

Solar Air Heating Metal Roofs for Re-Roofing and New Construction



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WHAT IS A SOLAR AIR HEATING ROOF?

- Conventional, long life, weather-tight, code approved metal roof
- Metal roof heated by sunlight
- Hot Roof heats air below
- Solar heated air collected from below the roof
- Heat used for varied purposes in the building



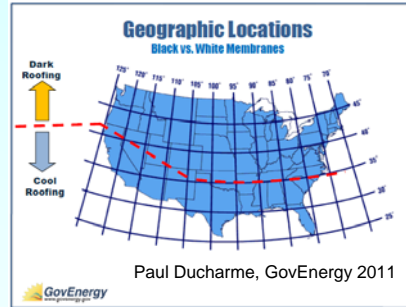
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"But, everybody knows" ...

Cool Roofs are the way to go.

So, Why Solar Heating Roofs?

- Solar Roofs give 10 to 40 times more energy cost savings per square foot
- Heating Dominant in North
- Your Always Heating Something, Somewhere
- Have it all
 - Cool Roof with Solar Heat Recovery



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“But, everybody knows” ...

Air Conditioning drives electricity use and costs in buildings, so.....

WHEN WE NEED MORE ELECTRICITY FOR COOLING..... Why Solar Heat.....?

It turns out.....

HEAT

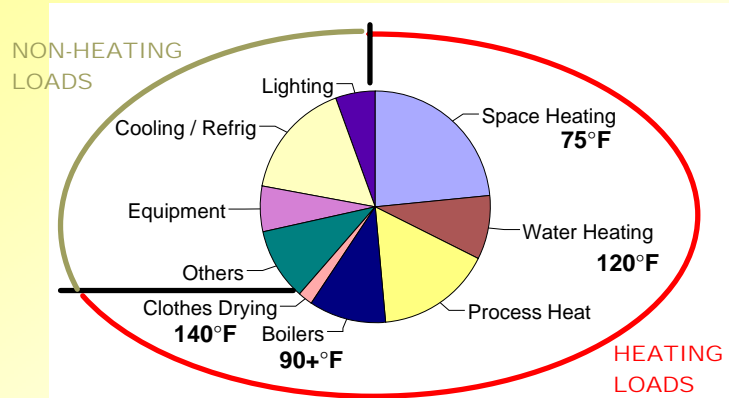
is BY FAR THE LARGEST ENERGY
NEED across all US buildings



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THE LARGEST NEED FOR ENERGY IN THE U.S. IS FOR HEATING

ENERGY USES IN RESIDENTIAL, COMMERCIAL,
AND INDUSTRIAL BUILDINGS



Portions of all energy used in buildings and facilities,
Source data: US Energy Information Administration

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Two thirds of all energy used in US buildings is for heating something. First is Space heat at about 75F, Next is Process heat for everything from cold temperatures like thawing blocks of frozen orange juice to high temperatures for melting steel. Water heating starts at cold water temperatures up to 140F. Boilers go from about 90F to 1,000F for a variety of uses (EIA could not segregate between uses). Even the humble act of drying clothes has is 2% of US building energy use.

Why Does Heating Dominate?

- High Outside Air Flow
 - 1-12 air changes/hr
- Low Outside Air Temperature
 - Ave Outside Temp = 53F
- Humidity
 - in winter, heat to vaporize H₂O,
 - in summer, condense and reheat
- Water Heating
 - ~1 Gal/person/day, Commercial
 - ~65 Gal/home/day, Single family
 - 40F to 140F hot



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That heating load in many buildings is driven by high outside air flows where outside air is typically colder and with humidity outside the preferred indoor range. There is also a high water heating need.

Solar Air Heating Roofs For Heating and Roofing

- Metal roof is a large solar collector surface
- No solar “collectors” needed
- Roofing budget serves roofing & energy needs
- Energy retrofit budget serves energy and roofing needs
- **Energy savings pay for better, metal roof**



- **Targets largest energy need - HEAT**

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So, what does the roof have to do with meeting the heating load?

