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Building Science

Wood Is Good

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R2



R2



R4



R2

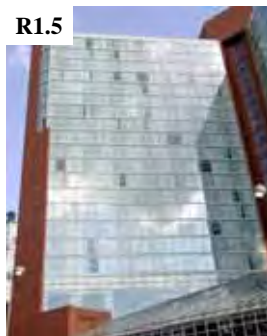


R4



R6

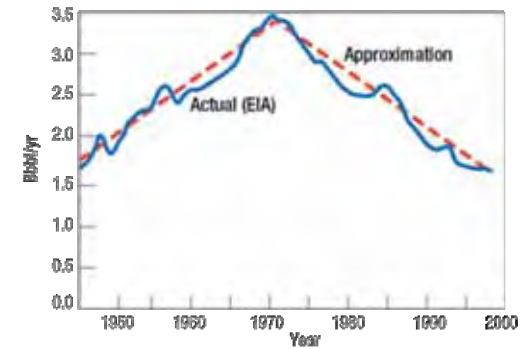




Energy Security
Climate Change

Hubbert's Peak

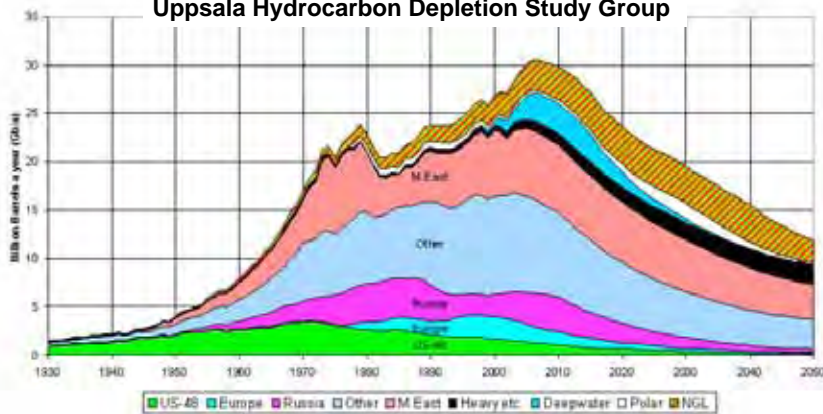
- Shape of oil production in the US lower 48
- Predicting the peak made Hubbert famous



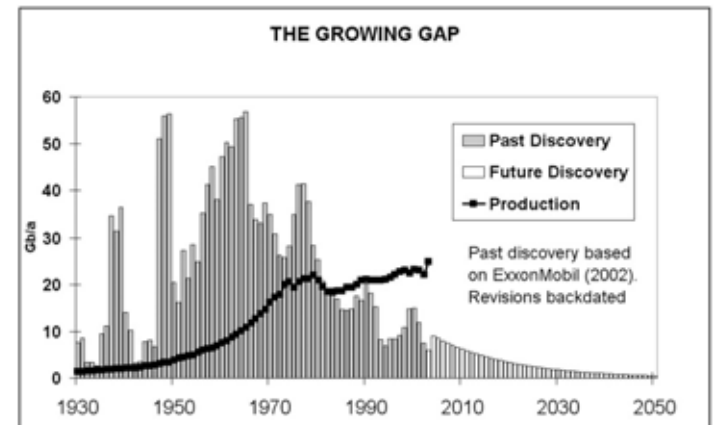
Ref: Hirsch 2005

OIL AND GAS LIQUIDS 2004 Scenario

Uppsala Hydrocarbon Depletion Study Group



Production vs Discovery



Where is the Oil?



Enhanced oil recovery

- Technology helps get oil out faster, and to get more (increases to 50%+ recovery)
- Increasing cost makes hard oil worth it
- The impact of enhanced oil recovery
 - Water and gas injection, heating, etc
- Delay peak followed by fast decay

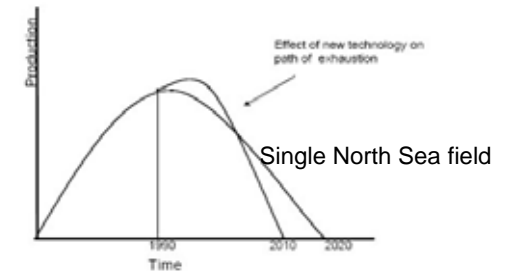


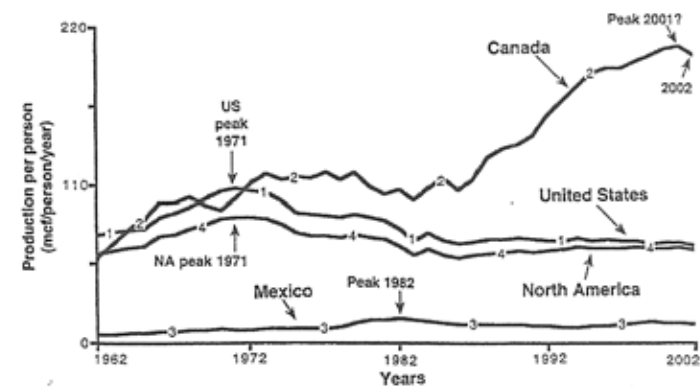
Fig. 2. Technological advance masks impending production declines

So will we “run out”?

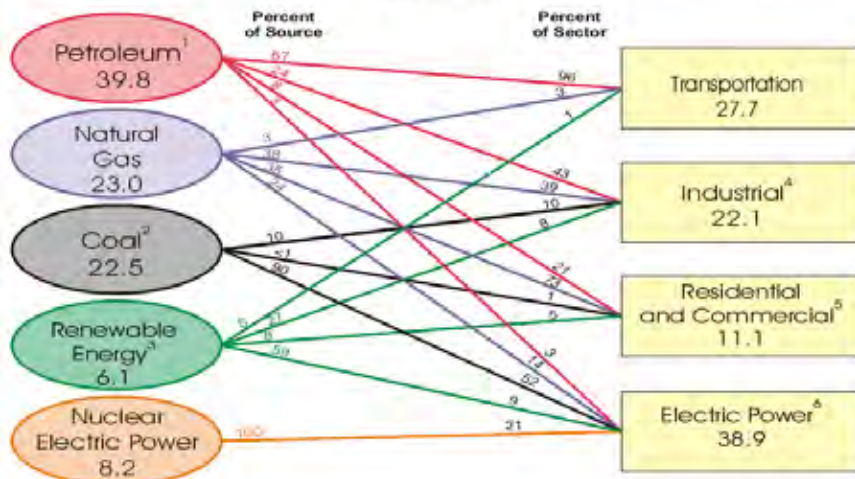
- We will always have expensive oil
- “The Stone Age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil.”
 - Zaki Yamani, Saudi Oil Minister 1962-1985
- As oil gets more expensive, we will develop substitutes
 - Natural Gas gets expensive too
 - coal, biofuel, wind, solar

