more enjoyable and successful design.

The next step is selecting the project. There are a few things that you need to keep in mind when you are looking for your net zero reuse project. This step may not be black and white, there are many different existing conditions and each project is unique. You will first want to make sure the building is not a historical building, if it is you will need to select another building. The next question you need to determine is if the project will be feasible. To answer the following list of questions, research social and economic trends in the specific location of the building in question. Below is a set of questions that you will want to ask yourself and look out for as you are determining whether the building is feasible or not.

1. Is there insufficient insulation? Or is the insulation poorly installed?
2. Is the HVAC system too large or too small?
3. Is the Duct work too large? Is it too small? Is it poorly installed?
4. Is there a thermostat control? Is it programed properly? Are there thermostats in each individual room?
5. Are the windows efficient? Is the R-Value below an R-8? Do the win dows have the correct SHGC depending on where they are located on the building?
6. Are there exterior windows shades or louvers on sunny windows?
7. Is fresh outside air managed / easily accessible?
8. Are the appliances inefficient? (Oven, refrigerator, dishwasher, washer, dryer, faucets, toilets, showers, etc.)
9. What type of light bulbs are there? Incandescent and Fluorescent are inefficient and should be replaces.
10. Are there any occupancy or daylight sensors?
11. Is energy consumption feedback provided?
12. Are there controls provided for users to control local heating / cooling?
13. Is the house oriented to maximize passive or solar resources?
14. Location of the building, is it located near public transit?
15. Is there market demand in this area for a renovated existing building?
16. Can the existing building be modified to meet market demand?
17. Is the potential use in that building going to meet market demand?
18. Is this building size and location efficient for the proposed use?

Depending on your results to the questions above, you will need to make the decision on whether you want to proceed or not. There may be multiple yes answers however some projects may be more extensive than others and will cost more than they need to. You want to make sure that the structure of the building is in good shape and that there are no major concerns there. Structural issues can get costly, but are still possible. If you determine that the building will be a feasible project for your situation, then proceed with purchasing the building. If you determine you will not proceed with the building, return to the initial step and start searching for another building.

Once you have selected your project you go further into analyzing the project. This is when you need to document the current issues with the building determined form the questions listed above. All issues and benefits need to be documented so you may step back and look at what you have to work with.

One of the first main steps is to make a plan. A plan should consist of finalizing the analysis of the building, determining what design process you will use, determine what aspects of the project have a greater priority. This plan should incorporate the following guidelines to help achieve successful status of net zero reuse.

Guidelines

Passive Design Overview

Passive design is a necessary technique in order to achieve net zero reuse. While there are many ways to successfully implement passive design, this section will outline some of the most common techniques.

As indicated in the previous chapters, passive design employs the buildings geometry, orientation and mass to condition the structure using natural and climatologic features such as the sites solar insolation, thermal chimney effects, prevailing winds, local topography, microclimate and landscaping. The guidelines are extracted and derived from the case studies and research that is presented in earlier chapters of this book.

Figure 5.1

Passive Design Strategies

Yes	N/A	No	Req.		
0	0	0	9		**Building Selection**
				Net Zero / Ad. Re.	Selection of building based off context, allows for walkability/public transportation.
			x	Net Zero / Ad. Re.	Selection of building based off ideal climate for solar energy and natural ventilation.
			x	Net Zero / Ad. Re.	Selection of building based off ideal market demands, allowing economic support.
			x	Net Zero / Ad. Re.	Building selection is reusing an existing structure and site, rather than a greenfield.
			x	Net Zero / Ad. Re.	Building is in fair condition, allowing materials and structure to be salvaged/reused.
			x	Net Zero / Ad. Re.	Use of drought tolerant / native species for landscaping.
			x	Net Zero / Ad. Re.	Building orientation allows for maximum daylight and natural ventilation.
				Net Zero / Ad. Re.	Building massed efficiently for mechanicals systems and provides thermal storage.
				Net Zero / Ad. Re.	Building mass allows for maximum amount of daylighting to reach interior spaces.
					Building Renovation
				Net Zero	Design based on climatic location.
				Net Zero / Ad. Re.	Evaluation of current building conditions: structure, insulation, efficient systems.
				Adaptive Reuse	Update structure as needed, maintaining maximum esisting materials as allowed.
			x	Net Zero	Minimum insulation and R-values met based on project's geographic location.
				Net Zero / Ad. Re.	Provide window openings to allow maximum daylight and natural ventilation.
			x	Net Zero	Provide operable windows in all occupied spaces.
				Net Zero	SHGC of windows varies based on orientation/location of window on building.
				Net Zero	Provide fresh air management through operable windows.
			x	Net Zero	Occupancy sensors to control mechanical systems with natural ventilation.
				Net Zero / Ad. Re.	Management and reuse of waste heat from mechanical systems for heating.
				Net Zero	Natural cross ventilation through design and use of operable windows.
				Net Zero	Natural stack ventilation through design and use of operable windows.
				Net Zero	Provide geothermal (gound source) heating and cooling.
				Adaptive Reuse	Recycled water / use of grey water system.
				Net Zero / Ad. Re.	Living Machine (on site waste water treatment system).
				Adaptive Reuse	Use of recycled materials.
				Net Zero / Ad. Re.	Use of the building and methods to serve as an education tool for occupants.
				Net Zero	Design to allow for implementation of renewable energy systems.
				Adaptive Reuse	Maintaining historic character of existing building.
				Adaptive Reuse	Utilizing / uncovering existing building design for passive strategies.
				Net Zero / Ad. Re.	Rainwater collection / Storm water management.

Passive Design

Intent:

To develop buildings that use nature to their advantage through reducing environmental impact and passive design methods reduce the energy consumption of buildings.

Building Selection:

The following guidelines are focused on selecting the building for net zero reuse:

+ Selection of building based off context, allows for walkability/ public transportation.

+ Selection of building based off ideal climate for solar energy and natural ventilation.

+ Selection of building based off ideal market demands, allowing economic support.

+ Building selection is reusing an existing structure and site, rather than a greenfield.

+ Building is in fair condition, allowing materials and structure to be salvaged/reused.

+ Use of drought tolerant / native species for landscaping.

+ Building orientation allows for maximum daylight and natural ventilation.

+ Building massed efficiently for mechanicals systems and provides thermal storage.

+ Building mass allows for maximum amount of daylighting to reach interior spaces.

1. Design based on climatic location.

   To design efficiently is to take into consideration the climate in which the project is located. Construction types and materials used also are dependent on climate. Providing lovers for windows in hot arid climates as well as wood construction in cooler climates to reduce thermal bridging.

2. Evaluation of current building conditions: structure, insulation, efficient systems.

   Whether personally or professionally evaluated, structure of a building is a large issue. While structure can be updated and replaced, this is a costly fix. Look for any visible issues such as cracking, rusting, bending, or rotted areas within the structure. Look for exterior areas with little or no insulation, this is a thermal issue and large amounts of energy are lost. Evaluate age and energy usage of the mechanical and electrical systems in the past years for that building high costs could be due to inefficient systems. Simply installing new energy certified appliances can help reduce the buildings energy consumption.

3. Update structure as needed, maintaining maximum existing materials as allowed.

   Where ever any structural issues are found, these areas should be updated to meet local codes. Structural fixes are costly but worth the investment. Simple upgrades are far less harmful to the environment than demolition and new construction.

4. Minimum insulation and R-values met based on project's geographic location.

   Where insulation is low or missing, new insulation should be added. Exterior walls are essential locations for insulation, make sure these locations are well insulated. The roof / attic is another area where energy loss can occur. Any insulation can be added to these areas as long as you are meeting the minimal R-Values needed.

