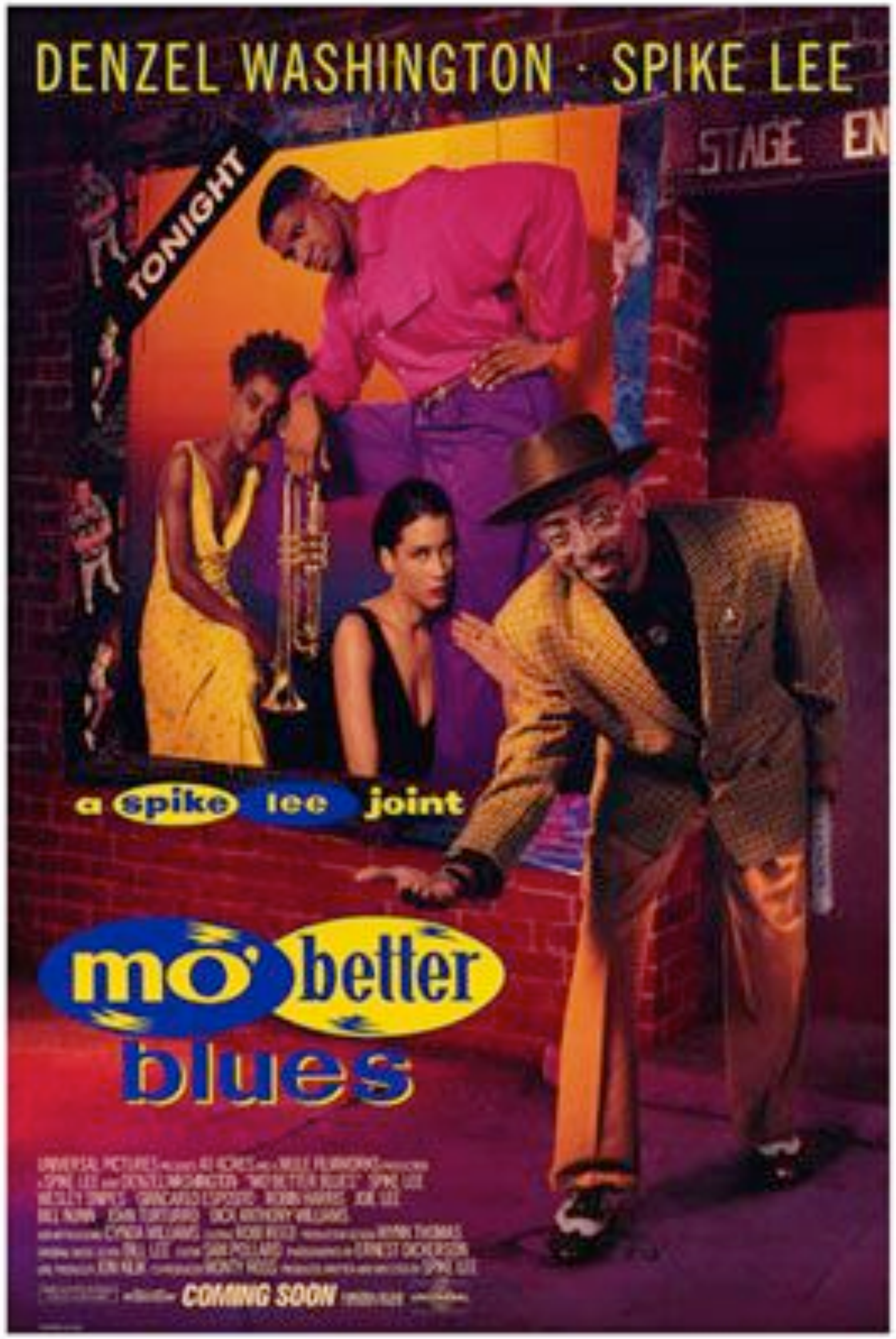
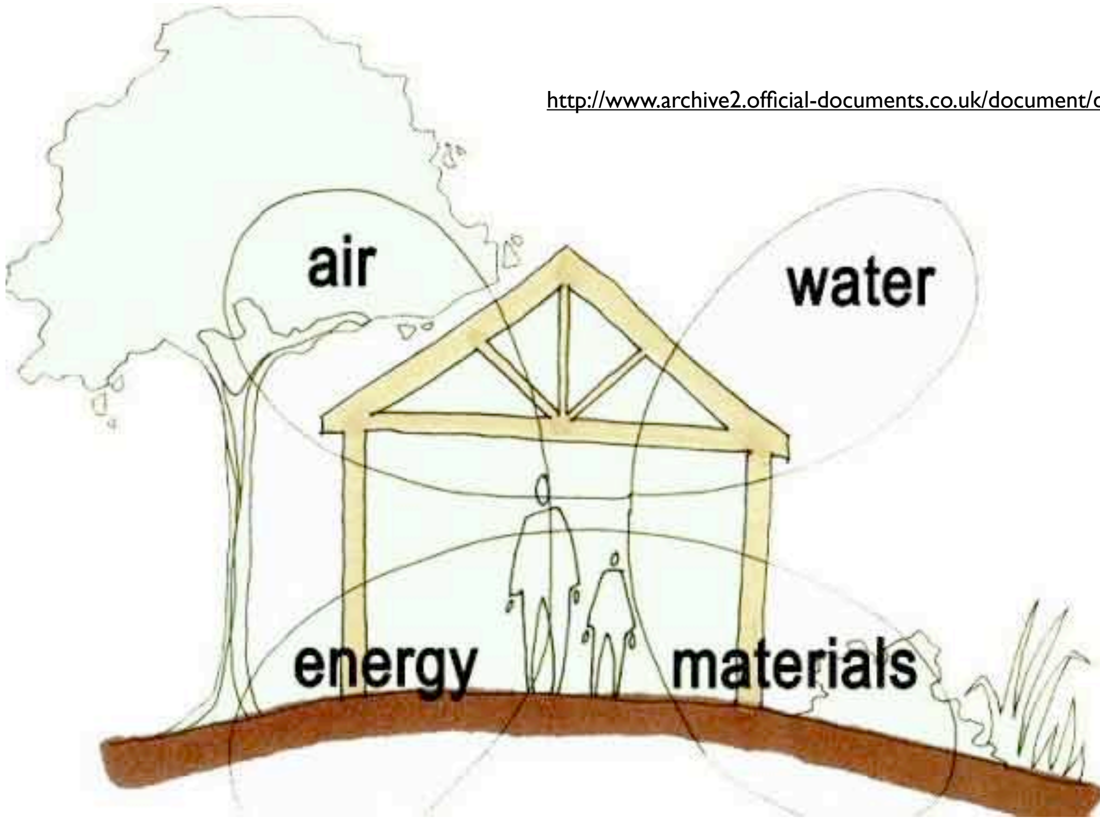
Principles of Sustainable Design

1st Lecture



Mo' better blues

Mo' Better Blues is a 1990 drama film starring Denzel Washington, Wesley Snipes, and Spike Lee, who also directed. It follows a period in the life of a fictional jazz trumpeter Bleek Gilliam (played by Washington) as a series of bad decisions result in his jeopardizing both his relationships and his playing career. The film focuses on themes of friendship, loyalty, honesty, cause-and-effect and ultimately salvation. It features the music of the Branford Marsalis quartet and Terence Blanchard on trumpet. The film was released five months after the death of Robin Harris and is dedicated to his memory.



http://www.archive2.official-documents.co.uk/document/deps/cs/shdg/index.html

5 Conditions for Sustainable Housing

- Low resource use
  - Energy
  - Water
  - Other resource(land, minerals, etc)
- Safe
  - Security through design
- Healthy
  - Physical health
  - Mental health(stress)
- Productive
  - Socially
  - Economically
- Beautiful
  - Aesthetically
  - Spiritually
  - ecologically
- ✳ UK

energy/carbon dioxide
water
materials
surface water run-off
waste
pollution
health and well-being
management
ecology

Grand Design

Grand Design

Kevin McCloud

Channel 4, UK

10 Great Renovation Opportunities – Build Your Own Grand Design!

As the Photoplan team will be spending the coming week at the Grand Designs Live event at the ExCel in London, we thought we would get into the spirit of the show and help whet your appetite for exciting property projects.

With this in mind we have trawled the property marketing pages and found 10 unique opportunities to create amazing character homes.

From renovations to conversions, we've picked out properties to suit all styles – just take a look below, and don't forget to come along and see us at the Grand Designs Live event to find out how we can help you make your vision a reality.

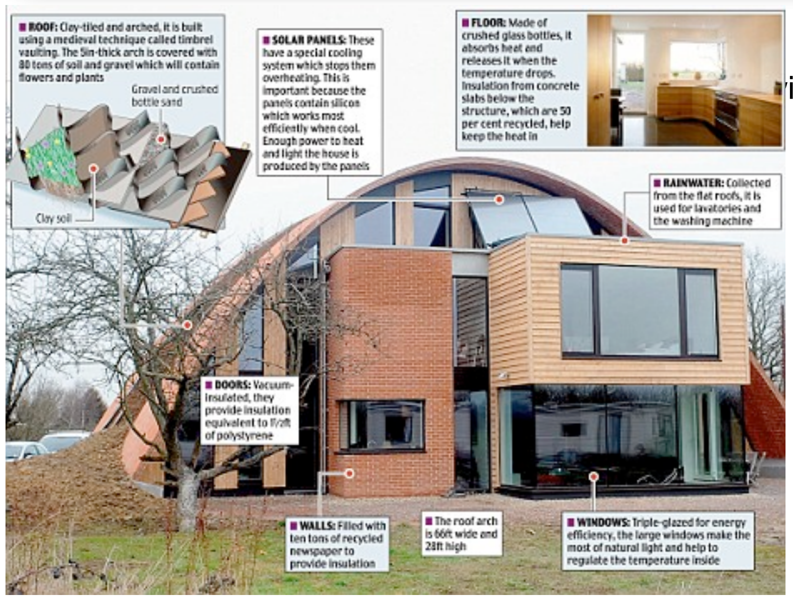
1. The National School House, Hawes This old school building offers stunning view from its period windows, and you won't have to look far to see its potential as a renovation project.
2. Stone Built Barn, Laughton Just 20 mins from Robin Hood airport and within commutable distance of the surrounding urban areas, this stone built barn could soon become your rural retreat
3. Hebridean Home, South Uist Large family home just a hop and a skip of the stunning white sandy beaches of South Uist. Four bedrooms, huge gardens and an amazing feature fireplace – all it needs is a little bit of love and this place could be heaven.
4. Historic Mill, Watten amazing 19th Century water mill in the Scottish Highlands. Awaiting planning permission for conversion to residential, and with the possibility of generating its own hydro electric power.
5. Detatched Stone Cottage, Brecon We were sold on this one by the bath and the woodburner – and can see how the rest of this cute traditional cottage could be brought into line for an amazing home or holiday home
6. Gate Lodge, Castletown Small but perfectly formed, this former gatehouse just oozes character from every crack (and yes, looking at the property photography it would seem there are a few!) It would need someone with vision and patience – but just imagine the finished article!
7. Former Baptist Chapel, Castle Donington Stunning frontage and interiors with bags of potential. We can imagine working hard to retain some of the stunning features – aperitifs under the organ anyone?
8. Cornish Farmhouse and Barn, Camelford Set in an acre and a half of Cornish countryside, this tumbledown combo is ripe for renovation and would make an amazing character conversion.
9. Castle Haven, Kirkcudbright Grade A Listed Edwardian model dairy in an amazing location on the Scottish coast with views to the Isle of Man. Planning permission previously granted for residential and commercial conversion though now lapsed.
10. Medieval House, Cazauban Ok, ok so we know it's across the channel but we couldn't leave out this little challenge! Built in the 15th century, this "restorers dream" was originally a presbytery and offers amazing views of the nearby Pyrenees. Renovate then relocate?!

http://www.photoplan.co.uk/blog/?p=6724

http://www.dailymail.co.uk/sciencetech/article-1148302/Theres-place-like-dome-An-eco-dream-house--straight-medieval-drawing-board.html

Crossway, Marden Thorn, Kent UK

The Crossway PassivHaus first featured on Grand Designs on Wednesday 18th Feb 2009



