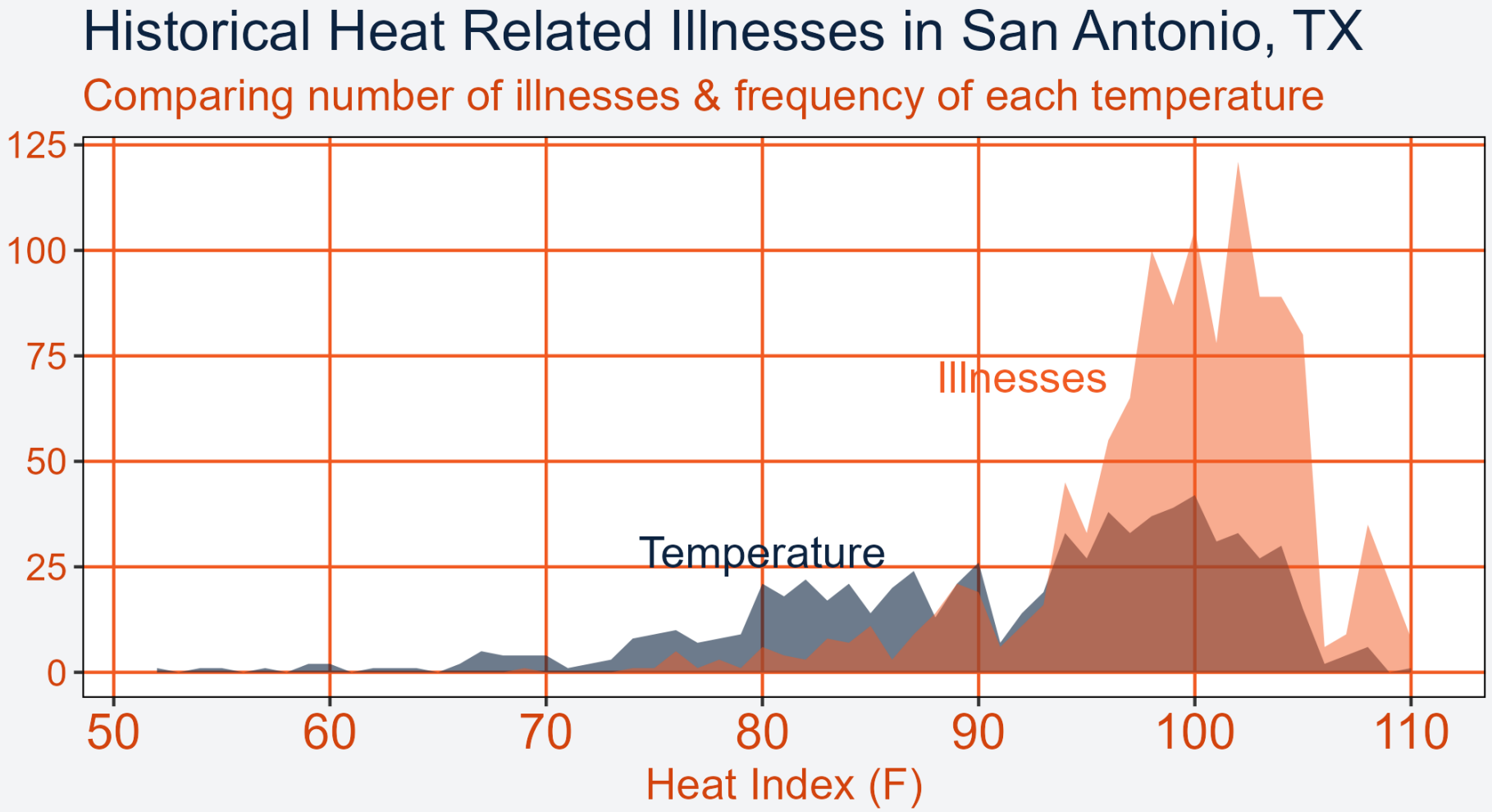
Energy Efficient Roofing in an Urban Heat Island

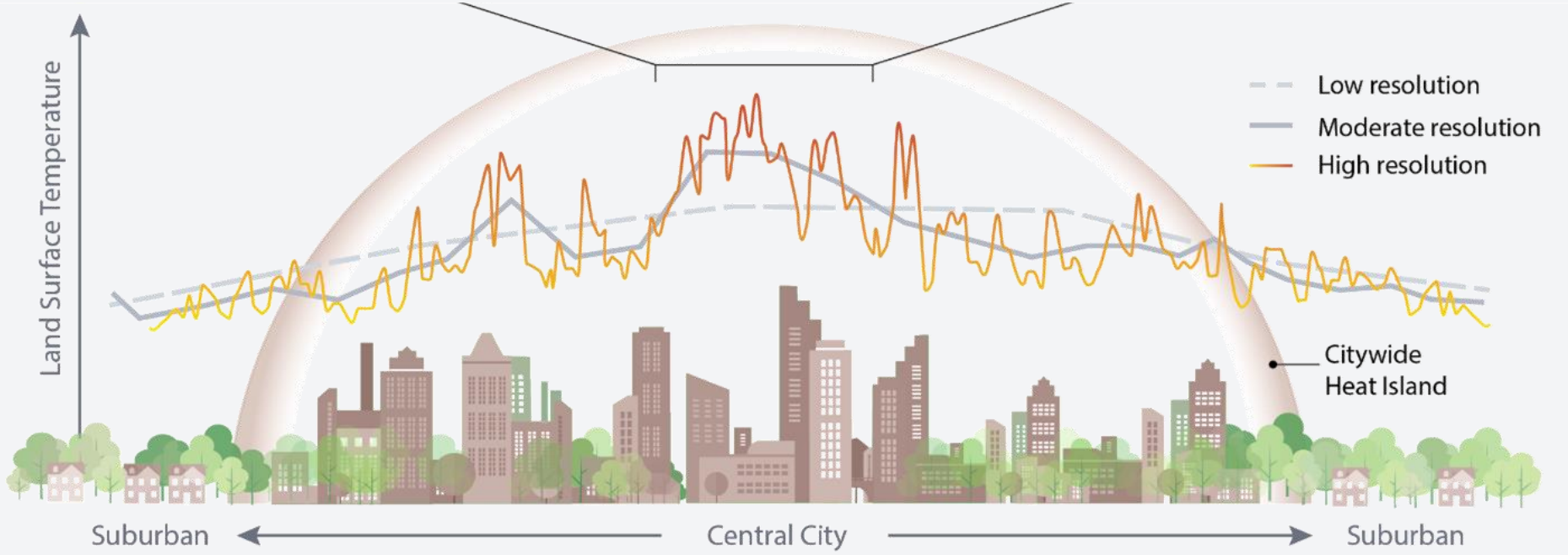
UTSA®
The University of Texas at San Antonio™

Kristen E Brown, PhD
Civil and Environmental Engineering

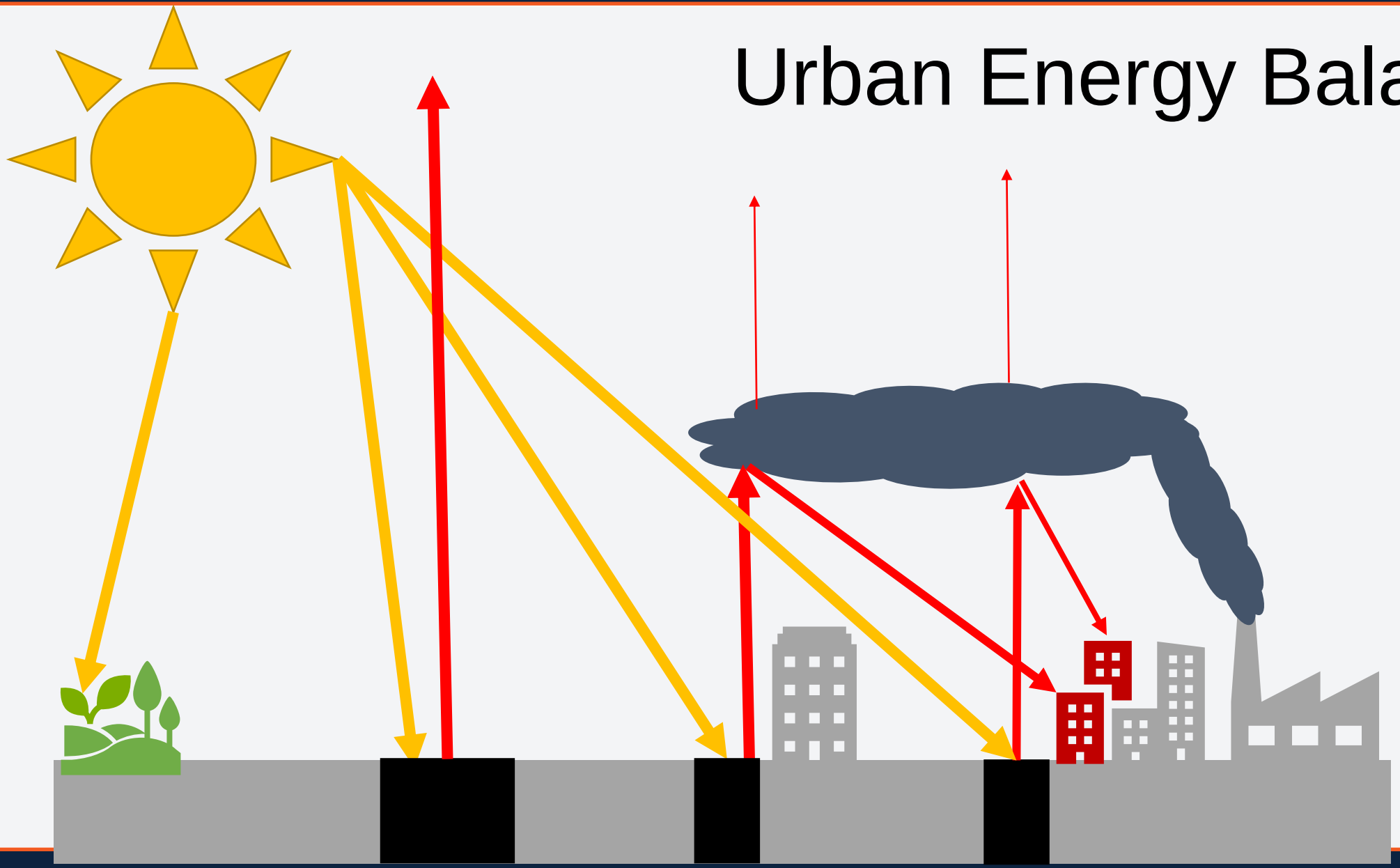
Heat


Historical Heat Related Illnesses in San Antonio, TX
Comparing number of illnesses & frequency of each temperature
125
100
75
50
25
0
Illnesses
Temperature
50
60
70
80
90
100
110
Heat Index (F)

