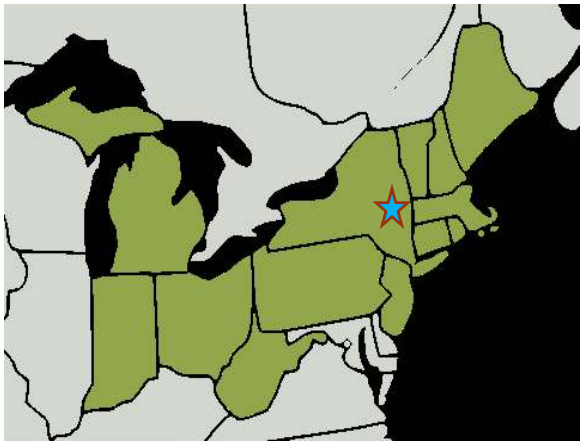
Green Built LLC

(March 2014)

Building Sustainability

Green Built in the Hudson Valley

- Founded by Jim Savage in 2012 to commercialize Hemp-Lime building materials in the Northeastern U.S.
- Focused on the insulation market – for retrofit and new construction
- Aims to be a cornerstone of Regional Sustainability in the Capital and Mid-Hudson Regions, contributing to:
  - Sustainable Economic Development
  - Energy Efficiency
  - Greenhouse Gas Reduction
  - Pollution Reduction and Cleanup
  - Recycling and Waste Reduction



What Is Hemp-Lime?

- A renewable, breathable, fire, insect, rodent and rot resistant natural building material
- Utilizes the woody inner core (hurd or shiv) of the fast-growing hemp plant's stem combined with a lime-based binder
- Material is lightweight, easy to use, structurally sound and durable
- Excellent thermal and acoustic properties
- Exceptional insulating qualities
- Non-load bearing, requires timber or other load-bearing frame
- Non-toxic, recyclable, carbon negative

Hemp-Lime Increasingly Adopted as a Mainstream Building Material in Europe

Hemp-Lime – A Sustainable Material

Climate adaptation applications

Carbon-sequestering throughout lifecycle

Durable

Non-toxic

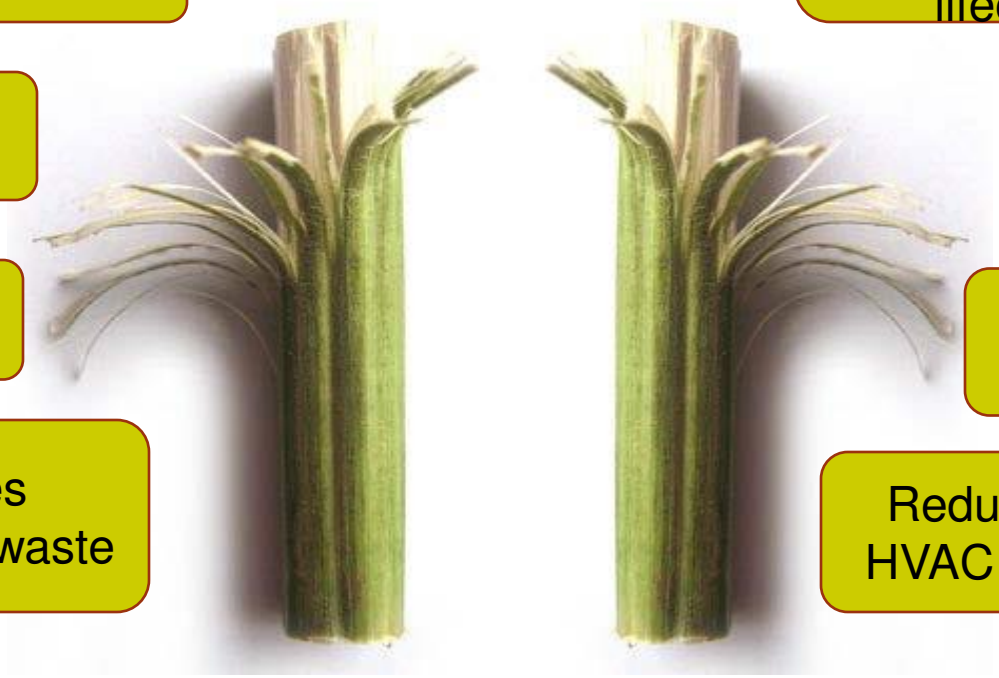
Energy efficient insulation

Recyclable

Renewable bio-material

Eliminates construction waste

Reduces need for HVAC mechanicals



History of Modern Hemp-Lime Construction

Late 1980s –
Process originally developed in Champagne region of France to repair old buildings

Mid-1990s –
Used in both new "hemp houses" and in the restoration of historic buildings

Late 1990s –
Multiple companies develop processes to manufacture building materials
Increased levels of industrial hemp cultivation



Early 2000s –
Full testing of properties and environmental impact

2000-2010 –
Increasingly accepted as a "Green Building" material in UK/Ireland, Western Europe. Many single family dwellings, social housing projects, industrial and office buildings constructed

