S

is for Sustainable

Study, Selection, and Significance

in defining sustainable approaches to affordable housing

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Wagner Zaun
Architecture

Session Learning Objectives

1. Learn how and why “Sustainable” is a complex concept and, as such, that the use of sustainability as a guiding principle in housing must be viewed and used relative to changing conditions.
2. Understand the concept of the 6 hierarchical building layers, as described in the book “How Buildings Learn” by Stewart Brand.
3. Understand and learn how to apply the relevance of the 6 building layers when making choices in affordable housing development and construction.
4. Learn how a tool like the NCLT Sustainability Index can guide ongoing decisions in an agency’s development of more sustainable practices.
5. Learn how to evaluate and prioritize elements in a changing environment, and with limited financial resources.
6. Consider thinking more critically about the overall concept of “green building.” Understand that not all guidelines are applicable to every situation, and learn how to discern what to apply and when, especially in a changing environment and economy.

Sustainable according to Webster

Sustain:

- “To maintain, or cause to continue”
- “To endure without failing or yielding; to bear up under.”

Webster’s Collegiate Dictionary, 5th edition

“To bear up under…”

Occupants of affordable housing are among the most vulnerable to factors that affect the sustainability of a dwelling:

- Volatility in the economy
- Increasing energy costs
- Decreasing energy supply
- Environmentally-caused illness
- Fragile materials and systems

Sustainable Affordable Housing

"To maintain, or cause to continue …"

"To endure without failing or yielding…"

- Decreasing supplies of fossil fuels
- Rising gas prices
- Rising electric prices
- Rising food prices
- Rising transportation costs
- Increased health care costs
- Tenuous community cohesiveness

Housing, Energy, & Sustainability

- Housing currently accounts for 21% of all U.S. energy consumption

- In 1850, about 90% of the energy consumed in the United States was from renewable energy resources. Now the U.S. relies on non-renewable fossil fuels: coal, natural gas, and oil. In 2004, about 6% of all energy consumed and about 9% of total electricity production was from renewable energy resources.

- Source:Energy Information Administration, www.eia.doe.gov

Sustainability:
A New Set of Conditions

“Anything built today will spend most or all of its life in a post-peak world of worsening energy shortages.”

Tim Moerman, planner

Simple?

How do we decide what to build today in the face of rapidly-changing circumstances?

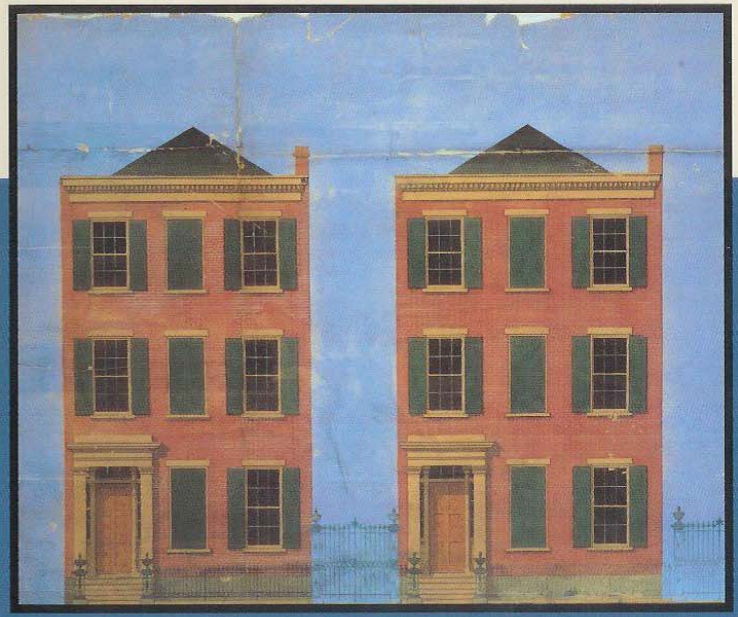
Study

How Buildings Learn:
The theory of building layers, a hierarchical system, helps to sort and prioritize elements within building construction and operation.

