DOCKETED

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Building Energy Efficiency Standards

2019 Pre-Rulemaking for Building Energy Efficiency Standards

Payam Bozorgchami, PE

Draft Proposal for Residential Walls

June 1, 2017

Acknowledgements

California Utilities Statewide Codes and Standards Team

CASE Authors:

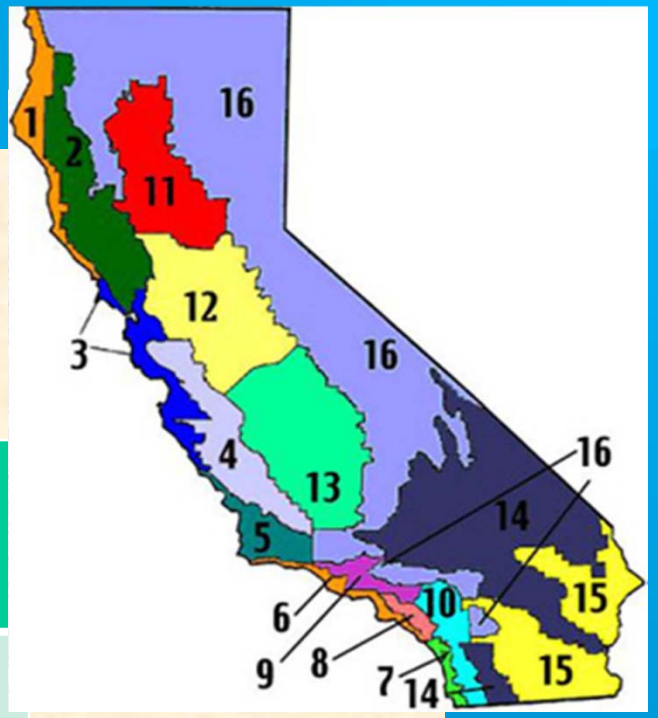
Alea German, Davis Energy Group

What We Will Cover Today

Residential Walls Proposal

- Prescriptive U-factor ~0.043 for exterior walls
    - o CZs 1 and 11-16 for low-rise residential buildings.
    - o CZs 11, 15 and 16 for multifamily buildings.

Current Code Requirements

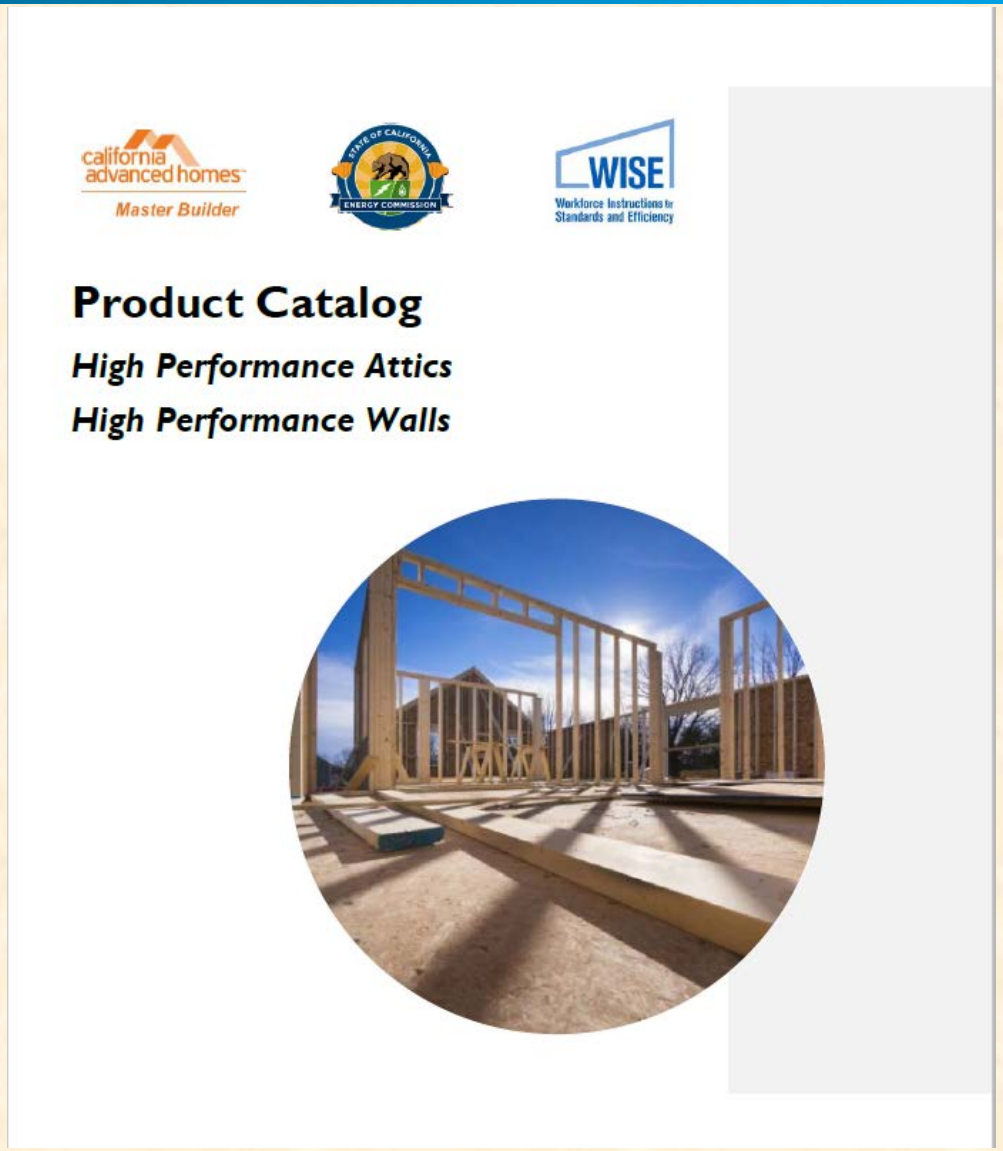


2016 Prescriptive

	CA CZ 1-5	CA CZ 6, 7	CA CZ 8-16
Max U-factor	0.051	0.065	0.051
Min R-Value Equivalency	R-21 + 4 or R-19 + 5	R-13 + 5 or R-15 + 4	R-21 + 4 or R-19 + 5
Other Assembly Type Options	SIPs, ICFs, AWF, or other wall assemblies (i.e., 2x6 @ 24" o.c. etc.)		

