

How to Drawdown Carbon Now with our Buildings:

Practical Solutions & Design Strategies Part 1 - Design and Planning

Ace McArleton - New Frameworks

Chris Magwood - Builders for Climate Action

Jacob Deva Racusin - New Frameworks

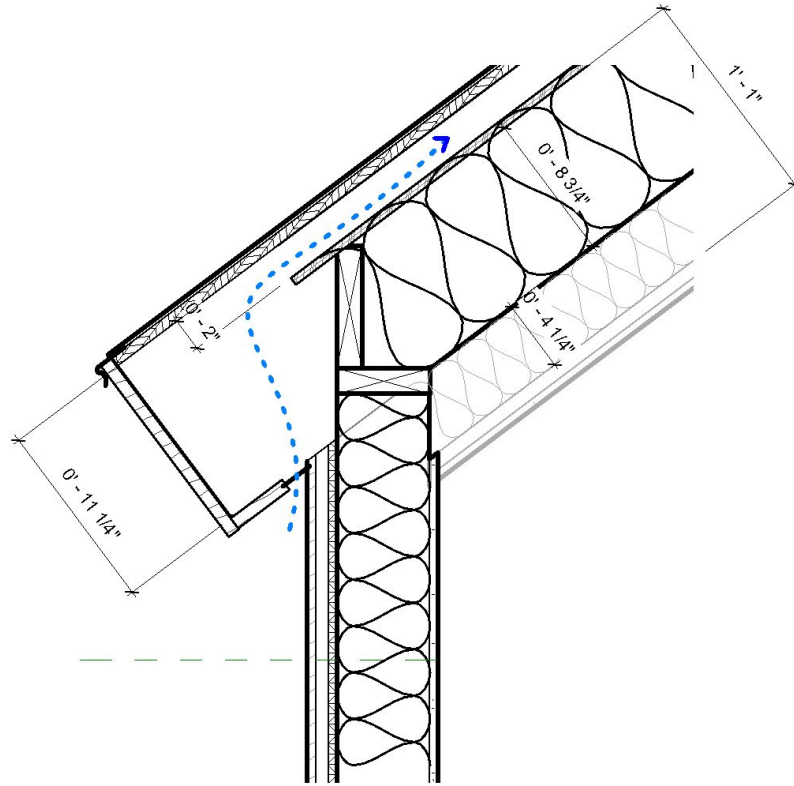
Better Buildings by Design Conference, Feb 6, 2020

You are designer or builder
starting a renovation project.

You've done the energy audit or have
had it done and are looking at the
report.

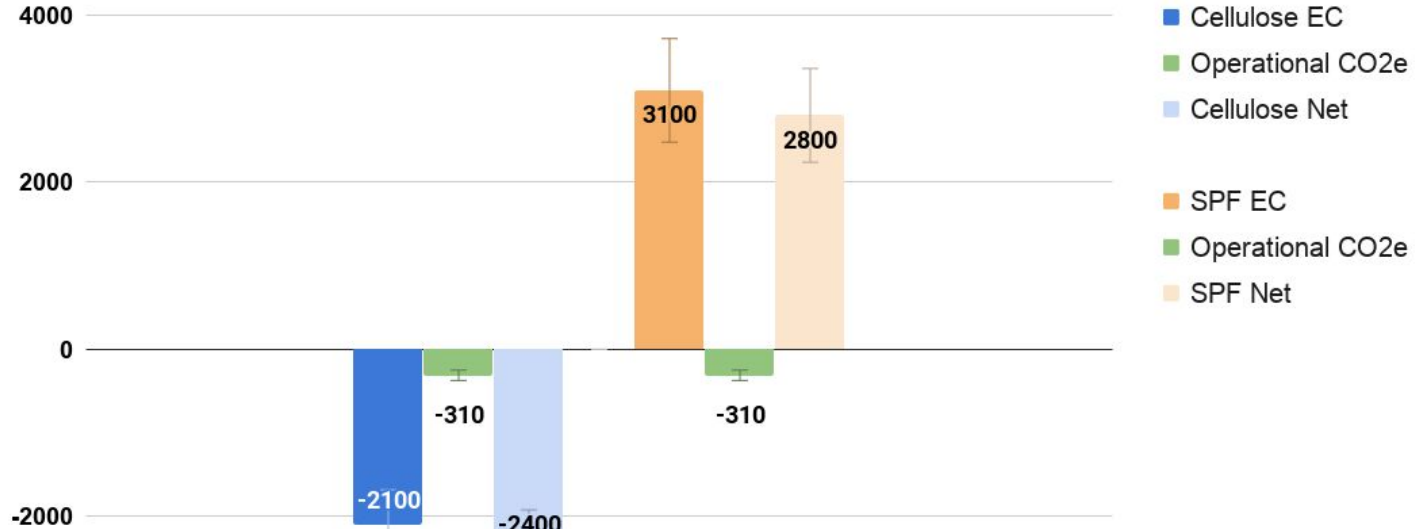
You're looking at the places in the building that need more insulation:

1. Band joist insulation & air sealing
2. Sloped ceiling insulation & air sealing
3. Board insulation wrap - walls



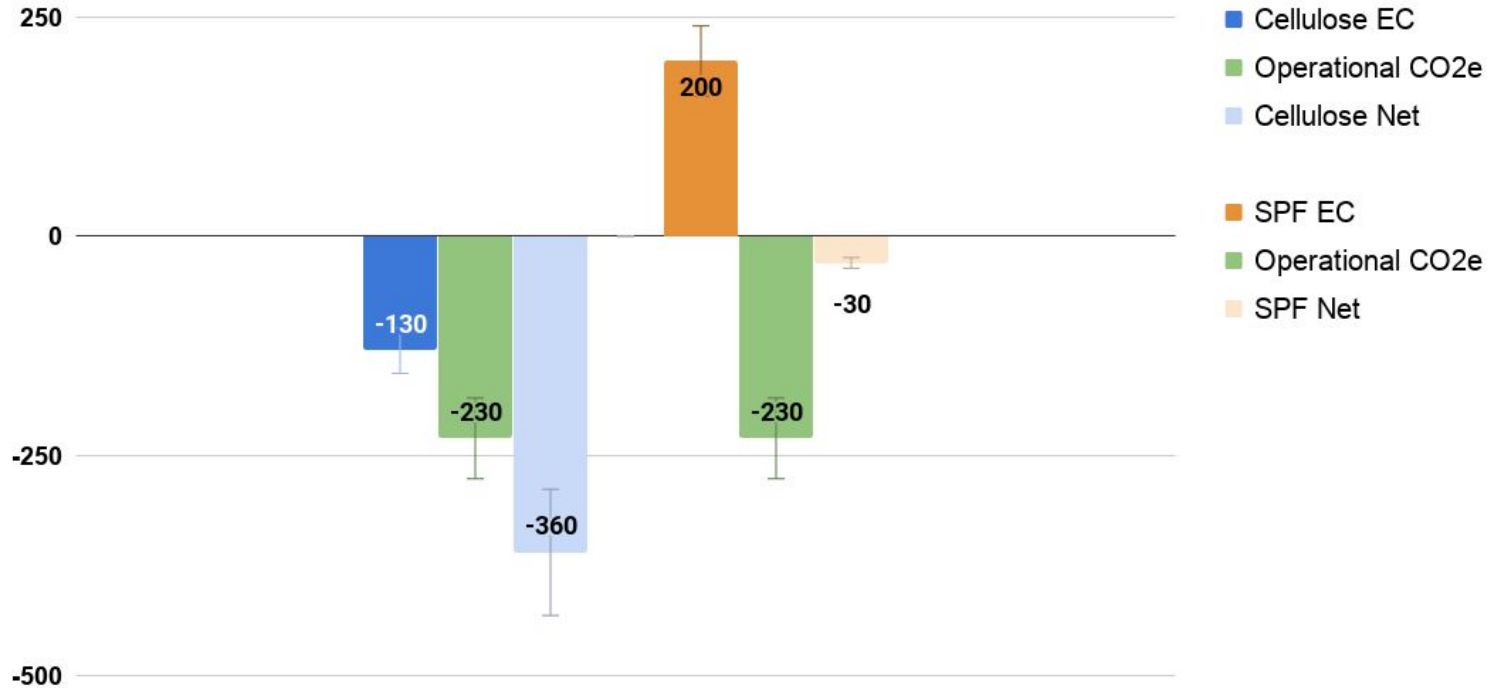
3 Cathedral Ceiling Transition
1" = 1'-0"

CO2e Emissions by 2050, kg - Closed Cavity Roof Insulation



CO2e Emissions by 2050, kg - Closed Cavity Roof Insulation, 945 sq.ft., R-49, Burlington,

CO2e Emissions by 2050, kg - Band Joist Insulation + Air Sealing



CO2e Emissions by 2050, kg - Band Joist Insulation, 168 sq.ft., R-18, St Albans, VT

Exterior foam wrap being replaced with wood fiber board

Charlotte, VT Deep Energy Retrofit, plaster finish, 2017







Burlington, VT Passive House Multi-unit, 2018-19
Charlotte, VT Deep Energy Retrofit, 2019-20