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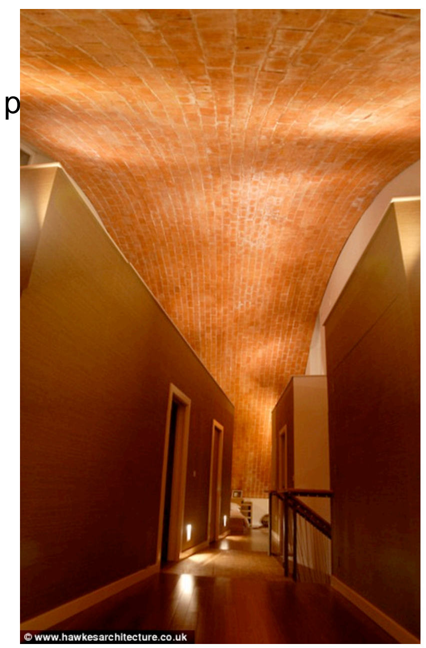
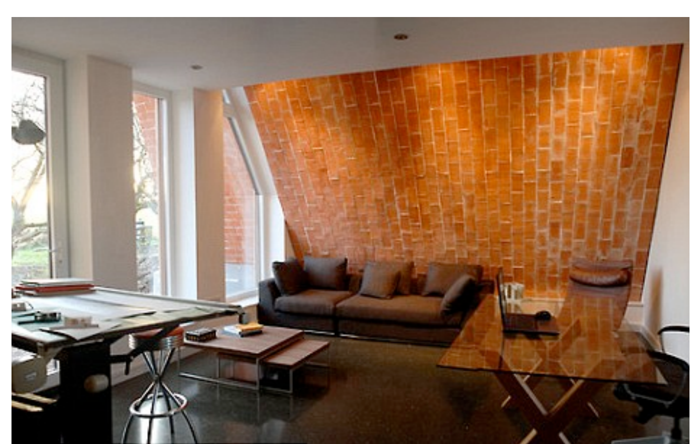


http://www.hawkesarchitecture.co.uk/projects

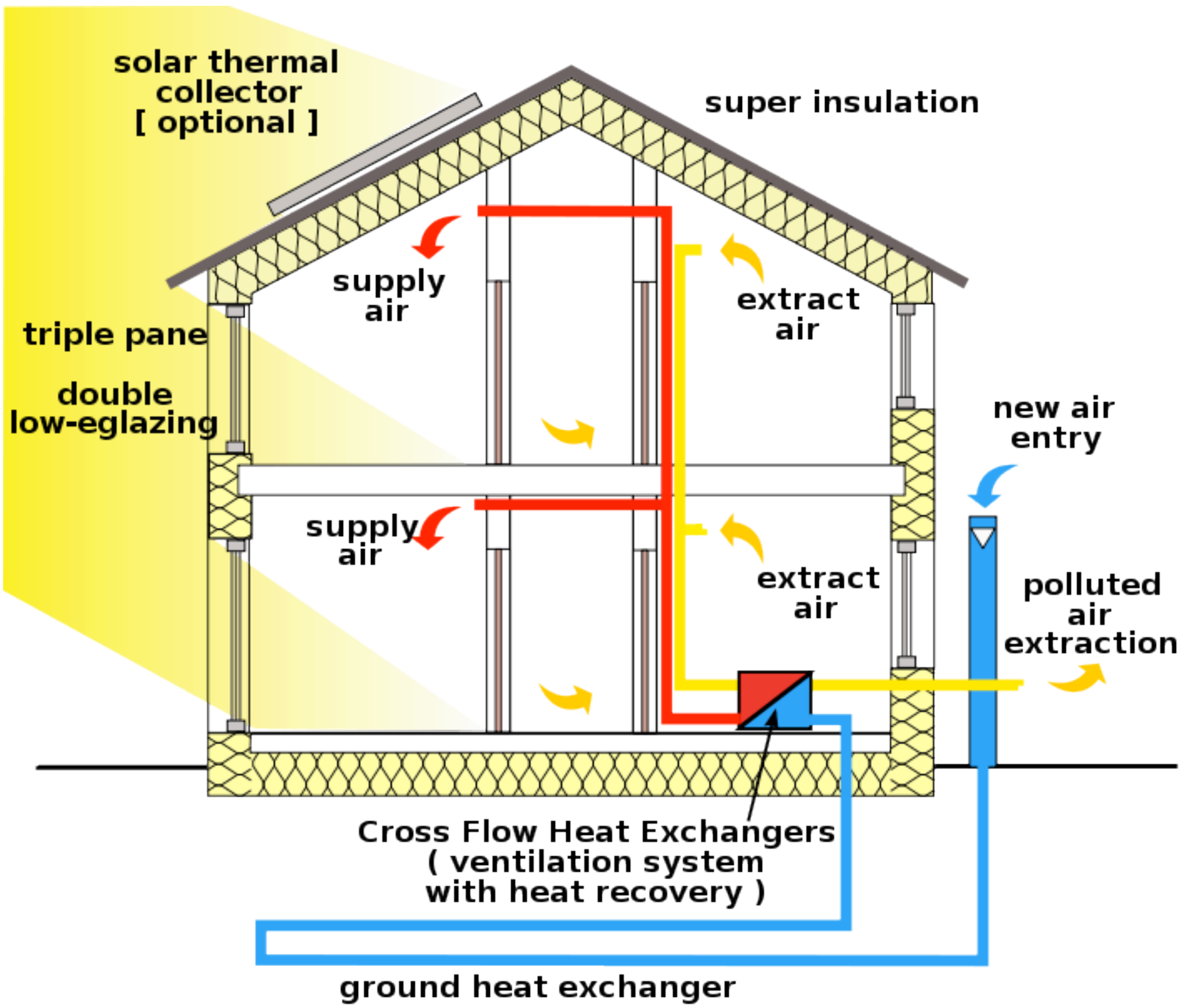


http://www.dailymail.co.uk/sciencetech/article-1148302/Theres-place-like-dome-An-eco-dream-house--straight-medieval-drawing-board.html

Click here for a 360-degree virtual tour of the house!

Groundbreaking: Eco home with architect Richard Hawkes outside his new zero carbon pad

Passive House



The term **passive house** (***Passivhaus*** in German) refers to the rigorous, voluntary, *Passivhaus* standard forenergy efficiency in a building, reducing its ecological footprint. It results in ultra-low energy buildings that require little energy for space heating or cooling. A similar standard, *MINERGIE-P*, is used inSwitzerland. The standard is not confined to residential properties; several office buildings, schools,kindergartens and a supermarket have also been constructed to the standard. Passive design is not an attachment or supplement to architectural design, but a design process that is integrated with architectural design. Although it is mostly applied to new buildings, it has also been used for refurbishments.

Estimates of the number of Passivhaus buildings around the world in late 2008 ranged from 15,000 to 20,000 structures. As of August 2010, there were approximately 25,000 such certified structures of all types in Europe, while in the United States there were only 13, with a few dozens more under construction. The vast majority of passive structures have been built in German-speaking countries and Scandinavia.

냉난방부하 - 연간 15 kWh/m^2 yr 이하, 최대 10W/m^2 이하

난방, 온수, 전기 부하 연간 120 kWh/m^2이하

시간당 0.6 이하의 환기 ($n_{50} \le 0.6$ / hour) at 50 Pa (N/m^2)

태양열 난방부하의 40%

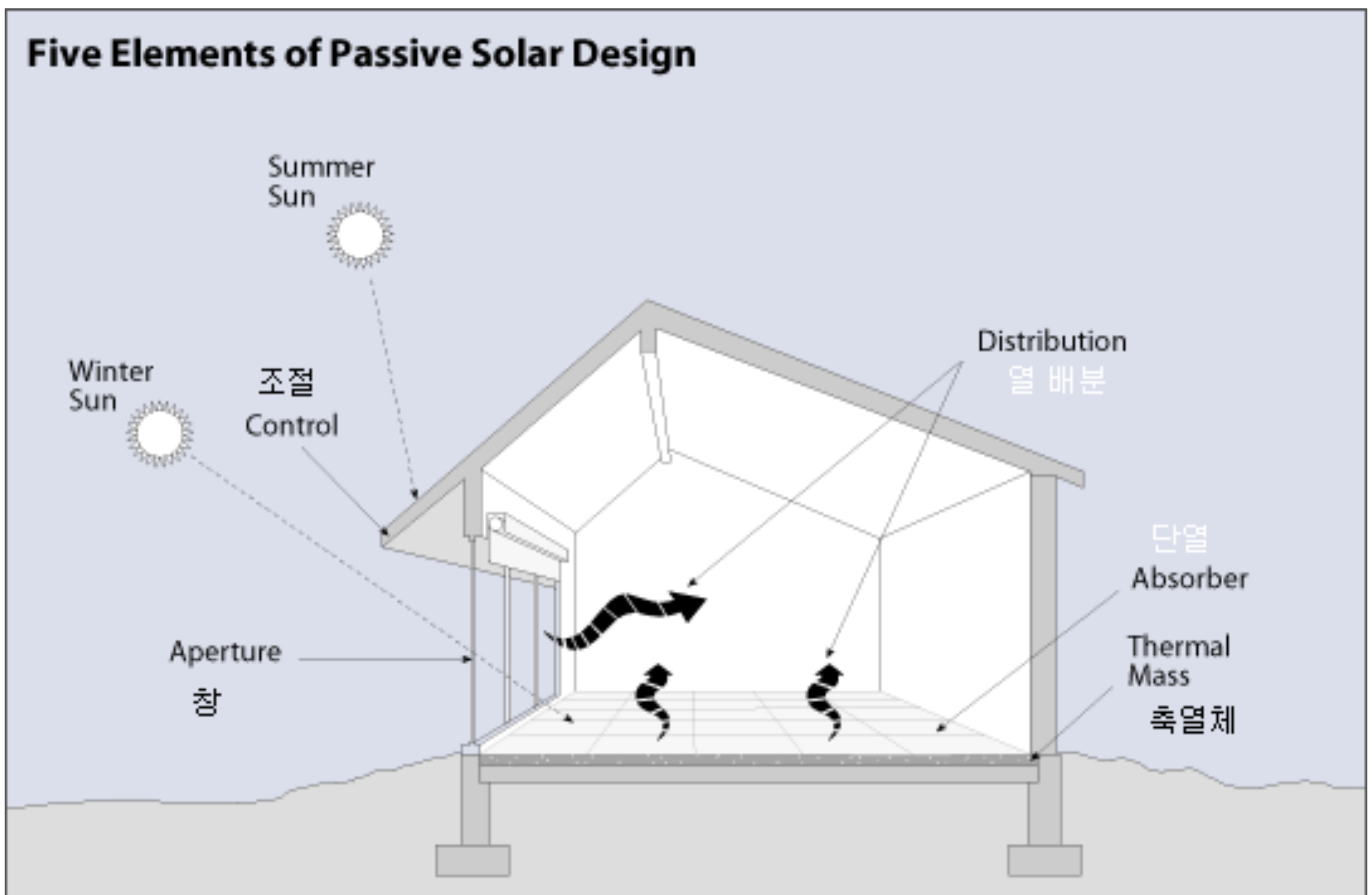
분류	난방부하kWh/m^2
Low-Energy-Building	40-79
Three Liter House	16-39
Passive House	15
Zero Energy House	0
Plus Energy House	

- Superinsulation/초단열
- Advanced window technology
- Airtightness
- Ventilation
- Space heating
- Lighting and electrical appliances

Passive House

The 5 Principles

- Insulation
- Air Tightness
- Solar Gain
- Heat Exchange
- Thermal Bridging minimised



우리나라 주택 냉난방 에너지 평균20 liters

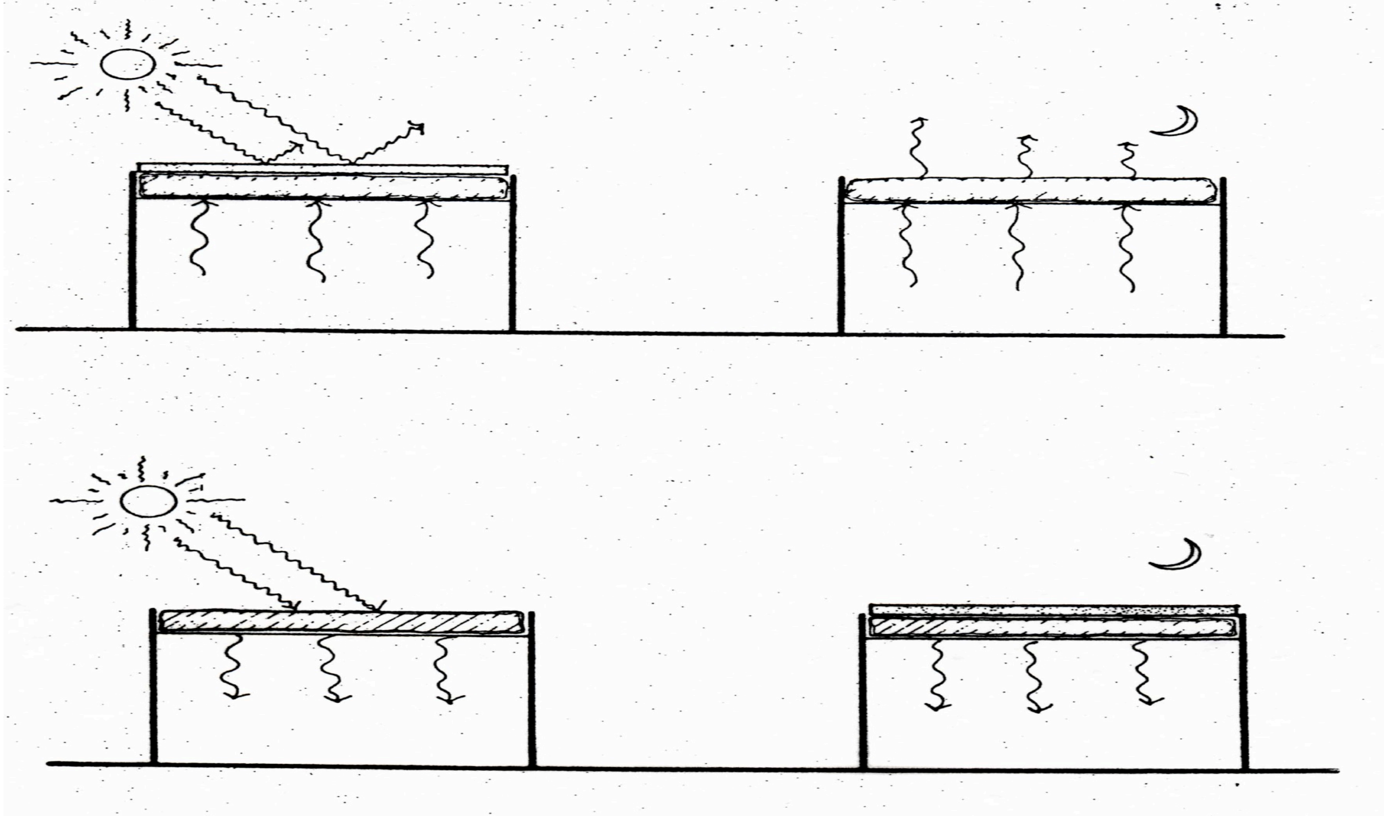
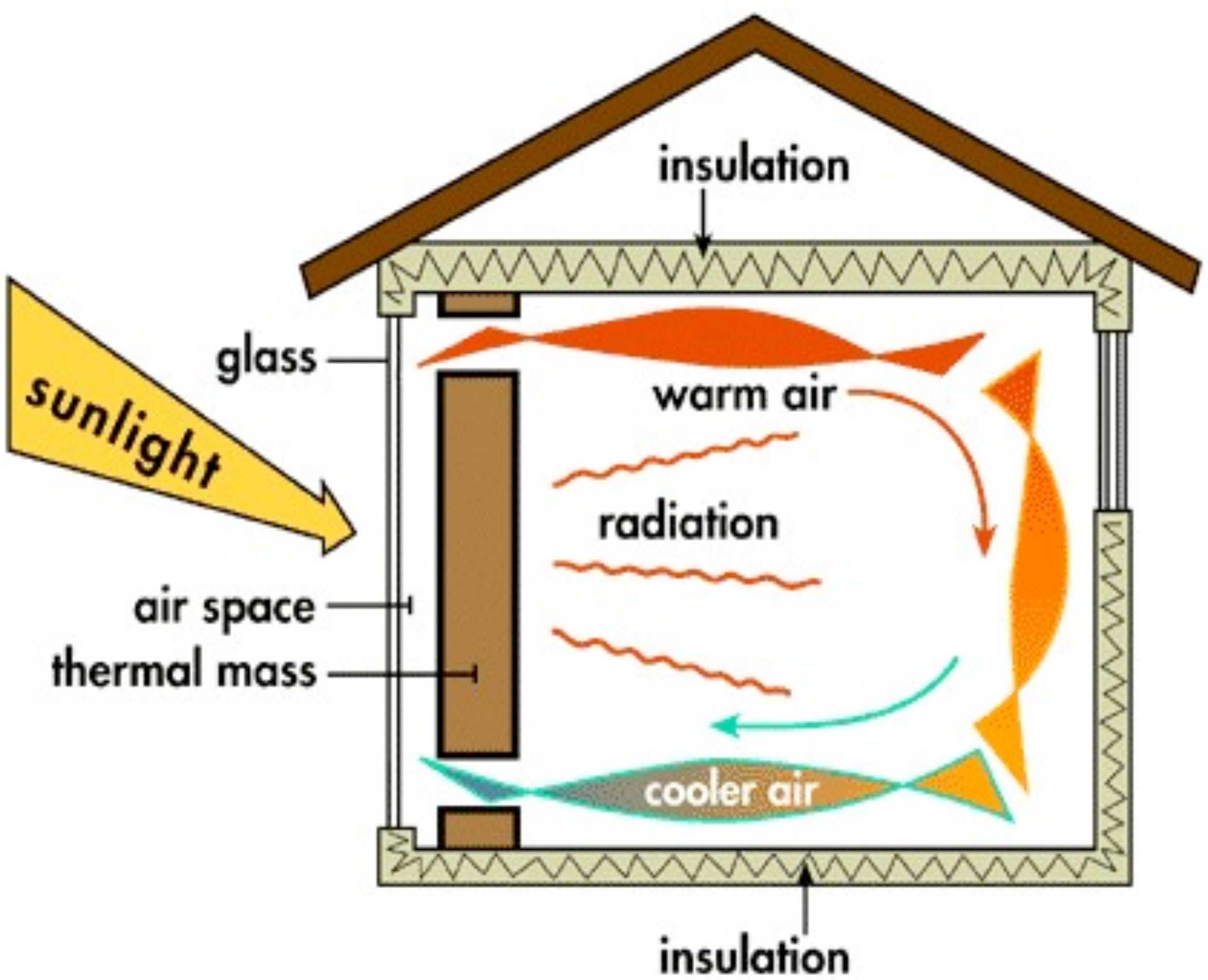


