California Energy Commission

CONSULTANT REPORT

Product Specific Guidelines for High Performance Attics & Walls

Workforce Instruction for Standards & Efficiency (WISE)

Prepared for: **California Energy Commission**
Prepared by: **ConSol & TRC Solutions**

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Edmund G. Brown Jr., Governor

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ABSTRACT

This report describes some of the products currently available to create high performance attic and wall assemblies that meet prescriptive energy code requirements for residential new construction in California. Categories of products described in this report include rigid foam sheathing, siding, roofing, fiberglass batt and polyurethane spray foam. Each of these products provide insulating or sealing characteristics that improve the thermal performance of buildings by reducing air movement and/or heat transfer, resulting in reduced household energy use.

Keywords: Energy Efficiency, Title 24, High Performance Attics, High Performance Walls, Residential Construction, Building Envelope, Prescriptive Requirements

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EXECUTIVE SUMMARY

This report describes some of the products currently available to create high performance attic and wall assemblies that meet prescriptive energy code requirements for residential new construction in California. Categories of products described in this report include rigid foam sheathing, siding, roofing, fiberglass batt and polyurethane spray foam. Each of these products provide insulating or sealing characteristics that improve the thermal performance of buildings by reducing air movement and/or heat transfer, resulting in reduced household energy use. Thought the use of these products residential buildings can be designed and constructed in California to meet or exceed current and proposed Title 24 Building Energy Efficiency Standards.

CHAPTER 1: Introduction

1.1 About the Catalog

The Workforce Instruction for Standards and Efficiency (WISE) program team created this catalog to assist builders, architects and energy consultants with planning, designing, and constructing high-performance attics (HPA) and high-performance walls (HPW). This catalog lists products and pre-fabricated assemblies that the building industry can use to comply with Title 24 standards—specifically prescriptive requirements for HPA & HPW. We do not intend for this catalog to be a complete list of available products, and we will add new manufacturers, products, and assemblies periodically as they become available.

1.2 About WISE & Partner Programs

HPA and HPW became prescriptive requirements in California's 2016 Building Energy Efficiency standards on January 1, 2017. These new standards created challenges for the state's homebuilding industry, which has faced a post-recession shortage of skilled labor and has limited experience with construction techniques necessary for code compliance. Funded by the California Energy Commission's Electric Program Investment Charge (EPIC) WISE is designed to help accelerate learning and implementation of high performance building by training workers and providing a platform for the exchange of best practices and solutions from industry experts.

WISE works in collaboration with existing programs that provide HPA and HPW tools & resources, such as the Master Builder component of the California Advanced Homes Program (CAHP). This program recognized early adopters of advanced design and building practice and provided training to builders and cash incentives for constructing high-performance residential envelopes in advance of the effective 2016 code change.

For more information about WISE visit www.wisewarehouse.org. For more information on Master Builder please contact Melissa Buckley at mbuckley@trcsolutions.com.

1.3 Disclaimers

This catalog does not review, nor endorse any product listed. It serves as a reference for builders, architects, and planners when developing new construction projects and considering Title 24 requirements. Information was obtained through conversations with manufacturers' company representatives and a literature review of manufacturer documents. The WISE team does not claim that the information is accurate, and we strongly recommended that builders thoroughly vet listed products before use.

CHAPTER 2: Types of Rigid Foam Insulation

2.1 Expanded Polystyrene Foam

Expanded polystyrene foam (EPS) is the material used for Styrofoam™ cups. It has an R-value of R-4 per inch. To manufacture EPS, polystyrene balls are placed into a mold, and then heat and pressure are applied to expand the balls so they fuse together, producing a smooth surface. EPS provides a good substrate for adhering stucco, and is not moisture resistant. EPS is usually less expensive than other types of foam insulation, and is widely used by California builders.

Many companies manufacture EPS. Builders can find EPS most anywhere building supplies are available, as a number of manufacturers produce EPS. EPS is commonly used for the substrate for one-coat stucco.

2.2 Graphite Polystyrene Foam

Graphite polystyrene foam (GPS) integrates high-purity graphite throughout the EPS polymer matrix (insulation bead). The addition of graphite results in insulation that can provide the same or greater R-value as EPS, but in a thinner product. This makes GPS insulation suitable for use in space-constrained areas and in colder climates. Another benefit is the graphite in GPS insulation enhances the material's R-value as temperatures decrease.

2.3 Extruded Polystyrene Foam

Extruded polystyrene foam (XPS) has an R-value of R-5 per inch. XPS is manufactured when hot polystyrene enters an extruding machine and produces a homogenous closed cell crossed section. Its surface is not as smooth as EPS and may need some sanding before adhering stucco. XPS is moisture resistant, and in the right locations and used in the right way, can be counted as a vapor barrier.

