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Context

DENVER'S SUSTAINABILITY GOALS AND STRATEGY

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Sustainability Defined

- What do we mean by “sustainability”?

Ensure a high quality of life for everyone in Denver now and in the future.

“Generations we will never meet.”

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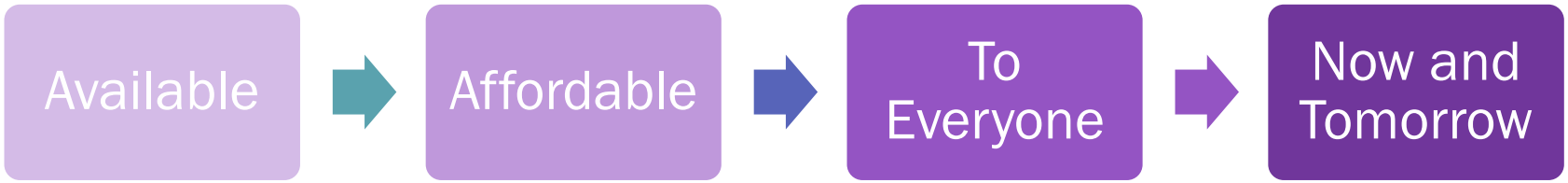
Basic Resources

- Air Quality
- Climate Stability
- Energy
- Materials
- Water Quality
- Water Quantity
- Food
- Health
- Housing
- Land Use
- Mobility
- Workforce



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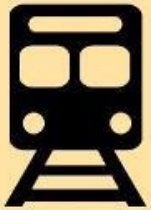
2020 Sustainability Goals

Air Quality	Climate	Energy	Food
			
Attain all National Ambient Air Quality Standards	Reduce Denver CO_2 emissions to below 1990 levels	Hold total energy usage below 2012 levels, while cutting fossil fuels by 50%	Grow and/or process at least 20% of food purchased in Denver in Colorado
Health	**Housing**	**Land Use**	**Materials**
			
Increase the % of youth in Denver at a healthy weight from 69% to 74%	Ensure 80% of neighborhoods are rated as affordable	Move Denver's Walk Friendly rating to Platinum from Gold	Increase the citywide recycling rate to 34% or greater
Mobility	**Water Quality**	**Water Quantity**	**Workforce**
			
Reduce trips in single-occupant vehicles to no more than 60% of commutes	Make all Denver creeks and rivers swimmable and fishable	Reduce water usage by 22%	Help at least 40% of workers living in transit deserts get to work without driving alone

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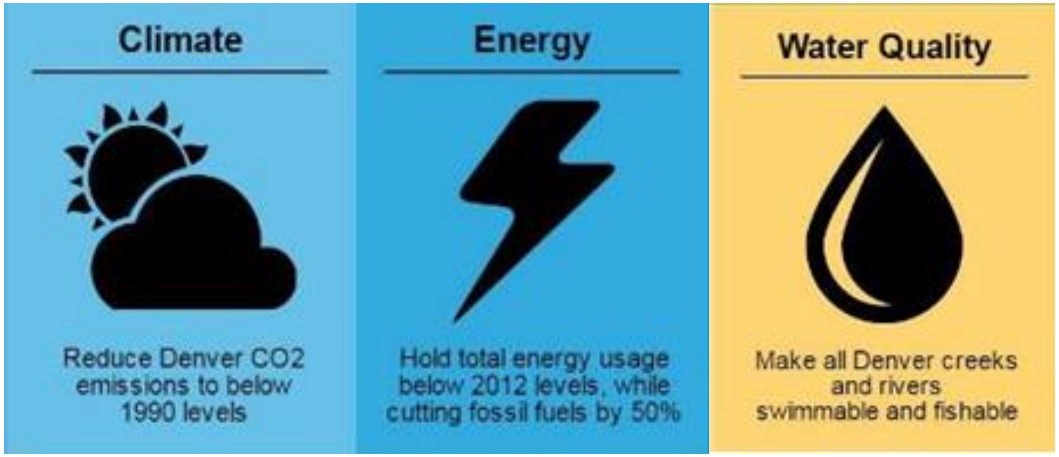
2020 Sustainability Goals



More Impact

Less Impact

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Climate ACTION Plan Goals

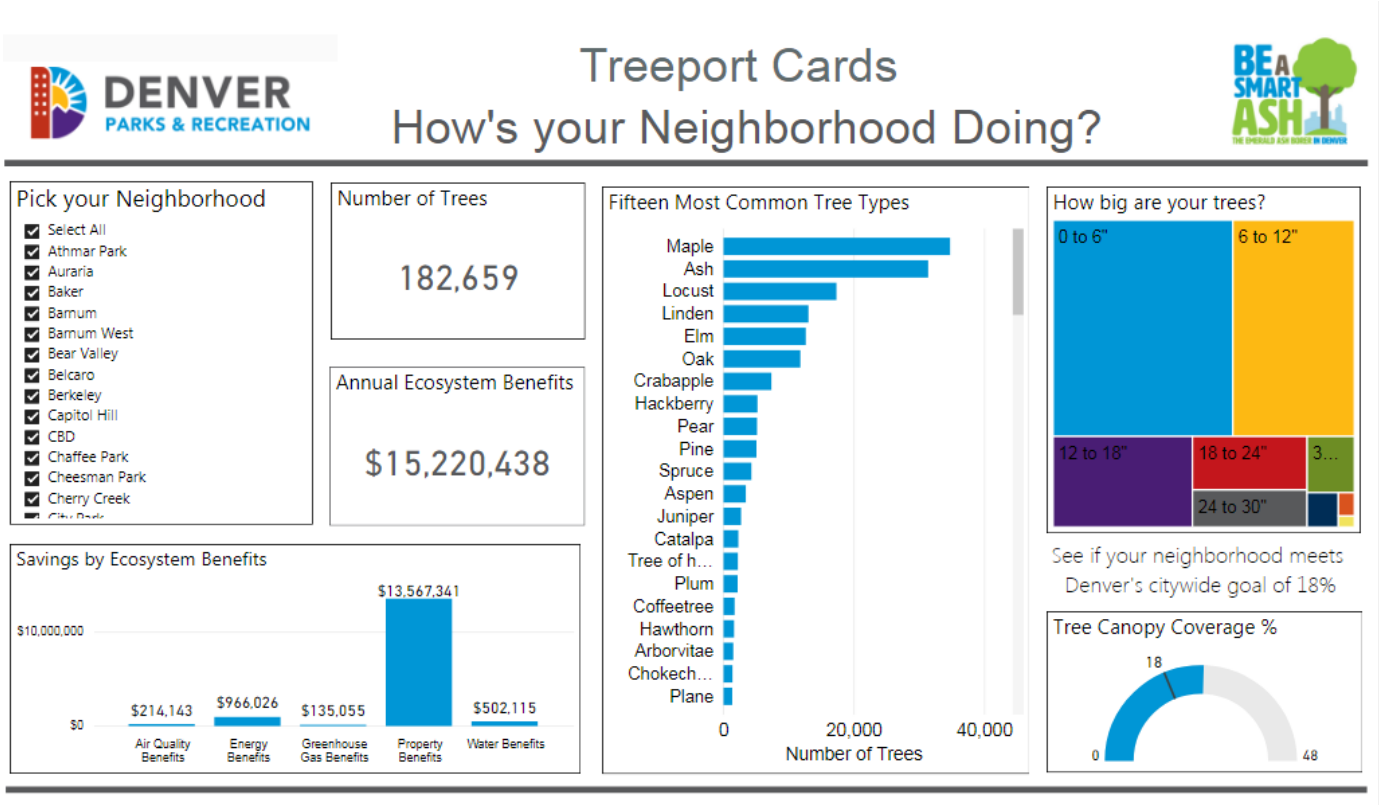
- 2020 Goal: Absolute reduction of GHG emissions to 1990 levels by 2020 – would require a 10 percent reduction of GHGs from 2005 levels
- 80% reduction in greenhouse gas emissions by 2050
- Tree Canopy: 18% goal; 19% per Executive Order 123

Climate ADAPTATION Plan Goals

- Buildings and Energy Sector
  - Goal 1: Reduce vulnerability to building energy supply disruptions
  - Goal 2: Reduce vulnerability of buildings to extreme weather
- Urban Natural Resources Sector
  - Goal 1: Enhance and preserve existing urban forest resources
  - Goal 2: Ensure all Denver streams are fishable and swimmable
- Food and Agriculture sector
  - Increase food security

Tree Canopy Goal

- Goal: 18% goal
- Executive Order 123: preserve 19%



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Headline Progress: Strategies Accomplished

- Non-City-Led Strategies Enacted
  - Clean Air Clean Jobs
  - Colorado Renewable Portfolio Standard
  - Demand-Side Management
  - Corporate Average Fuel Economy (CAFE) standards

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Headline Progress: Strategies Accomplished

- City-Led Strategies Enacted
  - Updated energy code to 2015 IECC
  - Joining into State's New Energy Improvement District to allow PACE financing
  - Energize Denver – existing building energy efficiency
    - Benchmarking requirement
    - Education and outreach, including promotion of PACE
  - Adoption of Greywater Ordinance allowing use

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Strategies In Progress

- Xcel's Colorado Energy Proposal
  - 55% Renewable Electricity by 2026
- 80x50 Plan in final development
  - 100% Renewable Electricity Goal, date to be set
- Exploring Voluntary Stretch Code

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Plans to Achieve Goals

- Sustainability Plan
- Climate Action Plan
- Climate Adaptation Plan
- 80x50 Plan (in development)
- Game Plan (in development)

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Climate ACTION Plan
Long-Term Strategies

Building Strategies

Category	Strategy/Activity	Priority
Building and energy codes	Phase in net-zero energy/carbon-neutral building codes.	High
District energy	Expand the use of district heating and cooling systems and decrease their carbon intensity through combined heat and power and distributed generation.	High
Finance	Develop meter-based financing programs to incentivize long-term efficiency upgrades and/or create incentives for renters.	High
Finance	Encourage and develop innovative financing programs for energy efficiency and onsite renewables (i.e., Property Assessed Clean Energy, revolving loan funds, and bond facilities).	High
Fuel switching	Incentivize switching away from natural gas heating to renewable electricity, geothermal or solar thermal.	High

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Climate Action Plan – Long-Term Strategies

Grid improvements	Expand high-efficiency transmission lines City-wide to reduce transmission and distribution losses.	High
Renewable energy	Implement shared renewable power purchasing programs.	High
Energy innovation	Support clean energy entrepreneurship and use City facilities for demonstration of new solutions.	Medium
Engagement and incentive programs	Expand advertising and outreach and set targets to increase residential energy efficiency programs in currently underserved communities.	Medium
Engagement and incentive programs	Structure permit fees to incentivize energy efficiency.	Medium
Demand side management	Incentivize use of "smart home" energy management systems.	Medium
Waste heat recapture	Create incentives for waste heat recovery in industrial processes, data centers, and new buildings; investigate waste heat recovery from sewer lines.	Medium

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Climate Action Plan – Long-Term Strategies

Urban and Natural Resources Strategies

Category	Strategy/Activity	Priority
Green infrastructure	Use green stormwater infrastructure when designing, building, or upgrading infrastructure.	High
Water conservation	Incentivize rainwater harvesting and conservation practices for residents.	High
Trees and open space	Protect existing tree canopy resources.	High
Trees and open space	Expand open space and green development projects.	Medium

Food Strategies

Category	Strategy/Activity	Priority
Urban farming	Reduce regulatory barriers to urban agriculture and increase acceptable zones for food production.	Medium
Urban farming	Promote development of rooftop gardens (e.g., on large commercial buildings).	Medium