Title 24
2019
Standards

Source for some Products



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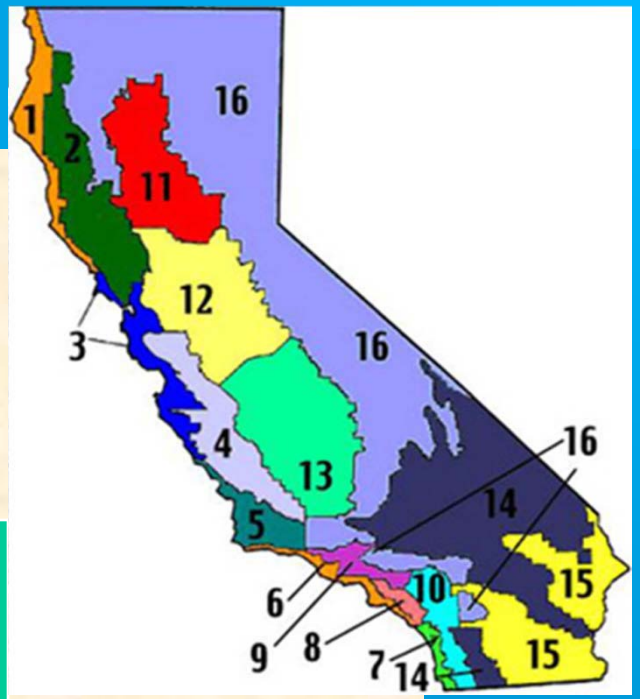
Proposed Code Requirements



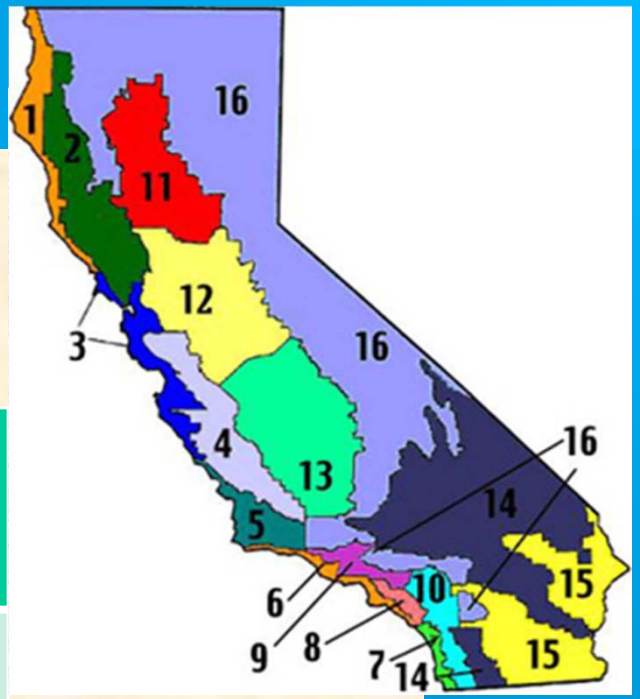
2019 Prescriptive Single Family

	CA CZ 2-5 & 8-10	CA CZ 6,7	CA CZ 1, 11-16
Max U-factor	0.051	0.065	0.043
Min R-Value Equivalency	R-21 + 4 or R-19 + 5	R-13 + 5 or R-15 + 4	R-21 + 7.5
Other Assembly Type Options	SIPs, ICFs, AWF, or other wall assemblies (i.e., 2x6 @ 24” o.c. etc.)		

Proposed Code Requirements

2019 Prescriptive Multifamily

	CA CZ 1-5, 8-10	CA CZ 6,7	CA CZ 11, 15-16
Max U-factor	0.051	0.065	0.043
Min R-Value Equivalency	R-21 + 4 or R-19 + 5	R-13 + 5 or R-15 + 4	R-21 + 7.5
Other Assembly Type Options	SIPs, ICFs, AWF, or other wall assemblies (i.e., 2x6 @ 24” o.c. etc.)		



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Prototype Buildings

Minimally Compliant with 2016 Standards

Item	Description	Unit	New Construction 2,100 Sqft	New Construction 2,700 Sqft	New Construction Multi-family 6,960 Sqft
1	Slab Perimeter	Linear feet	162	128	292
2	Wall Area	Square feet	1,018	2,130	3,760
3	Wall Area between house and garage	Square feet	250	250	0
4	Wall Area between house and attic	Square feet	0	42	0
5	Window Area	Square feet	420	540	1044
6	Window Perimeter	Linear feet	351	457	1,114
7	Door Area	Square feet	20	20	160
8	Door Area between house and garage	Square feet	20	20	0
9	Door Perimeter	Linear feet	19	19	155

