The Environmental and Economic Benefits of Cool Roofs and Walls

Building Green with Metal

By the end of this presentation you will know how metal roofs and walls can:

- **Reduce** energy consumption in buildings
- **Improve** air quality and thermal comfort
- Help **comply** with energy codes
- **Reduce** environmental impacts
- **Contribute** to LEED® points

Building Green with Metal

Presentation Content:

- Building Green
- Energy Consumption
- Cool Metal Roofing
- Cool Metal Walls
- Insulated Metal Panels
- Environmental Impact

Building Green

Practice of increasing the **efficiency of buildings** through their use of energy, water and materials.

Why Build Green?

- **Helps** the environment
- **Promotes** health among occupants
- **Improves** worker satisfaction and productivity
- **Requires** less maintenance
- **Reduces** short and long term costs

- **In 2004, approx. 2%** of non-residential construction starts incorporated sustainable building design.
- **By 2010, 5-10%** of non-res construction starts will incorporate sustainable building.

(Source: McGraw Hill Construction)

BUILDING GREEN

40% of today's building owners, architects, engineers and contractors report **involvement** with sustainable building.

(Source: McGraw Hill Construction)

Energy Consumption

Energy Consumption

The USA's 2-5-25 Conundrum

- **2%** of the world's resources
- **5%** of the world's population
- Using **25%** of the world's energy

Energy Consumption

- U.S. energy consumption expected to **grow 1.1% annually**
- **By 2030,** nation's electricity demands will **be 45% greater** than today

Energy Consumption

To meet forecasted 45% increase in **demand** by 2030, using the current fuel mix, the US will **need to construct:**

50 nuclear plants	(1000 MW)
260 coal-fired plants	(600 MW)
280 natural gas-fired plants	(400 MW)
90 renewable energy plants	(100 MW)

(Source: Nuclear Energy Institute)

Energy Consumption

"The cheapest , most reliable source of new energy is saved energy."

Peter Turnbull, PG&E

Energy Consumption

Buildings responsible for:

- 39% of nation's energy consumption
- 71% of nation's **electricity consumption**

Energy Consumption

How can metal help conserve energy?

- **"Cool"** metal panels for roofs and/or walls
- **Insulated** metal panels for walls and/or roofs

Energy Consumption

- Roof can be **least** energy efficient building envelope component.
- Energy efficient roofing makes **environmental** and **economic** sense.
- Heating/cooling **major** expense in building operation.

Cool Metal Roofing

Cool Roofing

Cool roofing gaining in popularity because it can:

- **Reduce** cooling **energy usage**.
- Help **reduce** peak **demand** during summer.
- Help **mitigate** "urban **heat island** effect."

Principles of Cool Roofing

Roof Categories

- **Low Slope**

  Used on roof pitches from 1/4:12 to 2:12

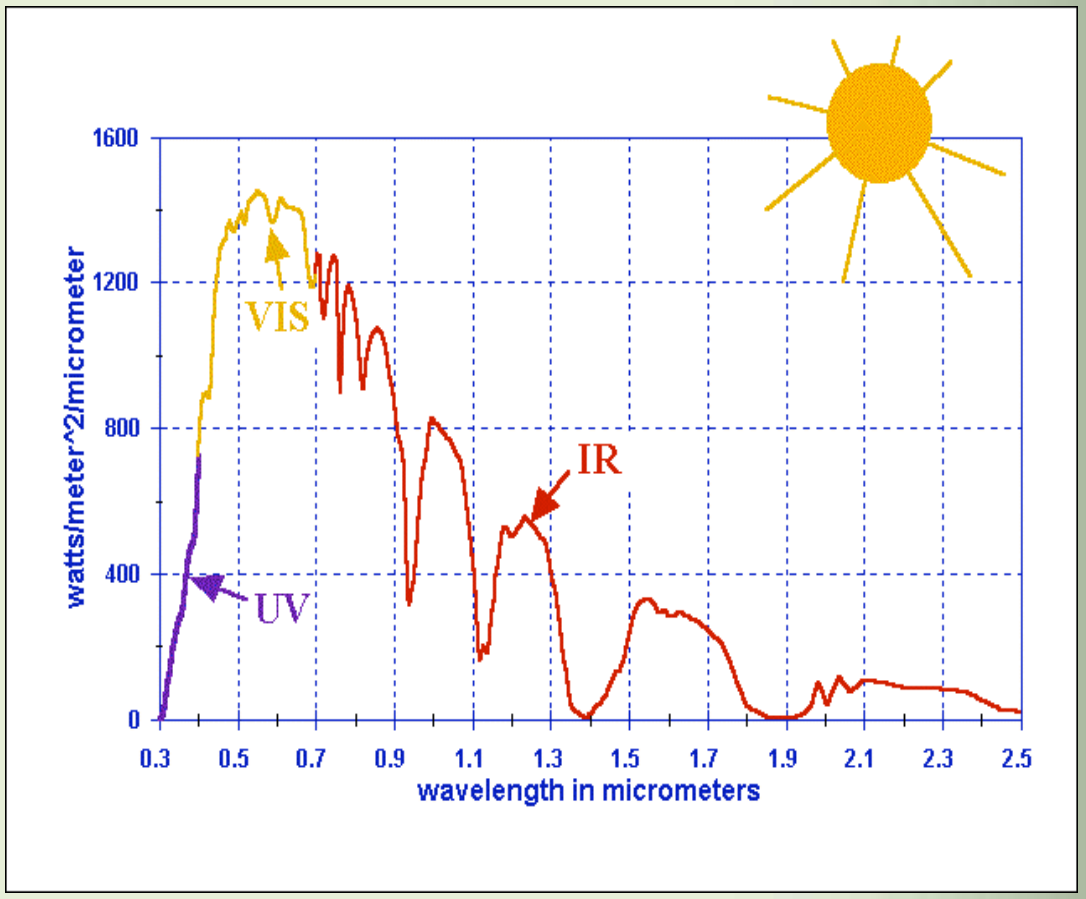
Roof Categories

- **Steep Slope**

  Used on roof pitches of 2:12 or greater

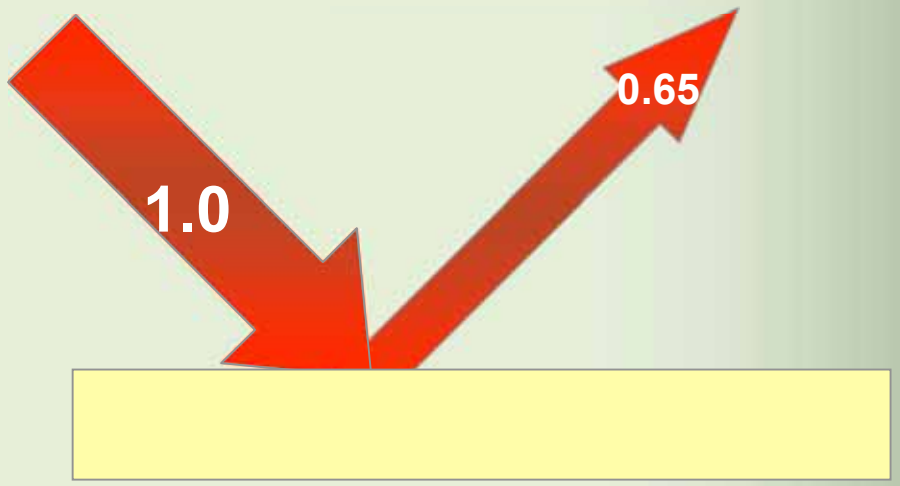
Solar Energy Spectrum

- **Ultraviolet (UV)**
  - Only 3% of total energy striking earth's surface
- **Visible (VIS)**
  - 40% of total energy
  - Visible light
- **Infrared (IR)**
  - 57% of total energy
  - Felt as heat



Solar Reflectance

- Percent of solar radiation **immediately** reflected from a surface.
- Expressed as decimal (0.65).
- Reflectance of painted metal depends on color and pigmentation.