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Data & Measures for Neighborhood Equity Index

Indicator	Measure(s)
1. Socioeconomic	• Families in poverty • Educational attainment
2. Built Environment	• Access to full service grocery stores • Access to parks or open space
3. Access to Care	• 1st Trimester care during pregnancy
4. Morbidity	• Children and youth overweight and obese
5. Mortality	• None –TBD

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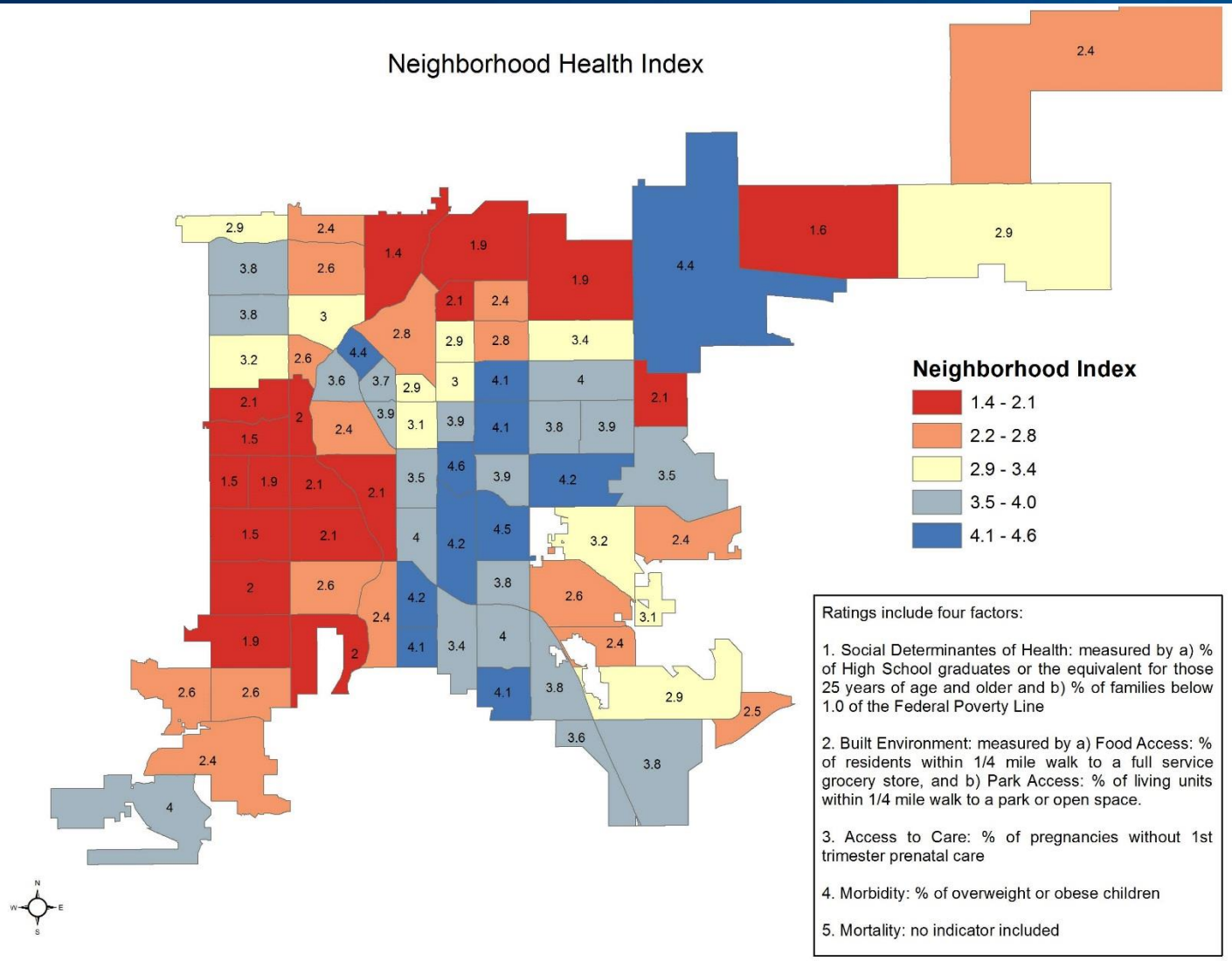
Neighborhood Equity Index



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Beginning to Populate the Framework

SOLAR

Renewable Energy Choices

Your guide to renewable energy choices through Xcel Energy

Kevin Cray – Solar Trade Relations Manager

COLORADO

Wide Array of Renewable Options

On-Site

Solar*
Rewards

Net Metering

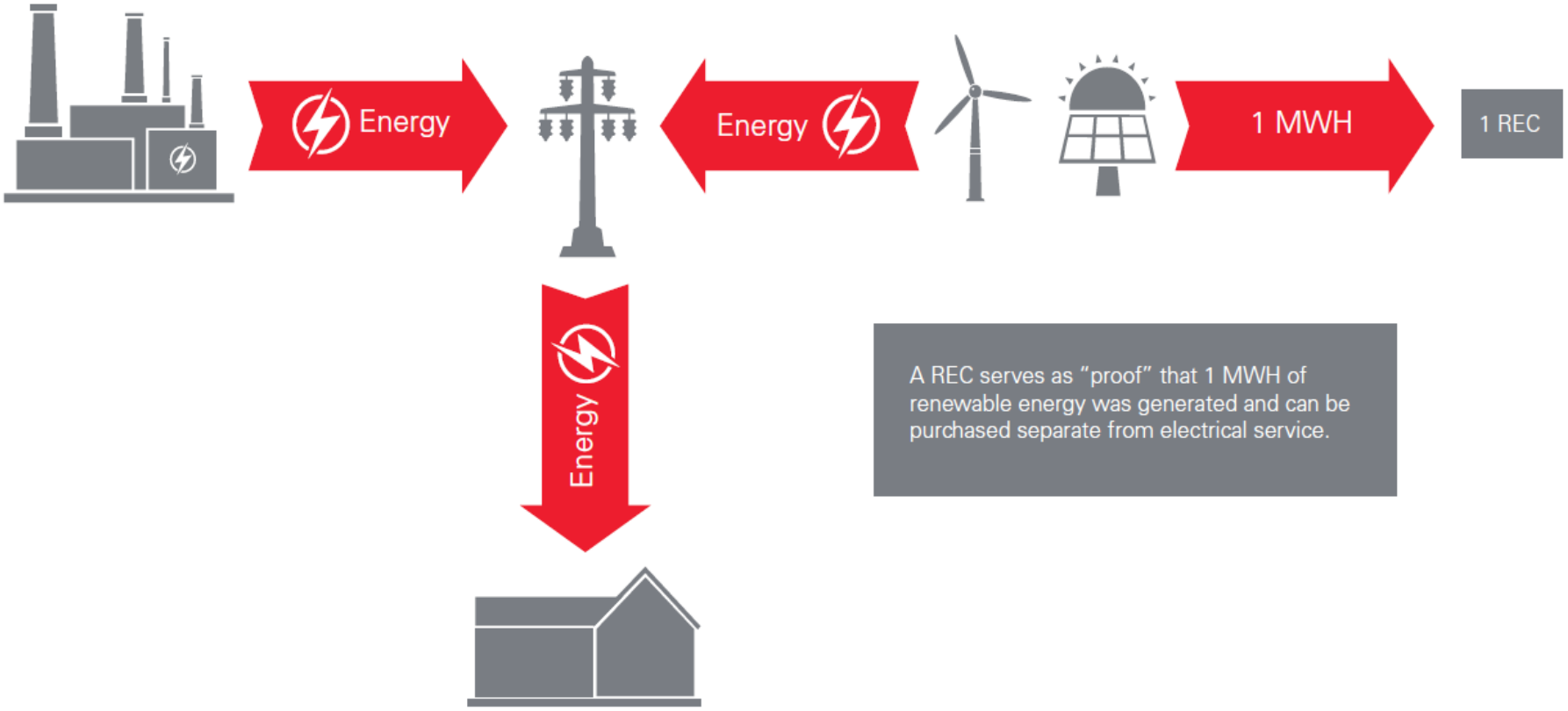
Subscription

Windsource

Solar*
Rewards
Community

Renewable*
Connect
(coming soon)

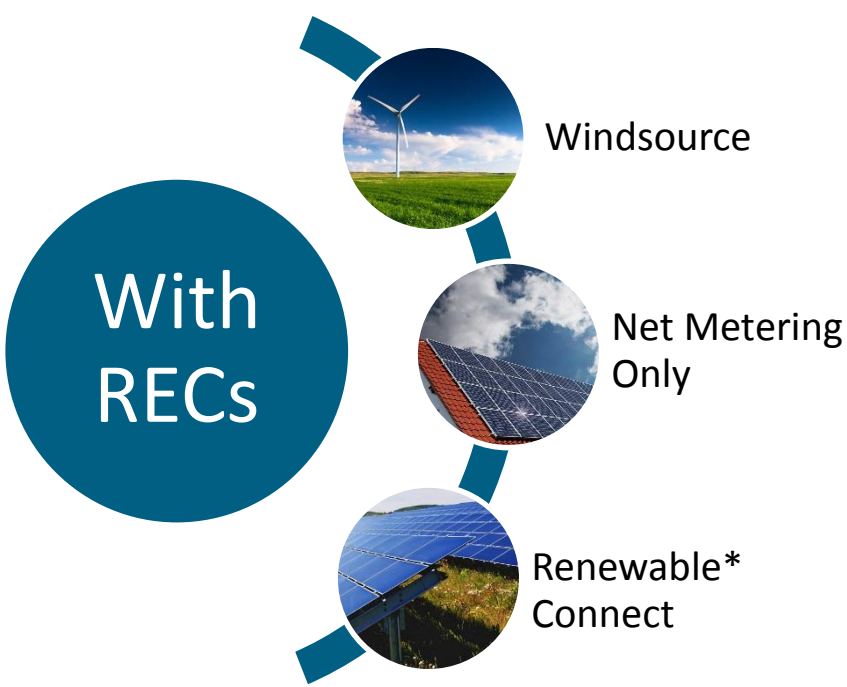
Renewable Energy Certificates (REC's)

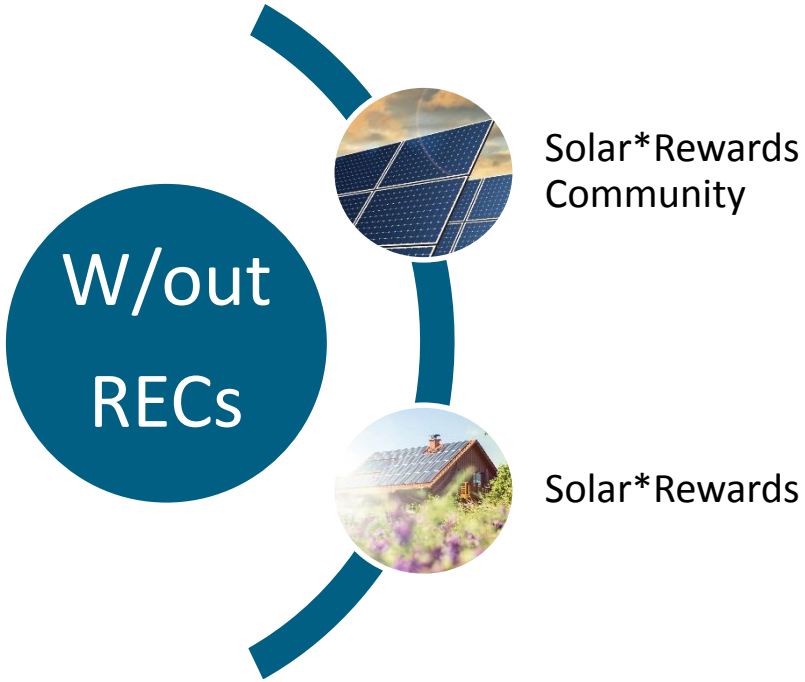


Source: Intermountain Rural Electric Association
https://www.irea.coop/customer-tools/recs/

When RECs are Yours to Claim

RECs can be used to reach sustainability goals, achieve green certification, and strengthen customer brands as they promoting their commitment to using clean energy. Some of our programs include RECs, while others do not.