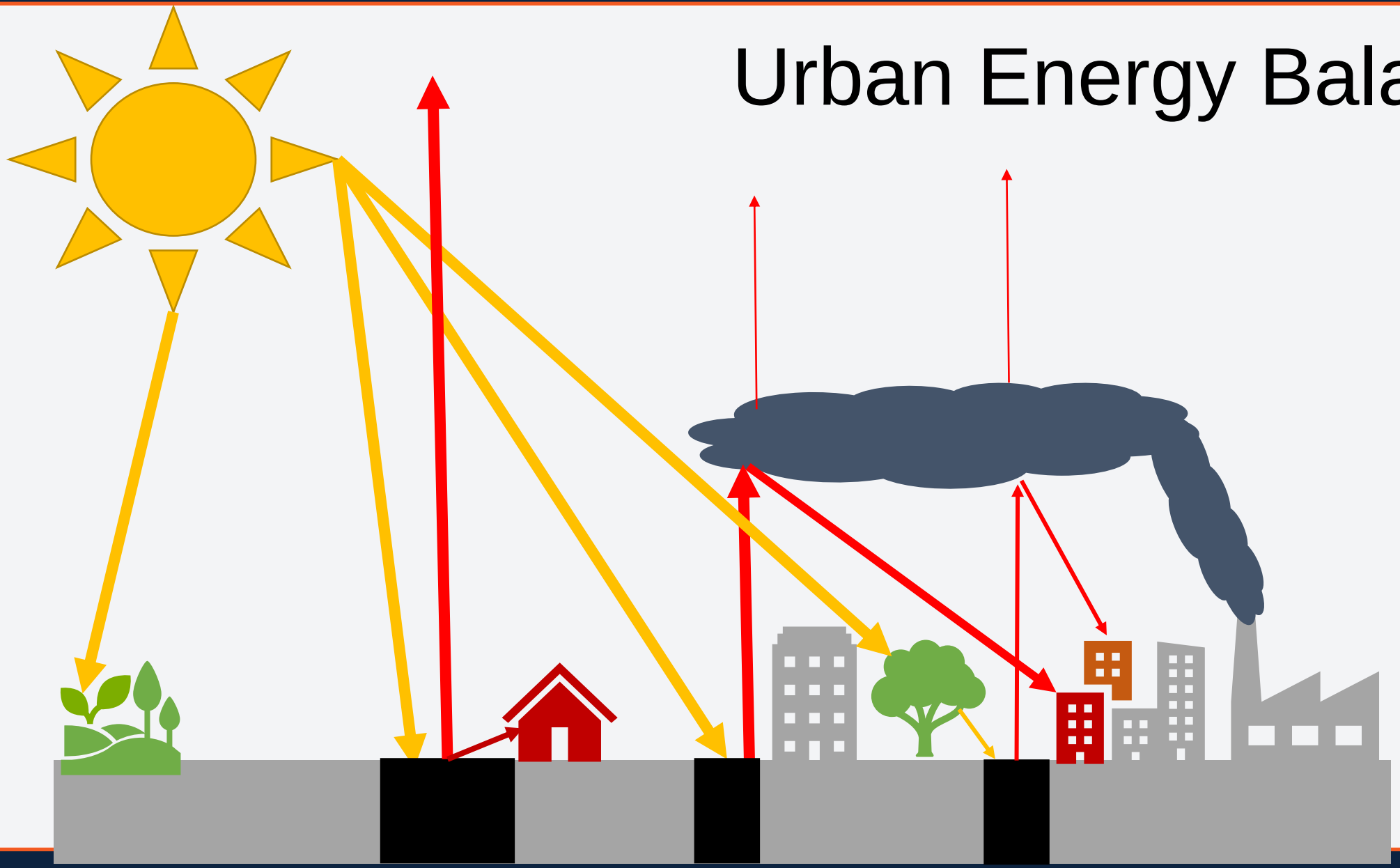
Urban Heat Island



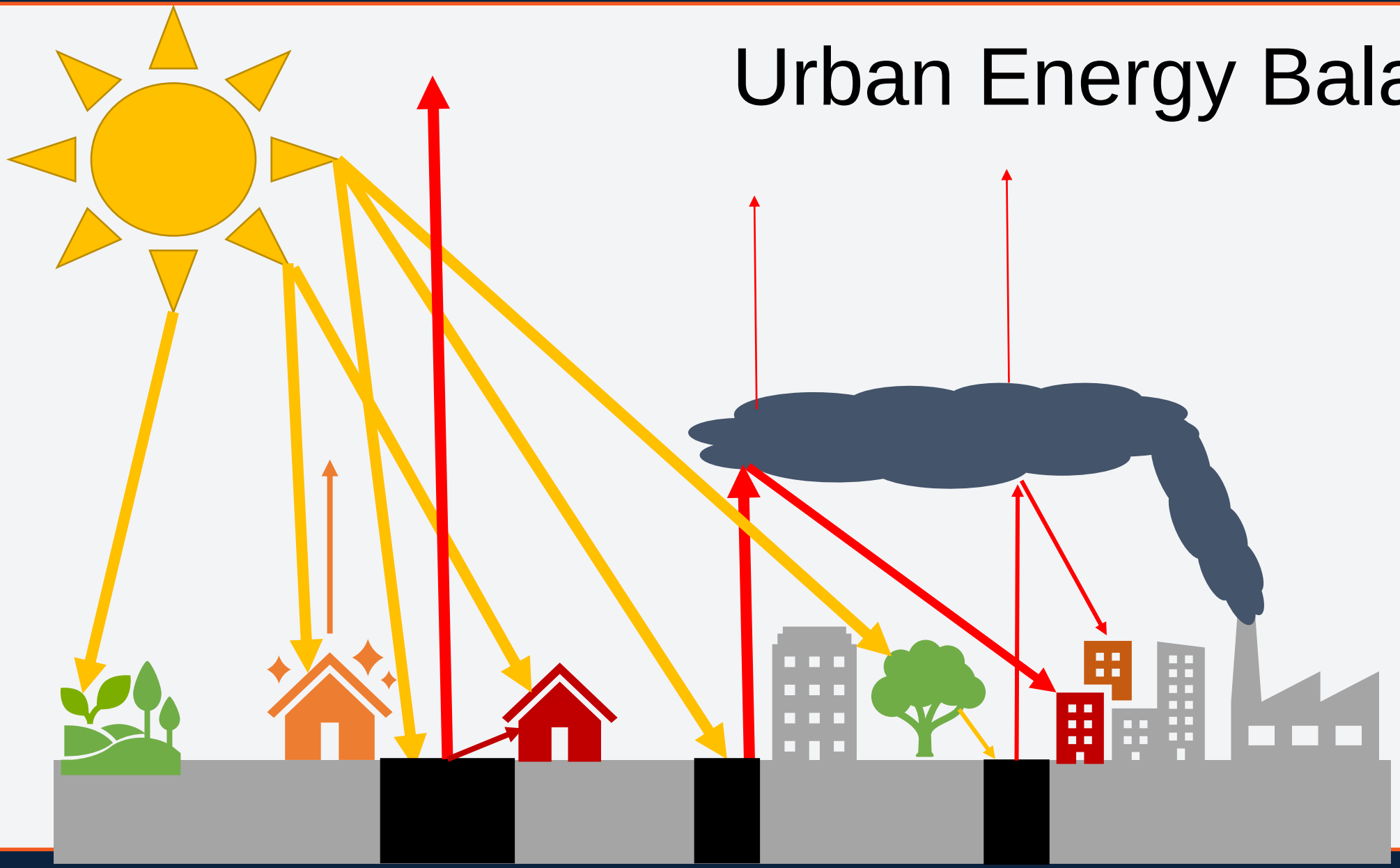
Urban Energy Balance



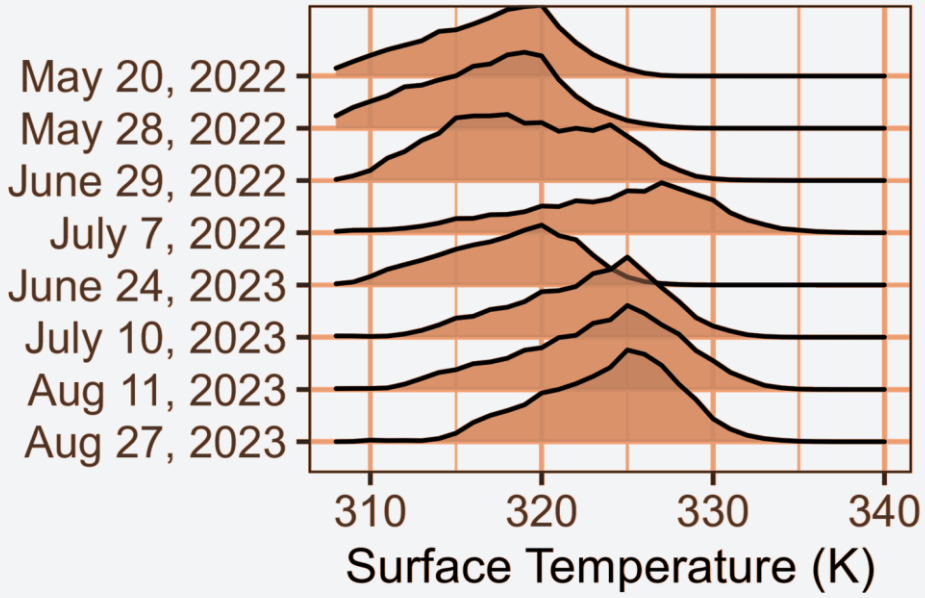
Urban Energy Balance

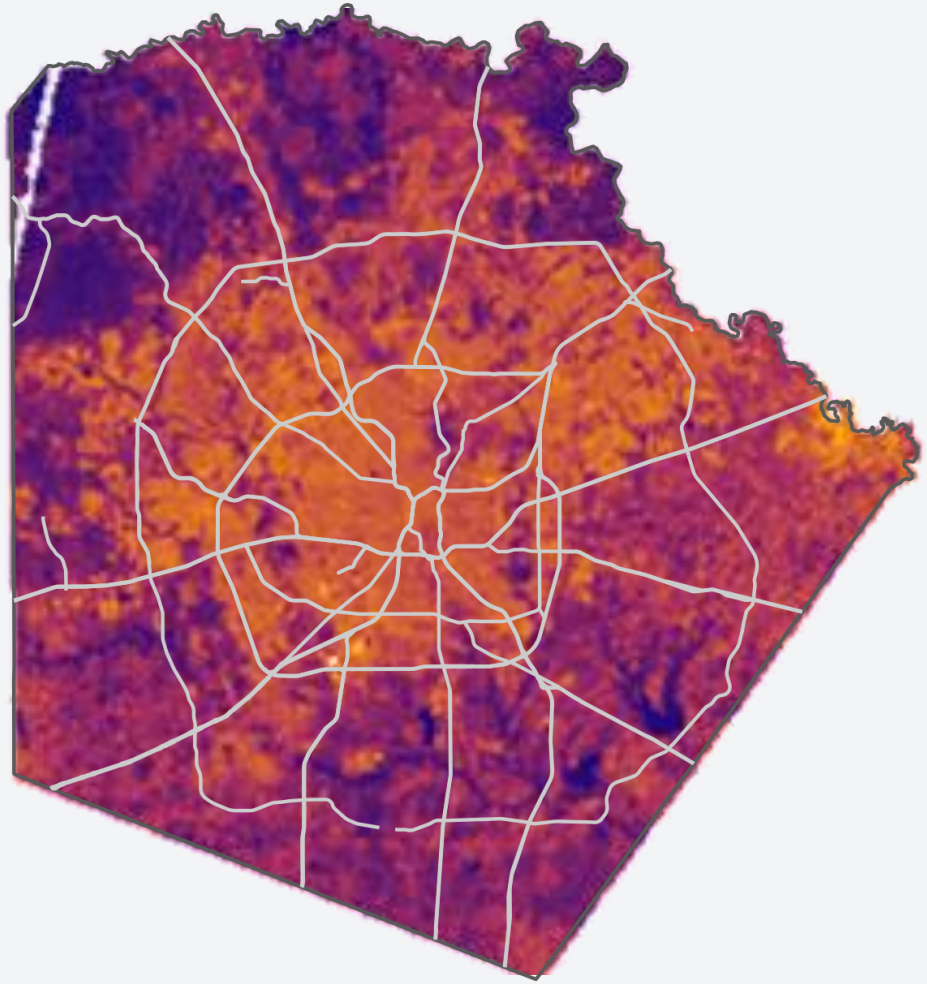


Urban Energy Balance



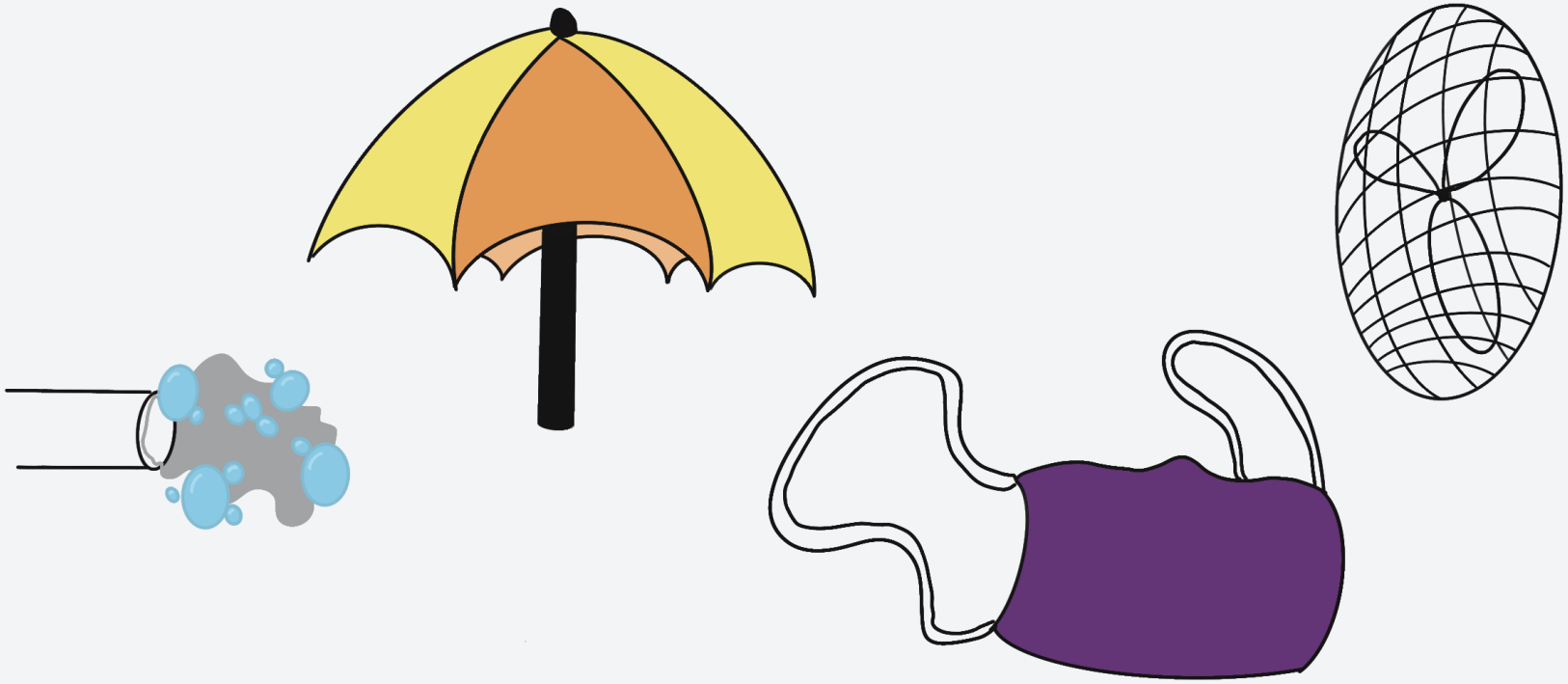
Relative Temperature



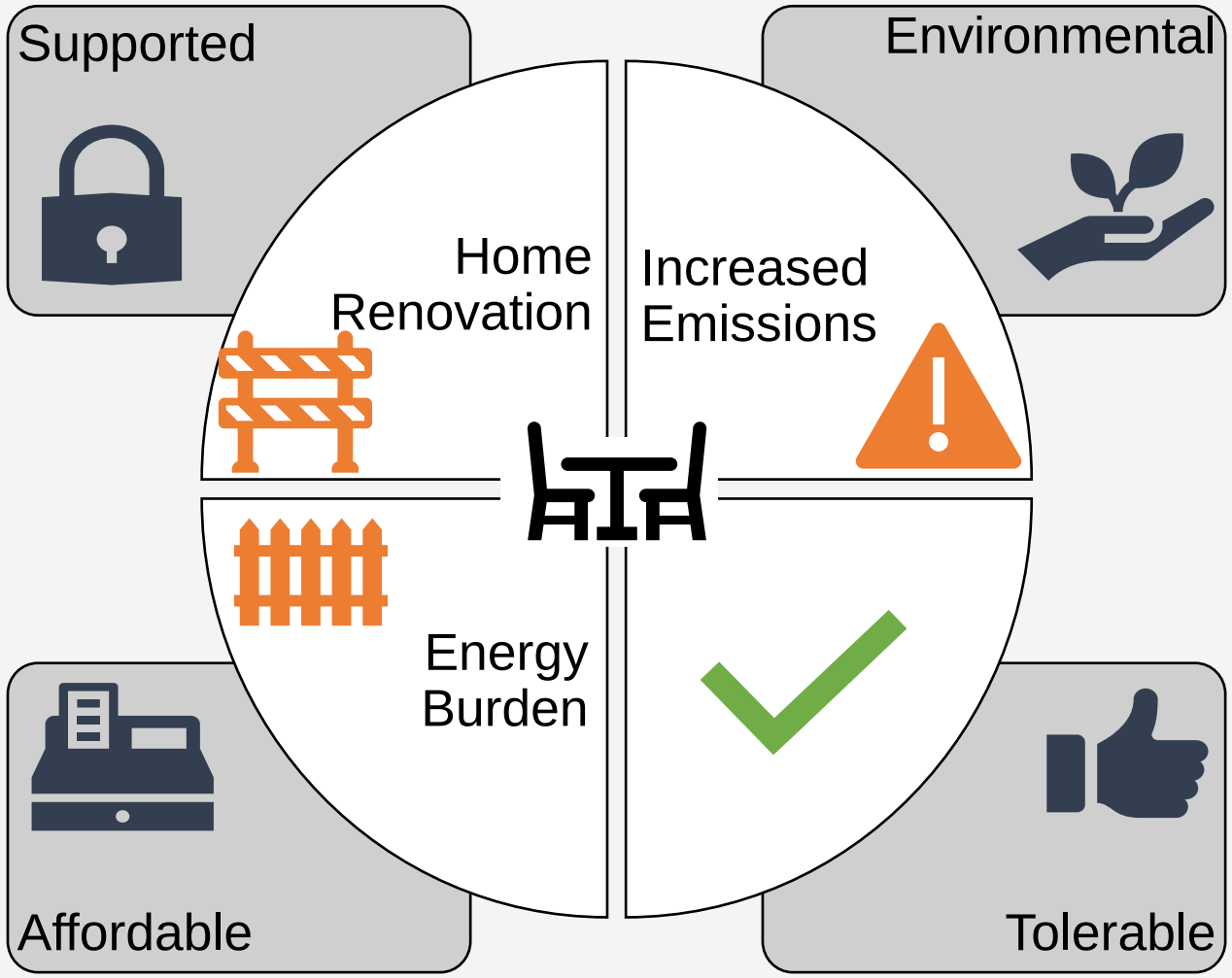


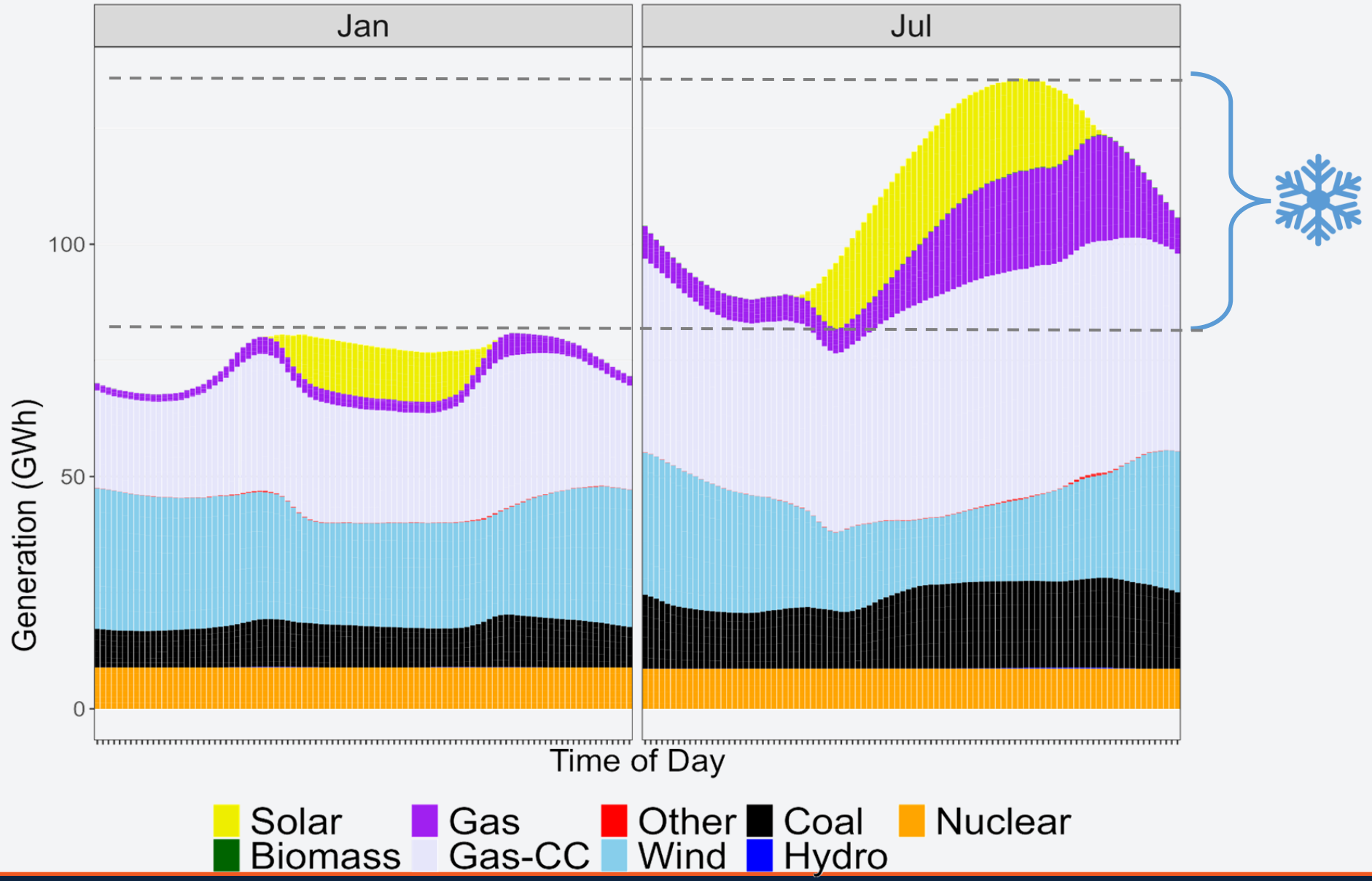
Mitigation

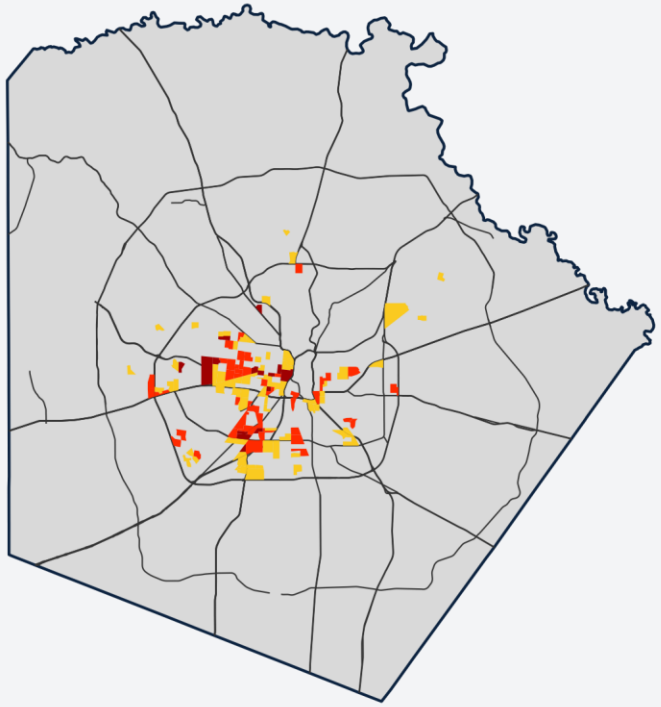
Adaptation

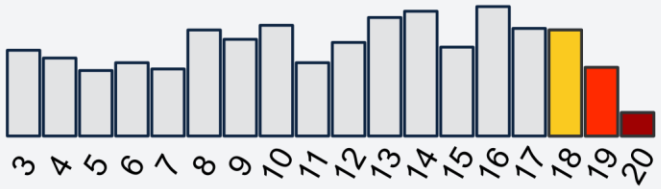


A SEAT at the table—Air Conditioning

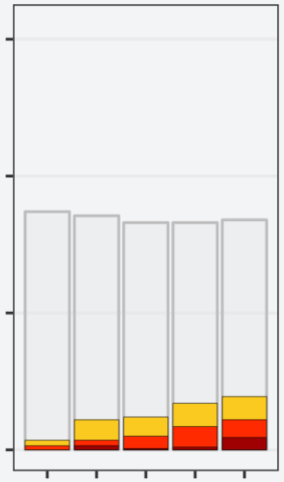



Jan
Jul
100
50
0
Generation (GWh)
Time of Day
Solar
Biomass
Gas
Gas-CC
Other
Wind
Coal
Hydro
Nuclear

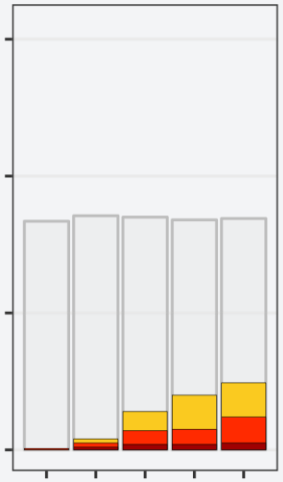




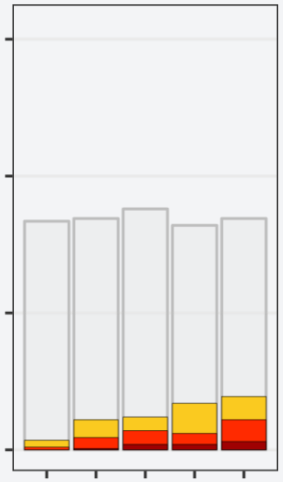