5. Provide window openings to allow maximum daylight and natural ventilation.

   Older buildings usually contain adequate windows for natural lighting however if they do not, adding windows to buildings should be done to increase natural daylight as well as ventilation. A goal should be to light the space with 100% daylight during sunlight hours, reducing the need for artificial lighting. Placement of windows can be on all sides of the building however north or south are the best locations for thermal implications.

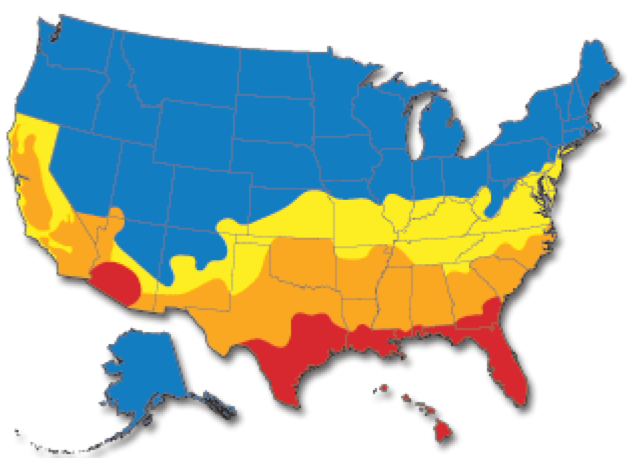
6. Provide operable windows in all occupied spaces.

While window location and daylight are essential to achieving an efficient building, operable windows are as well. Operable windows should be located near occupied spaces. Operable windows should also be placed near the floor and roof in large open spaces to provide a cross and stack ventilation through the space. Air will be drawing in and through the building providing natural ventilation and fresh air to the occupants.

7. SHGC of windows varies based on orientation / location of window on building.

While windows can be located on all sides of the building, the southern facade of the building has significantly higher direct sunlight on the windows. Direct sunlight results in the transfer of heat into the building. Solar Heat Gain Coefficient (SHGC) is a number between 0 and 1 and designates the about of heat a window transmits. The lower the SHGC the less heat the window transmits.

Figure 5.2



- Norther Zone (mostly heat): Windows SHGC .40 or less
- Norther / Central Zone (heating and cooling): Windows SHGC .40 or less
- South / Central Zone (heating and cooling): Windows SHGC .25 or less
- Southern Zone (mostly cooling): Windows SHGC .25 or less

8. Provide fresh air management through operable windows.

By providing operable windows in the sept above this step is also achievable. Operable windows help thermal comfort but are also essential to provide fresh air for health of the occupants.

9. Occupancy sensors to control mechanical systems with natural ventilation.

Install occupation sensors throughout the building in all occupied spaces, these sensors will be able to control the mechanical systems when spaces are unoccupied. A major energy loss today is that buildings are constantly maintaining the same temperature even when people are not occupying the spaces. Occupancy sensors shut down the systems as well as lighting when spaces are not occupied for an extended period of time.

10. Management and reuse of waste heat from mechanical systems for heating.

Through design of the mechanical systems, waste heat can be reused. Mechanical systems give off heat as they run, this heat can be used to heat other incoming air to reduce the energy needed to precondition the air. Locating intake and outgoing air near each other allow for an efficient way to achieve this.

11. Natural cross ventilation through design and use of operable windows.

As discussed in a earlier guideline, operable windows allow for natural ventilation. Based off the way air moves reacts, placing operable windows on both ends of the building .

12. Natural stack ventilation through design and use of operable windows.

As we know warm air rises, placing windows at varying heights pulls the air through the building as well as move air vertically through the space. Windows near the top of spaces allows for warm air to exit and cool air to be drawn in from below.

13. Provide geothermal (ground source) heating and cooling.

Ground source heating can be a bit more difficult due to the location and existing infrastructure near the building. Geothermal energy usually takes more site area as it is tubing beneath the ground. This method is good in cooler climates due to need for heating. Cooling can also be accomplished through ground source.

14. Recycled water / use of grey water system.

Reusing water is essential to lower energy today. By reducing the amount of water we use and recycling storm and waste water we are able to make a great environmental and economic impact. Collect storm water through a cistern located on site or even through a living machine. Both methods collect water and use if for non potable needs such as irrigation and toilets.

15. Living Machine (on site waste water treatment system).

A living machine is a process that collects and treats waste water and rain water naturally. This process consists of different stages where plants and organisms are grow in the water while cleaning it for reuse. These can be used in any location however a spaces needs to be provided to allow for daylight and plumbing for the system.

16. Use of recycled materials.

Materials can be recycled and reused for endless possibilities. When reusing an existing building the majority of the material in the space should be reused.

17. Use of the building and methods to serve as an education tool for occupants.

Allow all sustainable techniques incorporated into the design to be visible and used as a teaching tool within the project. The best way for people to learn and understand is through experiencing and seeing. Techniques such as living machine, solar energy, reuse of materials and other methods visually seen throughout the project can help educate the community and strive for a healthier environment.

18. Design to allow for implementation of renewable energy systems.

Whether renewable energy is affordable at the time of design or not, incorporating the idea within the design is essential to achieving net zero reuse. Providing options for potential renewable energy is simply achievable through orienting the building to allow for ideal solar energy as well as providing connections so that adding and installing solar panels is all that is needed to achieve net zero reuse once the project pursues renewable energy.

19. Maintaining existing / historic character of existing building.

When renovating existing buildings, an important character to successful adaptive reuse is maintaining the existing character of the building. This can be achieved my minimal changes to the existing building. Embrace the existing structure and create spaces that fit within. While physical change to the building is mostly likely when renovating, minimal change is ideal.

20. Utilizing / uncovering existing building design for passive strategies.

Existing buildings, depending on their age, can already contain passive design techniques. Analyzing the building will expose these strategies and allow you to use them in the design. Strategies such as sky lights or operable windows that have been boarded up and sealed off.

21. Rainwater collection / Storm water management.

While rain water or storm water can be collected for reuse as mentioned earlier, water management consists of reducing water run off entering the storm drains. By either collecting water for reuse or use of native plantings storm water runoff is greatly reduced. Native plants and landscaping absorbs water therefore reducing runoff.

Guidelines

Internal Load Reduction Overview

A major issue in existing building today is that they are using extreme amounts of energy. This is the number one issue of buildings in our environment today. Now that we know this it is essential that we reduce the amount of energy we consume. If we can lower energy usage we therefore can lower both CO2 emissions into our environment as well as reduce cost of energy in buildings.

Being the most essential method we must implement, it helps that it is also the easiest to implement. To reduce loads withing buildings, the following techniques are leading examples how implementation. The guidelines are extracted and derived from the case studies and research that is presented in earlier chapters of this book.