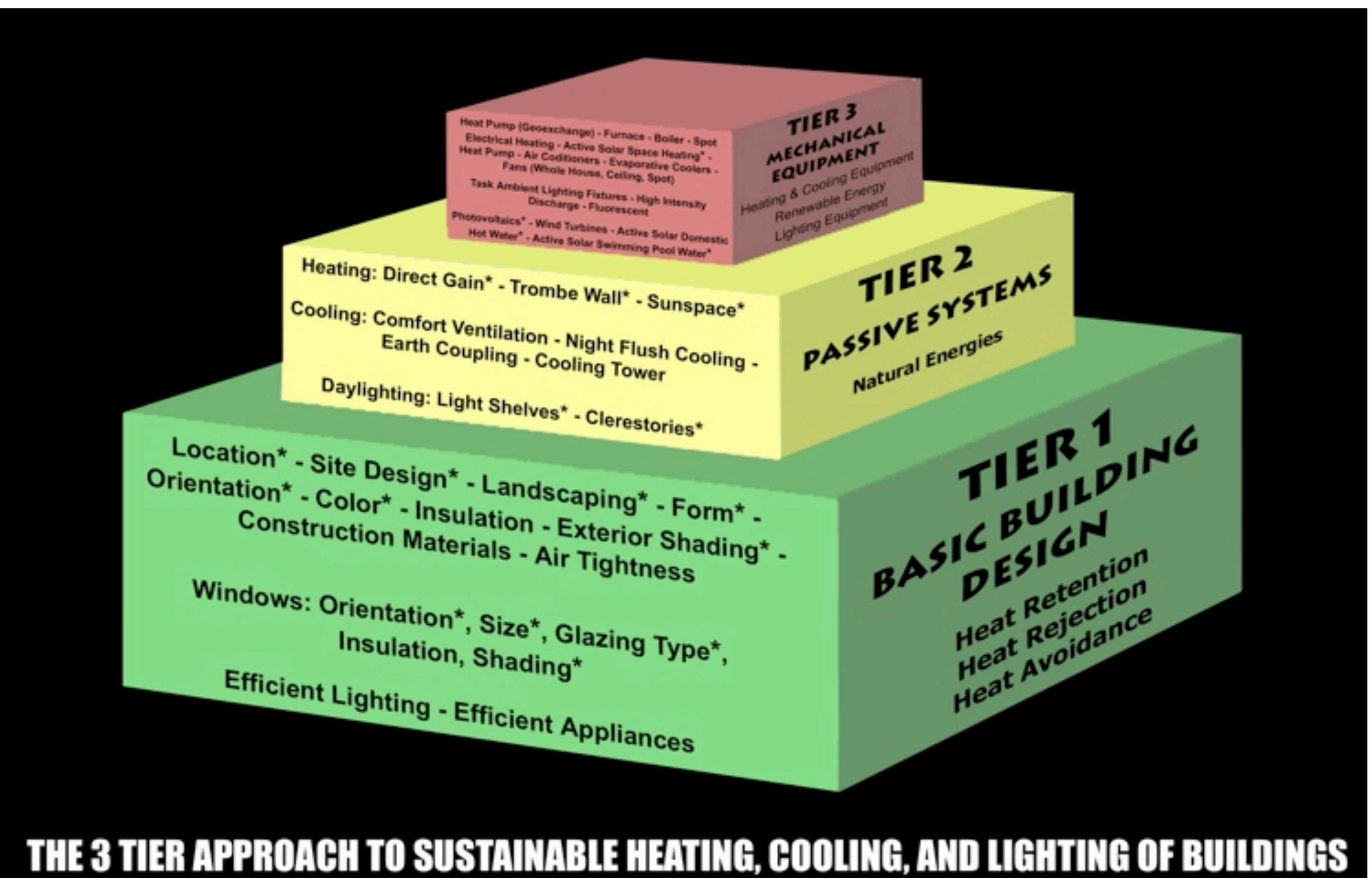
Figure A-4: "Skytherm"R sthermal storage roofs -- summer and winter operation (HON).

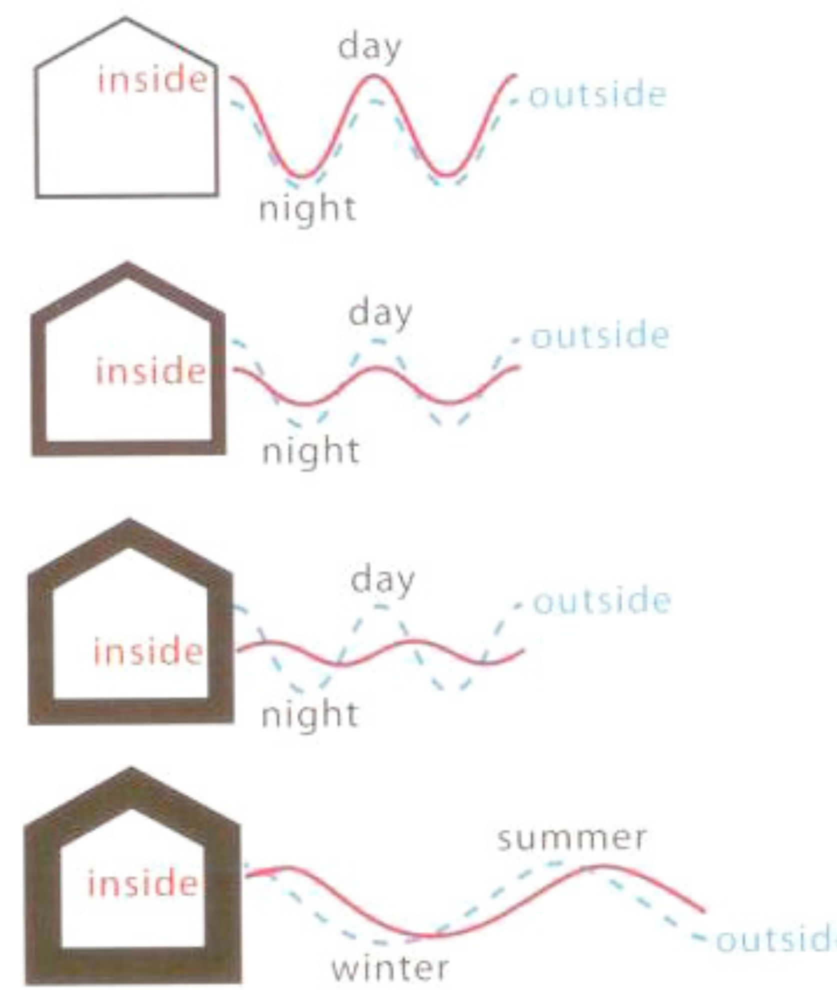
Trombe Wall with Vents



Passive House는 새로운 것이 아니다.

기본과 패시브 디자인만으로 에너지 소비의 80%이상을 줄일수 있다.





Sustainable Architecture Module:

Introduction to Sustainable Design

College of Architecture and Urban Planning
The University of Michigan 1998

5 Green Principles

The Green House exhibition discusses **5 Green Principles** that underlie sustainable homes:

- Optimizing use of the sun
- Improving indoor air quality
- Using the land responsibly
- Creating high-performance and moisture-resistant houses
- Wisely using the Earth's natural resources

When you are building, renovating, or choosing interior finishes and materials for your home, consider some of the following actions and measures you can take to incorporate these principles for more healthy, efficient, and sustainable living.

http://www.nbm.org/exhibitions-collections/exhibitions/the-green-house/principles.html

Optimizing Use of the Sun

Most of us rely on oil, coal, natural gas, and other fossil fuels to heat and cool our homes. Not only are these resources expensive and polluting, they are also being rapidly depleted. A simple and cost-effective alternative is to plug your house into the sun by either active or passive strategies.

Active strategies use solar photovoltaics that turn the sun's heat into energy.

Adopting passive strategies means that you do some of the following:

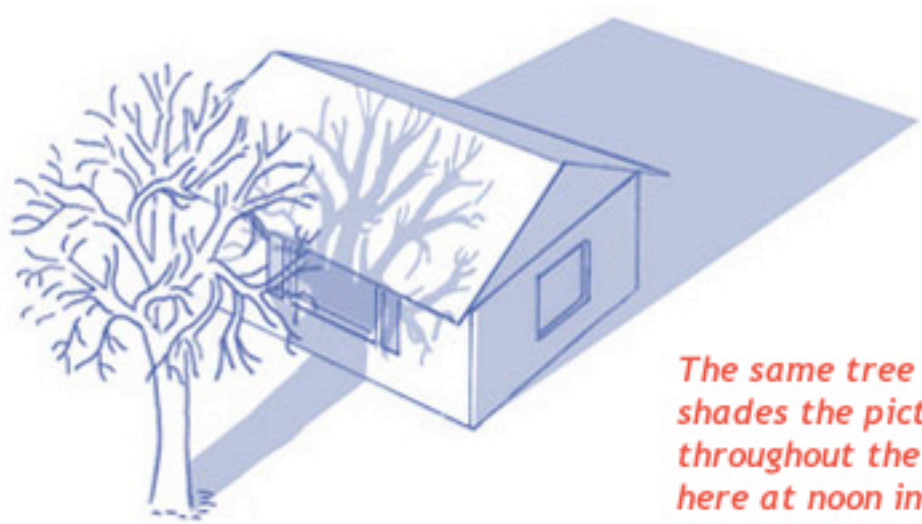
Design and orient the house to **minimize summer afternoon solar heat gain and optimize winter solar heat gain**.

Situate the house to take advantage of prevailing breezes during the spring, summer, and fall. Not only are these breezes valuable for cross-ventilation in the house, but they can make screened-in rooms and porches more comfortable places to live.

Plant shade trees and shrubs around your house. In summer, well-placed foliage helps keep the house cool, while bare branches in winter let the sunlight through to warm the house.

Statistic: *The world's oil reserves are expected to last about 40 more years. Natural gas reserves may last 67 years. The sun's energy supply will last billions of years.*
Smart Move: *Join thousands of others in turning to solar energy as a renewable, clean and cost saving alternative to fossil fuels.*

The shadow of a 25-foot-tall tree located 20 feet south of a home completely misses the home in summer as shown here at noon in July.



The same tree detrimentally shades the picture window throughout the winter as shown here at noon in January.

How to Plant Trees for Cooling Shade

West and East Plantings Best. If your house needs cooling in the summer, your first priority should be planting trees to shade the house's west or northwest walls from the afternoon summer sun. In summer and fall, when we have long days and the sun angle is very low in the sky, the sun can easily shine directly into windows, bringing unwanted heat. Cooling shade is most needed during the afternoon, when temperatures are highest and the incoming sunshine is greatest.

"During August and September, which are Ventura County's hottest months, the sun's angle is actually lower than it is on the solstice in June", says landscape architect Kathy Nolan. "When you are preparing to plant a shade tree, consider how the tree's shade will shelter your building during those late summer months."

A shade tree between the western afternoon sun and the house will help reduce the need for air conditioning. West/northwest plantings also minimize shading on southern windows, where winter sunshine is most desired. For even more shading during the longest days of the year, plant smaller deciduous or evergreen trees with lower limbs northwest of the building to provide late afternoon and early morning shade.

East walls are the second most important to shade from the morning summer sun.