Today – Moving into the Mainstream

- 114 unit and 42 unit housing developments in UK
- Many large scale energy efficient commercial and industrial buildings designed and completed
- Widely used in retrofits of historic buildings
- Accredited in France, England, Ireland, other EU countries
- Initial development begun in Canada, Australia, South Africa
- R&D ongoing to develop load bearing products to further reduce CO_2


Hemp-Lime Is a Versatile, Strong, Solid Composite Material That Can Be

- Cast like concrete
- Sprayed
- Used as a plaster or render
- Utilized as insulation for floors, walls and roofs
- Cast into blocks, bricks or panels

Hemp Building in Europe

7 Story Office Building in Clermont- Ferrand, France

- Regional Government Office of Housing and Environment
- Uses hemp-lime blocks throughout

CANNABRIC®

Houses Under Construction, Spain

Architect: Antonio Garcia Morales

Green Light Trust – Suffolk, England

Community Building designed by Ralph Carpenter, Modece Architects

First “Better than Zero Carbon” building in Suffolk, locks up 4 tons of carbon in building envelope

Hemp-lime used throughout, with materials sourced within 20 miles of site where possible

Green Light Trust basic carbon data	
Floor screed	+0.5Te
Floor blocks	- 2.8Te
Walls	- 4.3Te
Windows	+1.3Te
Roof insulation	- 7.2Te
Roof covering	+3.0Te
Brick floor	+2.0Te
Sundries	+3.0Te
Total	**- 4.5Te**

Affordable Housing – Suffolk, England

- Elmswell Affordable Housing Initiative – Suffolk
- Riches Hawley Mikhail Architects
- Hemp-Lime Walls – part of energy efficiency strategy reduces carbon emissions by 60%

Adnams Brewery Warehouse – England

- The 250,000ft^2 distribution center and commercial vehicle maintenance facility, located in Southwold, Suffolk and completed in 2006 for a total cost of £5.8 million, was constructed with a diaphragm wall using 100,000 high density blocks made of hemp, hydrated lime and quarry waste, with an infill of 1000 m^3 of low density hemp-lime material.
- Thermal performance: drinks stored at 12º to 14ºC, without the use of air cooling system, resulting in £400,000 saving on original costs, and £50,000 annually in operating costs.
- Carbon Sequestration: More than 500 tons of CO_2 locked up in the building fabric.

Architect: Aukett Fitzroy Robinson

Structural Engineer: Faber Maunsell AECOM

Wine Society Warehouse – England

Building walls constructed of 730 cubic meters of Tradical® Hemcrete® installed in 400 mm thick sprayed prefabricated 3.6 by 2.4 meter panels within factory manufactured timber cassettes, and supported on a structural steel frame, while a 40mm-thick composite aluminum panel is used to provide weather protection on the external face.

In use since mid 2008 without heating or cooling equipment, the internal environment has shown remarkable temperature stability (13-16°C) despite daily external temperature variation and extended periods of sub-zero temperatures.

The 2744 m² warehouse, located in Stevenage, Hertfordshire, was completed in September 2008 at a total cost of £3.8 million. The architects were Vincent and Gorbing

Wise Institute for Sustainable Education – Wales

"Britain's Best Building of 2010" –
The Daily Telegraph

- WISE's primary structure comprises a glue laminated timber frame, infilled with a spray-applied hemp-lime composite to a thickness of 500mm, providing a high degree of insulation and air tightness while remaining breathable. As an essentially monolithic form of construction it is also less prone to technical failure than conventional cavity assemblies, and finished externally in a coat of hydraulic lime render.

- WISE is a miniature campus tucked into the folds of the quarry combining a 200-seat lecture theatre, 24 en-suite bedrooms, three seminar rooms, three workshops, a laboratory and new office space for the organization's staff

The Nauhaus Prototype Asheville, NC

Designed to meet Platinum LEED and Passivhaus standards

NC's humid summer climate presents interior mold issues. Using imported hempcrete for the building envelope, the building achieved R-values of 40 for the wall and 70 for the roof.

The highly insulative hygroscopic wall also served as a perfect substrate for the interior plasters processed from the clay soil excavated for the foundation.

Architect: Tim Callahan, Alembic Studio

The Carbon Impact

"Attractive carbon sink with a lifetime of 100+ years"-- French Life Cycle Assessment

HEMP

- Grows up to 1 foot per week over a 12-14 week growing cycle. During its rapid growth, it captures carbon and releases oxygen into the atmosphere, sequestering CO_2
- 1 acre can produce up to 4 tons of hemp – enough to build a 700 square foot house with 8 inch thick walls
- An organic "aggregate," it replaces quarried and/or synthetic fossil fuel-based materials

LIME

- Lime-based binders emit substantially less energy in manufacturing than other materials (e.g. cement)
- Lower kiln temperatures + lower lime densities = less energy use