Walkable



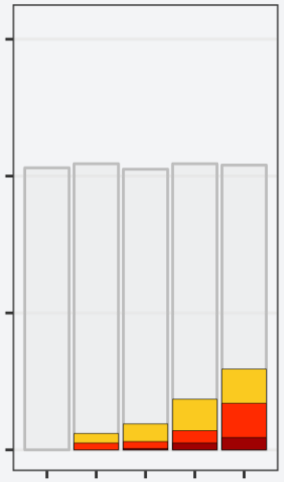
Lack of Trees



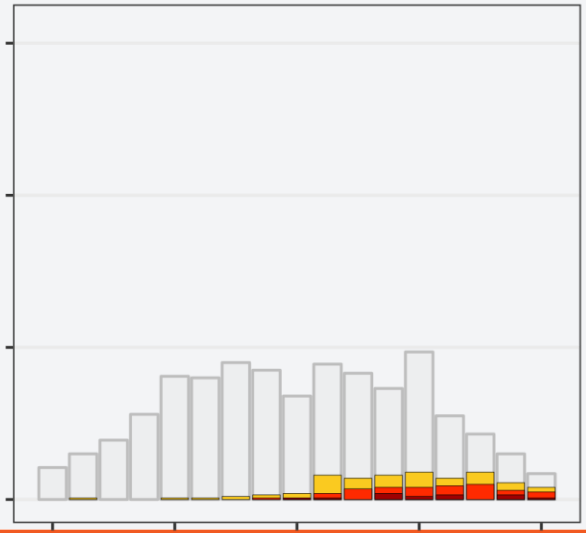
Paved



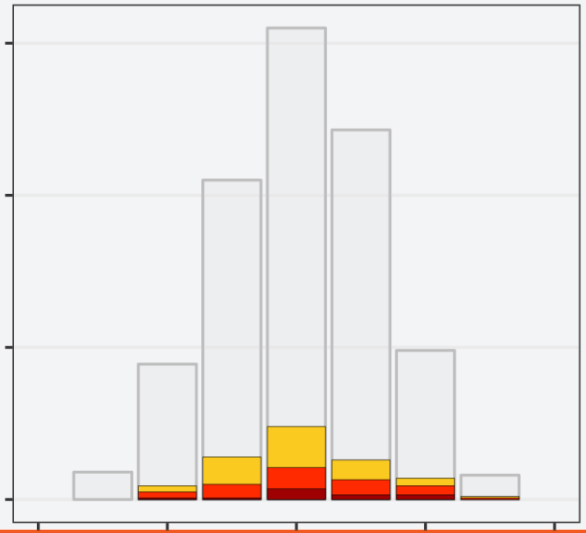
Energy Burden



Health



Mobility



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Cool Roofs

Types and Benefits

Presented by: John Follis

John Follis

- 18 years Construction & Building Envelope Solutions Issues
  - National School Sales & Marketing Manager, Quest Construction
    - 12 years Fabric Reinforced Acrylic Coating Contractor
      - 13 years Insurance Defense Attorney

Don’t ask a question when you don’t know the answer.
Anticipate the questions and have the answers.

Tell ‘em what you are going to tell ‘em,
tell ‘em, then tell ‘em what you told them.