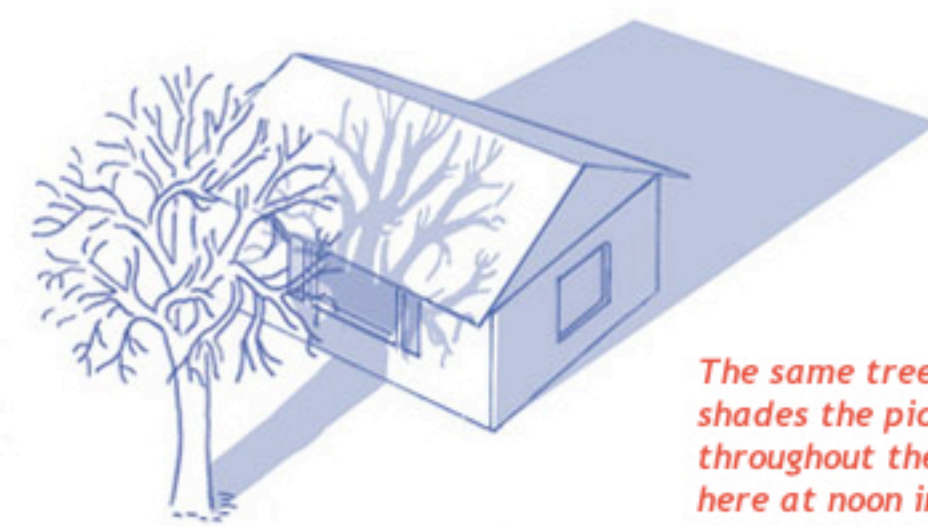
Plant trees at least 10 feet from the house, but more distance may be appropriate depending upon the species' height, width, and the invasiveness of the root system.

How to Plant Trees for Cooling Shade

Avoid South Plantings

Trees planted on the south side of a building are usually not helpful in our area.
These trees may not provide much shade in the summer, when the sun is high in the sky, and may block desired wintertime sun, when the sun is low in the sky. Even deciduous trees that have dropped their leaves cast quite a bit of shade in the winter.
Because the sun is so high in the summer, making shadows—and thus shade—small, trees planted to the south will only shade a building in the summer if they extend over the roof, so the shadow falls on the house.

The shadow of a 25-foot-tall tree located 20 feet south of a home completely misses the home in summer as shown here at noon in July.



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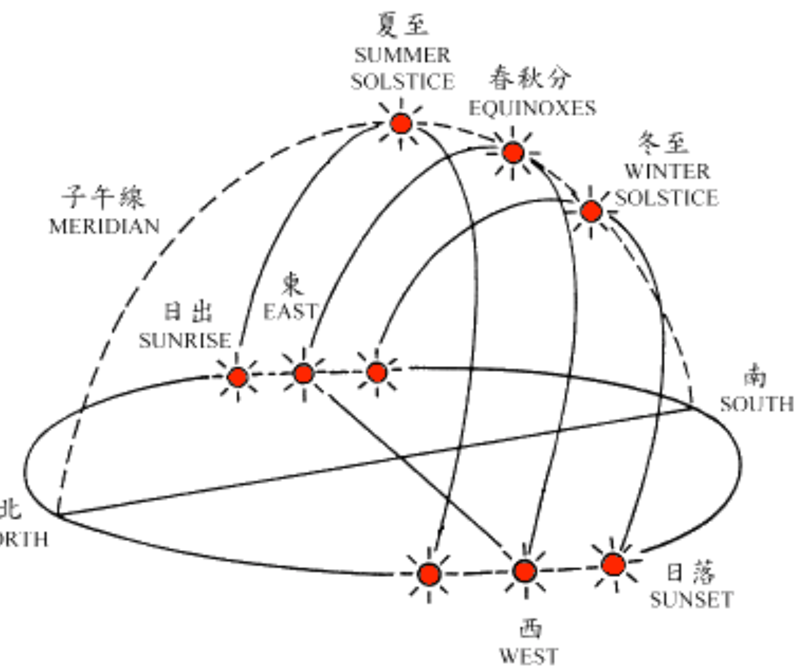
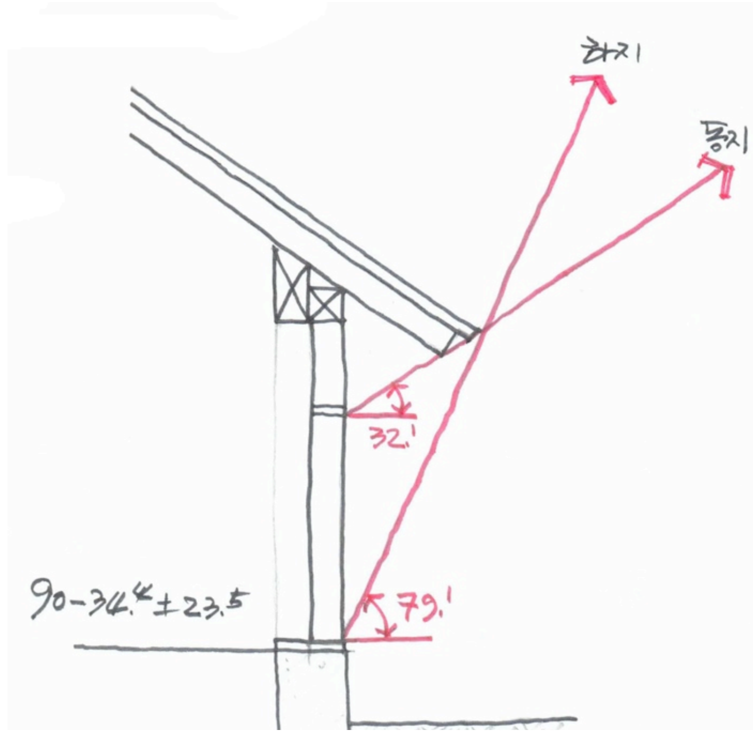
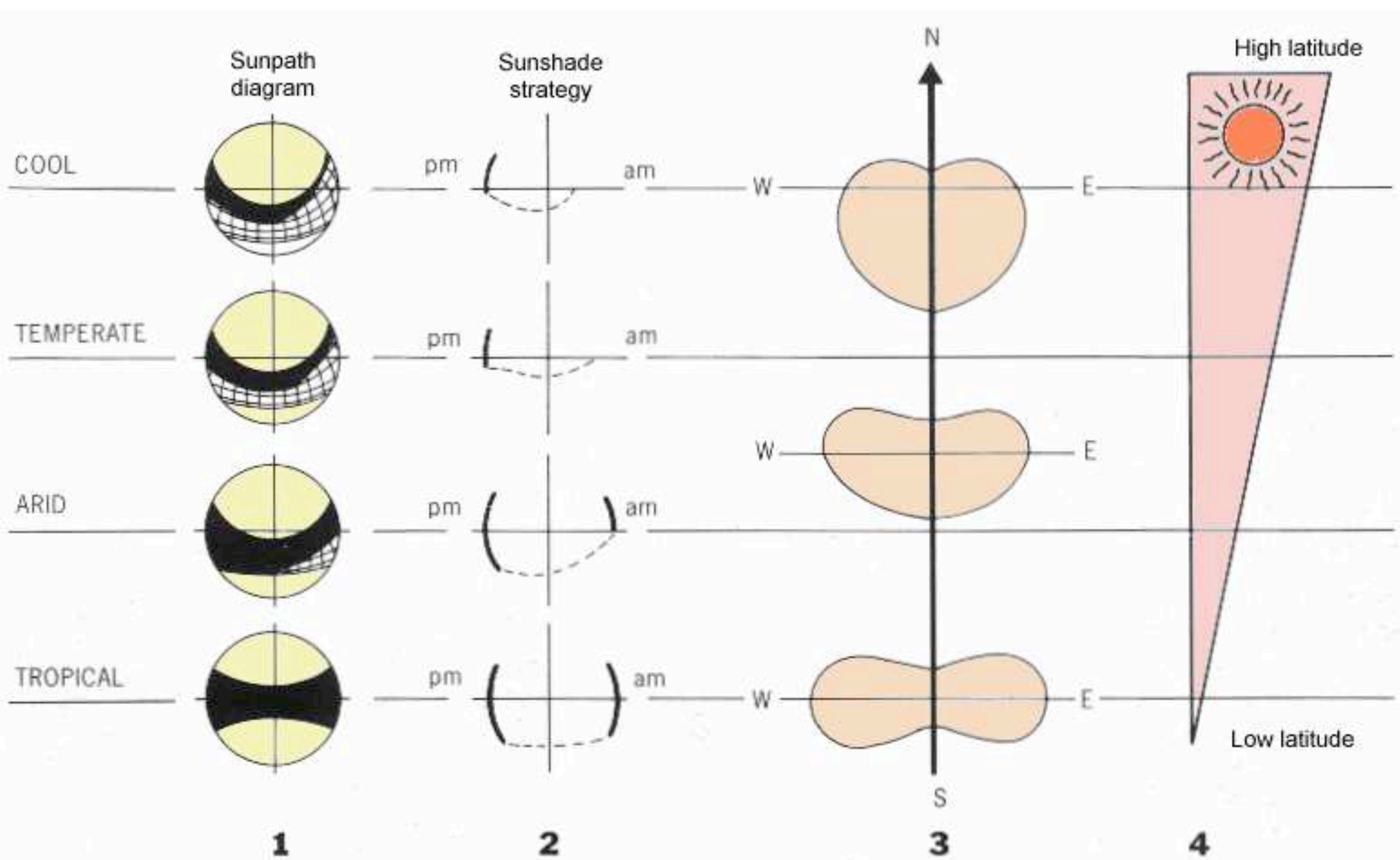