TIMBER

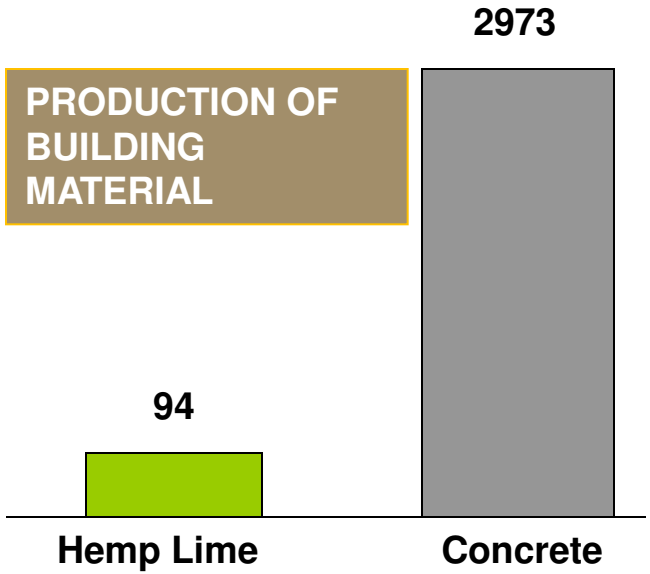
- Compared to far more energy intensive rebar used in reinforced concrete buildings, load-bearing timber frame can be a renewable resource, capturing CO_2 during growth

HEMP-LIME BUILDINGS

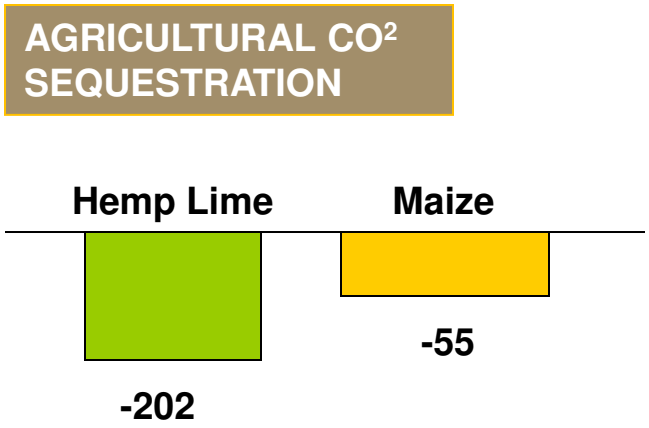
- During a building's lifetime, the embedded lime carbonates, absorbing CO_2 from the atmosphere

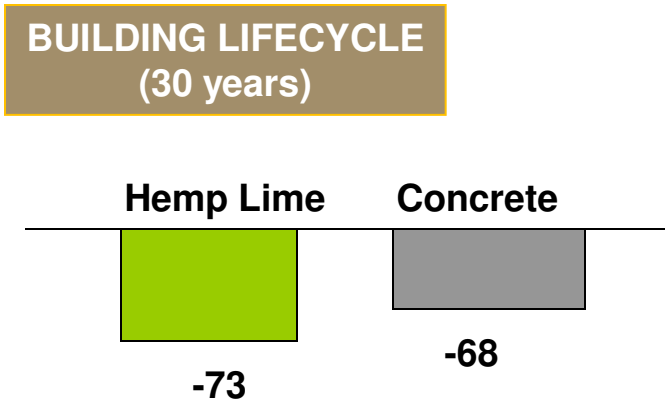
Relative Carbon Load
Hemp-Lime Construction vs. "Business as Usual"

(kg of CO^2 emitted/sequestered per m^3 of wall)



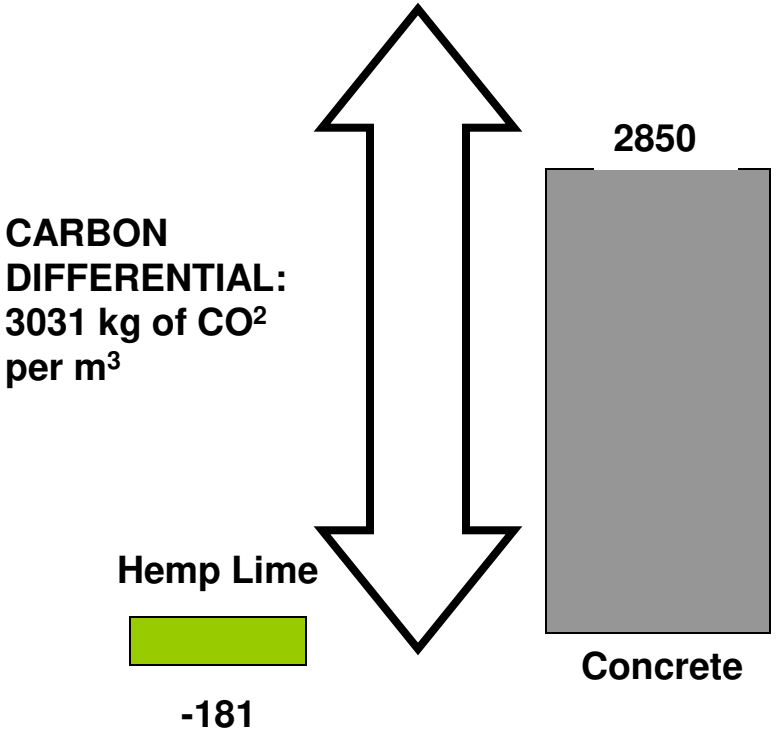
"…at least 5% of humanity's carbon footprint comes from the concrete industry ….."
- *National Science Foundation, May 24, 2009*





Opportunities for Additionality

LIFETIME
CO^2 IMPACT



One small 1,000 sq. ft. detached house with 12 inch thick walls will contain approx. 1,000 cubic feet of hemp lime material and **will result in sequestration/ avoidance of 332 tons of CO2 emissions**

R&D on Hemp Aggregates

Thermal and Hygroscopic Properties

"The walls are breathable and act as a sort of passive air-conditioning system, meaning that the internal humidity is kept constant and the quality of the air within the house is very good. The walls also have a 'virtual thermal mass' because of the remarkable pore structure of hemp shiv combined with the properties of the lime binder, which means the building is much more thermally efficient and the temperature inside the house stays fairly constant."

