Guidelines To Achieving Net Zero Energy Through Adaptive Reuse

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Master of Architecture Thesis

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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?

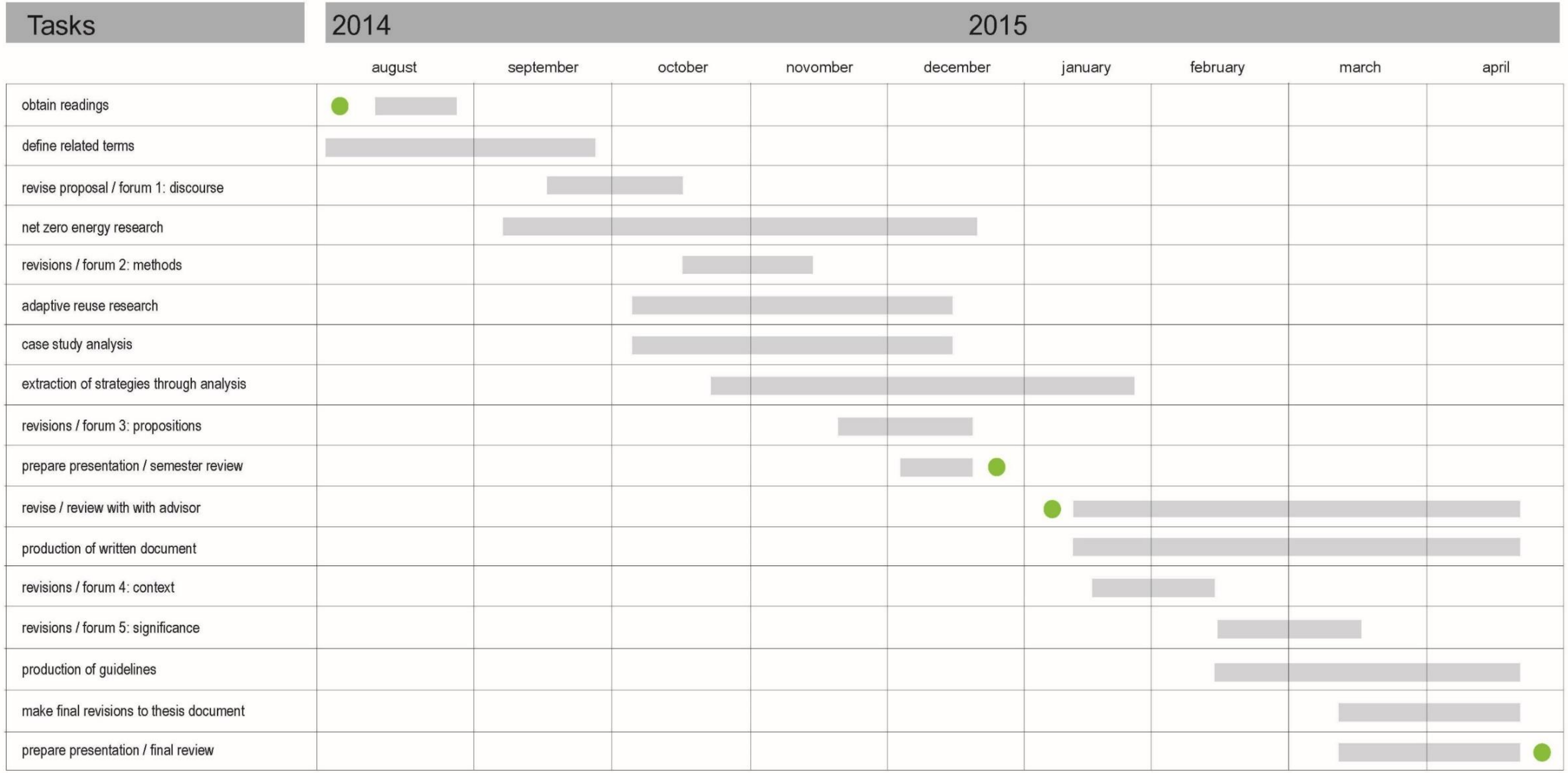
PROPOSITION:

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.