2.4 Polyisocyanurate

Polyisocyanurate, or Polyiso, is a thermoset plastic typically produced as a foam and used as rigid thermal insulation. It has an R-value of R-5-6 per inch, the highest R-value for foam insulation, and also the most expensive. Polyiso must be used with a skin as it needs to adhere to a material. The facing material must be on both sides and can be made of a variety of material, including fiberglass and foil, the latter of which can also serve as a radiant barrier.

Table 1: Rigid Foam Insulation Types

Type	R-value/inch	Permeance (Perms)	Climate Use
Expanded Polystyrene (EPS)	3.2 – 4.4	2.0 – 5.0	All climate, cold climate
Graphite Polystyrene Foam (GPS)	5.0	2.5 - 4	
Extruded Polystyrene (XPS)	4.6 – 5	1.0	All climate, cold climate
Unfaced Polyisocyanurate	6.0	2.8 – 4.5	All climates
Foil Faced Polyisocyanurate	6.5	0.0	All climate, hot humid

CHAPTER 3: High Performance Attic Products and Assemblies

3.1 Above Deck Roofing Products

3.1.1 Green Hybrid Roofing

Green Hybrid Roofing is an insulating foam core roofing material. It is an EPS polystyrene core wrapped with a fiberglass scrim and covered with a 1/8 inch thick cementitious base coat and a 1/16 inch cementitious top coat. It has virtually identical aesthetic characteristics to conventional concrete and clay tiles, but provides better heat and cold temperature insulation than conventional tiles. This roofing material is half the weight of conventional roof tile and five times as durable. When installed using standard roofing components, Hybrid Roofing materials will have an R-value of 7 for the product and R-4 per inch.

This product is currently on the market and is available for installation.

Figure 1: Green Hybrid Roofing

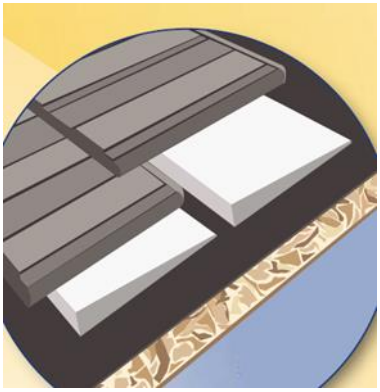
Credit: *http://ensoltisghr.com*

3.1.2 Wedge-It

Wedge-It is a wedge of EPS installed under roof tiles. Wedge-It has an R-value of R-4 per inch, and R-6 for the full product based on a weighted average. This product was originally designed by a roofer to increase the roof's load-bearing capacity, when properly installed under tile roofs it can more than double the load-bearing capacity of that roof. It is installed over the top of the tar paper between battens, no fasteners are required as the roofing tile holds the Wedge-It in place. Wedge-It requires a 1-2 inches clearance between each batten to allow proper water drainage and, therefore, does not provide fully continuous insulation. The CEC has approved Title 24 energy modeling for this product by specifying the weighted area average R-Value (including Wedge-It tiles, battens, and air gaps) as a continuous rigid layer.

This product is currently on the market and is available for installation.

Figure 2: Wedge It



Credit: www.*wedgeit.net*

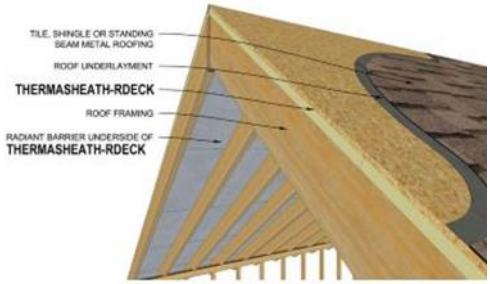
3.1.3 R-Max Nailable Base-3

Rmax Nailable Base-3 is an energy-efficient thermal insulation board composed of a closed-cell polyisocyanurate (polyiso) foam insulation with glass fiber reinforced aluminum facers bonded to 7/16" OSB. Rmax®-Nailable Base-3 is an IECC compliant product and its R-values are listed in the table below. Installed with the OSB to the exterior and the foam against the rafters, the interior surface, exposed to the attic space, is a heavy-duty, embossed 12mil aluminum. Rmax®-Nailable Base-3 is a multi-purpose composite panel that serves as the roof diaphragm and nailable surface in addition to continuous insulation and interior finish.

Figure 3: R-Max Nailable Base-3

Credit: *www.rmax.com*

Figure 4: R-Max Detail



.Credit: *www.rmax.com*

Table 2: Nailable Base 3 Insulation Values

Nominal Thickness (Inches)	Thermal Resistance (°F•ft2 •hr/Btu)	Weight (lbs per 4ft x 8ft)
1.5	6.3	175
2.5	12.0	190
3.5	18.0	210
4.5	24.2	225

3.2 Below Deck Insulation Products

3.2.1 Johns Manville Unfaced Fiberglass Batts

Johns Manville makes a fiberglass batt that can be used to meet the high performance attics requirement. The batts are inserted between the top chords of the roof truss and are wired into place on the underside of the roof deck. The wiring keeps the batts from sagging or falling and creates a layer of insulation below the roofline. The batts come in a number of widths and depths. R-values range from R-11 to R-38 (R-value of R-3.2 per inch).