Dr. Mike Lawrence, University of Bath, UK, Department of Architecture & Civil Engineering

Comparison of dry-lining versus a hemp and lime insulating render for internal thermal renovation

The main conclusions are:

- Dry Lining causes moisture to accumulate in the wall and space behind it which will lead to rot, internal structural damage and increased frost damage.
- Hemp renders are not only insulating but also dry out the external wall and handle moisture well suggestive that they reduce the risk of rot, mould and frost damage overtime.
- Hemp renders sequester significant amounts of carbon dioxide which could be used to offset the embodied carbon of renewables in a win-win scenario.
- U-values can underpredict actual performance.

– **Marion Wright, Naomi Miskin, Andrew Flower & Ranyl Rhydwen,** University of East London & Graduate School of the Environment, Centre of Alternative Technology, Machynlleth,Wales

Hygrothermal Behavior

"…Hemp-based materials naturally behave as phase-change materials (PCM); the thermal behavior reduces the amplitude of the variations in the ambient air temperature, whilst improving the thermal comfort by bringing down the surface heat of the material. Thus, the use of such materials is an excellent means of passively regulating the indoor temperature, and thereby decreasing the building's energy requirements. In addition, the experimental results show a regulation of the relative humidity in the envelope because of constant exchanges of water vapor between the indoor and outdoor environments, modulating sudden changes in temperature***. Hence, these materials are able to improve summer and winter comfort, and stabilize the indoor temperature between day and night, whilst preventing the phenomena of condensation and dampness on the walls.***"

– Laurent Arnaud, et. al., Bio-Aggregate Based Building Materials, Applications to Hemp Concretes

Mechanical Behavior

"As a mixture of plant particles and binder, hempcrete is an unusual construction material: the high flexibility of the aggregates in conjunction with the rigidity of the cement matrix leads to a non-fragile elasto-plastic behavior. Thus, it is distinguished from other construction materials by a high deformability under stress, lack of fracturing and marked ductility with absorbance of the strains even after having reached the maximum mechanical strength.

It is also helpful to highlight another peculiarity: the variability of the behavior depending on the formulation enables us to adjust and optimize the performances of this material for diverse applications as a roof filling material, in walling or as flagging."

– Laurent Arnaud, et. al., Bio-Aggregate Based Building Materials, Applications to Hemp Concretes

Life Cycle Analysis

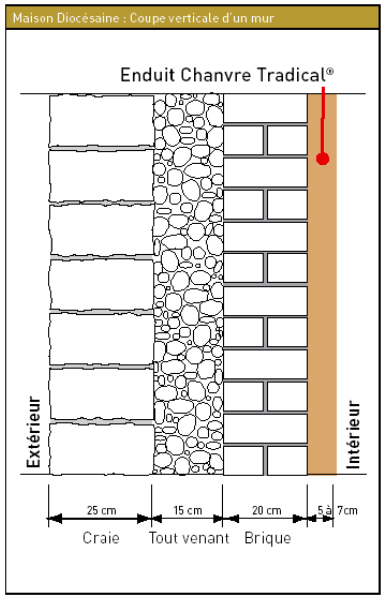
'Banked hempcrete, for its part, is particularly well adapted for building renovation; quite apart from its thermal resistance, which satisfies the thermal regulations in force with walls of less than 30 cm in thickness, "its hygrothermic performance, which combines mass transfer and phase change with the other thermal phenomena, means it is able to greatly exceed the expected energy performances. In addition, users have noted that they attain a satisfactory level of thermal comfort at relatively low ambient temperatures (17^0 or 18^0C, or sometimes less), which leads to a significant decrease in energy consumption"' (*Construire en Chanvre*).

– Laurent Arnaud, et. al., Bio-Aggregate Based Building Materials, Applications to Hemp Concretes

Chalon en Champagne
Diocesan House

Rénovation

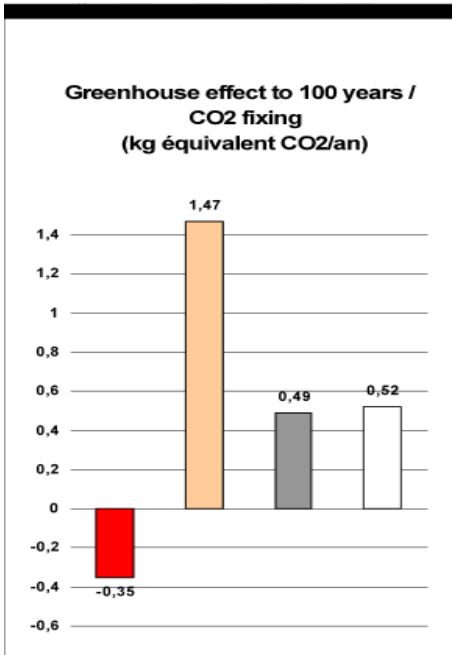
Walls insulated with hemp-lime concrete (only 5 to 7 cm)