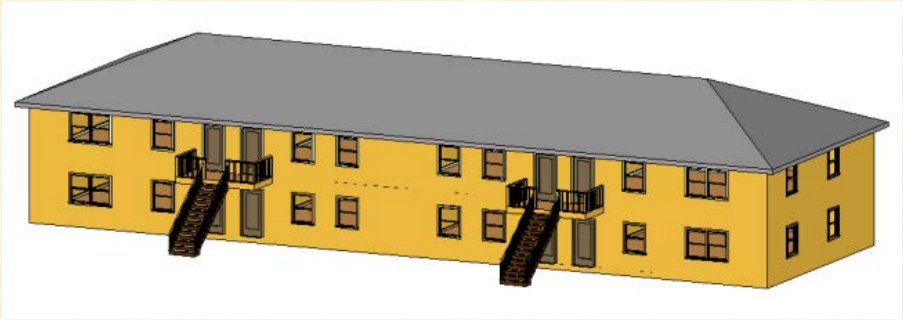
Title 24
2019
Standards

Building Prototypes

2,100 ft^2 Prototype

2,700 ft^2 Prototype

6,960 ft^2 Prototype



Title 24
2019
Standards

Summary of Incremental Costs Applied in the Analysis

Product Type	Description	Material Cost / Unit	Additional Labor Cost / Unit[1]	Total Cost / Unit Including Markup[2]	Unit
Cavity Insulation	R-21 vs R-19 fiberglass batt	$0.15	$0.00	$0.20	square feet exterior wall[3]
	R-23 blown-batt vs R-19 batt	$0.43	$0.00	$0.56	
	R-21 vs R-15 fiberglass batt	$0.13	$0.00	$0.17	
	2x6 wall vs 2x4 wall	$0.11	$0.03	$0.17	
Rigid Insulation	EPS - expanded polystyrene	$0.22	$0.48	$0.77	square feet exterior wall - inch foam
	GPS - graphite enhanced EPS	$0.29	$0.48	$0.84	
	XPS - extruded polystyrene	$0.55	$0.48	$1.20	
	Polyisocyanurate 1” [4]	$0.57	$0.48	$1.22	
	Polyisocyanurate 1.5”-2” [4]	$0.48	$0.48	$1.11	
Weed screed	1-3/8" weep screed - 1" CI	$0.77	$0.00	$1.00	linear feet foundation perimeter
	1-7/8" weep screed - 1.5" CI	$0.87	$0.00	$1.13	
	2-3/8" weep screed	$0.98	$0.00	$1.27	
Fasteners	2-1/2" staples, staple gun - 1" CI	$2.15	$0.00	$2.79	100 square feet exterior wall
	3" nail, hand nail - 1.5" CI	$2.04	$9.52	$12.18	
	4" nail, hand nail - 2" CI	$4.86	$9.52	$15.84	
Window picture framing & additional flashing	0.5" window buck - 1" CI	$0.22	$0.55	$0.83	linear feet window perimeter
	1" window buck - 1.5" CI	$0.34	$0.55	$1.00	
	1.5" window buck - 2"CI	$0.48	$0.55	$1.17	

Cost Effective Analysis

Single Family Incremental First Cost (2,430 ft^2 blended prototype)

- Rigid Insulation ($408)
- Window/Door Waterproofing ($355)
- Fasteners ($153)
- Weep Screed ($19)

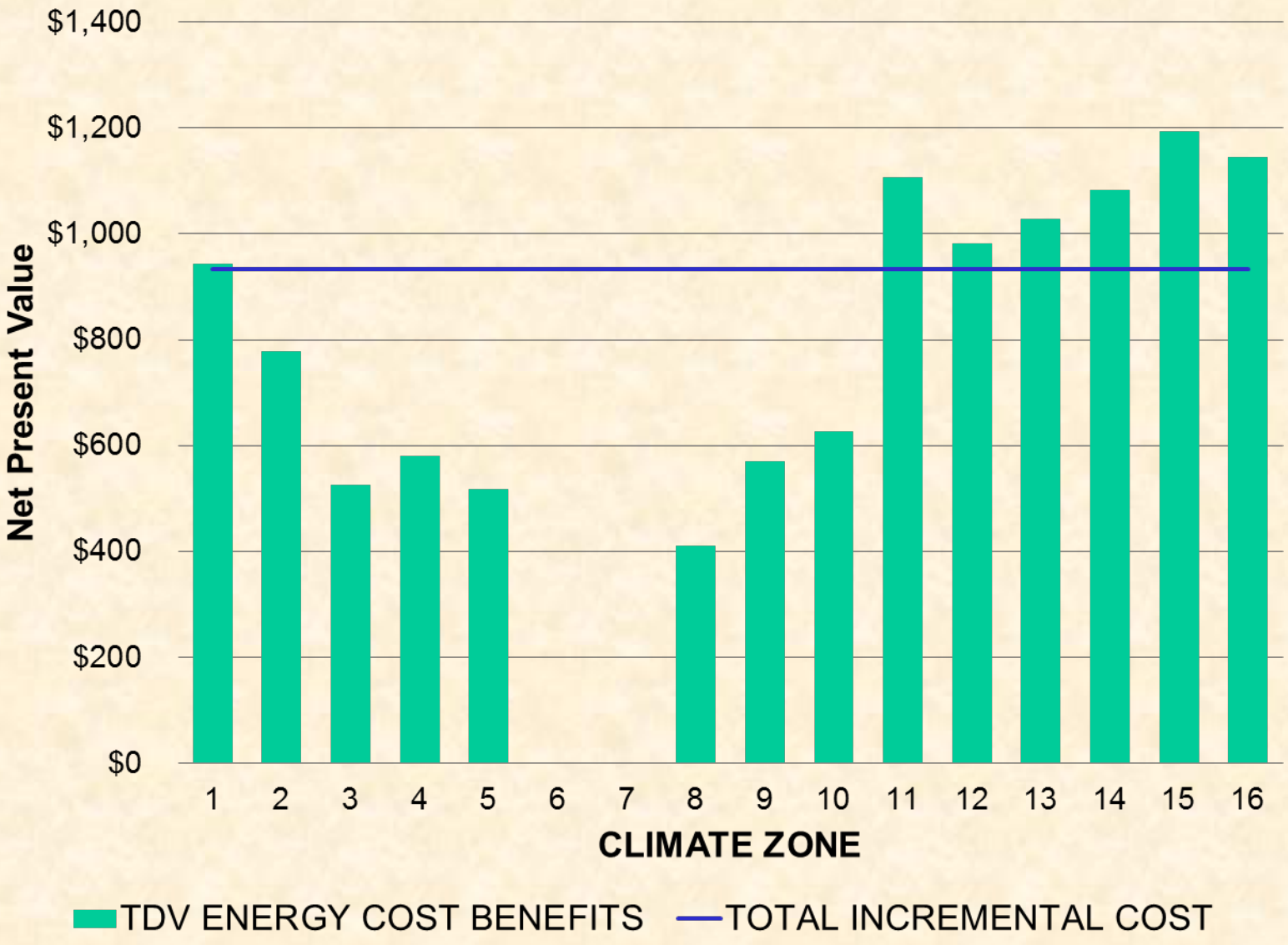
Total Single Family Incremental Cost over 30-year Period of Analysis ($935)