On-Site Options

Solar*Rewards (+ Net Metering)

- Xcel Energy retains the REC
- Net metering
- Must use new equipment
- System can be sized up to 120% of customers history usage
- 20 year contract term
  - Small program (up to 25kW)
  - Medium program (25 -500kW)
  - Large program (>500kW)

Net Metering Only

- Customer keeps the REC
- Net metering
- Can use existing/used equipment
- System can be sized up to 120% of customers history usage
- Open enrollment: no application expiration

Subscription Options

Solar*Rewards Community®

- 3rd party subscriptions
  - Gardens are owned and maintained by private companies
- Xcel Energy retains the RECs
- Monetary bill credit on Xcel Energy bill
- Subscribe up to 120% of historic usage

Windsource®

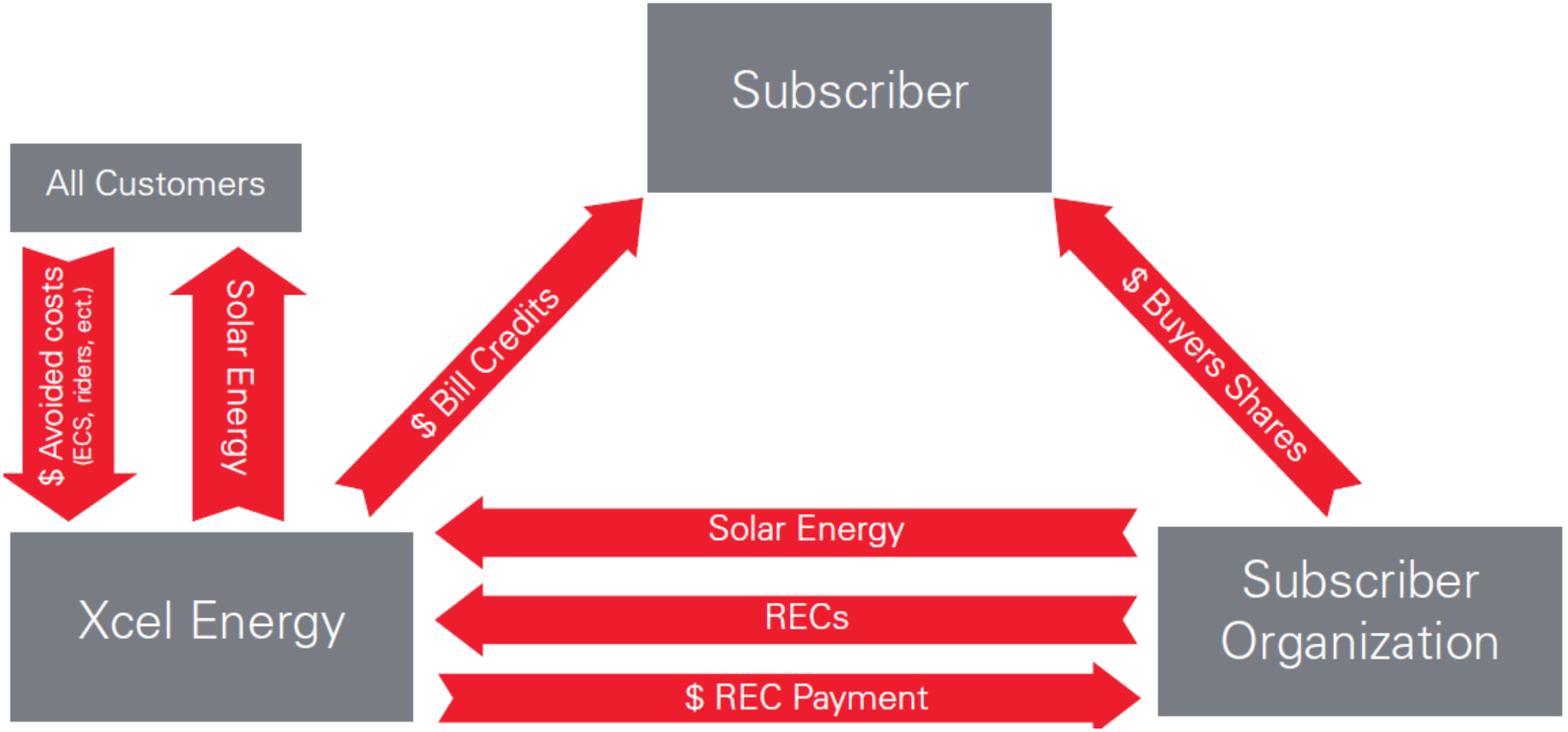
- 100% local wind to offset your energy use
- Sold in 100 kWh blocks
- Customer keeps the REC
- Up to 100% of energy use
- Net cost = 1.5¢ / kWh

Renewable*Connect

- Approved by PUC
- Coming in late 2018
- 100% large scale solar that will be locally sourced
- Customer keeps the REC
- Cost TBD
- Contract directly with Xcel Energy

Questions?

Third Party Community Solar Model



Programs at a Glance

	Renewable*Connect	Windsource	Solar*Rewards Community	Solar*Rewards	Net Metering
Renewable Energy Source	50 MW of additional competitively bid Colorado solar	Colorado wind	Competitively bid up to 2 MW per project	On-site personal solar	On-site solar or wind
Sustainability Claims	Claim renewable energy benefits	Claim renewable energy benefits	No claims to renewable energy benefits	No claims to renewable energy benefits	Claim renewable energy benefits
Impact to all Customers	No cost to non-participants	No cost to non-participants	Low cost to non-participants	Highest cost to non-participants for incentive + net metering benefits	Moderate cost to non-participants for net metering benefits
Cost Savings	Potential for cost savings	Cost savings not likely	Potential for cost savings*	Potential for cost savings*	Potential for cost savings*
Program Charge	Monthly charge on utility bill approved by PUC; locked-in during contract	Monthly charge on utility bill approved by PUC; subject to change	Negotiated with developer; not regulated by PUC	Negotiated with installer; not regulated by PUC	Negotiated with installer; not regulated by PUC
Financial Credit	Fuel cost credit on Xcel Energy bill	NA	Average Retail Rate + REC incentive	Net metering benefits plus REC incentive	Net metering benefits
Contract Terms	Xcel Energy contract with flexible terms and modest termination fee	Xcel Energy contract with monthly term and no termination fee	Third-party long-term contract termination clause	System contract with third-party solar installer; interconnect and incentive agreements with Xcel Energy	System contract with third-party solar installer; interconnect agreement with Xcel Energy

*Cost savings is dependent upon individual costs negotiated with developer/installer

Net Metering

Install on-site solar and keep the RECs

Features

Ownership- Generate clean energy with solar or wind installed on your home or business.

Use what you need- Fulfill your energy needs with what your system produces.

Green energy- RECs are yours to keep, allowing you to make claims on the use of renewable energy.

Get Started

Net Metering allows you to generate your own energy and retain the renewable attributes that your system produces.

Learn more about how to apply and interconnect to our grid by visiting xcelenergy.com/Solar.

Solar*Rewards

Install on-site solar and receive incentives

Features

Ownership- Generate clean energy through solar panels installed on your home or business

Use what you need- Fulfill your energy needs with what your system produces.

Energy credit- Receive a production based incentive to offset costs.

Net metering- Use the kWh you produce each month, and if you generate more energy than you need, you can sell the excess back to us

Get Started

Installing on-site solar is a great way to invest in renewable energy. Your system will still be integrated with our grid to ensure you receive reliable power even when the sun isn't shining.

Find out about availability and how to apply for incentives by visiting xcelenergy.com/Solar.

Windsource

Add more Colorado wind to your energy mix

Features

Low cost- No upfront fee, just a minimal monthly charge on your electric bill.

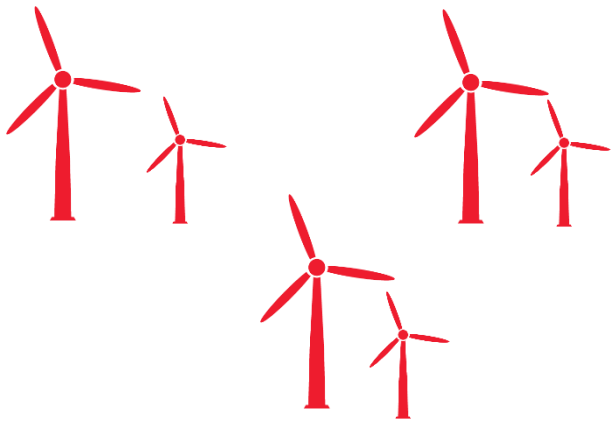
Choice- Choose how much wind power you want to purchase, from one 100 kWh block up to 100 percent of your usage.

Green energy- RECs are retired on your behalf, allowing you to make claims on the use of renewable energy.

Get Started

Windsource is an easy, inexpensive way to support green energy, and you can subscribe today. Just complete an online application or speak with your account manager for help enrolling.

Visit xcelenergy.com/Windsource to learn more.



Solar*Rewards Community

Support a solar garden and get paid for solar energy production

Features

Third-party provider- Contract terms defined by provider; and no installation is required.

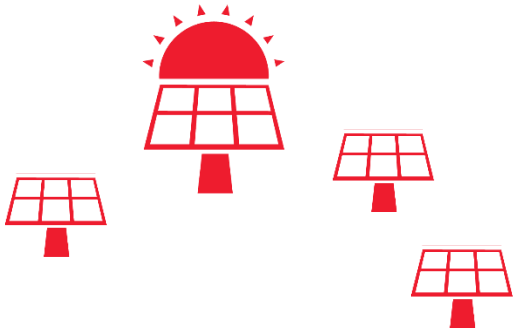
Consistency- You still receive electric service and billing from Xcel Energy.

Bill credit- Subscribers receive an Xcel Energy bill credit as payment for your portion of the garden's solar energy production

Get Started

Subscribe to a solar garden to get paid for the solar energy produced with nothing on your roof. Contact a provider to request a subscription to a nearby garden. The solar garden operator is your advisor to potential savings, as well as subscription terms and conditions.

View the list of solar gardens by visiting xcelenergy.com/Solar.



Renewable*Connect

Subscribe to local solar energy

Features

Flexible terms- Choose from monthly, five-year or 10-year subscriptions.

Choice- Decide how much renewable energy you want to subscribe to.

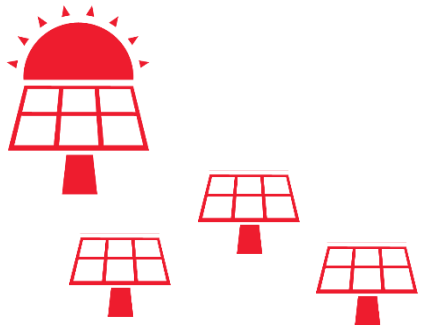
Locked-in pricing- Enjoy more certainty with set price schedules for the contract term.

Green energy- RECs are retired on your behalf, allowing you to make claims on the use of renewable energy.

Get Started

Renewable*Connect is our newest program coming to Colorado in 2018 that can deliver clean, local and reliable energy to your business or organization.