Hemp Batt Insulation

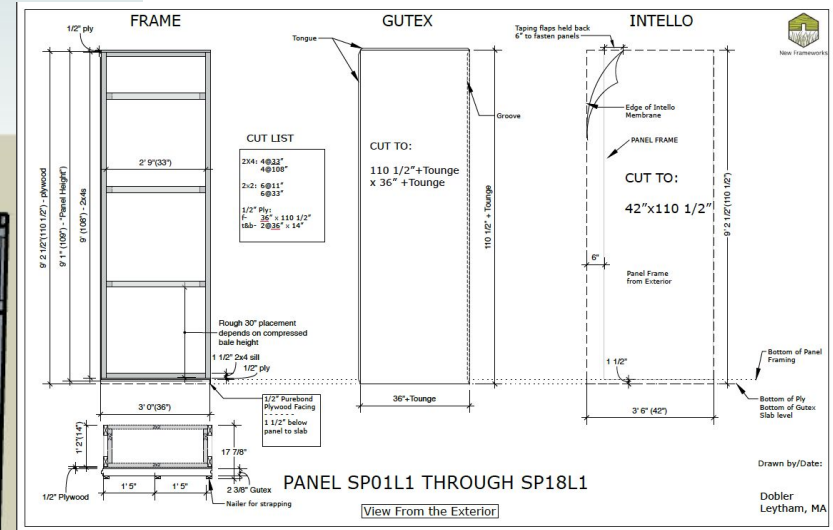
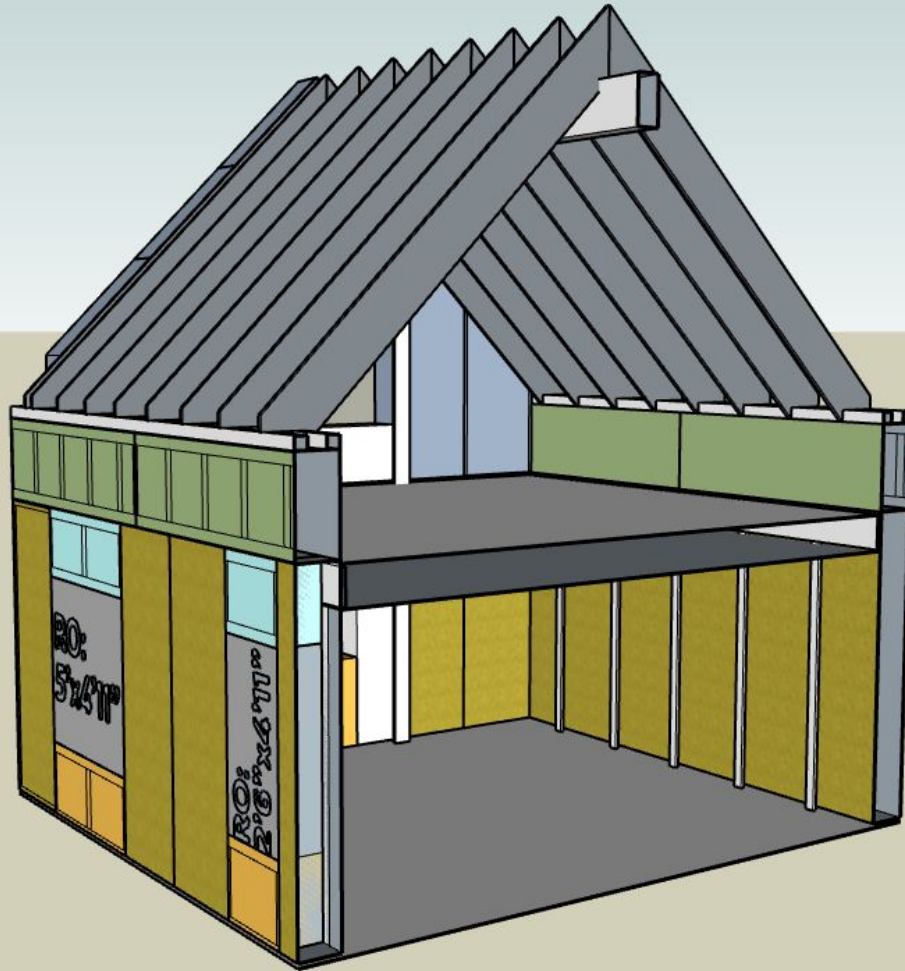
MEM Nature Fibre,
Quebec



Green Culture Verte Inc.

Description:	Number / Numéro	Thickness / épaisseur	Dimension	Panel ftz / Panneau piz	Panel per skid / panneaux palette	SqFt per skid / Palette piz	Price SqFt / Prix piz
AccoustiHemp / Accousti-chanvre	1201648-40	2"	15 1/4" x 48"	5,33	126	672	0,89\$
NaturHemp insulation / Isolant Natur-chanvre	1202448-40	2"	23 1/4" x 48"	8	84	672	0,89\$
NaturHemp insulation / Isolant Natur-chanvre	1351648-35	3 1/2"	15 1/4" x 48"	5,33	75	400	1,19\$
NaturHemp insulation / Isolant Natur-chanvre	1352448-35	3 1/2"	23 1/4" x 48"	8	50	400	1,19\$
NaturHemp insulation / Isolant Natur-chanvre	1551648-35	5 1/2"	15 1/4" x 48"	5,33	48	256	1,79\$
NaturHemp insulation / Isolant Natur-chanvre	1552448-25	5 1/2"	23 1/4" x 48"	8	32	256	1,79\$
NaturHemp insulation / Isolant Natur-chanvre	1751648-35	7 1/2"	15 1/4" x 48"	5,33	36	192	2,39\$
NaturHemp insulation / Isolant Natur-chanvre	1752448-35	7 1/2"	23 1/4" x 48"	8	24	192	2,39\$
NaturHemp felt / Feutre NaturChanvre	100100	1/4"	47 1/4" x 164"	645 ftz per roll / piz par rouleau			0,89\$
				2"	3 1/2"	5 1/2"	7 1/2"
" R" Value / Isolant facteur " R"				R-8	R-13	R-20	R-28