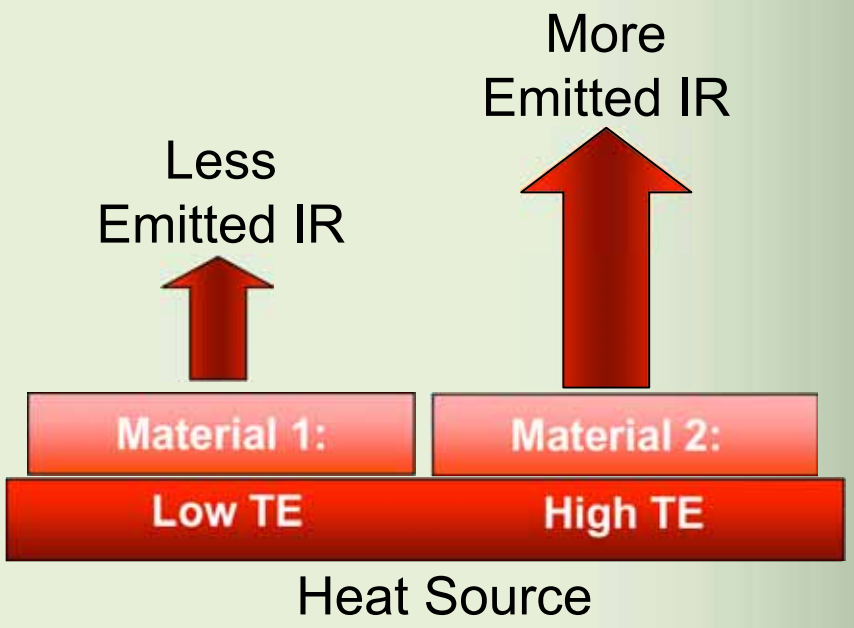


Solar Reflectance

- Any solar energy **not reflected is absorbed** by the material, causing it to heat.
  - Some heat **removed** by air flow over surface
  - Some heat **conducted** through surface
  - Some heat **emitted** as thermal infrared (IR) energy to night air

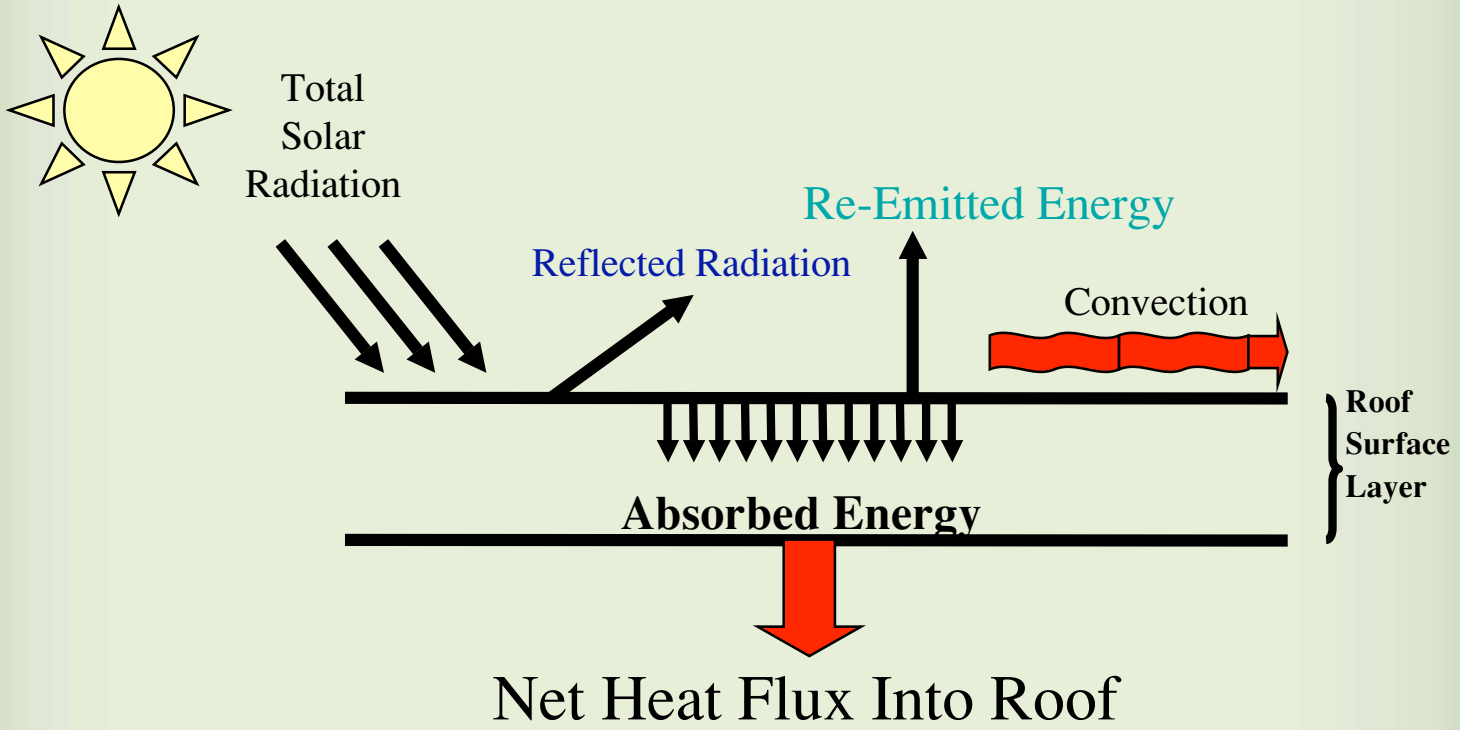
Thermal Emittance

- Percent of absorbed heat **emitted** from the surface to the night air.
- Expressed as decimal (0.90).
- Materials with high thermal emittance cool down faster than those with low thermal emittance.



