Hippie Architecture of the 70's

William Maclay & John Rahill

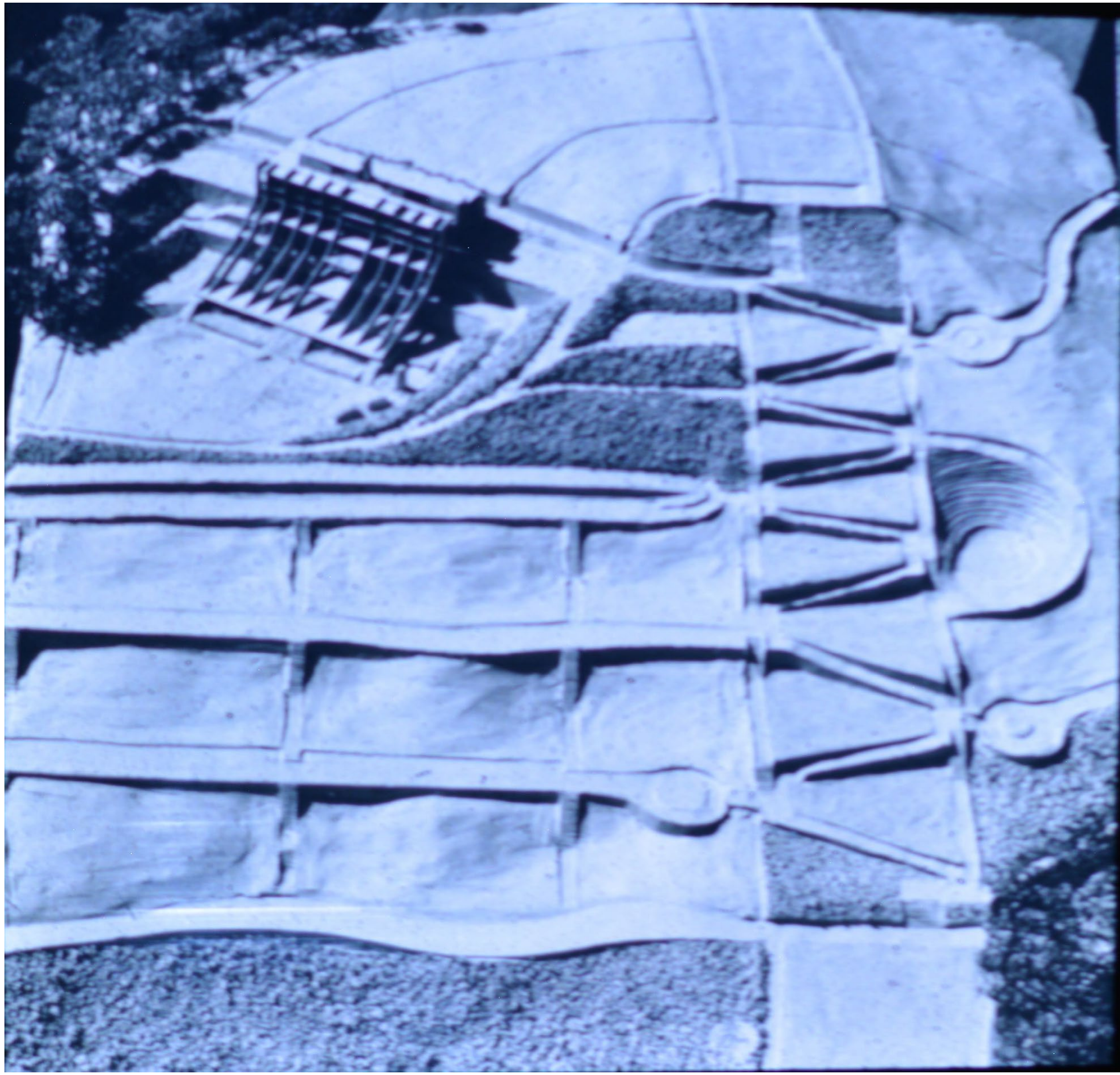
No electric, wood heat


Net zero?

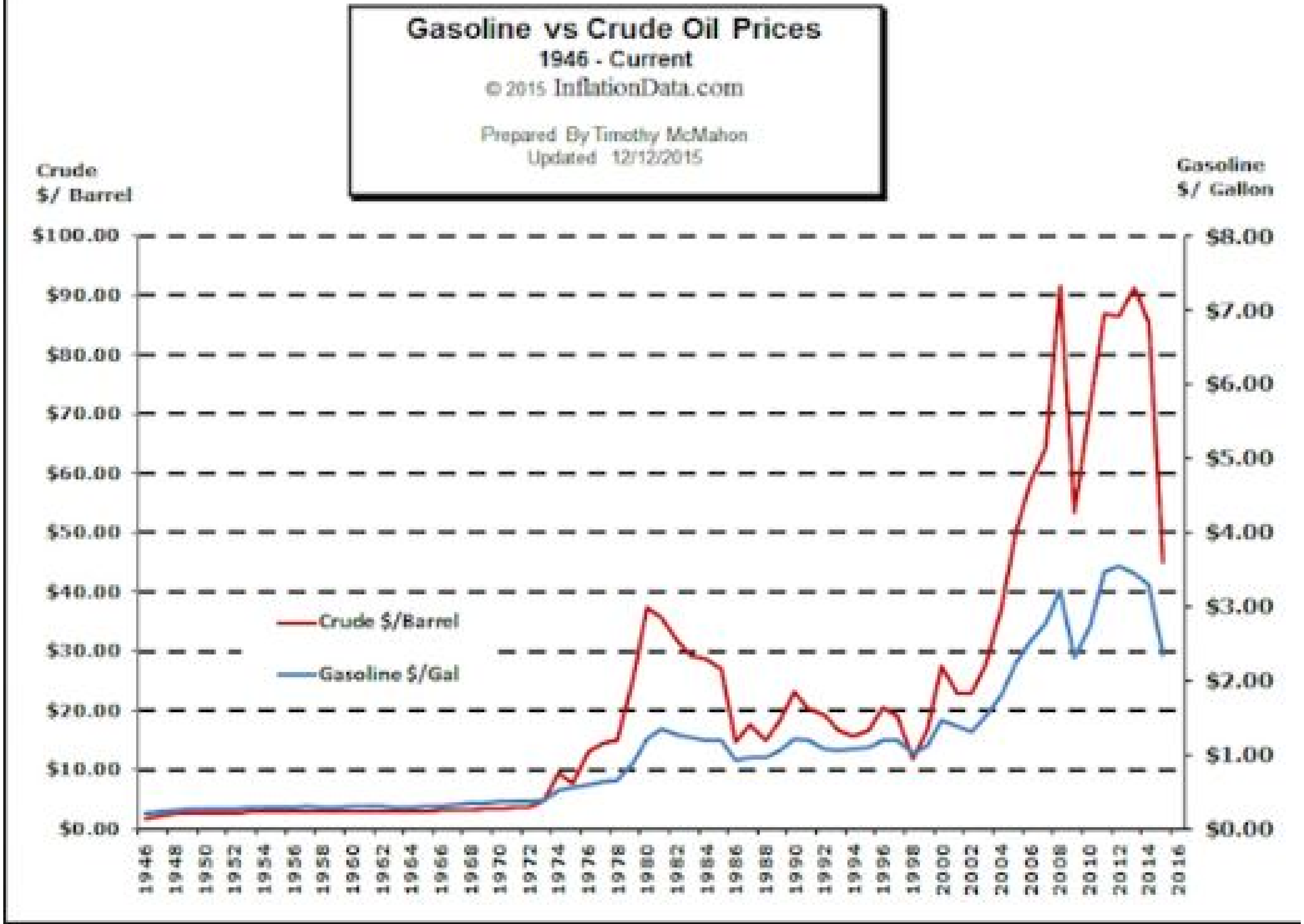

Zomeworks
Net Zero

Thesis: Mother Earth Eco Village and Research Center

Renewable Energy Community Masterplan



Net Zero


Gasoline vs Crude Oil Prices
1946 - Current
© 2015 InflationData.com
Prepared By Timothy McMahon
Updated 12/12/2015
Crude
$/ Barrel
Gasoline
$/ Gallon
$100.00
$90.00
$80.00
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$0.00
$8.00
$7.00
$6.00
$5.00
$4.00
$3.00
$2.00
$1.00
$0.00
Crude $/Barrel
Gasoline $/Gal
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THUNDERBIRD

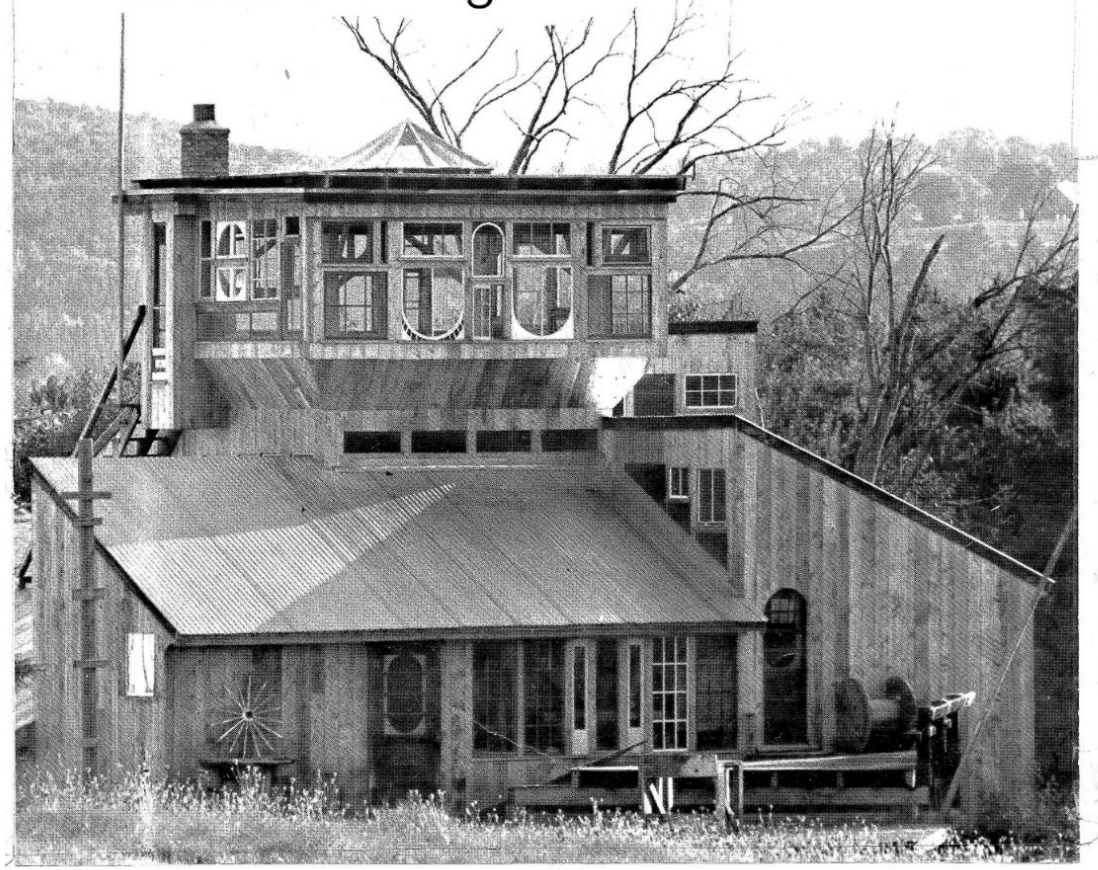

:

Architecture School independent study d to project:

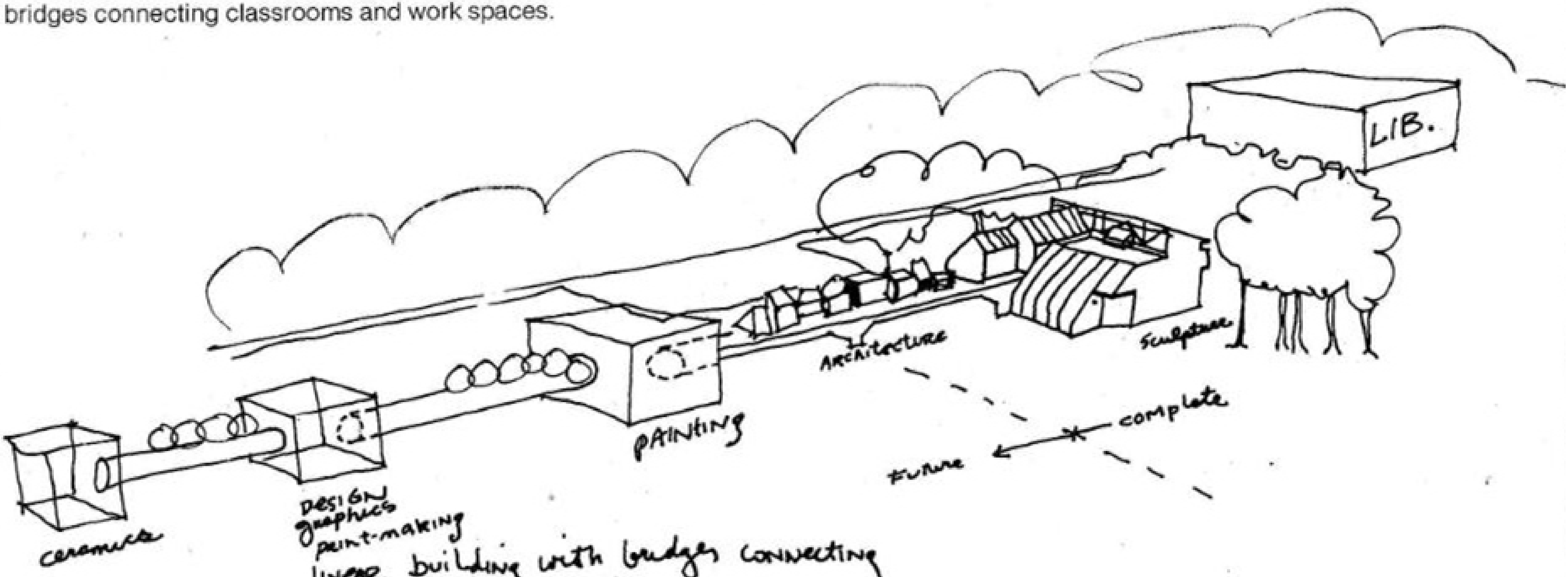
Judged to be
" irresponsible, given the millions of unhoused in the world"

Progressive Architecture

Organic architecture at
Goddard College



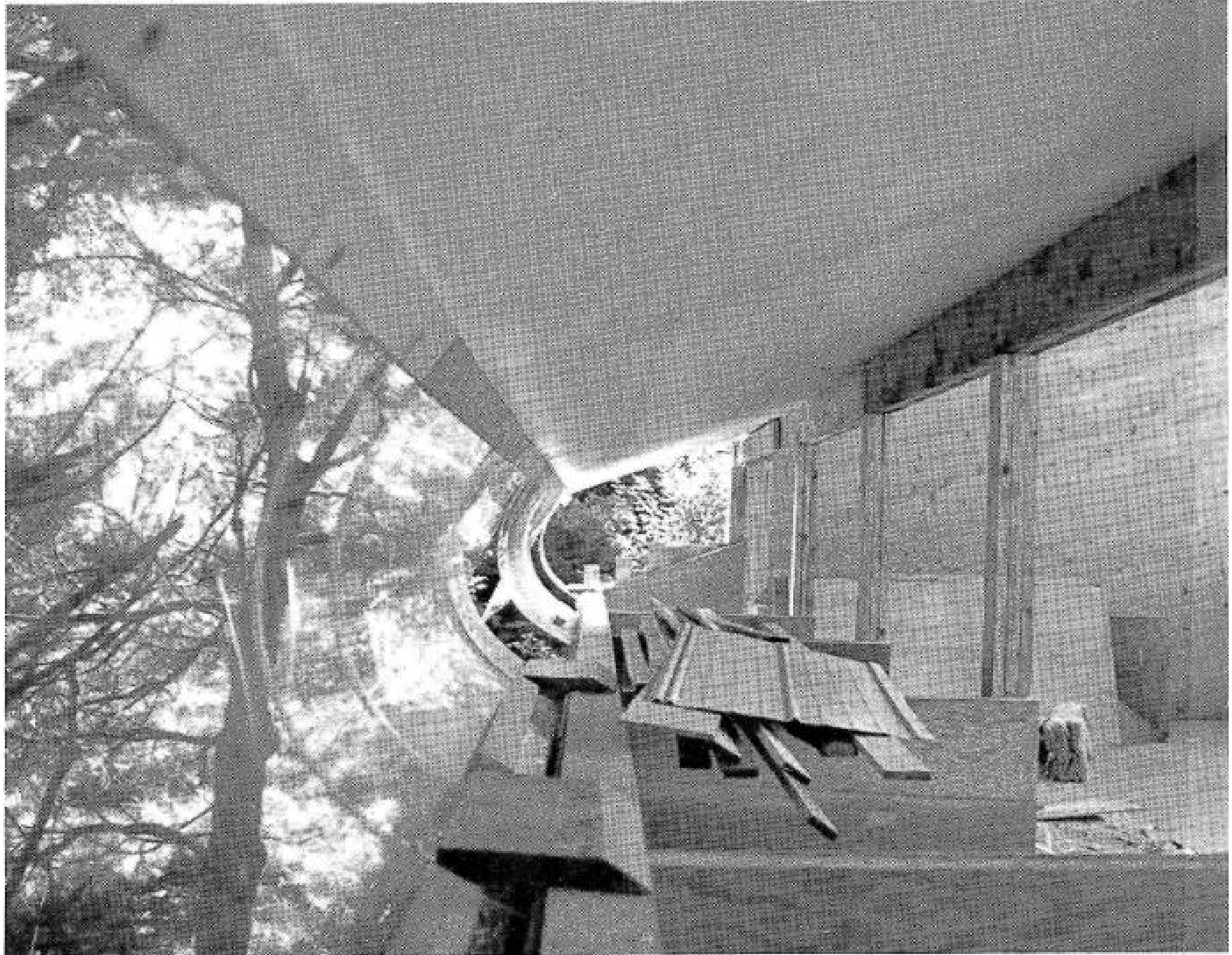
Photomontage of main sculpture studio whose space is framed around two large plywood bents. Sculpture Building is first part of a 500-ft long linear Arts Complex with bridges connecting classrooms and work spaces.