For the purpose of building high-performance attics, builders have been using 24" wide batts to fit around framing and trusses. The batts are formaldehyde-free, unfaced and provide a level of sound protection. This product is currently on the market and is available for installation.

Figure 5: Johns Manville Unfaced Fiberglass Batts

Credit: www.jm.com

3.2.2 Knauf Insulation EcoBatt® Integrated Rock Deck Insulation (EcoBatt IRD)

For Vented and Unvented Attics

The EcoBatt® Integrated Roof Deck (IRD) utilizes cutting edge installation technique that allows the insulation to exceed the framing depth with no compression ensuring full thermal performance. The insulation is available for both vented and unvented attics:

- Vented attic: R-19 6.25”X24”X48”
- Unvented attic: R-38 12”X24”X48”

A pneumatic or cordless stapler is used to install the 24”X48” IRD fiberglass batts directly underneath the roof deck using six staples per batt in a specified stapling pattern. The full 24” width creates a uniform layer of continuous insulation and provides a thermal break beneath the truss top chord. Both products are currently on the market and available for installation.

Figure 6: EcoBatt Integrated Roof Deck Insulation

Credit: *https://www.probuilder.com/best-pcbc-2017-parade-products*

3.2.3 Spray Foam Insulation

A popular performance path compliance option for residential construction is to incorporate spray polyurethane foam (SPF) on the underside of the roof deck to create an unvented attic. There are many types of spray foam products that are available within the industry. All of these products, open or closed cell, can be used to achieve HPA. Installation and R-values vary by manufacturer.

Figure 7: SPF Insulation Installation

Credit: *http://www.foamguardinsulation.com/spray-foam-insulation/*

3.2.4 Owens Corning Boxed Netting

The Boxed Netting System by Owens Corning is blown in fiberglass held with netting installed on the underside of the roof deck. Builders use Owens Corning's Boxed Netting, in conjunction with Owens Corning's foam sealant and ProPink® EcoTouch® Loosefill blown-in insulation, to create high-performance, unvented attics.

The netting is designed to hang from the truss top chord or rafter and deliver a cavity depth that creates a uniform insulation layer.

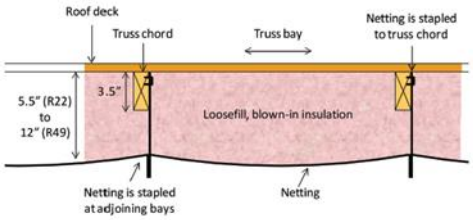
It does this by enveloping the framing members in insulation. It is available in a wide range of R-values (R-22 per 5.5 inches through R-49 per 12 inches), independent of the size of the roof deck framing.

The netting includes an integrated vapor retarder to provide moisture management for California microclimates where moisture is a concern.

Owens Corning has an installation guide describing their high performance attic systems called *PROPINK®High Performance Conditioned Attic System*: http://www2.owenscorning.com/literature/pdfs/HPCA%20Installation%20Instructions.pdf

This product is currently on the market and is available for installation.

Figure 8: Owens Corning Boxed Netting



Credit: *http://www.greenbuildingadvisor.com/articles/dept/musings/can-unvented-roof-assemblies-be-insulated-fiberglass*

CHAPTER 4: High Performance Walls Products and Assemblies

4.1 Wall Assembly Solutions

4.1.1 Owens Corning Wall Products

Owens Corning offers a portfolio of products designed to help builders create high performance walls.

For wall cavities, Owens Corning has ProPink Eco Touch Products, which is a line of pink fiberglass insulation batts and rolls, available in R-values of R-13, R-15, R-19, R-21, R-30 and R-38.

For the exterior of the house, Owens Corning offers the Foamular series, an XPS rigid foam insulation. It is available in a wide variety of sizes and thicknesses, has an R-value of R-5 per inch. It can be used as part of a high performance roof as well.

Owens Corning has a manual describing their recommended wall systems called *Builder's Guide: Owens Corning Residential Complete Wall Systems*: https://www.highperformancebuildingexchange.com/builders-guide-owens-corning-residential-complete-wall-systems

These products are currently on the market and are available for installation.

Figure 9: Owens Corning Fiberglass Insulation

Credit: *http://insulation.owenscorning.com/professionals/insulation*

4.1.2 Johns Manville Wall Products

Johns Manville offers a portfolio of products designed to help builders create high performance walls. The products are chosen to meet builders' budget, skill level, thermal and moisture needs when creating high performance walls.

Wall products available include:

- Blown in mineral wool: R-3.14 per inch
- Fiberglass batts and blown in fiberglass: R-3.14 per inch

- Open cell spray foam: R-3.6 per inch
- Closed cell spray foam: Up to R-7.1 per inch per ASTM C518 testing[1]
- Polyiso insulation board for the outside of the walls: R-6 per inch with product available in 1/10th inch increments.

