

Straw Bale Construction: Harvesting Its Potential as an Affordable and Energy Efficient Building Strategy

Environmental and Energy Study Institute Briefing

485 Russell Senate Office Building

June 20, 2008

Laura Bartels

President, GreenWeaver Inc.



With support from



Overview

- History
- Growth
- Building Performance
- Benefits
- Future Opportunities



High Performance, Low Impact Building Envelopes First

- 2,700 square feet
- Temperatures to -30°F
- 4 foot average snow pack
- Heating and hot water
\$30/month
- Indoor temperature when
unheated never below
 55°F



A Resource to be Taken Seriously

- The amount of straw available annually is substantial- 125 to 177 million tons.
- If half was available for building, it would create over 10 million 2,000 sf homes annually.

(Source: USDA Economic Research Service)

(Source: Toolbase Services, NAHB Research Center)

ANNUAL HOUSING STARTS (1978-2007)

Year	Single-Family	Multifamily	Total
2007	1,045,900	309,200	1,355,200
2006	1,465,400	335,500	1,800,900
2005	1,715,800	352,500	2,068,300
2004	1,610,500	345,300	1,955,800
2003	1,499,000	348,700	1,847,700

Source: U.S. Census Bureau

That's 5 times the highest number of US annual housing starts in history.

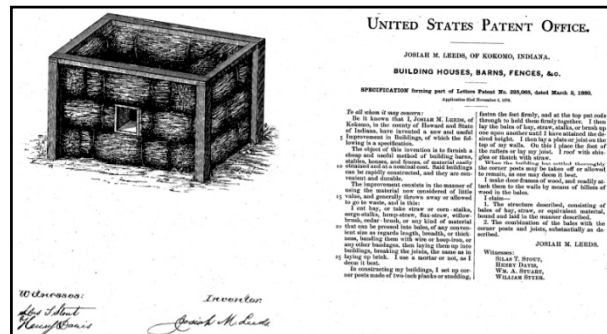
Straw Bale Building

An American invention older than jazz

Straw bale building began in the late 1800's after the invention of the baling machine.



The first U.S. patent on bale building was in 1880.