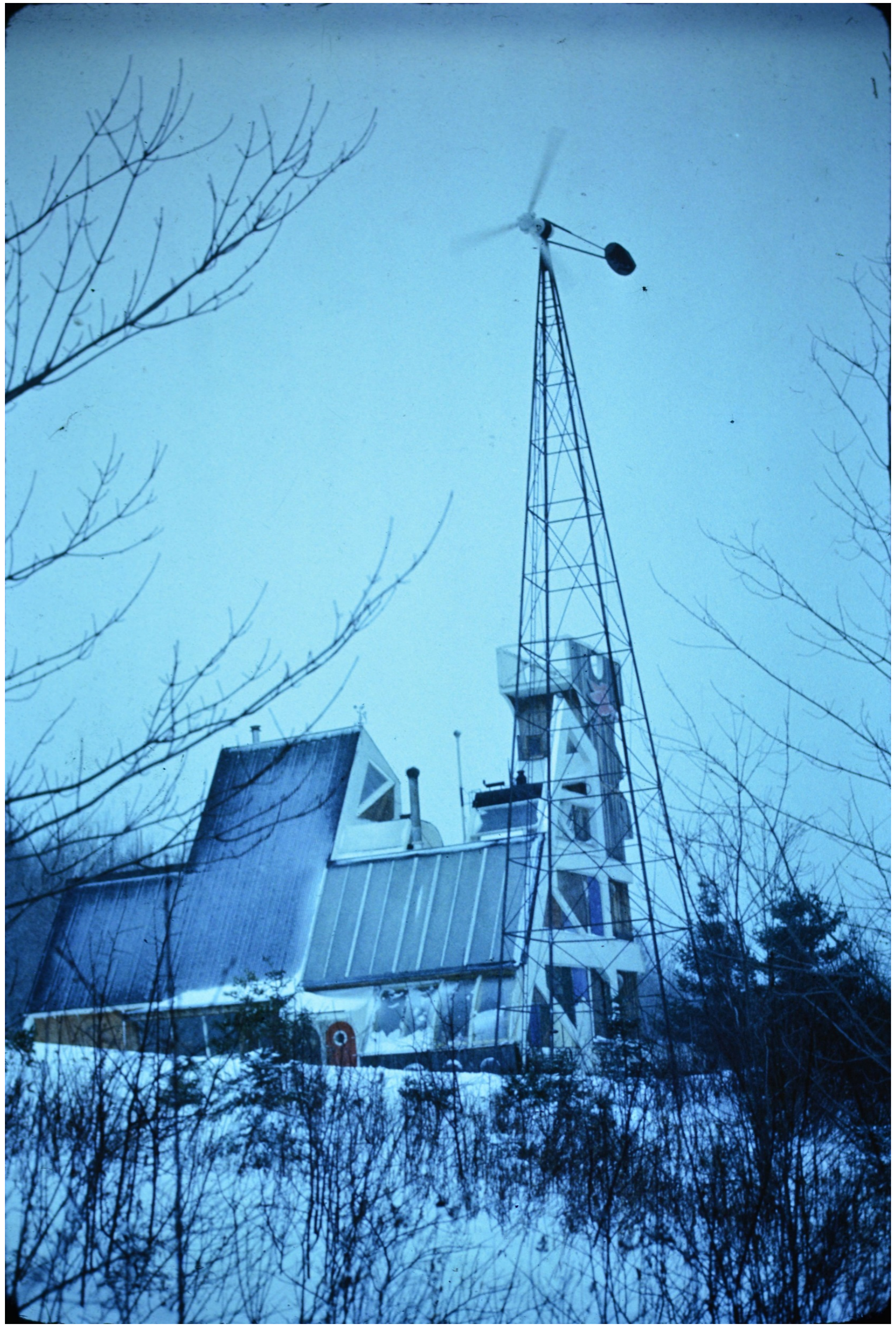
linear building with bridges connecting
— classrooms & work spaces.

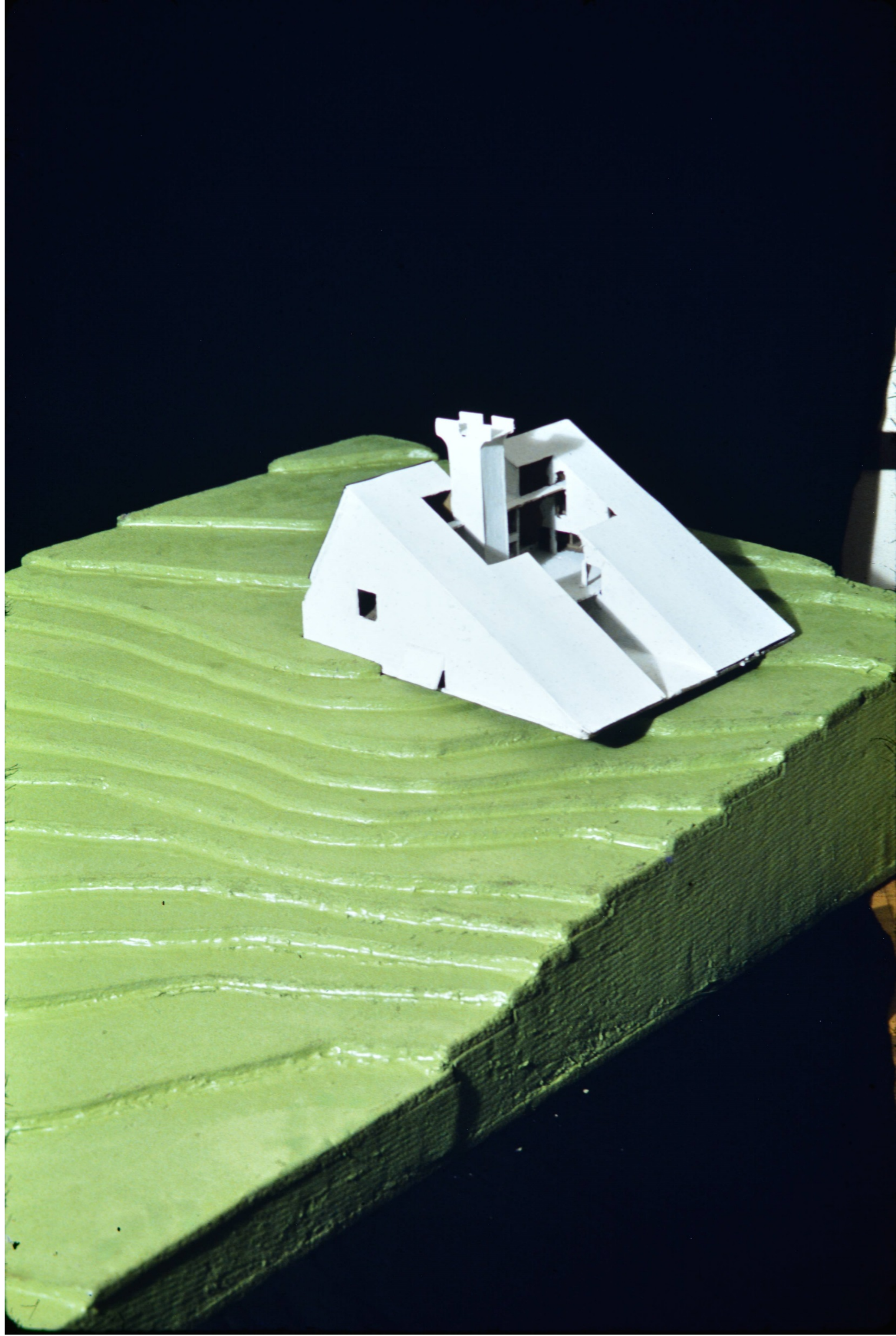
on top of bridge students build the own
— work studios —

ARTS complex. — mech. systems run under bridge.