Multifamily Incremental First Cost (8-unit 6,960 ft^2 prototype)

- Rigid Insulation ($941)
- Window/Door Waterproofing ($1,052)
- Fasteners ($353)
- Weep Screed ($38)

Total Multifamily Incremental Cost over 30-year period of analysis ($2,384)

Lifecycle Cost-effectiveness Summary per Dwelling Unit -(2,430 ft² blended prototype)



Title 24
2019
Standards

Lifecycle Cost-effectiveness Summary per Dwelling Unit (2,430 ft² blended prototype)

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings (2020 PV $)	Costs Total Incremental Present Valued (PV) Costs (2020 PV $)	Benefit-to-Cost Ratio
1	$944	$934	1.04
2	$779	$934	0.86
3	$526	$934	0.58
4	$581	$934	0.64
5	$518	$934	0.57
6	*n/a*		
7	*n/a*		
8	$410	$934	0.45
9	$570	$934	0.63
10	$626	$934	0.69
11	$1,106	$934	1.21
12	$982	$934	1.08
13	$1,029	$934	1.13
14	$1,083	$934	1.19
15	$1,194	$934	1.31
16	$1,145	$934	1.26

First-Year Energy Impact per single family (2,430 ft² blended prototype)

Climate Zone	Electricity Savings (kWh/yr)	Peak Electricity Demand Reductions (kW)	Natural Gas Savings (therms/yr)	TDV Energy Savings (TDV kBtu/yr)
1	20.6	0.00	24	5629
2	15.6	0.02	15	4672
3	10.3	0.00	13	3140
4	13.95	0.01	12	3469
5	10.3	0.00	13	3083
6	*n/a*			
7	*n/a*			
8	11.3	0.03	6	2445
9	22.25	0.04	7	3397
10	28.45	0.05	8	3737
11	62.45	0.06	15	6598
12	31.65	0.06	14	5886
13	65	0.06	13	6134
14	58.35	0.06	15	6462
15	150.25	0.11	3	7123
16	26.35	0.01	28	6849