Cool Roofing

Combination of solar reflectance and thermal emittance **determines** surface temperature of a roof and its **ability to be "cool."**



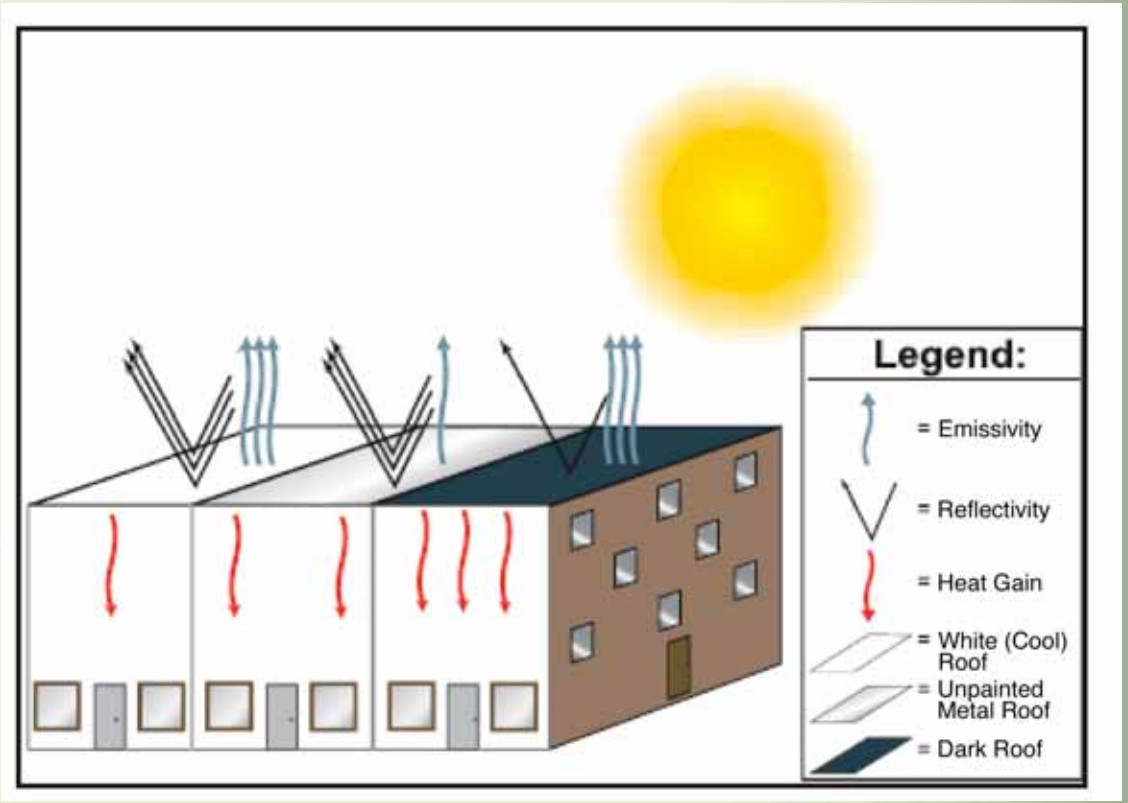
Metal Roofing Properties

	Solar Reflectance	Thermal Emittance
Metal (unpainted)	0.60 – 0.80	0.10
Metal (painted)	0.10 – 0.75*	0.80+

*Depending on color and pigment.
(Thermal emittance independent of color.)

Cool Metal Roofing

Roofs that are highly reflective and highly emissive, such as **prepainted metal**, offer a roof system that **significantly reduces** heat gain into the building.



Rule of Thumb

- For every 1% increment in roof reflectance, **surface temp decreases 1° F**.
- For every 10% increase in roof reflectance, **heating/cooling costs drop 2¢/sq ft per year.***

Source: Lawrence Berkeley National Lab
(*Depends on location and utility rates)

Added Benefits

- **Enhanced aesthetics**
  - Lower roof temp **increases** color stability of metal roof.
- **Increased durability**
  - Lower roof temp **decreases** thermal expansion/ contraction.

Impact of Color

- Dark colors **absorb** more heat than light colors.
- Light colors **reflect** more heat than dark colors.
- **Suggests** color is indication of reflectivity.

Paints and Pigments

- New infrared reflective pigments allow **darker** colors to **reflect more solar energy** than ever.
- Special pigments **do not affect color** of prepainted metal roofs.

Case Study

Case Study

Bessie L. Baggett Elementary
Dallas, GA

Lillian C. Poole Elementary
Powder Springs, GA

- Electric HVAC with gas-fired heating
- Thermostats **controlled at district office**
- Each with 90,000-square-foot footprint
- Each with Hunter Green metal roof

Case Study

Roof Construction:

- R-15 blanket insulation over purlins
- R-19 batt insulation at ceiling level

Baggett: Standard metal roof with **12%** solar reflectance
Poole: Cool metal roof with **29%** solar reflectance

- **Identical schools except for the roof!**

(Both schools constructed in 2003)

Case Study

Energy Costs (2007)	Baggett **(Std)**	Poole **(Cool)**
Annual Electric	$88,352	$78,045
Annual Gas	$24,989	$20,800
	$113,341	**$98,845**

Case Study

2003 Savings:
(1st year of operation)
$8,054 or 9.6%
compared to Baggett

2007 Savings:
(4th year of operation)
$14,496 or 12.8%
compared to Baggett

Savings are **more than keeping pace** with escalation of energy costs in region.

Research Studies

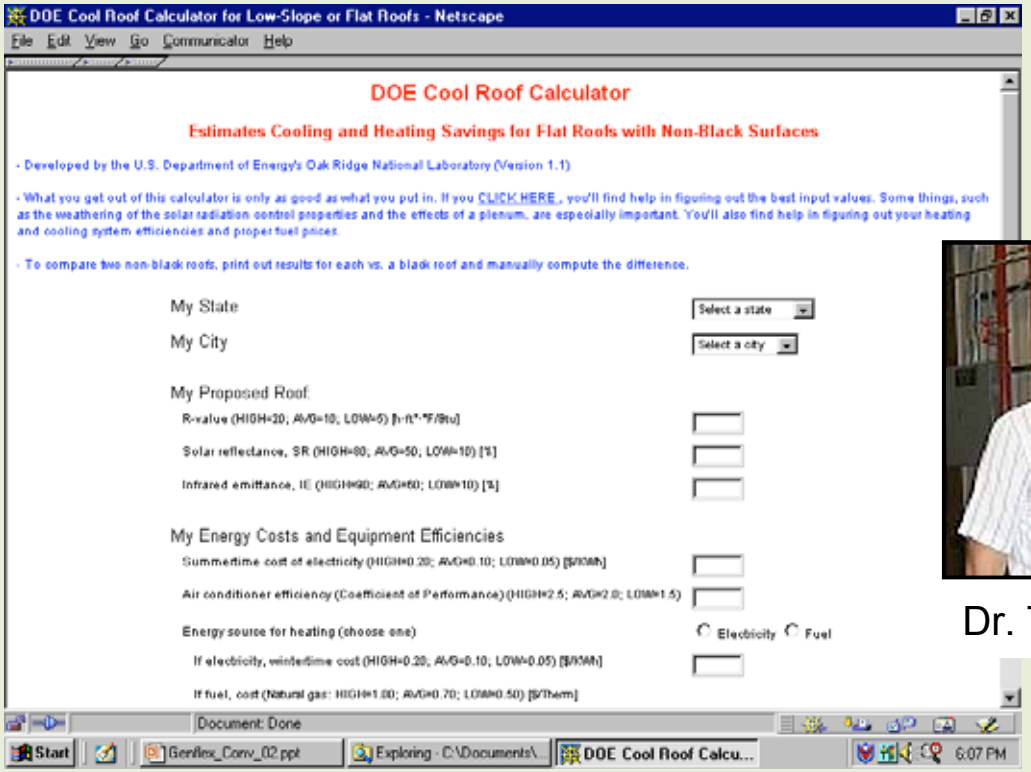
Oak Ridge National Laboratory
(A Department of Energy Facility)