Developed by Stewart Brand and Frank Duffy

HOW BUILDINGS LEARN

What happens after they're built



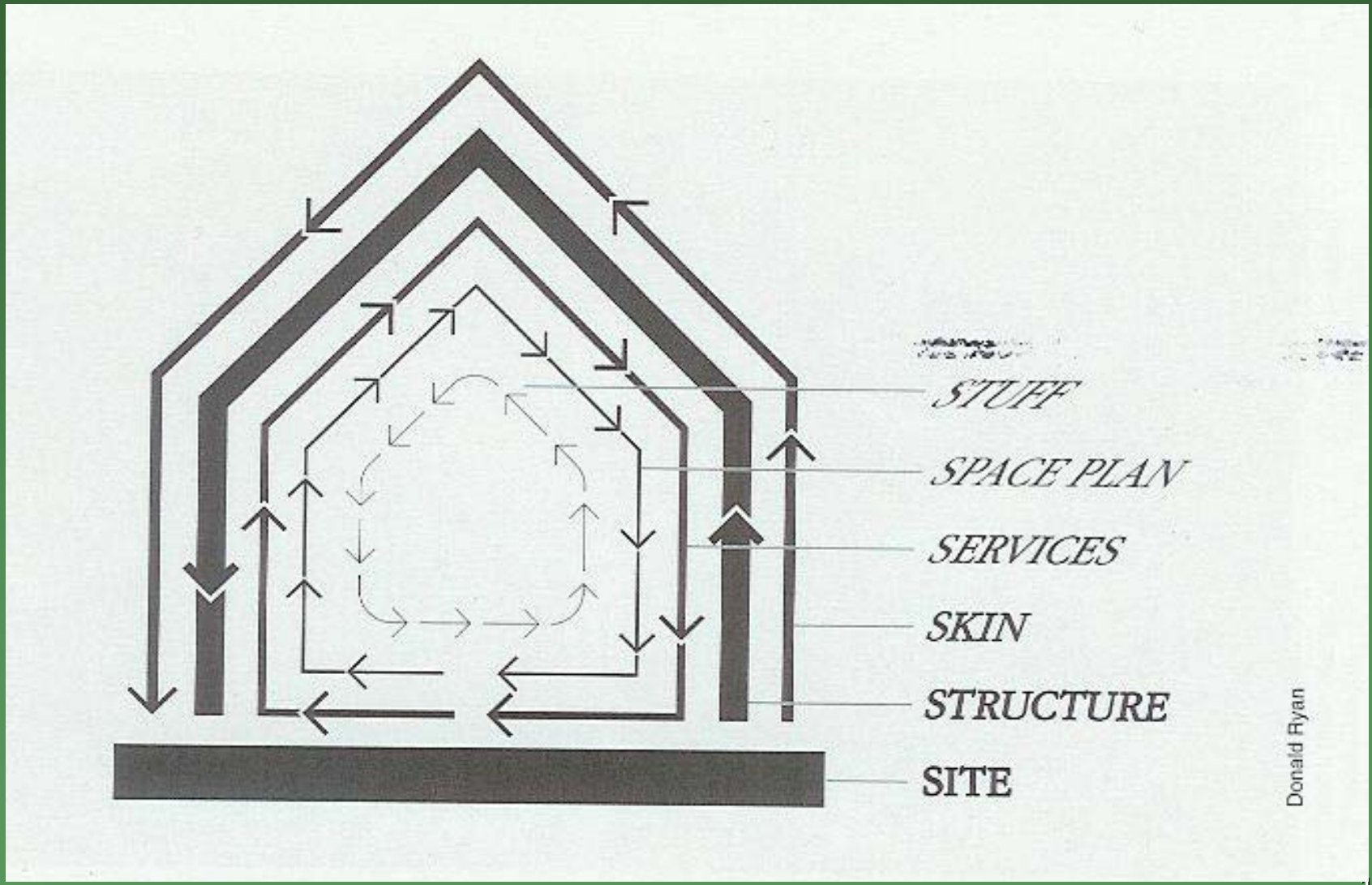
New Orleans, 1857

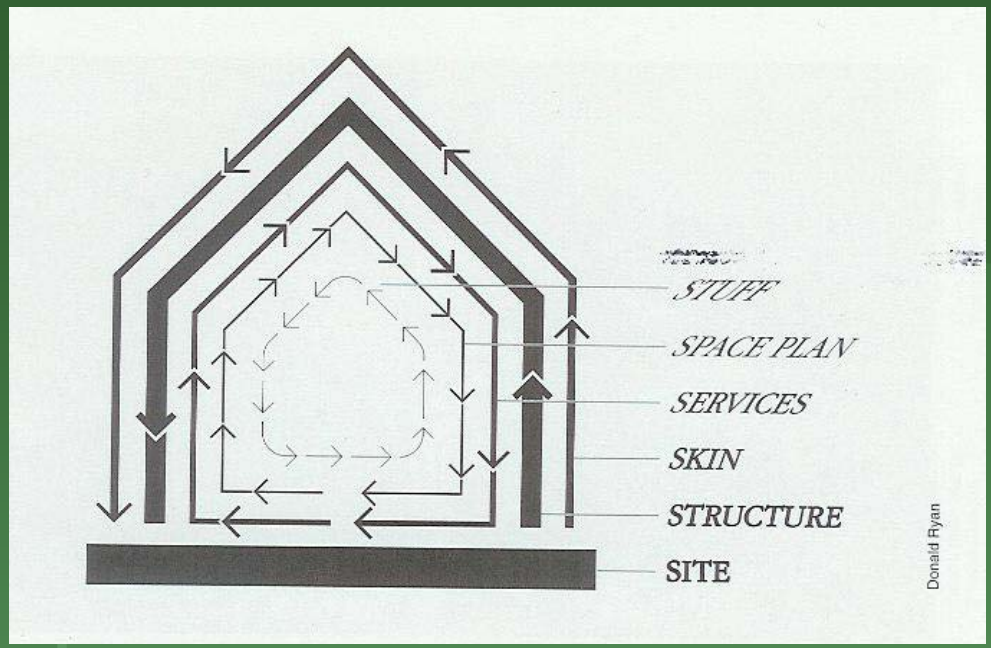
The same two buildings, 1993