Figure 5.2

Internal Load Reduction Strategies

Yes	N/A	No	Req.		
0	0	0	6		**Building Selection**
			X	Net Zero / Ad. Re.	Building selection is reusing an existing structure and site, rather than a greenfield.
				Net Zero / Ad. Re.	Building is in fair condition, allowing materials and structure to be salvaged/reused.
			X	Net Zero / Ad. Re.	Building orientation allows for maximum daylight and natural ventilation.
			X	Net Zero / Ad. Re.	Building massed efficiently for mechanicals systems and provides thermal storage.
					Building Renovation
				Net Zero / Ad. Re.	Evaluation of current building conditions: structure, insulation, efficient systems.
			X	Net Zero	Minimum insulation and R-values met based on project's geographic location.
			X	Net Zero	Provide operable windows in all occupied spaces.
				Net Zero	SHGC of windows varies based on orientation/location of window on building.
			X	Net Zero	Occupancy sensors to control mechanical systems with natural ventilation.
				Adaptive Reuse	Use of recycled materials.
				Net Zero	Design to allow for implementation of renewable energy systems.
				Net Zero	Thermostat and occupancy sensor per room.
				Net Zero	Variable spped / Variable output mechanical systems.
				Net Zero	Reuse of solar heat or waste heat to preheat incoming air.
			X	Net Zero	Minimum Value of R-10 for windows.
			X	Net Zero	Use of efficient LED or fluorescent lighting with occupancy and daylight sensors.
			X	Adaptive Reuse	Re-Insulate or porpper use of insulation.
				Net Zero	Energy monitoring with real time reporting of building energy usage by room.
				Net Zero / Ad. Re.	Use of reflective or green roof to cool building and reudce heat island effect.
			X	Net Zero	Provide occupant controls for lighting, heating, cooling and ventelation of the space.
				Net Zero	Use of heat exchanger for preconditioned fresh air.
			X	Net Zero / Ad. Re.	Provide energy efficient appliances.
				Net Zero	Use of energy recovery ventilator.
				Net Zero / Ad. Re.	Reducing various plug loads within the building of appliances and devices.
				Net Zero	Use of Laptos vs. Desktops when use of space allows.

Intent:

To reduce energy in buildings though use of efficient systems, passive design, updates to the building envelope, efficient appliances, and sensors. Reduction of building energy consumption reduces buildings environmental impact to CO2 contributions as well as allows minimal renewable energy to be provided on site.

Building Selection:

The following guidelines are focused on selecting the building for net zero reuse:

+ Building selection is reusing an existing structure and site, rather than a greenfield.

+ Building is in fiar condition, allowing materials and structure to be salvaged / reused.

+ Building orientation allows for maximum daylight and natural ventilation.

+ Building massed efficiently for mechanicals systems and provides thermal storage.

1. Evaluation of current building conditions: structure, insulation, efficient systems.

   When looking to reduce load reduction of a building, a few essential areas to look for when evaluating the existing building are structural and efficient methods currently in place. If the building has poor structure or is lacking insulation, this will need to be noted and planed for when budgeting what is needed for the building to achieve net zero reuse.

2. Minimum insulation and R-values met based on project's geographic location.

   When updating the insulation of an existing building, most likely there was an insufficient amount of insulation on the exterior envelope. These areas will need to be upgraded to the minimum r-values based on that climate location.

3. Provide operable windows in all occupied spaces.

   In order to reduce the energy for heating and cooling, providing operable windows in all spaces that are occupied throughout the building will allow for thermal comfort to be met naturally when adequate. While operable windows allow for natural ventilation, they can cause loss of energy as well, be sure to notify occupants when natural ventilation is adequate and windows can be opened.

4. SHGC of windows varies based on orientation/location of window on building.

   As noted earlier in the methods portion, SHGC should be chosen based on the climatic location of the building, as well as the windows orientation on the building. Providing the correct SHGC on windows is essential to reducing solar heat gain withing spaces significantly reducing the amount of energy needed to offset it.

5. Occupancy sensors to control mechanical systems with natural ventilation.

   By providing occupancy sensors in all occupied spaces, allows the building systems to turn on or off when spaces are unoccupied. This in turn saves a great deal of energy.

6. Use of recycled materials.

Whenever possible, use recycled materials versus new materials. Similar as to the FUS/ Kendall college of design where it reused over 90% of its materials, a large amount of energy can be reduced.

7. Design to allow for implementation of renewable energy systems.

Whether a project can incorporate renewable energy when designed or not, we should always incorporate availability to achieve net zero energy when the opportunity is available. By designing to allow future implementation of renewable energy means that all of the systems are ready to be connected to renewable energy, it is simply a matter of installing the solar panels to become net zero.

8. Thermostat and occupancy sensor per room.

A key to reducing energy is by placing both a thermostat and occupancy sensor for each occupied room. This is due to first the ability to turn off the system if the space is not occupied and second for the occupants to control the temperature in that specific area. By allowing control for individual areas within the building allows for reduced needs for alternate heating such as spaces heaters or even during warmer months when people open windows to warm up the space if it is too cool for comfort.

9. Variable speed / Variable output mechanical systems.

By providing systems that have variable speeds is also essential to providing comfort. There are times when systems do not need to be running at full speed for both comfort and efficiency. Allowing for variable speeds allows for lower settings and lower energy consumption.

10. Reuse of solar heat or waste heat to preheat incoming air.

Use of heat recovery ventilators and and energy recover units are an efficient way to reduce energy in that they take air that is already heated through the building to precondition incoming cool air. This allows for less energy needed to heat the space. Intake and outgoing air should be located near each other for this to work.

11. Minimum Value of R-10 for windows.

    Windows are a major area for heat loss. By providing windows with efficient thermal qualities such as a minimum r-value of 10 allows heat to remain within the building.

12. Use of efficient LED or fluorescent lighting with occupancy and daylight sensors.

    Many lighting systems and light bulbs in existing buildings are extremly inefficient. Upgrading both the system and bulbs themselves are necessary in order to achieve the best results. Lighting fixtures that are most efficient are LED and fluorescent. This is due to their material make up as well as technology used to provide the most efficient form of lighting.

13. Re-Insulate or proper use of insulation.

    As stated in the beginning of this section, many areas withing buildings are low in insulation. Re-insulation these spaces is necessary to reduce heat loss and in-turn reduce energy. Insulation should meet local requirements.

14. Energy monitoring with real time reporting of building energy usage by room.

    As similar to the other method guidelines, energy monotoning is necessary for collaborative results. Through real time energy data, occupants are able to see the amount of energy they are consuming versus what is being produced and are able to make adjustments and see the effects of their actions.

15. Use of reflective or green roof to cool building and reduce heat island effect.

    While most previous guidelines help reduce energy load are focused on interior techniques, through implementation of a reflective or green roof allows the building to self cool. As the sun makes contact with the buildings thermal mass for the majority of the day, buildings contain and release heat. By providing a green roof, that energy from the sun is used to grow plants and acts as a thermal barrier keeping the building cool from the suns rays.

16. Provide occupant controls for lighting, heating, cooling and ventilation of the space.

    Similar to providing thermostats and occupancy sensors per occupied room, allowing the occupant to manually control these functions allows them to turn down or turn off the systems when they are not wanted. There are many times when an area is too warm or too cool for specific occupants, but by providing multiple options for the occupants to control their thermal and visual comfort allows for less energy being wasted.

17. Use of heat exchanger for preconditioned fresh air.

    Using a heat exchanger near the incoming and outgoing air allows for reuse of energy on conditioned outgoing air to precondition incoming air.

18. Provide energy efficient appliances.

    This is a simple technique to achieve, older buildings contain many inefficient systems. as well as new appliances can be of poor quality using more energy than necessary. By providing energy star rated appliances within the building, a great deal of energy is conserved.

20. Reducing various plug loads within the building of appliances and devices.

    While there are many appliances and systems that are efficient today, there is always plug loads or energy that is running in the background that we are not aware of. These loads are not visible and are refereed to as phantom loads. Ways in which to reduce plug loads is by unplugging appliances when not in use, however this can be a annoyance and when things are not easy to the occupant they fail to be done. A efficient way of reducing the majority if not all plug loads is through a kill switch. This is actually a button that is connected to all of the electrical panel that allows for all power to the systems to be shut off when pushed. This serves as a one time kill and all systems are available to be turned on at anytime after the kill switch is activated. However all systems will remain off and not using energy until manually turned back on.

20. Use of Laptops vs. Desktops when use of space allows.

When allowable, the use of laptops in buildings can reduce energy by 50%. This is a simple technique to achieve as it is specifying which type of computer software will be used. While laptops are less energy, there are times when desktops are needed. Provide the method that is needed for that space directly and use laptops whenever available.