- **Increase in population has resulted in environment burdens: over extraction of raw materials and resources.**
- **Net zero energy and adaptive reuse are two design strategies with the most potential to improve our environment and economy.**
- **What does a successful net zero reuse project entail and how does it achieve success?**
- **Thesis goal is to break down barriers allowing net zero reuse to become more common in our society.**



THESIS 1 & 2 WORK PLAN



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.

+ **Making net zero reuse projects practical and achievable.**

+ **Creating a set of guidelines to help various audiences achieve successful projects. (architects, researchers, policy makers, contractors and developers)**

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.

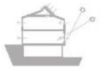
Throughout the thesis process, these three methods started to overlap and become incorporated within each other. Once successful methods were extracted; passive design, internal load reduction, and renewable energy, I used these methods as a parameter when analyzing the case studies. Each case explores 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.

+ **Analysis of existing methods; Passive Design, Internal Load Reduction, and Renewable Energy.**

+ **Analysis of case studies; various adaptive reuse, net zero energy, and net zero reuse projects throughout the United States.**

+ **Analysis of existing guidelines and written documents.**

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.

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

+ Use of nature in collaboration with design

+ Operable windows / natural ventilation

+ Reuse of material

+ Solar orientation / daylight

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 CO_2 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.

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

- **Reducing energy load within buildings**
- **LED or Fluorescent Light Fixtures**
- **Laptops vs. Desktops**
- **Energy efficient appliances and systems.**
- **Maximize use of daylight and apply occupancy sensors.**


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

+ **Producing energy though unlimited availability of natural resources**
+ **Photovoltaics**
+ **Net metering / grid connection**
+ **Solar hot water heater**

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

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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.

Adaptive Reuse Objectives

Environmental

"One of the main environmental benefits of reusing buildings is the retention of the original building's 'embodied energy.'" # 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" #

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" # 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.

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+ Conservation and preservation of Earth's resources.

+ Reduce CO2 emissions and waste contribution.

+ Reuse of existing embodied energy through building and material reuse.

+ Balance of our needs, producing as much energy as we are consuming.


Figure 4.15

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

Case Study 4

- **+ Varying heights of operable clearstory windows along with roof top ventilators create cross and stack ventilation.**
- **+ Light sensors allow occupants know when natural ventilation is adequate.**
- **+ Through the use of local stream water, geothermal heating is used to radiantly heat and cool the building slabs.**

Figure 4.17

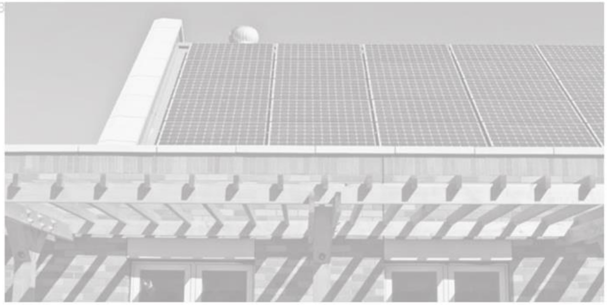
Permaculture, a creative design process based on building an understanding of the connection in all ecosystems and how humans can work with nature rather than against it. The goals of this project allowed for preservation of 21,000 sf of open site that consisted of native and instructional plants that 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 CO_2 sensors that regulate the amount of fresh air intake.