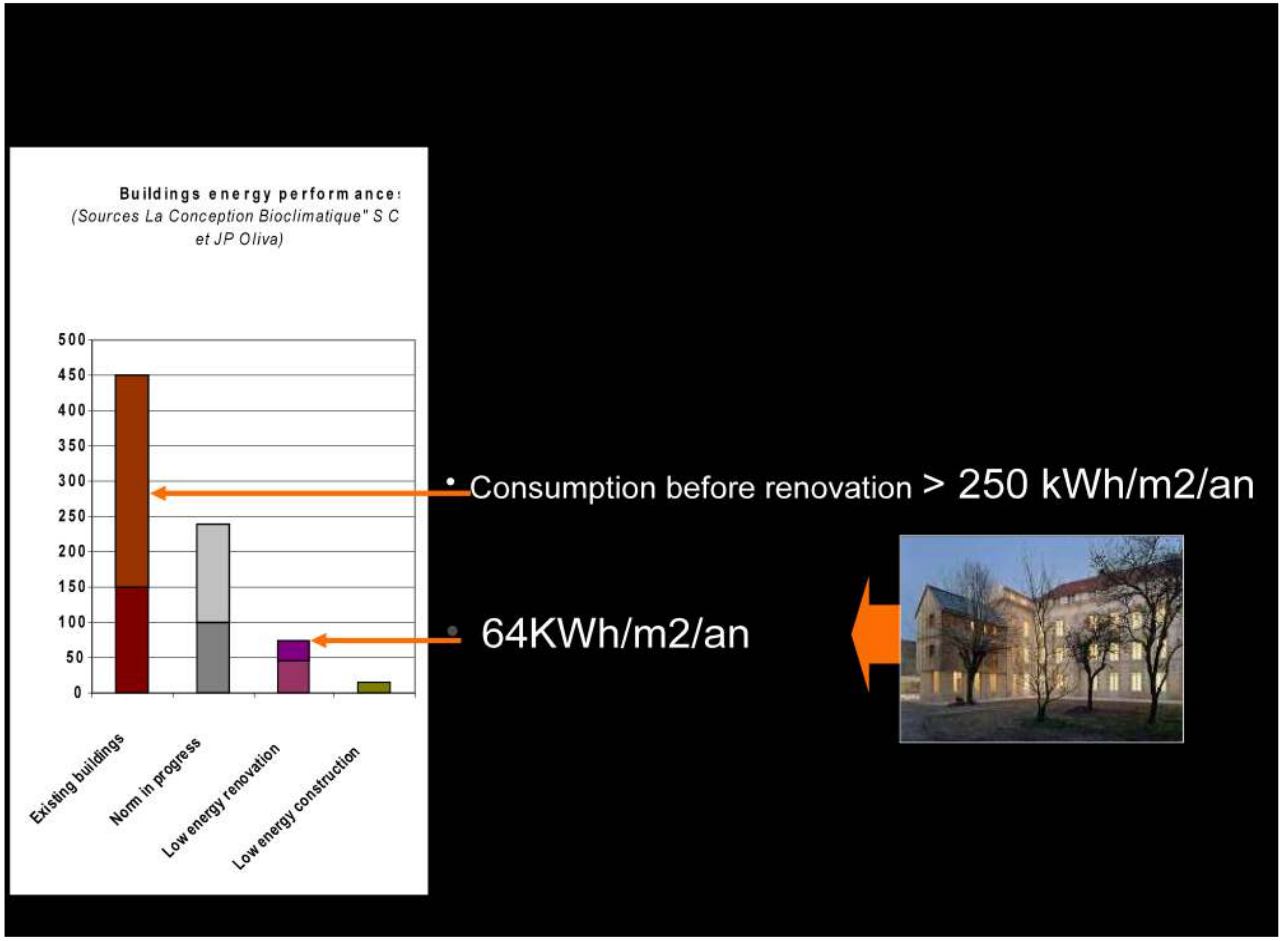


Jean Louis Coutarel
l'École nationale supérieure
d'architecture de Clermont Ferrand

Analyse du Cycle de Vie des bétons de chanvre

- Hemp Concrete (26cm)
  R = 2,36m2.K/W
- Clay brick (37cm)
  R = 2,5m2.K/W
- Concrete blocks and polystyrene/plasterboa
  R = 2,36m2.K/W
- AAC (30cm - 400 kg/m3)
  R = 2,5m2.K/W