Oak Ridge Research

- Continuous weathering of roofs **over 3 years**
- Installed in low and steep slope orientations

Oak Ridge Research

- Used to develop building energy savings **calculator** for low and steep slope roofs.

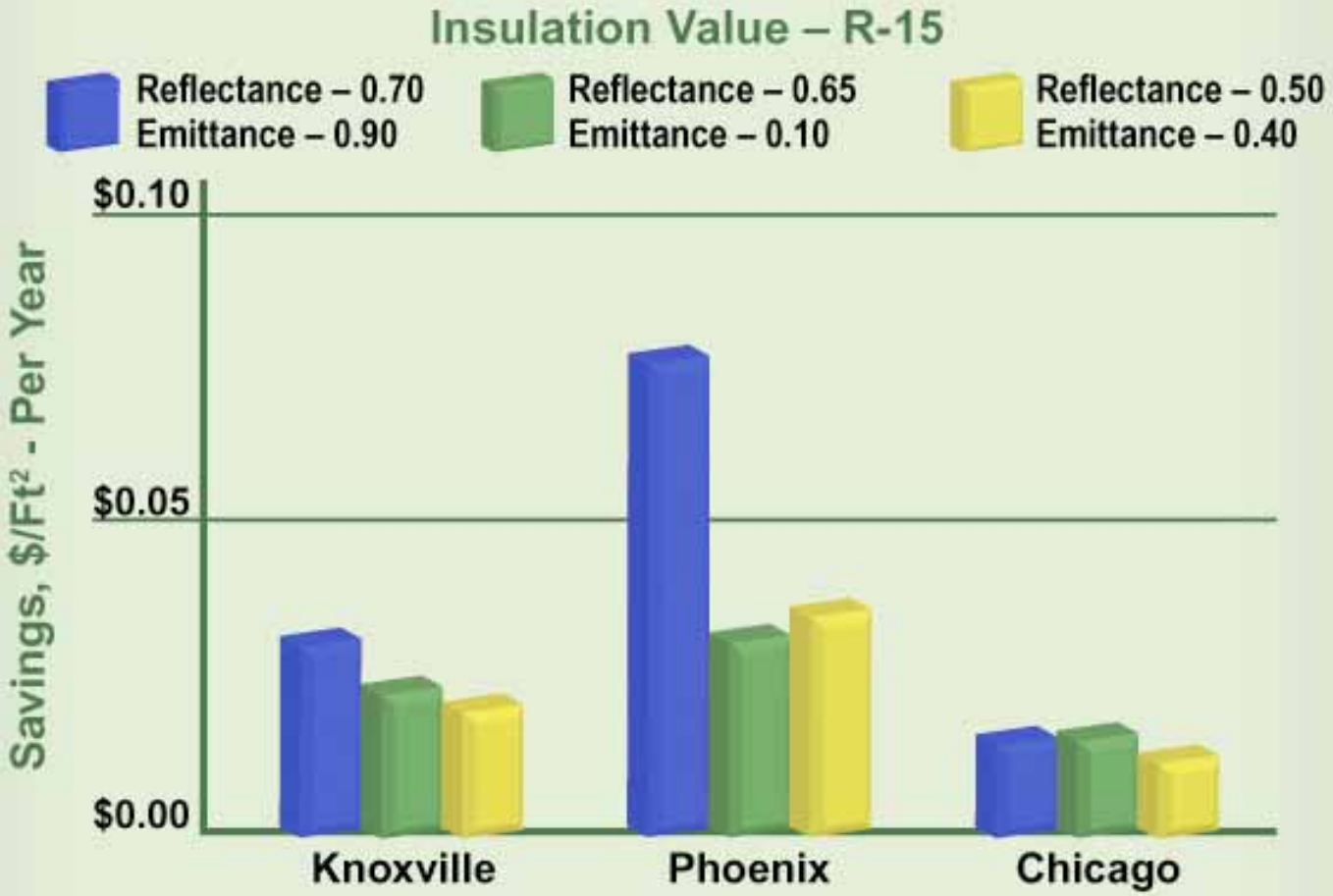


Dr. Tom Petrie

www.eren.doe.gov/buildings

Energy Savings

- Sample cooling and heating energy savings for three cities using three different roof systems.



Oak Ridge Research

- Compared metal roofing to other roofing materials in terms of **degradation** of solar reflectance.

- Important because **some codes assume** reflectivity of all roof materials **degrades at same rate**.