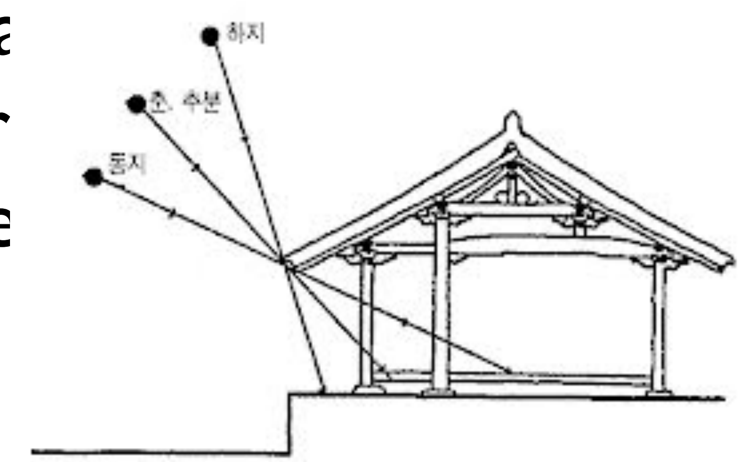


Sunshade Analysis

태양고도를 고려한 창대위치결정

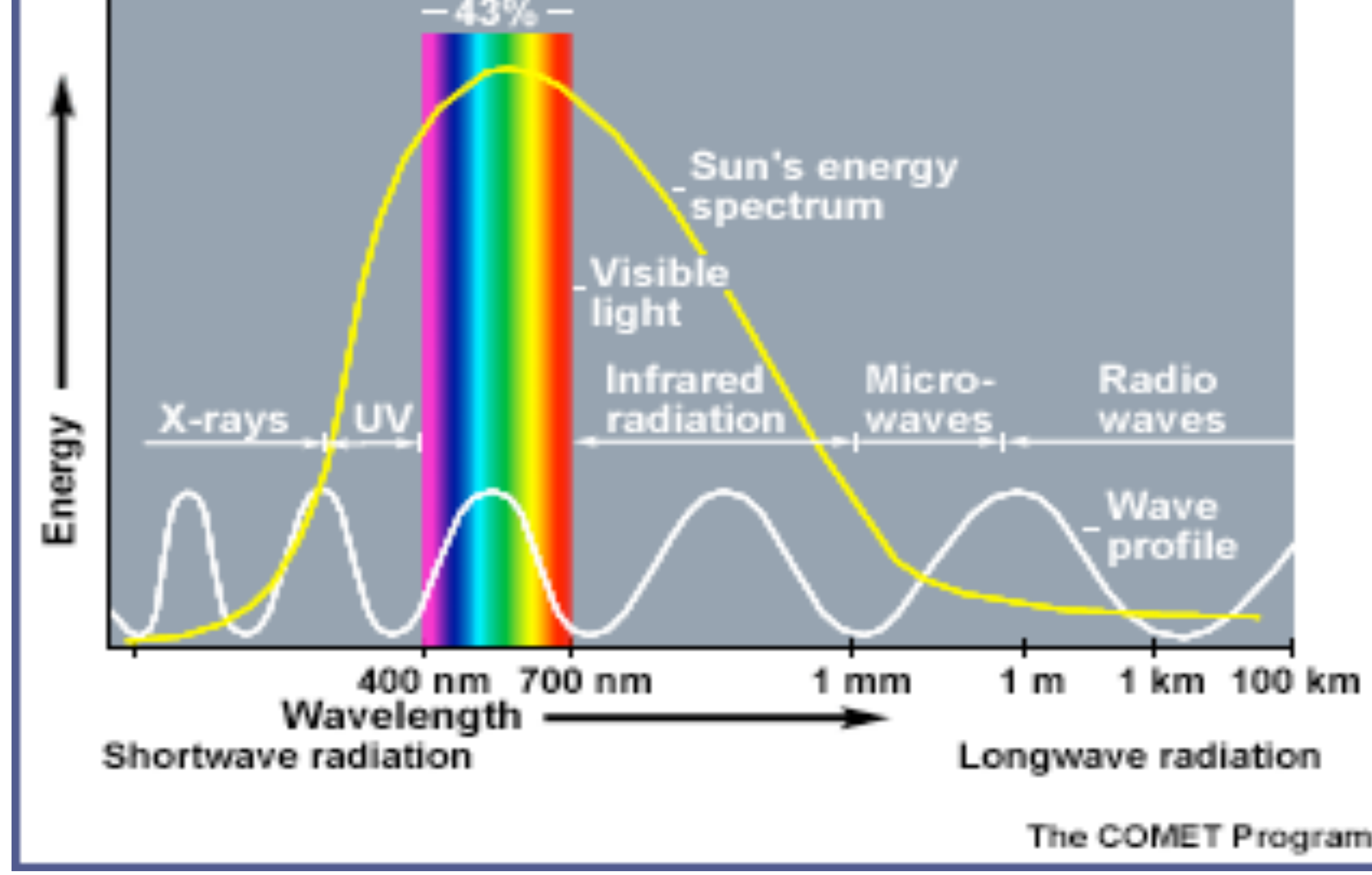


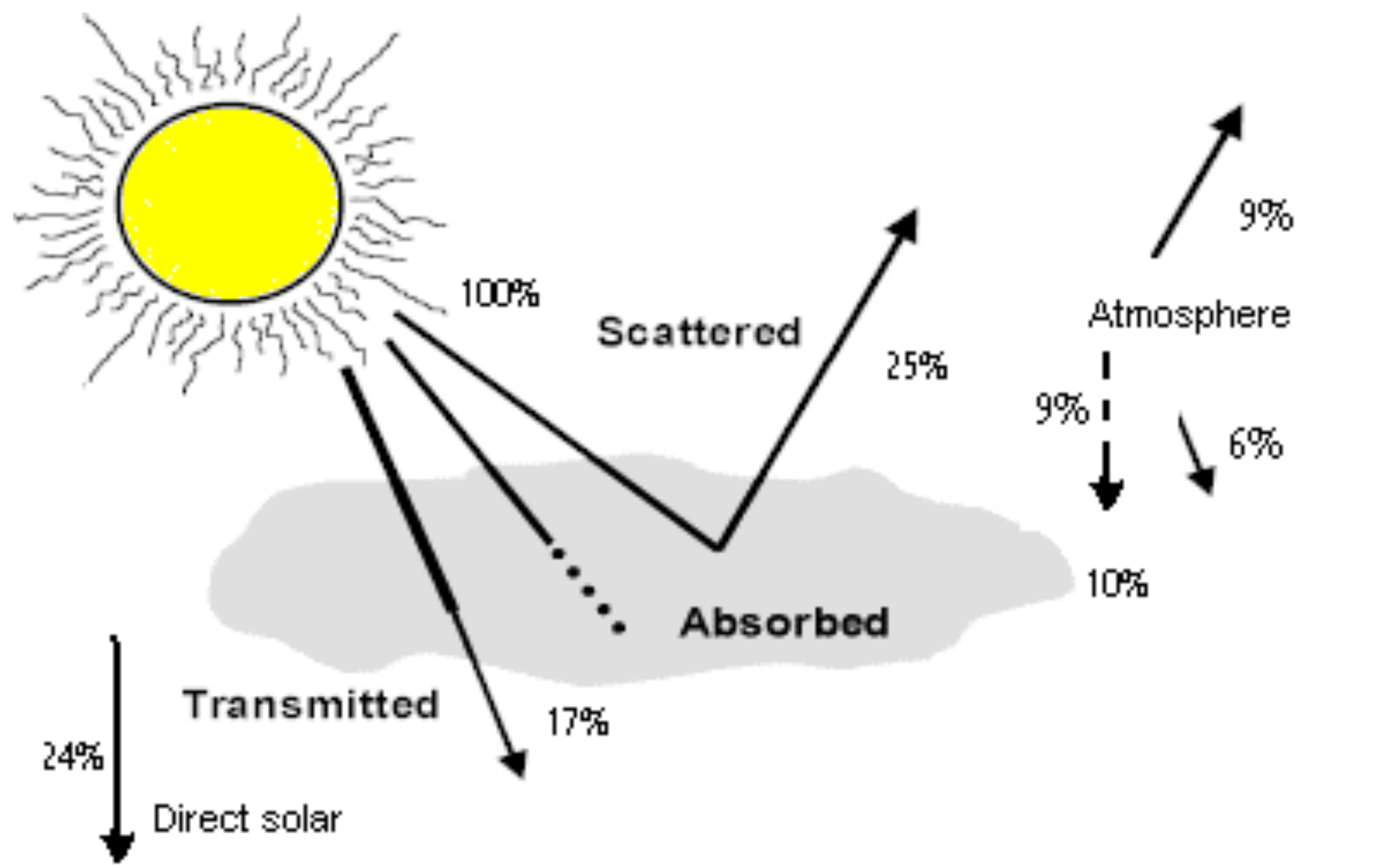
- Solar paths requiring shade
- Sunshade analysis(vertical and horizontal)
- Insol
- Sun r
  winte



태양

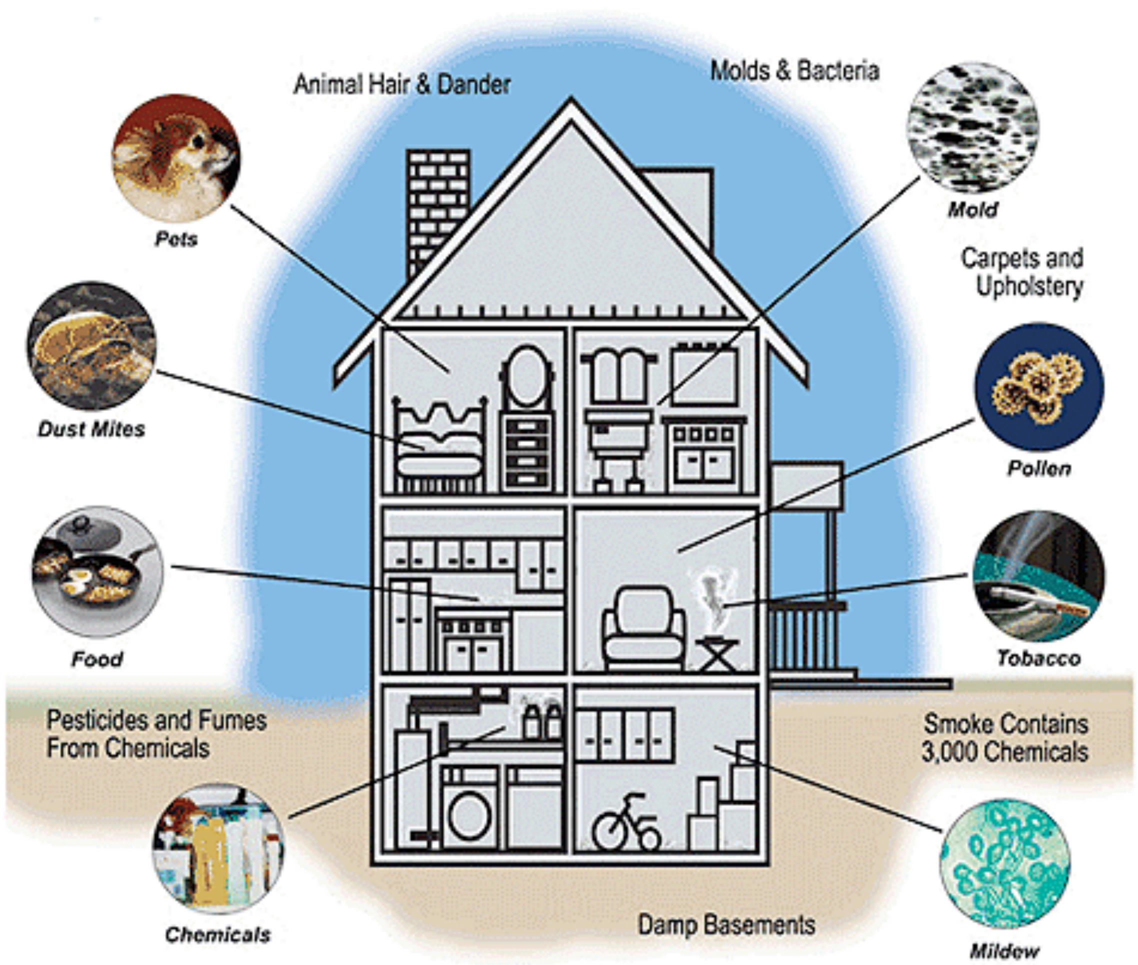
모든 에너지의 근원
 47% 만이 지구에 도달
 30일간의 태양빛은 전지구의 화석연료와 같음
에너지 밀도가 낮음





Improving Indoor Air Quality

Statistic: *Indoor air pollution consistently ranks among the top five environmental risks to public health.*
Smart Move: *Improve air quality in your home by increasing ventilation, choosing non-toxic materials, and using air filters to remove up to 95% of airborne pollutants.*



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Americans spend up to 90% of their time indoors where air quality can be more polluted than outdoors. Pollutants range from toxins, such as asbestos and formaldehyde found in building materials, to allergens such as mold, mildew, fungus, bacteria, and dust mites. The negative effects of these pollutants may cause health problems upon initial exposure or even many years later.

There are measures that can be taken to improve indoor air quality:

Choose ventilation systems that remove dirt, dust, moisture, humidity, and pollutants.

Seal off the garage from the house to eliminate fumes from cars and lawn mowers.

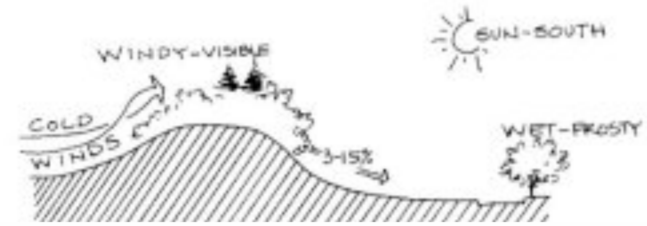
Select materials, such as those without formaldehyde, that limit off-gassing, have minimal or no toxic properties, and do not shed dust or fiber.

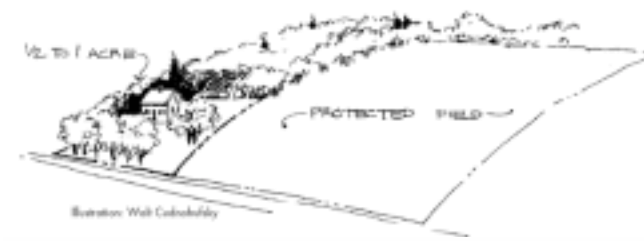
Test your home for toxins that influence air quality with a do-it-yourself kit or hire a specialist.

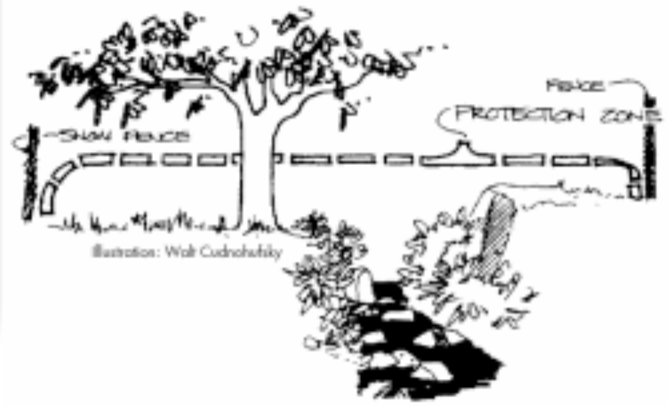
Use the exhaust fan over your stove to remove gases like carbon monoxide. Use fans in the bathroom to remove water vapors that can cause molds to grow.

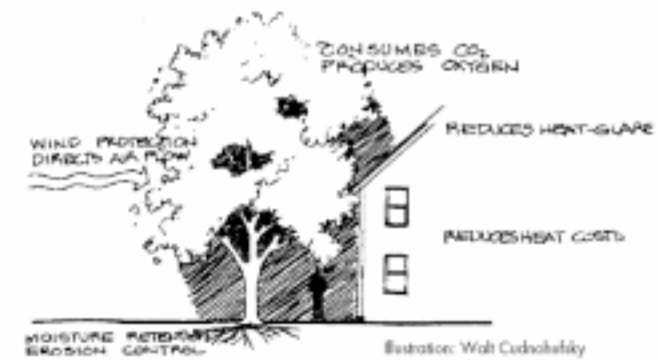
Using the Land Responsibly

Statistic: *Every year sprawling development engulfs 1 million acres of open space.*
Smart Move: *Vote to conserve wilderness areas and support one of the 240 anti-sprawl nitiatives across America.*









Using the Land Responsibly

You can create a sustainable house by making good use of the land your house sits on and by considering the impact of the house on the surrounding environment. When looking to buy a new home, consider the following advantages:

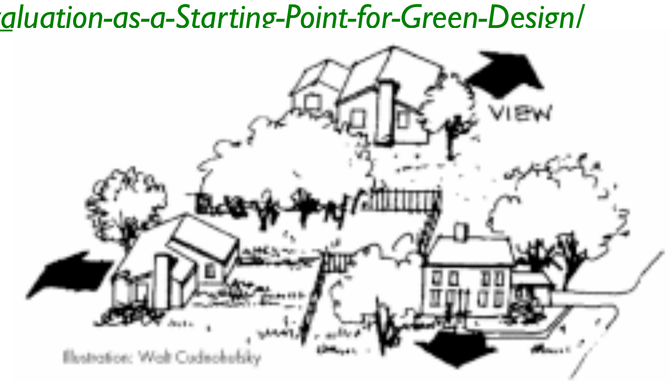
Buy a smaller, more compact house on a lot that is located near work, public transportation, and community services to save fuel and money.

Choose a neighborhood where houses are clustered closer together, leaving more open space for residents to enjoy and helping to preserve the natural landscape.

Adopt smart gardening practices like using organic pesticides and composts, as well as native plants that do not require extensive irrigation systems.