Natural Gas

- Tight supply – likely past peak



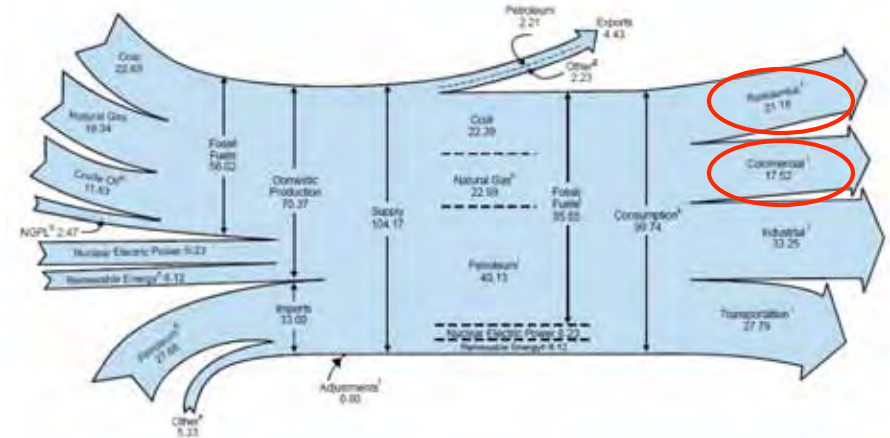
U.S. Primary Energy Consumption by Source and Sector, 2004 (Quadrillion Btu)



Total Energy

Domestic Sources Supply 70% of Total Energy
40% of Total Supply is Petroleum
23% of Total Supply is Natural Gas
Buildings are #1 Use of Energy in the US (40%)

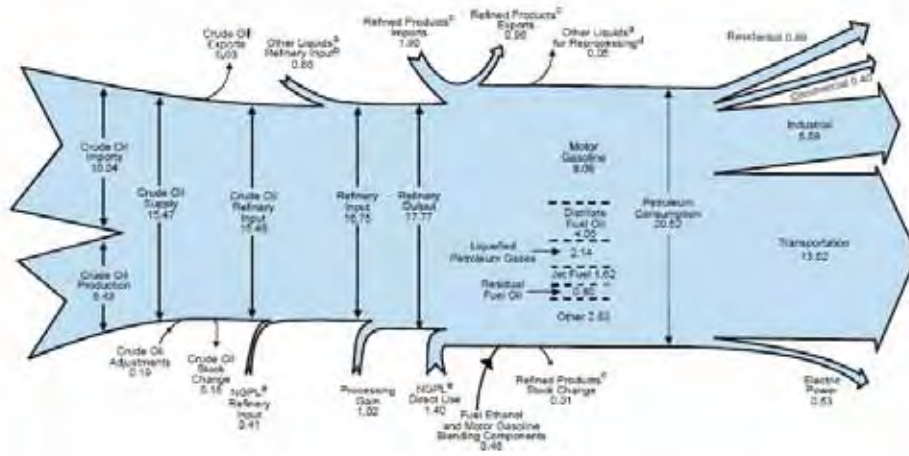
Quadrillion Btu



Petroleum Energy

2/3 of Oil is Imported
2/3 is Used in Transportation
Building Use is Very Small

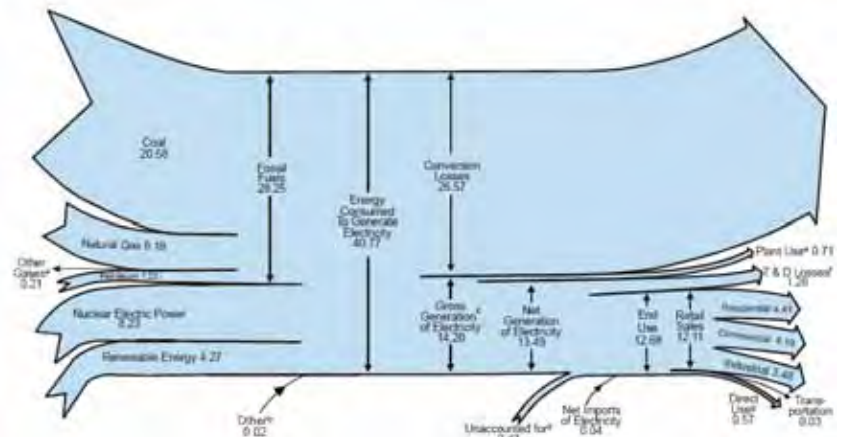
Millions barrels per day



Electrical Energy

2/3 From Fossil Fuels
Oil Very Small
2/3 is Lost at Generating Plant
2/3 Used in Buildings