Enrollment begins in 2018. Please visit xcelenergy.com/RenewableConnect to check availability and learn more.



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Beginning to Populate the Framework

COOL ROOFS. CERTIFICATION SYSTEMS.

Stantec

Green Roofs Task Force Meeting #3

Cool Roofs Overview

Cool Roofs: Summary

Impact:

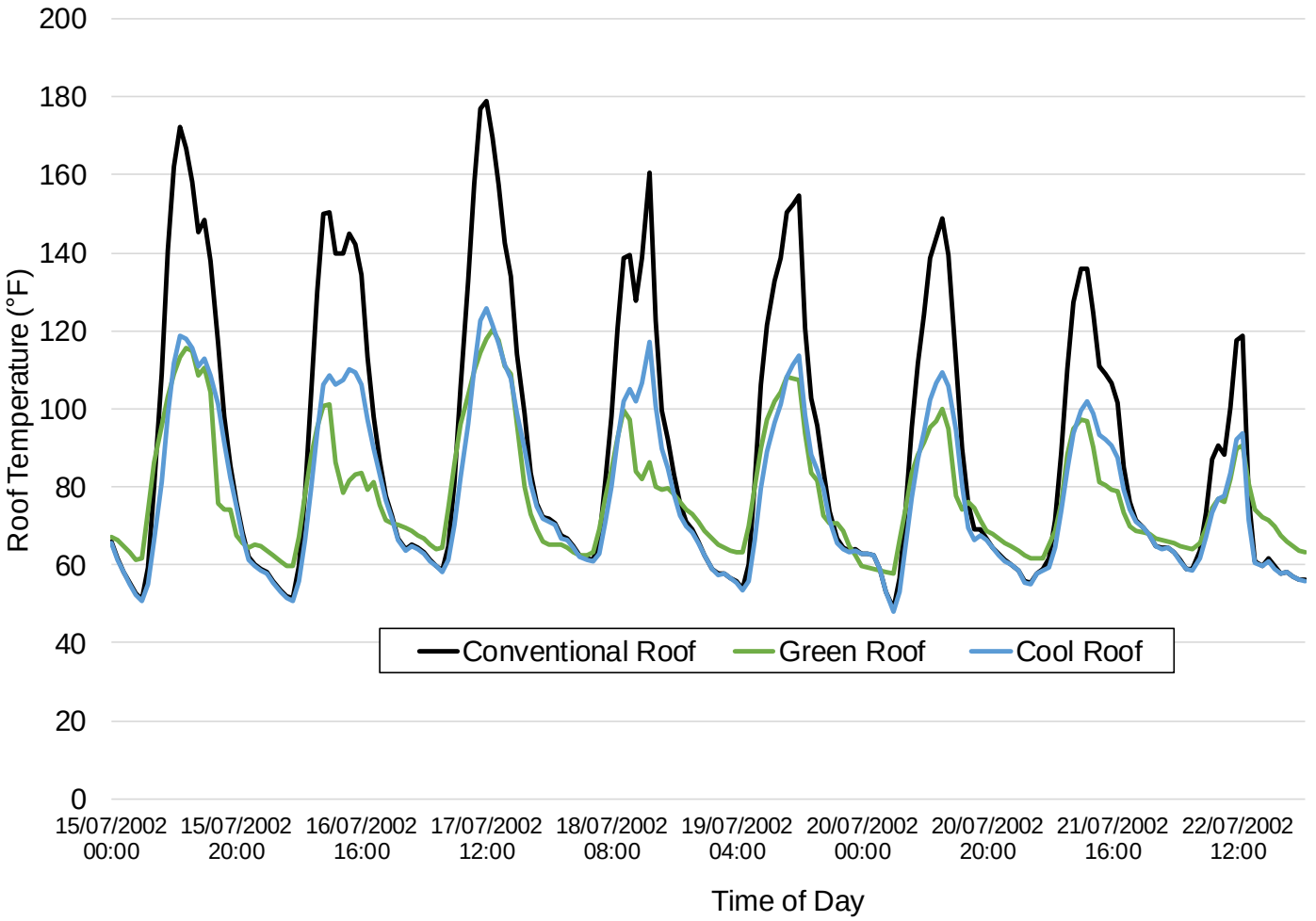
1. Cooling energy savings

2. Lower roof surface temperatures reduce heat island effect

3. Improved thermal comfort in spaces immediately below roof

4. Heating energy penalty

Summer Roof Temperatures



Winter Heating Energy Penalty

- Heating loads are typically higher in evenings, whereas the benefit of a darker roof in winter is mostly realized during daylight hours.

- Many commercial buildings require space cooling all year because of human activity or equipment usage, thereby negating the little—if any—heating benefit achieved by a dark roof.

Source: Shickman, Kurt. 2016. "There Is Evidence Cool Roofs Provide Benefits to Buildings in Climate Zones 4 through 8." Roofing: The Industry Voice. URL: http://www.roofingmagazine.com/evidence-cool-roofs-provide-benefits-buildings-climate-zones-4-8/.

Cost Evaluation

Representative Buildings

Apartment

5 flrs, 55,000 ft^2 total building area, 11,000 ft^2 roof area

Green Roof Coverage requirement: 30% or 3,300 ft^2

Industrial or Retail

1 flr, 150,000 ft^2 total building area, 150,000 ft^2 roof area

Green Roof Coverage requirement:

- 10% for Industrial or 15,000 ft^2
- 50% for Retail or 75,000 ft^2

Office

15 flrs, 300,000 ft^2 total building area, 6,000 ft^2 roof area

Green Roof Coverage requirement: 60% or 3,600 ft^2

Cost Evaluation

Cool Roof Replacement Costs

Source	Description	Building 1: Apartment	Building 2a: Industrial	Building 2b: Retail	Building 3: Office
Roof Consultant #1	Life Expectancy: 25 years	$144,500	$1,589,300	$1,589,300	$91,500
Roof Consultant #2	Life Expectancy: 20 years	$132,000	$1,500,000	$1,500,000	$114,000
	Average Capital Cost ($)	$138,250	$1,544,650	$1,544,650	$102,750
Roof Consultant #1	**Annual Maintenance Costs ($)**	$2,200	$30,000	$30,000	$1,200

Existing Building
First Costs & Premiums

Description	Building 1: Apartment	Building 2a: Industrial	Building 2b: Retail	Building 3: Office
Black Roof Replacement Cost ($)	$137,700	$1,539,900	$1,539,900	$101,250
Additional Green Roof Replacement Cost ($)	$140,636	$490,089	$2,224,759	$132,300
Green Roof Cost Increase vs Black Roof (%)	102	32	144	131
OR Additional Green Roof + PV Replacement Cost ($)	$134,634	$533,554	$2,548,439	$139,833
PV + Green Roof Cost Increase vs Black Roof (%)	98	35	165	138
***OR* Additional Cool Roof Replacement cost ($)**	**$550**	**$4,750**	**$4,750**	**$1,500**
Cool Roof Cost Increase vs Black Roof (%)	**0.4**	**0.3**	**0.3**	**1.5**

New Construction
First Costs & Premiums

Description	Building 1: Apartment	Building 2a: Industrial	Building 2b: Retail	Building 3: Office
Total Building Floor Area (ft^2)	50,000	150,000	150,000	300,000
Cost per ft^2 ($/$ft^2$)	$139.81	$130.95	$100.00	$186.69
New Building Total Construction Costs ($)	$6,990,500	$19,642,500	$15,000,000	$56,007,000
Additional Green Roof Cost per ft^2 ($)	$2.81	$3.27	$14.83	$0.44
Additional Green Roof Cost ($)	$140,636	$490,089	$2,224,759	$132,300
Cost Increase for Green Roof (%)	2.0	2.5	14.8	0.2
Additional Green Roof + PV Cost per ft^2 ($)	$2.69	$3.56	$16.99	$0.47
Additional Green Roof + PV Cost ($)	$134,634	$533,554	$2,548,439	$139,833
Cost Increase for Green Roof + PV (%)	1.9	2.7	17.0	0.2
Additional Cool Roof Cost per ft^2 ($)	$0.01	$0.03	$0.03	$0.01
Additional Cool Roof Cost ($)	$550	$4,750	$4,750	$1,500
Cost Increase for Cool Roof (%)	**0.008**	**0.024**	**0.032**	**0.003**

Cool Roof Benefits vs Green Roofs

Cool Roof	Green Roof
Typically fast payback, lower first costs Cooling energy savings, associated GHG emissions savings Minimal maintenance Easily implemented on existing buildings	Additional benefits beyond direct financial investment: • Amenity Value • Aesthetic Benefits • Biodiversity • Increased PV Efficiency • Stormwater • Revenue source (food garden)
Glare risk	Higher installation costs, long-term maintenance costs

Source: Kats, Greg; Glassbrook, Keith. 2018. “Delivering Urban Resilience”

Smart **Surfaces** Study

- Suite of Resilient Strategies to manage **Sun and Rain**
  - Green Roofs
  - Solar PV
  - Cool Roofs
  - Reflective Pavement
  - Permeable, Porous Pavement
- **Integrated cost-benefit** analysis for all strategies
  - Urban Heat Island
  - Energy & Greenhouse Gas Emissions
  - Financial Incentives
  - Health
  - Stormwater
  - Employment
  - Summer Tourism
- Specific benefits for **addressing urban low-income communities**

Source: Kats, Greg; Glassbrook, Keith. 2018. “Delivering Urban Resilience”

Smart **Surfaces** Study

Table D. Benefit-to-Cost Ratio summary for each solution

SOLUTION	BENEFIT-TO-COST RATIO		
	Washington, D.C.	**Philadelphia**	**El Paso**
Cool Roofs	8.29	7.40	4.23
Green Roofs	1.99	0.39	0.19
PV (Direct Purchase)	1.83	1.94	1.72
PV (PPA)	Very high	Very high	Very high
Reflective Pavements	2.57	3.03	2.50
Urban Trees	3.39	1.34	0.66

Swapping a square foot of dark, low albedo roof for a higher albedo generates nearly **$4/ft2 in net energy and health benefits**
(lower energy bills, improved health due to better air quality, lower heat stress and cooler indoor conditions)

Source: Kats, Greg; Glassbrook, Keith. 2018. “Delivering Urban Resilience”

Certifications: Multi-Attribute

USGBC LEED	**WELL Building Standard**
Addresses overall environmental impact	Focused on the impact of indoor spaces on human health & wellbeing
Weighted towards energy efficiency, and proximity to dense urban core with public transit	Weighted towards indoor air quality, water quality, healthy food choices, active lifestyles
Industry familiarity, lower cost impact, greater emphasis on documentation	More stringent criteria, higher cost impact, greater emphasis on performance verification
Pre-requisites and optional credits	Pre-conditions and optional optimizations

Certifications: Multi-Attribute

USGBC LEED

- Integrative Design Process
- Location + Transportation
- Sustainable Sites
  - Protect & Restore Habitat
  - Open Space
  - Rainwater Management
  - Heat Island
- Water Efficiency
- Energy & Atmosphere
- Materials & Resources
- Indoor Environmental Quality
- Innovation
- Regional Priority Credits
- *Resiliency Pilot Credits*

WELL Building Standard

- Air
- Water
- Nourishment
  - Food Production
- Light
- Fitness
  - Exterior Active Spaces
- Comfort
- Mind
  - Biophilia

Certifications: Single-Attribute

Verified Net-Zero Energy

Living Building Challenge Zero Energy Certification (note restrictions on combustion)

One Water

LEED Cost Premiums

USGBC LEED

LEED Silver	1-2%
LEED Gold	3-5%
LEED Platinum	Variable

Cost is highly contingent on:

- Proximity to public transit, dense urban fabric, diverse uses
- Achieving significant energy cost savings vs code baseline
- Funding mechanism for on-site renewables

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Beginning to Populate the Framework

PERCENT MORE EFFICIENT THAN CODE

ENERGY EFFICIENCY

Green Roof Ordinance
Task Force Meeting #3

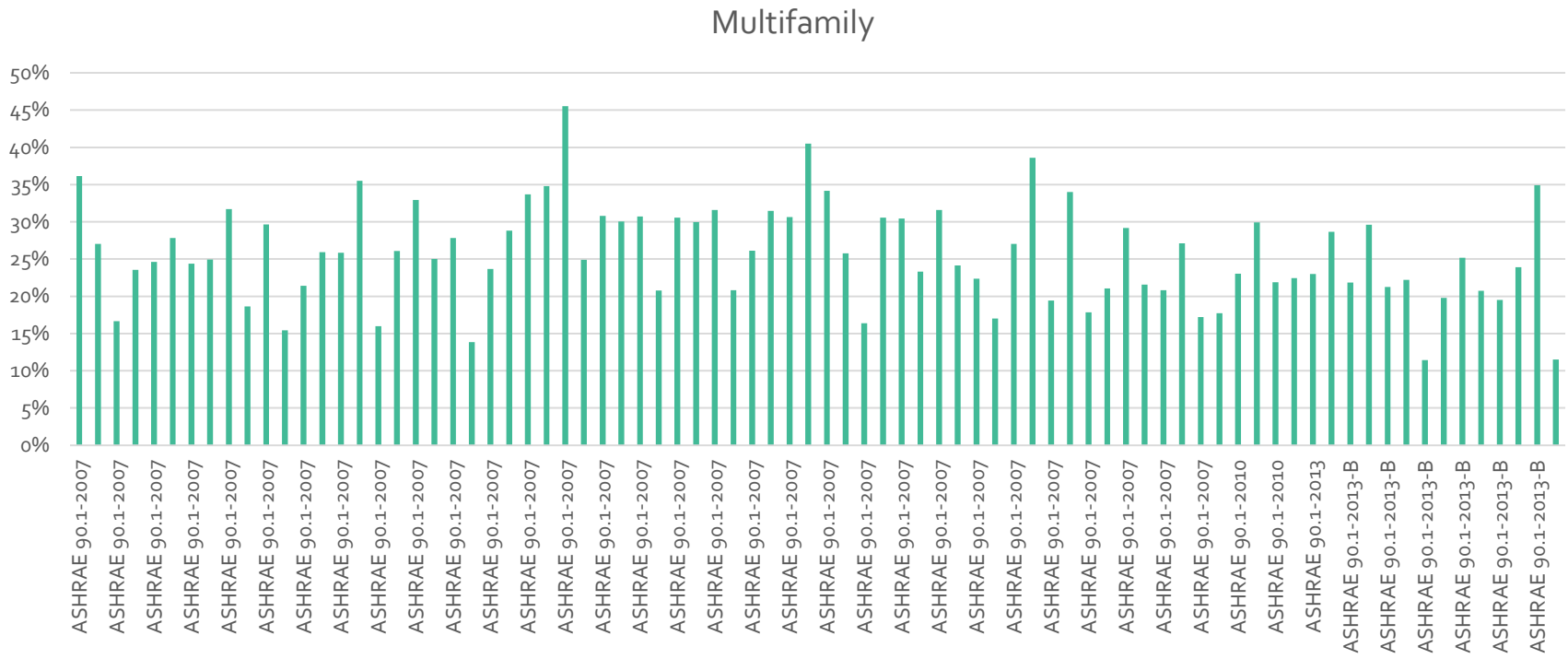
Group14 Engineering, PBC.

Predicted energy cost savings

New Bldg. Type	2009	2015	Certified
Hotel (11)	20%	18%	5
MOB (9)	21%	20%	4
Mixed Use (11)	27%	-	10
Multifamily (80)	27%	22%	60
Office (26)	32%	19%	20
Recreation (8)	24%	22%	2
K-12 (7)	35%	23%	5
Higher Ed (4)	25%	27%	3
Total Bldgs (156)	26%	22%	109

- Under 2009 IECC, average energy cost savings are 26%.
- Under 2015 IECC, average energy cost savings are 22%.
- Less than 10% of total buildings sampled were under 2015 IECC.
- To meet 2015 IECC using the whole building energy model approach, building must show at least 15% savings.

Multifamily



Energy Cost Savings

	Average SF	Energy Cost Savings ($/sf)*
Hotel (11)	161,300	$0.24
MOB (9)	81,603	$0.30
Mixed Use (11)	247,297	$0.31
Multifamily (80)	181,940	$0.26
Office (26)	199,225	$0.47
Recreation (8)	56,361	$0.87
K-12 (7)	73,932	$0.60
Higher Ed (4)	95,500	$0.35

*normalized over whole building

- This set of data is based on Group14's experience, which tends to be higher-performing new projects that go through green certification.
- Energy cost savings represent all the buildings in a category under both energy codes
- Energy cost savings are not related to green roofs (fewer than 1% of buildings have a green roof in this sample).
- On average, simple payback on investment in energy efficiency is 8-12 years for new construction.
  - Existing buildings, which are not represented here, simple payback on investment averages 2-5 years.

Green Roof Costs vs Energy Cost Savings

	Average SF	Energy Cost Savings from other EE Measures $/SF	Average Green Roof Cost ($/SF) of building area*
Hotel (11)	161,300	$0.24	$2.02
MOB (9)	81,603	$0.30	$3.43
Mixed Use (11)	247,297	$0.31	$3.41
Multifamily (80)	181,940	$0.26	$3.77
Office (26)	199,225	$0.47	$3.30
Recreation (8)	56,361	$0.87	$4.05
K-12 (7)	73,932	$0.60	$8.04
Higher Ed (4)	95,500	$0.35	$4.81

*based on square footages indicated in the ordinance.

- Average green roof cost is based on $25/sf of green roof. Higher costs occur on 1 and 2 story buildings.
- The investment in energy efficiency for a new building is generally in the order of the cost of a green roof.
- It takes approximately 10yrs of energy savings from other EE measures in a new building to pay for a green roof.
- Can never show payback from a strictly energy cost savings for a green roof.
- **If project invests in a green roof, will it invest in energy efficiency beyond the energy code? Will it invest in green certification?**

Considerations

- Ensure ordinance requirements are not deterring from investment in energy efficiency and green certifications.

- Offer alternative compliance pathways, such as:
  - New Construction projects achieving 25% better than code
  - Existing Buildings achieving Energy Star Certification (75+)
  - Green Building Certifications (LEED Gold/Platinum, Enterprise Green Communities, etc.)
  - Include menu of options that considers energy savings in addition to the application of green infrastructure for stormwater management, vegetated open space, and cool roofs.

DENVER
THE MILE HIGH CITY

Beginning to Populate the Framework

ENERGY EFFICIENCY IN EXISTING BUILDINGS

Quick Payback EE Upgrades (1-3 year payback)

- Lighting Upgrades and Controls — Medium
- Tuning Controls (Recommissioning) — High
- Matching Supply to Demand — Medium
  - Variable Frequency Drives — Medium
  - Variable-Air-Volume Systems, Demand Control Ventilation — High
  - Scheduling
- Taking advantage of natural conditions — Medium
  - Air economizer — Low
  - Temperature reset values
  - Heat recovery — Medium

Longer Payback EE Measures (3-15+ years)

- Controls upgrades

- Heating, Ventilation, Cooling (HVAC) System Upgrades

- Windows

- Insulation

- Ground Source

- Cool Roofs

- Vegetated Roofs

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PROJECT EXAMPLES

2/14/18 Green Roof Review Committee

Net Zero Energy Case Study

Discovery Elementary School

VMDO ARCHITECTS

Arlington Public Schools

630 students

Pre-K to 5th grade

$32.3 M construction cost

98,000 gsf / 15.5 acres

$273 / sf building only
$289 / sf building with PV

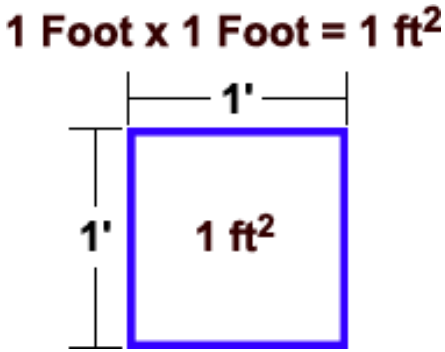
PV = 4% of construction cost

$264,900 / acre sitework

$3+ million of County req'd
site amenities included

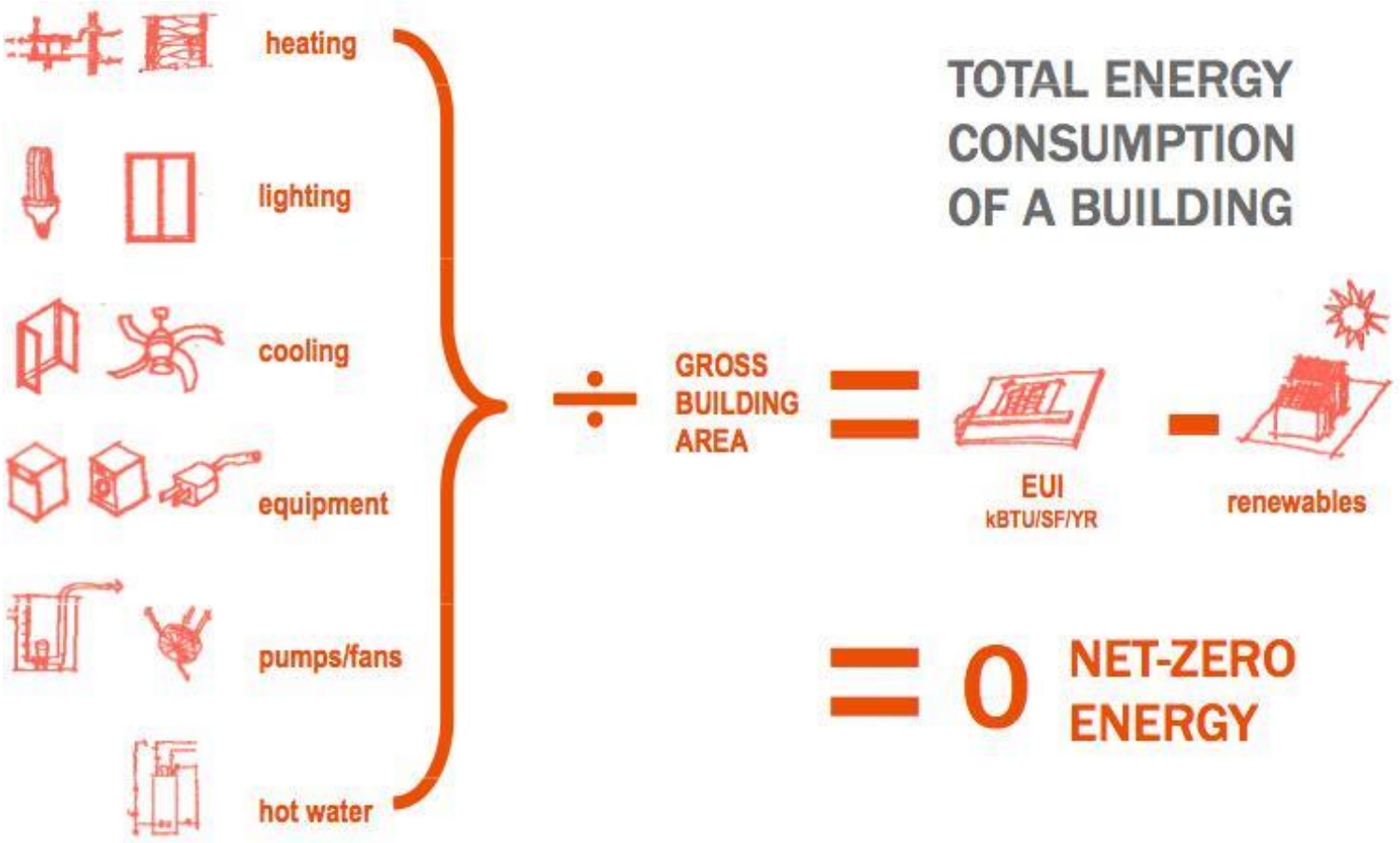
What is Net Zero Energy?