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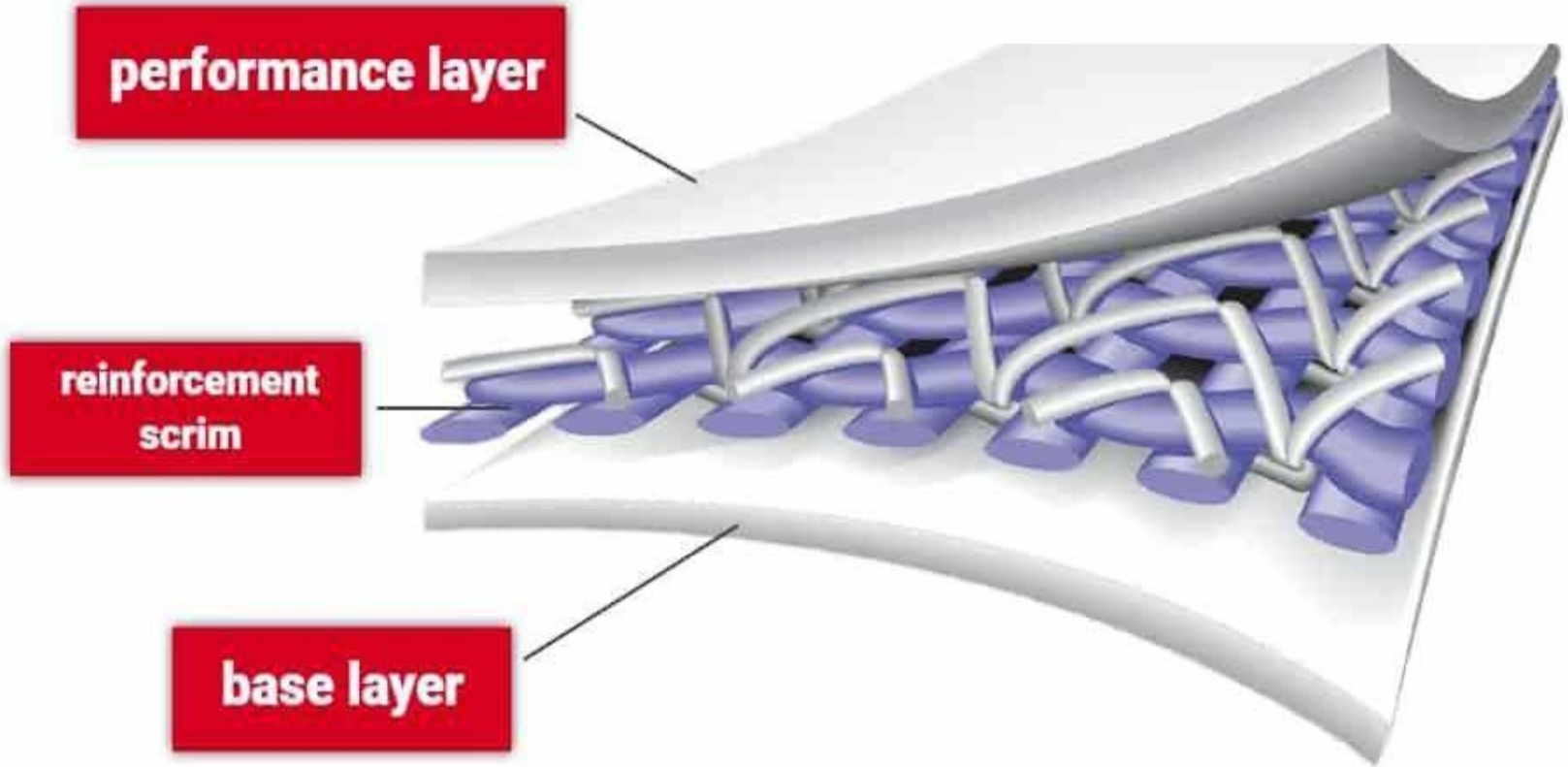
Types of Cool Roofs

- TPO
- PVC
- Fabric Reinforced Coatings



Duro-Last PVC Membrane

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Same Process Better System

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Installation

- Quiet application process.
- No tear offs.
- No smells/toxic emissions.

- Varying formula
- TPO formulations can vary widely from manufacturer to manufacturer. This is in part due to early trial-and-error attempts to address issues with cracking and other rooftop degradation, and some formulations continue to evolve to this day.
- This could be an issue down the road for your TPO roof if, for example, it requires patching or needs to accommodate a new roof penetration. The new TPO membrane may not be completely compatible with the old – even if from the same manufacturer – and may not weld securely.
- Not ideal in prolonged heat
- Although highly reflective, multiple independent studies in recent years have shown that TPO membranes do not perform well in climates with consistently high temperatures.

PVC Roofing Pros and Cons

- **Pro: Strong and Long-Lasting**
- Engineers create PVC roofs with durability in mind. This strong material's membrane boasts a long service life.,
- **Con: Requires Complete Removal of Old Roof**
- Contractor might need to entirely remove the old roof.
- With this extra work comes extra labor expenses.

- **Pro: Resistant to Chemicals and Other Hazards**
- This material can withstand frequent exposure to chemical compounds without wearing down. In fact, PVC's strong membrane can also withstand exposure to animal fat from grease vents and even fire
- **Con: Problems Occur with Age and Climate**
- Although PVC roofs can last up to 20 years, you'll need to account for extra repairs once the roof reaches 10 years old.
- Unfortunately, older PVC is tricky to repair. The hot air welds required for application/repairs don't perform as well on older roofs and the new sealants tend to wear away much faster.
- You should prohibit foot traffic on your PVC roof when the temperature falls below 50 degrees Schedule all your maintenance and repairs on a warmer day in the winter, or wait until spring or summer.

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Fluid Applied

- Quiet installation
- No Tear offs
- Cost effective
- Easy to repair
- Sustainable

“Environmental

Social

Governance”

ESG

IMAGE vs. IMPACT

The Reports Are In…
Corporate America's Focus

A shift in thinking

Operational Changes - Reassess - Think Differently - Innovate

- **Sustainability/Reflectivity**
- **Zero Waste Construction**
- **Green House Emissions**
- **Carbon Footprint**
- **Net Zero Energy**
- **Recycling**
- **Water Consumption**
- **Repurpose Buildings**
- **Solar**
- **Renewables**

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Waste to the landfill

Restore vs Tear Off	Unsustainable to Sustainable	Non Toxic	Zero Waste 397 Dumpsters
$4 vs. $10	Immediate Savings $2 million vs tear off	Score Rebate	**ROI Phase One**

Gravel Roof

Renovations 2 years to 1

Grandfathered on Codes

<u>More savings</u>

- Drains
- Insulation
- Noisy but fast

High Rise Buildings

Staging Costs
- Road Closures/Permits
- Delivery
- Dumpsters/Removal
- Loading Costs

Texas Children's Hospital

Energy Efficient

ROI Phase Two

Temperature Differential

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Potential Annual Savings from Changing Roof Reflectivity in 11 Metropolitan Areas

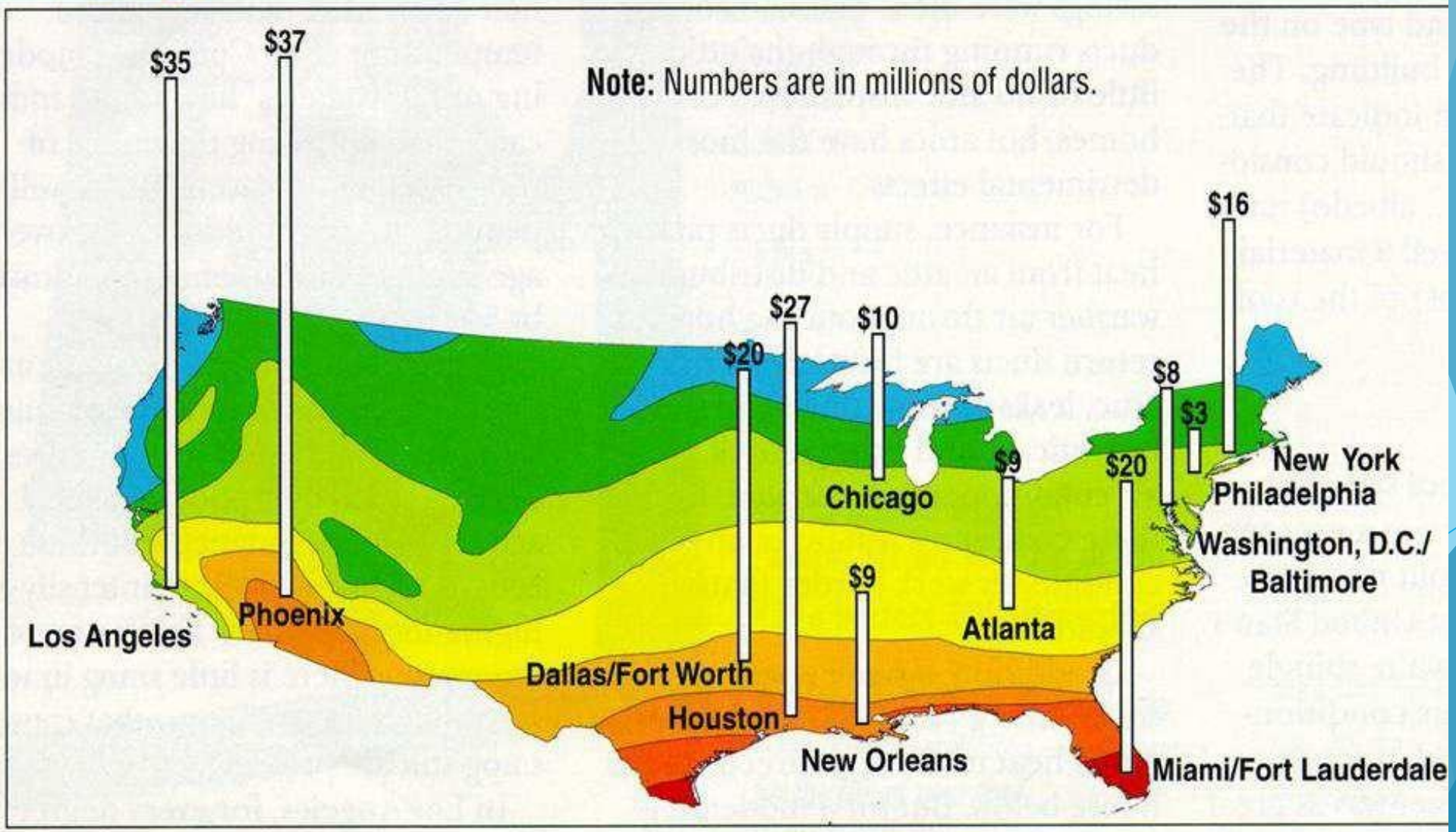

Figure courtesy of LBNL.

Figure 1: *Annual net cooling energy savings for 11 metropolitan areas.*

Lawrence Berkeley National Lab Test Results

Location	Description	Insulation	Roof Slope	Roof Covering	Attic	Uncoated Albedo	Coated Albedo	Cooling Energy Savings
Sacramento, California	1 story residence	R-11	Flat roof	BUR- Alum. Coating	No	0.18	0.77	67%
Sacramento, California	1 story school	R-19	Flat roof	Smooth BUR	Yes	0.08	0.68	40%
Cocoa Beach Florida	1 story residence	NONE	Flat roof	Granulated Modified	Yes	0.20	0.73	43%
Cocoa Beach Florida	1 story school	R-19	Flat roof	Granulated Modified	Yes	0.23	0.67	35%

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The above table summarizes the results of four studies performed by the Lawrence Berkley National Laboratory in California and Florida. The Albedo of all rooftops were raised by 40 to 60 percentage points well into the range of “very high Albedo” (over 50%). Regardless of the level of insulation in the roof, all buildings showed significant reductions in the amount of cooling energy used (Reductions from 35% to 67%). These studies were all performed on residences or small school buildings.

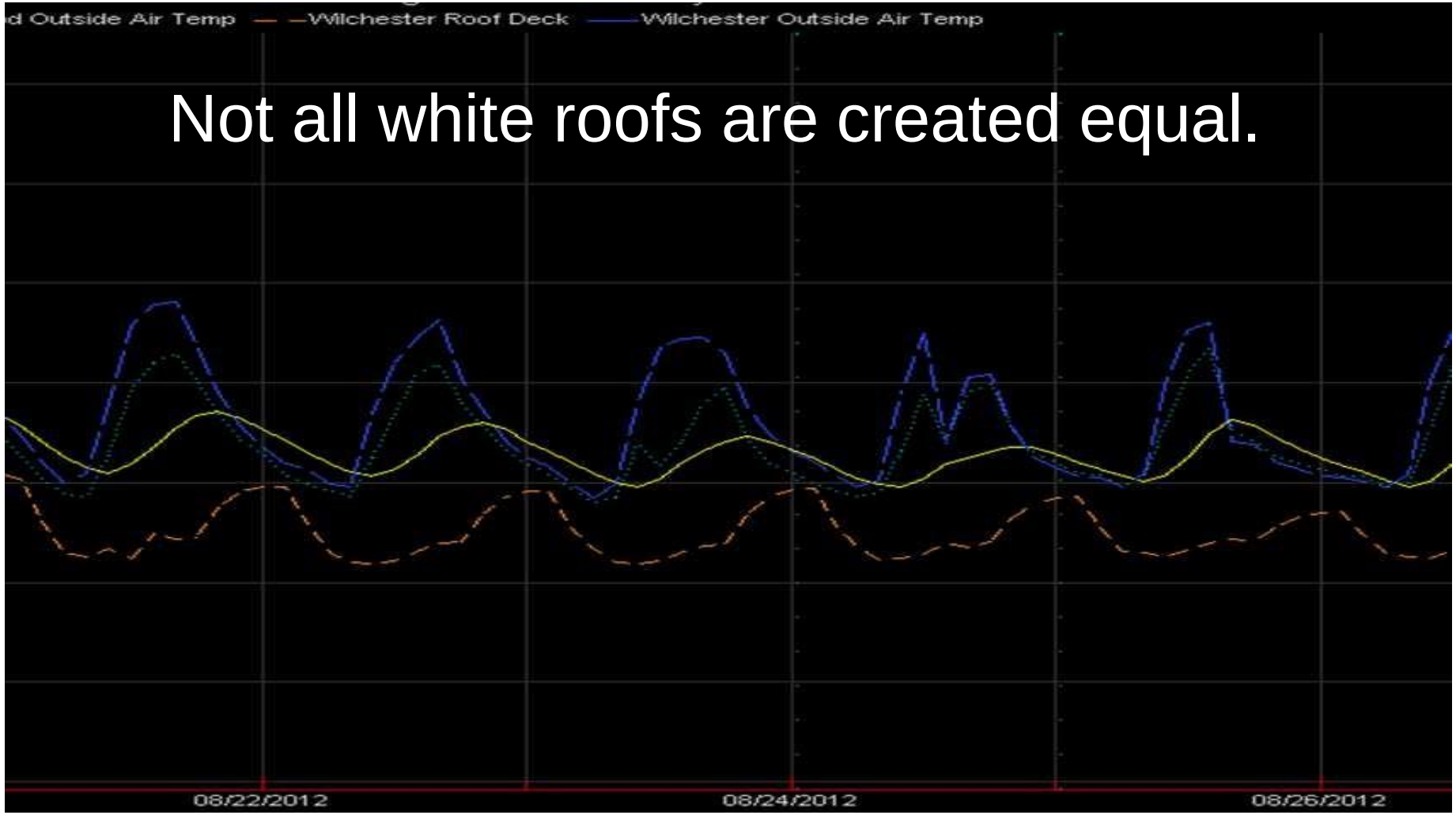
How much CO_2 equivalent is offset if we whiten all eligible urban flat roofs world-wide? (i/ii)

- Answer: **24 Gigatonnes (Gt)**
  - 2/3 of a year's worldwide emission
  - Gigatonne = billion metric tons

- If implemented over 20 years (the life of a roof or a program) this is ≈ 1.2 Gt/year.