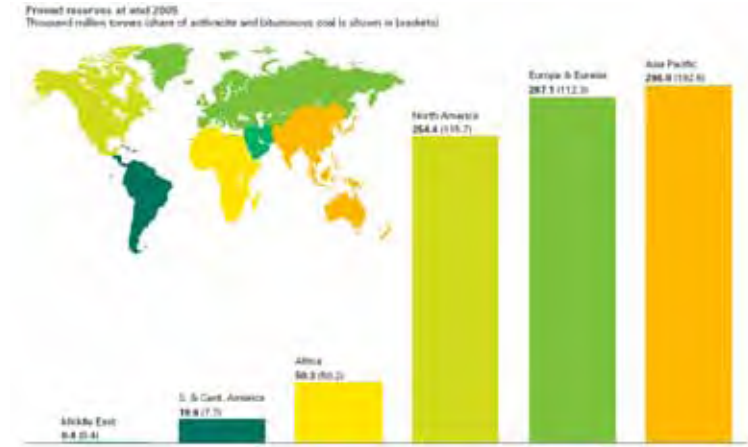
Quadrillion Btu



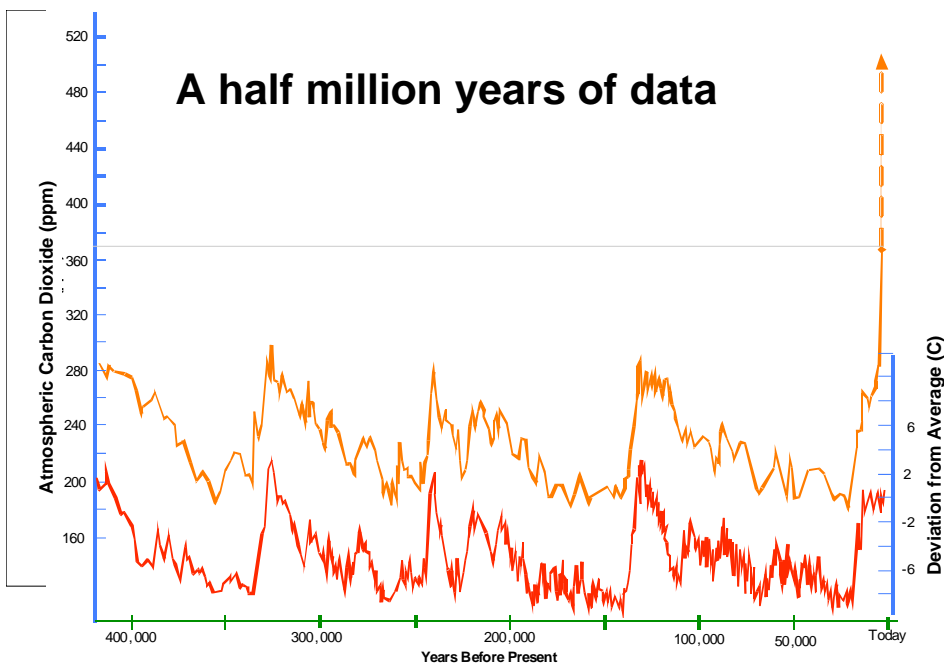
Transportation Sector Will Compete With The Building Sector For The Same Energy

Coal

- Fastest Growing Source of Energy
- America is the “Saudi Arabia of Coal”
- Carbon Dioxide Production Twice that of Natural gas (fundamental chemistry)

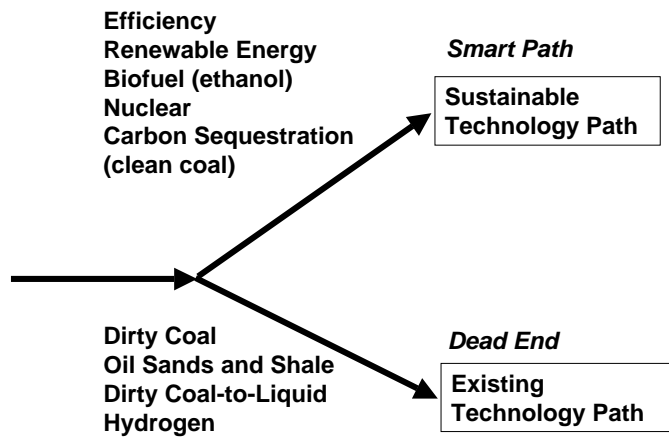


A half million years of data



- There is No Question that Climate Change is Happening
 - The Questions are When, How Bad, Did We do it and Can We Do Anything About it?
 - Looks Like Sooner Than Expected
 - Could be Pretty Bad, But then Again Maybe Not
 - Looks Like We Did Do it, But Not Completely Sure
 - We Can Fix It - But is it Worth it?
 - One Solution – Reduce CO2 Through Efficiency & Renewables
- Energy Security is a Decoupled Issue
 - Solution - Efficiency and New Energy Sources (coal?)
- Solving Energy Security the Wrong Way Will Worsen Climate Change
- Solving Climate Change also Solves Energy Security

Paths to Energy Security and Climate Change



It's The Energy Stupid

Typical Family Carbon Footprint
50 % House
50% Transportation

Buildings Are The Key To Energy Security
And Climate Change

Transition From A Hydrocarbon Based Economy to a Carbohydrate Based Economy

We Are The Saudia Arabia of Carbohydrates

It's Never A Good Idea To Trade Food For Fuel

Celluloistic Ethanol

Wood Is A Battery For Energy From The Sun

Carbon + Water + Sunlight = Wood
(photosynthesis)

The Ultimate Carbon Sequestration Is A
Wood Building That Is Energy Efficient

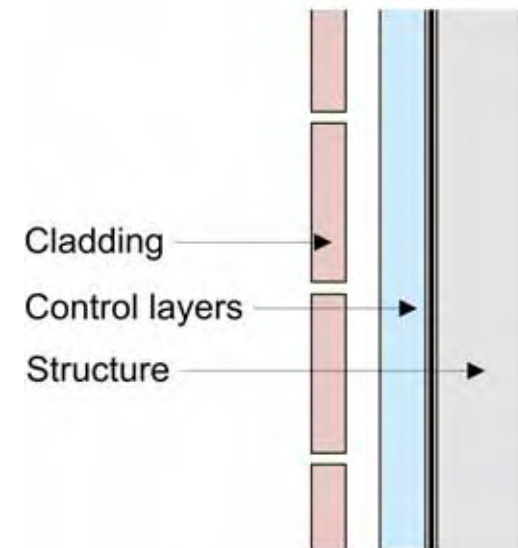
Wood Is The Ultimate Building Material

When We Are Done It Turns Back To
Carbon and Water and Releases The
Energy

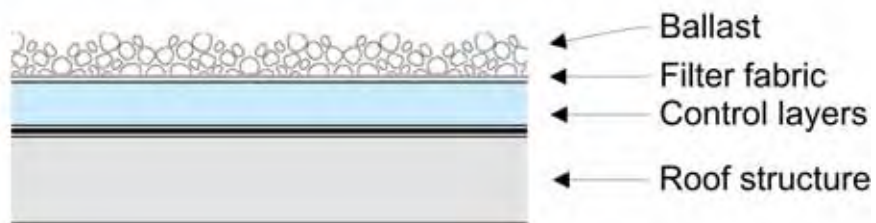
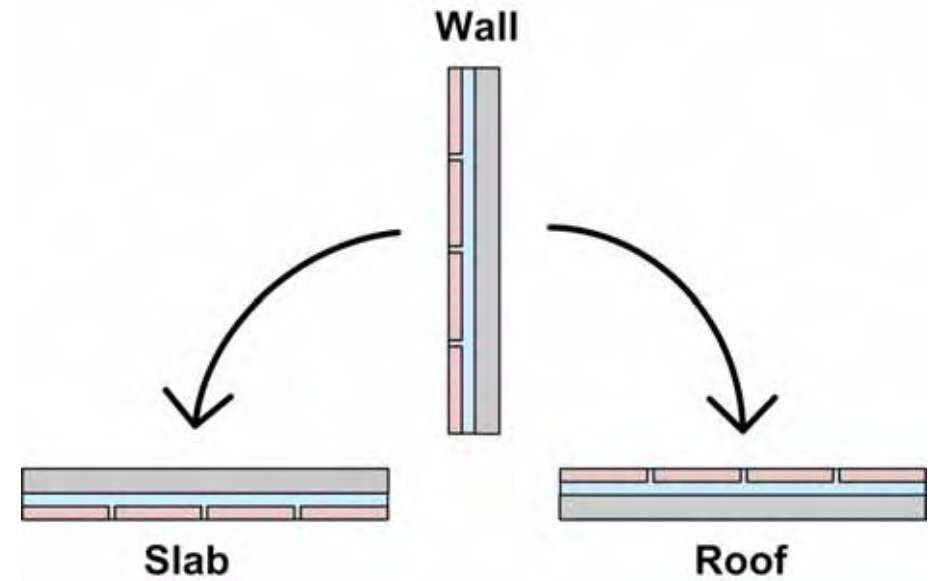
Plants Do A Better Job Of Converting Solar Energy Than Rocks