Straw Panels, New Frameworks, 2019





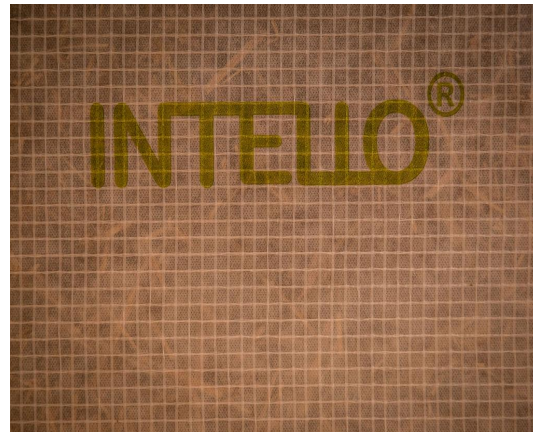








Dobler Cottage, Leyden MA

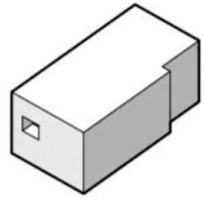


Glavel (aerated glass) under slab

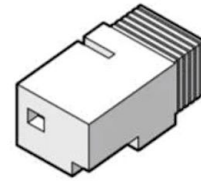
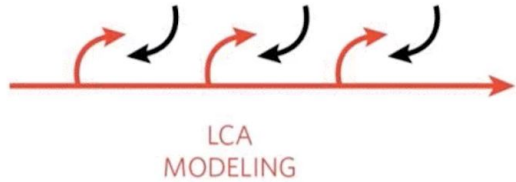
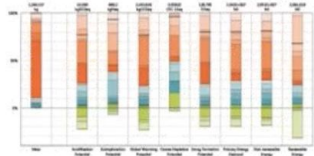


Tally

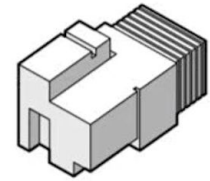
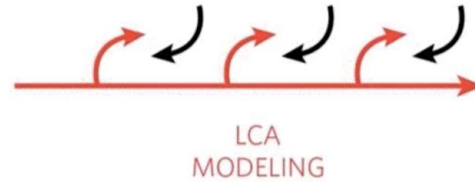
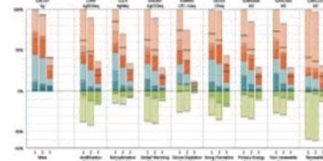
TALLY WORKFLOW



SCHEMATIC
DESIGN



DESIGN
DEVELOPMENT



CONSTRUCTION
DOCUMENTS

EC3

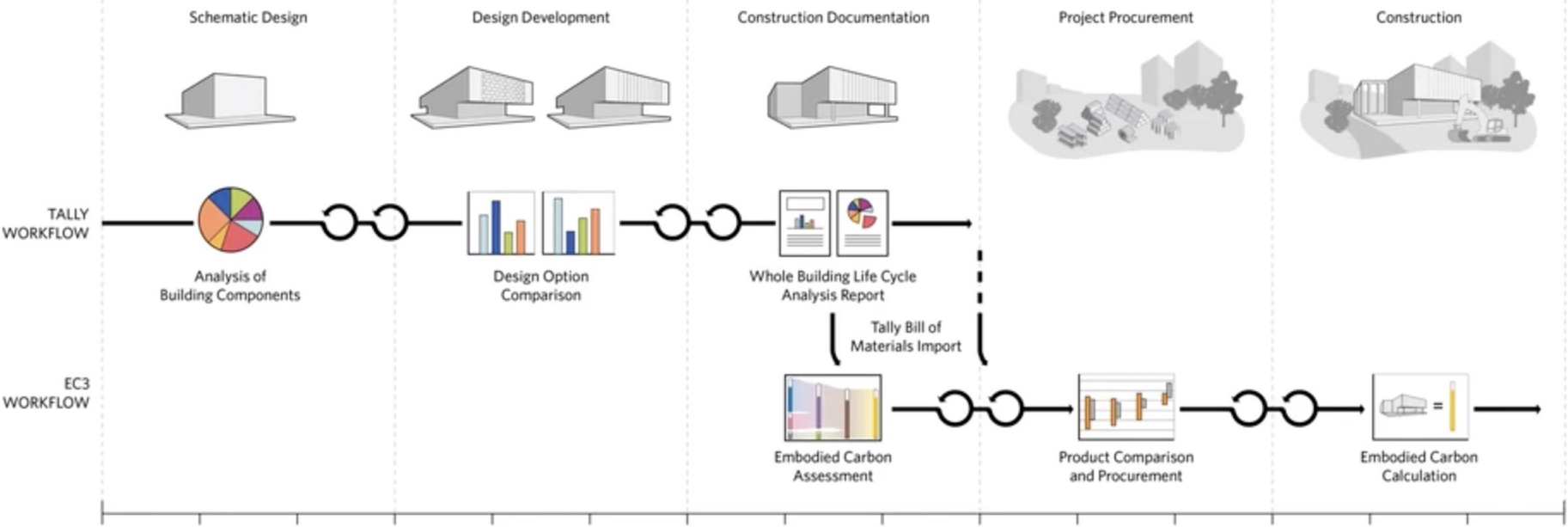


Table 7a. Summary Results (A1-A3): 2501-3000 psi (17.25-20.68 MPa) RMC product, per cubic yard