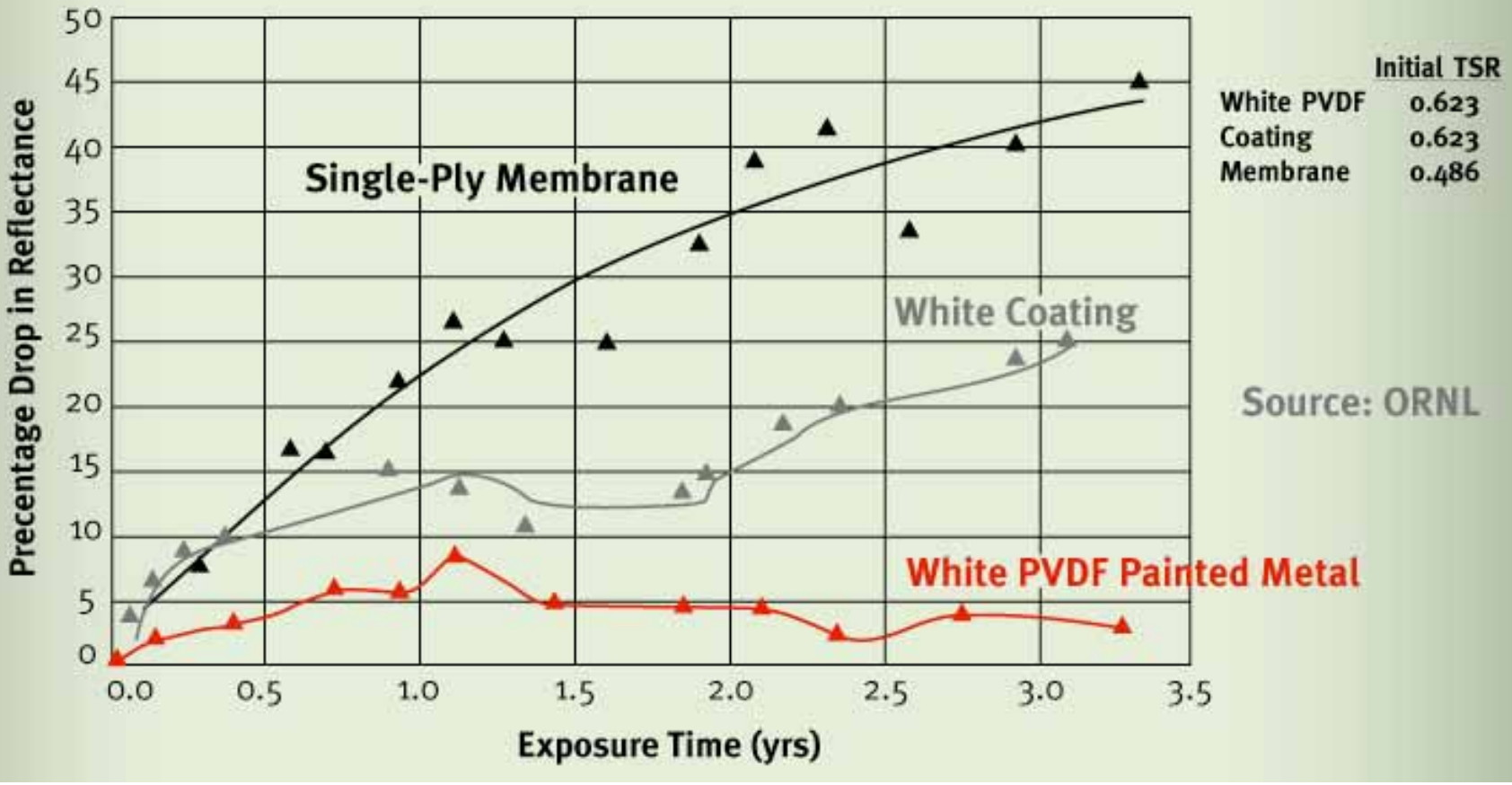
- ORNL data suggests this is not the case.

OAK RIDGE National Laboratory

Oak Ridge Research

Finding:

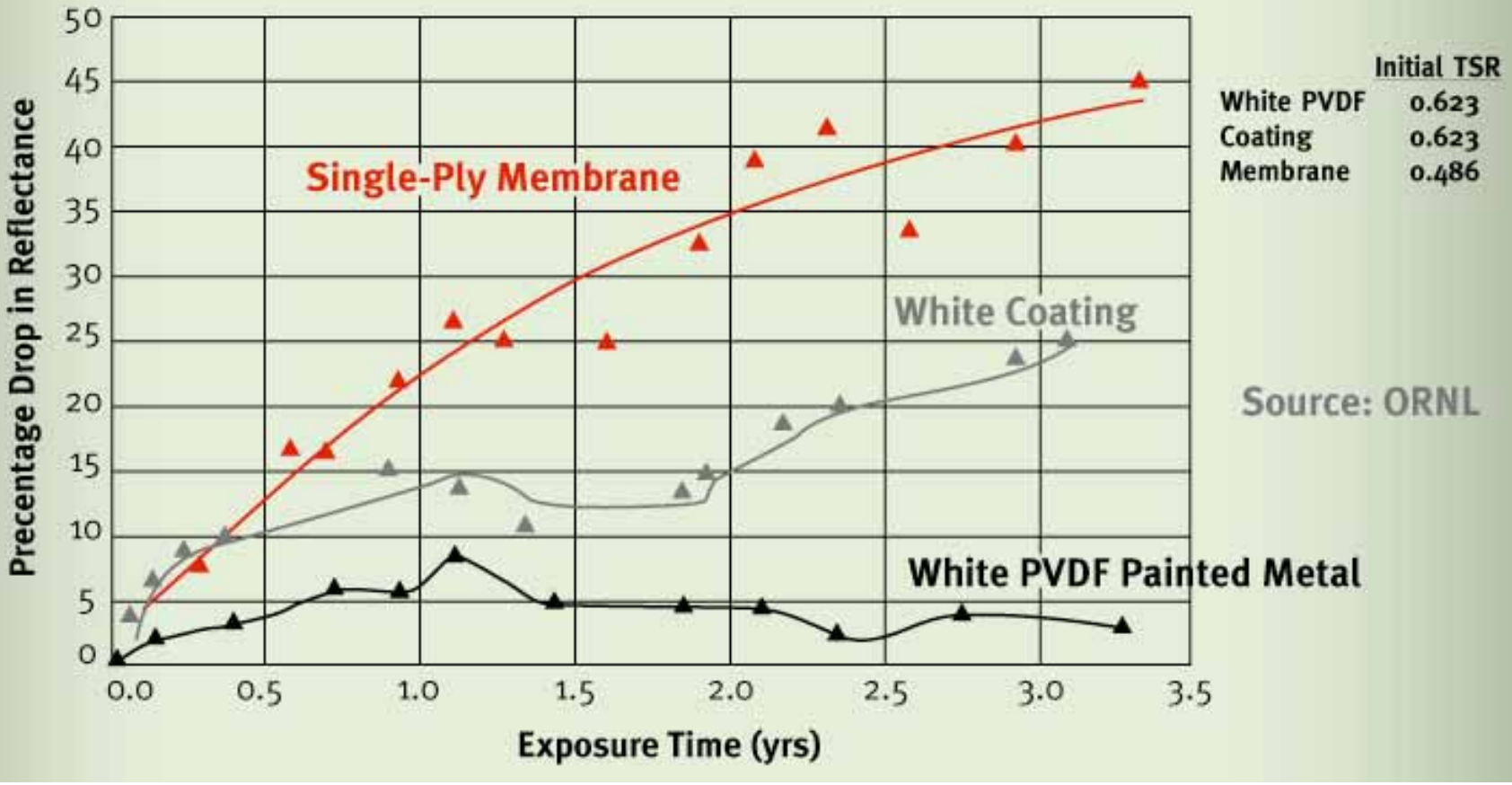
- Prepainted **metal** roofing **retained 95%** of its initial solar reflectance **over time**.



Oak Ridge Research

Finding:

- Some **membrane** products **lost 40%** of their solar reflectance **after only 3 years** due to dirt retention.
- Metal roofs shed dirt more readily than other materials.