Straw Bale Structures

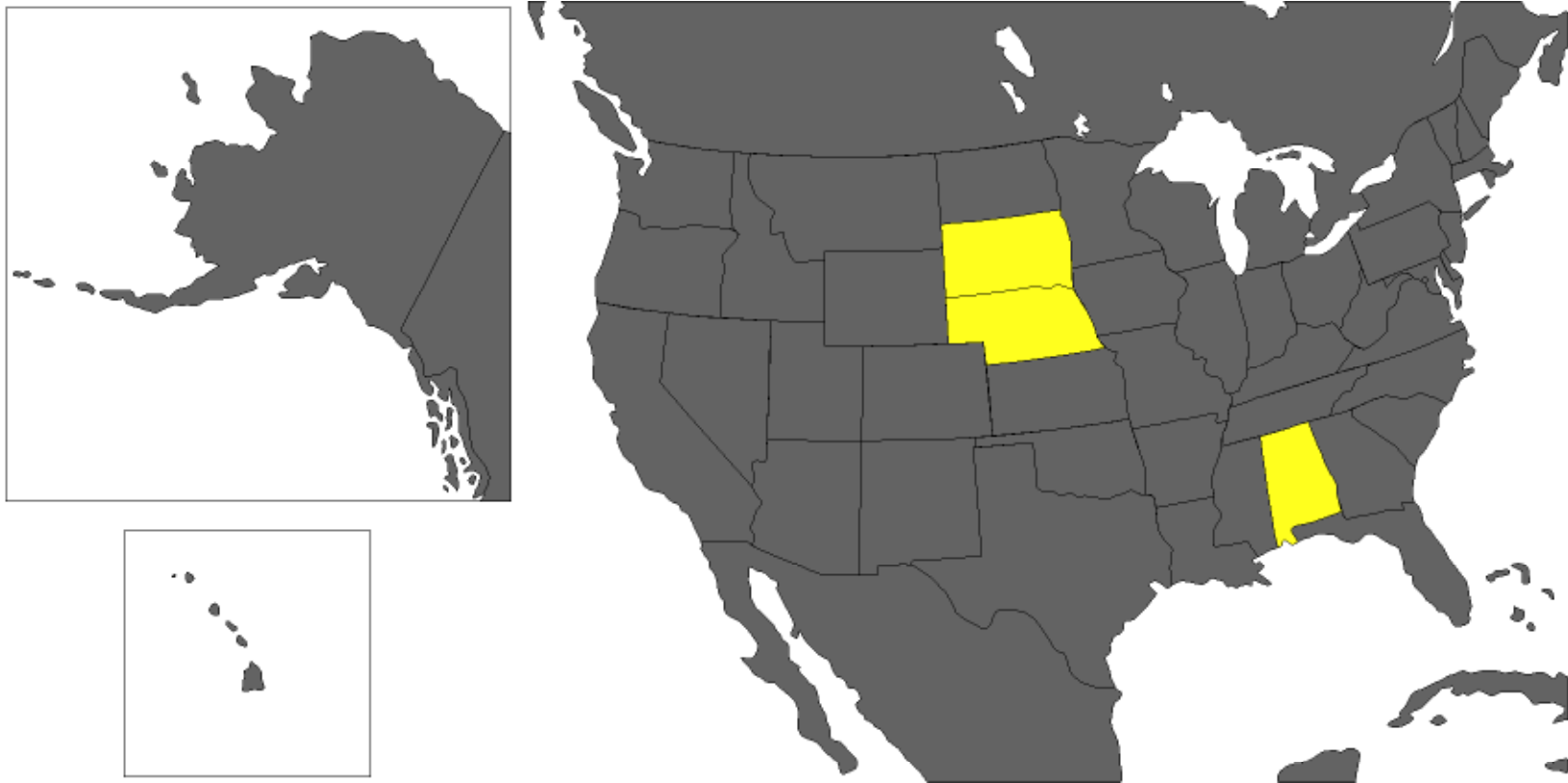
Durable and Versatile

- Built in 1936,
Huntsville, AL
- Listed on the National
Register of Historic
Places