Guidelines

Renewable Energy Overview

Renewable energy is an essential method in seeking net zero reuse. While both passive design and internal load reduction make a great contribution to the energy consumption of buildings, in order to balance our on energy consumption we must produce as much energy as we are consuming. With out this method, one can not achieve net zero reuse.

Renewable energy is achieved through means of solar, wind, hydro and geothermal. These means use nature to create energy, natural sources which are unlimited. By using these methods instead of fossil fuels, we are no longer take resources from the earth at a faster pace than she can sustain, but we are utilizing unlimited resources and allowing for reduced energy costs. The guidelines are extracted and derived from the case studies and research that is presented in earlier chapters of this book.

Figure 5.3

Renewable Energy Strategies

Yes	N/A	No	Req.		
0	0	0	3	**Building Selection**	
			X	Net Zero / Ad. Re.	Selection of building based off ideal climate for solar energy and natural ventilation.
				Net Zero / Ad. Re.	Selection of building based off ideal market demands, allowing economic support.
			X	Net Zero / Ad. Re.	Building selection is reusing an existing structure and site, rather than a greenfield.
				Net Zero / Ad. Re.	Building is in fair condition, allowing materials and structure to be salvaged/reused.
				Net Zero / Ad. Re.	Building massed efficiently for mechanicals systems and provides thermal storage.
				Net Zero	Building / Site allow for sufficient capacity to create renewable energy.
				Building Renovation	
				Net Zero / Ad. Re.	All wood products certified sustainable and located within 500 miles of the project.
				Net Zero	Use of radiant heating and cooling.
			X	Net Zero	Use of Photovoltaic Panels.
				Net Zero	Install properly sized photovoltaic (PV) panels.
				Net Zero	All systems to use electricity, photovoltaics for energy or another renwable source.
				Adaptive Reuse	Recycled or grey water system provided on site.
				Net Zero	Monitoring system that provides real time energy information of the building.
				Net Zero	Provide accessibility to public transportation.
				Net Zero	Solar hot water heater.
				Net Zero / Ad. Re.	Net zero energy and / or adaptive reuse incentives.

Intent:

To provide buildings an equal amount of energy that is being consumed to reduce environmental impact as well as increase public health.

Requirements:

In order to successfully achieve net zero energy through adaptive reuse, the following passive design methods are required:

+ Selection of building based off ideal climate for solar energy and natural ventilation.

+ Selection of building based off ideal market demands, allowing economic support.

+ Building selection is reusing an existing structure and site, rather than a greenfield.

+ Building is in fair condition, allowing materials and structure to be salvaged/reused.

+ Building massed efficiently for mechanicals systems and provides thermal storage.

+ Building / Site allow for sufficient capacity to create renewable energy.

1. All wood products certified sustainable and local to the project.

When using new wood products for a project, local materials are essential to reduce energy consumption. Local products allow from control of forestry, as well as allows for less transportation energy needed to transport the wood from one location to another.

2.Use of radiant heating and cooling.

Radiant heating and cooling is an efficient way to provide thermal comfort within a building. In projects with new concrete flooring, radiant heating is an ideal method. Tubes are laid within the concrete flooring and allow transfer of heat to the thermal mass. Once the mass contains the heat, it radiates the heat into the space above and the heat rises.

3. Use of Photovoltaic Panels.

In order to achieve net zero energy, renewable energy is necessary. Photovoltaics are the easiest and most efficient method of renewable energy.

4. Install properly sized photovoltaic (PV) panels.

In order to provide the correct size of photovoltaic panels in order to meet the energy needs of the space, energy analysis of all the the systems need to be completed. Real life simulation through building information modeling can generate the amount of energy projected to be used int he space so that the correct size of solar panels can be installed. While it is and extra cost, providing more panels than required if available is a good technique in resulting more energy produced than consumed. When doing this make sure that you are connected to the grid so any extra energy produced is sent to the gird for others to use.

5. All systems to use electricity, photovoltaics for energy or another renewable source.

All mechanical systems and appliances used within the building should be electric. In doing so you are not relying on appliances that use natural gas or other forms of energy. Electric appliances and systems are able to be powered by the solar panels. This allows for the building to run off 100% renewable energy and will allow it to be considered net zero reuse.

6. Recycled or grey water system provided on site.

Collection of rainwater or waste water on site allows for reduced amount of water that enters the storm system. Water has also become scarce in certain areas of the world, collecting and reusing water through rainwater collection, cisterns, and living machines allow for grey water to be used for irrigation and other non potable uses. Saving potable water for uses that are more essential.

7. Monitoring system that provides real time energy information of the building.

A monitoring system should be provided to allow the occupants to not only track the energy they are consuming but also to see how much energy renewable sources can provide a building. By providing display monitors throughout the building to allow occupants to engage and see the results of energy production of the building allow them to understand net zero reuse and more likely to educate others.

8. Provide accessibility to public transportation.

Depending on the building location, but availability to public transit is a valuable technique. By providing a bus stop near the project is necessary to allow ease for people to get transportation to work. Not only is this an easier transportation to work, it is also helping the environment by reduction of CO_2 emissions. Promoting access to public transit and walkability to the buildings context is both healthy for the person as well as the environment.

9. Solar hot water heater.

A solar hot water heater consists of adding a solar array that is specifically connected to a hot water heater. This allows the adequate energy to providing hot water to the occupants while using only renewable energy.

10. Net zero energy and / or adaptive reuse incentives.

While many cities do not offer incentives to pursue adaptive reuse or net zero project, a simple conversation with local authorities may be all that is needed. While incentives for these projects are not guaranteed, asking can never hurt. When making a case to get incentives for pursuing a net zero reuse project, be sure use knowledge covered in the book to help make your case.

11. Reuse of material for both structural and ornamentation.

Reuse of material is an easy and environmentally positive way to create a unique and interesting place. Whether material is reused for the same use it previously had, flooring re purposed, or for a new use, factory flooring used as accent wall surface, reuse of material can save energy and cost for buildings.

6. Future of Design

Conclusion

As we are well aware, our current state of environment and building practices have bot been sustainable. Through evidence of unsuccessful design that has caused harm to our environment, we now know what we need to fix in order to create a sustainable environment. While a solution to the current problems is not necessarily possible due to the evolution of humans within society, we are able to at least create a healthier environment through sustainable strategies.

While we are accustomed to a certain lifestyle of over using energy, technology may also be the answer to getting our energy usage back on track. Instead of fossil fuel emissions, we can enjoy fresh air and clear skies through sustainable practices of adaptive reuse and net zero energy, reusing what we have while minimizing the amount of energy used.

Sustainability has a high importance within architecture due to the high potential within buildings. Buildings in America use roughly 40% of the energy produced and are the largest contributor to landfill waste. The first step to reducing our impact on this planet and creating a healthier environment is to reduce the largest contributing factor.

As other countries have a head start on lower energy consumption, the united states needs to focus on net zero reuse in order to become a healthier and leading environment. We can achieve this through net zero reuse by following the guidelines stated through this research.

As stated earlier, the cost for net zero buildings is not as expensive as it once was. “The cost of all renewable energy sources including solar are decreasing as cheaper, more efficient technologies are being developed.”**1.11** It is time to take action and start pushing the need for change.

6.1 Maclay, William. The New Net Zero: Leading-edge Design and Construction of Homes and Buildings for a Renewable Energy Future. Print. 6.

While net zero energy is a leading trend in architecture, we must also think of how we can achieve true sustainability. The greenest building is the one that has already been built. Existing buildings contain a large amount of embodied energy which is why it is necessary to pursue adaptive reuse. While net zero energy methods do not consist of small amounts of embodied energy, we are at least reusing what we already have.