These products are currently on the market and are available for installation.

Figure 10: Johns Manville Spray Foam Wall Insulation

Credit: *www.jm.com*

4.1.3 Knauf Insulation Wall Products

Knauf Insulation offers a wide variety of thermal and acoustic solutions to create high performance walls. Knauf Insulation offers many varieties of insulation including, JetSpray® Thermal Spray-On Insulation, EcoBatt Insulation and JetStream® Ultra Blowing Wool Insulation. Knauf Insulation also provides an air sealing product, EcoSeal Plus ™ to enhance the performance of the building envelope. Products are available in the following offerings, and are all currently on the market:

- EcoBatt®
    - 2x4 framing: R-11, R-13, R-15
    - 2x6 framing: R-19, R-21, R-23, R-24
- Jet Spray Thermal Spray-On
    - 2x4 framing: R-15
    - 2x6 framing: R-23

1 https://www.icynene.com/sites/default/files/US%20content%20uploads/TDS/ProSeal%20-%20USA%20Technical%20Data%20Sheet%20-%20April%202017%20web.pdf

Figure 11: Knauf Insulation Wall Products

Credit: *www.knaufinsulation.us*

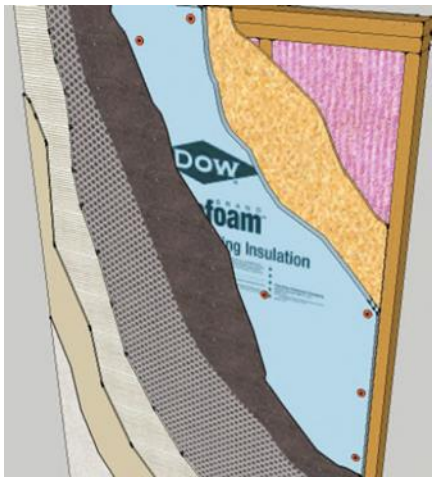
4.1.4 Dow Wall Products

Dow offers a portfolio of products to help builders create high performance walls. They suggest insulating the interior cavity and then adding continuous insulation over the OSB on the outside. Styrofoam™ Brand Residential Sheathing is an XPS foam board with plastic film facers on both sides. It is available in different sizes and R-values, as shown in the table below. Builders can cut the sheathing to any size with a score and a snap, and place it directly over uninsulated studs or over wood panel sheathings such as OSB or plywood. The table below details available sizes.

Table 3: Dow Wall Products Insulation Values

Board Thickness, in	R-value	Board Size, ft	Edge Treatment
.50	3.0	4x8/4x9	Square Edge
.75	4.0	4x8/4x9	Tongue and Groove
1.0	5.0	4x8/4x9	Tongue and Groove

Figure 12: Dow Wall Products



Credit: *http://building.dow.com/en-us/products/styrofoam-brand-residential-sheathing-us-only*

When combined with interior cavity insulation, it can create the following R-values for high performance walls. Listed below are four suggested wall assemblies using Dow Styrofoam and cavity insulation.

Table 4: Dow Styrofoam and Cavity Assembly Insulation Values

Option	Frame	Continuous Insulation	Cavity	U-Value
1	2x4, 16oc	1.5” R-7.5 Styrofoam	R-15	0.051
2	2x4, 16oc	2” R-10 Styrofoam	R-11	0.050
3	2x4, 16oc	.75” R-4 Styrofoam + 1-Coat R4 Stucco	R-15	0.050
4	2x6	1” R-5 Styrofoam	R-19	0.050
5	2x6	1.5” R-7.5 Styrofoam	R-21	0.042

These products are currently on the market and are available for installation.

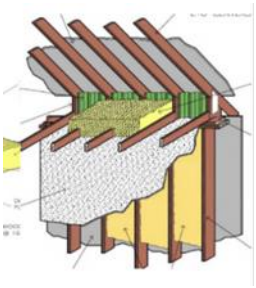
4.1.5 THERMAX by Dow

THERMAX™ Sheathing is a rigid foam insulation that has nominal 1.0 mil, smooth aluminum foil facers on both sides. THERMAX is a polyiso insulation product with R-value shown in the table below. A rigid foam insulation with a Class A fire rating, THERMAX is used in a range of concealed and exposed applications, above and below grade. Used in many applications including walls, crawl spaces, and basements.

Figure 13: Thermax Sheathing

Credit: *http://building.dow.com/en-us/products/thermax-sheathing*

Figure 14: Thermax Sheathing Suggested Assembly



Credit: *http://building.dow.com/en-us/products/thermax-sheathing*

THERMAX's R-value range depends upon its size:

Table 5: Thermax R-Values

Nominal Board Thickness[1], in	R-value[2][3]	Board Size, ft
.50	3.3	4 x 8, 4 x 9, 4 x 10
.75	5.0	4 x 8, 4 x 9, 4 x 10
1.0	6.5	4 x 8, 4 x 9, 4 x 10
1.5	9.8	4 x 8, 4 x 9, 4 x 10
2.0	13.0	4 x 8, 4 x 9, 4 x 10

2 https://static1.squarespace.com/static/57a39be0579fb3a3a8540f56/t/57ed3799cd0f68b48edc696f/1475164074460/Rmax+Thermasheath-RDeck+Data+Sheet

3 http://building.dow.com/en-us/products/the rmax-sheathing

This product is currently on the market and is available for installation.