It is a large solar collector surface that doesn't require the purchase of solar collectors to deliver heat.

Either the roofing budget can serve as the energy need , or the energy retrofit budget can serve as the roofing budget.

Either way the energy savings can give a better metal roof and reduce the large heating load.

Why Solar Heat Recovery?

- Recovers **low cost** solar heat from the roof - offsets **high cost** conventional heat
 - gas, oil, propane, electricity, steam, hot water, ...
- Actively manages roof temperature against the conditioned space, for heating and cooling
- Passively boosts R-value of the roof with air space and added insulation
- Improves humidity control in roof air space
- Targets largest energy need - HEAT



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The primary reason to use solar heat recovery is simple, ... The solar heat collected from the envelope can be the lowest cost source of heat available to the building and it targets the largest energy need in buildings, which is heating.

Solar Air Heating Roofs Technology Description

- A Conventional Metal Roof
 - Sun light heats the roof panels
 - ~80 F above outside air
 - Air in contact with underside of the metal roof panel heats up
 - ~40-80 F above outside air
 - Simple fan and ductwork delivers heated air for uses in the building
 - Space heat, water heat, outside air preheat, equipment heat, process heat (drying, etc.)
- 20 years development
 - 10 years installation
 - 28 roofs + 26 siding +17 designs



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The solar air heating roof is a conventional, code approved metal roof, the same as is normally installed. The sun warmed panels get up to 80F warmer than the outside air. Air under the panels is pulled by ducts and fans to serve many loads within the building including space heat, water heat, ventilation preheat, etc. American Solar has been developed over 70 projects in 10 years

Solar Air Heating Roof Types

- Retrofit & New Construction
- Low Slope & Steep Slope
- Concealed & Exposed Fastener
- Standing Seam & Shingle/Shake
 - Snap Lock, Double Lock, Trapezoidal, Batten Seam, R Panel, 4" Deep Corrugated
- Residential & Commercial
- Architectural & Structural
- Factory & Site Formed
- Cool Roof & Non-Reflective
- Backfit Solar Fans & Ducts to Existing Roofing



- Warranted
- Financed
- Engineer Stamped

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There are many types already installed.

Some Federal Solar Metal Re-roofing Projects



Army Research Lab 20,000 sq. ft.



Aberdeen Proving Ground 125,000+ sqft.

- Army, Air Force, Interior, NIH, FDA, Pentagon
- New construction and retrofit
- Space heat, Water heat, Air conditioning, Equipment heat, Dehumidification, Vent preheat