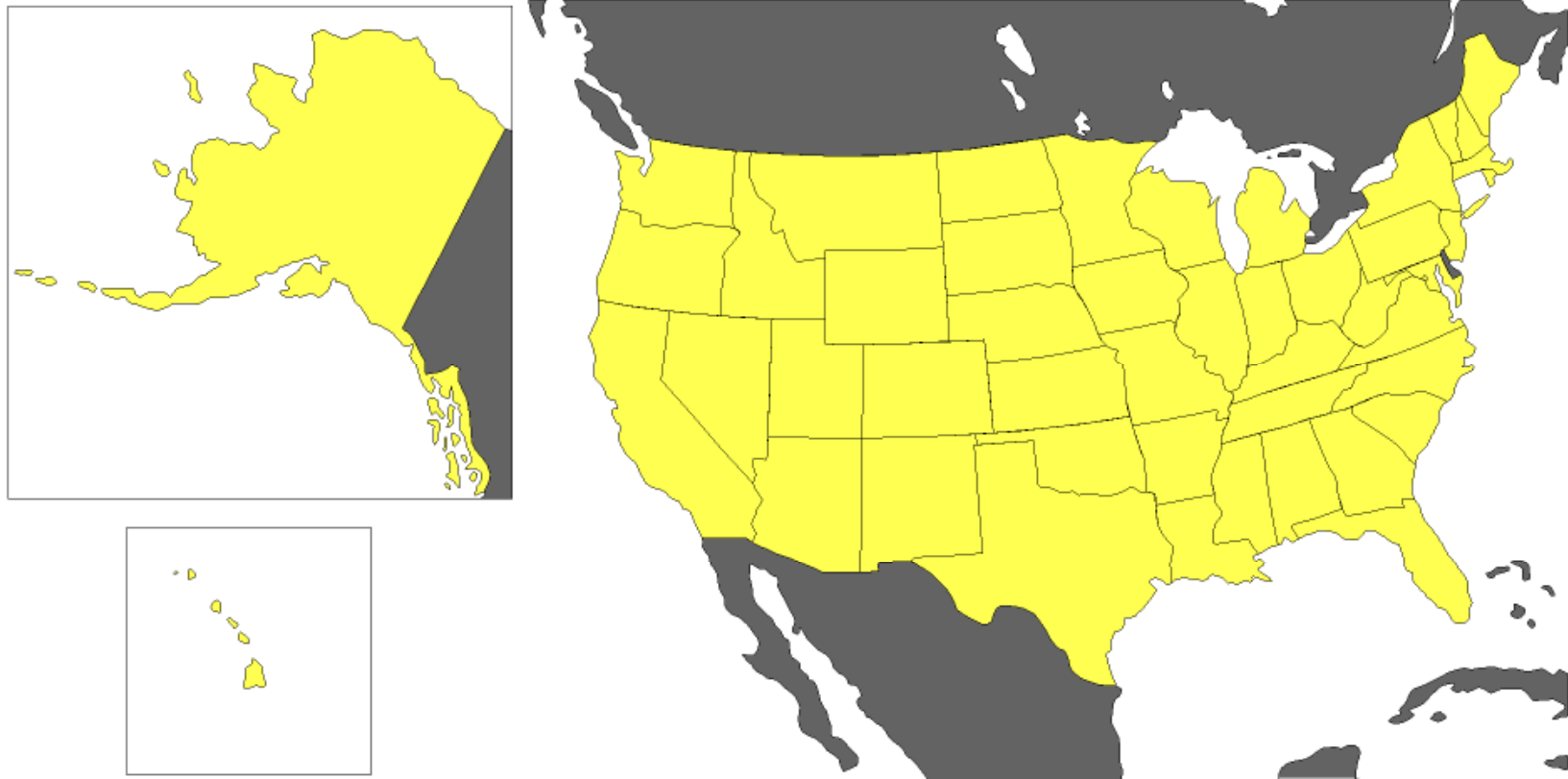
Pre-1940 Straw Bale Building

Many of these historic structures are still occupied



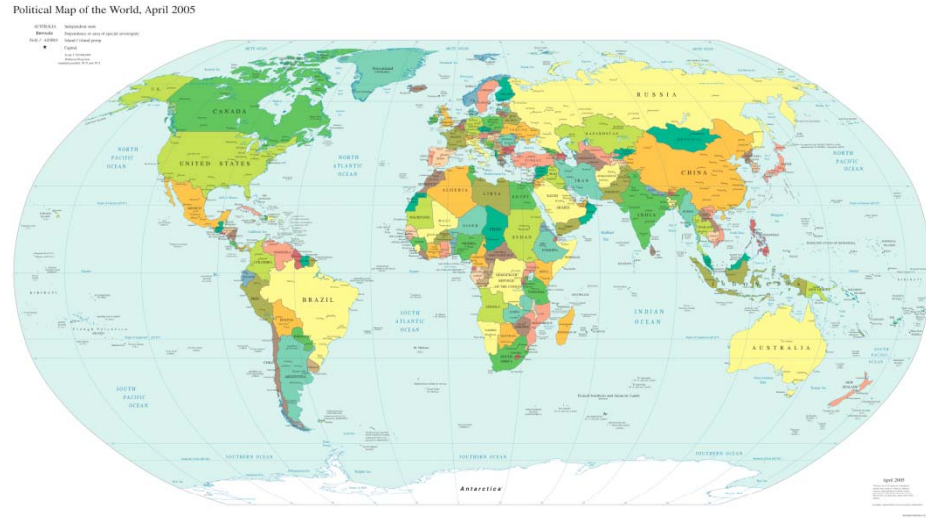
Modern Straw Bale Building

49 U.S. States currently have straw bale structures



It's Not Just Us

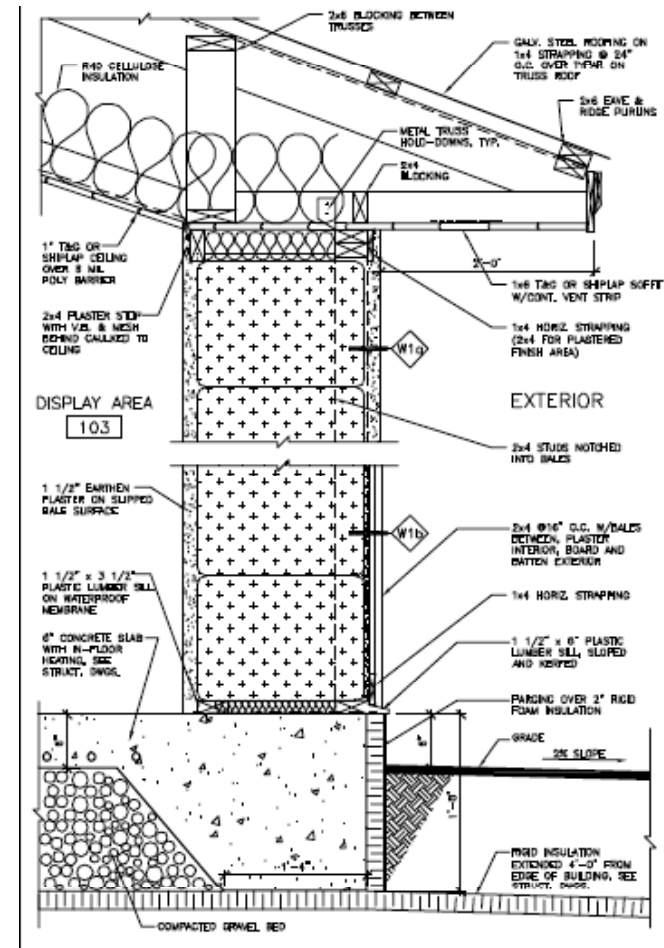
*Over 40 countries
have straw bale
structures*