Indicator/LCI Metric	GWP	ODP	AP	EP	POCP	PEC	NRE	RE	NRM	RM	CBW	CWW	TW	CHW	CNHW
Unit (equivalent)	kg CO2	kg CFC-11	kg SO2	kg N	kg O3	MJ	MJ	MJ	kg	kg	m3	m3	m3	kg	kg
Minimum Indicator/ Metric Value	157.8	2.92E-6	0.85	0.10	11.78	1430	1419	11	1561	0.37	0.10	0.09	0.19	0.31	2.04
Maximum Indicator/ Metric Value	257.7	4.46E-6	1.15	0.13	14.54	2020	2006	14	1758	0.46	0.10	0.09	0.19	0.31	2.04
3000-00-FA/SL	257.7	4.46E-6	1.15	0.13	14.54	2020	2006	14	1758	0.46	0.10	0.09	0.19	0.31	2.04
3000-20-FA	222.1	3.86E-6	1.00	0.11	13.23	1775	1762	13	1669	0.42	0.10	0.09	0.19	0.31	2.04
3000-30-FA	202.9	3.53E-6	0.93	0.10	12.52	1642	1630	12	1620	0.40	0.10	0.09	0.19	0.31	2.04
3000-40-FA	182.6	3.19E-6	0.85	0.10	11.78	1503	1492	11	1569	0.37	0.10	0.09	0.19	0.31	2.04
3000-30-SL	197.7	3.56E-6	1.02	0.12	13.69	1691	1678	13	1656	0.43	0.10	0.09	0.19	0.31	2.04
3000-40-SL	177.7	3.26E-6	0.97	0.11	13.40	1582	1570	13	1622	0.42	0.10	0.09	0.19	0.31	2.04
3000-50-SL	157.8	2.97E-6	0.93	0.11	13.12	1474	1461	12	1588	0.41	0.10	0.09	0.19	0.31	2.04
3000-50-FA/SL	159.0	2.92E-6	0.87	0.10	12.34	1430	1419	11	1561	0.38	0.10	0.09	0.19	0.31	2.04

ICE database

ICE (Inventory of Carbon & Energy)

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Hammond**

Affiliation:



***corresponding author.** Contact details: <http://www.circularecology.com/contact.html>

Version Control

Version:

V3.0 Beta - 9 August 2019

Codes and policies

World Green Building Council calling for 40% embodied carbon reductions by 2050



ILFI and CaGBC Zero Carbon certification programs seeing high uptake



Peterborough County Carbon Cap Incentive program

Township of Douro-Dummer
SUSTAINABLE DEVELOPMENT PROGRAM



Offering builders \$10,000 for meeting 50kgCO₂e/m² cap

How to Drawdown Carbon Now with our Buildings:

Practical Solutions & Design Strategies Part 2 - Materials

Ace McArleton - New Frameworks

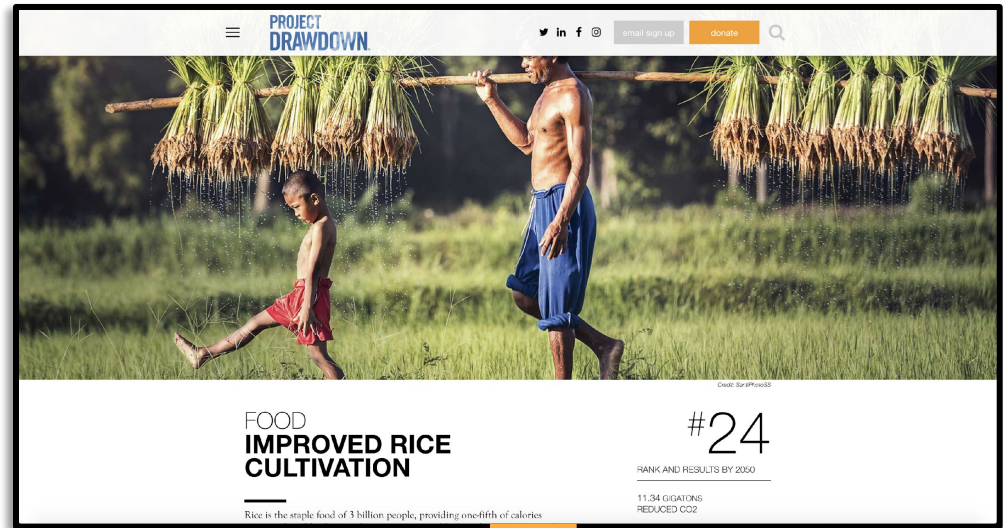
Chris Magwood - Builders for Climate Action

Jacob Deva Racusin - New Frameworks

Better Buildings by Design Conference, Feb 6, 2020

Drawdown solutions

Interdisciplinary industry
action improving supply
chains



The screenshot shows the Project Drawdown website interface. At the top, there is a navigation bar with the 'PROJECT DRAWDOWN' logo, social media icons for Twitter, LinkedIn, Facebook, and Instagram, an 'email sign up' field, a 'donate' button, and a search icon. The main visual is a photograph of a man and a young boy in a rice field; the man is carrying a long wooden pole with several bundles of harvested rice stalks balanced on it. Below the image, the text reads 'FOOD IMPROVED RICE CULTIVATION' in bold, with a rank of '#24' and the text 'RANK AND RESULTS BY 2050'. At the bottom right, it states '11.34 GIGATONS REDUCED CO2'. A small note at the bottom left says 'Rice is the staple food of 3 billion people, providing one-fifth of calories'. A small credit 'Credit: Sr @Procc5' is visible in the bottom right corner of the image area.