4.1.6 BASF HP+ ™Wall System

BASF HP+ Wall Systems are available in multiple assemblies, each engineered meet individual needs. The systems feature high-performance, easy to build assemblies that combine proven BASF products such as WALLTITE® high-performance insulating air barrier material, NEOPOR® a graphite-enhanced rigid thermal foam insulation, or ENERSHIELD® a water-based, fluid-applied, vapor permeable or impermeable air/water-resistive barrier. These purpose-built assemblies deliver you exceptional control of heat, air and moisture. The BASF HP+ Wall System will increase the strength in your structures, build a better barrier, improve quality and achieve an R-38 wall assembly with 2x4 framing.

Figure 15: BASF HP+TM Wall System

Credit: *http://www2.basfconstruction.us/HPwallsystem*

4.1.7 Thermal Buck

Thermal Buck™ solves multiple problems encountered when using exterior insulation. It extends the mounting point of the windows and doors and allows for direct structural attachment. Dimensionally stable and strong, ThermalBuck™ prevents compression of rigid insulation and helps to maintain the integrity of the window installation. ThermalBuck™ is a part of a continuous insulation solution.

Figure 16: Thermal Buck

Credit: *http://thermalbuck.com*

4.2 External Rigid Insulation

4.2.1 C-SIS Sheathing System

Composite Structural Insulated Sheathing, or C-SIS, is a closed cell polyurethane insulation. Offered as an alternative to plywood or OSB sheathing, it has a fiberglass reinforced thermoset (FRT) composite skin that provides water-resistant vapor and air barriers, as well as a structural sheathing. Manufactured without adhesives, C-SIS Sheathing's FRT skin is bonded by a chemical reaction to the polyurethane foam insulation during manufacturing so the risk of delamination is eliminated. Two product lines are available:

- 1-1/8″ thick has an R-value of R-6 per inch
- 2-1/8″ thick has an R-value of R-12 per inch

This product is currently on the market and is available for installation.

Figure 17: C-SIS Sheathing

Credit: *compositepanelbuildingsystems.com*

4.2.2 Insulfoam Continuous Insulated Panel

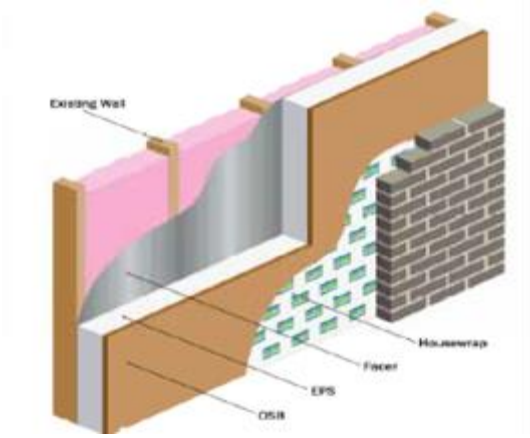
Insulfoam's Continuous Insulated Panel (CI Panel) by Carlisle Construction Material Company, is EPS or GPS insulation *and* an OSB for cladding attachment. Combining continuous insulation and nail base sheathing, it installs over stick framing.

The 2" panels work for new construction and retrofits, and have an R-value of 7.8 (3.9 per inch). OSB or plywood is laminated to the foam, allowing builders to install one product instead of two, and providing a suitable substrate for cladding attachment.

CI Panels install with a standard nail gun (using min. 3" nails), no additional tools are required. Builders can hang siding and house wrap/weather barriers directly on standard 4' x 8' Panels. The CI Panels add structural shear capacity and multiple substrates are available including plywood, gypsum, T1-11 and more. The CI panels will also help meet the desired house air tightness.

This product is currently on the market and is available for installation. See video showing how window products are attached:
https://www.youtube.com/watch?v=v7mGE-KnKoQ

Figure 18: Insulfoam's Continuous Insulated Panel



Credit: *http://insulfoam.com/insulwall-wall-insulation*

4.2.3 Huber Engineered Woods' Zip System R-Sheathing

Huber Engineered Woods' Zip System R-Sheathing is an all-in-one sheathing panel that has thermal, air and moisture resistance— replacing individual sheathing, insulation, and house wrap. It has a continuous Polyiso foam insulation layer with an engineering wood. The panels arrive assembled already to size. The product is approved by the manufacturer for use under stucco and has been requested by builders because of its humidity protection. The Zip System can be used with the construction of 2x4 walls, as well as 2x6. Sizes available are listed below.