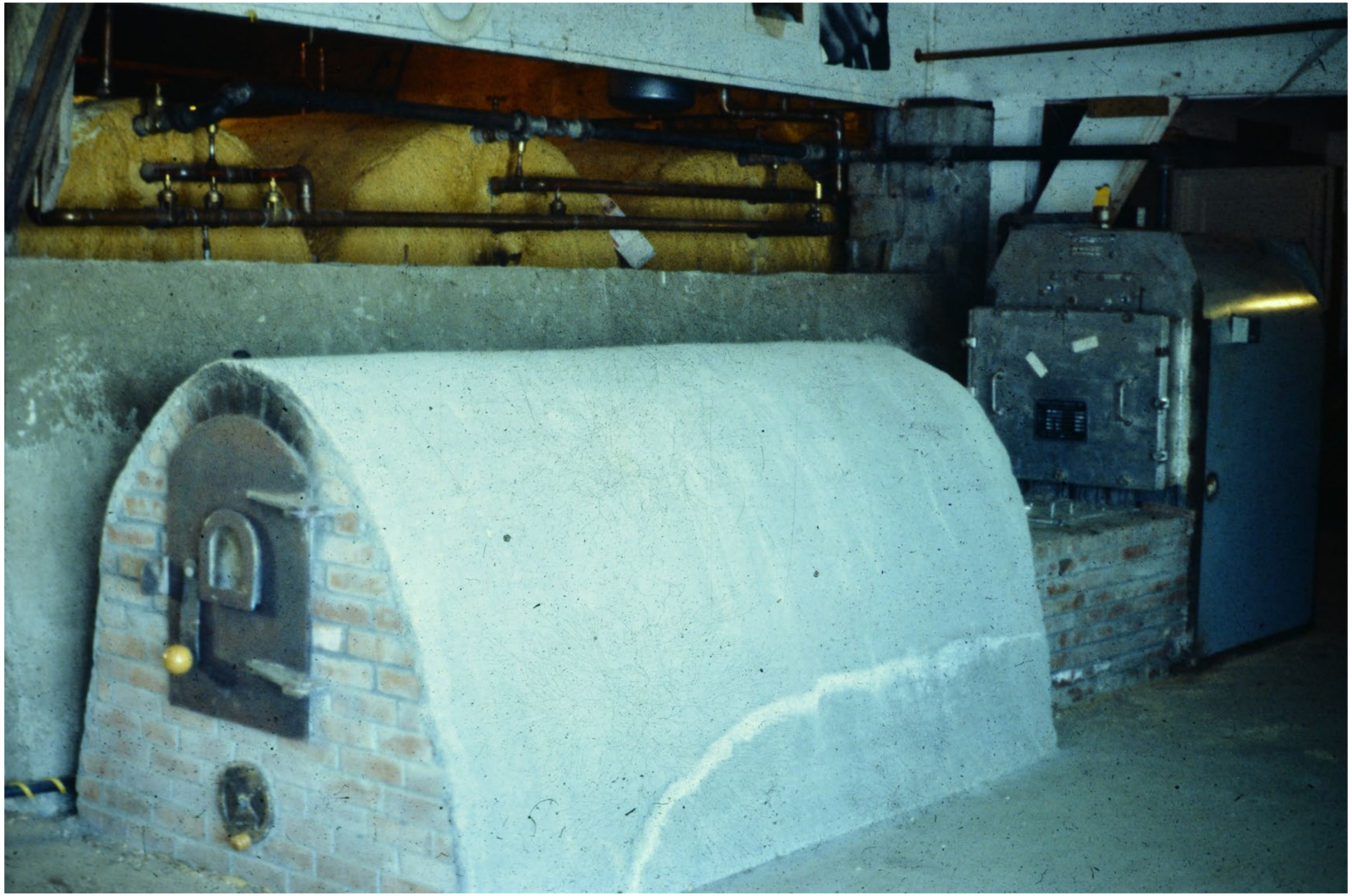
Dimetrodon

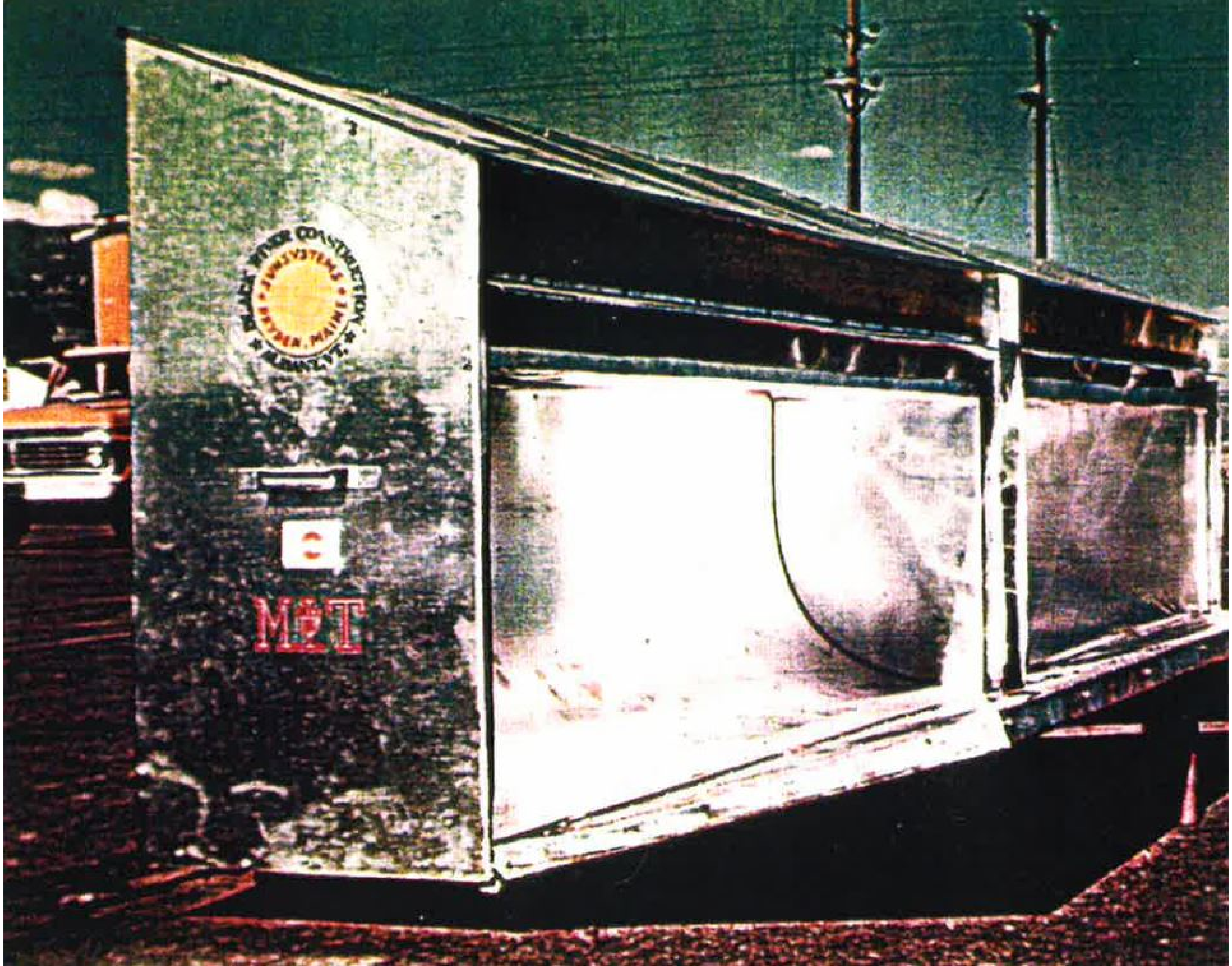


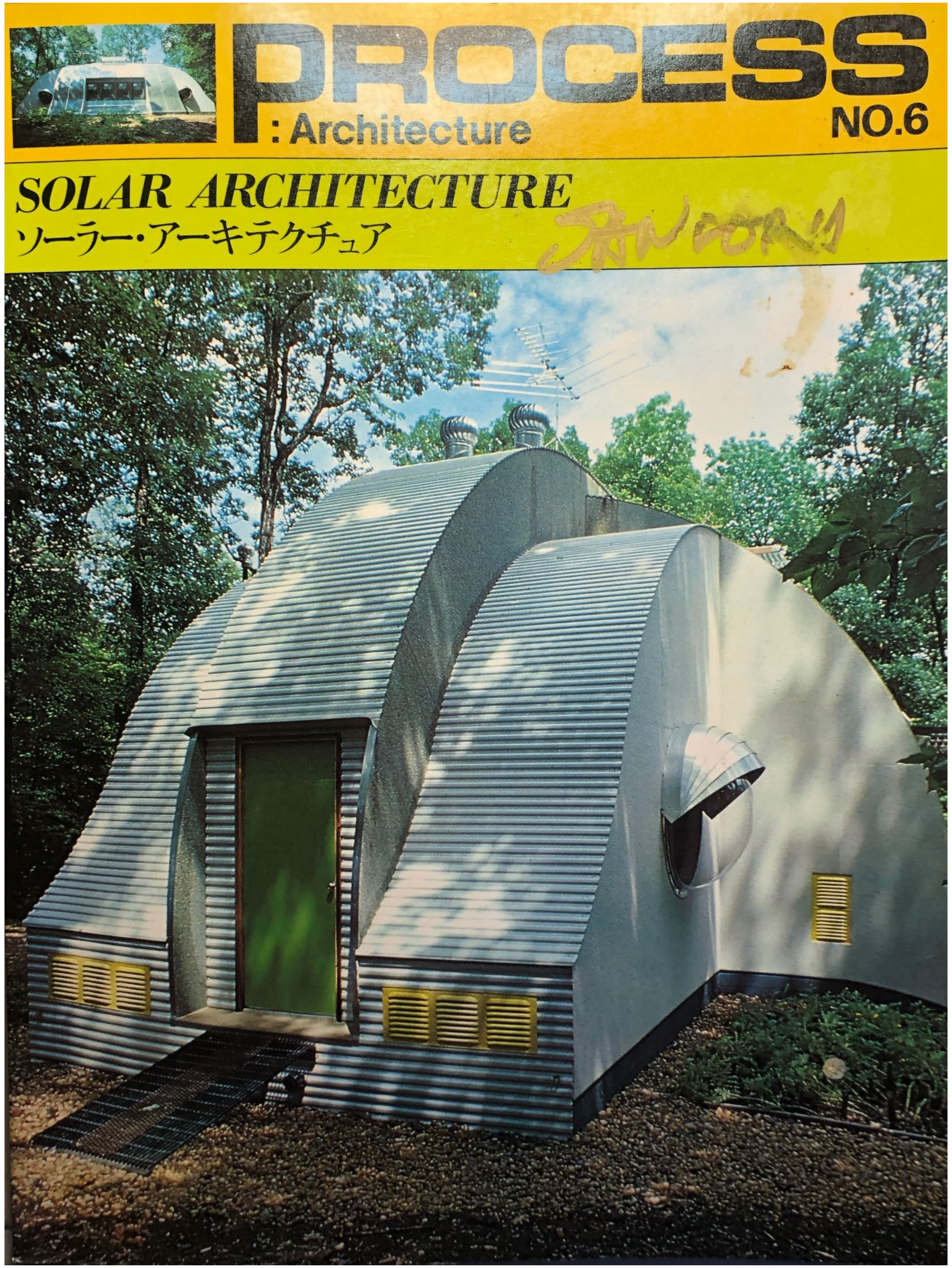



PREMIUM


BAUHAUS






PROCESS
: Architecture
NO.6
SOLAR ARCHITECTURE
ソーラー・アーキテクチュア

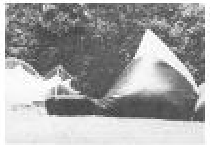
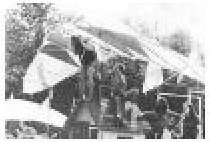

AA
L'ARCHITECTURE D'AUJOURD'HUI
GROUPE EXPANSION
Quelle architecture solaire ?

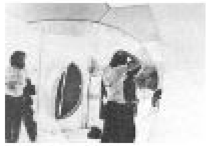
A Temporary City Celebrates Cooperation and Creativity

The Whiz Bang Quick City, an instant town of mostly cardboard domes and inflatable tents, existed for four days near Woodstock, New York.

By the MOTHER EARTH NEWS editors | *July/August 1972*

A temporary sauna near the pond is enjoyed by the inhabitants of Whiz Bang Quick City.
CASS WESTER



Les Walker and Robert Mangurian—both professors of design at City College in New

MORE

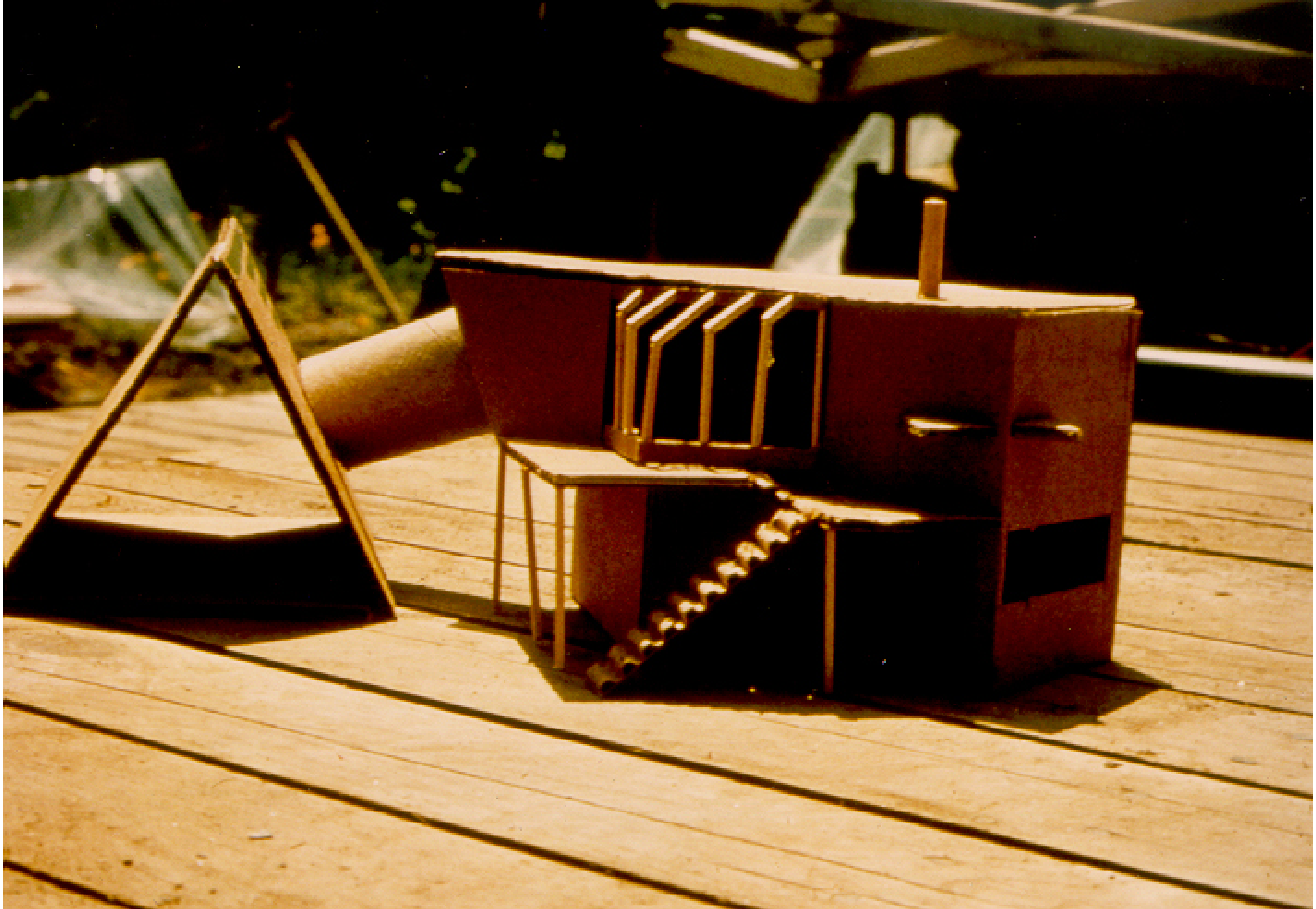
Passionate Producer: Erin Harvey of The Kale Yard

Unique Gardening Tools That are

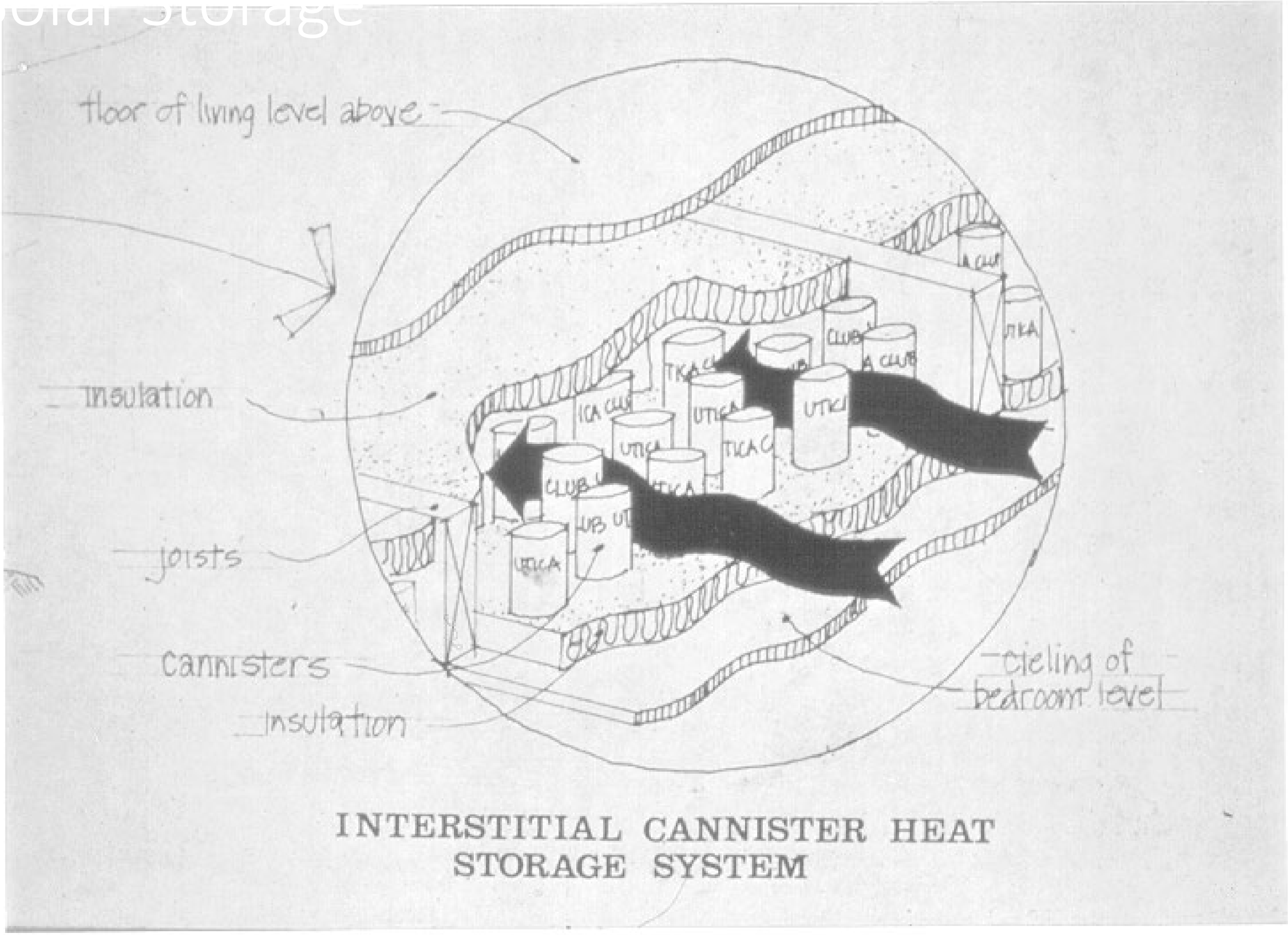
Whiz Bang Quick City 1972

Arcosanti- Paolo Solieri


ermal Shutters & Shades
Over 100 Schemes for Reducing Heat Loss Through Windows
Shurcliff
SUN EARTH
How to apply free energy sources to our homes and buildings
SolarGroup/Architects
THE NEXT
Whole Earth
Catalog
EDITED BY STEWART BRAND
$12.50
A Guide to Reducing Heating and Cooling Losses Through the Windows in Your Home
Movable Insulation
by William K. Langdon
Including insulating options for windows, glass doors, skylights, greenhouses, and solar hot water heaters.




Solar Storage



INTERSTITIAL CANNISTER HEAT STORAGE SYSTEM

Green Lumber Framing

Site Built Air Solar System

The solar wall on this house in Middlesex collects enough heat on a sunny day even in winter to send inside temperatures to 95 degrees. The steeply angled wall faces south and is designed to collect free heat from the sun to warm Peter O. Hood's home.

Solar Energy Is Free, And It Works

By GREGG BLACKBURN

MIDDLESEX — Temperatures were below freezing all day Friday but Peter O. Hood had to open windows in his solar heated house here when morning sun drove inside temperatures to over 80 degrees. Hood said on sunnier days, even in winter, the inside temperature hits 95 degrees.

The sun was obscured by clouds in the afternoon Friday, but the house will stay warm for a day and a half because of extra thick walls containing six inches of insulation, according to Hood. The 450 sq. ft.-solar wall is capable of producing a minimal amount of heat even on a mostly overcast day, Hood said.

Hood's solar heating system is not complete yet, but when it is he says it will provide an average two-thirds of all the heat requirements in the house.

The solar heating system now consists of the big south-facing wall angled to catch the maximum amount of sun. The wall is made up of a layer of special curved panels of transluscent fiberglass covering a layer of window glass and a layer of metal roofing painted black. There is an air space between each layer, and behind the roofing a larger air space open in the basement and on the top floor of the house. Cold air is drawn into that last larger air space by convection and is warmed by the sun before spilling out to heat the upstairs of the house.

Still to be added to the system is ductwork which will return the warm air to the space between the first and second floors. Hood plans to put a layer of 140 ~~beer cans~~ CASES OF BEER CANS between the floors, full of a mixture of anti-freeze and water to store the heat gained in the daytime.

The beer cans would be warmed in the day and slowly cool off at night releasing heat to the house.

Hood estimates the extra cost of the solar collector to be about $2,000, but it should save at least $500 a year in fuel costs if it provides two-thirds of the heat for his six-room house.

The fiberglass is put over the window glass partly for protection and partly because it forms a curved surface to collect the sun's rays. Hood said the curved surface is more efficient than a flat one at collecting heat as the sun moves across the sky and the angle of the rays changes.

Hood said he asked two architect friends, John Rayhill and David Bryan of the Black River Construction Co. of Albany to design and build a house for him. The two architects talked him in to the idea of a solar house, although Hood said he was a bit skeptical at first. He said he did some research and found that his location was one of the least sunny places in the country, according to weather records, but he decided to take a chance on the solar collector. Hood is pleased with the performance of the solar collector and he is a man who enjoys his warmth. In addition to the solar collector he has three working wood stoves in the house and it is wired for electric heat.