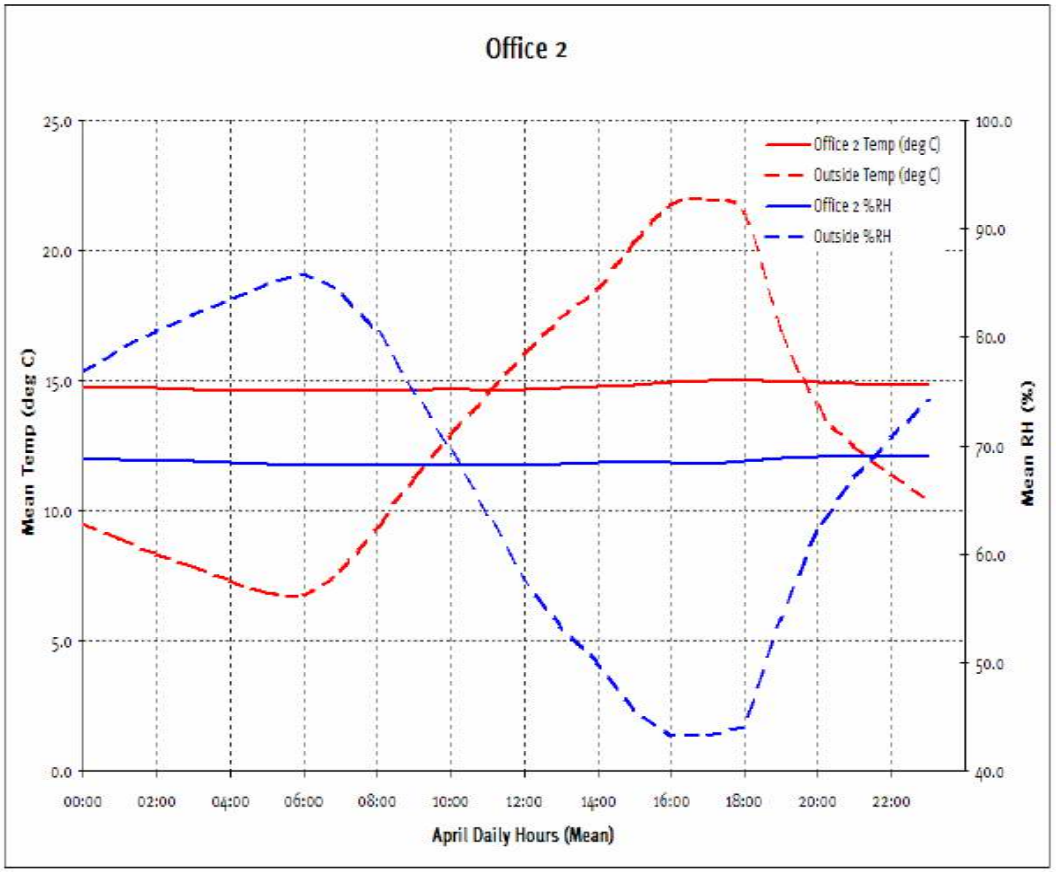
Compliance with UK Building Codes

- Structural Performance (Bldg. Reg. A) – Not load bearing, but provides excellent racking resistance; studwork requires no noggins or bracing; does not compact, remains stable over several stories; floors will support normal domestic loading
- Fire Resistance (Bldg. Reg. B) – Hemp/Lime is naturally fire resistant; will resist fire up to 1800^{o}C (cement shatters at 400^{o}C)
- Moisture (Bldg. Reg. C) – Walls remain dry and do not allow moisture to penetrate (testing by Building Research Establishment, Ltd. – BRE)
- Sound Resistance/Absorption (Bldg. Reg. E) – Open-pored hemp absorbs sound, reduces echo and sound transmission; provides better acoustic performance than mineral wools in floor voids; BRE testing in Haverhill showed 58db sound reduction
- Ventilation (Bldg. Reg. F) – Highly breathable; testing shows mechanical extraction not required as moisture migrates through structure in 3 hours
- Thermal Insulation (Bldg. Reg. L) – Light weight, dense material provides good insulation and energy storage, minimal air infiltration and low ventilation heat loss; tests of thermal conductivity show 0.072w/m^{2}K, loose hemp 0.064w/m^{2}K

Based on Presentation by Ralph Carpenter, Modece Architects, 2009

Improved Temperature/Humidity Performance

Office refurbished with hemp-lime insulating materials results in dramatically improved temperature and humidity stabilization – and thus substantially lower heating and cooling expense



126 Milton Park, Abingdon, Oxfordshire

Improved Comfort

- Monolithic -- inherently air tight.
- A 250mm wall can reduce external temperature changes by around 98%.
- A 20^0C change over 24 hrs is almost completely dampened.
- Any temperature change that does occur can be greatly delayed.
- High vapor permeability and absorption coefficient allows Hemp-Lime to buffer high humidity, combat condensation and improve air quality.