There is a level of return on investment when it comes to embodied energy. Just as existing buildings contain embodied energy and are able to last many years to serve their function, renewable energy methods may contain a higher amount of embodied energy but as we reuse buildings we are equalling the scale by doing so. Embodied energy that goes into net zero energy technology also is essential to the investment due to its ability to provide energy from renewable resources reducing the cost of energy as well as providing fresher and cleaner air.

Net zero reuse guidelines are meant to remove the barrier to pursuing these projects. Many times these projects seem hard or costly to achieve when simple education and knowledge about achieving net zero reuse is all that is needed.

While there are methods such as net positive and living buildings, net zero reuse is a practical and achievable method with the most potential today. While living buildings are ideal, this usually consists of new construction and requires mass amounts of embodied energy to demolish, extract, transport and construct new building. While achieving net zero energy is a minimum, buildings can also achieve net positive energy by simply providing more renewable energy than required by the building use.

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Glossary

Acidification: process where by air pollution in the form of ammonia, sulfur dioxide, and nitrogen oxides, mainly released into the atmosphere by burning fossil fuels, is converted into acids.

Active façade: a façade that responds to changing weather conditions by modifying its performance (by varying apertures, shading, etc.)

Adaptation: a form or structure modified to fit a changed environment.

Adaptive Reuse: the process of reusing an old site or building for a purpose other than which it was built or designed for. A key factor land conservation and reduction of urban sprawl.

Aerogel Insulation: a synthetic porous ultralight solid material with low density and low thermal conductivity.

Albedo or Solar Reflection: is a measure of the ability of a surface material to reflect sunlight on a scale of 0 to 1. Solar reflectance is also called albedo. Black paint has a solar reflectance of 0 and white paint has a solar reflectance of 1.

Altitude Angle: a solar angle that indicates the height of the sun in the sky.

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): a building technology society that focuses on building systems, energy efficiency, indoor air quality, refrigeration and sustainability within the industry.

Amorphous PV: a photovoltaic module manufactured using a thin film of silicon; amorphous modules do not have the circular structure characteristic of mono-crystalline PV modules.

Anidolic Zentithal Collector: a toplighting device that collects daylight from a view of the north sky and delivers the daylight into a space via a diffusing element; the daylight is reflected and redirected as it passes through the device.

Anode Side: the negatively charged side of a fuel cell.

Architecture 2030 Challenge: calls for rapid reductions in building energy consumption and associated greenhouse gas emissions such that by the year 2030, all new buildings would be carbon neutral.

Array: an assemblage of photovoltaic modules; PV manufacturers sell modules that are assembled on site into larger capacity units called arrays.

Azimuth angle: a solar angle that indicates the position of the sun relative to a reference orientation (typically solar south).''

Balance of system: describes the components of a photovoltaic system beyond the PV modules themselves (this usually includes batteries, inverters, and controllers).

Base Load: a “typical” average electrical load for a building or generating system.

Berm: an earthen construction rising above the surrounding ground plane; typically built to block views; channel wind, water, or circulation; or partially earth shelter a building.

Bilateral (daylighting): a daylighting system that introduces light into a space from two (generally opposite) directions.

Biodegradable: a material (organic) that will degrade under the action of microorganisms; generally describes a material that will decompose in nature in a reasonable time period.

Biodiesel: a domestic renewable fuel derived from natural oils with little or no modification.

Biodiversity: refers to the variety and variability of living organisms and the ecosystems in which they occur.

Biofuel: a fuel derived from un-fossilized plant material (such as wood, garbage, rapeseed, manure, soybeans).

Biomass: un-fossilized biological matter (wood, straw, dung) that can be processed (burned, decomposed) to produce energy (typically heat).

Biomimicry: is an emerging design discipline that looks to nature for sustainable design solutions.

Biophilia hypothesis: concept that humans have an affinity for nature and that they “tend to focus on life and life-like processes”.

Bioremediation: a process that uses microorganisms to break down environmental pollution.

Blackwater: is wastewater from toilets and urinals. Wastewater from kitchen sinks showers or bathtubs is also considered blackwater under some state or local codes.

Brownfields: abandoned, idle or under-used industrial and commercial facilities where expansion or redevelopment is complicated by contamination.

Building Assessment System: building rating system that is generic for LEED, BREAAM, CASBEE and DGNB/BNB.

Building Commissioning: the process of verifying, mainly in new construction of subsystems for mechanical, plumbing, electrical, fire/life safety, building envelopes, interior systems etc.

Building Environmental Efficiency (BEE): maximizing the ratio of building quality to environmental loading.

Building Geometry: the shape of the building that maximizes the energy efficiency and comfort of the building.

Building Information Modeling (BIM): is the process of generating a managing building data during its life cycle. It also refers to software that generates a three-dimensional building representation and with the ability to accommodate plug-ins that can potentially perform energy modeling, daylight studies, and life-cycle assessment (LCA) of building systems.

Building Integrated Photovoltaic (BIPV): photovoltaic modules that are integrated into a building enclosure element (such as a roof shingle, glazing unit, spandrel panel).

Building Orientation: the way in which the building is oriented in relation to the site context.

Building Use Survey: a formal means of obtaining information regarding building performance from occupants.

Carbon Dioxide: naturally occurring gas, also a byproduct of burning fossil fuels. It is the principle anthropogenic greenhouse gas that effects the earth's radioactive balance. Other greenhouse gasses are measured to this.

Carbon Emissions: polluting carbon substances released into the atmosphere. Carbon dioxide and carbon monoxide produced by motor vehicles and industrial processes and forming pollutants in the atmosphere.

Carbon Footprint: an estimate of how much carbon dioxide is produced to support your lifestyle.

Carbon Offset: used to reduce the amount of carbon an individual or institution emits. But actually instead of reducing, they put money towards an organization that offsets the amount they emit.

Carbon-neutral: making no net release of carbon dioxide to the atmosphere, especially through offsetting emissions by planting trees.

Carrying Capacity: the number of people who can be supported in a given area within natural resource limits, and without degrading the natural, social, cultural, and economic environment for present and future generations.

Casadia Green Building Council: northwestern US and western Canada intended to push the envelope of high performance building further than LEED was.

Cathode Side: the positively charged side of a fuel cell.

Cell: a unit of a photovoltaic controller panel; PV cells are assembled into modules by the manufacturer, modules are then assembled into arrays by the design teams.

Charrettes: is a collaborative session in which a project team creates a solution to a design or project problem. The structure may vary, depending on the complexity of the problem or desired outcome and the individuals working on the group.

Cistern: a storage container for rainwater.

Clarifier: a settling tank that separates residual solids from treated wastewater.

Climate Change: any significant change in measures of climate (such as temperature, precipitation or wind) lasting for an extended period of time.

Closed loop: a process of keeping materials in productive use by reuse and recycling rather than disposing them as waste.

Cogeneration: an electrical generation process that produces useful (versus waste) heat as a by-product; the process of co-producing electricity and heat on site.

Community capital: the natural, human, social and built capital from which a community receives benefits and on which the community relies for continued existence.

Community: a group of people who live and interact within a specific geographic area and their types of interaction.

Compact Fluorescent: a small fluorescent lamp, marketed primarily as a replacement for less efficient incandescent lamps.

Compositing Toilets: (sometimes called biological toilets, dry toilets, and waterless toilets) contain and control the composting of excrement, toilet paper, carbon additive, and, optionally, food wastes.

Compositing: controlled biological decomposition of organic material in the presence of air to form humus like material that is achieved mechanically or outdoors by mixing composite material periodically.

Comprehensive Assessment System For Building Environmental Efficiency (CASBEE): Japanese building assessment program.