STEWART BRAND

creator of *THE WHOLE EARTH CATALOG*

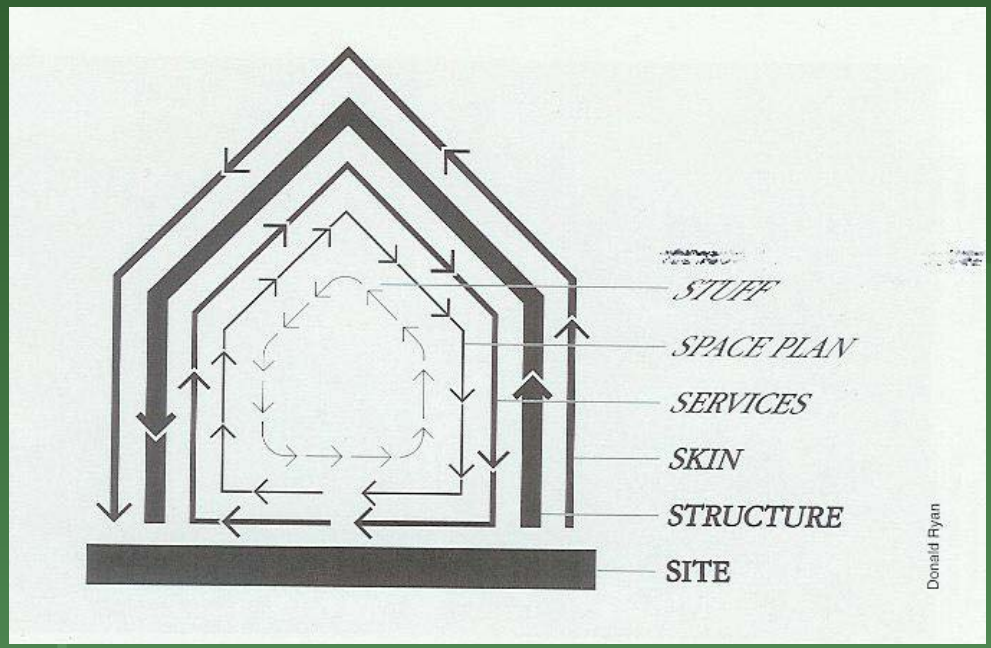
Six Building Layers





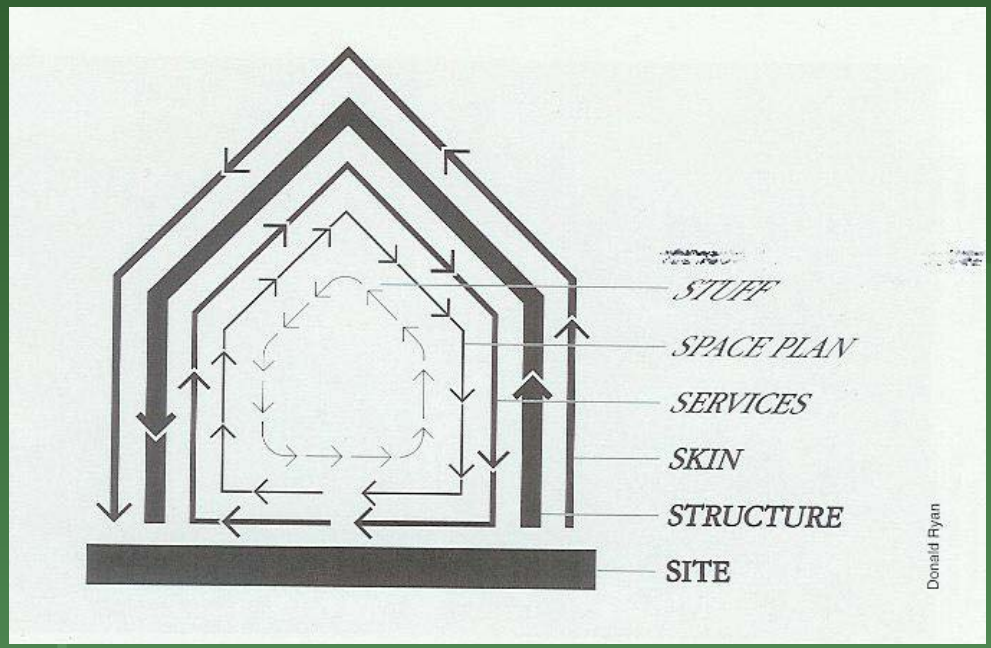
Site

- Essentially eternal
- Geographic location