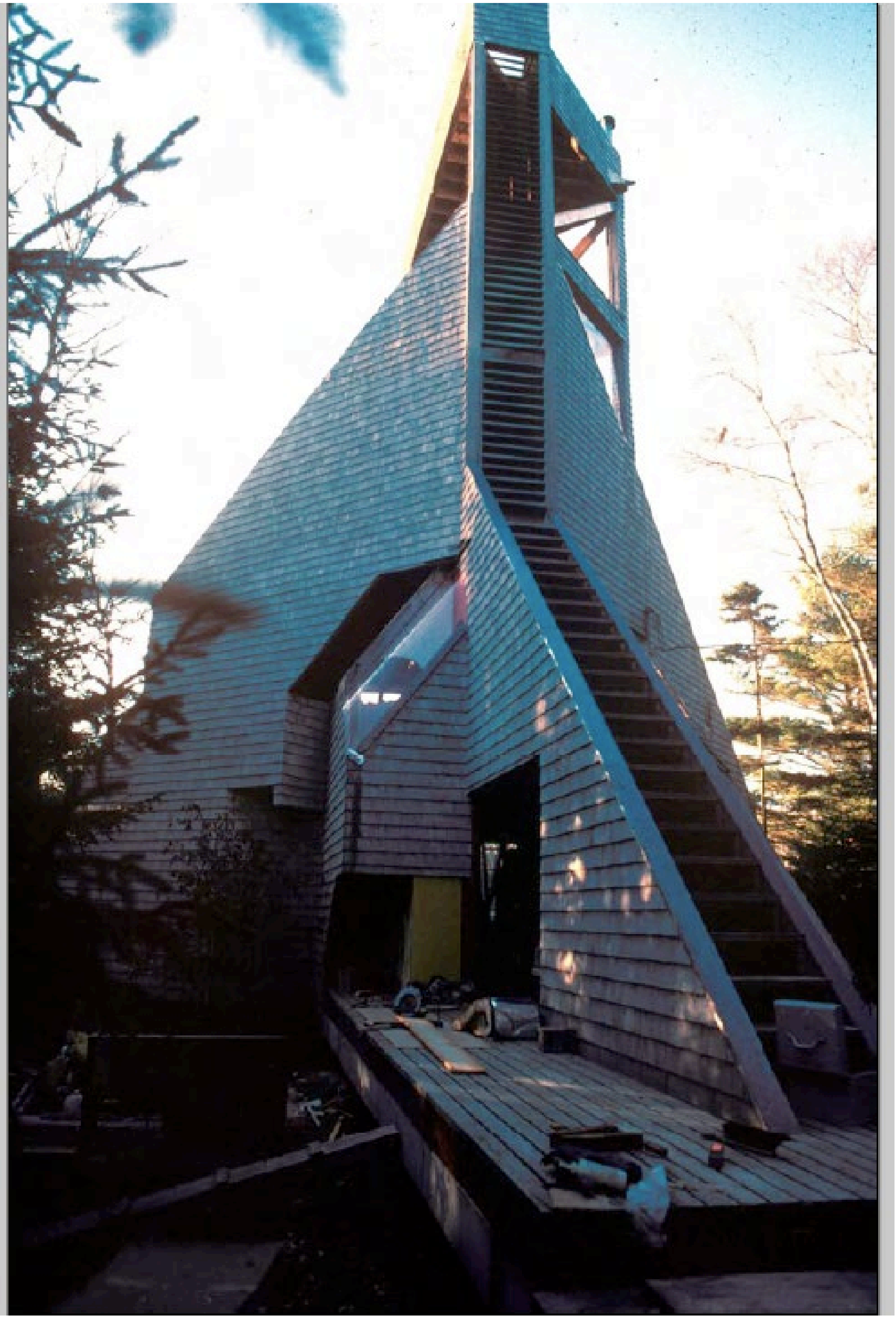
All that free heat from the sun plus the heat from wood cut on his property "means I can keep my house at a nice warm 72 degrees and not have to worry about the energy crunch or high fuel costs," Hood said.

Design Build

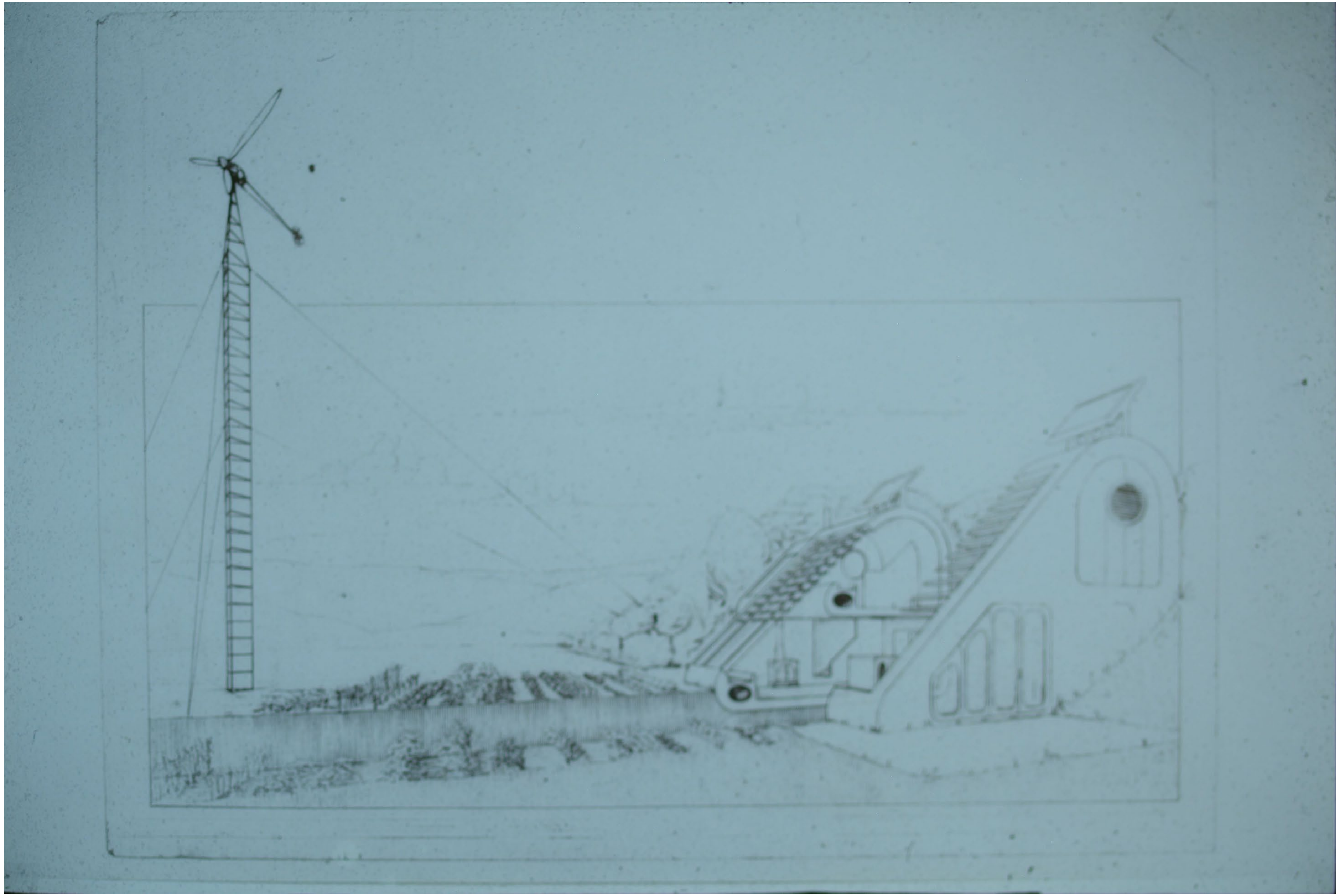
Institute for Social Ecology

Aspen House

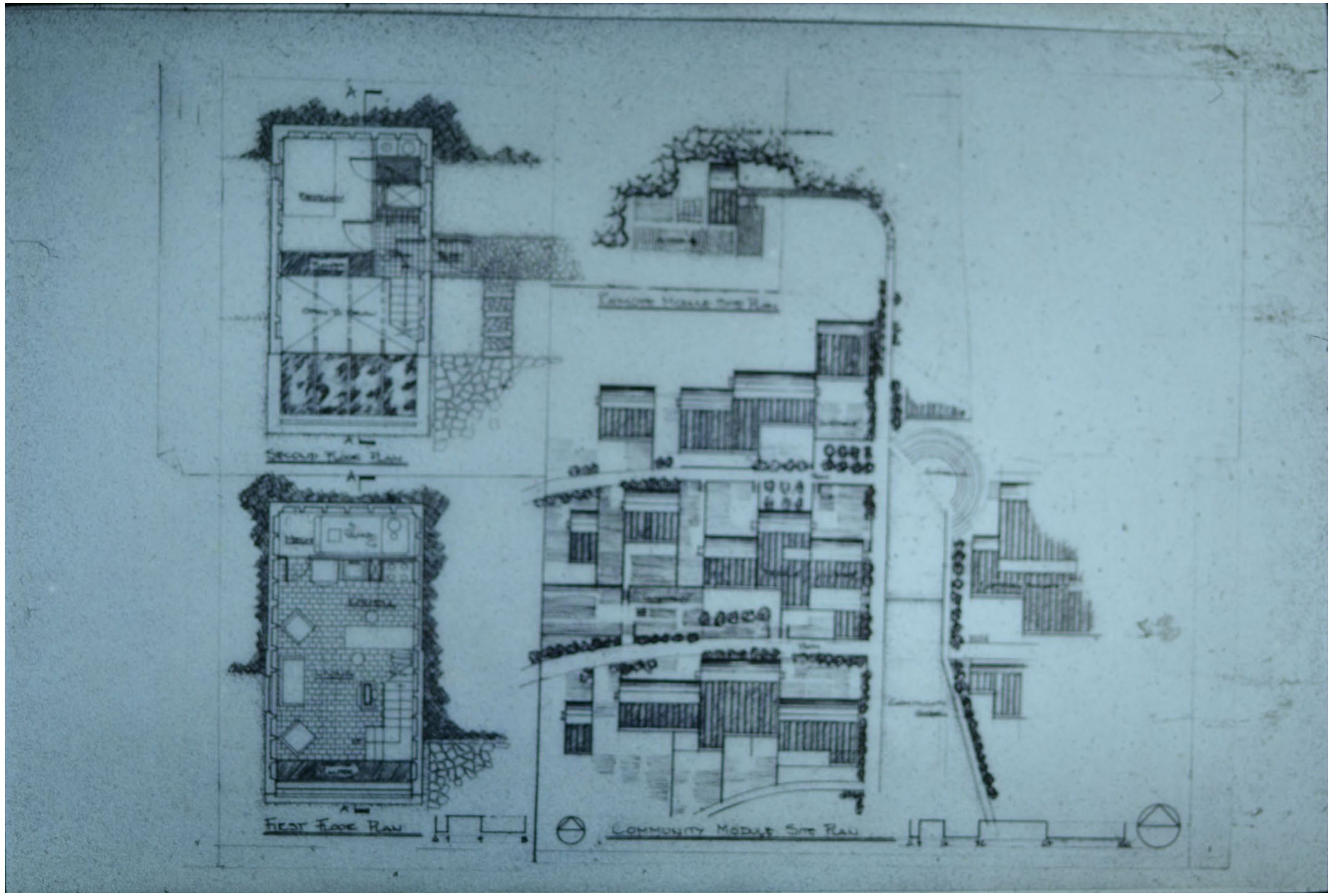
Skidompha House



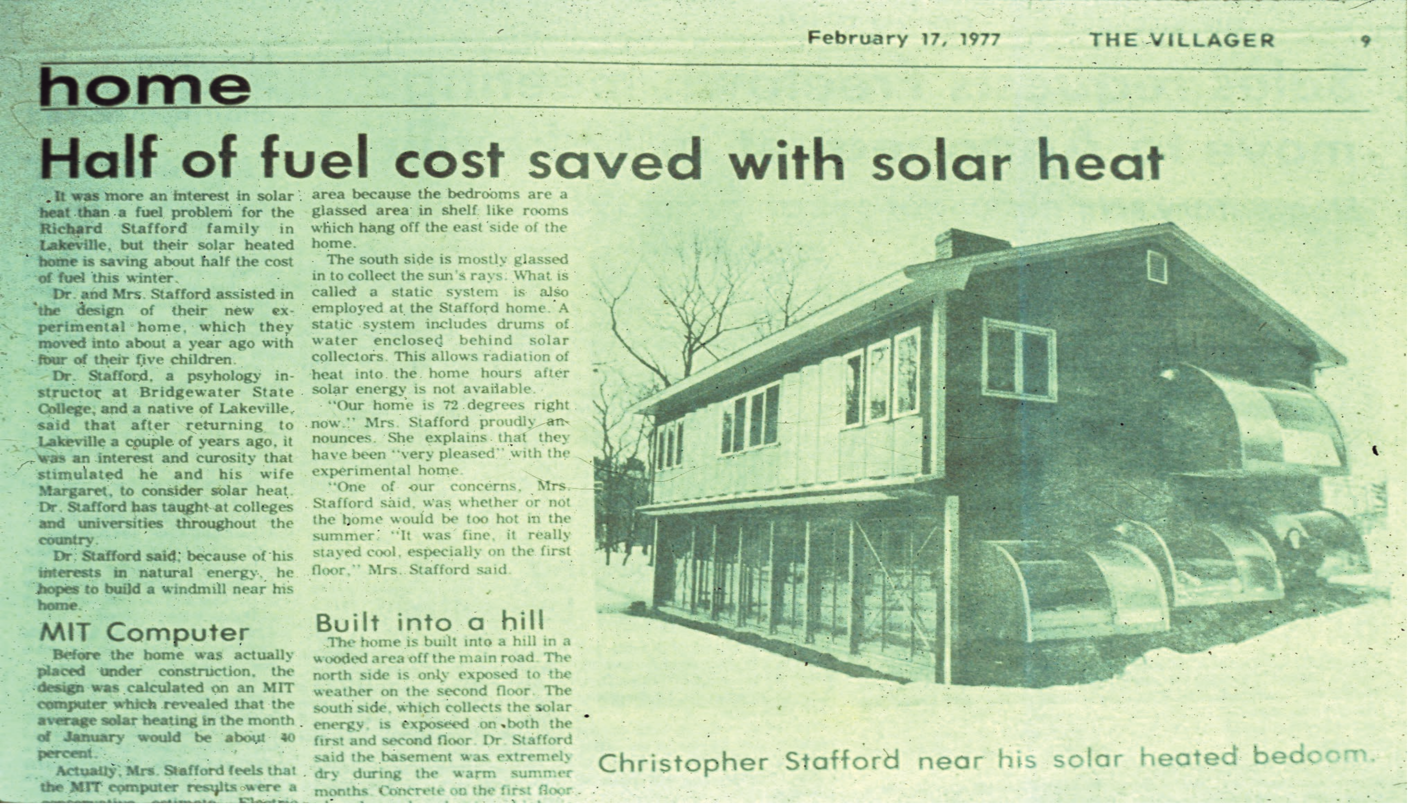
Solar Module



Community Solar Module



Stafford Passive House



February 17, 1977 THE VILLAGER 9

home

Half of fuel cost saved with solar heat

It was more an interest in solar heat than a fuel problem for the Richard Stafford family in Lakeville, but their solar heated home is saving about half the cost of fuel this winter.

Dr. and Mrs. Stafford assisted in the design of their new experimental home, which they moved into about a year ago with four of their five children.

Dr. Stafford, a psyhology instructor at Bridgewater State College, and a native of Lakeville, said that after returning to Lakeville a couple of years ago, it was an interest and curosity that stimulated he and his wife Margaret, to consider solar heat. Dr. Stafford has taught at colleges and universities throughout the country.

Dr. Stafford said, because of his interests in natural energy, he hopes to build a windmill near his home.

MIT Computer

Before the home was actually placed under construction, the design was calculated on an MIT computer which revealed that the average solar heating in the month of January would be about 40 percent.

Actually, Mrs. Stafford feels that the MIT computer results were a

area because the bedrooms are a glassed area in shelf like rooms which hang off the east side of the home.

The south side is mostly glassed in to collect the sun's rays. What is called a static system is also employed at the Stafford home. A static system includes drums of water enclosed behind solar collectors. This allows radiation of heat into the home hours after solar energy is not available.

"Our home is 72 degrees right now," Mrs. Stafford proudly announces. She explains that they have been "very pleased" with the experimental home.

"One of our concerns, Mrs. Stafford said, was whether or not the home would be too hot in the summer. "It was fine, it really stayed cool, especially on the first floor," Mrs. Stafford said.

Built into a hill

The home is built into a hill in a wooded area off the main road. The north side is only exposed to the weather on the second floor. The south side, which collects the solar energy, is exposeed on both the first and second floor. Dr. Stafford said the basement was extremely dry during the warm summer months. Concrete on the first floor

Christopher Stafford near his solar heated bedoom.

Roll Top House



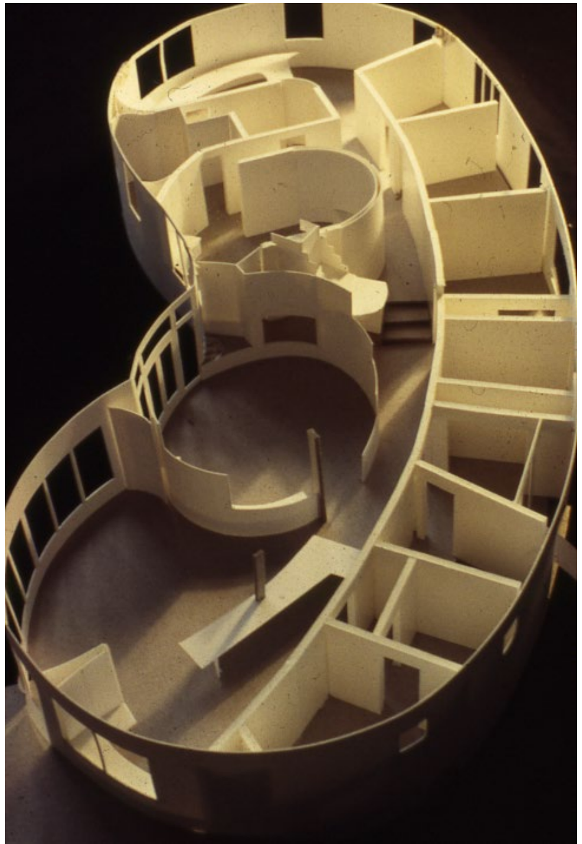


Rabbit house

Our first experiment with rigid foam insulation (1992)

- With insulation in the ceiling plane (cold attic) how are we going to prevent violations in thermal envelope?
- Vapor barrier?
- Ridge vent?
- Eave vents?

How do we insulate the meditation room?