Let The Trees Do It

Keep The Money Here

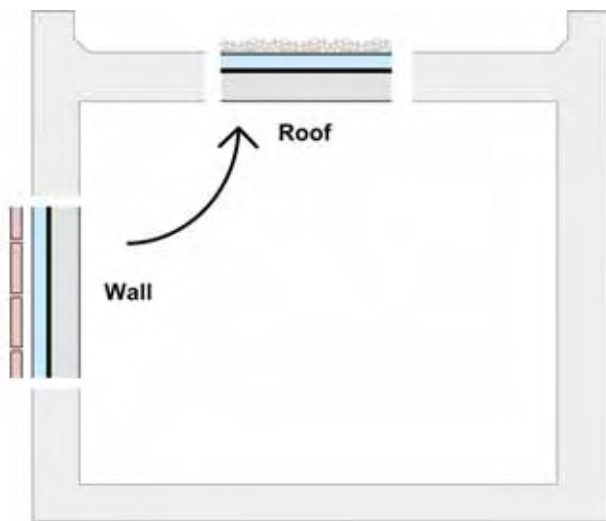


Rain Control Layer
Air Control Layer
Vapor Control Layer
Thermal Control Layer



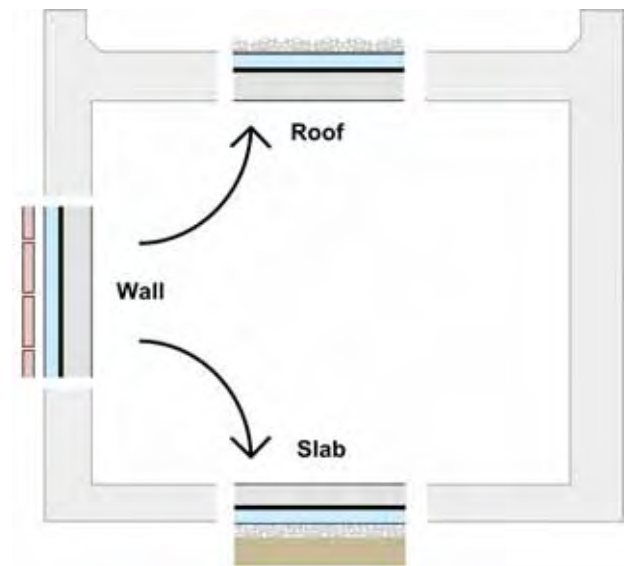


Wall



Roof

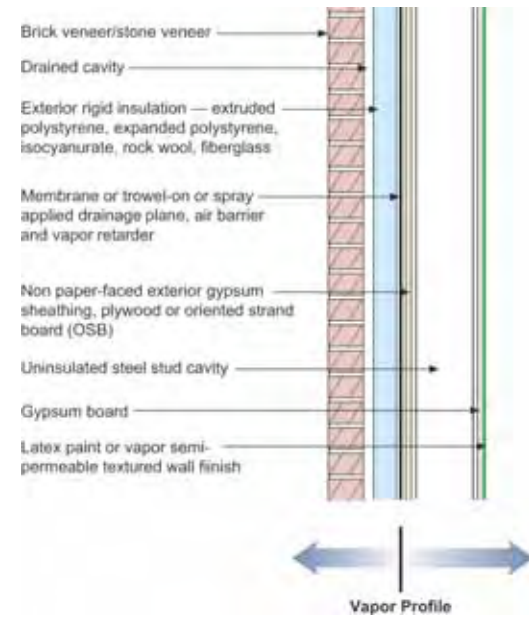
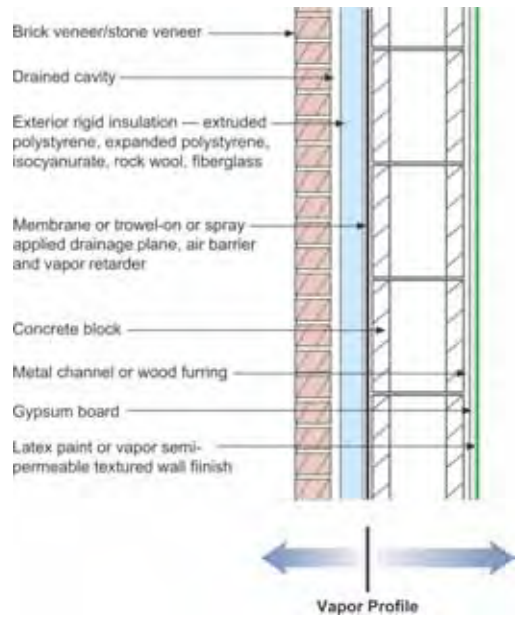
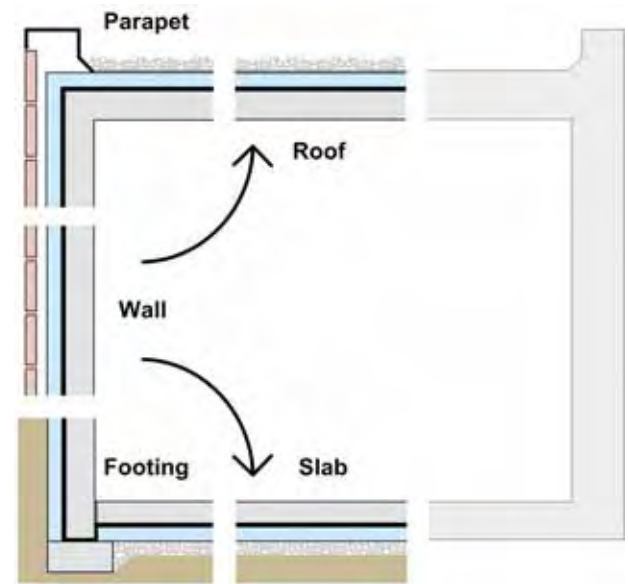
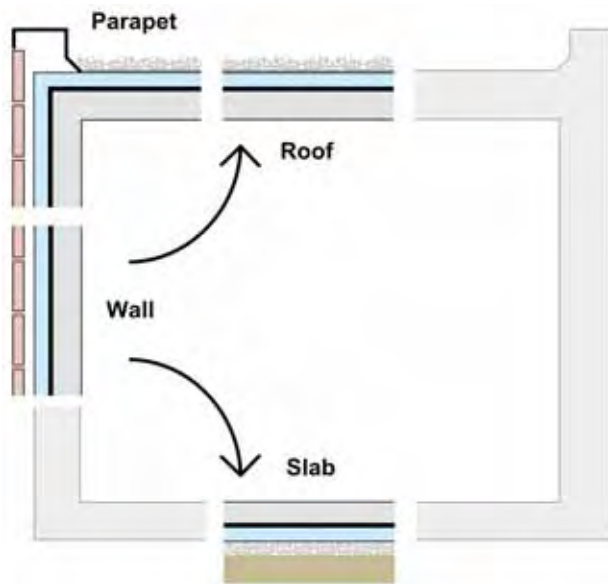
Wall