In terms of avoided power plants

- Full white roof potential avoids 500 medium-sized coal fired power plants or 1,000 medium-sized gas fired power plants
- For comparison, global power plants emit annually ~15 Gt CO2, equivalent to the output of 6,000 typical midsized power plants (2/3 coal, 1/3 gas)
- Further comparison – the real avoided emissions from global CFL deployment is equivalent to 400 power plants.



$77 savings per day.

Tomball Jr. High School Electrical Cost

Electrical cost before and after roofing application.

	Base year	1st Year	2nd Year
Month	**2007-2008**	**2008-2009**	**2009-2010**
September	$67,373	$43,986	$55,574
October	$56,599	$51,534	$48,649
November	$50,987	$41,870	$42,934
December	$43,072	$36,698	$37,601
January	$48,548	$41,994	$37,691
February	$46,440	$44,042	$42,319
March	$46,014	$40,528	$42,351
April	$53,221	$47,362	$39,678
May	$60,395	$53,807	$44,520
June	$58,745	$42,421	$52,670
July	$28,523	$47,699	$42,516
August	$59,622	$59,973	$44,146
Total	**$619,539**	**$551,914**	**$530,649**

Note 1: due to change in REP in May 09", electricity rate dropped less than 3%

Base Year	9/07-8/08	**$619,539**	
1st Year of application	9/08-8/09	**$551,914**	
1st Year Savings		**$67,625**	**or 20% reduction**
Base Year	9/07-8/08	**$619,539**	
2nd Y-T-D Totals	9/09-12/09	**$530,649**	
2nd Y-T-D Savings		**$88,890**	**or 24% reduction**
Savings since application in Summer of 2008		**$87,515**	

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1st Year of application	9/08-8/09	**$551,914**	
1st Year Savings		**$67,625**	**or 11% reduction**
Base Year	9/07-8/08	**$619,539**	
2nd Y-T-D Totals 2nd	9/09-12/09	**$530,649**	**or 14% reduction**
Y-T-D Savings		**$88,890**	
Savings since application in Summer of 2008		**$156,515**	

Note 2: Unlike Tomball J.H., this roof was not fully coated; approx. 66% was coated. A 100% coating would have resulted in a much higher cost reduction.

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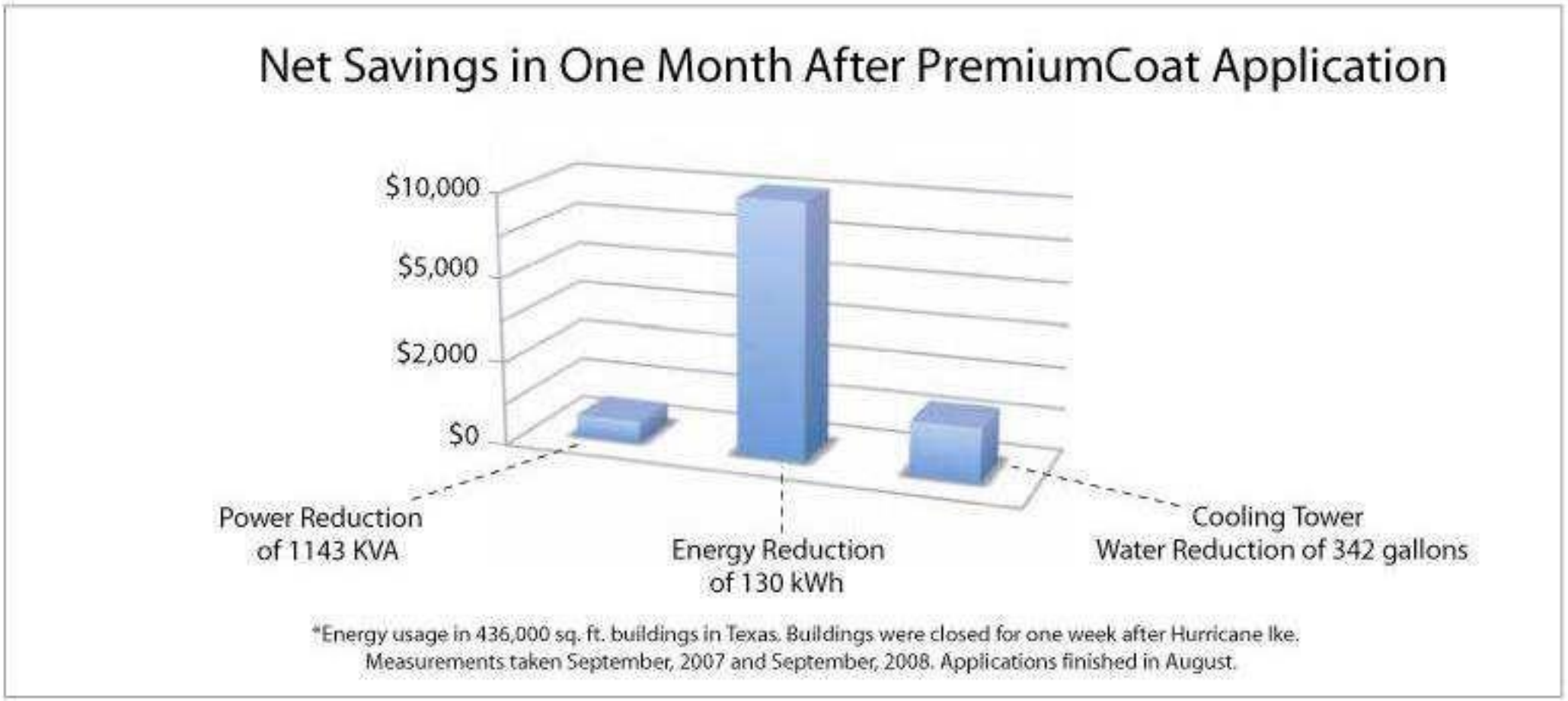
Tomball – net savings graph



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Low Budget, Low Maintenance

- Low-cost repairs performed quickly and easily.
- No seams, adhesives, or fasteners.
- No heavy equipment.
- Repairs can be made by trained maintenance staff.

Extend Roof Life Span:

Renewable Warranties

Unlike traditional roofing, acrylic-based F.A.S. weather from the top down. A measurable amount of surface millage is lost over the life of the product and can be replaced by additional coatings. Due to the chemistry of a F.A.S., the “regenerated” roof is as strong as the original installation and will last for another set time period depending on the additional coating’s millage.

F.A.S. that utilize a CRRC approved top coating will reduce the surface temperature as well as the internal temperature of a building. Any reduction of roof temperature will prolong the lifespan of not only that F.A.S., but any pre-existing roofs and insulations.

CRRC F.A.S. will also benefit roof mounted HVAC units. Cooler air will be used in the heat exchange, which makes the units more efficient. Reductions in internal temperatures will also decrease usage, prolonging equipment life.

May be eligible for LEED points.

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ROI Phase Three

Renewal Cost

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- Assume cost to renew doubles.
- $7 sq. ft

Traditional

- Assume cost stays the same.
- $10 per sq. ft

Savings: $1.35 Million

ROI for One Life Cycle

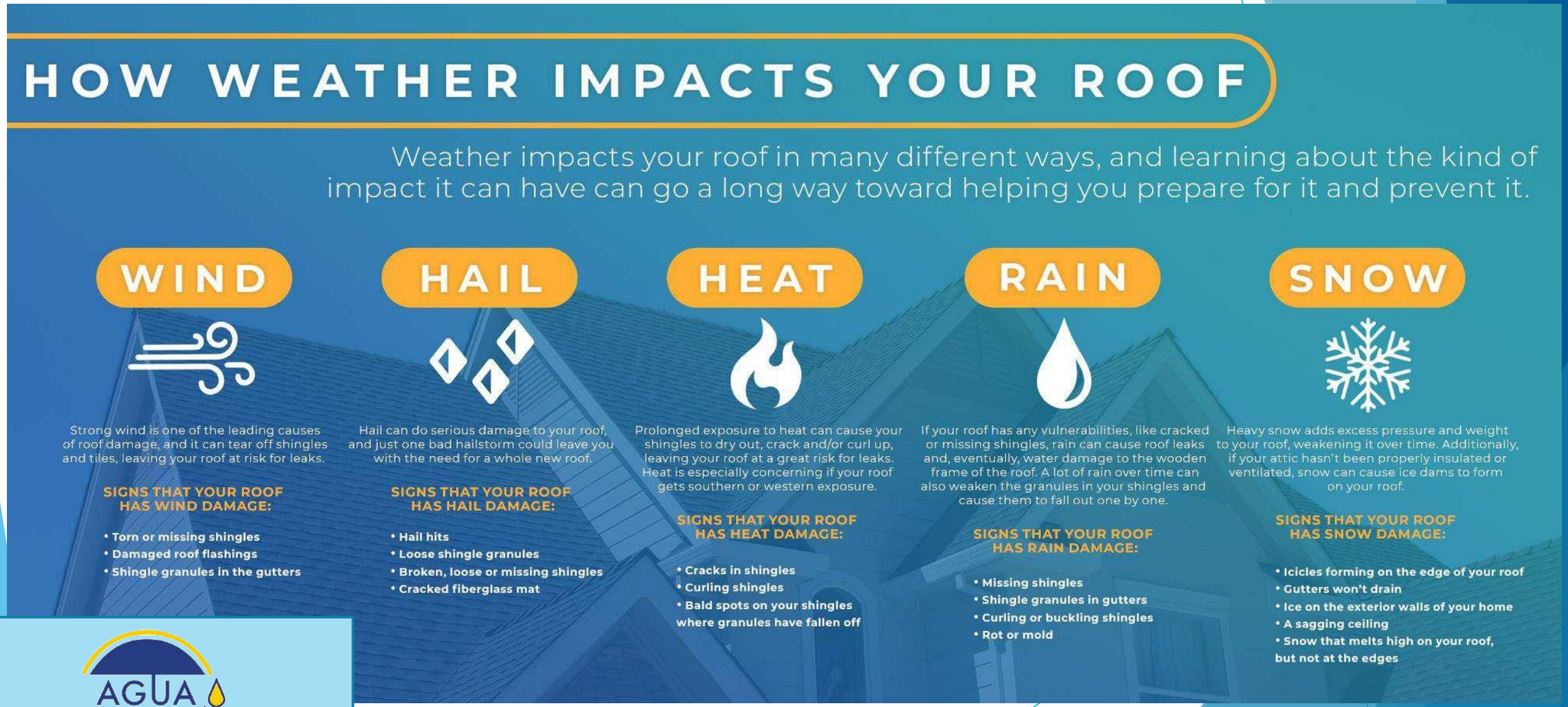
$2.1 million No tear off

$2.4 million energy savings

$1.35 million renewal

Total-$7.2 Million

Weathering


HOW WEATHER IMPACTS YOUR ROOF
Weather impacts your roof in many different ways, and learning about the kind of impact it can have can go a long way toward helping you prepare for it and prevent it.
WIND
Strong wind is one of the leading causes of roof damage, and it can tear off shingles and tiles, leaving your roof at risk for leaks.
SIGNS THAT YOUR ROOF HAS WIND DAMAGE:
• Torn or missing shingles
• Damaged roof flashings
• Shingle granules in the gutters
HAIL
Hail can do serious damage to your roof, and just one bad hailstorm could leave you with the need for a whole new roof.
SIGNS THAT YOUR ROOF HAS HAIL DAMAGE:
• Hail hits
• Loose shingle granules
• Broken, loose or missing shingles
• Cracked fiberglass mat
HEAT
Prolonged exposure to heat can cause your shingles to dry out, crack and/or curl up, leaving your roof at a great risk for leaks. Heat is especially concerning if your roof gets southern or western exposure.
SIGNS THAT YOUR ROOF HAS HEAT DAMAGE:
• Cracks in shingles
• Curling shingles
• Bald spots on your shingles where granules have fallen off
RAIN
If your roof has any vulnerabilities, like cracked or missing shingles, rain can cause roof leaks and, eventually, water damage to the wooden frame of the roof. A lot of rain over time can also weaken the granules in your shingles and cause them to fall out one by one.
SIGNS THAT YOUR ROOF HAS RAIN DAMAGE:
• Missing shingles
• Shingle granules in gutters
• Curling or buckling shingles
• Rot or mold
SNOW
Heavy snow adds excess pressure and weight to your roof, weakening it over time. Additionally, if your attic hasn't been properly insulated or ventilated, snow can cause ice dams to form on your roof.
SIGNS THAT YOUR ROOF HAS SNOW DAMAGE:
• Icicles forming on the edge of your roof
• Gutters won't drain
• Ice on the exterior walls of your home
• A sagging ceiling
• Snow that melts high on your roof, but not at the edges
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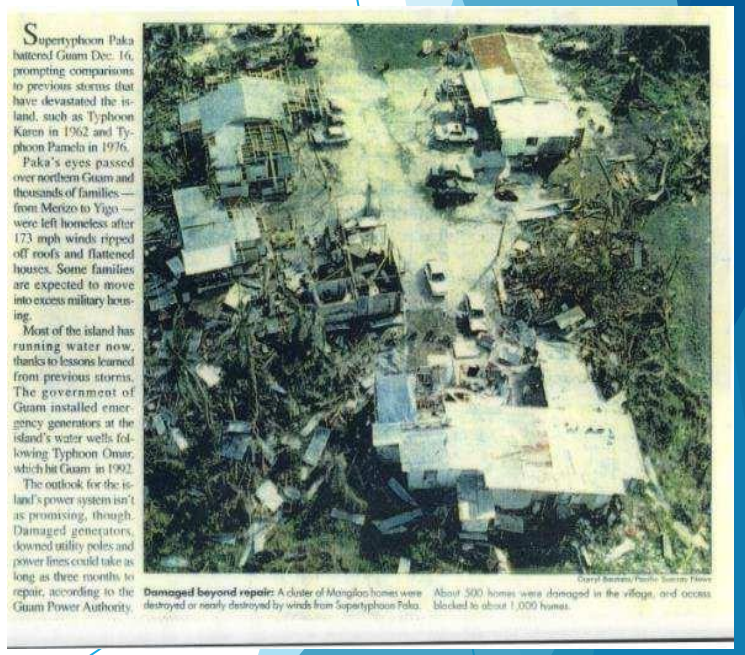
Wind-FM 4470