Additional Hemp-Lime Benefits

- Safe handling during installation
- No VOCs post-installation
- Pest repellent
- Mold/rot resistant
- Improves indoor air quality
- Racking resistance – can eliminate need for cross-bracing
- Monolithic hemp-lime walls reduce building complexity
- Material does not compact – does not develop pockets for air infiltration
- Air-tight envelope eliminates thermal bridging

- Regulates humidity
- Protects structural wall elements from moisture
- Thermal mass imparts thermal control and consistency
- Flexible in its uses
- Acoustic barrier
- Low-tech throughout life-cycle
- Simple lime-render finish
- Durable
- Removable
- Eliminates construction and demolition waste in landfills

Hemp-Lime Solves Current Building Material Issues

Including:

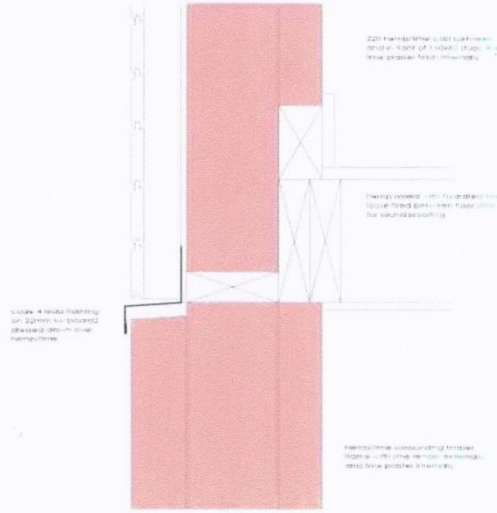
- Moisture accumulation in historic brick walls due to vapor-impermeable insulation
- Condensation in gaps between wall and insulation
- Pest attraction to insulation (e.g. fiberglass, soy based products)
- Embodied energy from non-renewable materials
- Exterior fire-resistant sheathing

Steve Allin – Building with Hemp
http://www.youtube.com/watch?v=FeW6kuZgPY4&feature=player_detailpage

Hemp-Lime – Different from Conventional Building

- No vapor barrier
- Fewer wall layers
- No air gap in ceiling between insulation and sheathing
- Material needs time to cure, as does the render (finish coat)
- Must use vapor-permeable sheathing, e.g. MgO board, not drywall
- Must use vapor-permeable paints, e.g. mineral paint
- Simple lime render as exterior finish
- Monolithic insulating protocols (eliminate gaps)
- Minimal maintenance requirements

First Floor Detail – developed after experience of construction



RALPH CARPENTER
Modece Architects
Friday 18th September 2009

In Sum: Hemp-Lime's Unique Properties

- Air-tight yet vapor-permeable
- Acts like passive air-conditioning system
- Highly flame-resistant without addition of toxic chemical flame retardants, e.g. PDBEs
- Recyclable, biodegradable
- Thermal & Hygroscopic qualities improve insulation performance
- R-value underestimates thermal performance – Studies show occupant comfort higher and fuel use lower than model predictions

Hemp-lime building systems are virtually unknown in the United States…

…but their use as a replacement material for existing insulation and concrete will have a substantial impact on emissions and waste in the built environment

Green Built's Initial Plan
Hemp-Lime Commercialization in the Northeast

- Retrofit existing historic and poorly insulated buildings with hemp-lime insulation materials.
- Construct new buildings in the region that use hemp-lime as non-load bearing wall, roofing and insulation material.

- Develop the market for hemp-lime through demonstration projects.
- Train and work with local masons and contractors in the use of environmentally sound hemp-lime insulation materials.

Targeted Applications

- Insulation retrofits – masonry and wood-framed buildings
- New construction – sustainable homes
- Small-Medium Residential and Commercial developments
- Solution for regional problems – mold, pests, humidity, periodic flooding

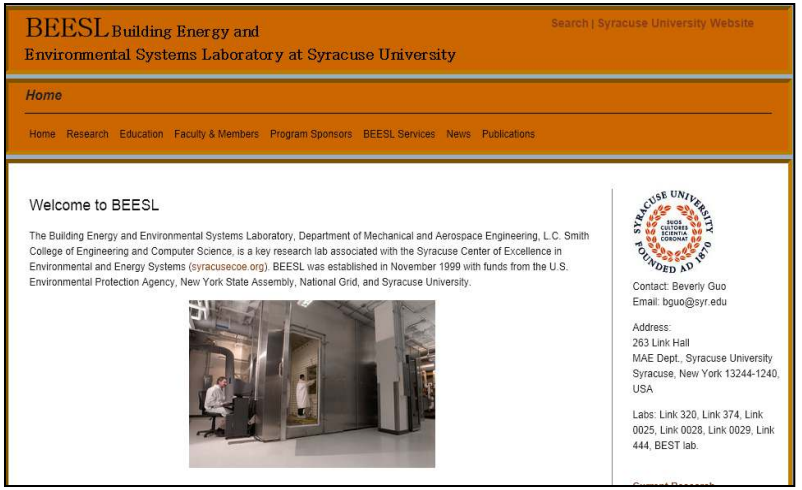
Product Development

- Testing and validation of materials, prior to full commercial development
- Alliances/partnerships with institutions, architects, building professionals, community development groups, complementary product companies
- Demonstration projects
- References

Green Built – Working with BEESL

Green Built is partnering with Syracuse University's Building Energy and Environmental Systems Lab (BEESL) to test and develop Hemp-Lime materials for multiple U.S. climate zones

- Jointly applying for NYSERDA R&D grant
- Testing to be done at SU and on-site in Columbia County
- Expect to continue partnership with Development and Demonstration Projects



SYRACUSECOE center of excellence

Making Hemp-Lime a Force for Regional Economic Development

Green Built plans to commercially develop Hemp-Lime technology in the Mid-Hudson and Capital Regions. Our plan addresses key initiatives of New York State's Sustainability Plans:

- Benefits Multiple Communities
- Energy Efficiency
- Green Jobs
- Innovation
- Promotes Green Infrastructure
- Reduces Solid Waste
- Agricultural Industry Support

40% of U.S. energy use is in buildings – New York State's goal of reducing per capita energy consumption by 20% by 2020 requires significant energy reductions in the built environment.