Table 6: Zip System R-Values

Components	R-value
½" insulation + 7/16" engineered wood	R-3.6
1" insulation + 7/16" engineered wood	R-6.1

Note: R-Sheathing is currently approved for CA earthquake zones A, B and C. However, Huber is working to get R-Sheathing approved for all of California's zones.

This product is currently on the market and is available for installation.

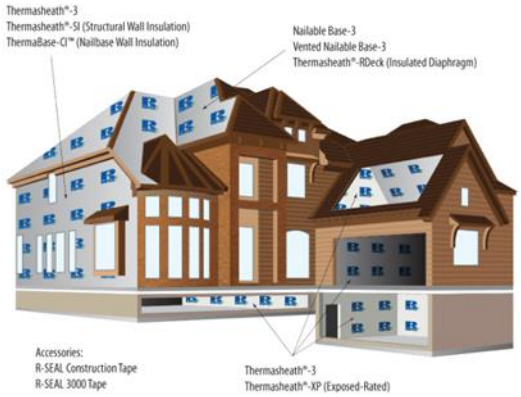
Figure 19: Zip System

Credit: *http://www.huberwood.com/zipsystem/products/zip-system-rsheathing*

4.2.4 R-Max

R-Max has been creating insulation solutions based on the latest building science since 1978. They have a full line of high-quality, polyiso-based wall insulation products for residential application that deliver maximum R-values and minimum environmental impact. Rmax Durasheath^{R} – 3, a building envelope insulation, is intended for use on exterior walls that use a stucco veneer. For a full list of wall, roof and foundation solutions and thermal values visit their website.

Figure 20: R-Max Residential



Credit: *http://www.rmax.com/residential-wall-applications*

4.2.5 ThermaCork

ThermaCork is a cork product that builders use as both insulation and an all-in-one wood siding. The latter is achieved by adding a denser version of ThermaCork to the outside of the house. ThermaCork has an R-value of 4.2 per inch and is a natural and renewable material. The industrial process is 100% natural, requiring no additives or any kind of treatment.

Cork is stable and can cope with major thermal variations, between (-) 292 °F to (+) 248 °F. It is hypoallergenic and free of all domestic toxins, and helps to prevent mold by its ability to dry through layers. Its thermal resistance does not decrease over time. It has excellent sound isolation, is dimensionally stable, and resistant to compression. ThermaCork can be cut to size at the factory and is available in a range of sizes, from 1/2" to 12" and has an R-value of 4.2 per inch.

This product is currently on the market and is available for installation.

Figure 21: ThermaCork insulation Plus Siding

Credit: *www.thermacork.com*

4.3 Insulated Cladding Products

4.3.1 HardiPlank Lap Siding with Insulation

HardiPlank Lap Siding with Insulation is an exterior siding that has built-in foam EPS insulation. It is available in 8.25 inch-width elect Cedarmill, and has an R-value of R-3. A product with increased insulation and an R-value of R-5 is due out in spring, 2016. James Hardie does support the use of its exterior siding products installed over rigid foam insulation.

Two products are designed to match different climate zones:

- HZ 10 is for areas of the country where it does not freeze often. It is commercially available now, and was tested extensively in Texas.
- HZ 5 is for areas that are subject to freezing on a continual basis and is not yet on the market.

Lap Siding with Insulation helps to diminish outside noise, enhances strength and impact resistance, reduces appearance of minor framing imperfections, and is faster

and easier to install. The added insulation allows the installer to stack the planks during installation. The stacking method can be accomplished by one installer instead of two.

The R-3 product is currently on the market and available for installation, and the R-5 product is coming soon.

Figure 22: Hardi Plank Lap Siding with Insulation

Credit: *http://www.jameshardie.com/JamesHardieMainSite/media/Products-Catalog/HS14156_FoamBacker_SS_*

4.3.2 Crane Insulated Siding by AXIALL

Crane Insulated Siding is a vinyl siding product line with an EPS back. The EPS is Neopour which they call a GPS, Graphite Polystyrene. See table below for R-values. Crane products are made by Royal Building Products who is owned by AXIALL. This product has been available 20 years and they have over 100,000 installations in the US.

There are four different products to cover vertical and horizontal styles and they have different size exposures and 27 color options. Crane offers an accessory package that goes with the product that includes: corners, window surrounds, soffits, and more.

Figure 23: Crane Insulated Siding

Credit: *http://www.exteriorportfolio.com/our-products/insulated-siding*

The product comes with a lifetime warranty. 100% material and labor warranty on the life of the home. Four products are available:

Table 7: Crane Insulated Siding Insulation Values

Product	R-value
Craneboard Board & Batten	R-Value of 2.5
Craneboard 6	R-Value of 2.5
Craneboard 7	R-Value of 2.5
Oracle 4.5” shiplap	R-Value of 3

This product is currently on the market and available for installation.