Construction Ecology: is a subcategory of industrial ecology that applies specifically to the built environment.

Cost Analysis: process where business decisions are analyzed, the benefits are summed up and the costs associated are subtracted.

Cradle to Cradle: is a framework for designing manufacturing processes powered by renewable energy, in which materials flow in safe, regenerative, closed-loop cycles.

Daily Heat Gain: the amount of heat from various sources gained during the course of a 24-hour period.

Daylight Factor (DF): the ratio of daylight illuminance at a given point within a building to the horizontal illuminance at an exterior reference point; daylight factor represents the efficiency of a daylighting system in delivering daylight to a specified location; expressed as a decimal or percentage.

Daylighting: is the controlled entry of natural light into a space, used to reduce or eliminate electric lighting.

Daylight-Responsive Lighting Controls: are photo sensors used in conjunction with other switching and dimming devices to control the amount of artificial lighting relative to the amount and quality of natural daylight.

Deconstruction: taking a building apart and preserving its elements for reuse.

Deforestation: the clearing of trees transforming of a forest into a clearing of land, known as one of the major cause of greenhouse effect.

Demolition: tearing down of buildings and other construction.

Desertification: destruction of natural vegetative cover, which prevents desert formation.

Design for the Environment (Green Design): practice that integrates environmental considerations into the product and process engineering procedures and considers the entire product life cycle.

Develop: to improve or bring to a more advanced state. Enhancement of what already exists in the community.

Displacement Ventilation System: introduces air through the floor at low velocity, providing very quiet places. Low velocity fans in the basement circulate air almost imperceptible and use relatively little energy.

Downcycling: the process of converting waste materials or useless products into new materials or products of lesser quality and reduced functionality. To prevent wasting potentially useful materials, reduce consumption of fresh raw materials, energy usage, air pollution and water pollution.

Drip Irrigation: delivers landscape irrigation water at low pressure through buried mains and sub-mains. Water is then distributed to the soil through a network of perforated tubes or emitters.

Earthship: a building design approach that relies upon passive heating/cooling and renewable energy, rainwater harvesting, on-site sewage treatment, food production, and the use of societal by-products as building materials.

Eco-Efficiency: describe the delivery of competitively priced goods and services that satisfy human needs and enhance the quality of life while progressively reducing impacts and resource intensity throughout the products life cycle to a level commensurate with the earth's estimated carrying capacity.

Ecological Design: is an approach to design that transforms matter and energy processes that are compatible and synergistic with nature and that are modeled on natural systems.

Ecological Economics: fundamental requirement of sustainable development that specifically addresses the relationship between human economics and natural ecosystems.

Ecological Footprint: land area required to support a certain population allowing a comparison of resource consumption of various live styles. Represents the amount of land needed to support a given population.

Ecological Rucksack: quantifying the mass of materials that must be moved in order to extract a specific resource.

Ecological Sustainability: is a school of sustainability that focuses on the capacity of ecosystems to maintain their essential functions and processes and retain their biodiversity in full measure over the long term.

Ecology: is the study of the living conditions of organisms in interaction with each other and with surroundings, organic as well as inorganic.

Economy: the way that goods and services are produced, distributed and consumed, life's "necessities" vs "extras".

Ecosystems: a biological community of interacting organisms and their physical environment.

Embodied Energy: the sum of all the energy required consumed in the acquisition and processing of raw materials, including manufacturing, transportation and final installment.

Energy Conservation: measures are installations of, or modifications to, equipment or systems intend to reduce energy use and costs.

Energy Payback: the time it takes for a device or system to save or generate the amount of energy required to produce and install the device or system.

Energy Recovery System: a technique or method of minimizing the input of energy to an overall system by the exchange of energy from one sub-system of the overall system with another.

Energy Simulation Model, or Energy Model: is a computer-generated representation of the anticipated energy consumption of a building. It permits a comparison of energy performance, given proposed energy efficiency measures, with the baseline.

Energy Star: a program that evaluates appliances within a home and can help save energy through the appliance use.

Energy Use Intensity (EUI): unit of measurement that describes a buildings energy use. It represents the energy consumed by a building relative to its size.

Energy: the capacity for vigorous activity; available power.

Environmental Amenity: integration of the built environment with an ecosystem that yields or helps in controlling external building loads, processing waste, absorbing storm water, growing food, and providing natural beauty.

Environmentalists: any person who advocates or works to protect the air, water, animals, plants, and other natural resources from pollution or its effects.

Equity: (or inequity) in the context of sustainability, the term equity has to do with fairness-whether all people have similar rights, opportunities and access to all forms of community capital.

Eutrophication: over enrichment of water bodies with nutrients from agricultural and landscape fertilizer, urban runoff, sewage discharge, and eroded stream banks.

Evaporative Cooling: reduction in temperature resulting from the evaporation of a liquid, which removes latent heat from the surface from which evaporation takes place. This process is employed in industrial and domestic cooling systems, and is also the physical basis of sweating.

Extensive Green Roof: a vegetated roof with fairly short plantings and limited depth of soil.

Extruded Expanded Polystyrene (XEPS): a form of thermal insulation manufactured by extruding expanded polystyrene; XEPS has a higher R-value and higher compressive strength than MEPS.

Factor 10: suggests that in order to achieve long-term sustainability we must reduce consumption by a factor of 10.

Factor 4: suggests that for humanity to live sustainability today, we must rapidly reduce resource consumption to a quarter of its current levels.

Fair Trade: trade in which fair prices are paid to producers in developing countries.

First Cost: the cost to acquire a facility, not including operation, maintenance, and other repairs.

Fluorescent: a low-pressure gaseous discharge electric lamp that operates on the basis of electron flow through an arc tube.

Forest Stewardship Council (FSC): an international non-profit organization that promotes sustainable forestry and timber use practices.

Generate: to bring into existence by a vital or natural process.

Greenhouse Gas: a gas that contributes to the greenhouse effect by absorbing infrared radiation e.g. carbon dioxide and chlorofluorocarbons.

Greenhouse Effect: the trapping of the sun's warmth in a planet's lower atmosphere due to the greater transparency of the atmosphere to visible radiation from the sun than to infrared radiation emitted from the planet's surface.

Geothermal Energy: electricity generated by harnessing hot water or steam from within the earth.

Global Warming Potential (GWP): is an index that describes the radiative characteristics of well-mixed greenhouse gases and that represents the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation.

Global Warming: a gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect caused by increased levels of carbon dioxide, chlorofluorocarbons, and other pollutants.

Graywater: wastewater generated from wash and basins, showers, and baths, which can be recycled on-site for uses such as toilet flushing, landscape irrigation and constructed wetlands.

Green Building Certification Institute (GBCI): is a nonprofit, third-party organization that reviews the application for buildings applying for USGBC LEED certification and tests applications for Green Associate or LEED AP credentials.

Green Building Initiate (GBI): is a nonprofit organization whose mission is to accelerate the adoption of building practices that result in energy-efficient, healthier, and environmentally sustainable buildings by promoting credible and practical green building approaches for residential and commercial construction.

Green Building Movement: the response of the construction industry to the environment and resource impacts of the built environment.

Green Building: is a facility designed using a holistic and collaborative process that addresses life-cycle resource consumption, environmental impacts, and the health of the occupants and local ecosystems.

Green Globes: is a green building guidance and assessment program that offers an effective, practice, and affordable way to advance the overall environmental performance and sustainability of commercial buildings.

Green Roof: Is a roof system that may include a water-proofing and root-repellant system, a drainage system, filter cloth, a light-weight, growing medium, and plants. Vegetated roof systems can be modular, with drainage layers, filter cloth, growing media, and plants already prepared is movable, interlocking grids, or each component can be installed separately.