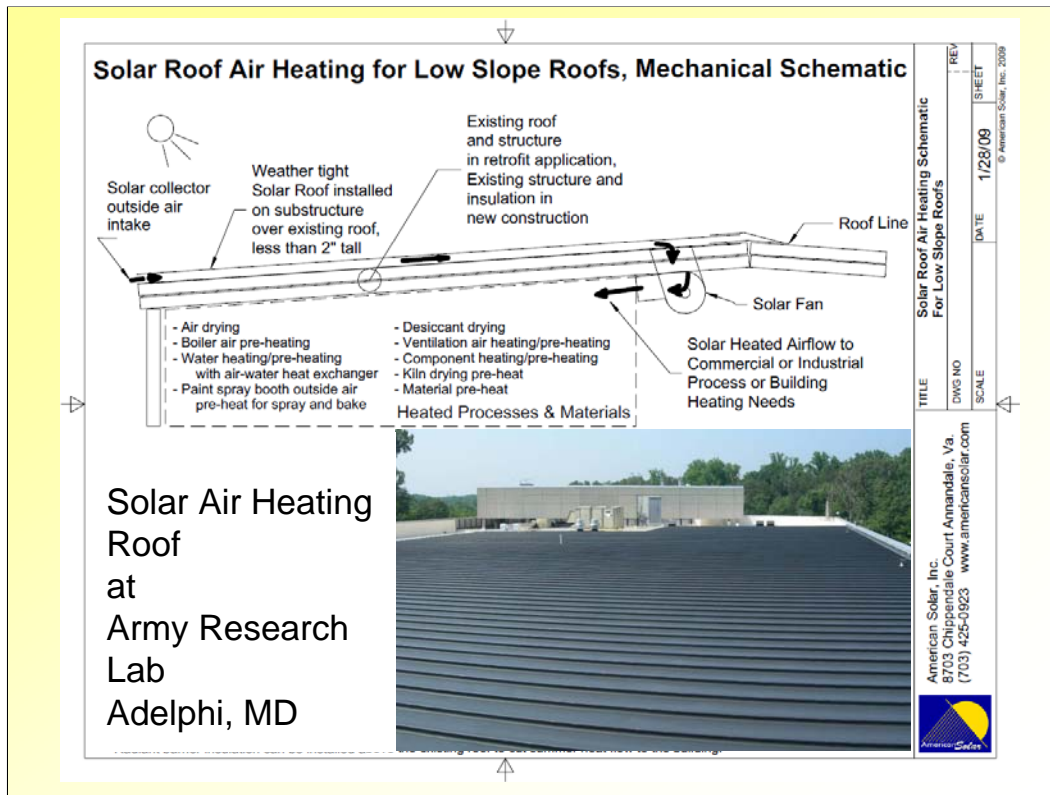


Air Force Medical Depot
~10,000 of 250,000 sq. ft.



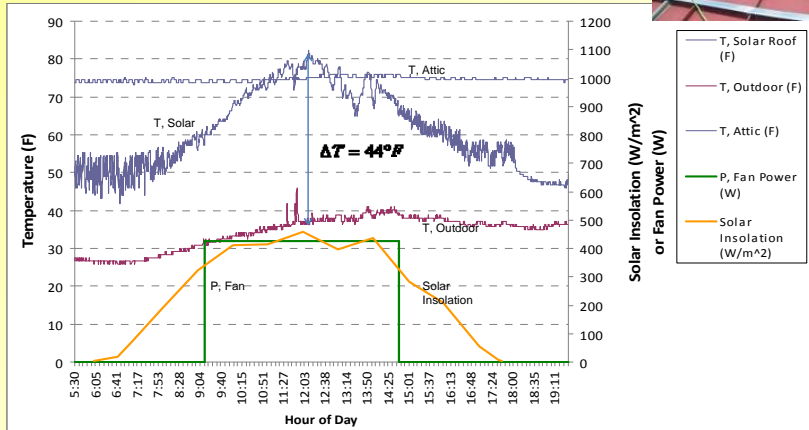
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American Solar's biggest customer has been Federal buildings due to my background in Federal energy management. DOD has been the largest single customer and owns all the largest solar air heating roofs in North America.



One of the large solar roofs is an Office Building at the Army Research Lab.

Laboratory Outside Air Preheat Solar roofing and siding preheating outside air for 100% outside air buildings



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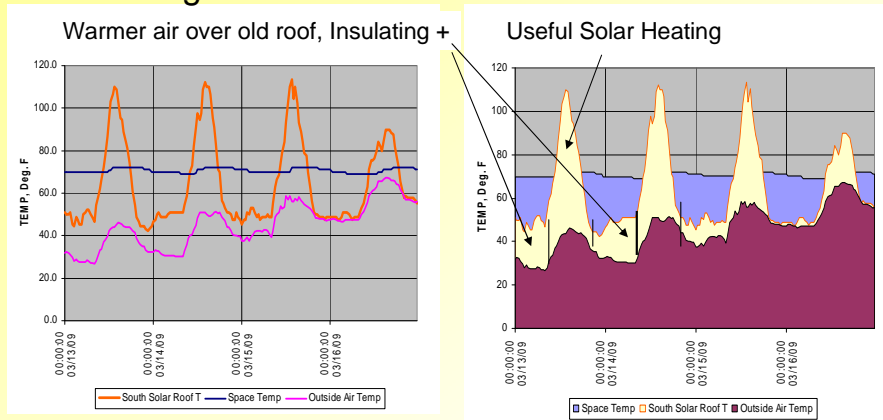
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Monitored 11/19/08