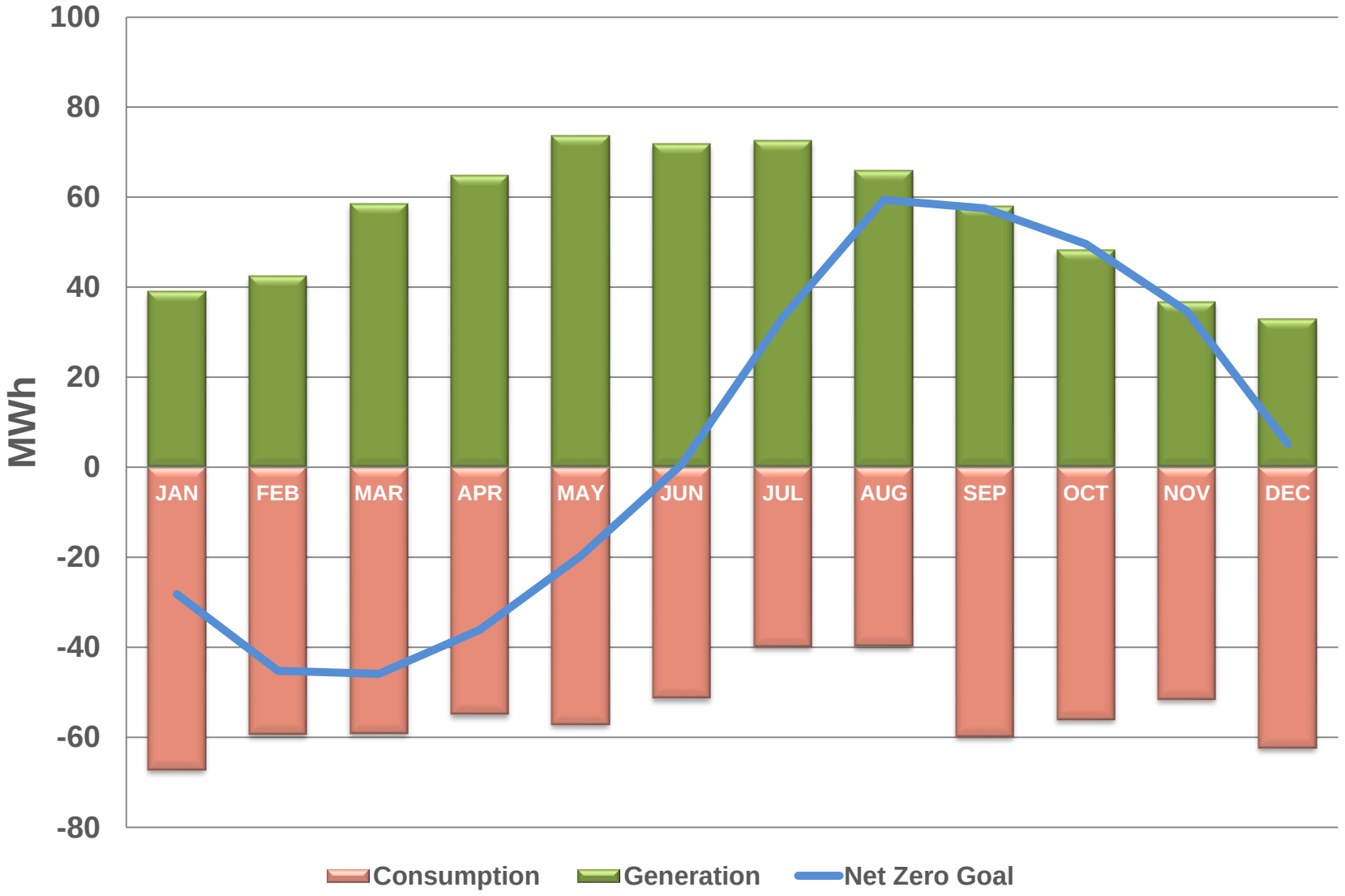
Energy Use Index (EUI) =
Energy use per square foot over one year



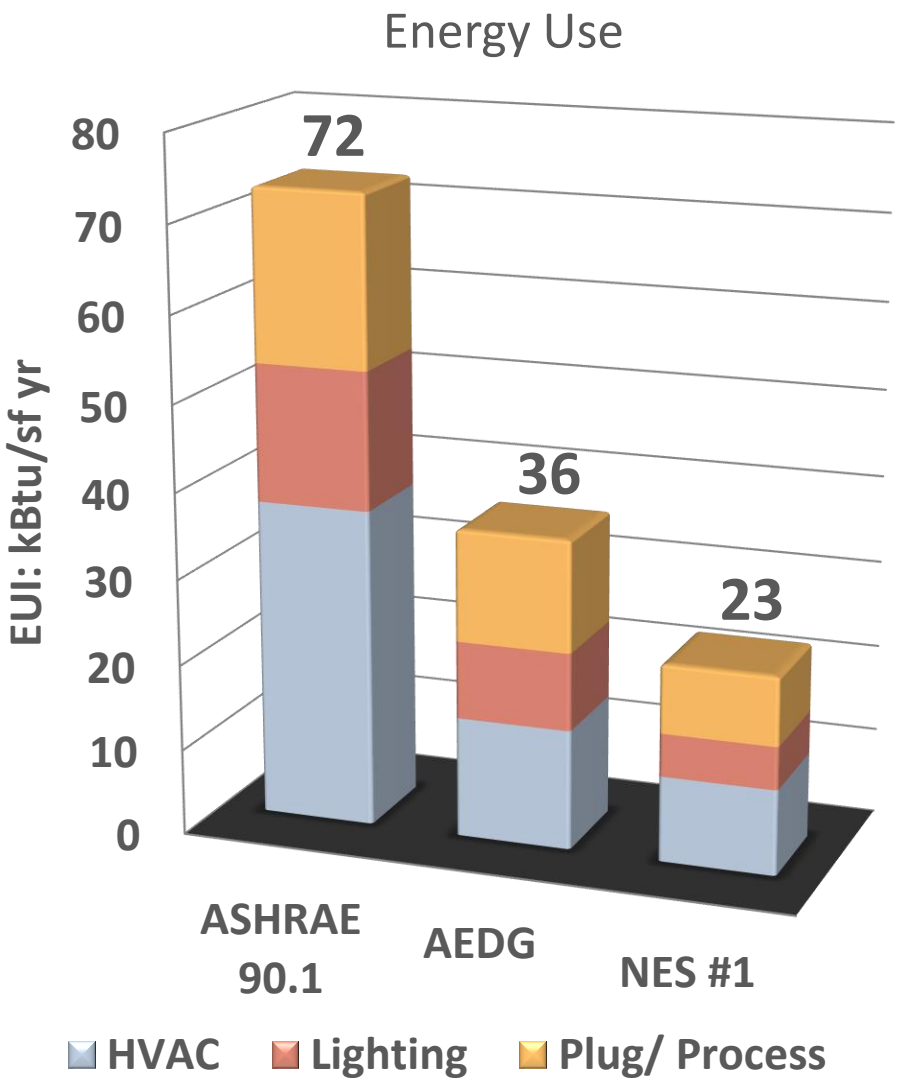
kBTU / s.f. / yr.

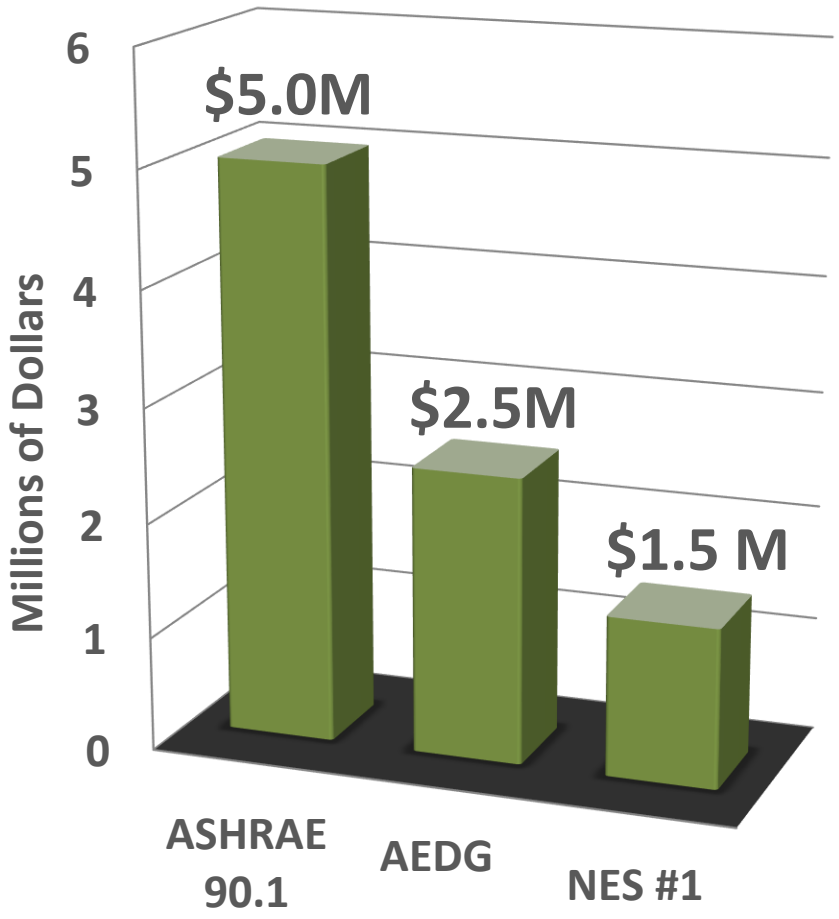
A Net Zero Energy school returns as much energy to the power grid as it uses in a year