- Land features
- Building placement and orientation



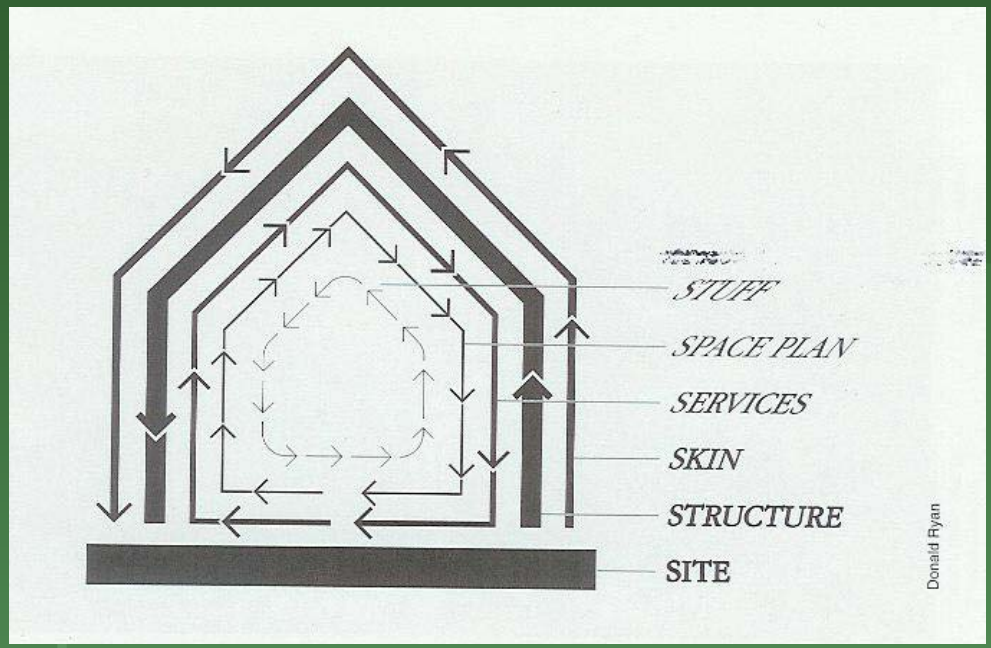
Structure

- 60 - 100 years or more
- Foundation
- Load bearing structure
- Longest lasting of the built elements