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This chart shows the heating performance of the solar roof, heating 100% of the outside air for an animal building with a high ventilation load. In November in Maryland the system ran from 9AM to 3PM delivering air at 24-44F warmer than outside air. At night the added insulating effect of the solar air space kept the old roof 10-24F warmer than the outside air temperature during a cold winter night.

Solar Air Heating Performance Daytime Solar Outdoor Air Preheat & Nighttime Insulation +



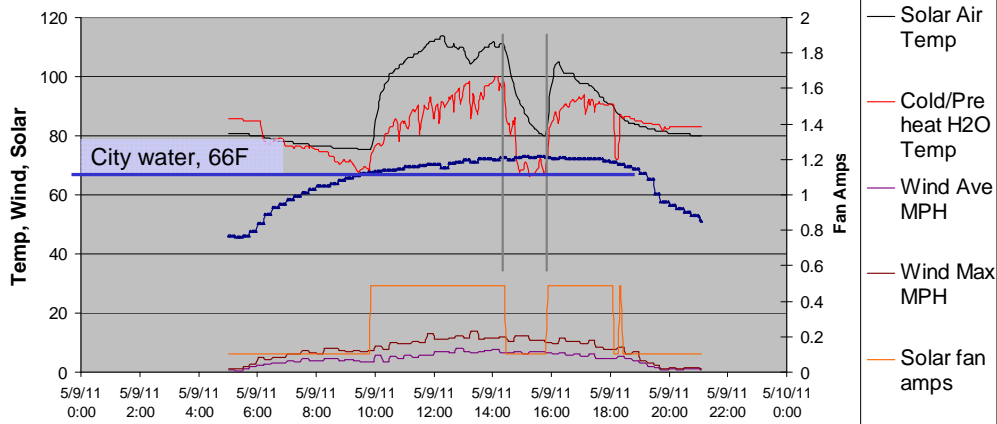
At night time, the 20 deg warmer air over the old (inner) roof surface, is equivalent to adding R-19 insulation (6")
 During the daytime, the solar air adds 70 F to preheat outdoor air



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This chart shows 4 March days at Hill Air Force Base, North of Salt Lake City. The light brown roof heats to 70F above outdoor air temperatures and keeps the old roof 20F warmer than outside air at night. The area in white shows how many hours the solar air is either ready to contribute to preheating outside air or is insulating the old roof below

Solar Air to Water Heating Army Research Lab Domestic Hot Water



Solar air ~40F hotter than outside air
 Solar air heats water from 66 to 100F
 93% electricity savings vs. electric hot water heater
 Clouds at 14:30 cool roof, stops fan - Re-starts at 15:45



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This graph shows the solar air preheating water at the Army Research Lab office building in may. The 66F city water is heated up to 100F by 110F solar air savings 93% of the electricity that would otherwise be used to heat the water. The existing water heater handled the full load during a brief cloudy period, before solar quickly recovered.

Energy and Roofing Costs in DOD

- **2 Billion square feet** of DOD buildings “under roof”
- **\$3 Billion/Year** to Heat and Roof/Re-roof
- **Heating** - \$2.4 billion/year
~\$1.28/sqft/year
- **Roofing** - **\$640 million/yr** ~\$10/sqft roof every 15 yrs ~\$0.67/sqft roof/yr ave.