Green Built
Developing a *New* New York Industry

- Work with New York State, regional and county agencies that promote the use of green building materials and support economic redevelopment activities.
- Apply for green development grants and tax incentives to help achieve early economic viability.
- Source raw materials locally, whenever possible, adding to regional economic value.
- Market Hemp-Lime as infill material and prefabricated panels.
  - Initially market material as environmentally sound insulation retrofit, with additional benefit of mold, rodent and insect resistance.
  - Develop hemp SIPs as cost effective green material in new construction.
- Create infrastructure to manufacture, market and install Hemp-Lime materials in existing and new structures throughout the region.

Prospective Management, Directors and Key Professionals

Jim Savage – Founder and Chief Executive

An investment professional for twenty years, Jim is known for his work as a leading supply chain equity analyst, and was twice named as an Institutional Investor All-American and a Wall Street Journal Best on the Street analyst. He led a multi-industry team of analysts and served as an Associate Director of Research. More recently, he was the Chief Investment Officer of Savage Capital, LLC, a Supply Chain-c entered equity portfolio. Jim's research skills, broad knowledge of financial markets, and supply chain expertise, as well as his ability to understand financially sound investment models, enables him to have the broad view necessary to make a project of this scope successful.

Gail Beverly – Strategy and Marketing

Following a 20+ year career as a marketing and global programs executive at IBM, in 2009 Gail became an independent Sustainability Consultant in the Hudson Valley. In addition to managing LEED (Leadership in Energy and Environmental Design) construction projects, she has developed curriculum and programming for the Sustainable Building Advisor Institute, the U.S. Green Building Council for Southern Dutchess and Putnam Counties, and been a guest instructor at SUNY Ulster. She is accredited as a Green Roofs Professional, Sustainable Buildings Professional, and a LEED Green Associate.

Avi Eden – Director

Avi is an independent consultant for business development. He is currently a Director of Bel Fuse, Inc., and previously served as Vice Chairman and Executive Vice President of Vishay Intertechnology, Inc., a Fortune 1000 company, where he oversaw worldwide environmental policy and implementation and was instrumental in developing industrial and mining facilities in developing countries. He has worked extensively as a Director of the non-profit Delaware River Waterfront Corporation. His activity in the HIV/AIDS community includes his work with the AIDS Law Project, where he is a Director. He is also experienced in international finance.

John Van Dusen Lewis, Ph.D. – Advisory Board

John is a Managing Director of Terra Global Capital, LLC, an organization formed in 2006 to facilitate the market for land use carbon and other environmental credits. His career has combined his discipline in ecological anthropology, with international development management experience. He completed his 22-year career with US AID after six years as the Agency Senior Agriculturalist and Director of its central Office of Agriculture and Food Security. Serving in Senegal, Mali, Cameroon, Egypt, Tunisia, and then Haiti, he was able to design and implement path-breaking new approaches to community-driven sustainable development.

Diana Coughlin – Advisory Board

The former Board President of Columbia County Habitat for Humanity, Diana has been active in the construction industry in the region for decades. Under her direction, Columbia County Habitat hired an executive director, developed its ReStore, initiated a strategic plan and hired a site manager. She currently serves on the organization's Construction Committee. Diana was a founder of Greenport Building Supply, and co-managed the operation.

Jorgen Hempel – Advisory Board

Jorgen is the founder and CEO of Hemp Eco Systems SA and Maison du Nord SARL, and is one of the founders of modern hemp-lime building. his companies have been instrumental in developing materials and building techniques. He has worked throughout Europe in both new construction and insulation retrofits, and has consulted for international NGOs and the European Commission.

Greg Flavall – Advisory Board

A lifelong construction professional and former general contractor, Greg co-founded Hemp Technologies (USA) Inc. in Asheville, NC, which built the first hemp houses in the U.S. Greg recently launched Hemp Technologies (NZ) Inc., a hemp building materials and construction business. In addition to building several houses, he is engaged in developing new hemp-based building products and in launching industrial-scale hemp agricultural production and materials processing in his native New Zealand.

Tim Callahan – Advisory Board

Tim is the Chief Designer at Alembic Studio, a design and architecture firm in Asheville, NC, specializing in the design and planning of Net-Zero Energy homes. He was the architect of The Nauhaus Prototype, a hemp-lime structure designed to meet both Passive House and LEED Platinum standards, and has provided design-build and historic restoration services for a spectrum of commercial and residential clients. Tim is the co-author of "Building Green," published by Sterling Press.

Hemping Columbia County

Installing Green Insulation in an Historic Hudson River House

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