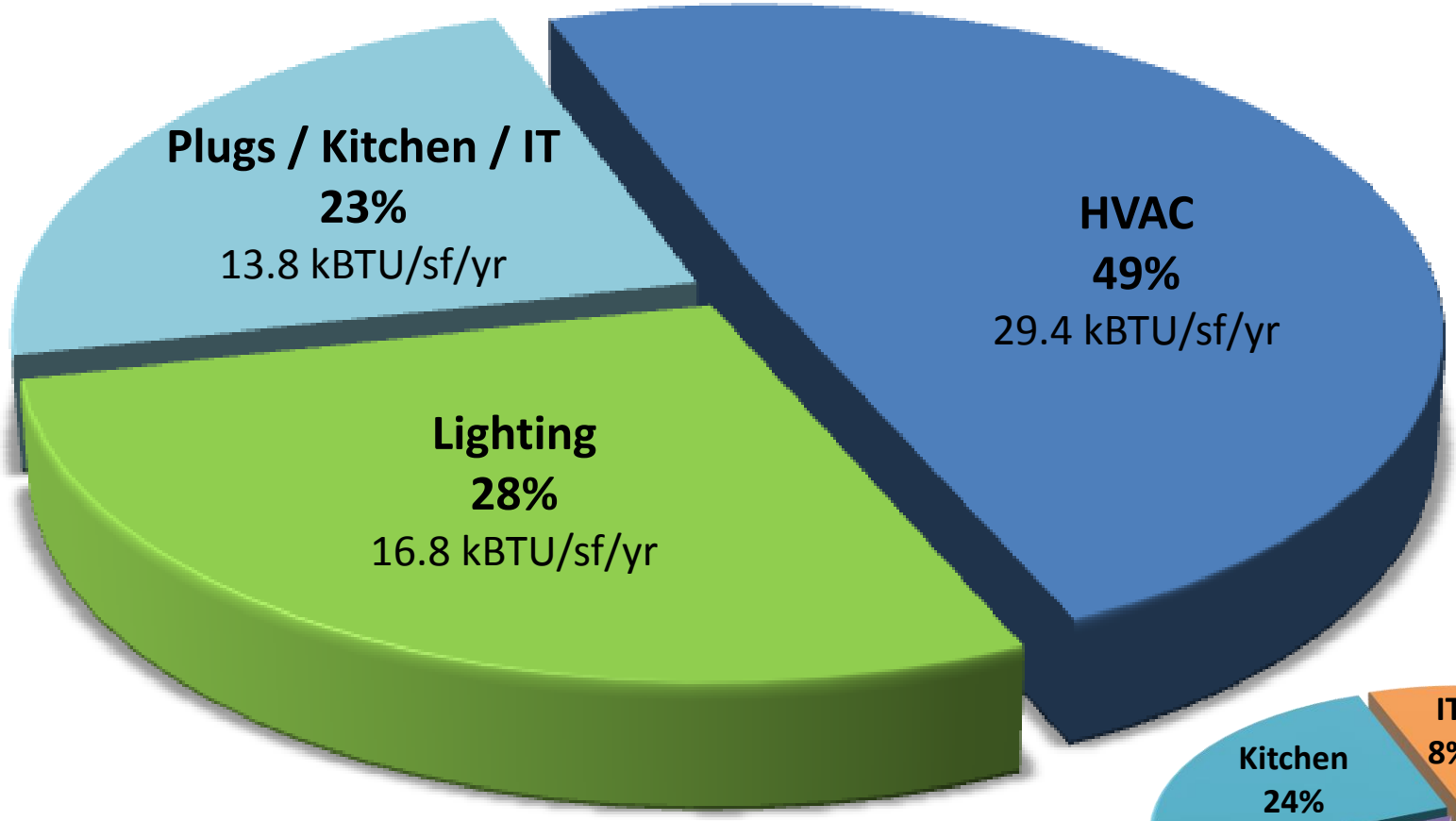




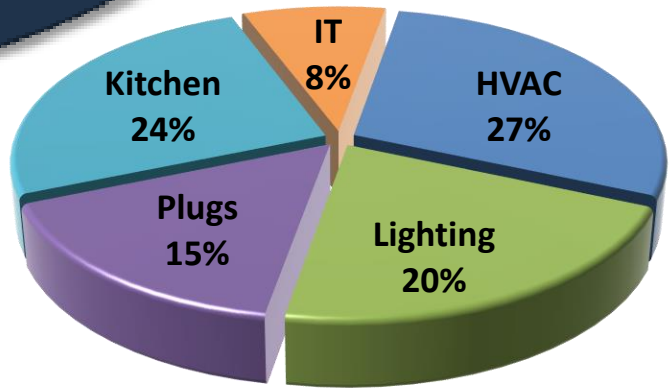
GENERATION v/s CONSUMPTION


Energy Use
EUI: kBtu/sf yr
80
70
60
50
40
30
20
10
0
72
36
23
ASHRAE 90.1
AEDG
NES #1
HVAC
Lighting
Plug/ Process


Cost of PV array to get to NZE
Millions of Dollars
6
5
4
3
2
1
0
$5.0M
$2.5M
$1.5 M
ASHRAE 90.1
AEDG
NES #1



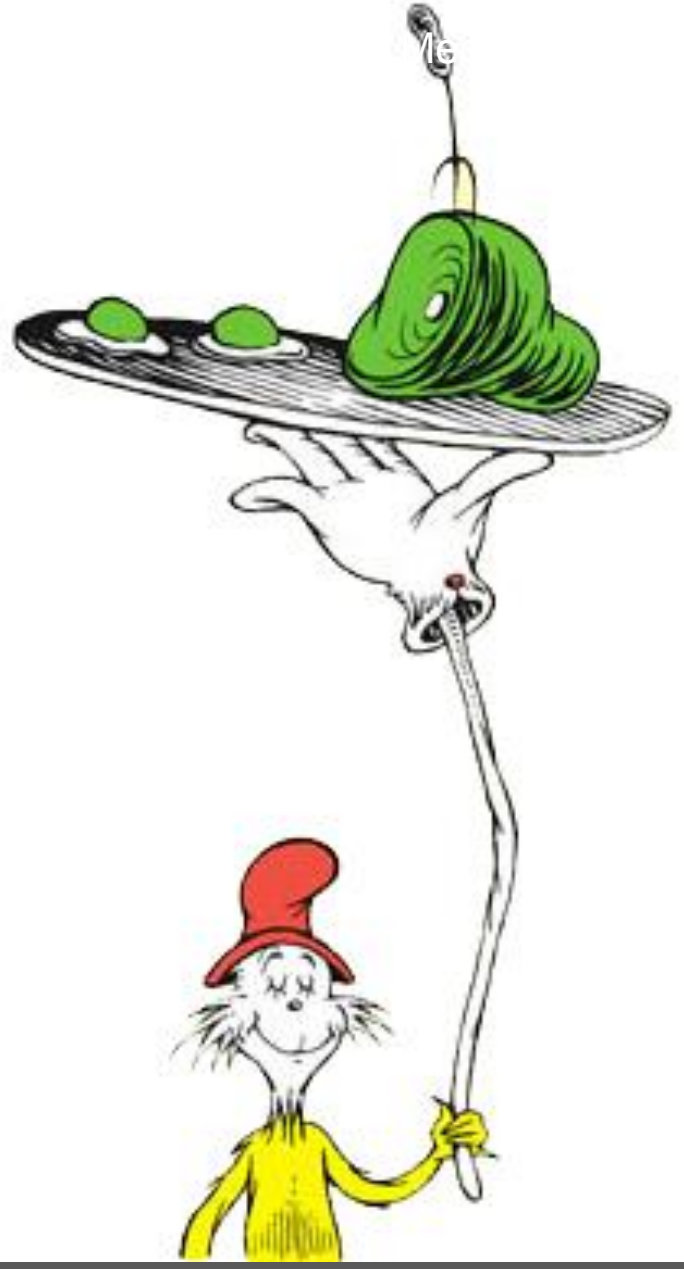
Total EUI: 60

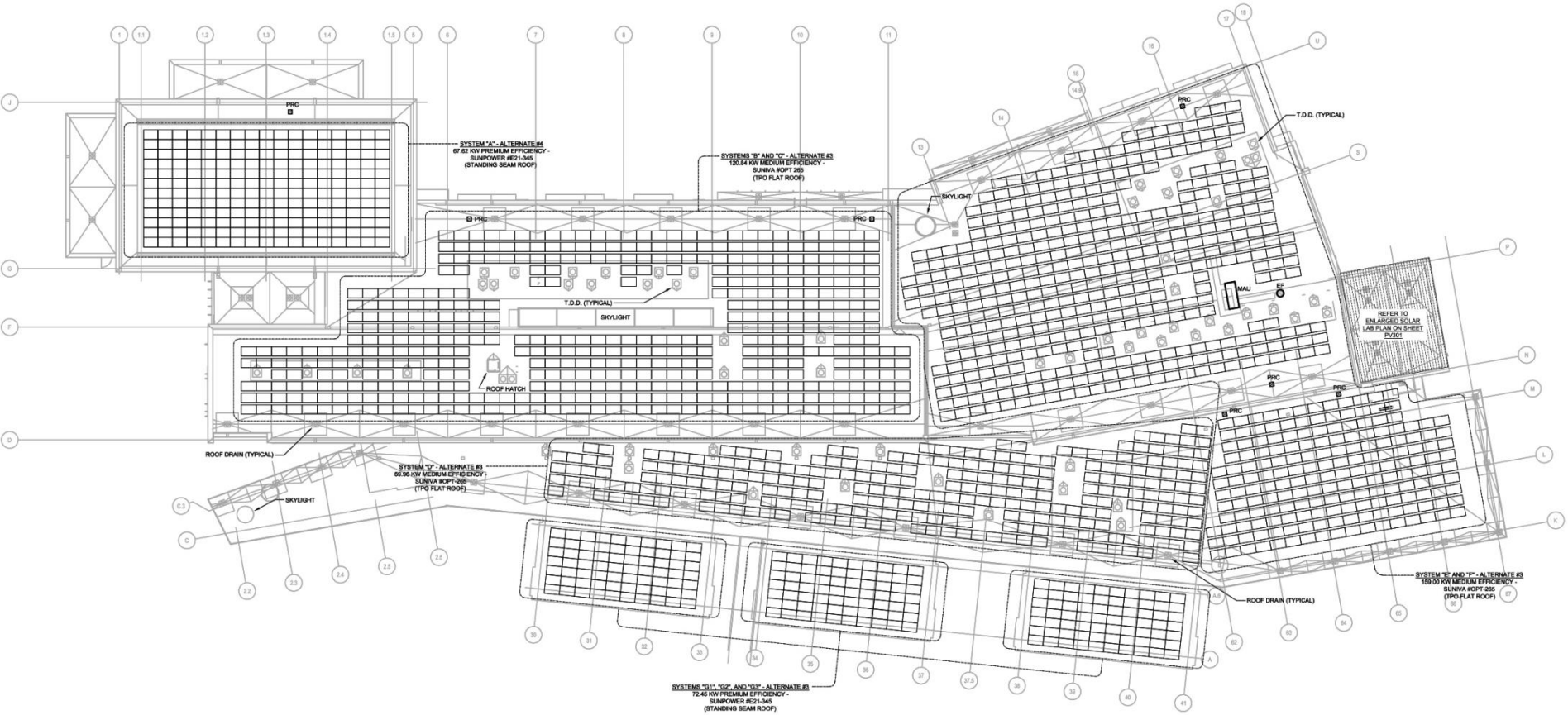


Total EUI: 23

Roof Design

black roof,
white roof,
green roof,
blue roof.