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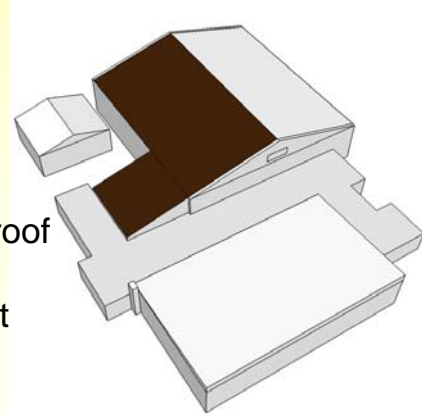


During the Year when MCA proposed the project at Goodfellow Air Force base, American Solar was also selected for a solar air heating roof project at Fort Meade in Maryland. In our proposal we described the DOD roofing and energy situation that you see here.

ESTCP Solar Metal Re-roofing Project Gaffney Fitness Facility, Fort Meade, MD



- Provide Space Heat, Domestic Water Preheat, and a Better Re-Roof for the Building



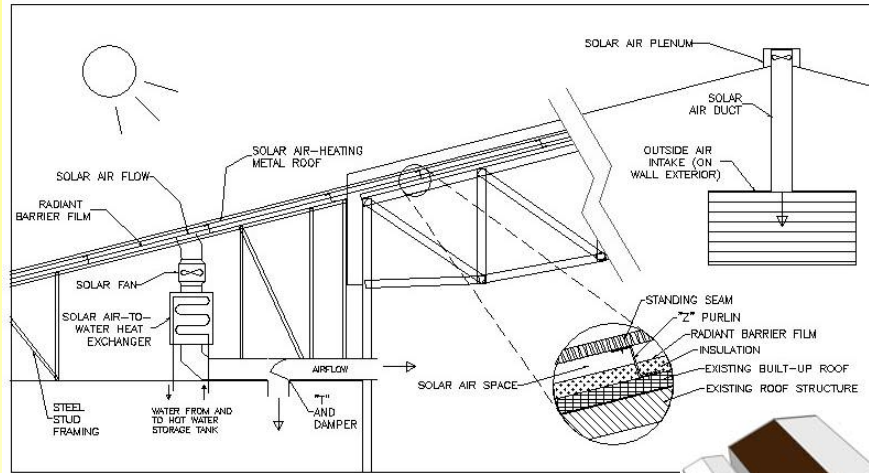
- Demonstrates
 - Re-roof of sloped roof
 - Re-roof of flat roof
 - Outside air preheat
 - Water preheat
 - Direct space heat



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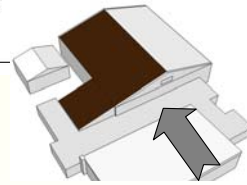
For the Fort Meade project, we re-roofed over a failed sloped and flat built up roof sections at a fitness center. The solar heated air from the roof was used for outdoor air preheat, domestic water preheat and for direct space heat.

ESTCP Solar Metal Re-roofing Project Gaffney Fitness Facility, Fort Meade, MD



- Components are conventional structure, roofing, and HVAC fans, ducts & controls

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The solar air from the roof was delivered to the outdoor air intakes, and to an air-to-water heat exchanger to preheat cold city water for the showers and sinks. When conditions were right, and the solar air was above 75F, it was also delivered from the heat exchanger exhaust directly to the gym for space heating.

ESTCP Solar Metal Re-roofing Project Gaffney Fitness Facility, Fort Meade, MD

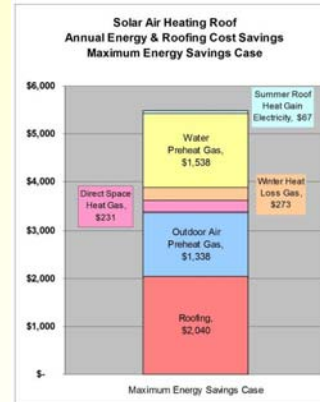
- Document the design-build process
- Collect, analyze, report energy performance data and outcomes
- Create case study for outreach to DOD & Public
- Document Life Cycle Cost & Savings