Green Star: Australian building assessment scheme.

Green Travel Plan: a management policy to encourage environmentally-friendly travel for employees.

Green: a building, project, or philosophy based upon reducing environmental impacts related to energy, water, and materials use; green buildings respect building occupants as well as those indirectly affected by building construction/operation.

Greenfield: is undeveloped lands such as fields, forests, farmland, and rangeland.

Greenspec: a directory of products addressed to high performance building needs, and provides the green building advisor, computer software that facilitates green building design.

Greyfields: blighted urban areas.

Grid-Connected: an on-site power generation system that is linked to the local utility system.

Ground Source Heat Pump: a heat pump that transfers heat to/from the below-ground environment rather than to/from the ambient air; more energy-efficient than a conventional heat pump.

Ground Source Heat Pumps: a geothermal heat pump or ground source heat pump is a central heating and/or cooling system that pumps heat to or from the ground. It uses the earth as a heat source or a heat sink.

Guideline: is a statement by which to determine a course of action. A guideline aims to streamline a particular process according to a set routine or sound practice. By definition, following a guideline is never mandatory. Guidelines are not binding and are not enforced. (US Dept. of Veterans Affairs)

Halogen: a relatively small, long-life incandescent lamp; the terms quartz-halogen or tungsten-halogen are also used.

Hard Costs: are the costs of the land, materials, labor, and machinery used to construct a building and are sometimes referred to as direct construction costs.

Heat Recovery System: a system that captures “waste” heat (which would otherwise be rejected) as a means of increasing building energy efficiency.

High Performance Green Building: is the terminology used to more specifically define the intended outcome of a green building design and construction process.

Historic Preservation: preserves, conserves and protects buildings, objects, landscapes and other artifacts of historical significance.

Holistic Approach: thinking of and designing the project as a whole system that works as one unit.

Hybrid System: an on-site power generation system that includes alternative devise (such as PV, wind, or fuel cells) as well as conventional devices (such as a diesel generator).

Impervious (surface): a material that prevents the passage or diffusion of a fluid (such as water).

Impervious Surfaces: have a perviousness of less than 50 percent and promote runoff water instead of infiltration into the subsurface. Examples include parking lots, roads, sidewalks, and plazas.

Indicator of Sustainability: point to areas where the links between the economy, environment and society are weak allow you to see the problem areas and help show a way to fix them, they reflect the reality that the three different segments are very tightly connected.

Indoor Air Quality (IAQ): refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants.

Industrial Ecology: the study of physical, chemical, and biological interaction and interrelationships both within and among industrial and ecological systems.

Inert Substances: an element which does not easily react with other chemicals.

Insolation: the intensity of solar radiation that reaches a given surface (wall, ground, solar collector) at a specific time.

Integrated Design: a collaborative method for designing buildings which emphasizes the development of a holistic design. Conventional building design usually involves a series of hand-offs from owner to architect, from builder to occupant.

Intensive Green Roof: a vegetated roof with some tall plantings and a fairly deep soil cover.

Land Recycling: reuse of land that is unused or under-utilized whether or not it is contaminated.

Land: the part of earth's surface that is not covered by water, as opposed to the sea or the air.

Leadership in Energy and Environmental Design (LEED): building assessment system for new construction that identified specific criteria requirements.

Life-Cycle Assessment (LCA): method for determining the environmental and resource impacts of a material, product or even a whole building over its entire life.

Life-Cycle Costing (LCC): ability to model a buildings financial performance over its life cycle necessary to justify measures that may require greater initial capital investment but yield significantly lower operational cost over time.

Light Pollution: is waste light from buildings and their sites that produces glare, is directed upward to the sky, or is directed off the site, wasting energy and creating navigation problems for some species, such as sea turtles.

Light Scoop: an architectural device used to collect and bring light into a building.

Light Shelf: a device that is installed at the building façade to more evenly introduce daylight into a space to improve daylight distribution; light shelves may be eternal to the daylight aperture, internal, or both.

Living Building Challenge: international certificate program that promotes advanced sustainability in the built environment, new construction or renovation.

Low E (low emissivity): a coating appied to glass to improve its thermal performance by reducing radiation heat transfer through the glass.

Low Impact Development (LID): relatively new strategy that integrates ecological systems with landscape design to effectively manage storm water runoff.

Materials: anything that serves as a crude or raw matter to be used or developed.

Microclimate: a localized area of differential climate relative to the larger surrounding macroclimate; examples include the climate under a shaded tree (versus in the open), the climate on a south-facing slope (versus a north-facing one), the climate at an airport (versus a downtown location in the same city).

Mixed-mode Ventilation: combines mechanical and natural ventilation modes of ventilation system operation.

Molded Expanded Polystyrene (MEPS): a form of thermal insulation manufactured by molding expanded polystyrene; commonly called beadbord.

National Association of Home Builders: one of the largest trade associations in the United States intending to enhance the climate for housing and the building industry through providing and expanding opportunities for all consumers to have safe, decent and affordable housing.

National Renewal Energy Laboratory (NREL): the United States primary laboratory for renewable energy and energy efficiency research and development.

Native (or indigenous) Plants: are plants that live or grow naturally in a particular region.

Natural Step: provides a framework for considering the effects of material selection on human health.

Natural, or Passive, Ventilation: is provided by thermal, wind, or diffusion effects openings in the building façade, roof, or other components for the purpose of creating low-energy air movement.

Net Metering: is a metering arrangement that allows on-site generators to send excess electricity flows to the regional power grid. These electricity flows offset all or a portion of those drawn from the grid.

Net Zero Energy: a building that produces more energy that it consumes on an annual basis using only renewable energy.

Net Zero Reuse: the process of reusing an existing site or building for a Purpose other than which it was originally intended for while incorporating high efficient systems and design ideas so that the building produces more energy than it consumes on an annual basis using only renewable energy.

Non-Potable Water: water that is not fit for human consumption.

Off-Site Renewable Energy: is green power from an electrical utility or other source. There is no physical renewable energy system either on-site or specifically connected to the building.

On-Site Renewable Energy: is energy derived from the sun, wind, water, earth's core, and biomass that is captured and used on the buildings site, using such technologies as wind turbines, photovoltaic solar panels, transpired solar collectors, solar thermal heaters, small-scale hydroelectric power plants, fuel cells, and ground source heat pumps.

Organic: noting or pertaining to a class of chemical compounds that formerly comprised only those existing in or derived from plants, animals, but now that includes all other compounds of carbon.

Passive Design: employs the buildings geometry, orientation and mass to condition the structure using natural and climatologic features such as the sites solar insolation, thermal chimney effects, prevailing winds, local topography, microclimate and landscaping.

Payback: the time that it takes for a system (investment) to for pay itself through accrued savings (often energy cost savings).

Pervious (surface): a material that readily permits the passage or diffusion of a fluid (such as water.

Perviousness: is the percentage of the surface area of a paving system that is open and allows moisture to soak into the ground below.

Photosensor: a light-sensitive sensor used to control the operation of an electric lighting system; often used in daylight-integrated electric lighting systems and to control exterior lighting elements.

Photovoltaic (PV) Energy: is electricity from photovoltaic cells that convert sunlight into electricity.

Photovoltaic Systems: convert sunlight directly to electricity by means of PV cells made of semiconductor materials.

Place-making: how we collectively shape our public realm to maximize shared value. Rooted in community-based participation, Place-making involves the planning, design, management and programming of public spaces.

Post-consumer Recycled Content: is the percentage of material in a product that was consumer waste. The recycled material was generated by household, commercial, industrial, or institutional end users and can no longer be used for its intended purpose. It includes returns of materials from the distribution chain.