Argentina, Australia, Belarus, Belgium, Bulgaria, Canada, Chile, China, Croatia, Czech Republic, Denmark, Ecuador, England, Estonia, Finland, France, Germany, Greece, Guatemala, Hungary, India, Ireland, Israel, Japan, Korea, Mexico, Mongolia, Netherlands, Neutral Zone, New Zealand, Norway, Pakistan, Peru, Portugal, South Africa, Spain, Sweden, Switzerland, United States, Uruguay, Yugoslavia, Zambia

Building With Baled Straw

- Uses baled straw (not hay)
- Straw is either structural or non-structural
- Plaster applied on both sides
- Well designed for moisture



Structural Wall System



Affordable Housing Project, Guadalupe, AZ

Non Structural Wall Systems



Single Family Homes - CO & CA

Why the Growth?

“[Straw bale building] is a powerful strategy in creating energy and resource efficient buildings.”



Charles R. Smith, Jr. AIA, LEED AP
Vice President, HOK
#1 Architectural/Engineering Firm,
Engineering News-Record, April 21, 2008

Santa Clarita, CA Transit Maintenance Facility, LEED Gold

Properties of Plastered Bale Walls

- Thermal
 - ORNL testing demonstrates R-value of 27 for 18” wall
 - CA Energy Commission allows R-value of 30 for plastered bale wall
 - Mass of plaster shown to enhance R-value of assembly
- Structural
 - Compressive, lateral and seismic testing demonstrate impressive capacity and that it is a nearly ideal seismic material
 - Plastered wall acts like a stress skin panel with optimal ductility
- Acoustic
 - Testing shows straw bale wall to be excellent sound barrier
- Fire
 - Assemblies meet 1- and 2- hour ASTM fire ratings