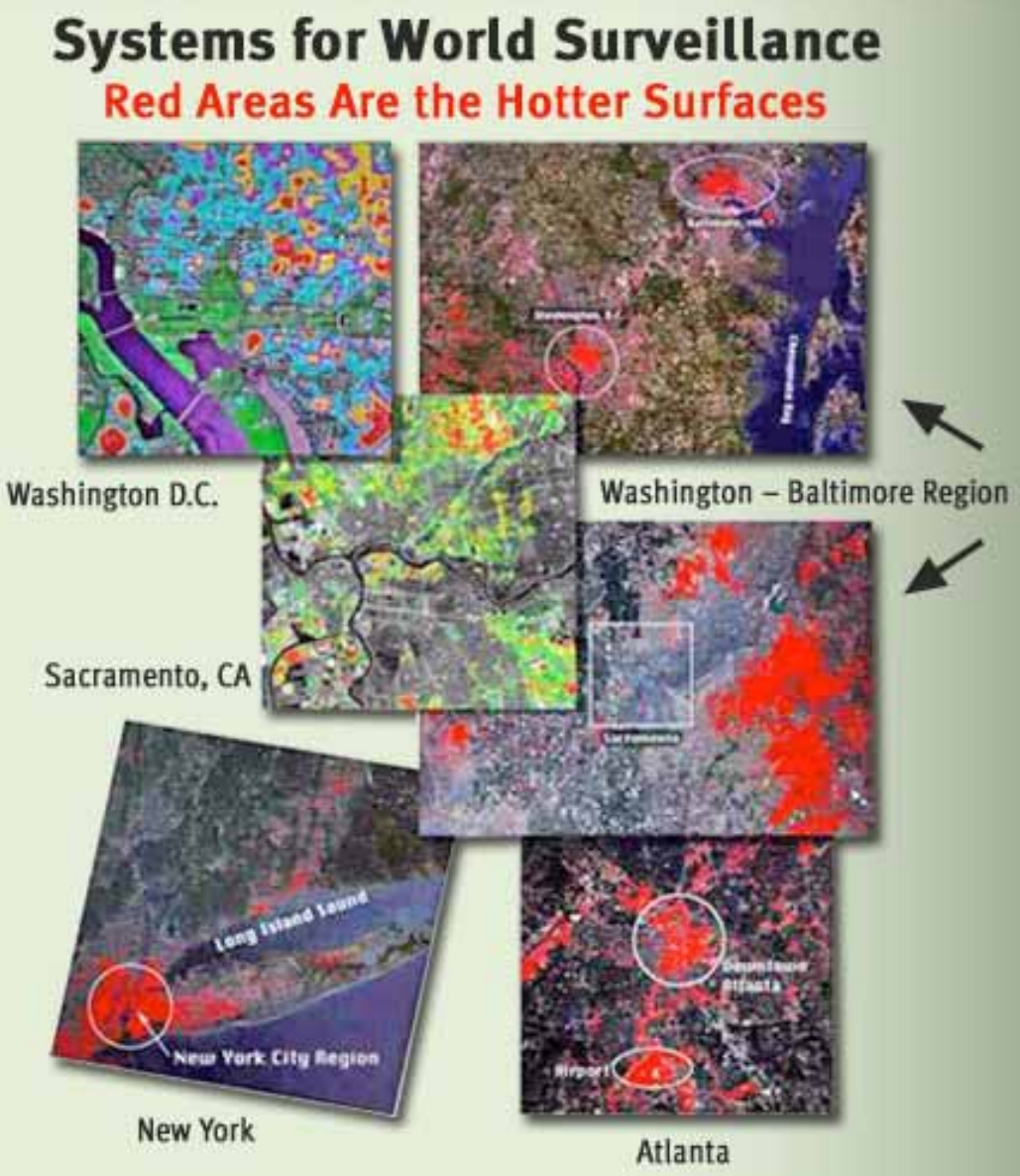
Urban Heat Island Effect

Heat Island Effect

- Abundance of dark roads, roofs and parking lots creates micro-climate where **temperatures are higher than surrounding areas.**
  - Higher a/c loads required to cool buildings.
  - Higher temperatures contribute to smog.

Heat Island Effect

Proof of Heat Island Effect through thermal imagery



Heat Island Effect

- Roofs with higher reflectance have lower surface temperatures.
  - Helps **reduce** ambient **air temperatures**
- Helps **improve air quality** since less smog formed.
  - 0.5° F decrease in heat = 5% reduction in smog

Source: Lawrence Berkeley National Lab

Initiatives and Programs

- **More codes** and standards now including building envelope energy efficiency requirements.
- **More labeling** and/or rating systems being developed for energy efficient building envelope products.
- **More incentives** now exist to install cool metal roofs and walls to reduce energy consumption.

Initiatives and Programs

- LEED®
- California Title 24
- California Energy Commission
- Florida White Roof Credit
- Georgia Energy Code
- New York Tax Incentive
- Chicago Urban Island Code
- Federal Energy Bill
- DOE Programs
- EPA Programs
- LBNL Urban Island Group
- ORNL Building Technology Center
- ASTM Committees
- ASHRAE Committees
- Cool Roofing Rating Council
- Millennium Star

California Title 24

- **Energy code** that's part of overall state building code.
- Contains language specific to **cool roof** requirements.
- Current version applies only to **non-residential** buildings with **low slope** roofs.
- Pending **2008 version adds** steep slope **buildings,** commercial and residential

How Does It Work?

- All **building permits** must include **energy budget**:
  - Based on climate zone
  - Based on building components
  - Each component gets "baseline" value
  - Baseline now includes cool roof value
- **Must meet budget…or no permit!**

How Does It Work?

Three ways to comply:

- **Prescriptive**
- **Building envelope tradeoff**
  - Windows, insulation, etc.
- **Whole building performance tradeoff**
  - Lighting, HVAC, etc.

TITLE 24

Why is Title 24 significant?

- Because California often leads the way and other states typically follow!

Energy Policy Act of 2005

- **Tax deduction** up to $1.80/sq ft if building conserves energy.*
- Energy efficient building envelope components required.
- Cool roof can be used to **reduce energy use** in building.

* Extended through at least 2008.

IRS website address: www.irs.gov

Cool Metal Roofing

Cool metal roofing can:

- **Reduce** cooling energy consumption
- **Improve** air quality by reducing heat island effect
- Help **comply** with energy codes
- Help **qualify** for tax deductions

Cool Metal Roofing

In **cooler** climates, where heating dominates:

- A lower emittance may be desirable.
- Can be **met** with an **unpainted metal roof**.

Cool Metal Roofing

In **warmer** climates, where cooling dominates:

- A high reflectance and emittance is desirable.
- Can be **met** with a **prepainted metal roof** using lighter colors and/or reflective pigmentation.

Solar Energy

Metal roofs are also an **excellent platform** for **photovoltaic** installations

- Panels can be mounted on a metal roof **without penetrating** the roof surface.
- Passive **solar water heating** systems also.

Cool Metal Walls

Cool Metal Walls

While much attention on energy efficiency has been focused on metal roofing, **metal wall systems** are also becoming **“cool”.**

Cool Metal Walls

- **ASHRAE** High Performance Building Standard draft contains **provision for cool wall systems**.
- Other energy provisions in codes and standards are being added to make **walls more energy efficient**.