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ESTCP Solar Metal Re-roofing Project Gaffney Fitness Facility, Fort Meade, MD

- Outcomes
 - heat to air, 47-60 BTU/hr/sqft of solar
 - heat to water, 14-64 BTU/hr/sqft of solar
 - 25% reduction in life cycle roof cost
 - 10-19% reduction in overall building heating energy use
 - 5-15% reduction in greenhouse gas emissions



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The Bigger Picture US Metal Roofing, Siding, and Energy



- ~\$20-30 billion/yr new and retrofit roofing installed in US
- ~\$4.8 billion/yr new metal roofing and siding in US
- Compare to Total US energy expenses of ~\$1.4 trillion/yr



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When we think about the nation wide building envelope market, we can think of \$20-\$30 billion spent on roofing alone with nearly \$5 billion spent on 300 to 400 million square feet of Metal roofing and siding. Compare that to the market of purchased energy which is \$1.4 trillion per year in the US.

Solar Heat Recovery Potential from New & Existing Metal Roofing & Siding

- ~300 - 400 million square feet of metal installed every year (lasts ~40 years)
- Estimate 1 billion square feet in place with good orientation, color, & heating demand
- ~\$1/sqft/yr solar energy from metal
- **Roughly \$1 billion per year in recoverable roof/siding solar energy in US**



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Given 300-400 million square feet of metal installed each year, you can conservatively estimate that there is about 1 billion square feet of metal in place with good orientation and heat demand in the building. That metal roof or siding can save about \$1 of energy per square foot per year, or roughly \$1 billion per year. From the customer's perspective, that metal is going to save them \$40, for the 40 years that the sun shines on that metal.

Solar Heat Recovery Potential from the Customer Perspective

- Prefer a better, metal roof
- But 1st cost can be a problem
- **With Solar Metal Air Heating**
 - One square foot gives ~\$40 of energy over 40 year life
 - Commercial owner gets 30% - 65% off in taxes for retrofit & 5 year depreciation
 - Can be lower 1st cost than membrane



- **Energy & tax savings more than pay for the metal roof**

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From the customer's perspective, Metal is preferred but 1st cost may be more than membrane or shingles. However, metal is going to save \$40 in energy, for the 40 years that the sun shines. Commercial owners can get tax breaks that actually make the roof lowest 1st cost and cash positive on day 1.

How Does the Industry Get There?

- Commercial / Institutional
 - Sales and Installer Training
 - Outreach / Marketing information
 - Document technical and economics for Architects, Engineers, Facility Managers, Schools, Industrial, Agriculture
- Residential
 - Pre-package emphasis
 - Too small for custom engineering expense
 - Large market for simple, standard component kits
 - Fans, ducts, thermostats, heat exchangers, heat pumps
 - Demonstrated demand
 - Need to get standard design & kits set first



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How Do WE Get There?

- Codes & Standards
 - Not an obstacle, but improve over time
 - LEED opportunity, 42 points in play
- Trade Shows, Print, Internet, etc.
- Government Energy Agencies
 - Aware, ...becoming engaged
 - More likely to fund industry (not one company) research & demonstrations



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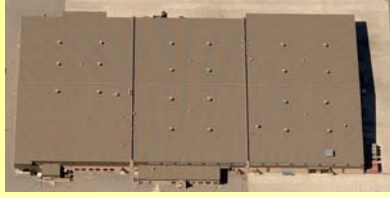
What does it look like 'when we get there'?

- Metal Roofing Sold at Energy + Roofing Value
- New Sales to Energy Focused Customers
- New Sales to Energy Service Companies
- New Product Sales (Structural, Mechanical, Electrical, ...)
- Fans, Ducts, etc. from multiple sources
- Solar Financing & 30+% Tax Benefits for Metal Roofing



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Happy to answer any questions