Figure 4.18



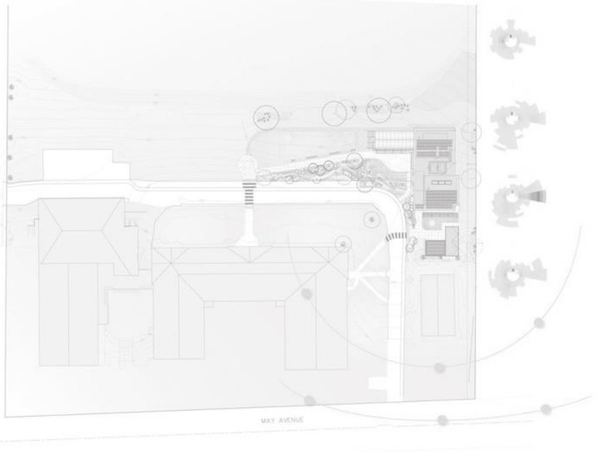
Another major way this project reduced its energy comsumption is by energy smart appliances. For this project those appliances consisted of laptops instead of desktops. A laptop uses 1/3 the amount of energy a desktop uses, and depending on what those devices are used for, many times a laptop is easier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



- **Permaculture**
- **Native landscaping and greenhouse's**
- **Design allows for seasonal shading**
- **Living Machine, purification process to reuse waste water**

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 CO2 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.

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." # 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.

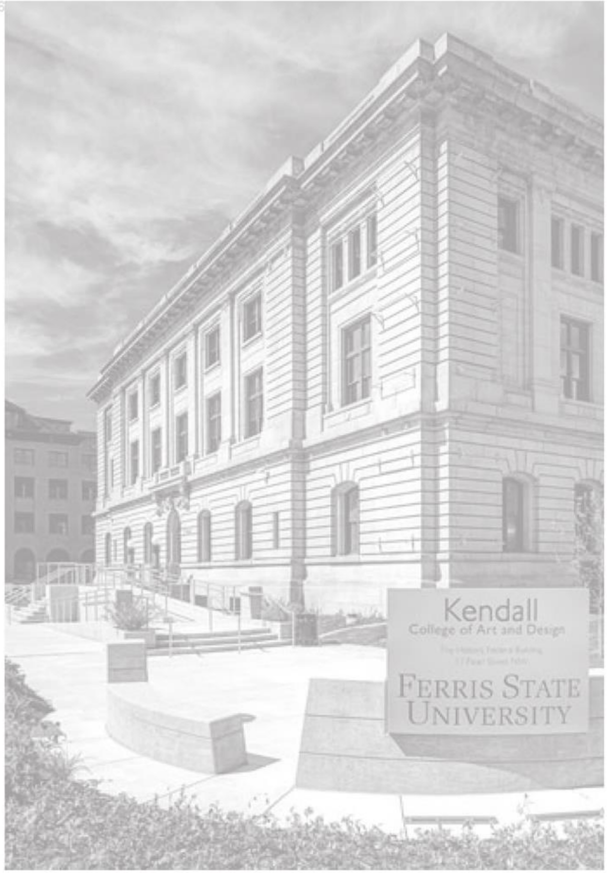
A few of the social aspects that make this project achieve successful place-making was its strong consideration to preserve its existing character. By reusing a large majority of materials that were existing in the building and uncovering its original daylighting qualities, gives the sense of time allowing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

Figure #

(pps.org)

- **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.**
- **Increase in market demand: historical quality in collaboration with energy efficient methods.**

Figure 4.26



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

+ **LEED Gold**
+ **Material Reuse: 91 %**
+ **Existing daylighting methods**
+ **Central location within city.**

Case Study 7

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.