Cool Metal Walls

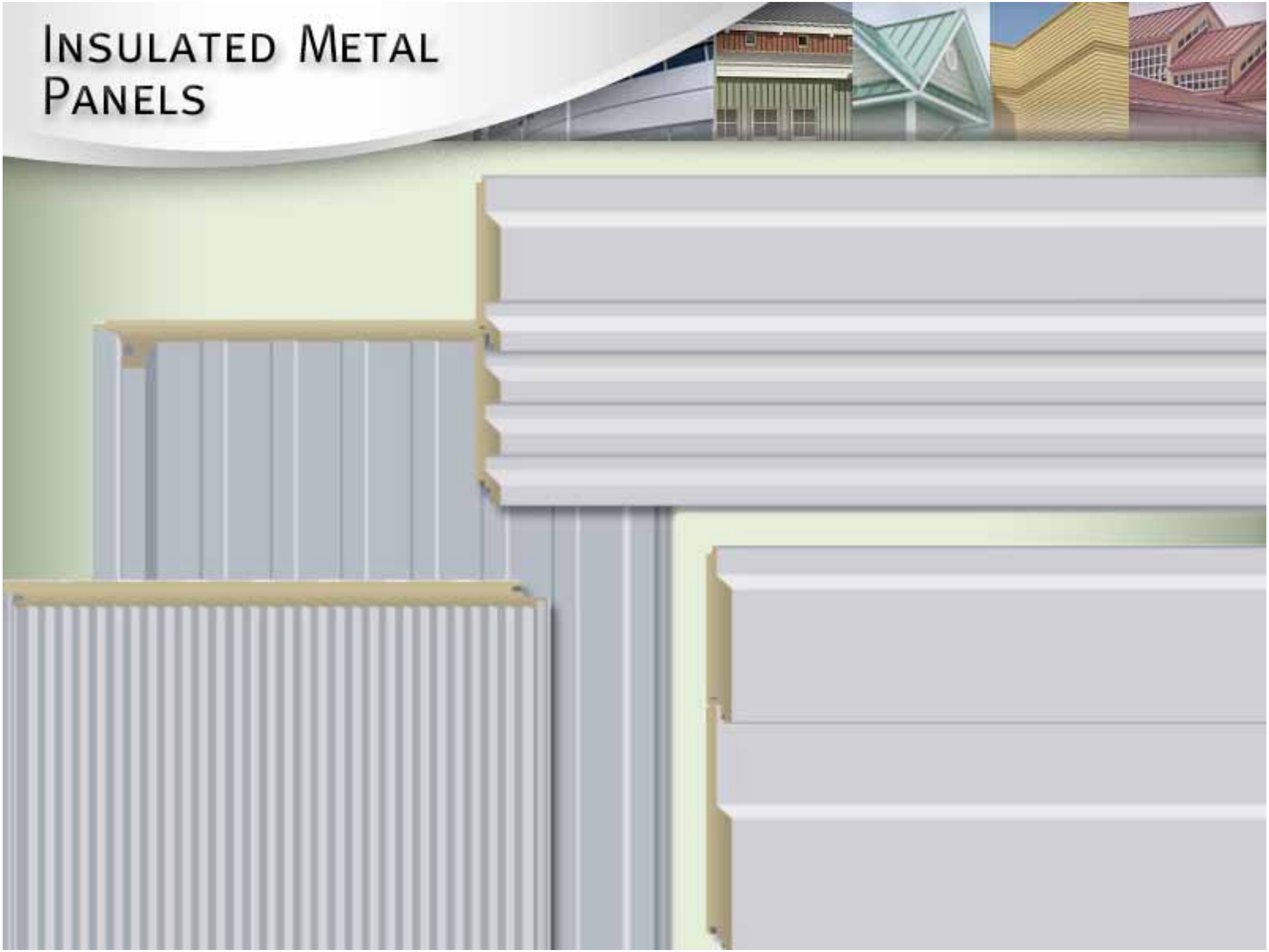
- **Same paint systems** used for cool metal roofing can be used on metal wall panels
- Research at Oak Ridge on cool walls – **10% reduction** in cooling energy

Insulated Metal Panels

Insulated Metal Panels

- Combine **thermal performance** and **aesthetics**
- Made by injecting polyurethane foam between two metal face sheets, typically steel or aluminum
- Foam expands to fill cavity, then solidifies to create solid, monolithic panel

Insulated Metal Panels

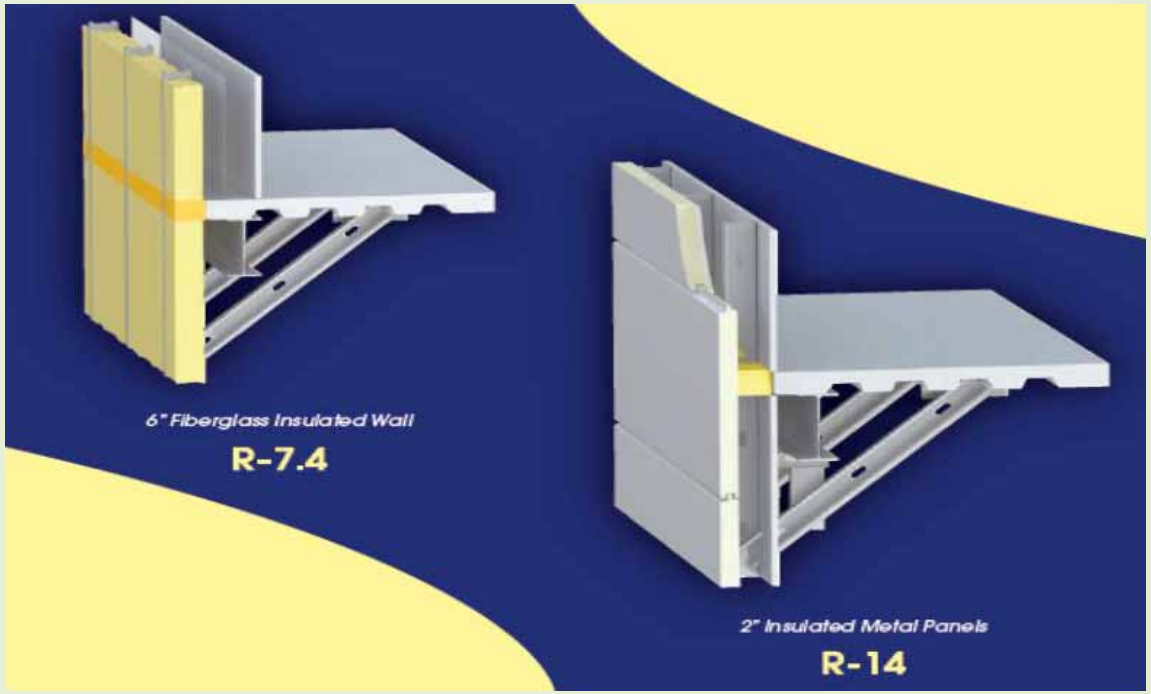


Insulated Metal Panels

- **Highest insulating value** per inch of all wall-insulating products

Insulated Metal Panels

- In commercial applications, **2-inch-thick panel** meets most buildings' insulating requirements.