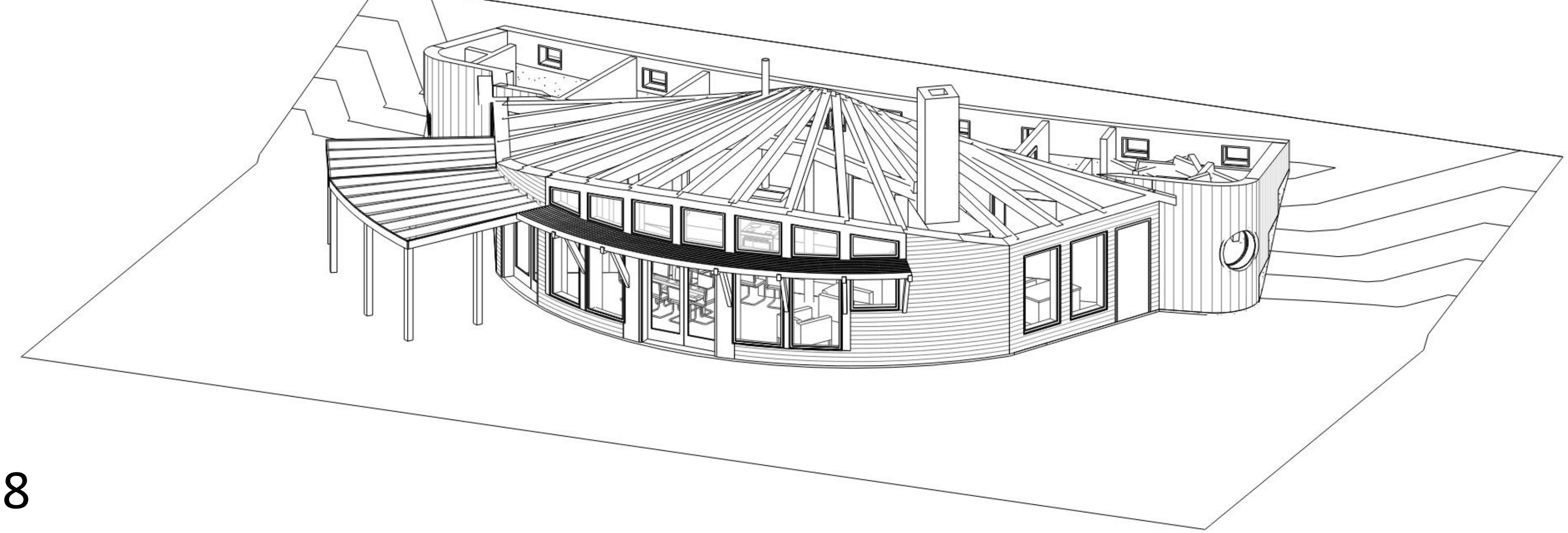


Vermont Healthy Homes



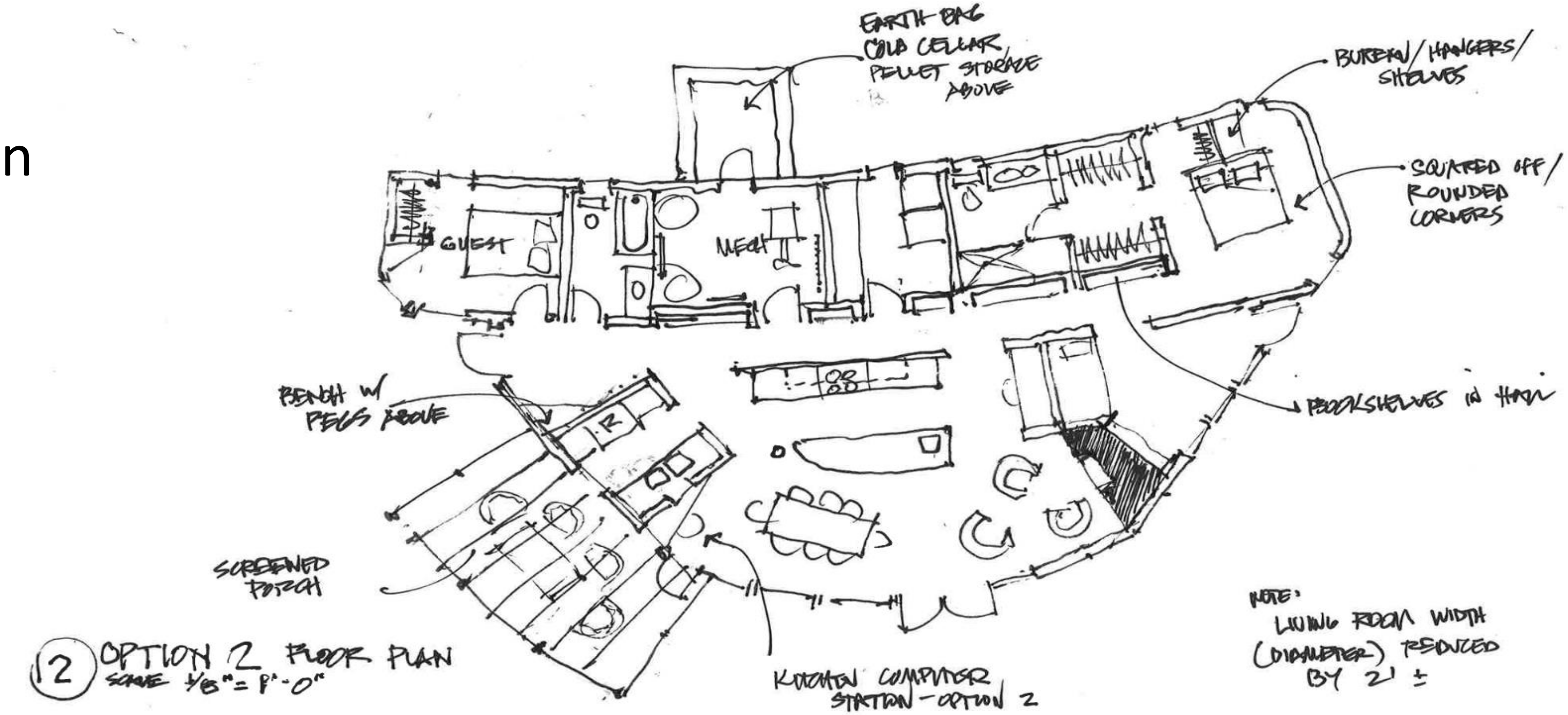


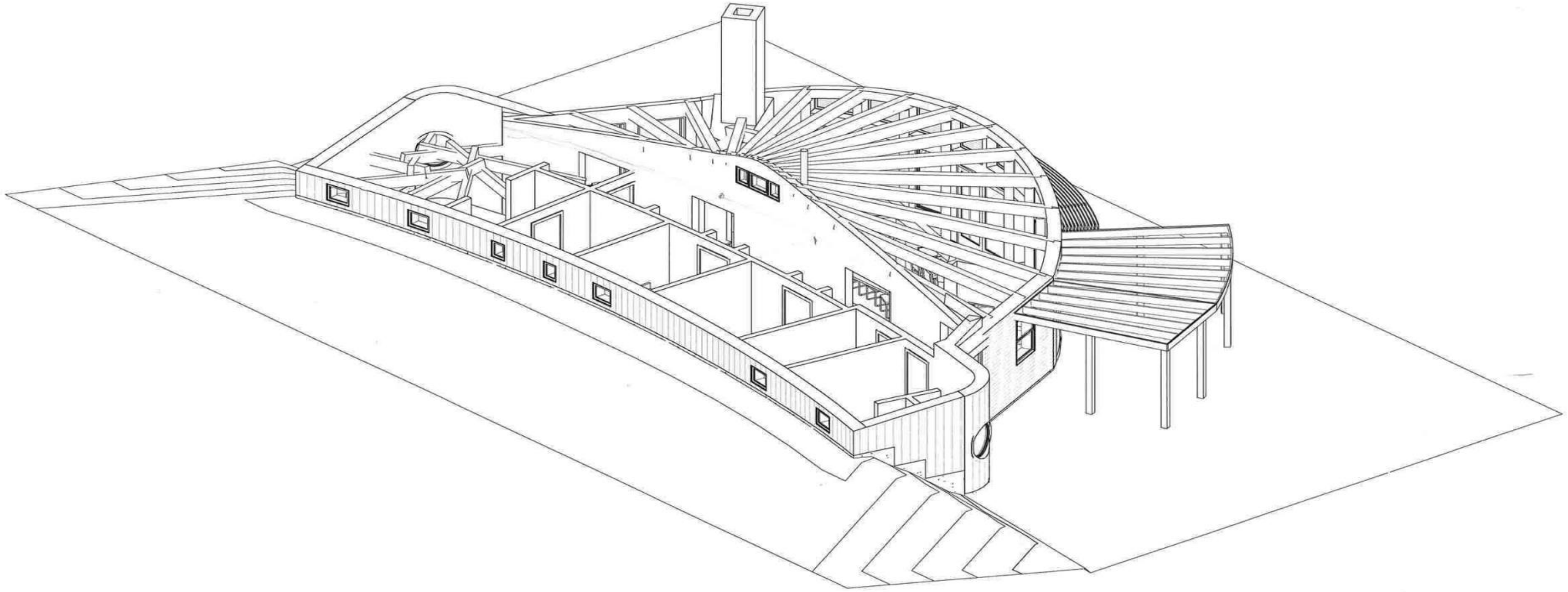

Pogany Residence



Stratton Residence 2018

- Underground
- no concrete
- earth bag construction
- net zero
- natural materials
- clay floors





Otte Huling Residence

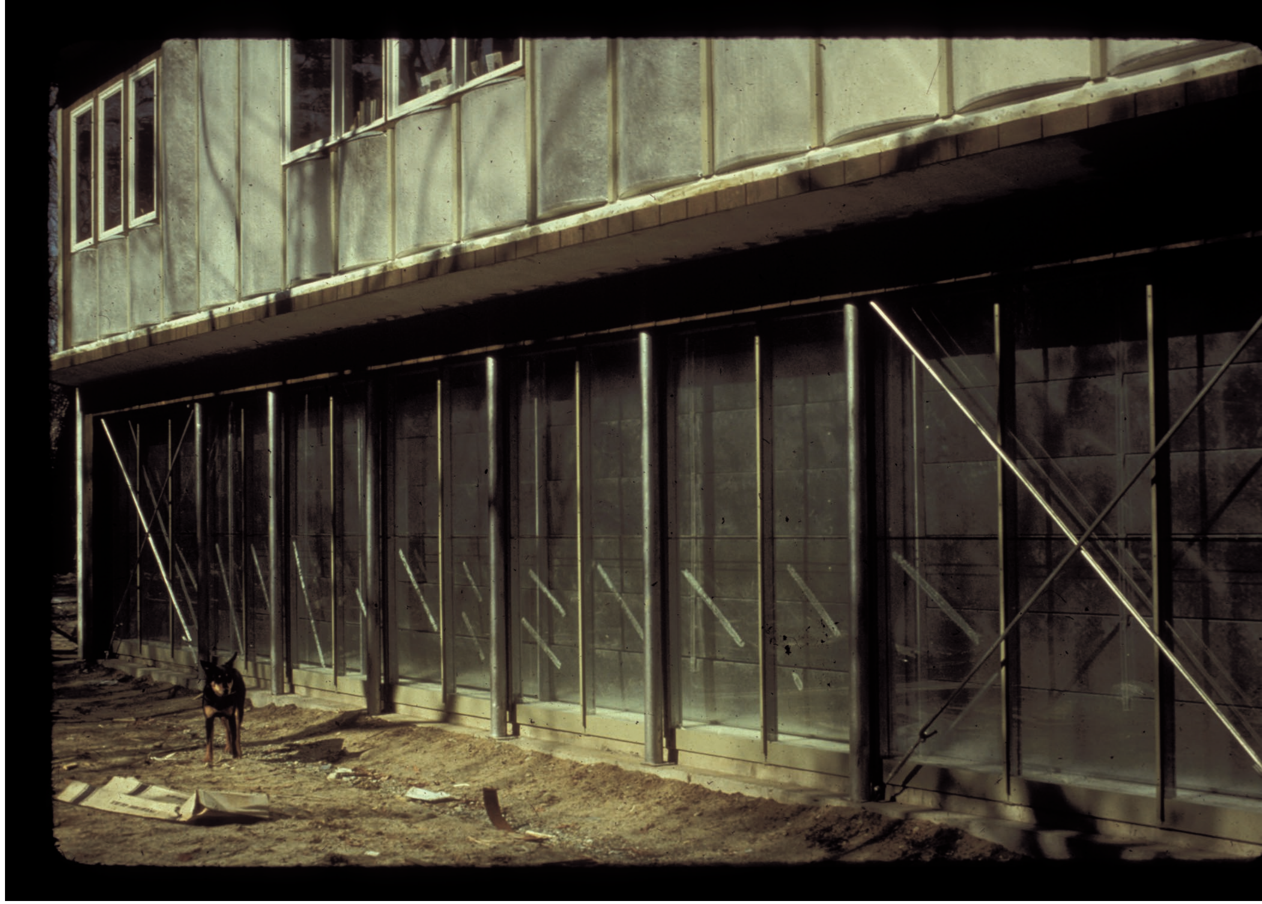
Hindsight is 20/20. What we now recognize that we didn't know

Poor surface to volume ratio

Compact Shape

Airtight construction was not understood

Airtightness is critical, and doable, and the best energy saving investment



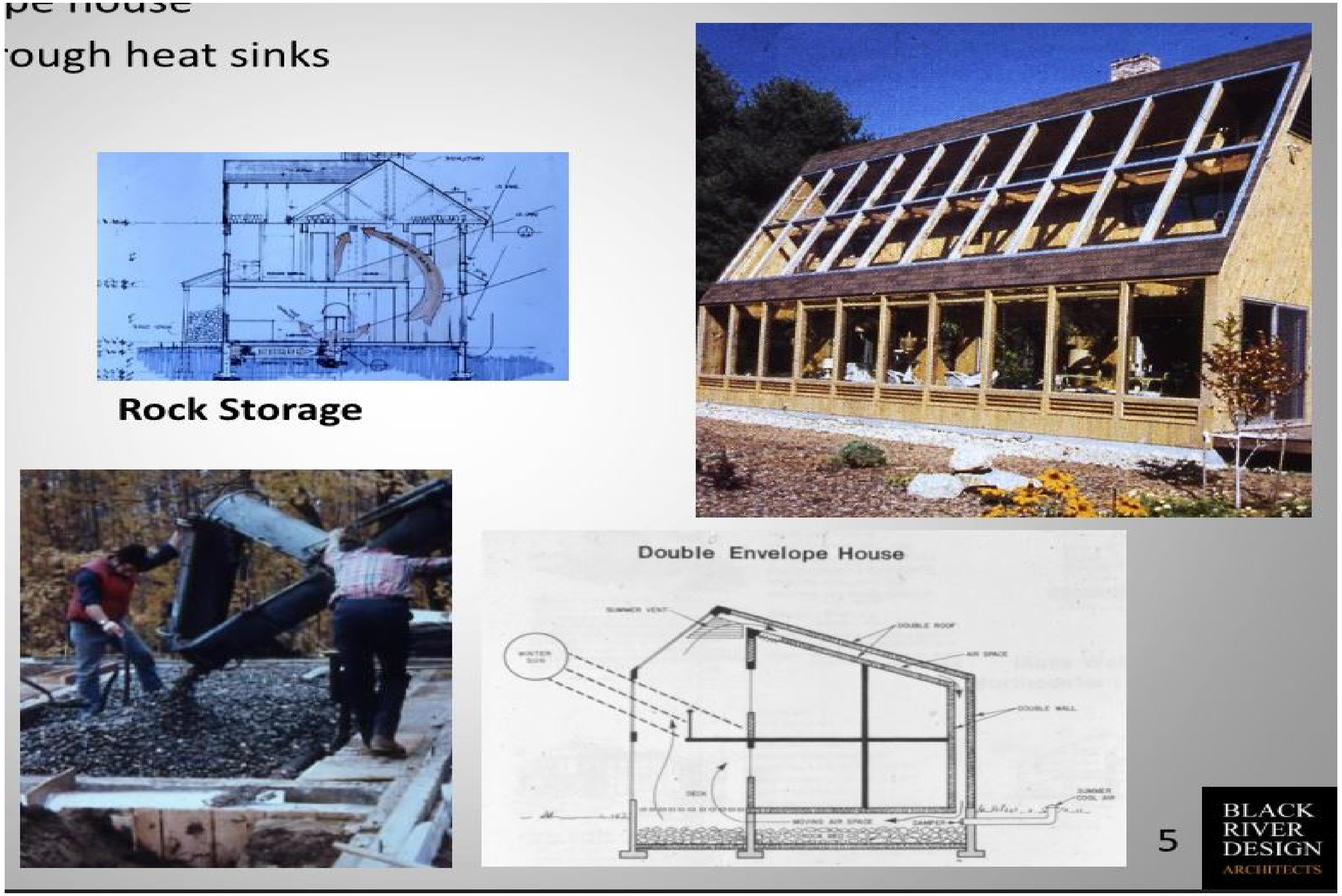
Daylight is great, but too much glazing leads to overheating as well as net heat loss

How much south glazing makes sense?