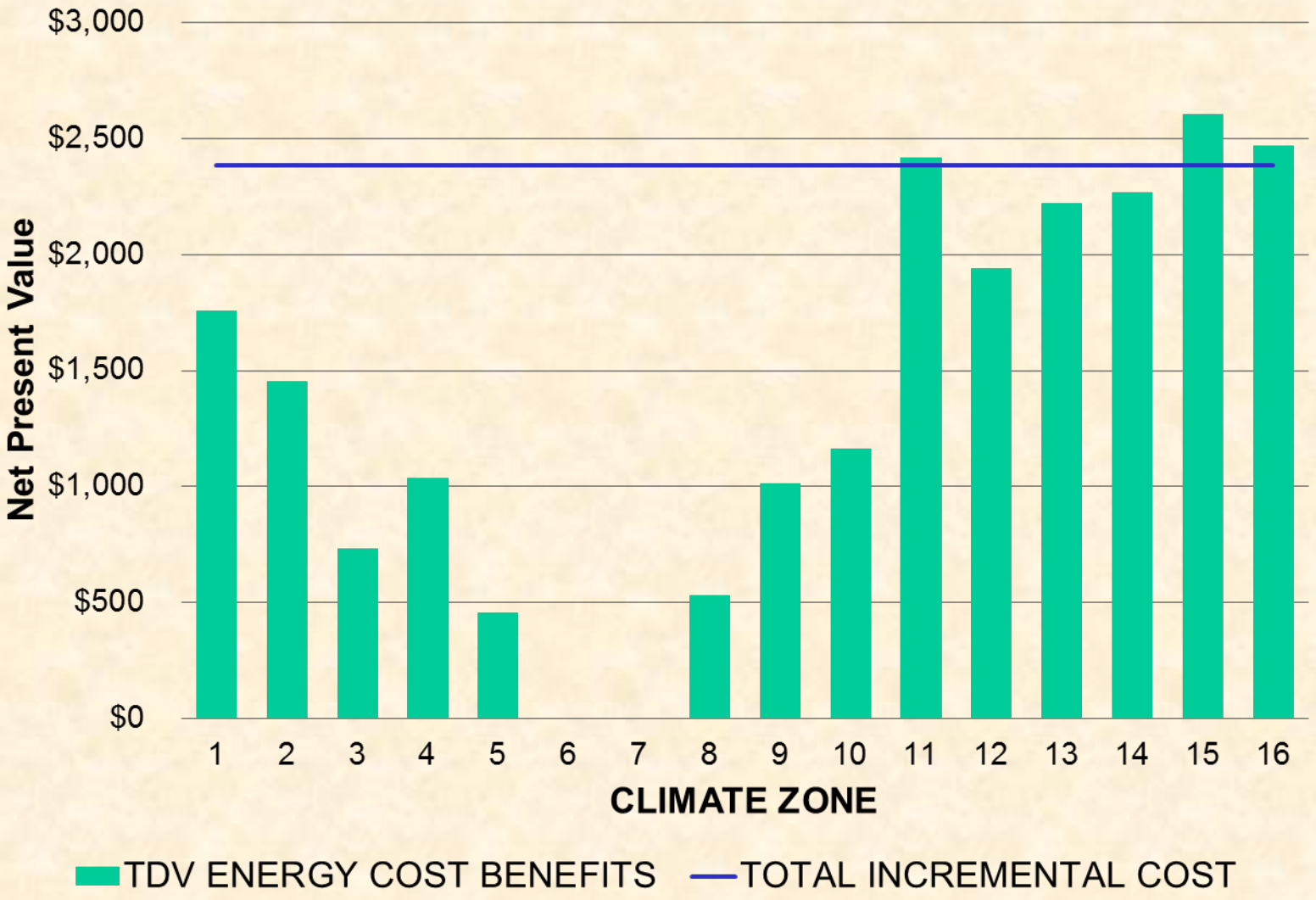
Title 24
2019
Standards

TDV Energy Cost Savings over 30-Year Period of Analysis (2,430 ft² blended prototype)

Climate Zone	30-Year TDV Electricity Cost Savings (2020 PV $)	30-Year TDV Natural Gas Cost Savings (2020 PV $)	Total 30-Year TDV Energy Cost Savings (2020 PV $)
1	$3	$971	$974
2	$192	$617	$808
3	$19	$524	$544
4	$89	$512	$600
5	$6	$527	$534
6	*n/a*		
7	*n/a*		
8	$189	$234	$423
9	$297	$290	$587
10	$317	$329	$646
11	$527	$614	$1,141
12	$418	$600	$1,018
13	$517	$544	$1,061
14	$494	$624	$1,118
15	$1,119	$114	$1,232
16	$26	$1,158	$1,184

Title 24
2019
Standards

Lifecycle Cost-effectiveness Summary per Dwelling Unit (Multifamily 8-unit prototype)



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2019
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Lifecycle Cost-effectiveness Summary per Dwelling Unit (Multifamily 8 unit prototype)

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings (2020 PV $)	Costs Total Incremental Present Valued (PV) Costs (2020 PV $)	Benefit-to-Cost Ratio
1	$1,758	$2,384	0.74
2	$1,451	$2,384	0.61
3	$734	$2,384	0.31
4	$1,036	$2,384	0.43
5	$458	$2,384	0.19
6	*n/a*		
7	*n/a*		
8	$530	$2,384	0.22
9	$1,011	$2,384	0.42
10	$1,162	$2,384	0.49
11	$2,420	$2,384	1.02
12	$1,939	$2,384	0.81
13	$2,222	$2,384	0.93
14	$2,270	$2,384	0.95
15	$2,607	$2,384	1.09
16	$2,468	$2,384	1.04

Title 24
2019
Standards

First-Year Energy Impact per 8-Unit (Multifamily Building)

Climate Zone	Electricity Savings (kWh/yr)	Peak Electricity Demand Reductions (kW)	Natural Gas Savings (therms/yr)	TDV Energy Savings (TDV kBtu/yr)
1	23	-0.02	44.42	10,162
2	24	0.02	29.26	8,387
3	-1	0.00	19.24	4,246
4	18	0.02	23.31	5,986
5	-20	-0.05	17.70	2,645
6	*n/a*			
7	*n/a*			
8	-5	0.05	5.10	3,062
9	24	0.11	9.25	5,846
10	41	0.11	11.39	6,716
11	127	0.14	29.00	13,990
12	56	0.10	28.62	11,206
13	130	0.14	25.79	12,841
14	118	0.13	29.11	13,120
15	328	0.26	1.26	15,068
16	44	0.01	59.01	14,268

Title 24
2019
Standards

TDV Energy Cost Savings over 30-Year Period of Analysis
8-Unit (Multifamily Building)

Climate Zone	30-Year TDV Electricity Cost Savings (2020 PV $)	30-Year TDV Natural Gas Cost Savings (2020 PV $)	Total 30-Year TDV Energy Cost Savings (2020 PV $)
1	$12	$1,746	$1,758
2	$259	$1,192	$1,451
3	-$24	$759	$734
4	$96	$939	$1,036
5	-$205	$662	$458
6	*n/a*		
7	*n/a*		
8	$355	$175	$530
9	$662	$349	$1,011
10	$710	$452	$1,162
11	$1,228	$1,192	$2,420
12	$759	$1,180	$1,939
13	$1,150	$1,072	$2,222
14	$1,078	$1,192	$2,270
15	$2,577	$30	$2,607
16	$36	$2,432	$2,468