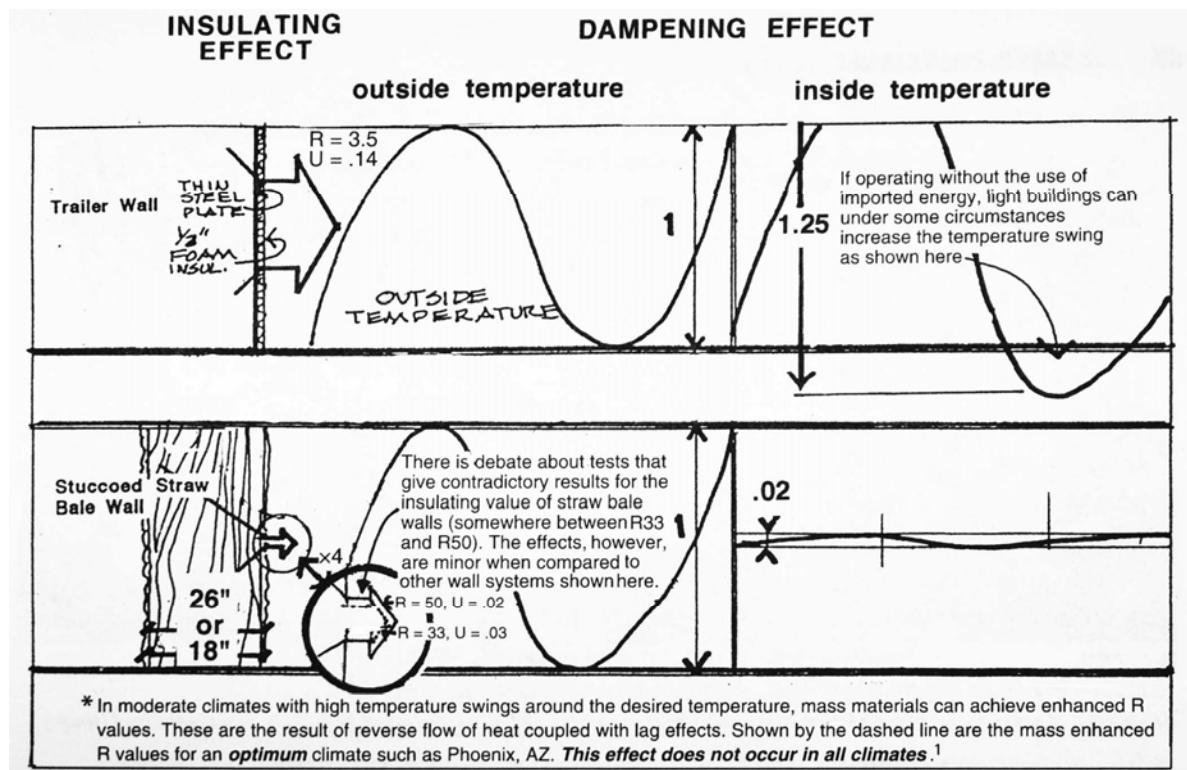
Meeting Energy Goals

- Low operating energy
 - Good thermal performance (reducing heating and cooling needs)
- Low embodied energy
 - Minimally processed
 - Local or regional, widely available
- Passive Survivability
 - Reduces likelihood of deaths from heat or cold in blackouts