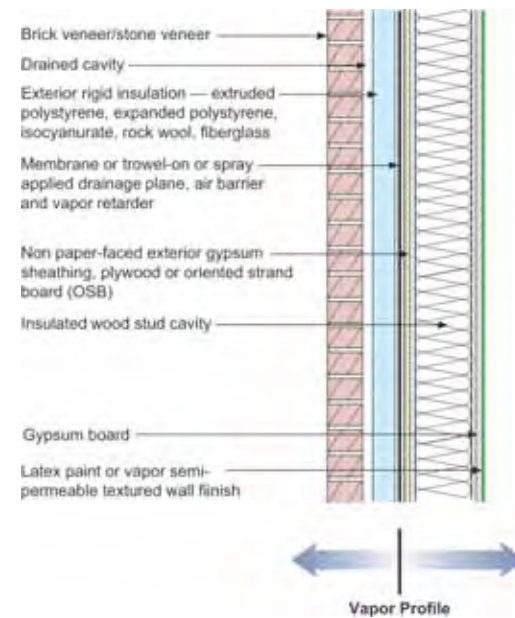
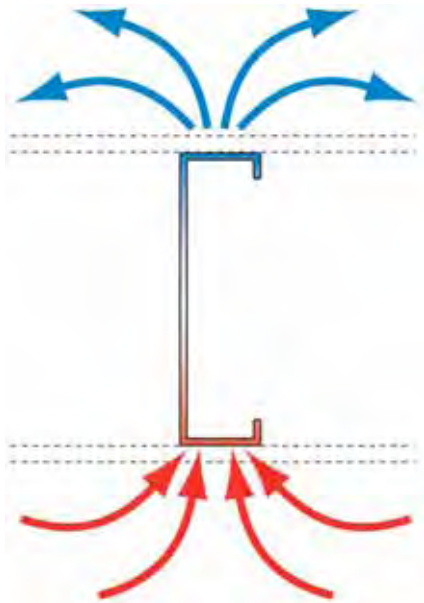


Roof

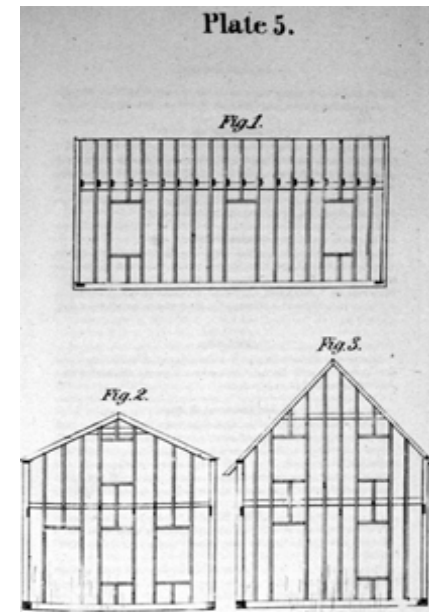
Wall

Slab



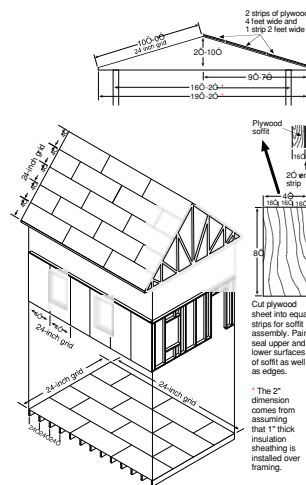


Advanced Framing Use Less Stuff Better



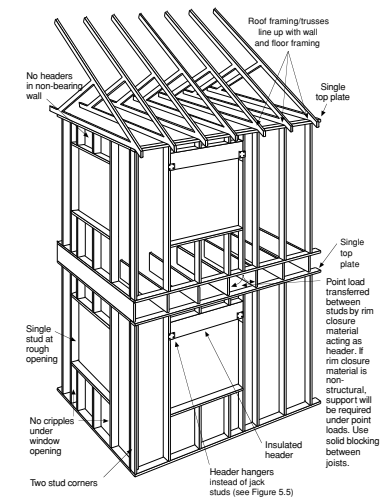
Design Issues

- Design buildings that coordinate advanced framing practices with material availability and integrate with building envelope design and mechanical system layout



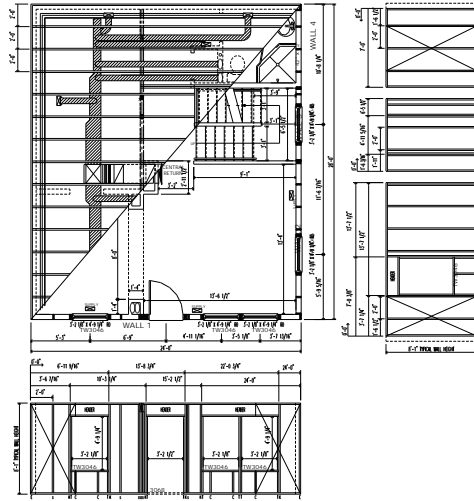
Advanced Framing System

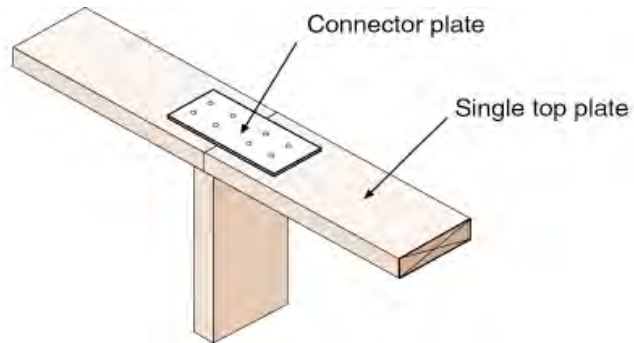
- Stack Framing Concept



Design Issues

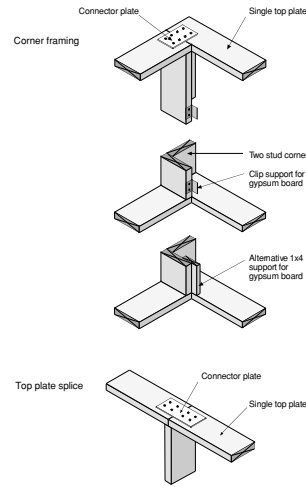
- Provide drawings that integrate advanced framing into complete building envelope design and mechanical system layout