4.3.3 U-Stucco

U-Stucco is one coat stucco with insulating properties. It is a light-weight, ready-to-use powder mix which is blended with water to provide fire resistance, thermal insulation (R-value of R-2.2 per inch), water insulation, and sound insulation to buildings with one single coat. It can be applied up to 1” thickness at a time. It is not typically applied over rigid foam insulation because R-values are built into the product.

U-Stucco features the following specifications:

- Class 1 non-flammable material
- Made of breathable materials, which prevents mold
- Can be used in both new construction and renovation projects
- Can be used inside or outside
- Can be applied on various substrates including OSB and plywood
- 700% lighter than conventional 3 coat stucco
- Made of 99% inorganic and recycled materials

This product is currently on the market and available for installation.

Figure 24: U-Stucco

Credit: *www.ustucco.com*

4.4 SIPS

4.4.1 Insulfoam's Structurally Insulated Panel

Insulfoam's Structural Insulated Pane Premier (SIP) consists of an insulating EPS foam core laminated between two sheets of oriented strand board (OSB) using a structural adhesive. R-values are shown in the table below. This system provides a strong building panel that needs no additional frame or skeleton for support. Premier's large, pre-fabricated SIPs make the framing process faster than other building methods and enable a more airtight, well insulated building for high energy efficiency. Premier SIPs are rigorously tested to meet and exceed building code standards and energy efficiency requirements, helping them achieve some of the highest insulation/R-values (and load capacities) in the SIPs industry. They are cut to size in the factory and then trucked to the location.

Figure 25: Insulfoam's Structurally Insulated Panel

Credit: *http://premiersips.com/wp-content/uploads/2014/05/PSIPS_MasterBroch_10-2012_lo.pdf*

Table 8: Insulfoam's Insulation Values

Core Thickness	SIPs R-value @ 75"	SIPs R-value @ 40"	SIPs R-value @ 25"
3-½"	15	16	17
5 ½"	23	25	26
7-¼	30	32	33
9-¼	37	40	42
11-¼	45	49	51

This product is currently on the market and available for installation.

4.5 Exterior Insulation Finish System (EIFS)

The International Building Code and ASTM International defines an Exterior Insulation and Finish System (EIFS) as a non-load bearing, exterior wall cladding system that consists of an insulation board attached either adhesively or mechanically, or both, to the substrate; an integrally reinforced base coat; and a textured protective finish coat.

An EIFS typically consists of the following components:

- An optional water-resistive barrier (WRB) that covers the substrate.
- Has a drainage plane between the WRB and the insulation board that is most commonly achieved with vertical ribbons of adhesive applied over the WRB.
- Insulation board typically made from expanded polystyrene (EPS), but can also be XPS, GPS, or polyisocyanurate.
- An insulation board is attached with an adhesive or mechanically to the substrate.
- Glass-fiber reinforcing mesh embedded in the base coat.
- A water-resistant base coat that is applied on top of the insulation to serve as a weather barrier.
- A finish coat that typically uses colorfast and crack-resistant acrylic co-polymer technology.

4.5.1 Dryvit

Dryvit is an exterior insulation and finish system (EIFS) product. It combines both continuous insulation (CI) and design-flexible aesthetics into a single exterior wall system, called “Outsulation.” Dryvit Systems, Inc. provides all components of the Outsulation System from ‘flashing to finish’ and the Outsulation System components are installed by a single sub-contractor.

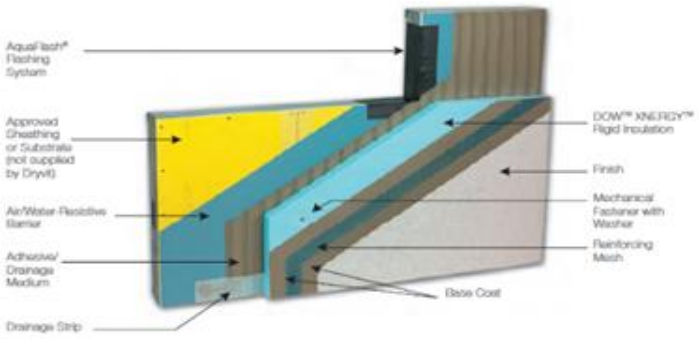
Figure 26: Dryvit

Credit: *http://www.dryvit.com*

Dryvit’s insulation is available in EPS with an R-value of R-4 per inch, or XPS with an R-value of R-5 per inch. It comes in varying levels of insulation that are achieved by increasing the amount of EPS or XPS in each system. The product arrives as one piece. Dryvit can be special ordered, allowing builders to choose between different exterior

finishes. The continuous insulation (CI) component of the Outsulation Systems can be shaped, cut, and grooved to create multiple and diverse architectural styles. Using acrylic copolymer, UV resistant, and hydrophobic chemistry, a Dryvit finish can provide a variety of high performance characteristics with the appearance of stucco, limestone, granite, brick, and metal.

Figure 27: Dryvit Schematic



Credit: *http://www.dryvit.com*

This product is currently on the market and available for installation.