- Extreme weather resistance
- Withstood Super Typhoon Paka
  - Sustained winds of 145 mph
  - Wind gusts of over 236 mph
- All 240+ roofs intact

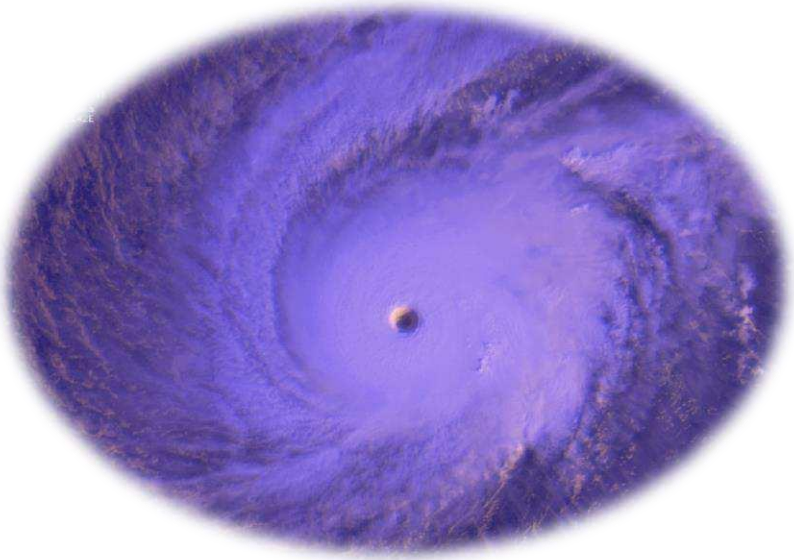

Supertyphoon Paka battered Guam Dec. 16, prompting comparisons to previous storms that have devastated the island, such as Typhoon Karen in 1962 and Typhoon Pamela in 1976.

Paka's eyes passed over northern Guam and thousands of families — from Merizo to Yigo — were left homeless after 173 mph winds ripped off roofs and flattened houses. Some families are expected to move into excess military housing.

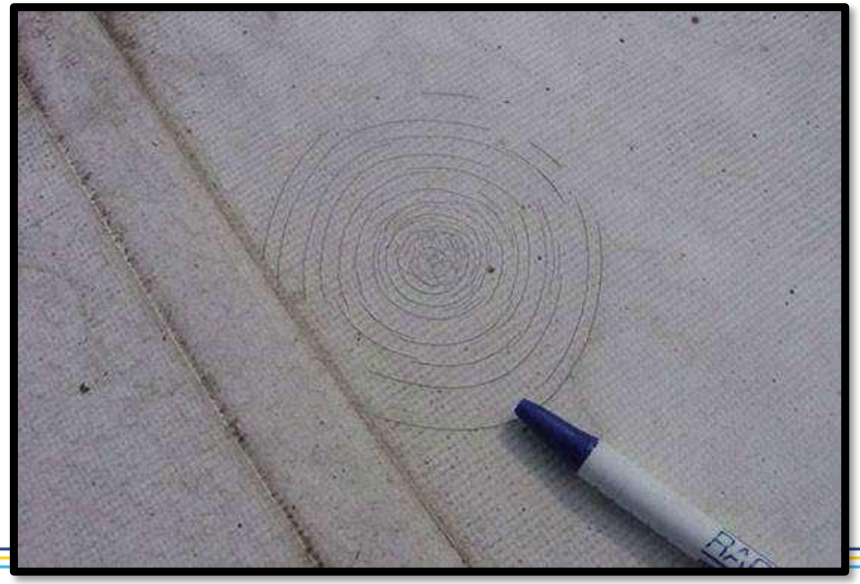
Most of the island has running water now, thanks to lessons learned from previous storms. The government of Guam installed emergency generators at the island's water wells following Typhoon Omar, which hit Guam in 1992.

The outlook for the island's power system isn't as promising, though. Damaged generators, downed utility poles and power lines could take as long as three months to repair, according to the Guam Power Authority.

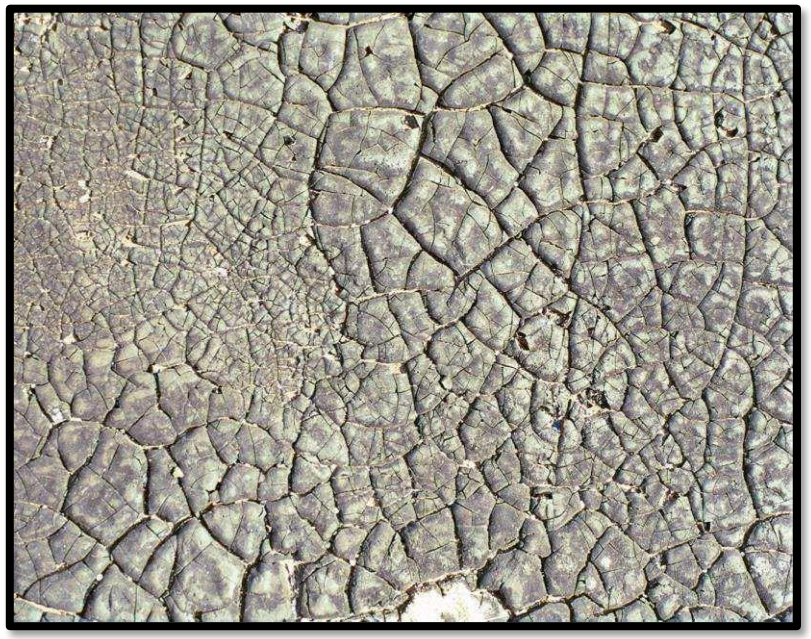
Damaged beyond repair: A cluster of Mangilao homes were destroyed or nearly destroyed by winds from Supertyphoon Paka. About 500 homes were damaged in the village, and access blocked to about 1,000 homes.



Hail-FM-4470



Heat



Apps: Details/Accessories

7 Points of Failure

- Drains
- Flashing
- Seams
- Penetrations
- Expansion Joints
- Corners
- Perimeter

Drains

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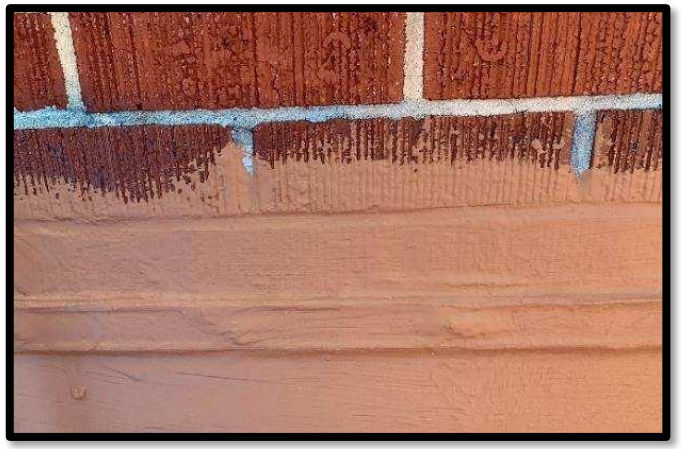
Wall Details

Flashing



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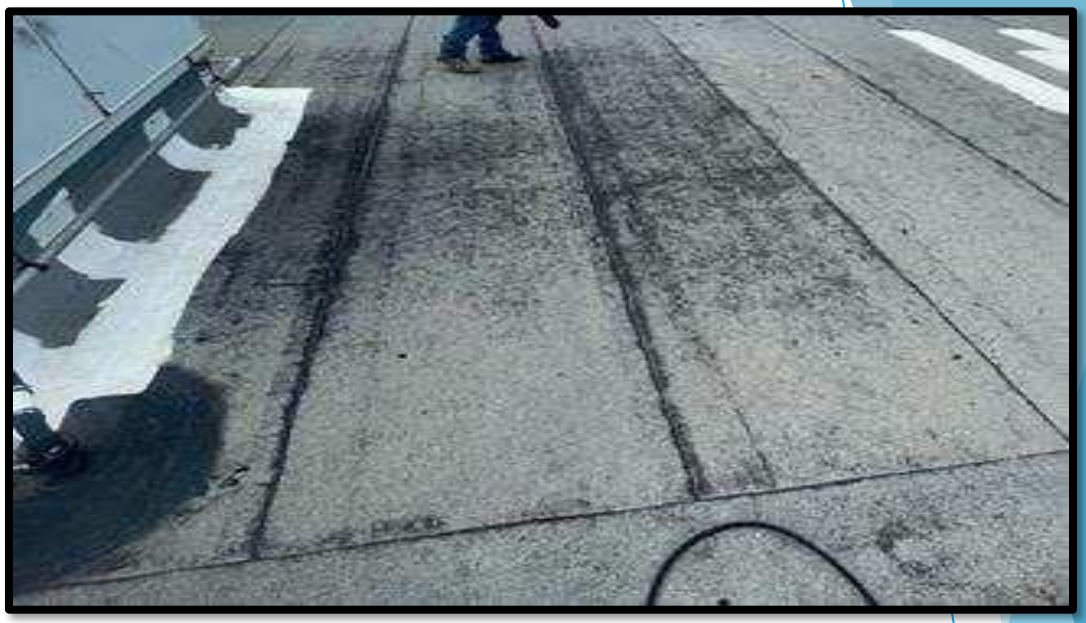
Seams



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Seamless

Monolithic

Penetrations

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Expansion Joints

Expands and contracts with underlying structure.

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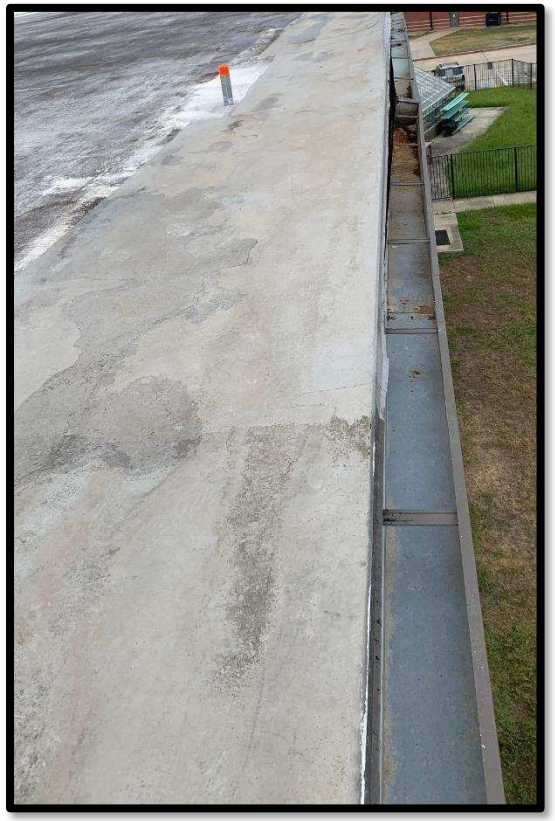
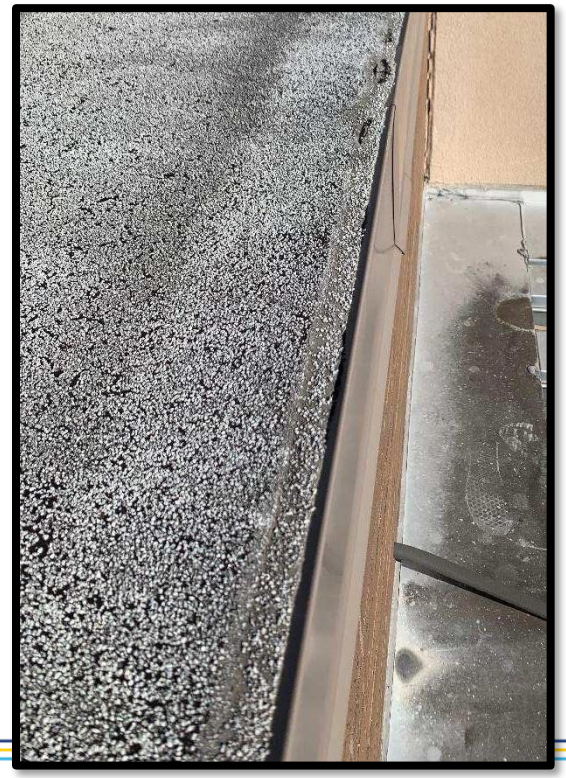
Corners

AGUA SEAL

Perimeter





Self Adhering

Warranties

Application Error

- Seams, Corners

Failure to Maintain

Assembly System Failure

- Drains, Expansion Joints, Penetrations, Flashings

Owner made unauthorized repairs.

Result - Failure Points Not Covered!

AguaSeal NO LEAKS!

Fluid Applied fabric reinforced roofs are…

- Cost Effective
- Energy Efficient
- Sustainable Roofing

…that eliminates leaks for the life of the building.

A Roof Like No Other

Your Guide to Rooftop Excellence

LiveRoof®
Dedicated to Your Success

Green Roofs Provide Ongoing Cost Benefits and Much More!

LiveRoof®
Dedicated to Your Success

Green Roofs Can Turn Ugly Rooftops Into Beautiful Usable Space

LiveRoof®
Dedicated to Your Success

Green Roofs Save Money

Extends Roof Life – 2x-3x

Turn a 30 Year Roof Into a 90 Year Roof

LiveRoof®
Dedicated to Your Success

Stormwater Code Compliance With Benefits

Stormwater compliance means reduced or no water discharge fees.

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Dedicated to Your Success

Reduced Healing Time

Patients with a natural view heal faster and experience less pain.

LiveRoof®
Dedicated to Your Success

They Save Energy

Green roofs reduce AC costs by approx. 10-75% during hot weather.