Advanced Framing System

- 2 Stud Corners



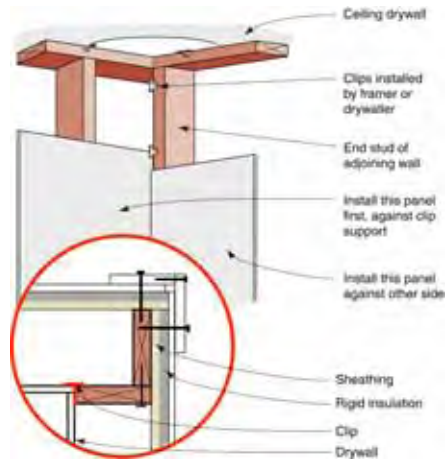
Advanced Framing System

- Insulated headers
- No header necessary at non-bearing walls



Advanced Framing System

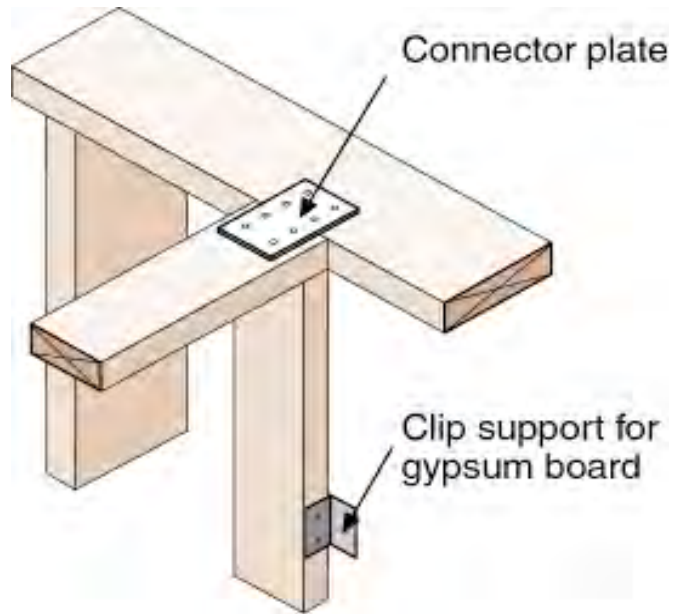
- Drywall clips allow for better installation with less drywall cracking



Advanced Framing System

- Drywall clips at corner and intersecting wall





CASE STUDY

• HOUSE SPECIFICATIONS

– Conditioned Floor Area	2,495 sq ft
– Total Floor Area	2,910 sq ft
– Typical Wall Height	9'-11"
– Total Conditioned Volume	24,850cu ft
– Length of Exterior Wall	252 ln ft
– Length of Interior Wall	340 ln ft

CASE STUDY

• 2x4 16" oc WALL

	8'Studs	Bd Ft	Cost
– Ext Wall	467	1634 bd ft	\$ 866
– Ext Plate	95	331 bd ft	\$ 175
– Int Wall	715	2502 bd ft	\$1326
– Int Plate	126	446 bd ft	\$ 237
– Header		273 bd ft	\$ 145
– TOTAL WALL FRAME COST		\$2749	

CASE STUDY

• 2x6 24" oc ADVANCED FRAME WALL

	8'Studs	Bd Ft	Cost
– Ext Wall	238	1312 bd ft	\$695
– Ext Plate	63	347 bd ft	\$183
– Int Wall	279	977 bd ft	\$518
– Int Plate	85	298 bd ft	\$158
– Header		148 bd ft	\$78
– TOTAL WALL FRAME COST		\$1632	

CASE STUDY

• WOOD FRAME WALL SUMMARY

	2x4	2x6	REDUCED BY
- 8' Studs	1403	665	(-738 / -52%)
- Bd Ft	5186	3082	(-2104 / -40%)
- COST	\$2749	\$1632	(-\$1117 / -40%)

Shear Panel



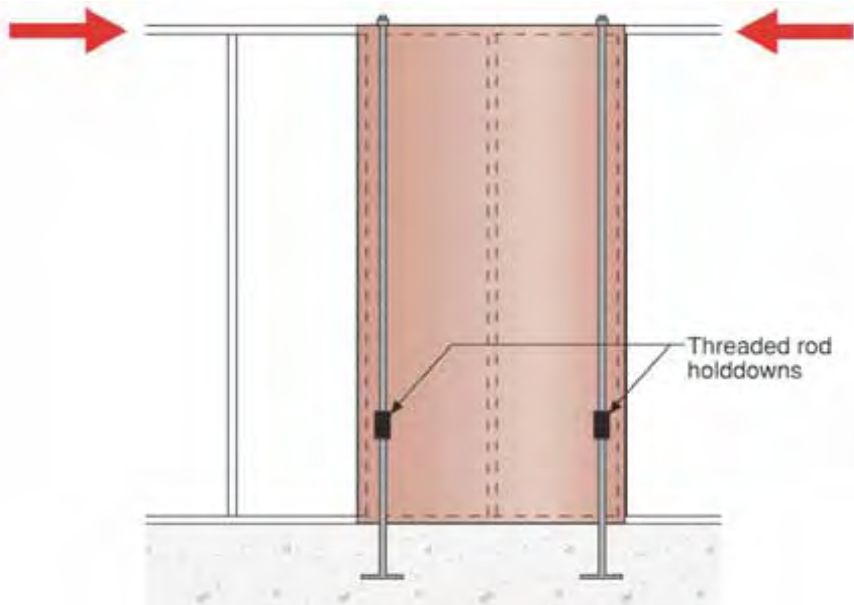
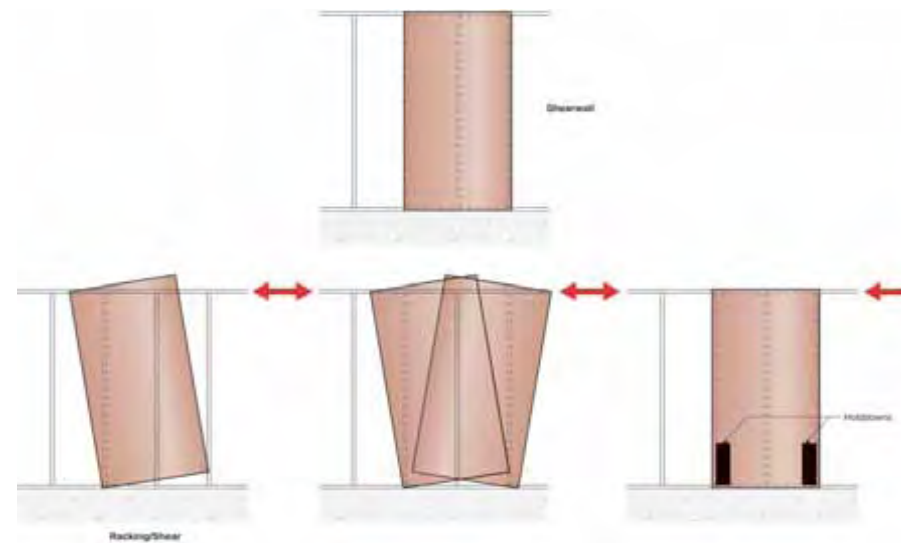
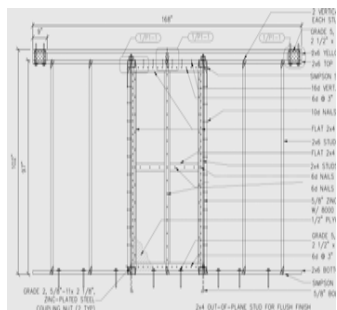
Shear Panel