Use landscaping rather than paved surfaces, which impede storm water infiltration, often resulting in the contamination of local water sources.

http://www.buildinggreen.com/auth/article.cfm/1998/3/1/Getting-to-Know-a-Place-Site-Evaluation-as-a-Starting-Point-for-Green-Design/



Creating High-Performance and Moisture-Resistant Houses

The roof, walls, windows, and doors of a house create an envelope that protects residents from the weather and intruders, including pests, noise, and dirt. It also controls the entry of sunlight and, most importantly, helps maintain indoor comfort. Maintaining a constant level of comfort is often wasteful and expensive but can be done efficiently and economically by the following means:

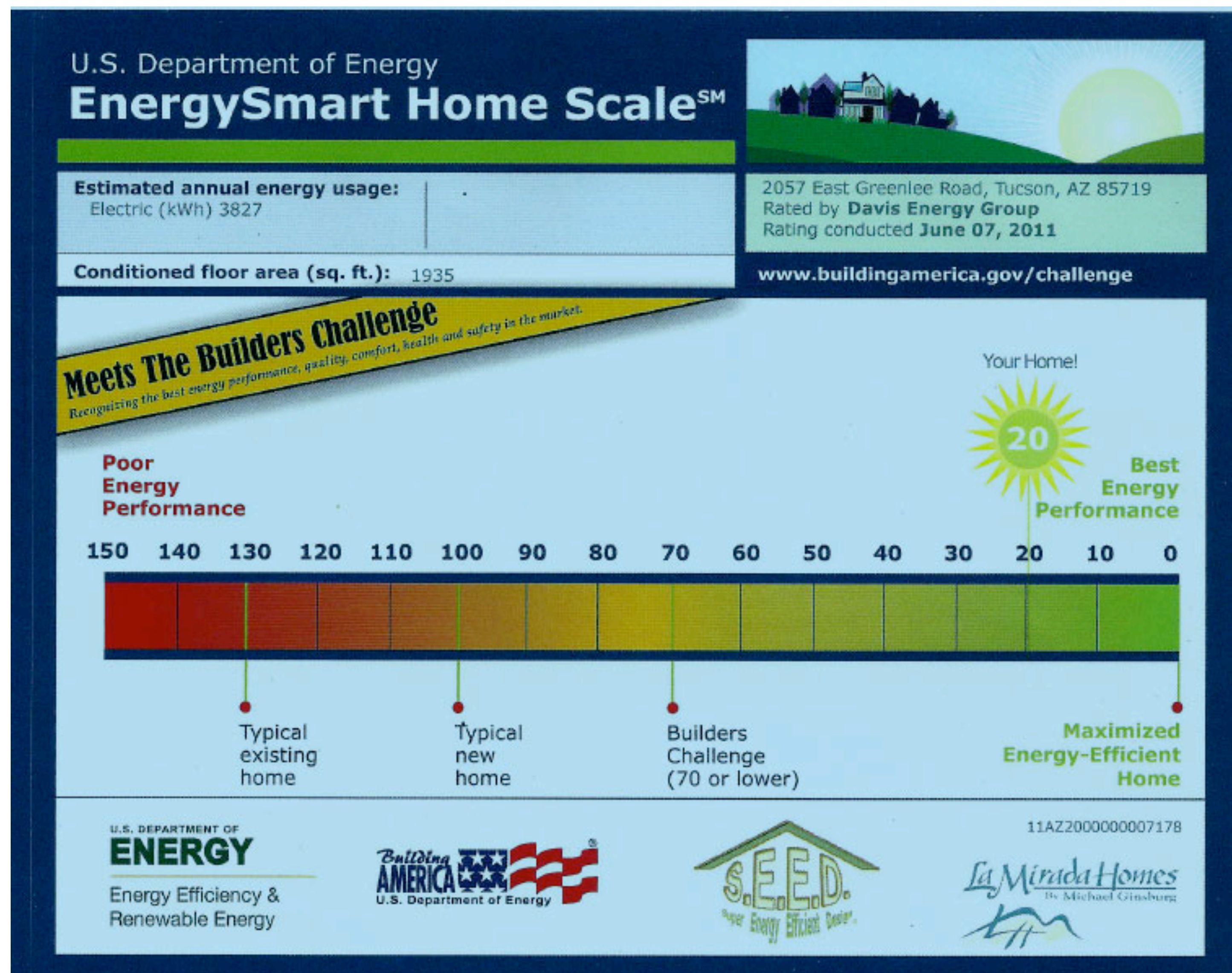
Create a building envelope with more durable and energy-efficient materials that reduce drafts, balance room temperatures, control moisture, and save on heating and cooling costs.

Seal any gaps or cracks where moisture can get in and heat or cooling can leak out.

Schedule a home energy audit. Many utilities offer them for free and the expert advice can result in big energy savings.

Statistic: *According to recent estimates, the United States consumes more energy than any other nation, accounting for 22.8% of the world's total energy use. Nearly one quarter of that share of that is used to power our homes.*

Smart Move: *By sealing air leaks and using energy-efficient technologies in your home, you can significantly reduce your energy consumption and cut your bills by up to 80%.*



Wisely Using the Earth's Natural Resources

Statistic: *Less than 20 % of the world's old growth forests remain today.*
Smart Move: *By choosing wood products certified by the international Forest Stewardship Council, you can help ensure that our ancient forests don't disappear. Visit www.fsc.org for more information.*

The earth provides us with a finite amount of natural resources and it is our responsibility to make them last. It is also up to us to use these resources in ways that are not detrimental to the environment or our health. When selecting products and materials to use in your home, look for ones that have:

High levels of:
Renewability, Reusability & Durability

Low levels of:
Embodied energy, or energy required to extract, process, and transport materials Environmental impact, or negative effects on outdoor and indoor environments.

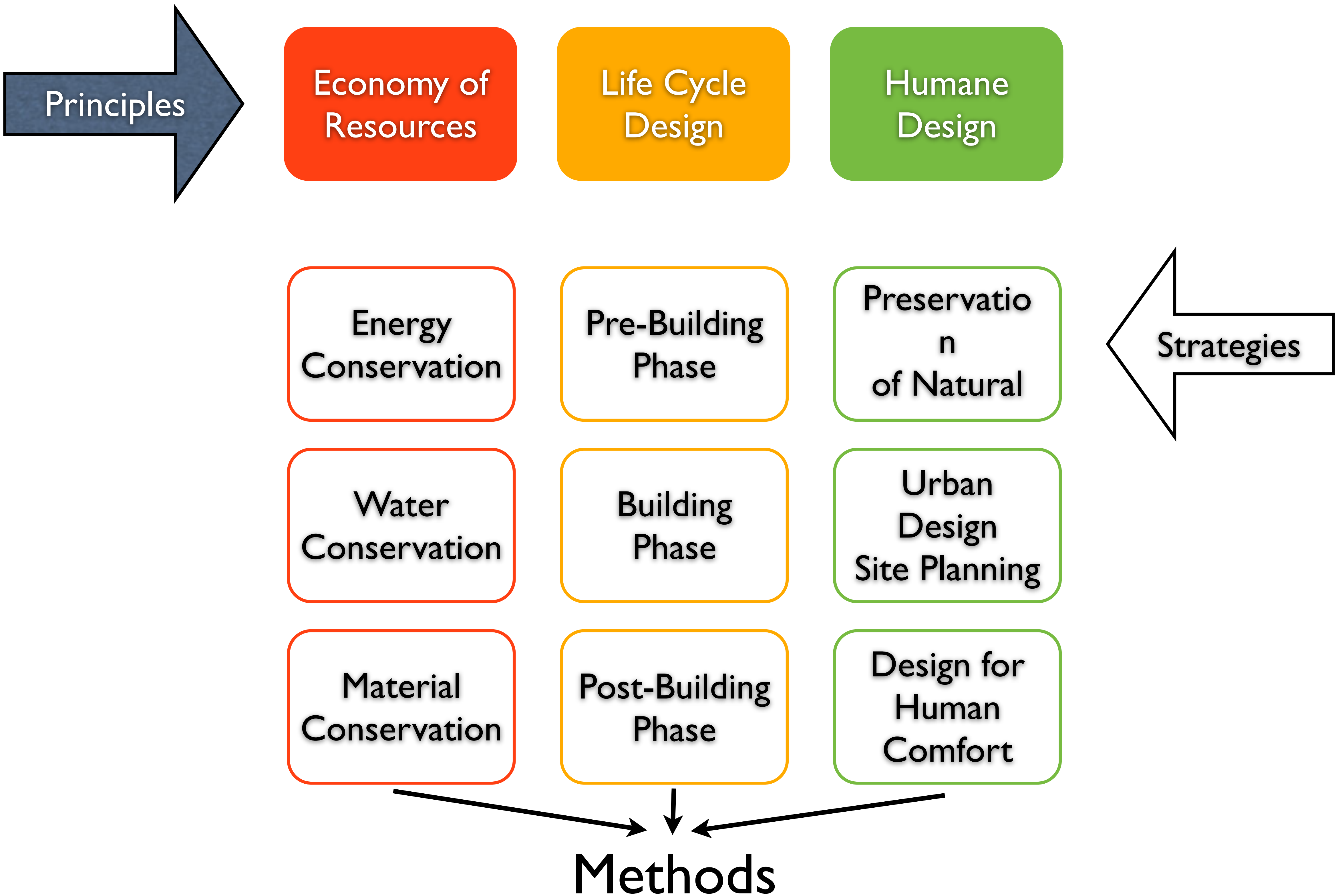
Principles of Sustainable Design

Economy of Resources is concerned with the reduction, reuse, and recycling of the natural resources that are input to a building.

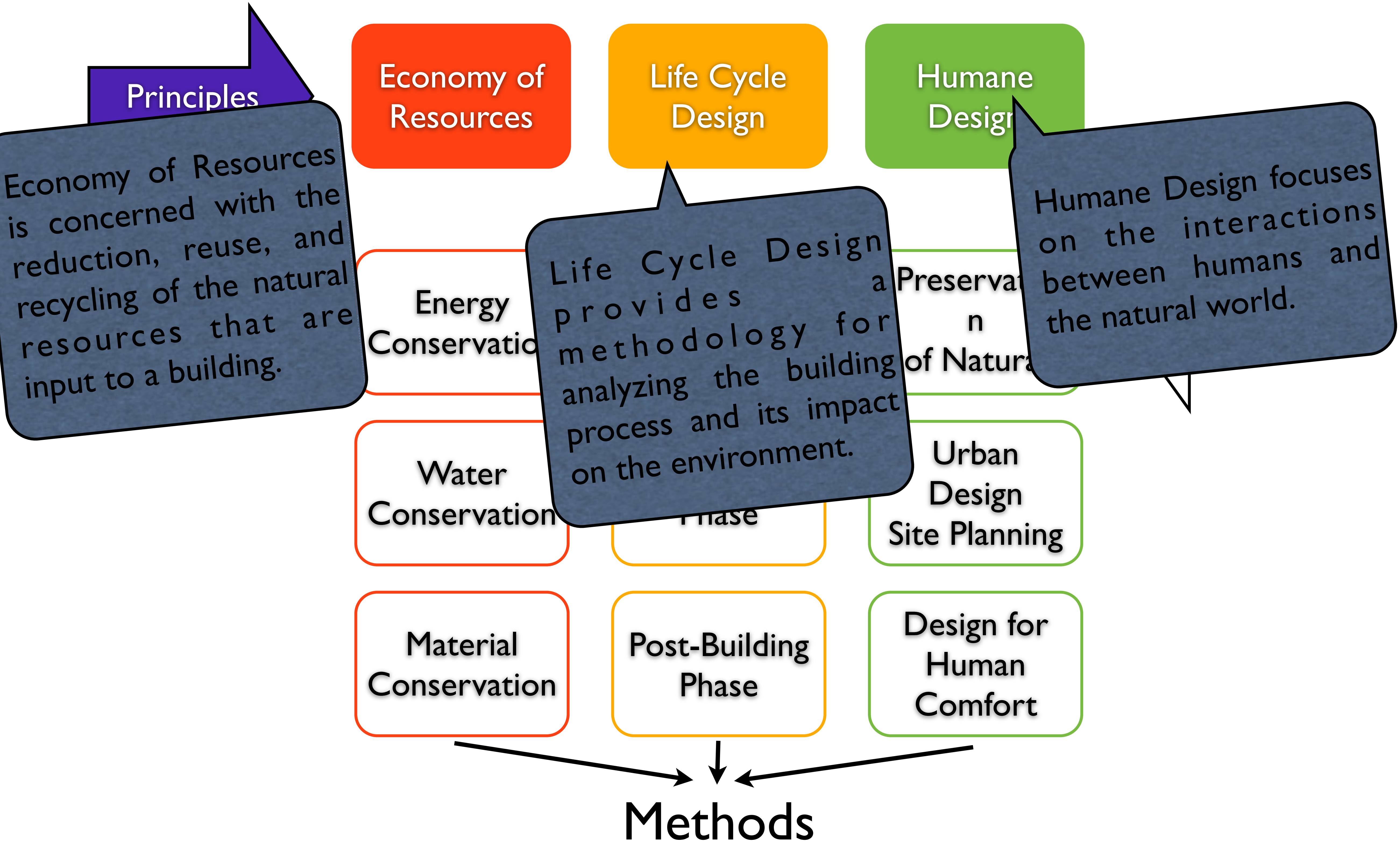
Life Cycle Design provides a methodology for analyzing the building process and its impact on the environment.

Humane Design focuses on the interactions between humans and the natural world. These principles can provide a broad awareness of the environmental impact, both local and global, of architectural consumption.

Conceptual framework for Sustainable Design and Pollution Prevention in Architecture



Conceptual framework for Sustainable Design and Pollution Prevention in Architecture



Principle I Economy of Resources

By economizing resources, the architect reduces the use of nonrenewable resources in the construction and operation of buildings. There is a continuous flow of resources, natural and manufactured, in and out of a building. This flow begins with the production of building materials and continues throughout the building's life span to create an environment for sustaining human well-being and activities. After a building's useful life, it should turn into components for other buildings.

When examining a building, consider two streams of resource flow. Upstream, resources flow into the building as input to the building ecosystem. Downstream, resources flow out of the building as output from the building ecosystem. In a long run, any resources entered into a building ecosystem will eventually come out from it. This is the law of resource flow conservation.

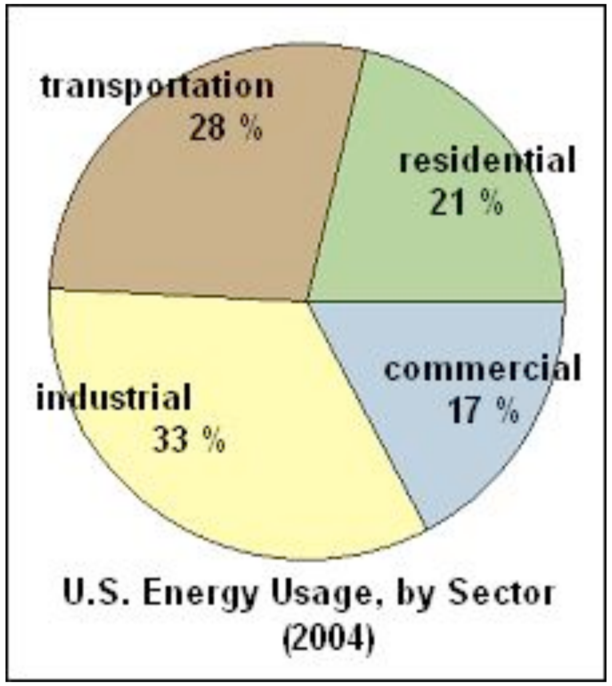
For a given resource, its forms before entry to a building and after exit will be different. This transformation from input to output is caused by the many mechanical processes or human interventions rendered to the resources during their use in buildings. The input elements for the building ecosystem are diverse, with various forms, volumes, and environmental implications.