Much has changed in the last half century in our understanding of sustainabilty

- Emphasis on opportunities for energy saving instead of renewable energy generation
- Energy modeling helps direct your dollars toward saving energy
- Importance of the emergence of critical building science- not only understanding the underlying science of failures, but sharing the information
- Airtightness is critical, and doable, and the best energy saving investment
- With more efficient equipment, and the potential to send green energy over the electric lines, suddenly electric is no longer evil
- Cost of PV’s comes way down, changing the limits of energy saving investments
- Increased consciousness of global warming impacts of building materials vs energy use over time

1. Shift from focus on Energy Savings Generation to energy saving



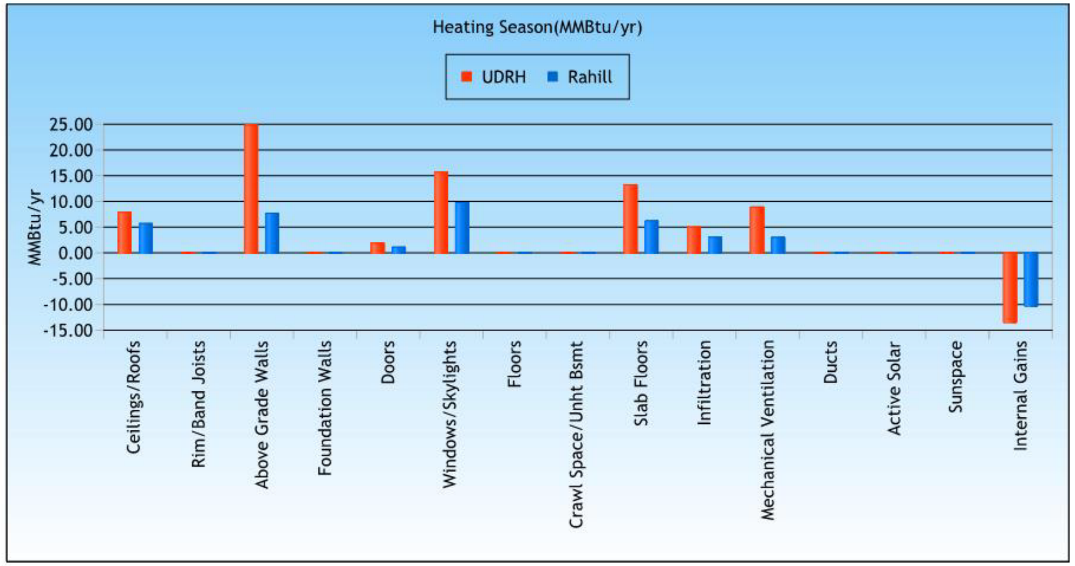
2.Energy modeling helps direct your dollars toward saving energy

Component Consumption

Property	Organization	HERS
Rahill	VT Energy Investment Corp	Projected Rating
, VT	888-921-5990	5/31/16
	Bruce Courtot	Rating No:6038P076
Weather:Montpelier, VT		ID:5851998
Rahill	**Builder**	
P076p Rahill BGJ version.blg		

Vermont Energy Investment Corporation

Heating Season(MMBtu/yr)	UDRH	Rahill	Savings	%Saved
Ceilings/Roofs	7.9	5.7	2.2	27.8%
Rim/Band Joists	0.0	0.0		
Above Grade Walls	24.8	7.7	17.2	69.2%
Foundation Walls	0.0	0.0		
Doors	1.9	1.1	0.8	40.0%
Windows/Skylights	15.7	9.8	5.9	37.9%
Floors	0.0	0.0		
Crawl Space/Unht Bsmt	0.0	0.0		
Slab Floors	13.2	6.2	7.0	52.9%
Infiltration	5.0	3.1	1.9	38.4%
Mechanical Ventilation	8.9	3.0	5.9	66.6%
Ducts	0.0	0.0		
Active Solar	0.0	0.0		
Sunspace	0.0	0.0		
Internal Gains	-13.5	-10.3	-3.3	-24.1%
Total	63.9	26.3	37.7	58.9%



REM/Rate - Residential Energy Analysis and Rating Software v15.2 Vermont

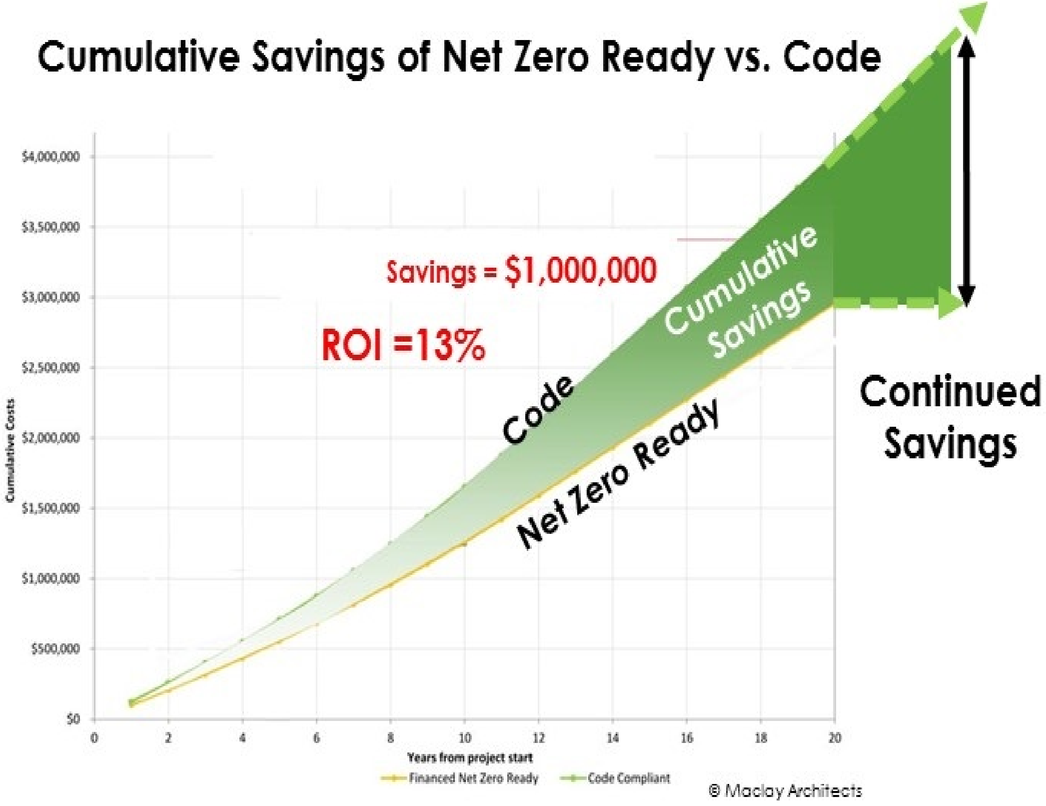
3. Project Energy Tracking for Results

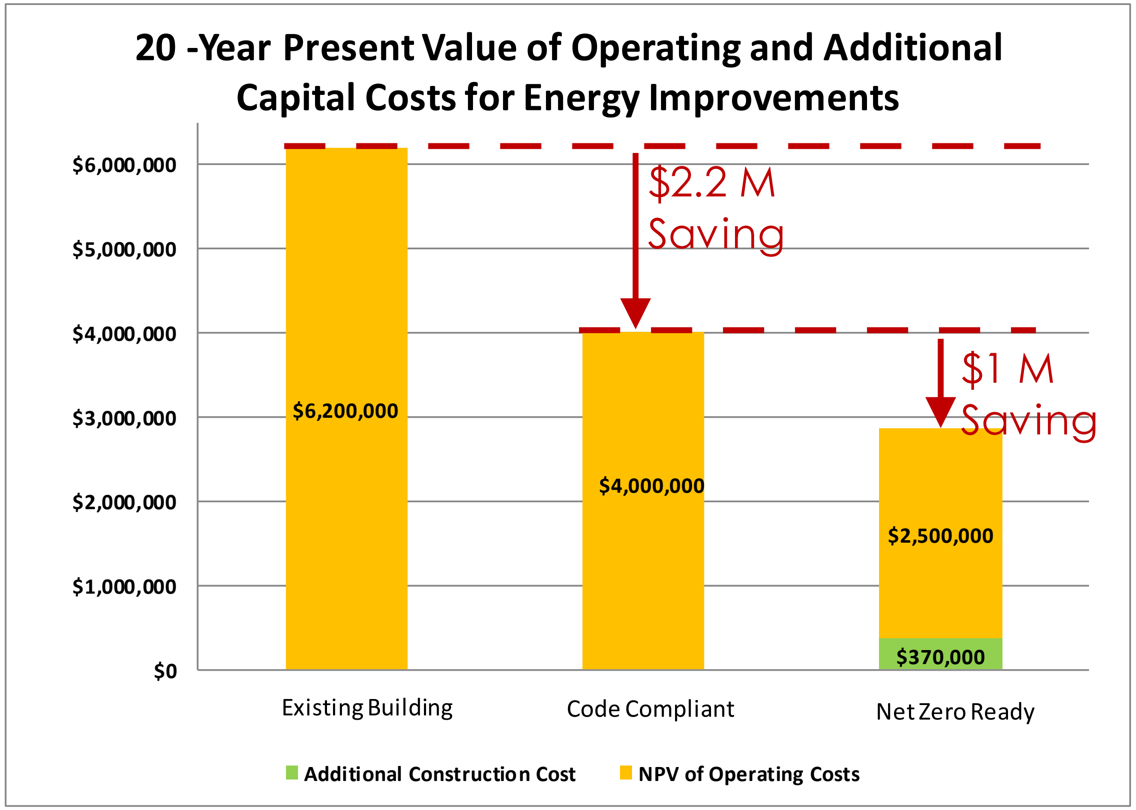
Project Data and Performance Metrics

Project	Project Location	SF	New/ Reno	Process Loads	Year Complete	Modeled	Actual	Net EUI	Additional Capital Cost	Additional Envelope Capital Cost/sf	Total Additional Capital Cost/sf	Air infiltration	Construction Cost	Net Zero Energy Performance/ Certification	Other Certs: LEED, Full/ Petal LBC, Passive House
						Energy Use Intensity (EUI) kBtu/sf-yr						(cfm50/sf 6-sided surface area)		LBC Net Zero Certified, Net Zero (not certified), Net Zero Ready, Near Net Zero	
Bennington Downtown SOB**	Bennington, VT	22,775	Reno		2005	N/A	40		N/A	N/A	N/A	N/A	$2,700,000		
Bennington Superior Courthouse and SOB	Bennington, VT	65,000	Reno/ Add		2012	24	25.6		$372,000	$5.72	$5.72	0.05	$12,246,000	anticipated NZ	LEED Gold
Coastal Maine Botanical Gardens -Bosarge Education Center	Booth Bay, ME	8,200	New		2011	20	19.2	-4.3	N/A	N/A	N/A	0.11	$3,200,000	LBC NZ Cert	LEED Gold
DVTA, Transit Facility		16,000	New	Bus washing	2015	N/A	83		N/A	N/A	N/A	0.14			
Environmental Learning Center - Mass Audubon	Lincoln, MA	3,700	New		2018	25	TBD	-17.8	$49,000	$10.28	$13.24	0.021	$1,665,000	anticipated LBC NZ Cert	
George D. Aiken Center	Burlington, VT	40,000	Reno	EcoMachine	2011	33	TBD	24				0.051	$7,294,200	NZR	LEED Platinum
Greylock Glen Outdoor Center	Adams, MA	9,900	New	Kitchen	projected 2020	37	TBD	0	$140,000	$10.98	$14.14	0.05*	$7,750,000	anticipated NZ	
Lincoln School*	Lincoln, MA	150,000	New/ Reno	Kitchen	2021	23	TBD				$11-$27		$95,000,000	NZ	
Maclay Offices**	Waitsfield, VT	2,568	Reno		2006	N/A	23	0	N/A	N/A	N/A	N/A	--	LBC NZ Cert	
Middlebury South Village Offices		17,000	New		2011	N/A	28		$50,000	$16.00	$2.94	0.039		NZR	
Moosilauke Ravine Lodge	Woodstock, NH	11,000	New	Kitchen	2017	25	TBD					0.154	$9,000,000	NNZ	
Moretown Town Offices		1,300	New		2016		TBD		N/A	N/A	N/A	0.048		NZR	
North Country School Walter P. Breeman Performing Arts Ctr	Lake Placid, NY	10,000	New		projected 2019	22	TBD	0	$90,000		$9.00	0.0385	$5,100,000	anticipated LBC NZ Cert	
NRG Systems 1	Hinesburg, VT	46,000	New	Light Manufacturing	2004	N/A	18.2	12.8	N/A	N/A	N/A	0.12	$5,440,000	NNZ	LEED Gold
NRG Systems 2	Hinesburg, VT	31,000	New	Light Manufacturing	2008	N/A	17.7	9.4	N/A	N/A	N/A	0.06	$6,500,000	NNZ	LEED Gold
Proctor Academy Dining Commons	Andover, NH	15,000	New	Kitchen/pizza oven	2016	77	85	0	$369,777	$6.29	$24.65	0.032	$6,500,000	NNZ	
Putney School Field House	Putney, VT	16,814	New		2009	11	9	-2	$1,058,000	-	$62.92	0.044	$5,209,764	LBC NZ Cert	LEED- NB 3.0 Platinum
Putney School Gray House	Putney, VT	6,084	Reno	Dormitory	2017	N/A	32.7	0*			$23.46		$700,000	NZ	
SunCommon Headquarters - warehouse	Waterbury, VT	7,000	New		2016	N/A	26.3	-11	N/A	N/A	N/A			anticipated LBC NZ cert	
SunCommon Headquarters - office	Waterbury, VT	9,000	New		2016	22	22.1	-11	$128,194	$14.24	$14.24	0.059	$1,620,000	anticipated LBC NZ cert	
Waitsfield United Church of Christ	Waitsfield, VT	7,415	Reno/ Addition		2017		34.5								
Wellesley - Hunnewell Elementary*	Wellesley, MA	78,000	New	warming kitchen	2022						$2.22		N/A	anticipated NZ	
The Willow School - Health, Wellness and Nutrition Center*	Gladstone, NJ	20,000	New	Kitchen	2015	21.9	25.9	-16	N/A	N/A	N/A		--	LBC NZ Cert	Full LBC Certified
Twin Pines Housing - Tracy Street Community Housing	West Lebanon, NH	25300	New		2019	25.4	TBD	0			$7.60	0.044	$5,000,000	anticipated LBC NZ Cert	anticipated Passive House (PHIUS)
Vermont Creamery Offices		3000	Reno		2015	19	42.6		$129,022	$20	$43.01	0.05		NZR	
Vermont Land Trust**	Montpelier, VT	6000	Reno		2015	27	30.2		$77,580	$8	$12.93	0.23	$1,400,000	NNZ	
Waitsfield Town Office		4700	New		2016	16	23.9	0				0.057		NZ	
Ramapo College*	Mahwah, NJ	4000	New		N/A								N/A		
Marshall Center**	St. Albans, VT	--	Reno		–								--		
Putney General Store	Putney, VT														
Huntington PO	Huntington, VT														
Groton Village Revitalization**	Groton, VT	--	Reno		–								--		
Seventh Generation	Burlington, VT	30000	Reno		2008								$2,500,000		LEED Gold