The screenshot shows the CalPlant I LLC website. On the left, there is a green square logo with the text 'CalPlant I LLC'. Below the logo, the text reads 'High-performance MDF to revolutionize the composite panel industry.' On the right, there is a photograph of several stacked sheets of light-colored medium-density fiberboard (MDF) panels, with a pile of wood shavings or chips in the foreground.

Drawdown solutions

Urban centers cannot realize sustainable material needs without the support of rural land-based industries.

Sustainable supply chains can bolster rural economic development.

Working landscapes avoid problematic land-use change.



LAND USE AFFORESTATION

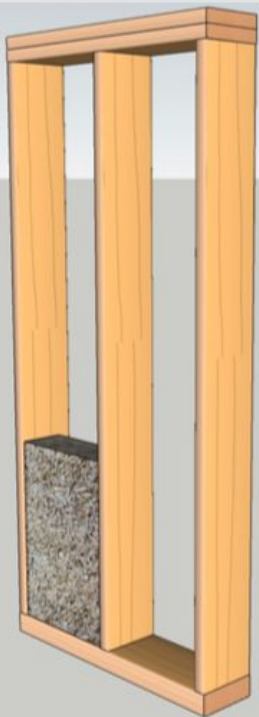
This is a typical single-story tree plantation in Umatilla, Oregon, consisting of poplar trees planted with eight-foot spacing in order to force upward, knot-free growth.

#15

RANK AND RESULTS BY 2050

18.06 GIGATONS
REDUCED CO2E





Hempcrete 100 ft² @ R-19

Carbon storage 595 lbs.

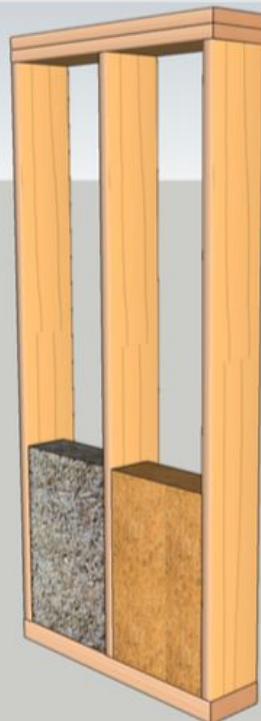
R-value R-2/inch

Material Cost \$75.00

Density 15.5 lb/ft³

Testing Full CND/EU

Availability Limited commercial



Wood Fiber 100 ft² @ R-19

Carbon storage 595 lbs.

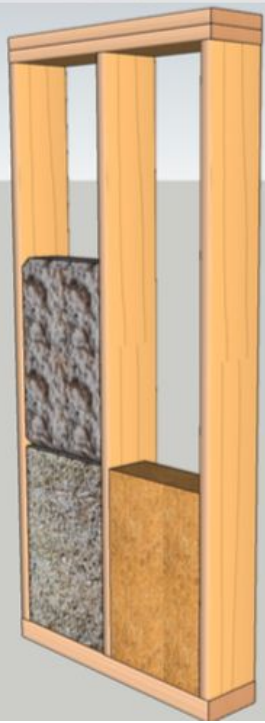
R-value R-3.8/inch

Material Cost \$100-180.00

Density 1.8 lb/ft³

Testing Full EU testing

Availability Limited commercial



Cellulose 100 ft² @ R-19

Carbon storage 265 lbs.

R-value R-3.6/inch

Material Cost \$32.00

Density 3.5 lb/ft³

Testing Full ASTM testing

Availability Widely available



Rice Hulls 100 ft² @ R-19

Carbon storage 440 lbs.

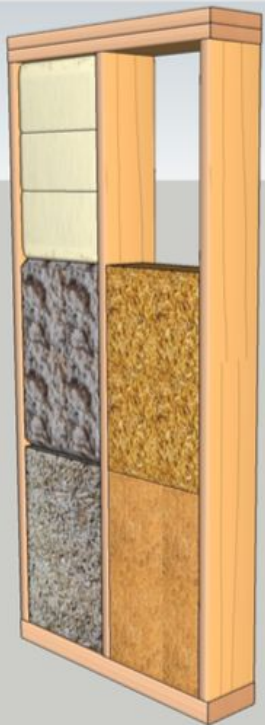
R-value R-3.0 to 3.2/inch

Material Cost \$6.00

Density 9 lb/ft³

Testing Full ASTM testing

Availability No commercial



Straw 100 ft² @ R-19

Carbon storage 640 lbs.