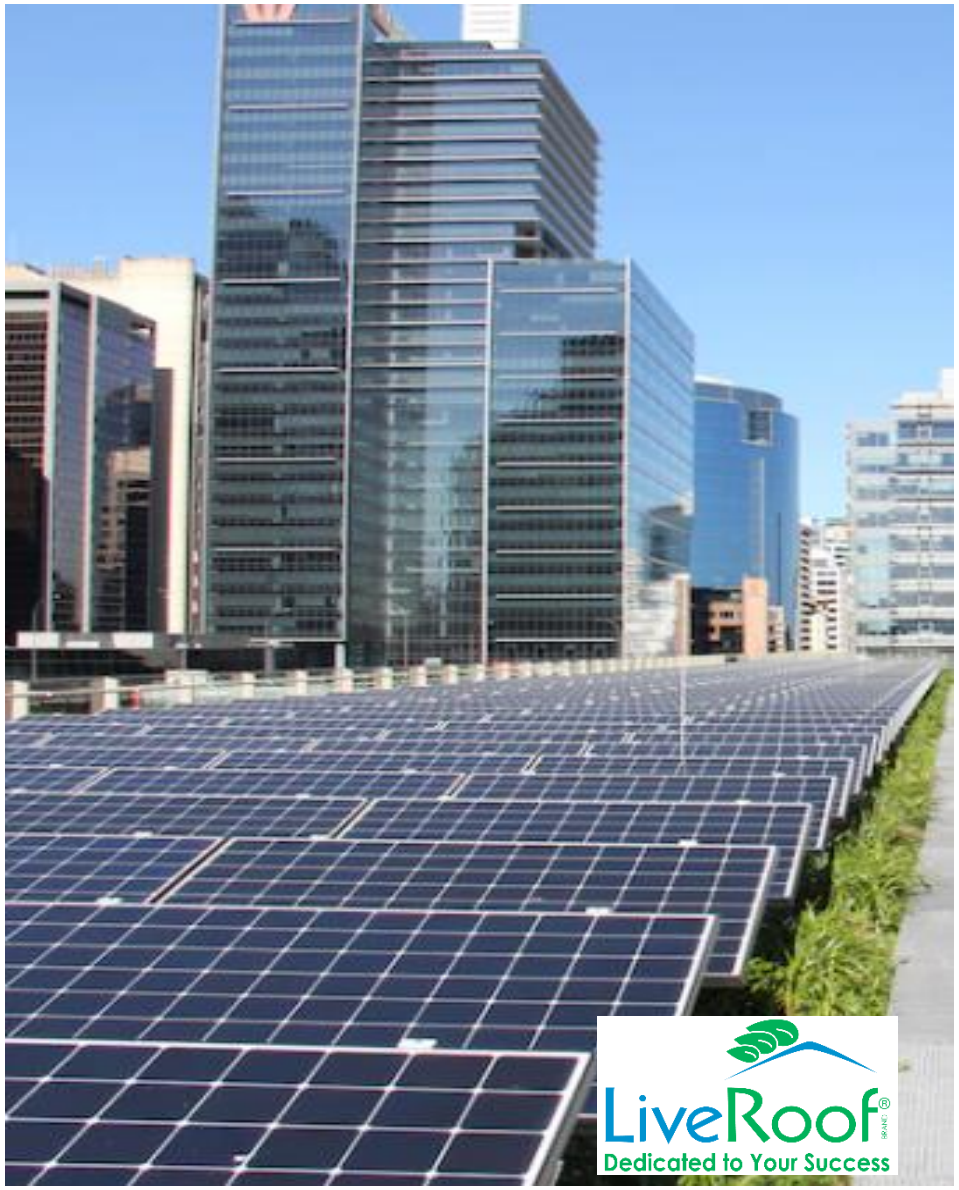
Increase Revenue

Visible green roofs can boost rental rates and Increase occupancy.

LiveRoof®
Dedicated to Your Success

Boost Solar Output

Evaporative Cooling (from LiveRoof plants) cools the air and makes solar panels 5-15% more efficient.



Increase Productivity and Prevent Employee “Burnout”

When employees work in more natural environments, stress is reduced and job satisfaction is increased.

Display Stewardship to Foster Goodwill.

Vegetated roofs filter pollutants from runoff before it reaches waterways.

LiveRoof®
Dedicated to Your Success

Promote Your Cause

Like this cancer treatment hospital.

LiveRoof®
Dedicated to Your Success

Expand Usable Space

Rooftop gardens with pathways and patios make buildings more usable.

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Retrofit for Posterity

Green Roofs are for Old as well as New buildings.

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Green Roofs are Beautiful

LiveRoof®
Dedicated to Your Success

LiveRoof Systems

Green Roof Modules

- 4.25” STANDARD Vegetated Module
- 6.5” DEEP Vegetated Module
- 8” MAXX Vegetated Module

RoofBlue

- RETAIN
- DETAIN

RoofEdge

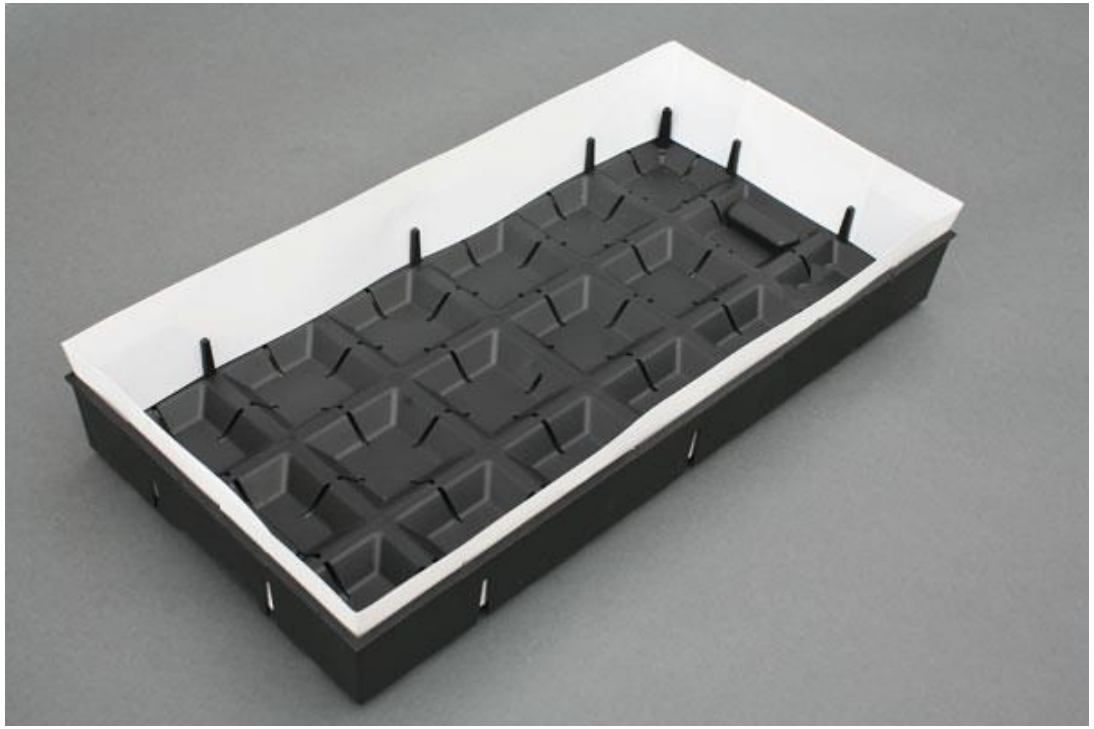
- 4.25, 6.5 and 8 inch aluminum edging and corners

RoofStone

- Non pedestal paver system

4.25" STANDARD Module

Module with soil elevators installed



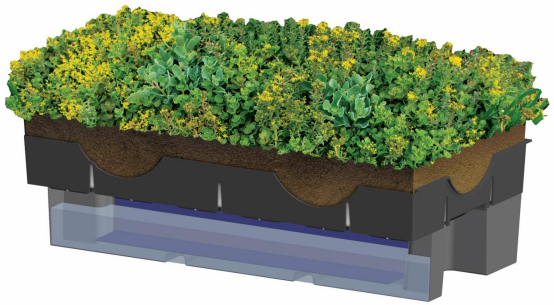
Engineered soil

Vegetated Module

LiveRoof® has 2 great options for Enhanced Stormwater Management

RoofBlue® RETAIN™

To Reduce Runoff



RoofBlue® DETAIN™

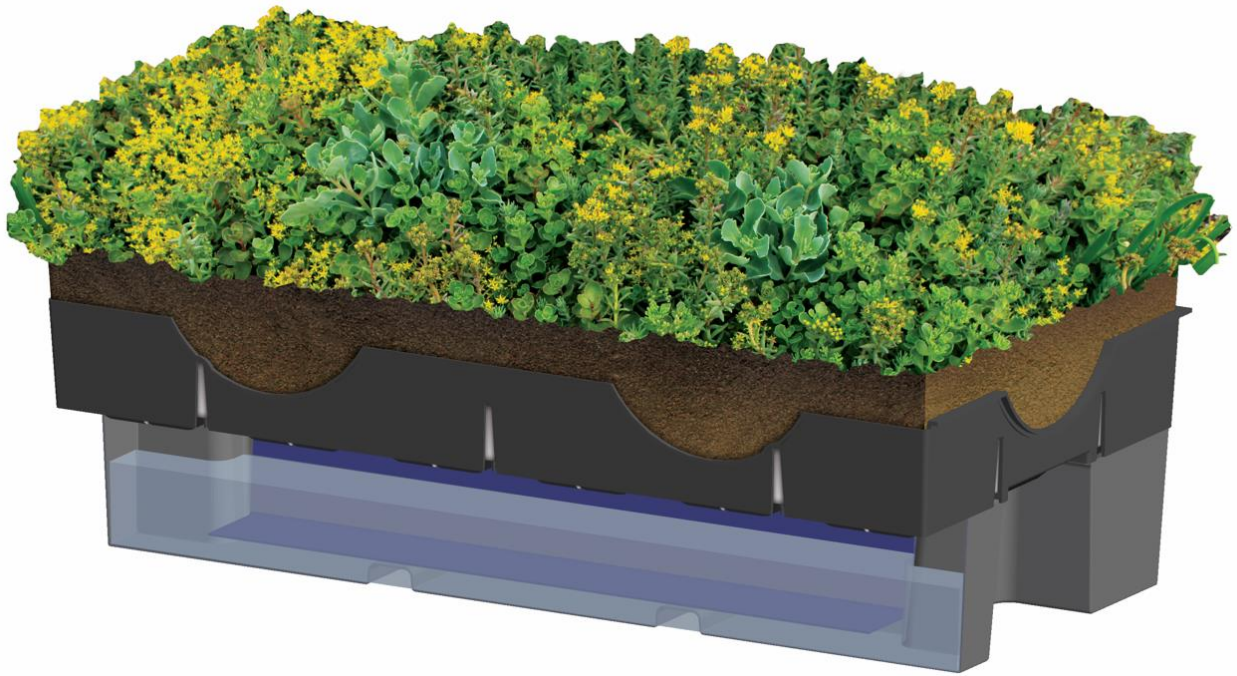
To Delay Runoff

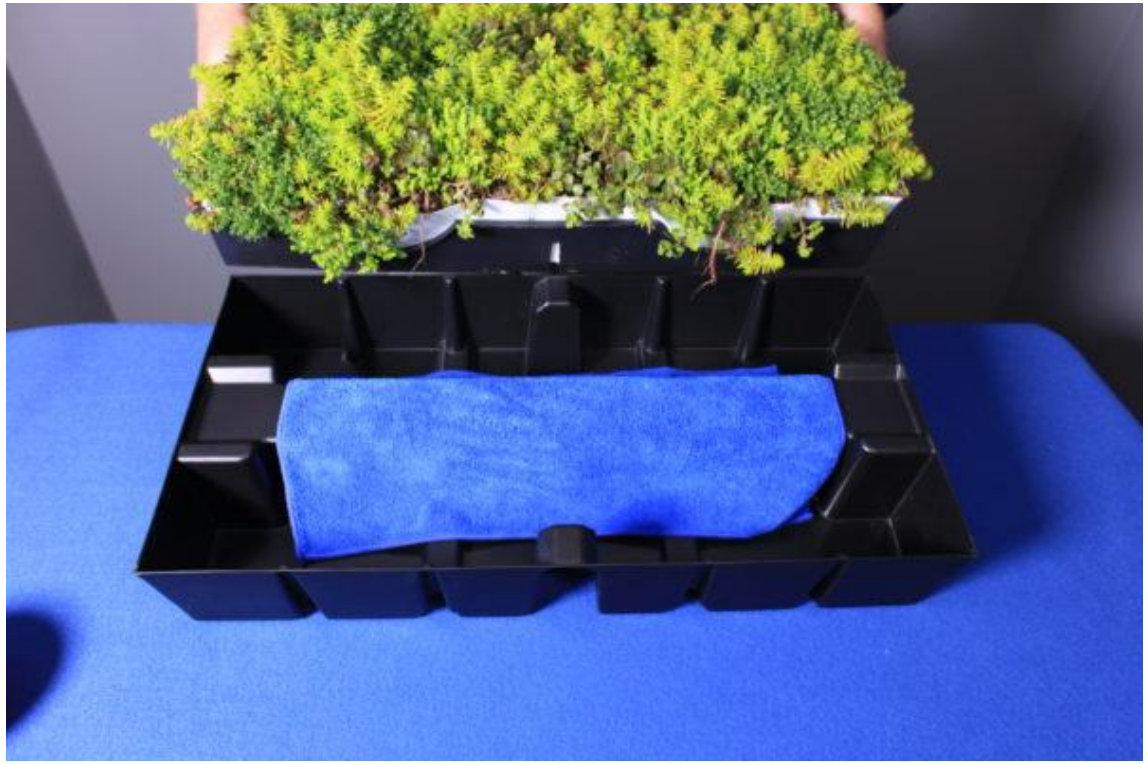
for use with control-flow drains

RoofBlue® RETAIN™

RoofBlue RETAIN captures and ***retains*** storm water.