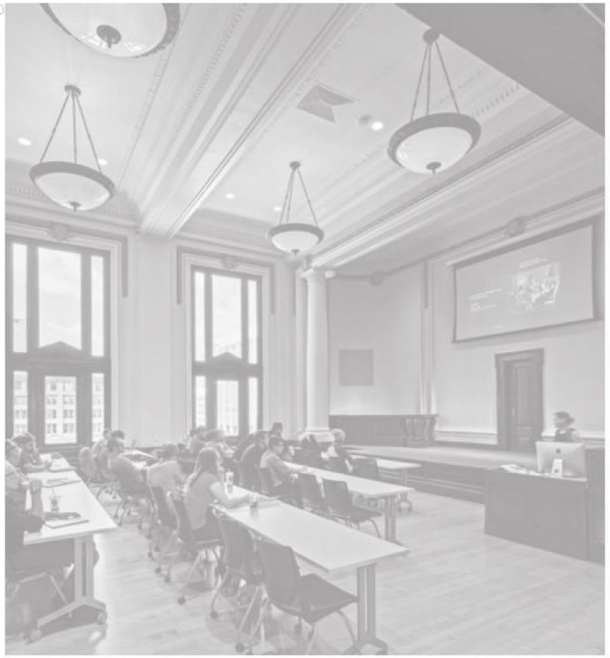
Internal Load Reduction

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

- **+ Reuse of storm water runoff, 50% less irrigation energy.**
- **+ Energy efficient appliances and fixtures, specifically plumbing with 33% savings.**
- **+ recycled material consisted of 24% of entire cost of materials**

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

Economic

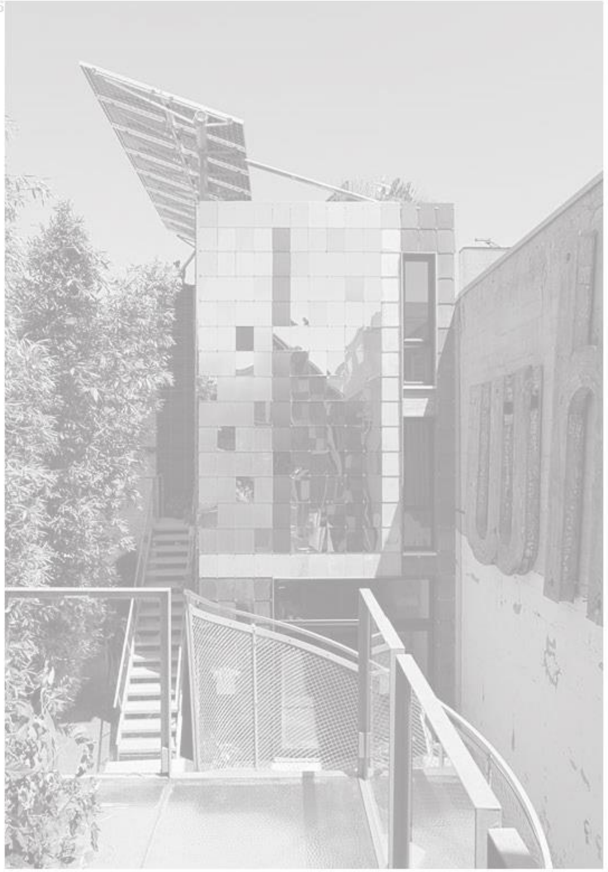
As similar to the environmental objective, embodied energy is not only better for the environment, it also is an economical objective. Embodied energy reduces the cost of construction due to less labor and materials that are needed for a project. "Embodied energy savings from not demolishing a building will only increase with the predicted rise of energy costs in the future." # 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." #

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 projcts due to their ability to increase the market and economy in that area.

- **Renewable energy provides savings in energy**
- **Reuse of embodied energy, savings on new materials**
- **Total cost over lifetime of building**
- **Financial incentives for adaptive reuse**

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

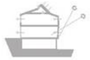
For more information see: http://living-future.org/case-study/zero-cottage

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.

- **Passive House Standards, allow for less reliance on mechanical systems**
- **LiveWork, misused space including residence and workshop**
- **Use of exiting building with walkable context**
- **Placement of windows allowing for cross and stack ventilation and views**

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

- **maximum use of daylight with occupancy sensors, reducing need for artificial lighting**
- **Solar hot water heater located on roof, along with skylights, solar panels and a green roof.**
- **Heat Recovery Ventilator, allows for 92% efficiency**
- **Renewable energy through solar panels cantilevered on the roof, provide 22% more energy than the building consumes**

Summary

What are the qualities of a successful guideline?

Initial Organization:

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.