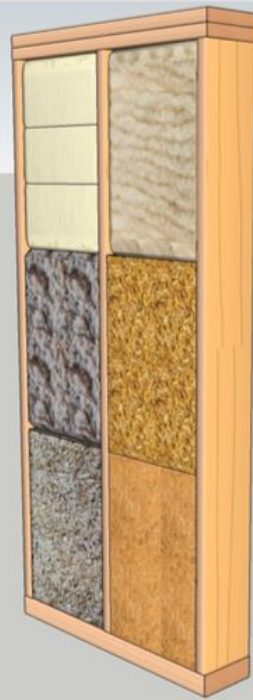
R-value R-2.6/inch

Material Cost \$28.00

Density 6.25 lb/ft³

Testing Full EU testing

Availability Widely available



Wool 100 ft² @ R-19

Carbon storage ?

R-value R-4/inch

Material Cost \$240.00

Density 1.2 lb/ft³

Testing Full ASTM testing

Availability Limited commercial



Wood Wool 100 ft² @ R-4

Carbon storage 200 lbs.

R-value R-1.8/inch

Material Cost \$150-200.00

Density 15.5 lb/ft³

Testing Full ASTM testing

Availability Limited commercial



Cork 100 ft² @ R-4

Carbon storage 45 lbs.

R-value R-3.6/inch

Material Cost \$150-200.00

Density 7.2 lb/ft³

Testing Full ASTM testing

Availability Limited commercial



Wood Fiberboard 100 ft² R-4

Carbon storage 47 lbs.

R-value R-2.4 to 3.8/inch

Material Cost \$100.00-\$180.00

Density 8.75 lb/ft³

Testing Full ASTM testing

Availability Limited commercial



VestaEco WALL / WALL S

Impact-resistant and vapour-permeable thermal insulation for masonry walls.

Impact-resistant and vapour-permeable thermal insulation for masonry walls. Improves energy conservation by keeping heat inside the building during winter while providing a favourable microclimate of its interiors. Thanks to high thermal capacity it also protects against high temperatures and provides pleasant coolness during summer. Recommended in particular when erecting new buildings, when the amount of water to be discharged in connection with mason works is the largest. Available with an increased density layer (WALL S).



Advantages of the product:

- Healthy, eco-friendly material based on natural resources
- Protection against cold in winter and heat in summer thanks to high thermal capacity
- Vapour-permeable material, regulates the microclimate of interiors
- Does not absorb water
- Eco-friendly production process, thanks to the use of innovative, patented DefibraTech 1.0 technology



Certificates





Ekopanely board E40/800



Construction straw board without surface finish

Recommended applications:

- Exterior wall cladding on the inside
- Partitions and floors
- Ceilings constructions
- Roof extensions and loft conversions
- Interior cladding of an existing wall on a wooden grid
- Determination of volatile organic compounds (VOC) - A+

Specifications:

- Thickness 38 mm (tolerance +2 mm)
- Width 800 mm
- Length 1200 - 3200 mm
- Average density 379 kg/m³
- Thermal conductivity $\lambda=0.099$ W/m.K
- Water vapour resistance factor $\mu=9.7$
- Fire response category E



Ekopanely board E60/800, E60/1200



Construction straw board without surface finish

Recommended applications:

- Exterior wall cladding
- Cladding of interior load bearing walls
- Partitions and floors
- Ceilings constructions
- Roof extensions and loft conversions
- Interior cladding of an existing wall on a wooden grid
- Determination of volatile organic compounds (VOC) - A+

Specifications:

- Thickness 58 mm (tolerance +2 mm)
- Width 800, 1200 mm
- Length 1200 - 3200 mm
- Average density 379 kg/m³
- Thermal conductivity $\lambda =0.099$ W/m.K
- Water vapour resistance factor $\mu=9.7$
- Fire response category E



Straw bale panels

The straw bale panels were our first effort at creating a version of a straw SIP that does not use a plaster finish.

Horizontal strapping is integrated into the panel, providing additional fastening for the sheathing and creating a 3/4" space that we filled with loose cellulose insulation. This insulation was compressed between the sheathing and the bales and fills in the highs and lows of the bale surface. This provides continuous insulation and prevents convection loops.

The bales are placed into the frame and tightly packed at the edges of the panel.





Growing mycofoam onto straw panels

One of the straw bale panels was "sheathed" in Mycofoam. We started the culture in the bags (top left) and then placed the material directly on the straw bales in the panel (top right), to a depth of 1-1/2 inches to match the fiberboard sheathing on the other half of the panel. In five days, we exposed the culture to the light and allowed it to dry.

The finished Mycofoam (left) had bonded well with the straw surface, and provided R-5 as a thermal break on the exterior face of the panel.



Wall assembly

Each of the wall panels is lifted into place with the zoom boom.

The panels are braced with temporary bracing on the interior of the building and fastened to the floor assembly and adjoining panels using GRK structural screws.

All the hard work that went into making the panels so accurately paid off with a quick and hassle-free assembly.