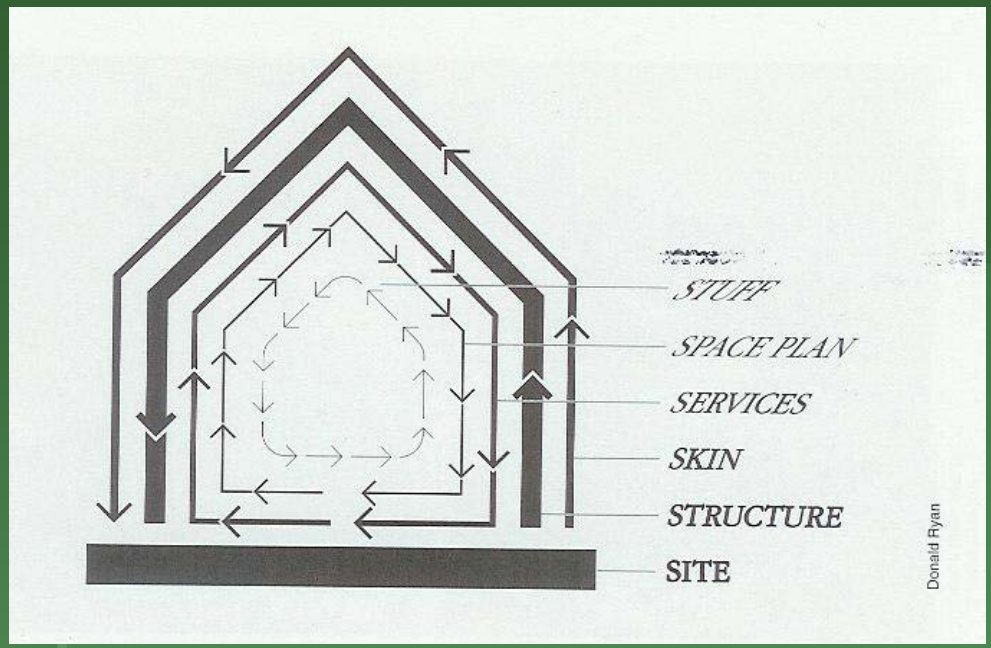
Skin

- 20 – 100 years
- Exterior surfaces of the building:
  - Roof, siding, windows
- Often replaced due to wear and tear
- Sometimes replaced for “fashion”



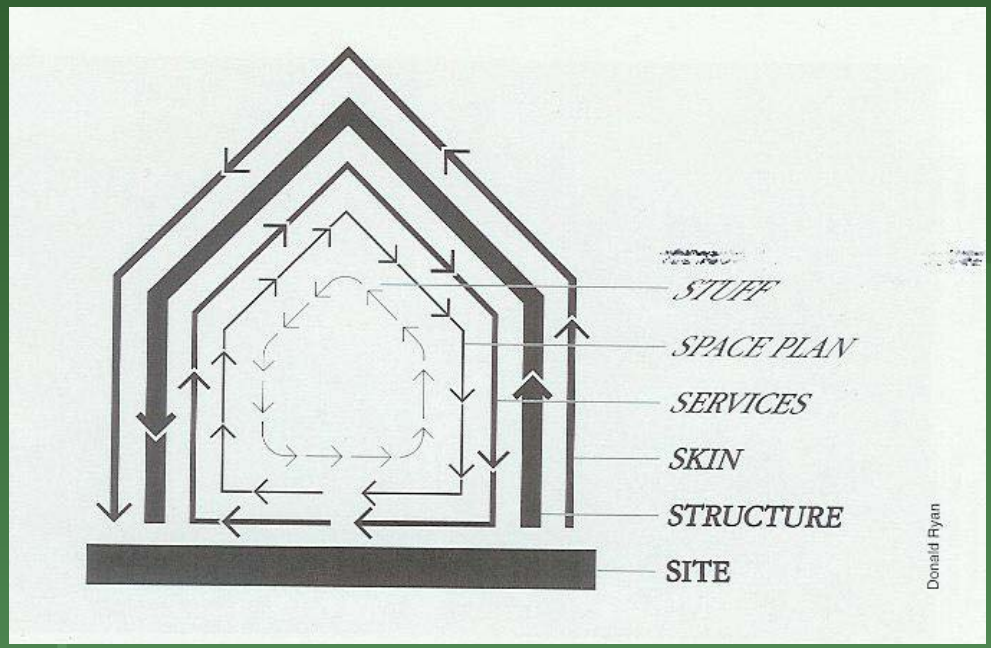
Services

- 7-30 + years
- The working systems, the “guts” of a building
- Plumbing, heating, cooling, ventilation, electrical
- Distribution systems harder to change than plants
- Replaced from wear or obsolescence