The three strategies for the economy of resources principle are energy conservation, water conservation, and material conservation. Each focuses on a particular resource necessary for building construction and operation.

Material Flow in the Building Ecosystem

Upstream	Building	Downstream
Materials		Used Materials
Energy		Combustion Byproduc
Water		Graywater Sewage
Consumet Goods		Recycleable Materials
Solar Radiation		Wasted Head
Wind		Polluted Air
Rain		Groundwater

Principle I Economy of Resources



Energy Conservation

After construction, a building requires a constant flow of energy input during its operation. The environmental impacts of energy consumption by buildings occur primarily away from the building site, through mining or harvesting energy sources and generating power. The energy consumed by a building in the process of heating, cooling, lighting, and equipment operation cannot be recovered.

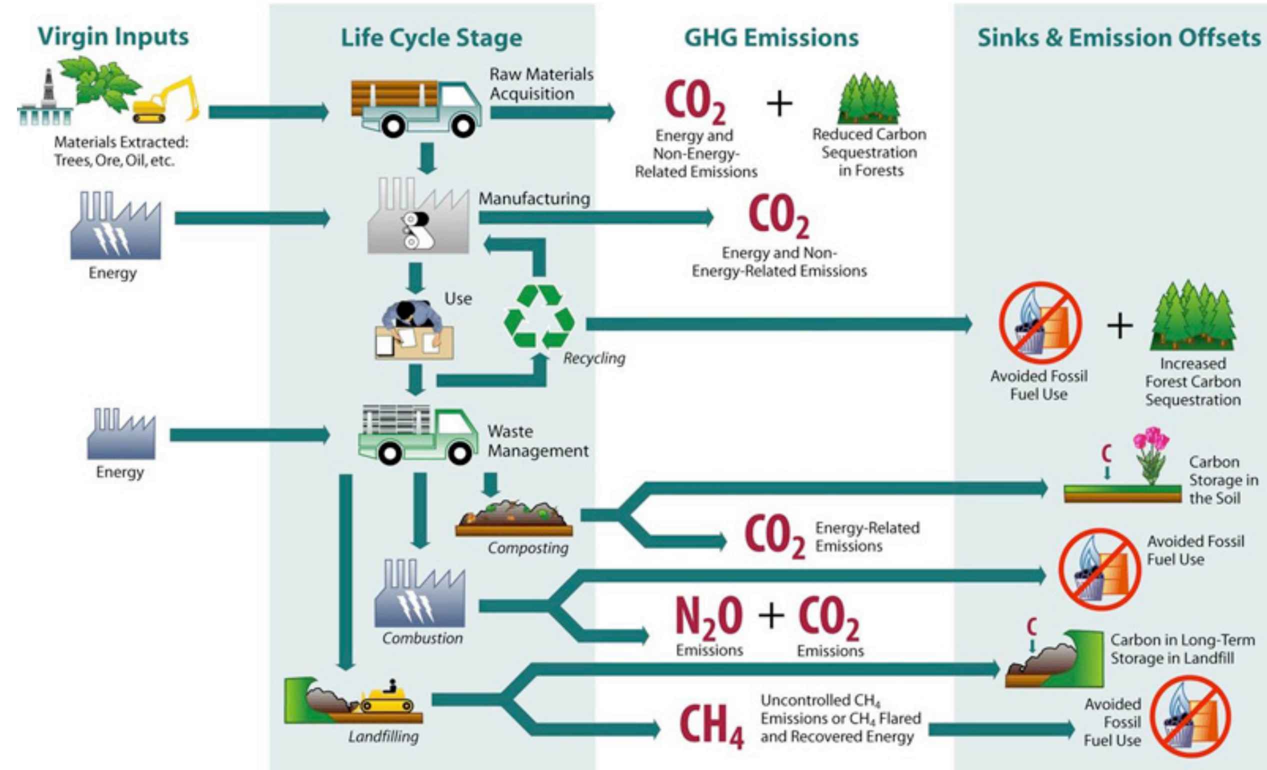
The type, location, and magnitude of environmental impacts of energy consumptions in buildings differ depending on the type of energy delivered. Coal-fired electric power plants emit polluting gases such as SO2 , CO2 , CO, and NOx into the atmosphere. Nuclear power plants produce radioactive wastes, for which there is currently no permanent management solution. Hydropower plants each require a dam and a reservoir which can hold a large body of water; construction of dams results in discontinuance of river ecosystems and the loss of habitats for animals and plants.

Principle 1 Economy of Resources

Water Conservation

A building requires a large quantity of water for the purposes of drinking, cooking, washing and cleaning, flushing toilets, irrigating plants, etc.. All of this water requires treatments and delivery, which consume energy. The water that exits the building as sewage must also be treated.

Principle I Economy of Resources



Material Conservation

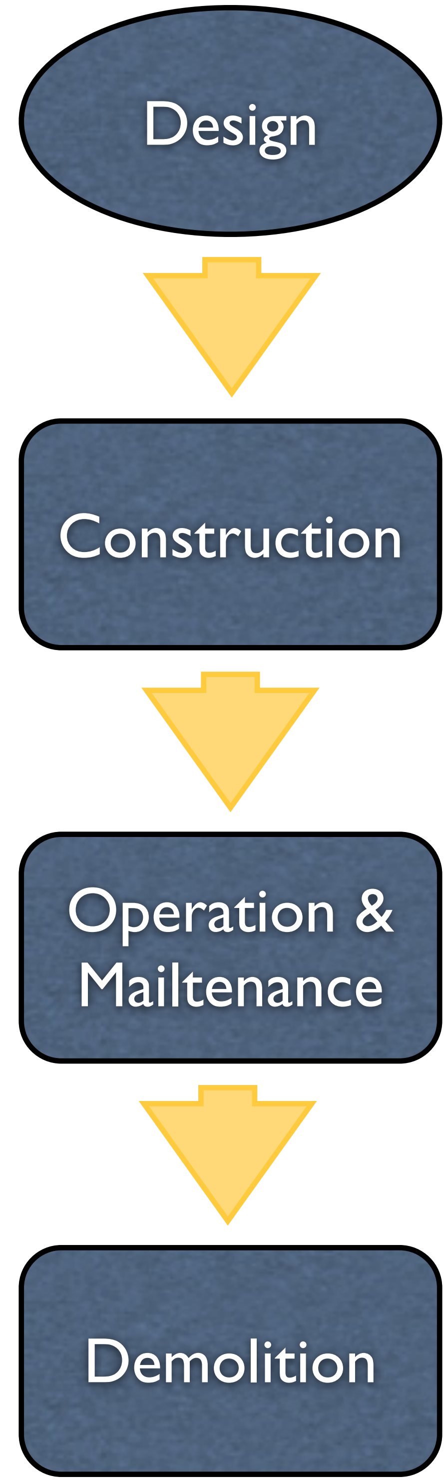
A range of building materials are brought onto building sites. The influx of building materials occurs primarily during the construction stage. The waste generated by the construction and installation process is significant. After construction, a low-level flow of materials continues in for maintenance, replacement, and renovation activities. Consumer goods flow into the building to support human activities. All of these materials are eventually output, either to be recycled or dumped in a landfill.

Principle 2 Life Cycle Design

The conventional model of the building life cycle is a linear process consisting of four major phases: design; construction;operation and maintenance; and demolition. The problem with this model is that it is too narrowly defined: it **does not address environmental issues** (related to the procurement and manufacturing of building materials) or waste management (reuse and recycling of architectural resources).

The second principle of sustainable architecture is life cycle design (LCD). This "cradle-to-grave" approach recognizes environmental consequences of the entire life cycle of architectural resources, from procurement to return to nature. LCD is based on the notion that a material transmigrates from one form of useful life to another, with no end to its usefulness.

For the purpose of conceptual clarity, the life



Conventional model of the building life cycle

Principle 2 Life Cycle Design

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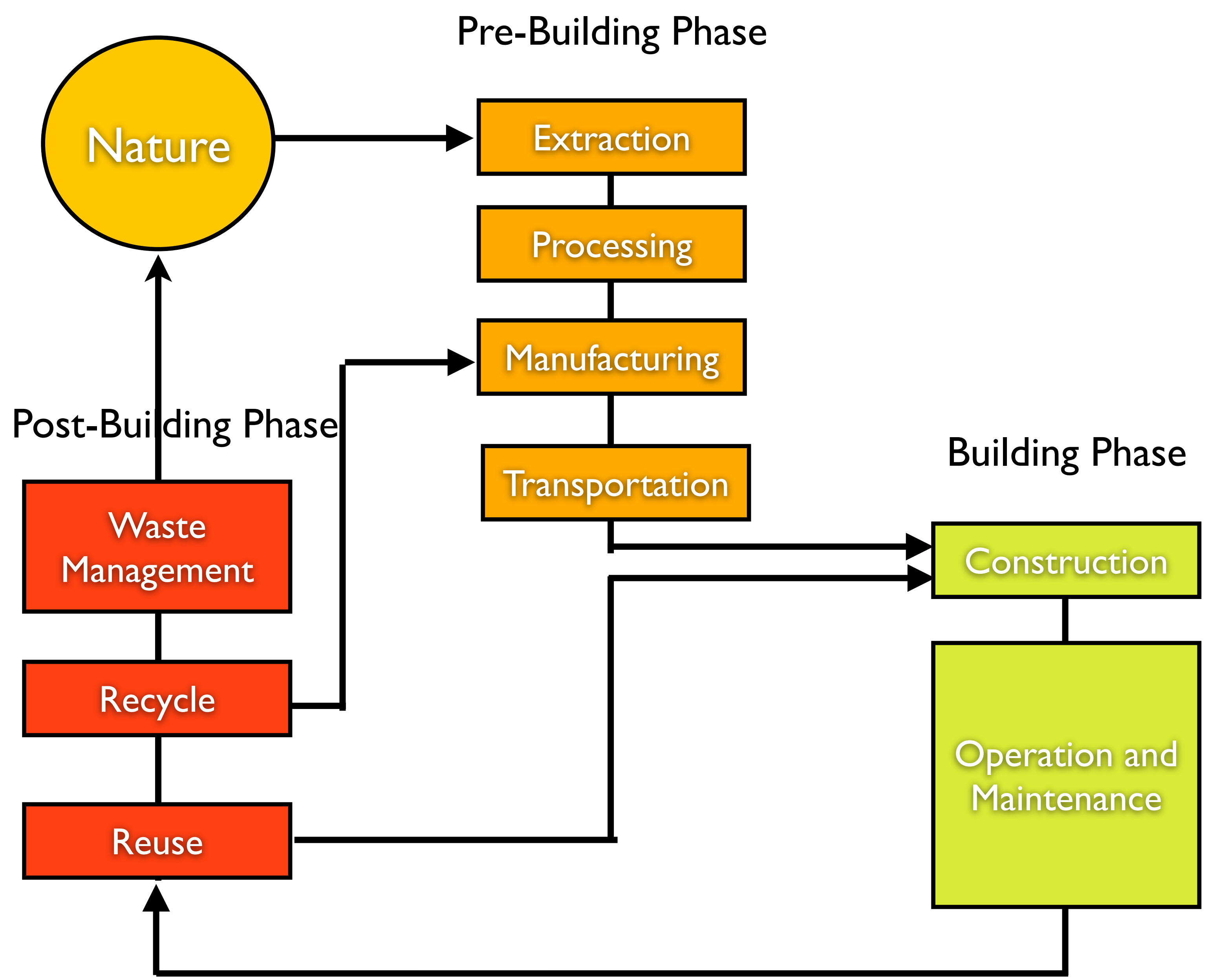
For the purpose of conceptual clarity, the life cycle of a building can be categorized into three phases: **pre-building, building, and post-building**. These phases are connected, and the boundaries between them are not obvious. The phases can be developed into LCD strategies that focus on minimizing the environmental impact of a building. Analyzing the building processes in each of these three phases provides a better understanding of how a building's design, construction, operation, and disposal affect the larger ecosystem.