4.5.2 One Coat Stucco

One Coat Stucco is an exterior wall treatment for residential, commercial, institutional or industrial buildings. One Coat Stucco consists of a blend of Portland cement, sand, fibers and special chemicals. One Coat Stucco provides design flexibility, durability, water management, versatility as well as cost savings and it can be finished in a variety of ways including premixed colored cement stucco finish coats, elastomeric coatings, and paints or even acrylic textured finishes.

Figure 28: Finished Stucco

Credit: *https://www.biggerpockets.com/renewsblog/arizona-market/*

The individual products are pre-blended at the manufacturer's facility. The only additional materials that need to be added to the base are sand and water. The base coat is applied in a single application (combining the scratch and brown coat) to a minimum

thickness of 3/8-inch (9.5 mm), unless otherwise noted. The maximum thickness, including the finish coat, is 1/2-inch (12.7 mm). Thickness around penetrations, such as doors and windows is a nominal 3/8-inch (9.5 mm), backed by framing and blocking. The base coat is applied over lath and over flashing or weather-resistive systems.

This system can be hand troweled or machine sprayed to almost any common weather-protected wall substrate including foam plastic sheathing, insulation foam, exterior grade gypsum sheathing, glass mat-faced sheathing, fiberboard sheathing, asphalt impregnated sheathing, plywood or OSB exterior sheathing. It can also be used over masonry and brick without lath reinforcements. Each manufacturer has code approval through their individual evaluation reports.

There are a wide variety of one coat stucco systems available on the market today. The R-Value of the one coat stucco wall assembly depends upon the type and width of the insulation specified in the system. Please discuss with your preferred stucco installer. Listed below are some of the prominent one coat stucco manufacturers:

- Merlex Stucco
- Eagle Building Materials
- Kwik Kote
- Omega Products International
- CEMCO

4.6 Insulated House Wrap

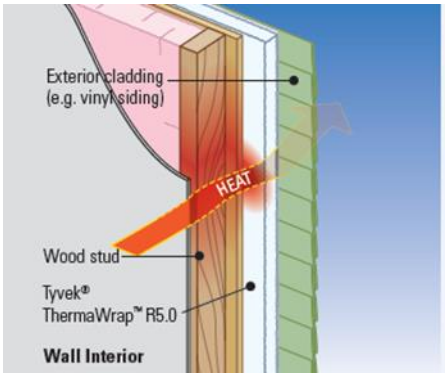
4.6.1 DuPont™ Tyvek® ThermaWrap® R5.0

DuPont's™ Tyvek® ThermaWrap® R5.0 is a house wrap product that has insulation built in. ThermaWrap R5.0 uses a blanket insulation made of polyester and polyolefin fibers and has a thickness of 1.5 inches. It has an R-value of R-5 and provides breathable air, water, and thermal protection in one product. The structure of Tyvek ThermaWrap allows any moisture that may get inside the wall to dry and escape to the outside, helping to prevent the accumulation of water in the wall.

DuPont™ Tyvek® ThermaWrap® R5.0 is a breathable alternative to other exterior insulation products, like XPS, EPS, and Polyisocyanurate foam exterior insulation.

This product is currently on the market and available for installation.

Figure 29: Tyvek ThermaWrap



Credit: *www.dupont.com*

APPENDIX A: PRODUCT AND MANUFACTURER RESOURCE LISTING

Product	Manufacturer	Website
Green Hybrid Roofing	Green Hybrid Roofing	ensoltisghr.com
Residential	R-Max	www.rmax.com
Wedge-It	Wedge-It	www.gowedge.com/about.htm
Thermax and Thermax Sheathing	Dow	building.dow.com/en-us
Unfaced Fiberglass Batts	Johns Manville	www.jm.com/en/building-materials/building-insulation/commercial-residentialbuildinginsulation/unfaced-batts-androlls
Boxed Netting	Owens Corning	www.owenscorning.com
Wall Products	Owens Corning	www.owenscorning.com
Wall Products	Johns Manville	www.jm.com/en/building-materials/building-insulation
Roof and Wall	Knauf Insulation	www.knaufinsulation.us info.us@knaufinsulation.com
C-SIS Sheathing System	Composite Panel Building Systems	compositepanelbuildingsystems.com
Continuous Insulated Panel	Insulfoam	insulfoam.com/insulwall-wall-insulation
NeoPor Continuous Insulation Sheathing	BASF	www.neopor.basf.us
R Sheathing Huber Engineered Woods	Zip System	www.huberwood.com/zipsystem/products/zip-system-rsheathing
ThermaCork	ThermaCork	www.thermacork.com
Block-It House Wrap	Kimberly-Clark	www.kimberly-clarkbuildingmaterials.com
Tyvek ThermaWrap R5.0	DuPont	www.dupont.com
Dryvit	Dryvit	www.dryvit.com
Lap Siding with Insulation	HardiPlank	www.jameshardie.com
U-Stucco	U-Stucco	www.ustucco.com