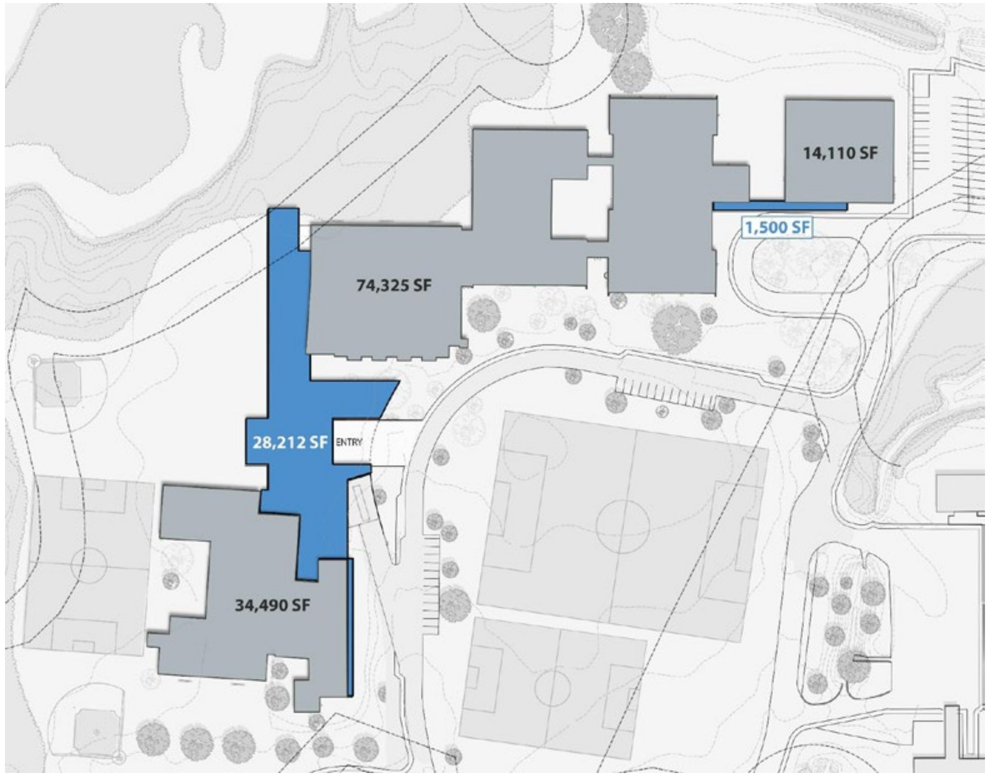
Net Zero Lowers State Taxes

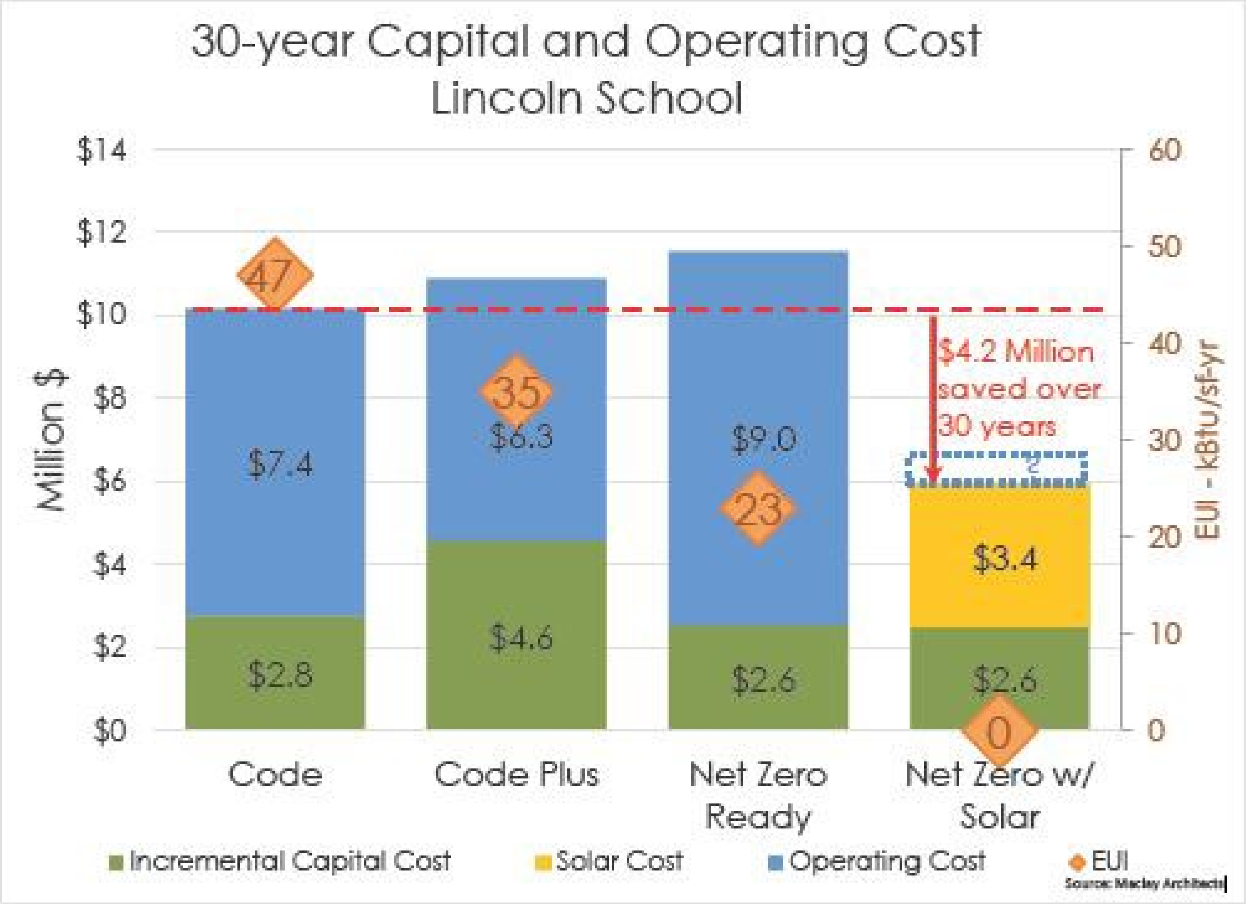
20-Year Present Value of Operating and Additional Capital Cost for Energy Improvements





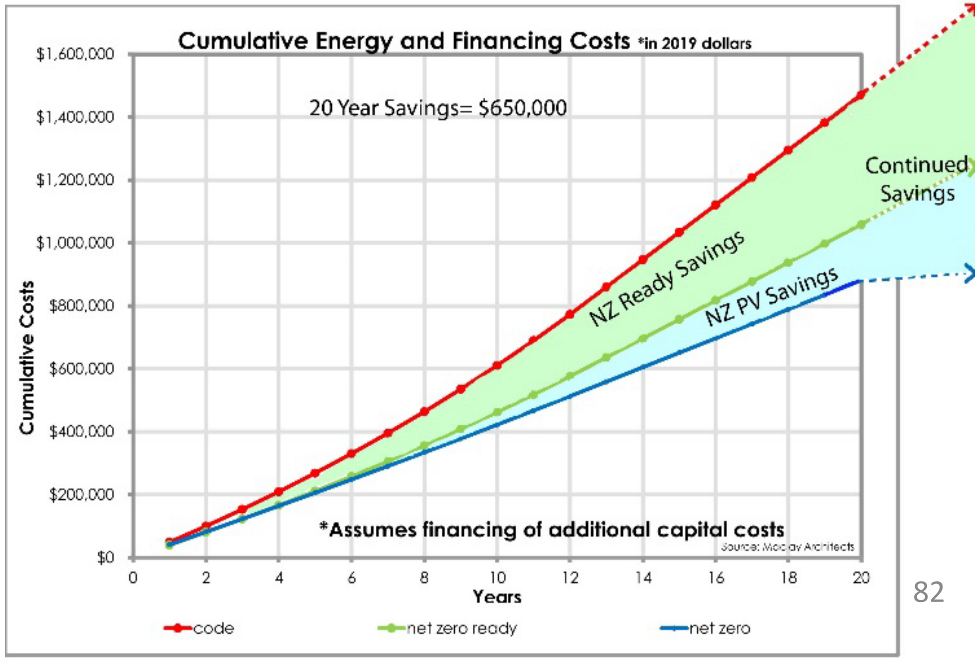
Net Zero Supports Public School Bond Votes





Net Zero sustains affordable housing

20-year Cumulative Capital, Energy, and Finance Costs with Solar



4. Net zero is possible. Cost of PV's comes way down, changing the limits of energy saving investments.

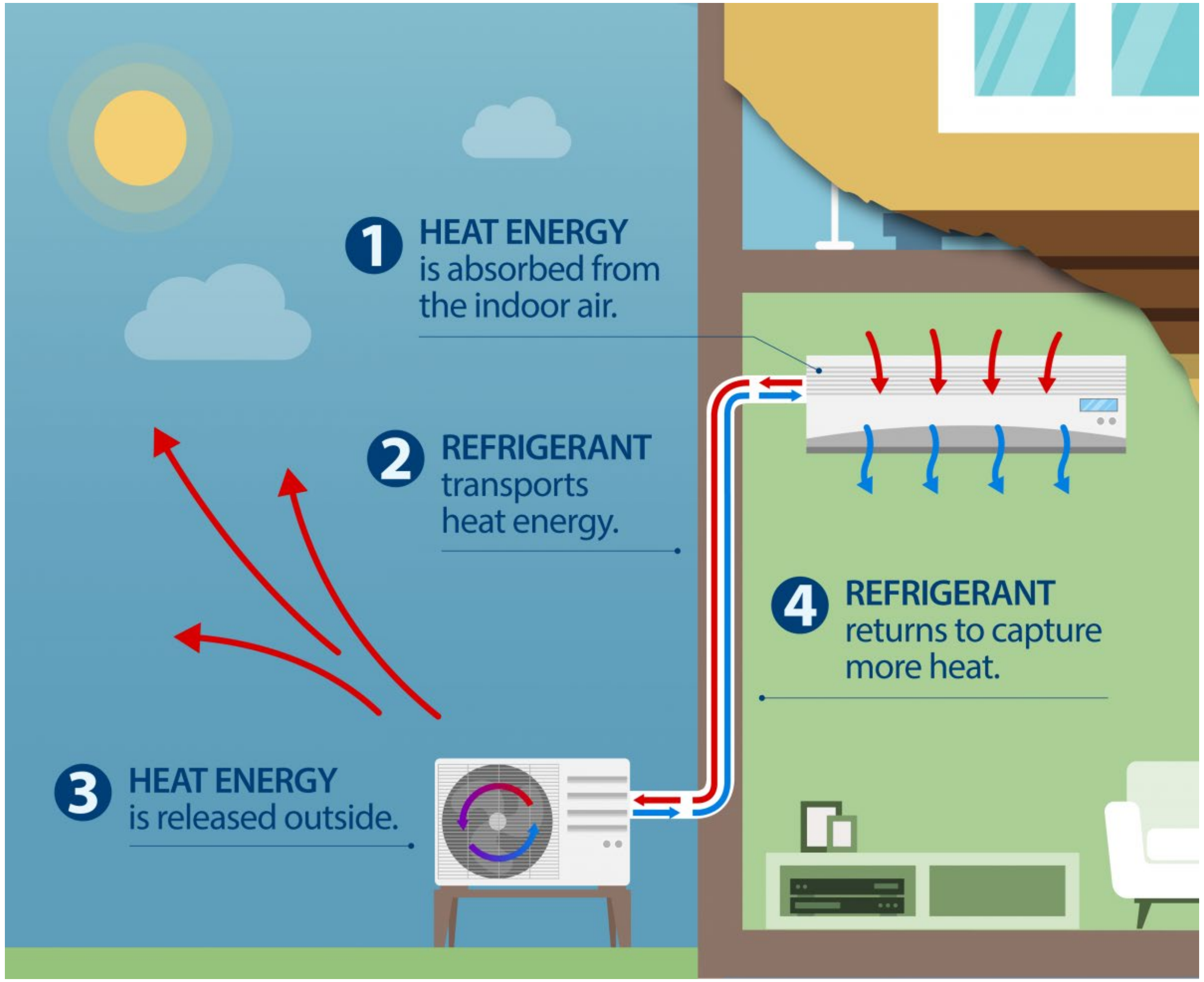
★ 15 year payback

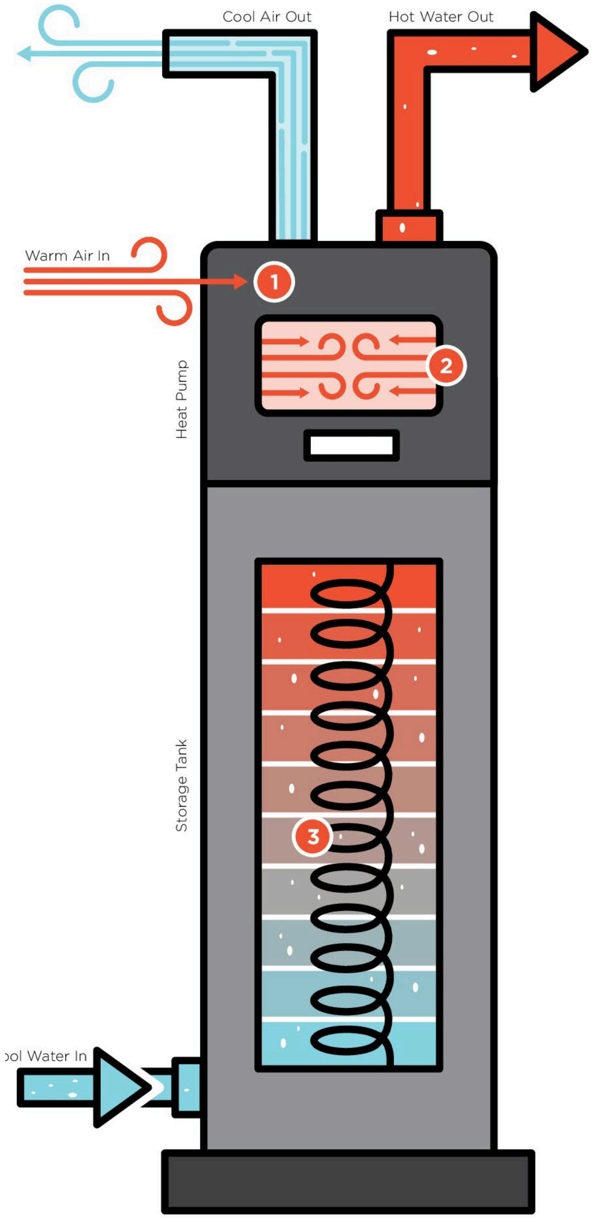
Components			Area	SQ/FT cost Material	SQ/FT cost Labor	Total Construction Cost	Incremental Construction Cost	Annual Energy Loss (MBTU)	Annual Energy Savings (MBTU)	Cost/MBTU of Incremental Savings	Energy Costs (@$25.69 of propane/MBTU)	Annual Incremental Savings	Incremental Payback (years)	
Foundation foot wall/under slab insul.														
Base	R-10	2" xps	3791	$ 1.05	$ 0.26	$ 4,966.21		10.50			$269.75			★
1	R-15	3" xps (additional 1" thickness)	3791	$ 1.49	$ 0.26	$ 6,634.25	$1,668.04	8.40	2.10	$ 794.30	$215.80	$53.95	30.9	
	R-20	4"	3791	$ 2.10	$ 0.52	$ 9,932.42	$3,298.17	5.70	2.70	$ 1,221.54	$146.43	$69.36	47.5	
	R-25	5"	3791	$ 2.54	$ 0.52	$ 11,600.46	$1,668.04	4.90	0.80	$ 2,085.05	$125.88	$20.55	81.2	
2	R-30	6"	3791	$ 3.00	$ 0.52	$ 13,344.32	$1,743.86	4.30	0.60	$ 2,906.43	$110.47	$15.41	113.1	
Above grade walls														
	R-13	2x4 Dense Pak in Cavity	2279	$ 0.17	$ 0.37	$ 1,230.66		26.00			$667.94			
	R-20	2x6 Dense Pak in Cavity	2279	$ 0.28	$ 0.46	$ 1,686.46		17.70			$454.71			
Base	R-13	2" ISO	2279	$ 1.05	$ 0.50	$ 3,532.45	$0.00	17.50	0.00		$449.58			
	R-19.5	3" ISO	2279	$ 1.72	$ 0.50	$ 5,059.38	$1,526.93	13.90	3.60	$ 424.15	$357.09	$92.48	16.5	
1	R-26	4" ISO	2279	$ 2.10	$ 1.00	$ 7,064.90	$2,005.52	10.00	3.90	$ 514.24	$256.90	$100.19	20.0	
	R-32.5	5" ISO	2279	$ 2.77	$ 1.00	$ 8,591.83	$1,526.93	8.30	1.70	$ 898.19	$213.23	$43.67	35.0	
2	R-39	6" ISO	2279	$ 3.44	$ 1.00	$ 10,118.76	$1,526.93	7.20	1.10	$ 1,388.12	$184.97	$28.26	54.0	
Adding Rigid Polyiso to Cavity Insulation														
2	R-41	R26+R13(2x4 cavity and 4" ISO)	2279	$ 2.10	$ 1.00	$8,295.56	$7,064.90	7.90	18.10	$ 390.33	$202.95	$464.99	15.2	★
2	R-47	R-26 +R19(2x6 cavity and 4" ISO)	2279	$ 2.10	$ 1.00	$8,751.36	$7,064.90	7.00	10.70	$ 660.27	$179.83	$274.88	25.7	
Adding Cavity Insulation to Rigid Polyiso														
2	R-41	R26+R13(4" ISO and 2x4 cavity)	2279	$ 0.17	$ 0.37	$8,295.56	$1,230.66	7.90	2.10	$ 586.03	$202.95	$53.95	22.8	
2	R-47	R-26 +R19(4" ISO and 2x6 cavity)	2279	$ 0.28	$ 0.46	$8,751.36	$1,686.46	7.00	3.00	$ 562.15	$179.83	$77.07	21.9	
Adding a second wall to the R-13 2x4 Dense Pak in Cavity Wall														
2	R-40	Double stud Wall 11 1/2"	2279		$ 5.20	$ 11,850.80	$ 10,620.14	7.70	10.00	$ 1,016.43	$197.81	$256.90	41.3	

5.Continuous and Airtight Insulation is the most cost effective energy saving measure. (Requiring New Construction Detailing)

6. Importance of the emergence of critical building science- not only understanding the underlying science of failures, but sharing the information

7. With more efficient equipment, and the potential to send green energy over the electric lines, suddenly electric is no longer evil