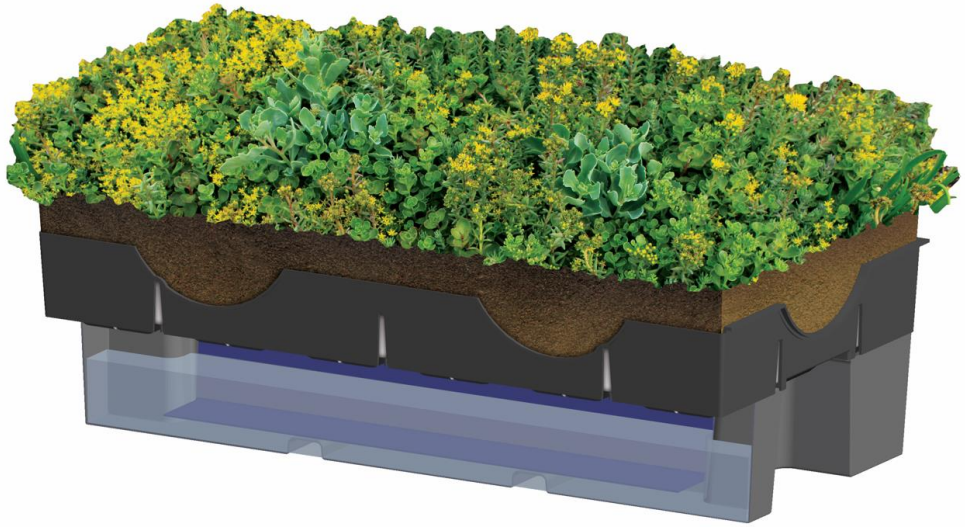
Later transfers storm water upward to the plant roots, for plant growth and transpiration (to the atmosphere).



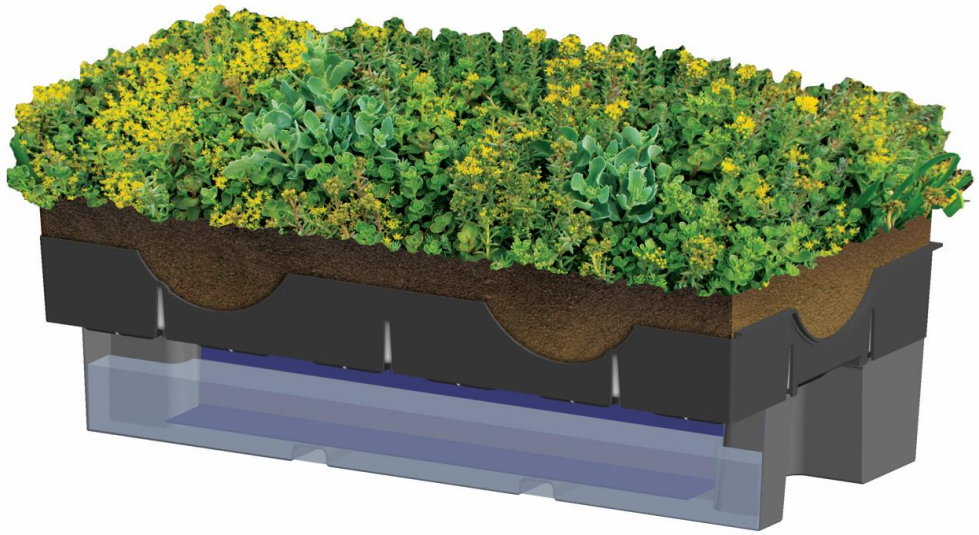


LiveRoof® RETAIN™ REDUCES STORMWATER RUNOFF

- University study shows 46% Retention with LiveRoof® Standard and 66% when combined with **RoofBlue Retain** during one year.
- Study showed that with medium rain events(.041”-1”) RoofBlue Retain captured over <u>80% on average</u>.



RoofBlue® RETAIN™



RoofBlue® RETAIN™

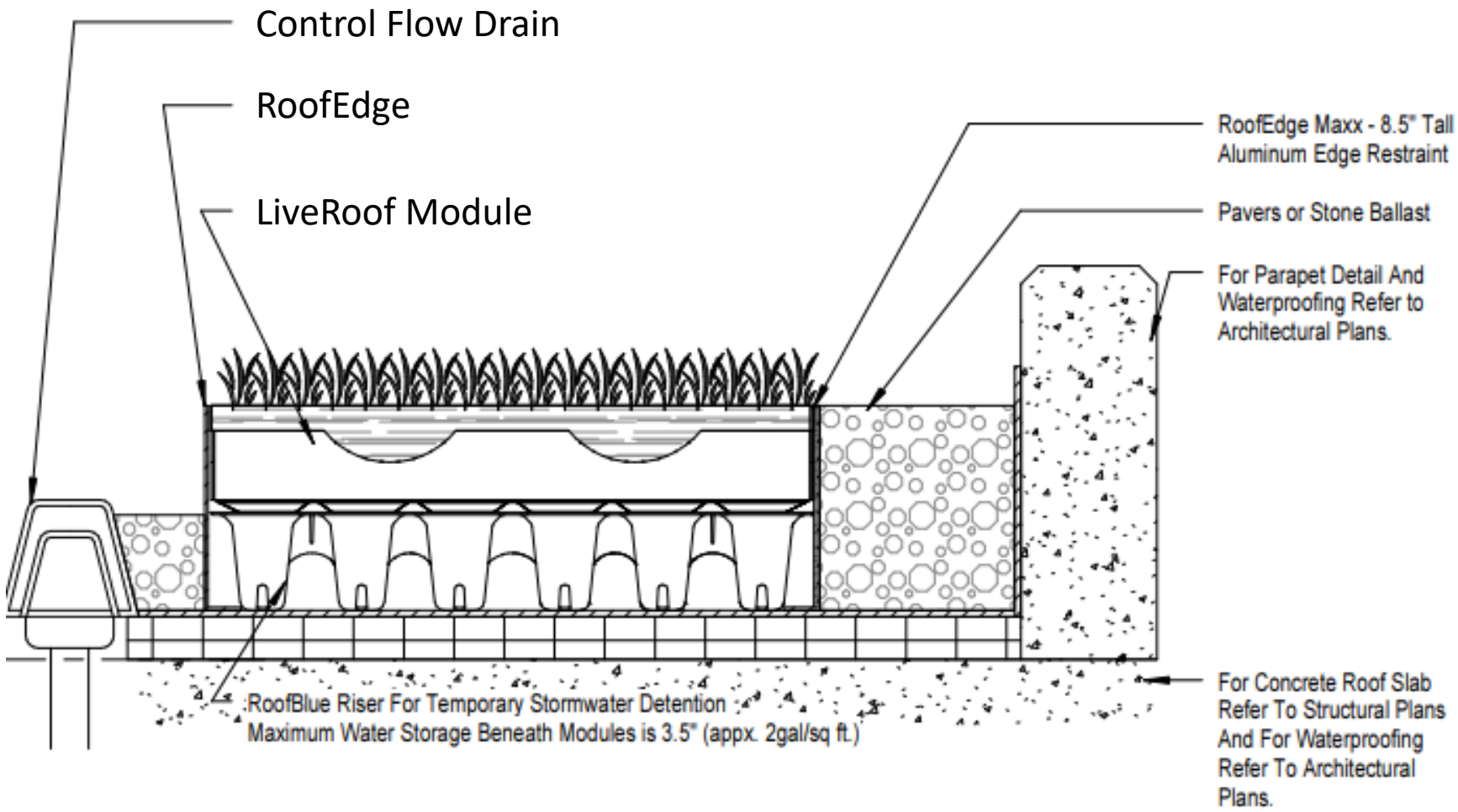
Total Water Storage of LiveRoof Module and Retain

Maximum Water Holding Capacity of **RoofBlue RETAIN module**	2.16 in 1.35 gal/ft²			
LIVEROOF MODULE SIZE	LITE	STANDARD	DEEP	MAXX
Maximum Water Volume **Retention (LiveRoof Module + RoofBlue RETAIN)**	3.17 in 2.05 gal/ft²	3.91 in 2.45 gal/ft²	4.51 in 2.85 gal/ft²	5.31 in 3.35 gal/ft²
Design Dead Load **(LiveRoof Module + RoofBlue RETAIN)**	≤29.5 lbs/ft²	≤41.5 lbs/ft²	≤62.5 lbs/ft²	≤77.5 lbs/ft²

RoofBlue® DETAIN™

RoofBlue Stormwater Detention System Designed For Use with the LiveRoof Green Roof System

When used with control flow drains, RoofBlue DETAIN expands the usefulness of a green roof system as a stormwater management tool.



Another Effective option from LiveRoof®

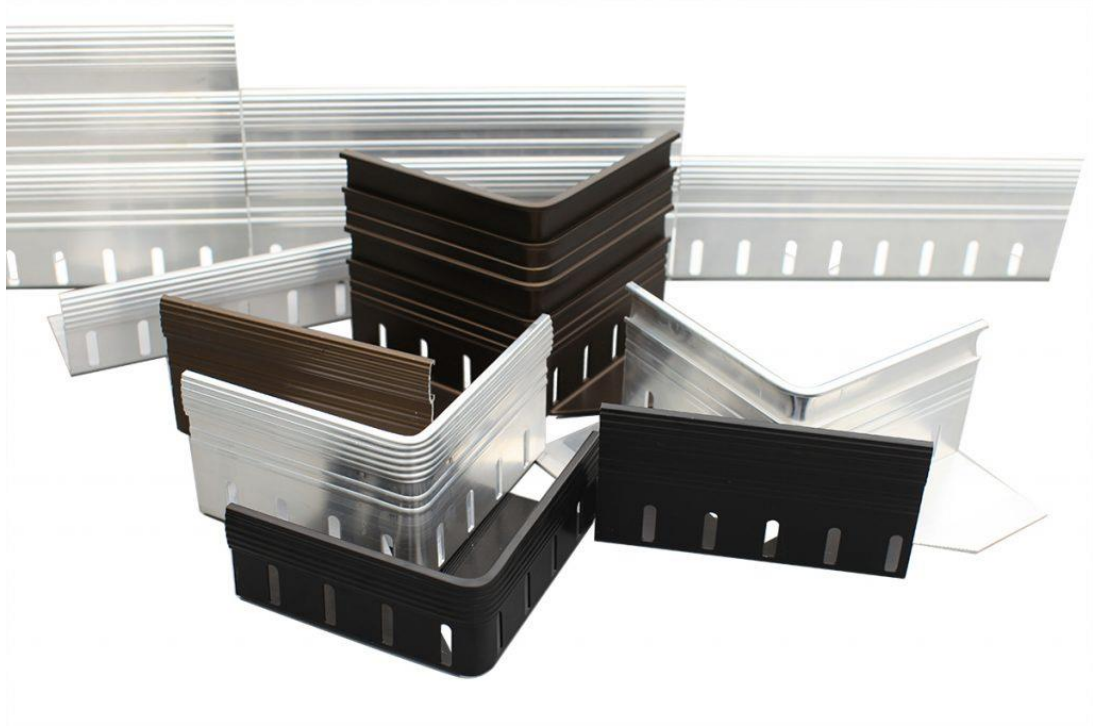
for use with control-flow drains

RoofBlue® DETAIN™

Delays stormwater

Maximum Water Depth	3.5 in
Void Space	90.5%
Maximum Water Volume **Detention** below the green roof system	456 in^3 / 0.26 ft^3 1.97 gal/ft^2
Additional design dead load	18.2 lbs/ft^2

RoofEdge® Aluminum Edge Restraint



RoofStone® Integrated Pavers

- **Contributes to Stormwater Management:** In a recent study, RoofStone pavers **retained 25%** of annual rainfall.
- Integrates with weight, height and dimensions of LiveRoof Standard and Deep modules.
- Installs in 1/10th time and labor as traditional pedestal and paver solutions
- Eliminates the need for RoofEdge between pavers and modules
- Recycled plastic base.

RoofStone® Integrated Pavers

- **ADA Compliant** when set on pitch of ¼” per 1’ or less.
- **Size:** 24” L x 12” W x 4” H
- **Weight:** 50 lbs
- **Finish:** Beautiful artisan surface, top edge chamfered, sides with chip-preventing, water-conducting standoffs.
- **LEED Interface:** Base of 95% post-industrial polypropylene. Concrete recycled content varies with paver color.
- **Compressive Strength:** 5000+ psi at 28 days; exceeds SPRI standard of 3000 psi by greater than 50%.
- **Flexural Strength:** 770+ psi at 28 days per ASTM C140.
- **Water Absorption:** Less than 5% by cold water method at 28 days per ASTM C140.
- **Air Content:** 4 to 8% maximum.

RoofStone® Integrated Pavers

RoofStone Paver	Conventional Pedestal & Paver	
Pedestal	Built-in	Purchased separately
Edging	Not required at green roof interface	Required
Installation	Fast, easy, inexpensive, labor saving	Can be cumbersome and costly

LoanSTAR Revolving Loan Program

- Revolving loan to finance energy-related, cost-reduction retrofit projects
- Cities, counties, independent school districts, state agencies, public institutions of higher education and tax-supported public hospital districts are eligible
- Loans repaid from energy cost savings realized by projects. Up to $6 million in financing
- Borrower must own and occupy the facility where the proposed retrofit project will occur

Open enrollment begins June 1, 2024

Property Assessed Clean Energy (PACE)

- 100% long-term, low-cost private financing made possible with assessment lien imposed on property
- Commercial, non-profit, industrial & multi-family (5+ units) eligible
- Energy efficiency, water conservation, distributed generation, and demand reduction (resiliency) projects eligible
  - Chillers, boilers, HVAC, lighting, energy management systems, roofing, windows, doors, insulation, elevator modernization, solar panels, toilets, greywater systems

EPA Community Change Grants Program

- Grant funding for community-driven projects that address climate challenges and reduce pollution while strengthening community engagement
- Partnership between community-based non-profit organization and a local government (COG)
- Will fund ~150 grants of $10 million - $20 million each

Energy Efficient Commercial Buildings Tax Deduction

- Building owners who install energy efficient commercial building property or energy efficient commercial building retrofit property
- Must be part of a plan to reduce the buildings total annual energy and power costs by 25% or more
- $0.50 per square foot for a building with 25% energy savings
- Up to a maximum of $1.00 per square foot for a building with 50% energy savings

Thank You For Your Time!

Contact Us

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Take Our Survey!