Seismic Testing

•Work with CERL (the US Army research laboratory), and BSC to facilitating code approval of advanced framing techniques by the Division of the State Architect in California, and other earthquake and high wind loading locations.

•Full scale assemblies have been tested under the new dynamic seismic loading protocols developed after the Northridge earthquake. New non-proprietary shear panels are now available for use that allow for advanced envelope design

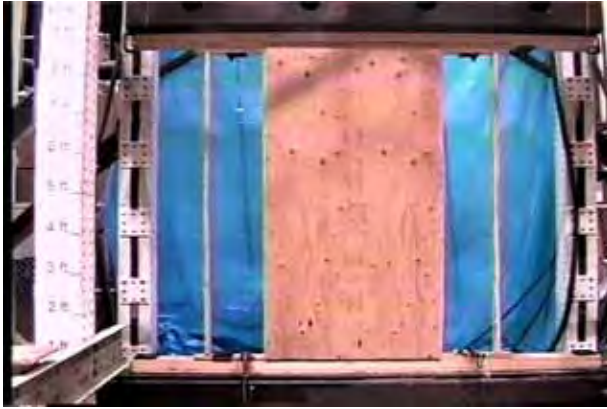


2 Story Aligned

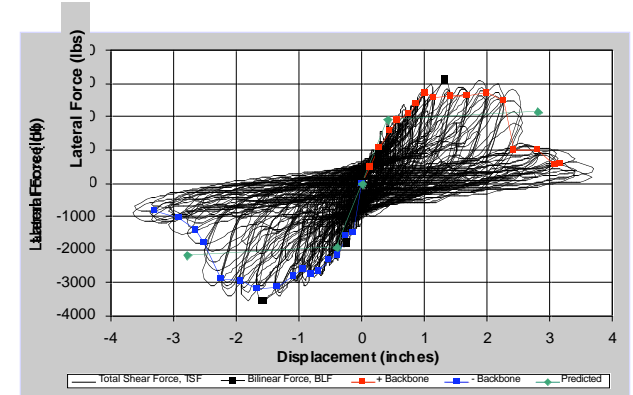


Standard Plywood Panel

2x4 panel with plywood to establish baselines



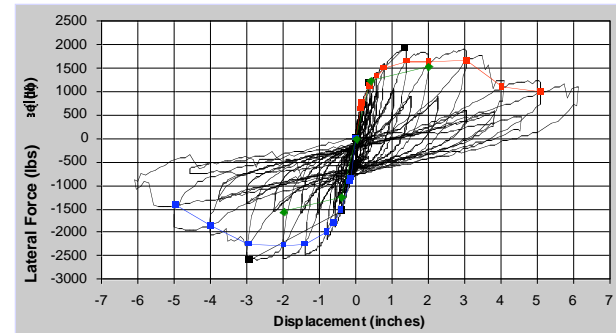
Standard Plywood Panel Performance



Standard OSB Panel



Standard OSB Panel Performance

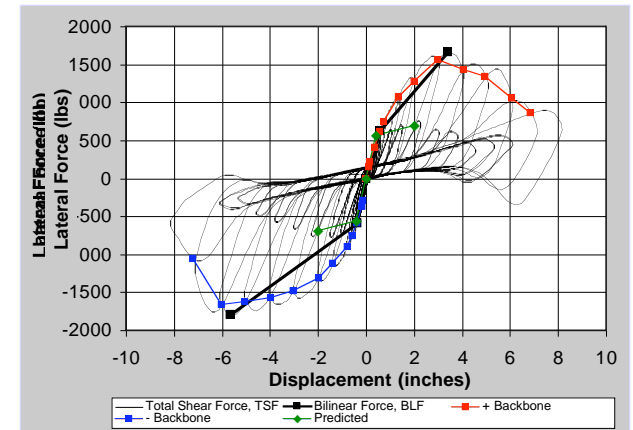


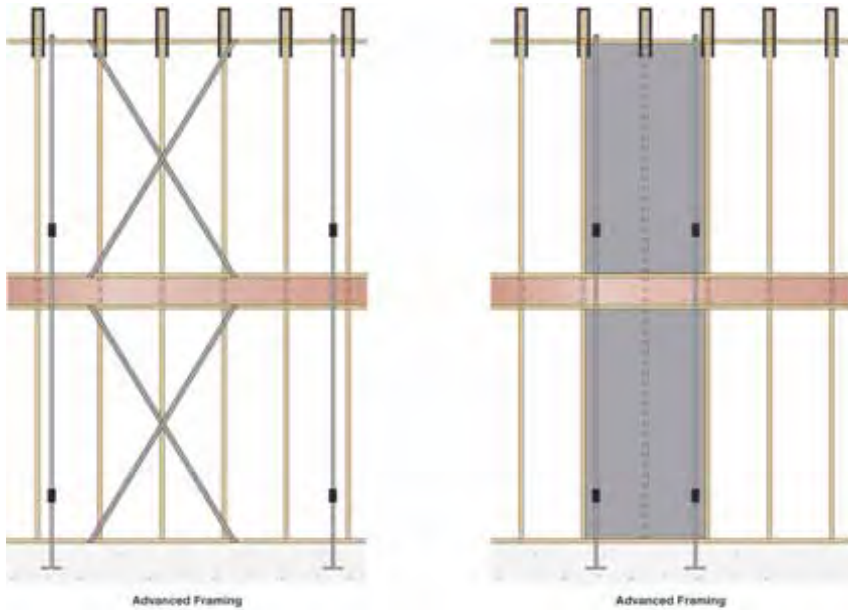


Diagonal Strap Shear Panel CURE1



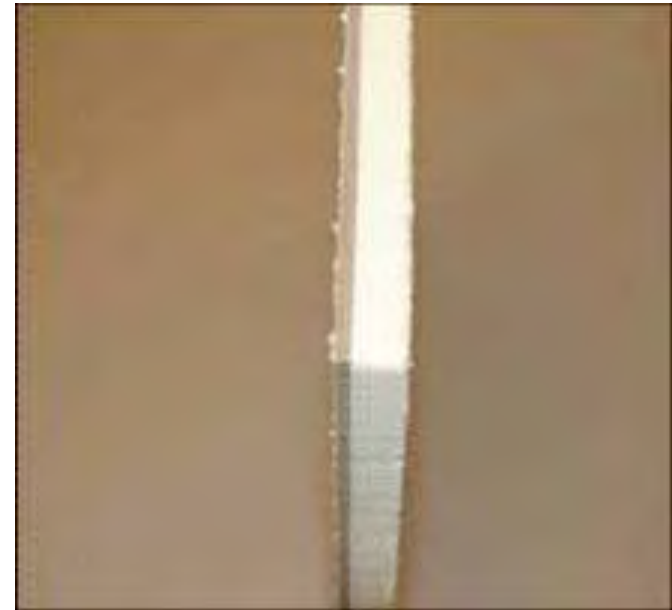
Diagonal Strap Shear Panel CURE1





Advanced Framing

Advanced Framing



50 % Total Energy Reduction (1,500 ft² house over basement)

Advanced Framing	- less \$1000
Insulating Sheathing	- wash
95 % Furnace	- add \$200