Electric heating is no longer a “crazy” option

Vermont Fuel Price Report

November 2016

Comparing the Cost of Heating Fuels

Type of Energy	BTU/unit	Typical Efficiency	$/unit	$/MMBtu	High Efficiency	$/MMBtu
Fuel Oil, gallon	138,200	80%	$2.23	$20.14	95%	$16.96
Kerosene, gallon	136,600	80%	$2.80	$25.65		
Propane, gallon	91,600	80%	$2.54	$34.64	95%	$29.17
Natural Gas, Ccf	100,000	80%	$1.41	$17.67 *	95%	$14.88
Electricity, kWh (resistive)	3,412	100%	$0.15	$43.46		
Electricity, kWh (heat pump)	3,412		$0.15	#	240%	$18.32
Wood, cord (green)	22,000,000	60%	$227	$17.21 ^		
Pellets, ton	16,400,000	80%	$275	$20.96 ^		

* Natural Gas price is based on VGS residential rate effective Aug 5th, 2016.

see October 2015 Fuel Price Report for discussion of heat pump coefficient of performance

^ Cord Wood price updated 8/2015 from small survey sample. Pellet price updated 5/2016 from small survey sample

Vermont Fuel Report, 2016

8. Net Zero: Fuel Mileage for Buildings?

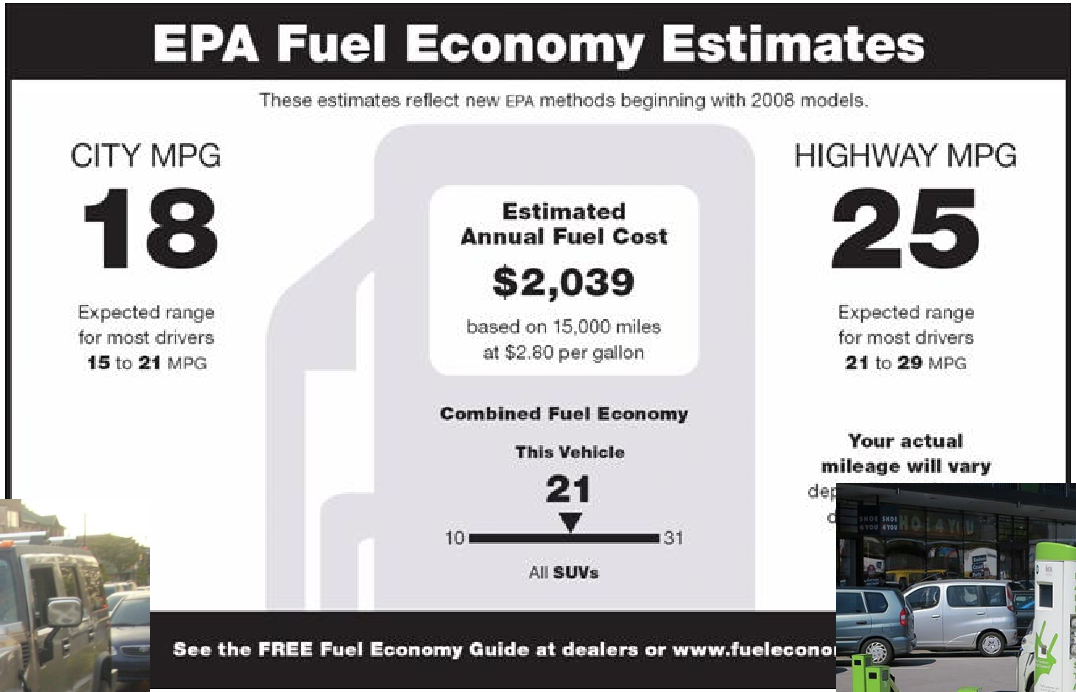


Photo by Bull-Doser / public domain

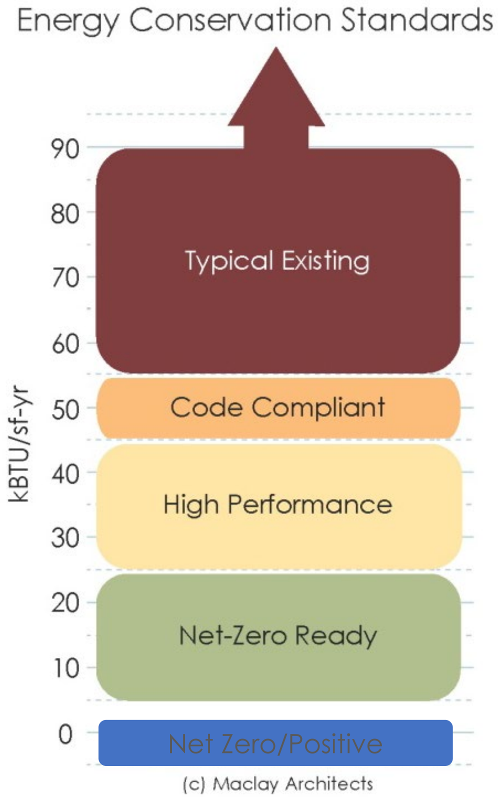
Photo by Reinraum

Energy Use Intensity (EUI)

Net Zero Building Metrics

Performance Metrics

SITE 10-25 EUI kBTU/sf
*without process loads



Prescriptive Metrics

R-60

0.1 cfm/sf
above grade
surface area@
50 Pascals

R-40

R-5
Windows

R-20

Blower Door Testing for reliable results

Passive House (PHIUS +2018) air sealing requirements

0.06 cfm50/sf gross envelope

13 completed Maclay Architects' Projects

0.02-0.06 cfm50/sf gross envelope

Envelope and MEP Commissioning

9. Certifications Accelerate the Process

U.S. GREEN BUILDING COUNCIL
LEED
USGBC

PH

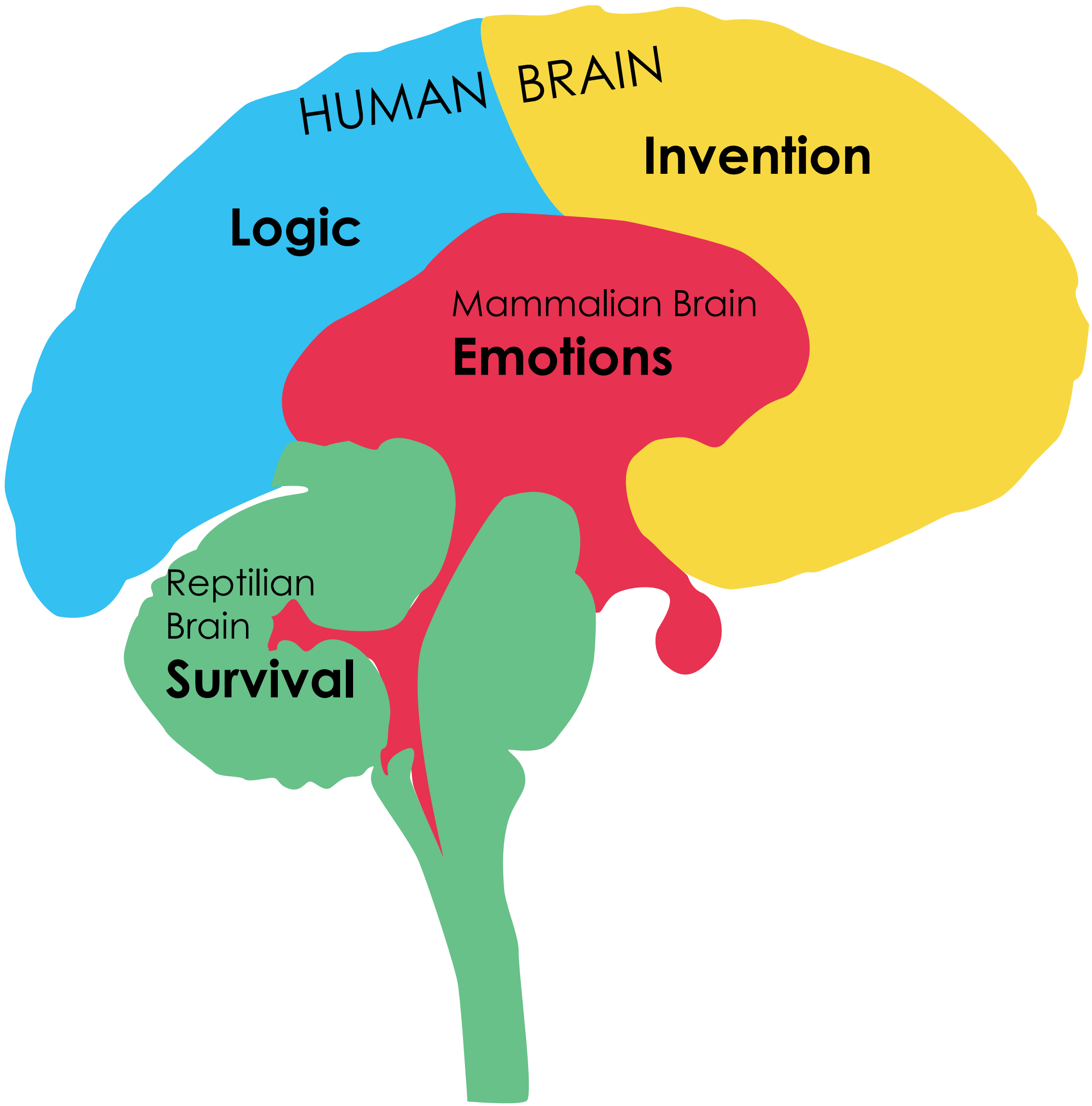
INTERNATIONAL
LIVING FUTURE
INSTITUTE℠

LIVING
BUILDING
CHALLENGE

ZEROENERGY
CERTIFICATION

ZERO CARBON
CERTIFICATION

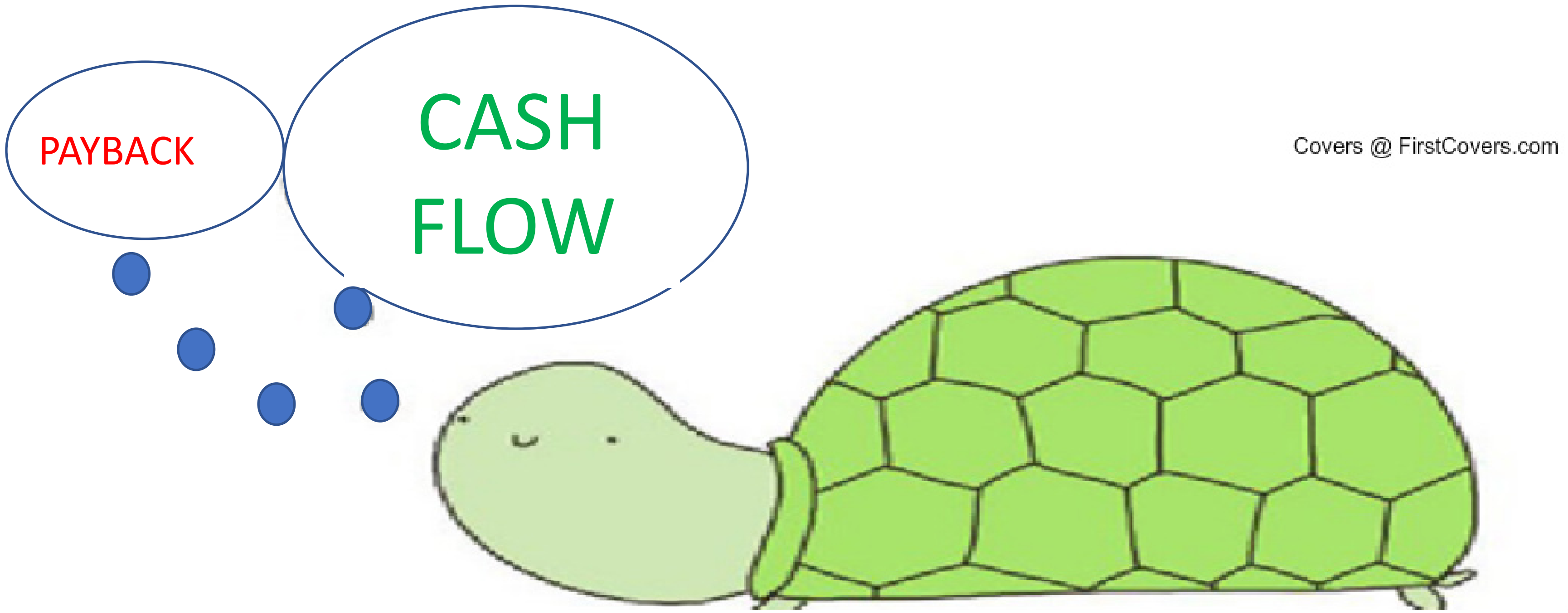
10. Thinking affects outcomes



Whole Brain Thinking

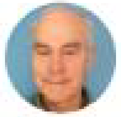
MONEY = SURVIVAL

Paradigm Shift



A Better Path to a Low-Carbon Future?

Building materials capable of reducing up-front carbon to zero are available, code-compliant, and affordable, study shows

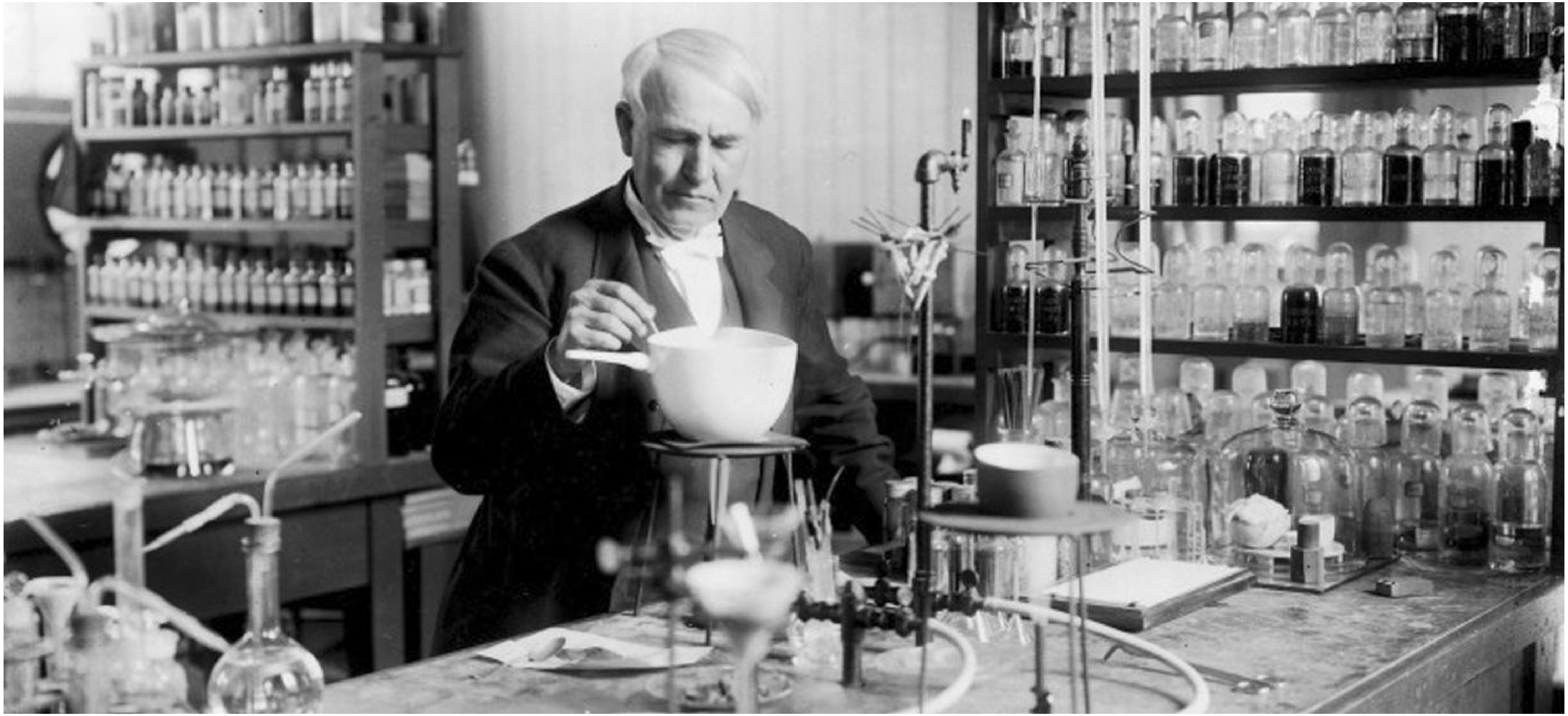


By Scott Gibson | January 14, 2020

Building superinsulated houses with low energy needs and highly efficient mechanical systems is the best way for builders to lower greenhouse-gas emissions that contribute to global climate change, right?

Maybe not. A group of builders and designers led by the director of a sustainable building school in Canada has concluded that energy efficiency is only part of the answer, and that accounting for embodied carbon in the materials used to construct houses is much more important than previously believed.

Town of Wellesley Town Office Annex



“Negative results are just what I want. They’re just as valuable to me as positive results. I can never find the thing that does the job best until I find the ones that don’t.”

— Thomas A. Edison

What was the most beneficial aspect of being involved in the design and construction of the innovative projects 40-50 years ago?