Advanced Framing Construction Option

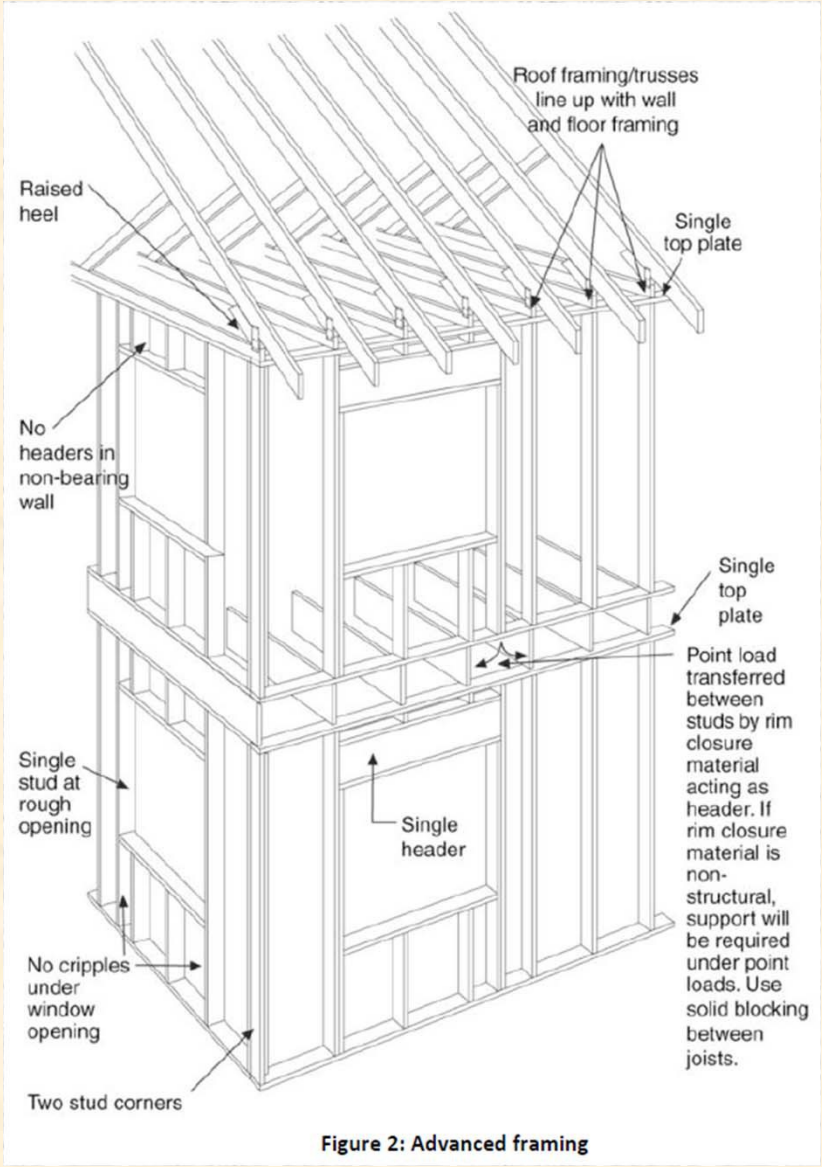


Figure 2: Advanced framing

Source: Building Science Corporation (2010)

Title 24
2019
Standards

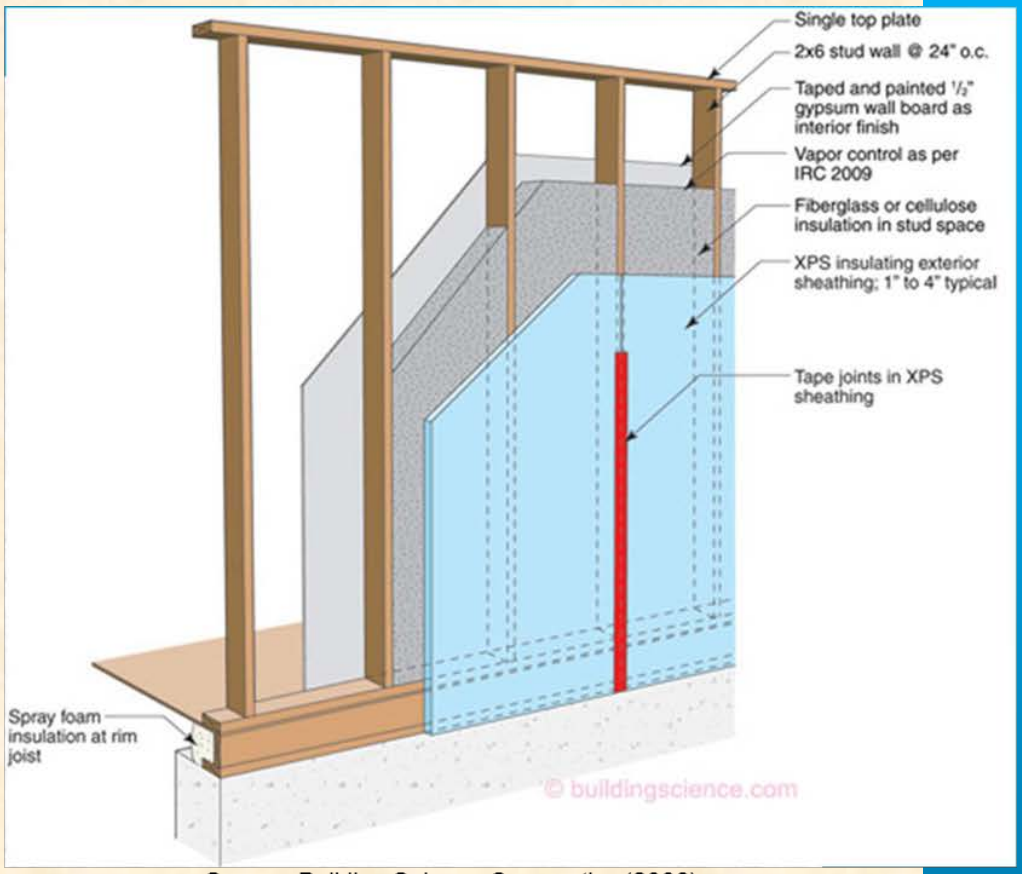
Advanced Framing Construction Option

Benefits:

- Reduces material costs
- Reduces labor (after learning curve)
- Reduces thermal bridging (lower framing factor)
- Dry wall clips can reduce drywall cracking

Challenges:

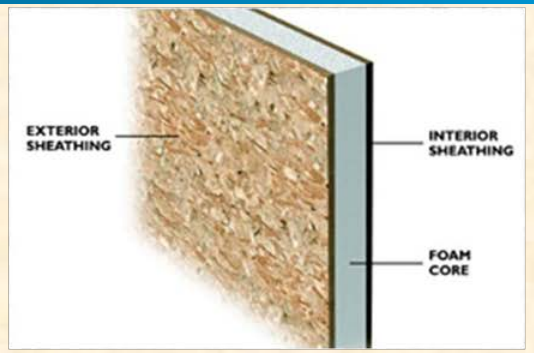
- Learning curve
- Additional upfront planning more important to reap full benefits



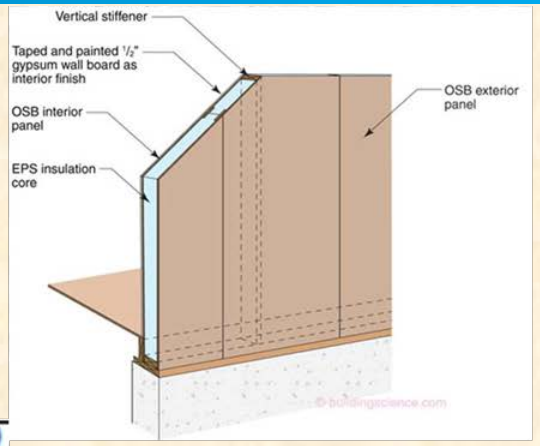
Source: Building Science Corporation (2003)

Title 24
2019
Standards

SIP Construction Option



Source: www.sips.org



Source: Building Science Corporation (2004)

Table 4.3.2 – U-factors of Structurally Insulated Wall Panels (SIPS)

Wood Framing Connection Type (spline)	Insulation Core R-value[1]	Typical Panel Thickness		Rated R-value of Continuous Insulation[4] None A	R-2 B	R-4 C	R-5 D
OSB	R-14	4.5 in	1	0.061	0.055	0.049	0.047
Single 2x	R-14	4.5 in	2	0.071	0.061	0.054	0.051
Double 2x	R-14	4.5 in	3	0.077	0.065	0.057	0.054
I-joist	R-14	4.5 in	4	0.070	0.060	0.053	0.051
OSB	R-18[2]	4.5 in	5	0.053	0.045	0.041	0.039
Single 2x	R-18[2]	4.5 in	6	0.061	0.052	0.047	0.045
Double 2x	R-18[2]	4.5 in	7	0.066	0.056	0.050	0.048
I-joist	R-18[2]	4.5 in	8	0.059	0.051	0.046	0.044
OSB	R-22	6.5 in	9	0.041	0.038	0.036	0.035
Single 2x	R-22	6.5 in	10	0.050	0.044	0.040	0.039
Double 2x	R-22	6.5 in	11	0.054	0.048	0.043	0.041
I-joist	R-22	6.5 in	12	0.048	0.043	0.039	0.038
OSB	R-28	8.25 in	13	0.032	0.030	0.029	0.028
Single 2x	R-28	8.25 in	14	0.039	0.036	0.033	0.032
Double 2x	R-28	8.25 in	15	0.043	0.039	0.035	0.034
I-joist	R-28	8.25 in	16	0.037	0.034	0.032	0.031

Benefits:

- High insulation, low thermal bridging
- Factory fabricated
- Lower labor costs
- Seismic durability
- Easier to meet the tight house requirement

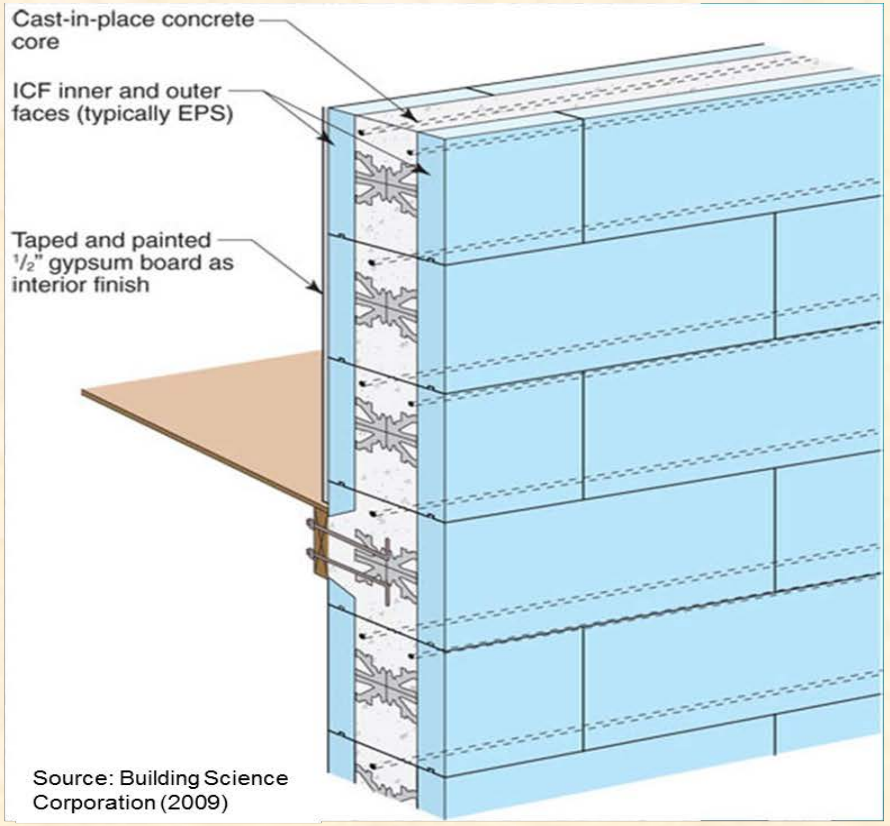
Challenges:

- Uncommon practice
- Material costs

Title 24
2019
Standards

ICFs Construction Option

Case Description	Wall U-factor
4" flat core 2" EPS each side	0.058
8" flat core 2.5" EPS each side	0.046
8" flat core 2.5" XPS each side	0.036
10" flat core 4.5" polyurethane each side	0.022



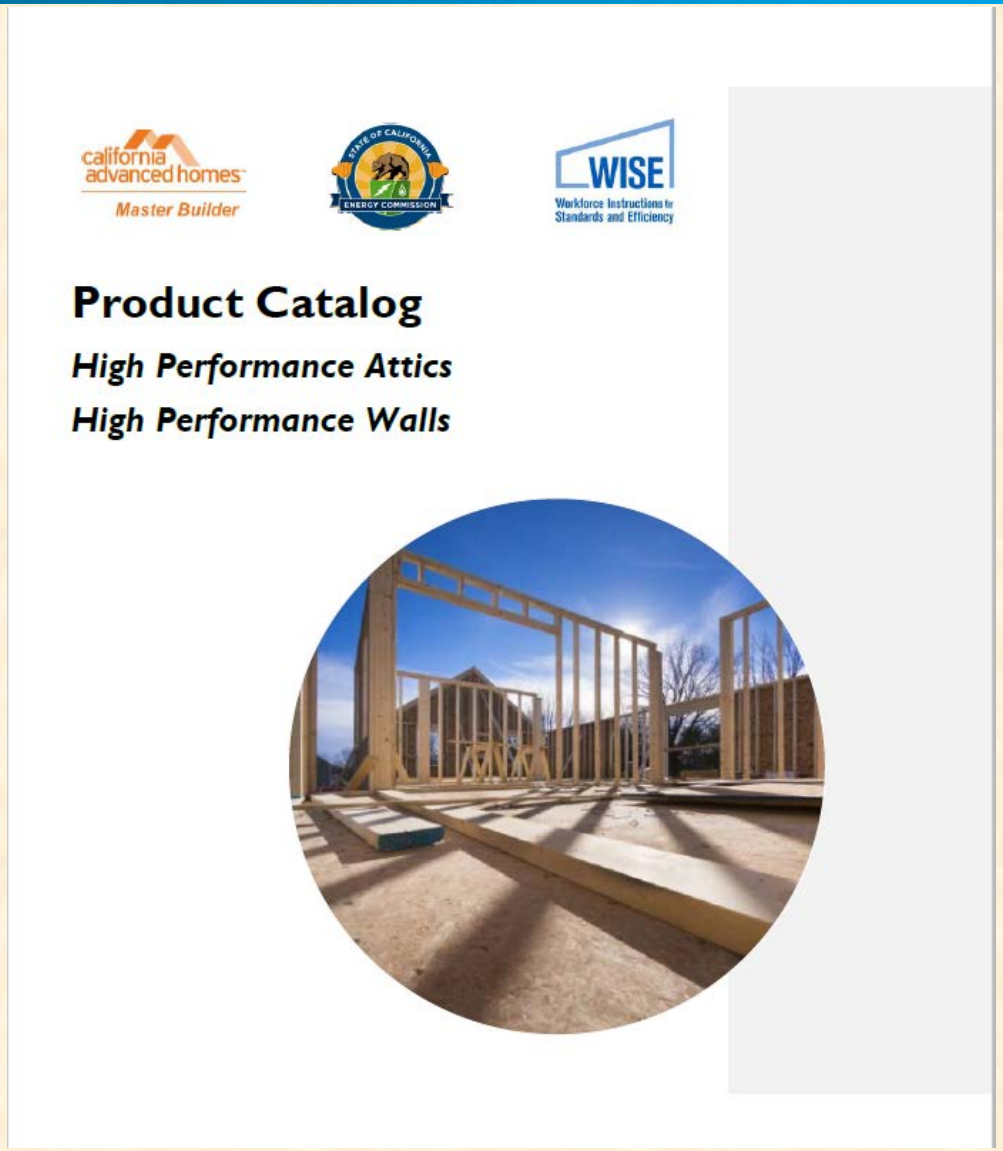
Benefits:

- High insulation, low thermal bridging
- Factory fabricated
- Lower labor costs
- Seismic durability

Challenges:

- Uncommon practice
- Material costs
- Need additional equipment for installation (crane)

Source for some Products



http://www.wisewarehouse.org/

KEY WEB-LINK

2019 Title 24 Utility-Sponsored Stakeholder
http://title24stakeholders.com/

Building Energy Efficiency Program
http://www.energy.ca.gov/title24/

Comments to be submitted to
https://efiling.energy.ca.gov/EComment/EComment.aspx?docketnumber=17-BSTD-01.

Standards Contact Information – Energy Commission

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Title 24
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Questions?