Simplified Ductwork	- less \$500
Basement Insulation	- add \$1000
Cavity and Roof Insulation	- add \$250
Heat Exchanger	- add \$1000
Air Sealing	- add \$250
16 SEER a/c	- add \$450
Tankless DHW	- add \$575
Compact Fluorescent Lighting	- add \$250
Energy Star Appliances	- add \$750

Approximately \$3,500 more

50 % Total Energy Reduction

(1,500 ft² house over basement)

Costs Approximately \$3,500 more

Financed For Approximately \$25/month

Saves \$75/month in Utilities

Cash Flow is \$50/month positive

We Don't Have An Energy Problem

We Have A Stupid Problem

We're Stupid

Don't Do Stupid Things







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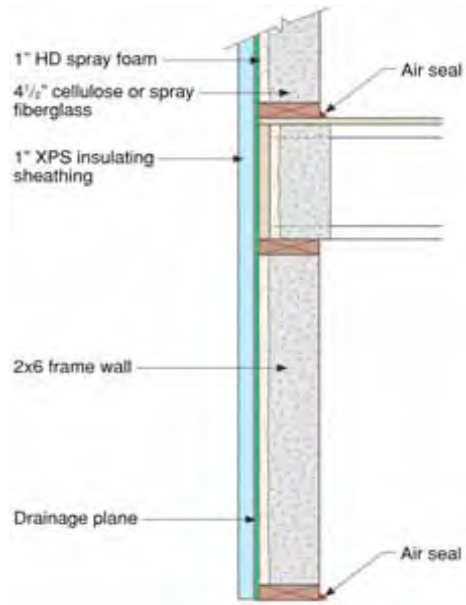
Building Science Corporation
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Joseph Lstiburek – Wood 111

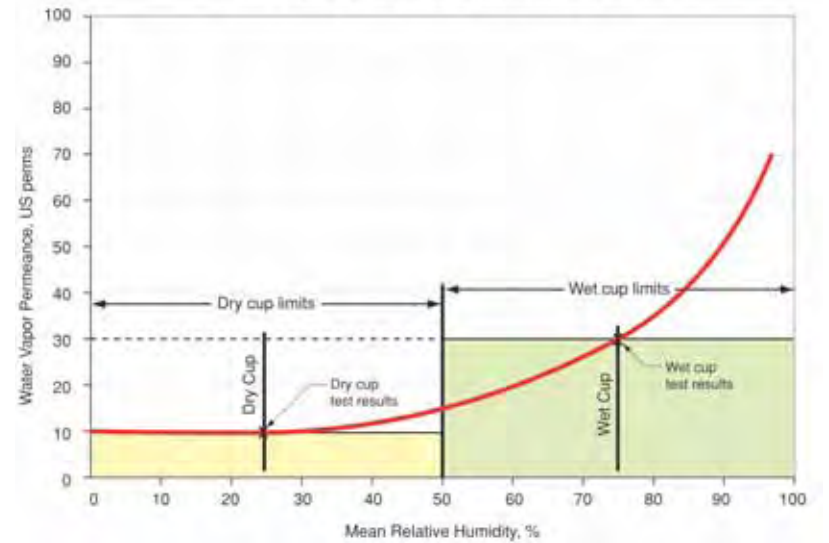


Building Science Corporation
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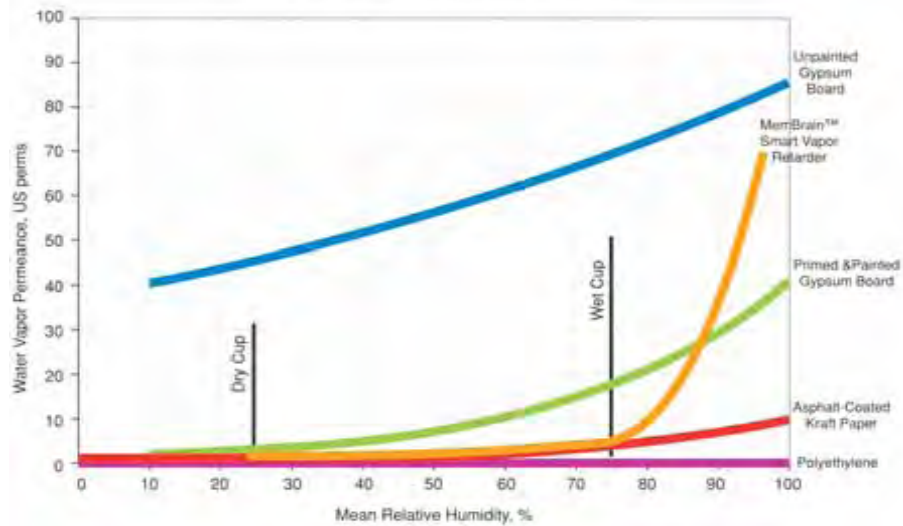
Joseph Lstiburek – Wood 112



Water Vapor Permeance of Hygroscopic Materials



Water Vapor Permeance of Interior Materials



Water Vapor Permeance of Sheathing Materials