Space

- 5 – 40 years
- Considered mutable, changeable without changing structure, services, or skin
- The building interior:
- Partitions, surface finishes, cabinets, fixtures



Stuff

- 5 – 40 years
- Things easily movable
- Most frequently changed by occupant
- Appliances, lighting, fixtures, furniture, hardware

Selection

Prioritizing Choices using the relevance of the 6 Building Layers and the complexity of "Sustainability"

Significance

What is done initially to the first two layers, Site and Structure, has the longest impact and is the least easily changed after the initial construction.

For better or for worse, the initial decisions regarding these two layers will have the biggest impact on sustainability.

Site – selecting what to build

Land Use, Density, Energy, Community

Site – the layer least changeable

Site and Solar

- Passive solar design is one of the most sustainable and cost effective approaches to residential design and it is often overlooked

- Effective passive solar design will reduce both heating and cooling loads

Solar Design Strategies

- Roof overhangs or awnings to let in winter sun and keep out summer sun
- Minimize north and west windows
- Place windows to facilitate cross ventilation
- South glazing with a relevant SHGC
- There is no “all climate” glass!

Structure, Insulate!

You only get one chance to do this.

Structure and Insulation

- More insulation can best be integrated into the structure at the initial construction

Skin – windows, siding, roof

- Air tightness
- Water management
- Insulation
- Durability
- Integration
- Building Envelope

Services

- Insulation upgrades and better air sealing, combined with small super-efficient heating and ventilation systems, are the most sustainable things that can be done to decrease a building's reliance on energy for heating and cooling.

Renewable Energy Systems

- Site sensitive design vs. renewable energy systems …
- With limited initial funds, make “solar ready” changes to site and structure
- With proper solar orientation and roof pitches, solar PV or SDHW can be easily added later

Selection

The most visible “green” features are not necessarily the most important.

Adhere to a definition of sustainable: “To endure without failing or yielding.”

- *In the world of "affordable" housing, the (in)ability to increase initial investments often limits the ability to achieve meaningful change.*
- This is an enormous problem because what we build today will be around for a LONG TIME.

Selection Criteria

Will the project remain affordable to those who pay for maintenance and operation in 10 years? 20 years? 40 years?

Thinking ahead …

(A Case) Study:
The NCLT Sustainability Index

Scope

NCLT Sustainability Index

Research and analysis:
To create a framework that the Northern Communities Land Trust will use to monitor and measure choices as the agency improves the sustainability of its homes.

Start - NCLT Sustainability Index

Current agency construction practices and energy use of buildings were defined to create a baseline.

Existing models of sustainability were researched, especially in affordable housing

Sustainable defined:

1.Safety

2.Durability

3.Energy and resource efficiency

4.Affordability

A Systems Approach

- The 6 layers are combined with the defined criteria of sustainability

3 Tools Created for Analysis:

- Matrix 1: the Decision-Making Framework
- Matrix 2 : the Attribute Data
- Matrix 3 : the Spectrums

Sorting Priorities

- The Index provides a protocol and tools to update analysis of options
- It only works when elements are considered within the CONTEXT of current (and potential) circumstances

Savings

- 2006 - Change from R-10 to R-23 basement walls (ICF) results in a savings of $222/year at 2006 cost of natural gas and over 2,000 lbs of CO2 avoided/year
- The change to ICF is STRUCTURE, long lasting, hard to do later
- 2008 – metal siding instead of fiber cement; informed decision to cut cost in SKIN

Selection Criteria, Ongoing

Is the building resilient?

Can it continue to support health and comfort under changing conditions, with a minimum of external fossil fuel input?

Selecting Priorities

Many agencies are getting many things right …

Infrastructure
Water management
Durability
Toxicity
Indoor Air Quality

*But… **ENERGY** is the elephant in the room and it is the most important issue.*

Situation Normal? a changing environment

- 2004: Oil $50/barrel
- 1999-2006: Price of residential natural gas doubles
- 2007: Biggest single-year increase in greenhouse gas emissions from U.S. Power Plants
- “Heat or eat” dilemma reported in Boston Globe

- 2008:
- Oil $110/barrel
- Cost of food staples up 50% in 6 months
- New Website: www.energyshortage.org

Energy – The #1 Priority

- In the face of current circumstances, Energy Star for buildings is an inadequate benchmark, essentially outdated.
- 15% better than the 2004 IECC is not sustainable.