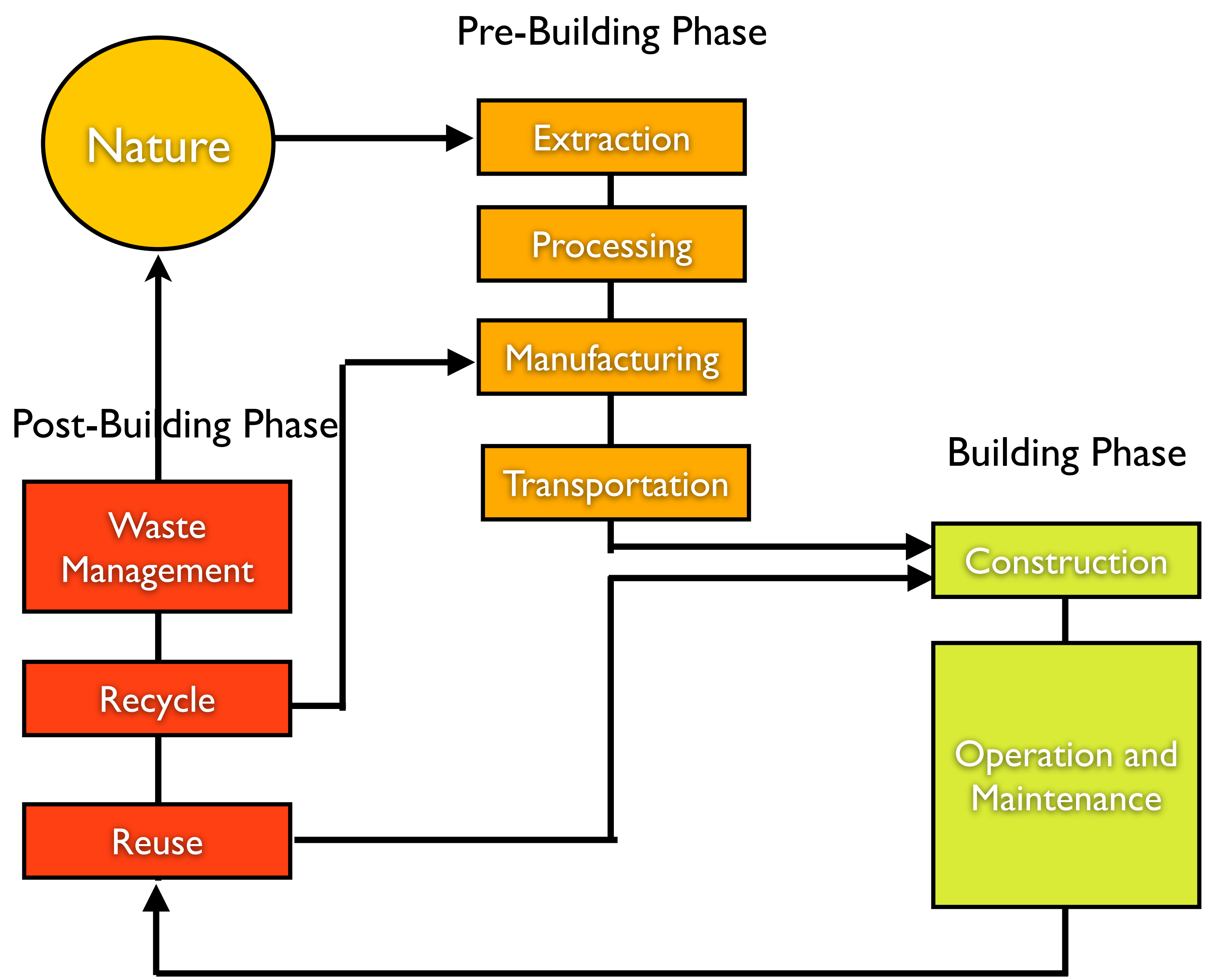
The Sustainable Building Life Cycle

Principle 2 Life Cycle Design

Pre-Building Phase

This phase includes site selection, building design, and building material processes, up to but not including installation. Under the sustainable-design strategy, we examine the environmental consequences of the structure's design, orientation, impact on the landscape, and materials used.

The procurement of building materials impacts the environment: harvesting trees could result in deforestation; mining mineral resources (iron for steel; bauxite for aluminum; sand, gravel, and limestone for concrete) disturbs the natural environment; even the transport of these materials can be a highly polluting activity, depending on their weight and distance from the site. The manufacturing of building products also requires energy and creates environmental pollution: for example, a high level of energy is required to manufacture steel or aluminum products.

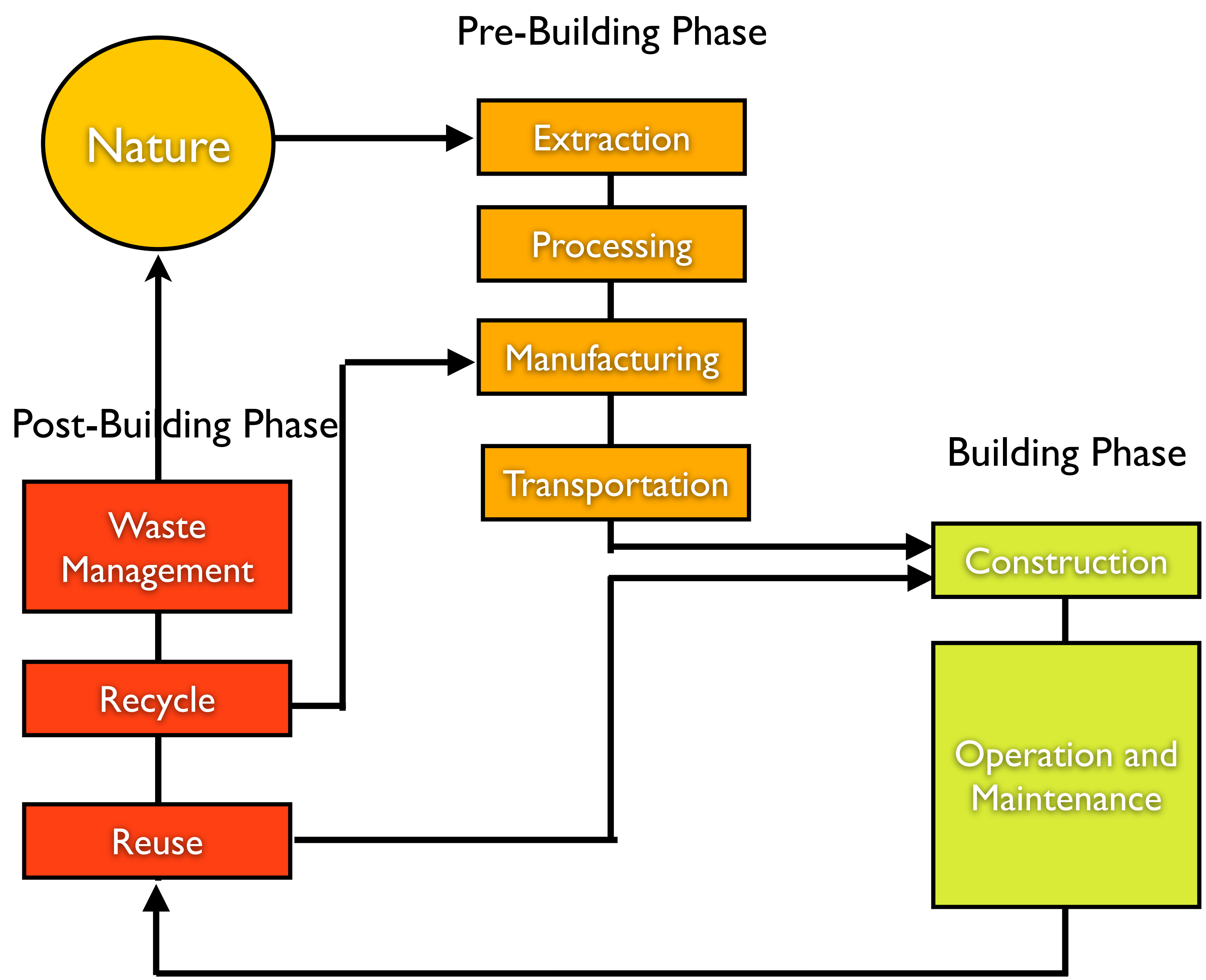


The Sustainable Building Life Cycle

Principle 2 Life Cycle Design

Building Phase

This phase refers to the stage of a building's life cycle when a building is physically being constructed and operated. In the sustainable-design strategy, we examine the construction and operation processes for ways to reduce the environmental impact of resource consumption; we also consider long-term health effects of the building environment on its occupants.

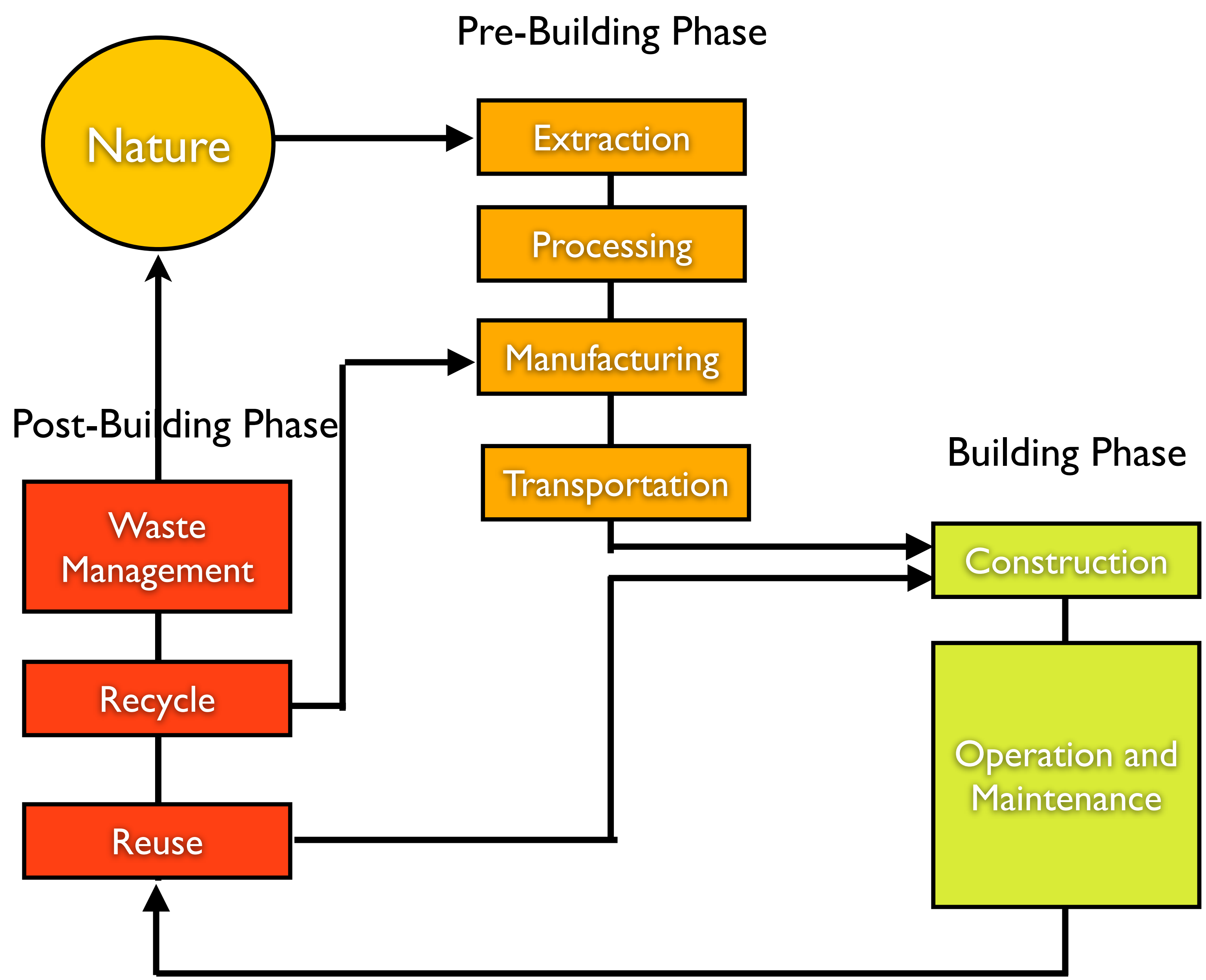


The Sustainable Building Life Cycle

Principle 2 Life Cycle Design

Post-Building Phase

This phase begins when the useful life of a building has ended. In this stage, building materials become resources for other buildings or waste to be returned to nature. The sustainable design strategy focuses on reducing construction waste (which currently comprises 60% of the solid waste in landfills1) by recycling and reusing buildings and building materials.



The Sustainable Building Life Cycle

Principle 3 Humane Building

Perhaps the most important, principle of sustainable design. While **economy of resources and life cycle design deal with efficiency and conservation**, **humane design is concerned with the livability of all constituents of the global ecosystem**, including plants and wildlife. This principle arises from **the humanitarian and altruistic goal of respecting the life and dignity of fellow living organisms**. Further examination reveals that this principle is deeply rooted in the need to preserve the chain elements of the ecosystems that allow human survival.

In modern society, more than 70% of a person's lifespan is spent indoors. **An essential role of architecture is to provide built environments that sustain occupants' safety, health, physiological comfort, psychological well-being, and productivity.**

Because environmental quality is intangible, its importance has often been overlooked in the quest for energy and environmental conservation, which sometimes seemed to mean "shivering in the dark." Compounding the problem, many building designers have been preoccupied with style and form-making, not seriously considering environmental quality in and around their built environments .

Remember the **performance factor of design**. When a product saves energy, does it perform as well as what it is replacing? And how does it affect the performance of building occupants? For instance, early fluorescent lighting systems were more efficient than their incandescent counterparts; however, some fluorescents were known to buzz. The bulb might save $30 in annual energy costs, but if the noise irritated the employee working nearby, the employee's resulting drop in productivity could cost the employer a lot more, thereby wiping out any financial benefits gained from lighting energy conservation.

A general rule of thumb in such comparisons is that the annual energy bill of a typical office building amounts to around five hours of employee labor cost; therefore, **any building energy conservation strategy that annually reduces productivity by more than five hours per employee defeats its purpose**. This is not to say that energy conservation can't be financially beneficial, just that it should be kept in holistic perspective, taking other pertinent factors into accoun.

Principle 3 Humane Building

Preservation of Natural Conditions
An architect should minimize the impact of a building on its local ecosystem (e.g., existing topography, plants, wildlife).

Urban Design and Site Planning
Neighborhoods, cities, and entire geographic regions can benefit from cooperative planning to reduce energy and water demands. The result can be a more pleasant urban environment, free of pollution and welcoming to nature.

Human Comfort
Sustainable design need not preclude human comfort. Design should enhance the work and home environments. This can improve productivity, reduce stress, and positively affect health and well-being.

Summary

To achieve environmental sustainability in the building sector, architects must be educated about environmental issues during their professional training. Faculty have to foster environmental awareness, introduce students to environmental ethics, and developing their skills and knowledge-base in sustainable design.

The current status of sustainable design in architecture is that of an ethic rather than a science. While a change of lifestyles and attitudes toward the local and global environments is important, the development of scientific knowledge-bases that provide skills, techniques, and methods of implementing specific environmental design goals is urgent.

To enhance environmental sustainability, a building must holistically balance and integrate all three principles —Sustainable Design, Economy of Resources, and Life Cycle Design — in design, construction, operation and maintenance, and recycling and reuse of architectural resources. These principles comprise a conceptual framework for sustainable architectural design. This framework is intended to help designers seek solutions rather than giving them a set of solutions. Specific design solutions compatible with a given design problem will emanate from these principles.