Operating Costs

- Insulated metal panels **lower energy consumption** by providing **uniform** performance.
- Insulation thickness **maintained** between metal panels. No points at which it is compressed.
- Tongue and groove joinery **ensures** entire wall area is covered.

Insulated Metal Panels

- Panels can be flat, profiled or curved
- Wide range of colors
- Wide range of finishes and textures
- Can be installed vertically or horizontally

Environmental Impact

Environmental Impact

Metal roof and wall systems are an **environmentally responsible** and **sustainable choice** for buildings of all types.

GREEN

- Metal roofs and walls contain high levels of **recycled content**
- Are **recyclable** or **reusable** at end of useful life

SUSTAINABILITY

- Metal roofs and walls are **extremely durable** with long service lives
- Lowers demand for raw materials to produce replacement systems

SUSTAINABILITY

- High performance **paints and coatings** applied to metal to protect panels.
- Formulated to last up to **25 years** or more.
- Help panels **retain appearance**, ensuring building maintains aesthetic appeal.

SUSTAINABILITY

- **Patina** that forms on unpainted natural metals like zinc and copper **protects metal surface naturally.**

Air Quality

- Metal roofs and walls are **inert**
  - No off-gasing, no VOCs
- Mitigate Urban Heat Island Effect
  - **Less smog** produced

RETROFIT

Metal roofs can be **installed over old flat roofs**

- Eliminates need to remove old roofing and **preserves landfill space**
- Can create ventilation cavity that can **reduce peak heat gain**

Case Study

Challenge: Raytown, MO School District was advised by RTI Consultants to **retrofit** its two leaky, barrel-shaped bus garage roofs rather than tear off and replace the roofs.

Case Study

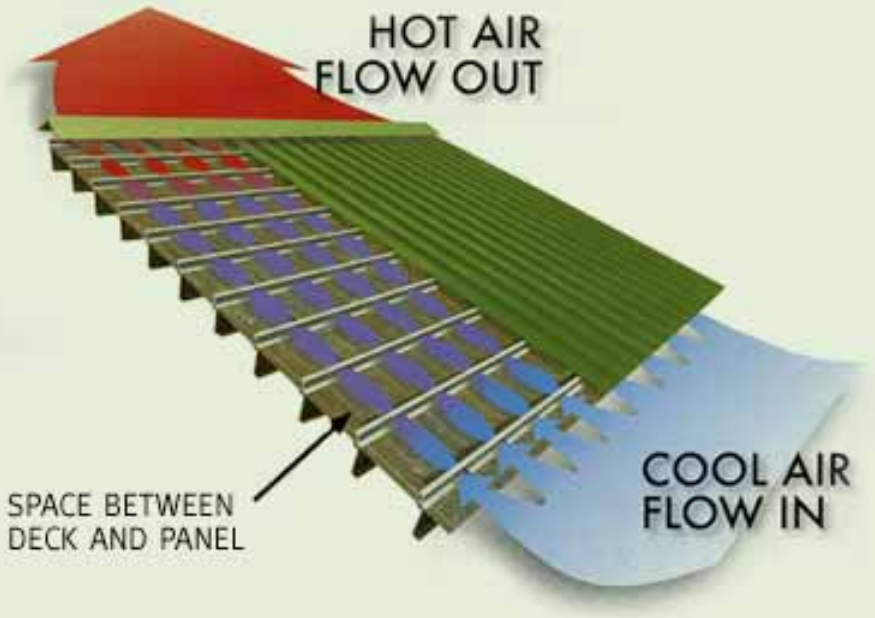
Solution: Replace curved roofs with low slope standing seam metal roof. New roof **installed over existing roof** after “piggyback frames” welded to original trusses.

During Retrofit

After Retrofit

Above Sheathing Ventilation

- **Created by air space** between roof deck and metal roof panel
- Yields **energy savings** in summer and winter
- Also helps remove **unwanted moisture**



Above Sheathing Ventilation

Without ASV:

- **Heat is conducted** directly through sheathing into or out of the building depending on the weather.

With ASV:

- In hot weather, **heat is dissipated** out through the air space.
- In cold weather, air space acts as **added insulation** to prevent heat loss.

Above Sheathing Ventilation

When **combined with cool metal roof** surface, ASV can **reduce heat gain** through the roof assembly **up to 45%.**

(Source: Oak Ridge National Laboratory)

LEED®

Leadership in **E**nergy and **E**nvironmental **D**esign

"A leading-edge system for designing, constructing, operating and certifying the world's greenest buildings."

- LEED **criteria appearing** in local, state and Federal building **codes**.

U.S. GREEN BUILDING COUNCIL

LEED®

LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

Metal roof and wall components can contribute to 24 LEED points.

U.S. GREEN BUILDING COUNCIL

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Cool Metal Roofing

- Cool metal roof can contribute to a **LEED point** under Sustainable Site Credit 7.2, Urban Heat Island
- Must meet minimum **Solar Reflectance Index** (SRI) values.
- Must cover a minimum of **75% of roof surface area**

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Cool Roof Credit

Requirements (SRI minimum)

Roof Type	Slope	SRI
Low slope roof	≤ 2:12	78
Steep slope roof	> 2:12	29

Eligible prepainted metal roofs:

- Reflectance of **66% or greater** comply for low slope.
- Reflectance of **30% or greater** comply for steep slope.

Recycled Content

- Metal used in typical roof and wall installations generally contains **at least 25% recycled content**.
- Can raise overall building's average recycled content
- Can contribute up to two **LEED points** under Material & Resources 4.1, 4.2, Recycled Content.

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RECYCLABILITY

- Steel, aluminum, copper and zinc in metal panels is **100% recyclable** at end of products' service life.

- Can contribute up to two **LEED points** under Materials & Resources 2.1, 2.2, Construction Waste Management

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Building Reuse

- When a building is renovated, **existing metal roofing** can qualify
- Can contribute up to two **LEED points** under Materials & Resources 1.1, 1.2, Building Reuse

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Water Efficiency

- Metal roofs are excellent **rainwater catchment surfaces**
- Captured rainwater can be used for building or irrigation use
- Can contribute up to four **LEED points** under Water Efficiency 1.1, 1.2 Water Efficient Landscaping, and 3.1, 3.2, Water Use Reduction

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Energy Performance

- Cool metal roofs and insulated metal wall panels are part of **energy simulation calculations.**
- Can contribute up to ten **LEED points** under Energy & Atmosphere 1.0, Optimize Energy Performance

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Summary

Metal roofs and walls:

- **Sustainable**
  - Retain properties over decades
- **Low impact** on environment
  - High recycled content
- **Reduced** solid waste stream
  - 100% recyclable
- **Reduced** energy consumption
  - Efficient in all climates
- **Improved** air quality
- **Improved** water efficiency

Building Green with Metal

You should now know how metal roofs and walls can:

- **Reduce** energy consumption in buildings
- **Improve** air quality and thermal comfort
- Help **comply** with energy codes
- **Reduce** environmental impacts
- **Contribute** to LEED® points

Questions?

Website address

www.themetalinitiative.com

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