Targeting Energy Consumption

- Using percentages, i.e. 50% better, doesn't tell you how much energy a building uses
- The HERS Index doesn't tell you this either
- Energy Use needs to be measured like mpg

Energy – Defining Meaning

- Indicators regarding climate change, fuel scarcity, and rising costs suggest that anything built today should use a maximum of ½ the energy of that which we built yesterday

- The good news is we know how to do this.

- www.architecture2030.org

2030 CHALLENGE Targets: Residential Regional Averages

U.S. Regional Averages for Site Energy Use and 2030 Challenge Energy Reduction Targets by Residentail Space/Building Type (RECS 2001)[1]

From the Environmental Protection Agency (EPA): Use this chart to find the site fossil-fuel energy targets.

Residential Space/Building Type[2]	Average Source EUI[3,4] (kBtu/Sq.Ft./Yr)	Average Site EUI[3,5] (kBtu/Sq.Ft./Yr)	2030 Challenge Site EUI Targets (kBtu/Sq.Ft./Yr)				
			50% Target	60% Target	70% Target	80% Target	90% Target
Midwest							
Single-Family Detached	76.2	49.5	**24.7**	19.8	14.8	9.9	4.9
Single-Family Attached	66.6	44.8	**22.4**	17.9	13.4	9.0	4.5
Multi-Family, 2 to 4 units	104.8	74.0	**37.0**	29.6	22.2	14.8	7.4
Multi-Family, 5 or more units	93.3	50.9	**25.4**	20.4	15.3	10.2	5.1
Mobile Homes	168.9	103.3	**51.6**	41.3	31.0	20.7	10.3

Notes

1. This table presents values calculated from the Energy Information Administration in the Residential Energy Consumption Survey (RECS), conducted in 2001. The survey data is available on the EIA's website at http://www.eia.doe.gov/emeu/recs/recs2001/detailcetbls.html.
2. Space/Building Type use descriptions are taken from valid building activities as defined by the Energy Information Administration in the Residential Energy Consumption Survey (RECS), conducted in 2001.
3. The average Source EUI and Site EUI are calculated in kBtu/Sq.Ft./Yr as weighted averages across all buildings of a given space type in the RECS 2001 data set. Souce Energy is a measure that accounts for the energy consumed on site and the energy consumed during generation and transmission in supplying energy to the site.
   Converting Site to Source Energy:
   Source Energy values are calculated using a conversion for electricity of 1 kBtu Site Energy = 3.013 kBtu Source Energy; a conversion for natural gas of 1 kBtu Site Energy = 1.024 kBtu Source Energy; and a 1:1 conversion for fuel oil and district heat.
4. Energy Information Administration (EIA), U.S. Residential Energy Intensity Using Weather-Adjusted Primary Energy by Census Region and Type of Housing Unit, 1980-2001, Table 8c.
5. Energy Information Administration (EIA), U.S. Residential Energy Intensity Using Weather-Adjusted Site Energy by Census Region and Type of Housing Unit, 1980-2001, Table 6c.

EUI: Energy Use Intensity

Architecture 2030 Residential Targets

Mpg = kBtu/sf annual site energy

- Converts all energy consumed on the site to kBtu's per square foot annually
- Electricity is usually kWh
- Heating and cooling usually kBtu
- Domestic hot water varies
- In heating dominated climates, heating alone will usually account for more than ½ the energy used

Mpg

20.8 kBtu/sf ann

32.5 kBtu/sf ann

24 kBtu/sf ann w/ICF

43.2 kBtu/sf ann

24.7 kBtu/sf ann = 50% Target

Solutions

- Suitable
- Site sensitive
- Solar oriented
- Superior performance
- Safe materials
- Smart details
- Shock-resistant ($)
- Salvageable
- Sustainable

Significance

“Sustainable Development meets the needs of the present without compromising the ability of future generations to meet their needs.”

“Our Common Future,” 1997 U.N World Commission on Environment and Development

S

This presentation was brought to you by the letter S

This concludes the American Institute of Architects Continuing Education Systems Program.

Questions?

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