Building Element	Material	Kg in Project	EPD	EPD-Off brand	ICE 2.0	Other data	Averaged	Sequestration @ 45% carbon	Notes
Foundation	Diamond pin footing								
	DP-75 blocks - 14 @ 74lb (24mpa concrete)	470		0.127	0.107		70.09		
	Steel pins - 4 @ 60" per block x 14 blocks = 3360 i	530		1.5	1.4		734.93		
	Wooden beams -74lf @ 8x10 inches	523.8	0.161				84.33	865.06	
	Floor trusses	957.08	0.161				154.09	1580.62	
	Plywood under trusses - 1/2" x 628 ft2	363.47	0.264				95.96	587.06	97.8% of mass is wood, 2.1% is resin
	Plywood around trusses	251.7	0.264				66.45	406.54	97.8% of mass is wood, 2.1% is resin
	LVL beams 56 lf x 1-3/4"x18"	189.39	0.37				70.07	305.08	97.54% of mass is wood, 2.46% is resin and filler
	ReWall sheathing 628 sf @ 1/2" (37pcf)	498.5				0.485 (from 1	120.89	740.95	Some mass is binders, quantity unknown. 90% assumed. 1/2 value for recycled product.
	Cellulose insulation @ 65kg/m3 density	1589.25		0.0497		0.0033 (from	42.11	2362.18	90% of mass is paper fibers, 10% is borate fire retardant
Flooring	Hardwood (ash), 3/4" 530 sf main floor	646.72			0.24 0.47 (from Ti	229.58		1068.06	
Walls	Double stud cellulose w/interior ReWall and exterior wood fiber board								
	Framing lumber 2527 lf of 2x4	1174.5	0.161				189.09	1939.69	
	Plywood around prefab panels 577 lf @ 1/2"x10"	278.49	0.264				73.52	449.8	97.8% of mass is wood, 2.1% is resin
	Fiberboard sheathing 728 sf @ 1.5" (265kg/m3)	683.7		1.18		1.22 (from P.	643.82	1038.8	92% of mass is wood fibers, 8% is binders
	ReWall interior sheathing 968 sf @ 0.5" (37pcf)	676.86				0.485 (from 1	164.14	1006.05	Some mass is binders, quantity unknown. 90% assumed. 1/2 value for recycled product.
	Cellulose insulation 25.49m3 @ 65kg/m3	1656.85		0.0497		0.0033 (fron	43.9	2462.66	90% of mass is paper fibers, 10% is borate fire retardant
	Double stud straw bale panels w/interio ReWall and exterior wood fiber board								
	Framing lumber 504 lf of 2x4	234	0.161				37.67	386.45	
	Plywood around prefab panels 168lf @ 1/2"x16"	129.67	0.264				34.23	209.44	97.8% of mass is wood, 2.1% is resin
	Fiberboard sheathing 352 sf @ 1.5" (265kg/m3)	331.25		1.18		1.22 (from P.	309.72	503.29	92% of mass is wood fibers, 8% is binders
Straw bales 82 @8pcf @ 4.375 ft3 per bale	1301.8			0.01		13.02	2149.92		
Cellulose insulation @ 352 sf @ 3/4" per side	80.99		0.0497		0.0033 (fron	2.15	120.38	90% of mass is paper fibers, 10% is borate fire retardant	
ReWall interior sheathing 352 sf @ 0.5" (37pcf)	246.21				0.485 (from 1	59.71	365.95	Some mass is binders, quantity unknown. 90% assumed. 1/2 value for recycled product.	
Roof	Roof trusses	973.41	0.161				156.72	1607.59	
	Fiber board exterior sheathing 820sf @ 1.5" (265kg/	768.5		1.18		1.22	723.67	1167.64	92% of mass is wood fibers, 8% is binders
	ReWall interior sheathing 820sf @ 0.5" (37pcf)	573.47				0.485 (from 1	139.07	852.38	Some mass is binders, quantity unknown. 90% assumed. 1/2 value for recycled product.
	LVL beams 68lf x 1-3/4" x 20"	255.47	0.37				94.52	411.53	97.54% of mass is wood, 2.46% is resin and filler
	Cellulose insulation 36.76 m3 @ 65kg/m3	2389.4		0.0497		0.0033 (fron	63.32	3551.49	90% of mass is paper fibers, 10% is borate fire retardant
	Strapping 444lf of 2x4, 626 lf of 1x4	400.05	0.161				64.4	660.68	
	Steel roofing 820 sf @ 26ga. (0.9lb/ft2)	334.75		1410kg/93m2	1.54		835.76		
Second floor	Trusses	408.23	0.161				65.73	674.19	
	Wood sheathing 324sf @ 9/16"	193.5	0.161				31.15	319.57	
	Hardwood flooring 324sf @ 3/4"	394.22			0.24 0.47 (from Ti		139.95	651.05	
Interior walls	Framing lumber 390 lf of 2x4	181.35	0.161				29.2	299.5	
	Strapping 1320lf of 2x3	437.85	0.161				70.49	723.11	
	Finished sheathing plywood 1312sf @ 1/2"	760.33	0.264				200.73	1228.06	97.8% of mass is wood, 2.1% is resin
Ceiling	Plywood 760sf @ 0.5"	440.58	0.264				116.31	711.61	97.8% of mass is wood, 2.1% is resin
Cladding	Strapping 1108lf of 2x4	514.35	0.161				82.81	849.45	
	Exterior steel 921 sf @ 26 ga (0.9lb/ft2)	375.98		1410kg/93m2	1.54		938.1		
Total CO2 kg							6991.4	32255.83	
									less 6991.4 CO2 emissions
									25264.43 Total kg CO2 sequestered