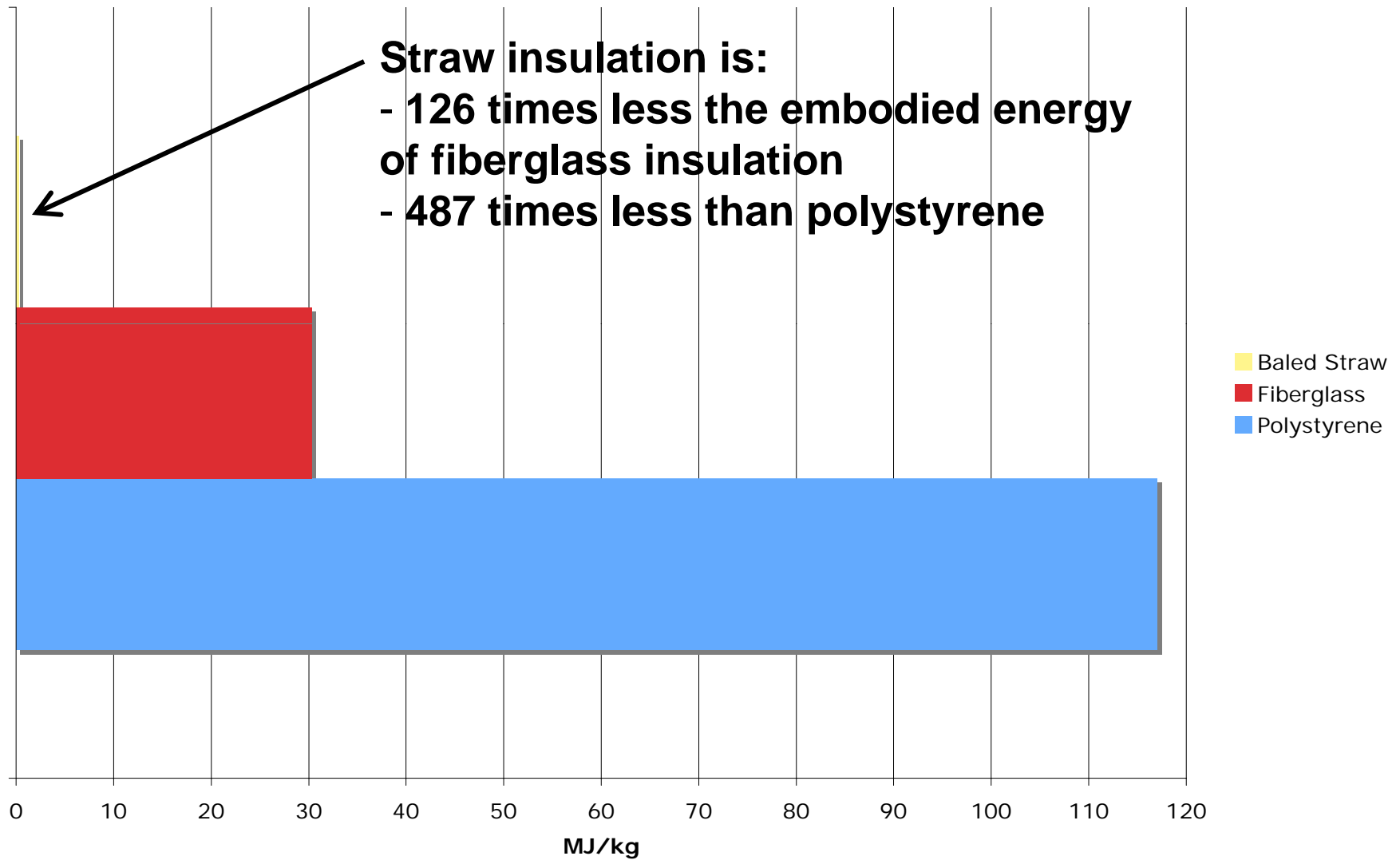


INSULATION + MASS – COMFORT

R 3.14 + minimal mass VS. R 30 + distributed mass



Embodied Energy of Insulation Materials



Source: Centre for Building Performance Research, Victoria University of Wellington

Springs Preserve, Las Vegas

- Achieved LEED Platinum using straw bale and rammed earth
- Winner, High Performance Building Award, Sustainable Buildings Industry Council



Presentation Center, CA

- LEED Gold
- AIA San Francisco Design Award for Energy and Sustainability, 2007



Schools Choose Straw Bale to Reduce Cost and Energy Use and Offer Healthy Environment



Photo © Hord Coplan Macht



Net Zero Energy Home, CA

- “67% of energy efficiency came from straw bale building envelope and passive solar orientation in this net zero energy home” - Dan Smith, Dan Smith & Associates Architects



Swiss Examples Far Surpasses Passivhaus Standards

- Uses “jumbo” bales
- Structural straw walls
- R-value 113
- Eliminates need for conventional heating
- Requires 10 times less heat than Passivhaus Standard



China Straw Bale Housing

- Over 700 homes built
- Eliminated need for coal in heating
- Dramatically improved earthquake resistance
- 2005 UN World Habitat Award



USDA FARM WORKER HOUSING

- Zero interest loans from USDA
- Projected costs approx. \$110/sf, reduced by occupant labor
(low in the context of CA earthquake code requirements)
- Straw bales displace need air conditioning
- Straw bale common wall in duplexes provide excellent sound and fire separation
- Plastered bale walls provide the seismic bracing
- Farm workers to assist with bale work, site built trusses, plastering



Frog Hollow Farm - Brentwood, CA

Retrofits and Wraps



Addressing Building Science and Design

Rainscreen over plastered straw bale walls



Photo © Bill Steen

Support needed for

- Research, testing, demonstrations
- Professional and layperson education

Like any technology it can be done poorly. Properly addressing issues such as moisture protection in every situation is essential.

Straw bale trailer wrap and extension technology



Intertribal COUP

Sustainable Affordable Housing

Capital Cost + Operating Cost = Affordability

1. Energy

- **Reduce utility costs for heating and cooling**
- **Stretch energy assistance funding**
- **Reduce imports of higher cost building materials**

2. Employment & Economic Development

- **Create training & job opportunities**
- **Create value added businesses**

3. Health

- **Reduction of IEQ related medical expenses**
- **Reduction of absenteeism from work and school**

Sustainable Affordable Housing

Low Capital Cost + Low Operating Cost = Affordability



Frog Hollow Farm, Brentwood, CA



Staff Housing, Aspen Center for Environmental Studies, CO

The Link Between High End and Low Income Housing



Photo © Todd Winslow Pierce

Federal Involvement

US Dep't of Housing and Urban Development

US Department of Energy

Oak Ridge National Laboratory

US Department of Agriculture

United States Post Office

U.S. Botanic Garden Exhibits Straw Bale House



Further Resources

Ecological Building Network - www.ecobuildnetwork.org

Development Center for Appropriate Technology - www.dcat.net

The Last Straw Journal - www.thelaststraw.org

***Design of Straw Bale Buildings: The State of the Art,*
Bruce King, editor, Green Building Press, 2006.**



POST OFFICE BOX 912 ☎ CARBONDALE, CO 81623

telephone 970 379 6779 ☎ facsimile 970 963 0905 ☎ info@greenweaverinc.com ☎ www.greenweaverinc.com