Potable Water: (drinking water) is water that is safe enough to be consumed by humans or used with low risk of immediate or long term harm.

Power Purchase Agreement: a contract between two parties, one who generates electricity for the purpose (the seller) and the one who is looking to purchase electricity (the buyer).

Precautionary Principle: requires the exercise of caution when making decisions that many adversely affect nature, natural ecosystems and global biogeochemical systems.

Preconsumer Recycled Content: is the percentage of material in a product that is recycled from manufacturing waste.

Project Planning: scheduling and reporting process of the project from the initial scope through the completion of the project.

Radiance: software used to model lighting conditions; provides high-end simulation capabilities.

Radiant System: refers to temperature-controlled surfaces that exchange heat with their surrounding environment through convection and radiation.

Rainwater Harvesting: is utilizing rainwater for potable, non-potable, industrial, or irrigation applications.

Rainwater: water in the form of droplets that have condensed from atmospheric water vapor and then precipitated over the built environment and land.

Rapidly Renewable Materials: are agricultural products, both fiber and animal, that take 10 years or less to grow or raise and can be harvested in a sustainable fashion.

Reclaimed Materials: materials that are being reused, but have not been significantly altered from their physical form in a previous application.

Reclaimed Water: wastewater that has been treated for reuse.

Regenerative Design: a system of technologies and strategies, based on an understanding of the inner working of ecosystems, which generates designs to reinforce rather than deplete underlying life-support systems and resources.

Regionally Extracted Materials: raw materials mined or harvested within a 500-mile radius of the project site.

Regionally Manufactured Materials: are assembled as finished products within a 500-mile radius of the project site. Assemble does not include on-site assembly, erection, or installation of finished components.

Renewable Energy: energy produced by a source that is rapidly replaceable by a natural process (examples include wood, biofuels, wind and solar radiation).

Renewable Energy: reusing materials that we already have, that already consist embodied energy, are available and cheap.

Renewable Resource: a natural resource which can replenish with the passage of time, either through biological reproduction or other naturally recurring processes.

Renovation: process of improving a broken, outdated or damaged structure.

Resilience: to absorb disturbance and to undergo change and still retain essentially the same function, structure and feedback. Whole system will not collapse.

Resource Efficiency: high levels of energy and water efficiency, appropriate use of land and landscaping, the use of environmentally friendly materials and minimizing the life cycle effects of the building's design and operation.

Reuse: returns materials to active use in the same or a related capacity as their original use, thus extending the lifetime of materials that would otherwise be disregarded.

R-Value: a measure of thermal resistance; the inverse of the thermal conductance of a material.

Salvaged Materials (Reused Materials): construction materials recovered from existing buildings or construction sites and reused. Common salvaged materials include structural beams and posts, flooring, doors, cabinetry, brick and decorative items.

Sanitary Drainage: building wastewater that contains biological pollutants and must be treated before discharged into the environment.

Selective Surface: a surface coating applied to solar collectors to increase absorptivity and decrease emissivity, thereby increasing the effectiveness of the absorber surface.

Site Analysis: element of site planning and design process that involves evaluation of existing or potential site for determining the success of the project.

Soil Erosion: the removal of topsoil faster than the soil forming processes can replace it, due to natural, animal, and human activity. Soil erosion results in land infertility and leads to desertification and devastating flooding.

Solar Chimney: an architectural device that collects solar radiation to enhance the stack effect (typically as part of a natural ventilation system).

Solar Thermal Systems: collect or absorb sunlight via solar collectors to heat water that is then circulated to the building's hot water system. Solar thermal systems can be used to heat water for residential and commercial use or for heating swimming pool water.

Source Energy: the total amount of raw fuel energy required to operate a building; it incorporates all transmission, deliver, and production losses for a complete assessment of a building's energy use.

Stack effect: a naturally occurring phenomenon wherein hot air rises establishing a vertical circulation of air; employed in some natural ventilation systems.

Stand Alone: an on-site power generation system that is not linked to the local utility system; also known as "off-the-grid".

Stormwater Runoff: is water from rain or melting show that "runs off" across the land instead of seeping into the ground.

Sun-tracking Photovoltaic's: a photovoltaic module mounted on a movable frame that rotates to follow the sun's path, maximizing total isolation and thereby electrical energy production.

Sustain: to continue without lessening, to nourish, and to allow to flourish. Maintain and improved to lead to healthy lives.

Sustainability: the quality of not being harmful to the environment or depleting natural resources and support long term ecological balance.

Sustainable Construction: creating and operating a healthy built environment based on resource efficiency and ecological design.

Sustainable Development: development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable Forestry: is the practice of managing forest resources to meet the long-term forest product needs of humans while maintaining the biodiversity of forested landscapes. The primary goal is to restore, enhance, and sustain a full range of forest values, including economic, social and ecological considerations.

Sustainable Land Use: based on the principle that land, particularly underdeveloped, natural or agriculture land (Greenfields) is a precious finite resource and its development should be minimized.

Sustainable: a building, project, or philosophy that is based upon allowing this generation to meet its needs without impeding the ability of future generations to meet their needs; in essence a project with no net negative environmental impacts.

Task Lighting: lighting for a specific use or area (as opposed to ambient lighting).

Thermal Capacity: the heat storing capability of a material; the amount of heat stored by a thermal mass.

Thermal Efficiency: is a measure of the efficiency of converting a fuel to energy and useful work. Useful work and energy output is divided by the higher heating value of input fuel.

Thermal Mass: a material that is selected and / or used based upon its ability to store heat; good thermal mass will have high thermal capacity (density times specific heat).

Toxic Substance: chemical that can cause death, disease, behavioral reproductive malfunctions, or physical deformities in any organism or its offspring, or that can become poisonous after concentration the food chain or in combination with any other substance.

Transmittance: the amount of light (or solar radiation) that passes through a substance; expressed as a percentage of incident light (or solar radiation).

Transportation Energy: the energy, resources, and emissions impacts due to transportation to create or maintain a buildings everyday services.

Trickle Vent: an opening in a building envelope that allows a steady and controlled flow of outdoor air to enter the building.

Unilateral (daylighting): a daylighting system that introduces light into a space from only one direction.

Urban Heat Island Effect: the tendency for urban areas to maintain a higher ambient temperature that surrounding suburbs or rural areas; caused by the absorption of solar radiation by built surfaces and heat emissions from buildings.

Us Department Of Energy (DOE): a department of the executive branch responsible for developing policies for effective use of the nation’s energy resources. The DOE is involved in energy conservation, regulation oil pipelines, and encouraging research on new sources of energy.

Us Environmental Protection Agency (EPA): an agency of the U.S. federal government whose mission is to protect human environment and health.

Us Green Building Council (USGBC): a private membership-based non-profit organization that promotes sustainability in how buildings are designed, built, and operated, also founded LEED.

Volatile Organic Compounds (VOC'S): compounds that vaporize (evaporate) at room temperature; VOCs are produced by many building materials and furnishings; an indoor air pollutant; low or no VOC options are available for many products.

Waste Heat: heat produced as a generally unusable by-product of some process.

Wastewater: water that must be treated for proper disposal; sanitary drainage.

Water Supply: the provision of water by public utilities, commercial, community endeavors or by individuals, usually via a system of pumps and pipes.

Waterless Urinals: are dry plumbing fixtures that use advanced hydraulic design and a buoyant fluid to maintain sanitary conditions.

Zero Net Energy Buildings: grid-connected buildings that export excess energy produced during the day and import energy in the evenings, such that there is an energy balance over the course of a year.

Zero-Carbon Buildings: is a building with zero net energy consumption or zero net carbon emissions on an annual basis.

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