Basic assumptions:

Readers will not read off of the guidelines.
Keep guidelines short and simple.
Think carefully about type of reader and their understanding with the topic.

Write for the user.

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.)

+ **Write for the user; be specific and clear**

+ **Keep guidelines simple yet descriptive, used as a guide, not read in full**

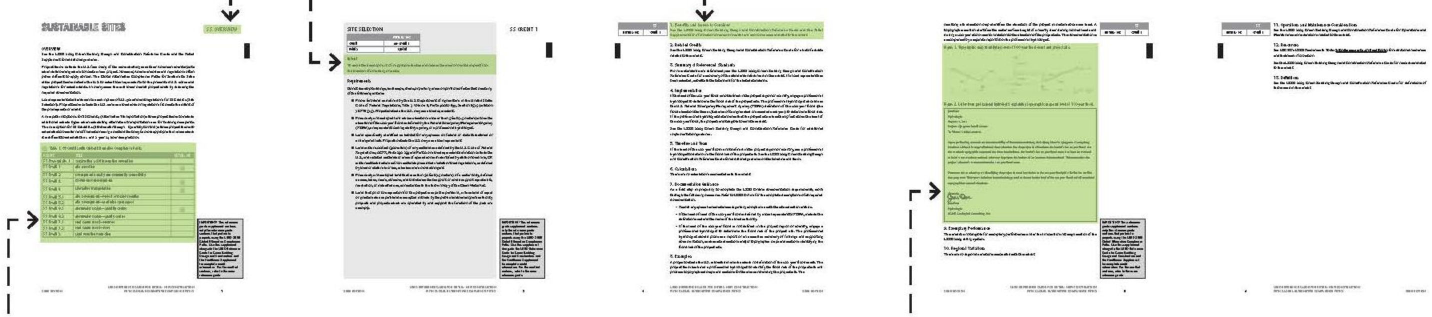
+ **State Cleary what should / should not be done**

+ **Include diagrams and graphics allowing for visual connection.**

Provide overview of Guideline category.

State the Intent of each category.

Guidelines should be well organized and easy for readers to keep track of their progress, usually done through numbering.



Provide a checklist or a table stating each guideline for each overall category.

Provide images, charts, tables and or graphs.

+ **Overview**
+ **Checklist**
+ **Intent**
+ **Numbered system, ease of tracking process**
+ **Graphs, tables, and images**

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 #

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.

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.
+ Use of drought tolerant / native species for landscaping.
+ Building orientation allows for maximum daylight and natural ventilation.
+ Minimum insulation and R-values met based on project's geographic location.
+ Provide operable windows in all occupied spaces.
+ Occupancy sensors to control mechanical systems with natural ventilation.

- **Overview, checklist, intent, list**
- **Reuse of greyfields**
- **Meet minimum insulation values based on climate location**
- **Provide operable windows in all occupied spaces**
- **Use of native species / drought tolerant plants for landscaping**

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 CO_2 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 #

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.

Internal Load Reduction

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 CO_2 contributions as well as allows minimal renewable energy to be provided on site.

Requirements:

In order to successfully achieve net zero energy through adaptive reuse, the following internal load reduction methods are required:

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

+ Building orientation allows for maximum daylight and natural ventilation.

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

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

+ Provide operable windows in all occupied spaces.

+ Occupancy sensors to control mechanical systems with natural ventilation.

+ Minimum Value of R-10 for windows.

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

+ Re-Insulate or proper use of insulation.

+ Overview, checklist, intent, list

+ Fair condition of existing structure

+ Energy efficient system upgrades

+ Occupancy sensors in all occupied spaces

+ LED or Fluorescent lighting fixtures

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 #

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 incentves.

Renewable Energy

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.

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

+ Use of Photovoltaic Panels.

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

+ Overview, checklist, intent, list

+ providing equal amount of energy as being consumed

+ Use of photovoltaics

+ Development of existing structures, reuse of material

+ Building monitoring system, real time energy analysis.

Guidelines for Net Zero Reuse

Comments