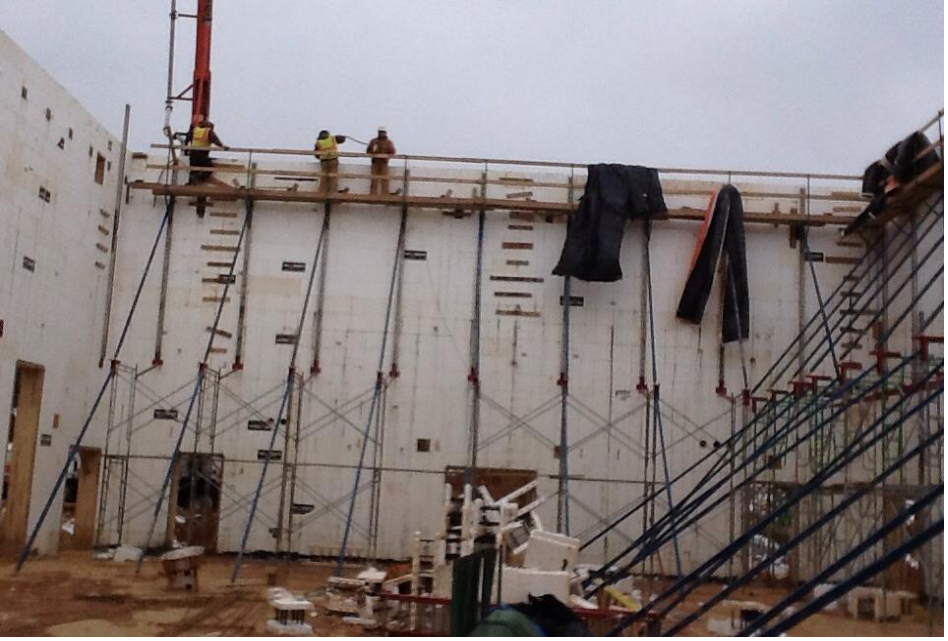


VMDO ARCHITECTS

PRIME SOLAR REAL ESTATE

496 kW ARRAY – ALL ON THE ROOFTOP

Exterior Wall Design



VMDO ARCHITECTS

INSULATED CONCRETE FORMS

ICF: THERMAL MASS + ACOUSTICS

ICF offers high R-Value
+ Thermal Mass

Windows sized for views and quality of interior space – not harvesting

Reduce number of mullions & increase glass size

Trade-off method of energy code compliance

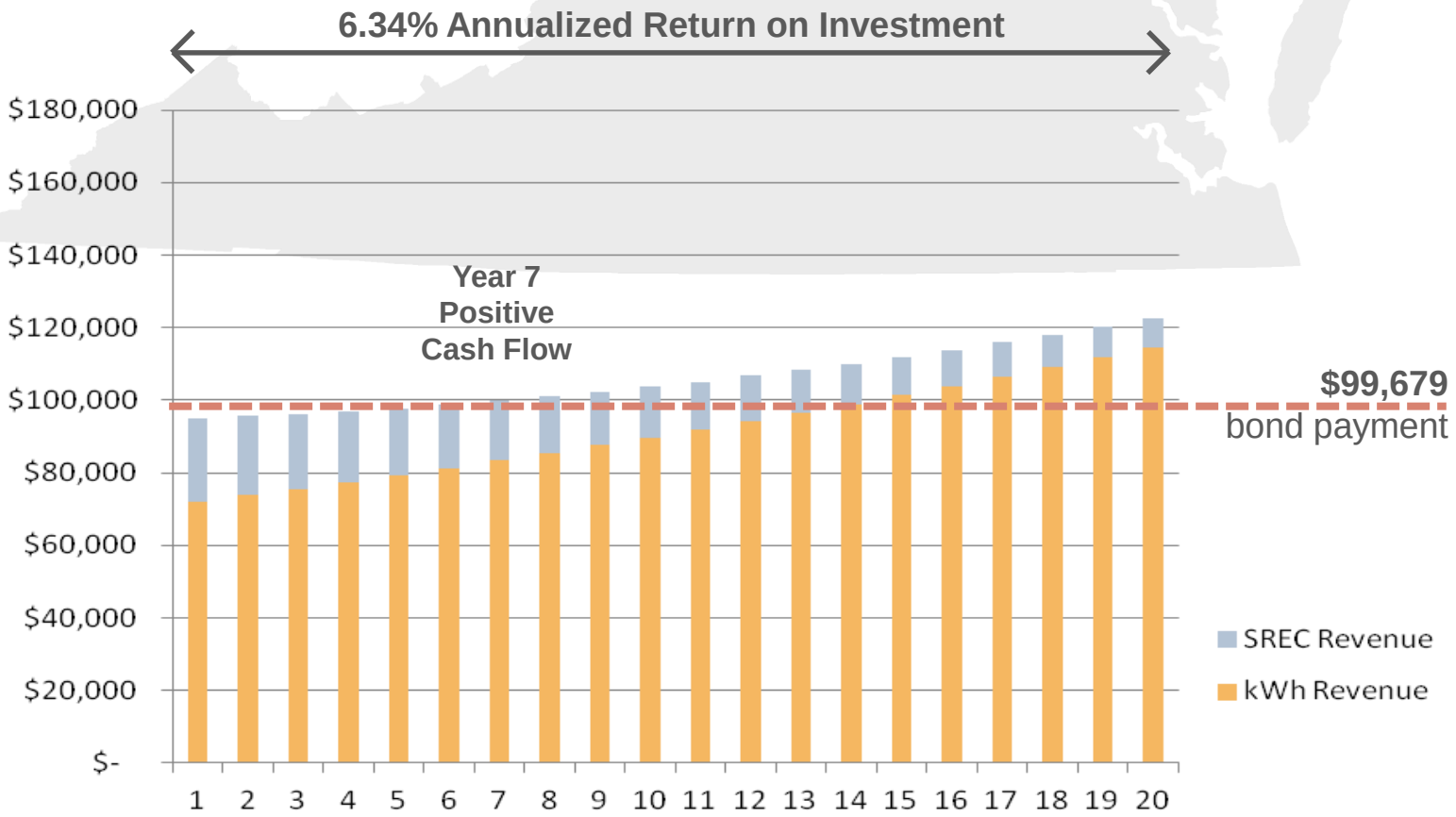
Cost Shifting

Daylight Harvesting Controls

Added Roof Insulation R40 to R30

Triple Pane Windows

PV system cost:	**$1,535,000**
Bond rate:	**2.63%**
Year 1 Energy rate	**$0.109 kWh**
Energy Inflation:	**3%**
2014 SREC value:	**$35**



PV REVENUE & EXPENSES: VIRGINIA

$2.12M IN GROSS REVENUE OVER 20 YEARS

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PROJECT EXAMPLES

February 2018

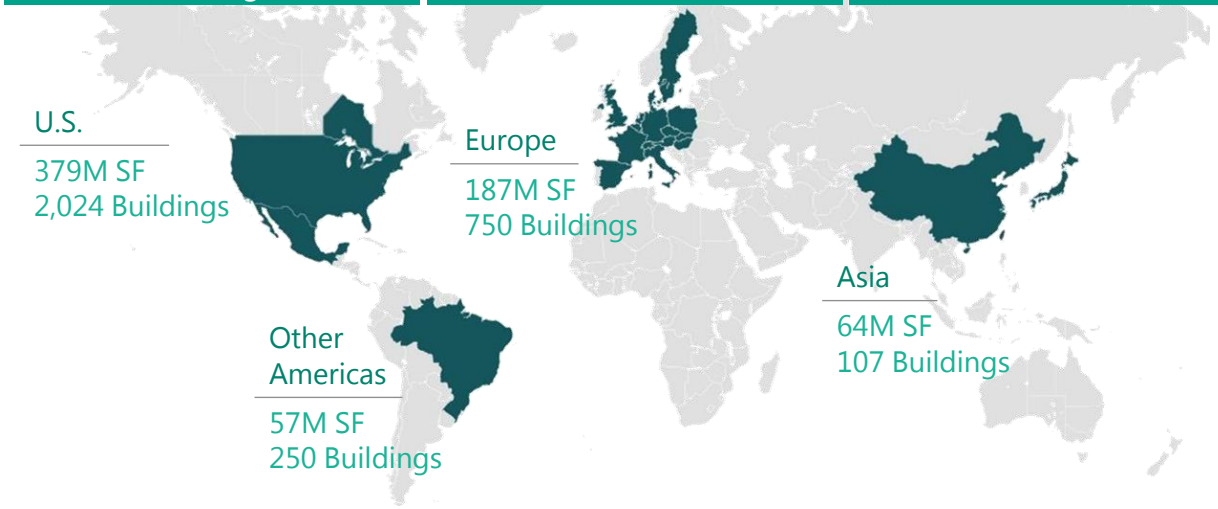
Prologis: Sustainable Design Overview

Jeannie Renne-Malone, *LEED AP*
VP, Sustainability

PROLOGIS®

About Prologis

19 Countries	**687M** Square Feet	**1500+** Employees
3,307 Buildings	**5,200** Customers	**7,000+** Leases



Data as of September 30, 2017

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Prologis Has an Integrated Approach to Sustainability

- Commitment to minimizing the environmental impact of our operations and development activity to deliver long-term value to our investors, customers, employees and communities
- We track and report progress against our goals through reputable reporting standards including GRI, CDP and GRESB
- Our management policies, including those on sustainability, apply to all properties, whether held by a co-investment venture or directly by Prologis

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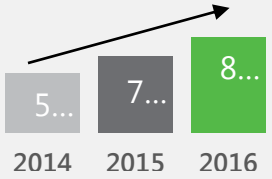
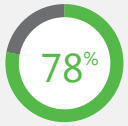
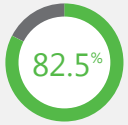
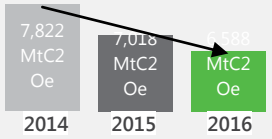
Environmental Goals and Progress

Goals		Progress	Results	
100%	of new development is designed with a goal of certification where recognized sustainability rating systems are available		87 MSF 233 16	of sustainable building certifications projects countries
100%	energy-efficient lighting across our operating portfolio		78%	of our operating portfolio has energy efficient lighting (97% of the portfolio surveyed)
200 MW	solar by 2020		165 MW	total solar generating capacity
20%	reduction of corporate GHG emissions by 2020 from a 2011 baseline		22%	reduction in Scope 1 and 2 GHG emissions since 2011

Note: Chart shows 3 years of data, as of year-end 2016

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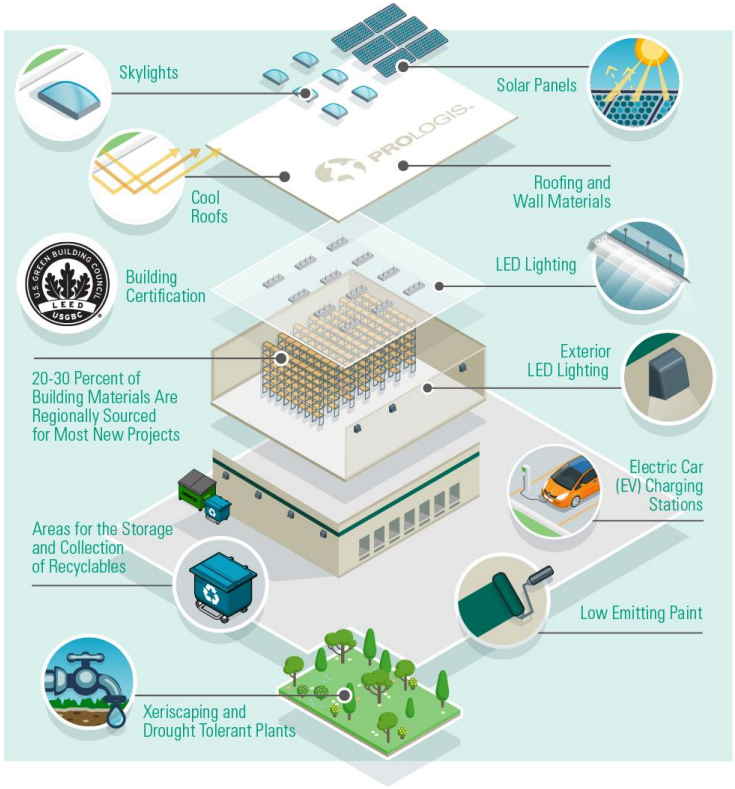
Key Sustainability Considerations for a Typical Prologis Building



- All new buildings are designed and developed with a goal of certification (e.g., LEED, BREEAM)
- We aim to retrofit existing buildings with LED lighting, cool roofs, smart meters and water-saving solutions
- Our industry-leading, energy-efficient buildings are designed to cost less to operate, reducing overall occupancy costs for our customers

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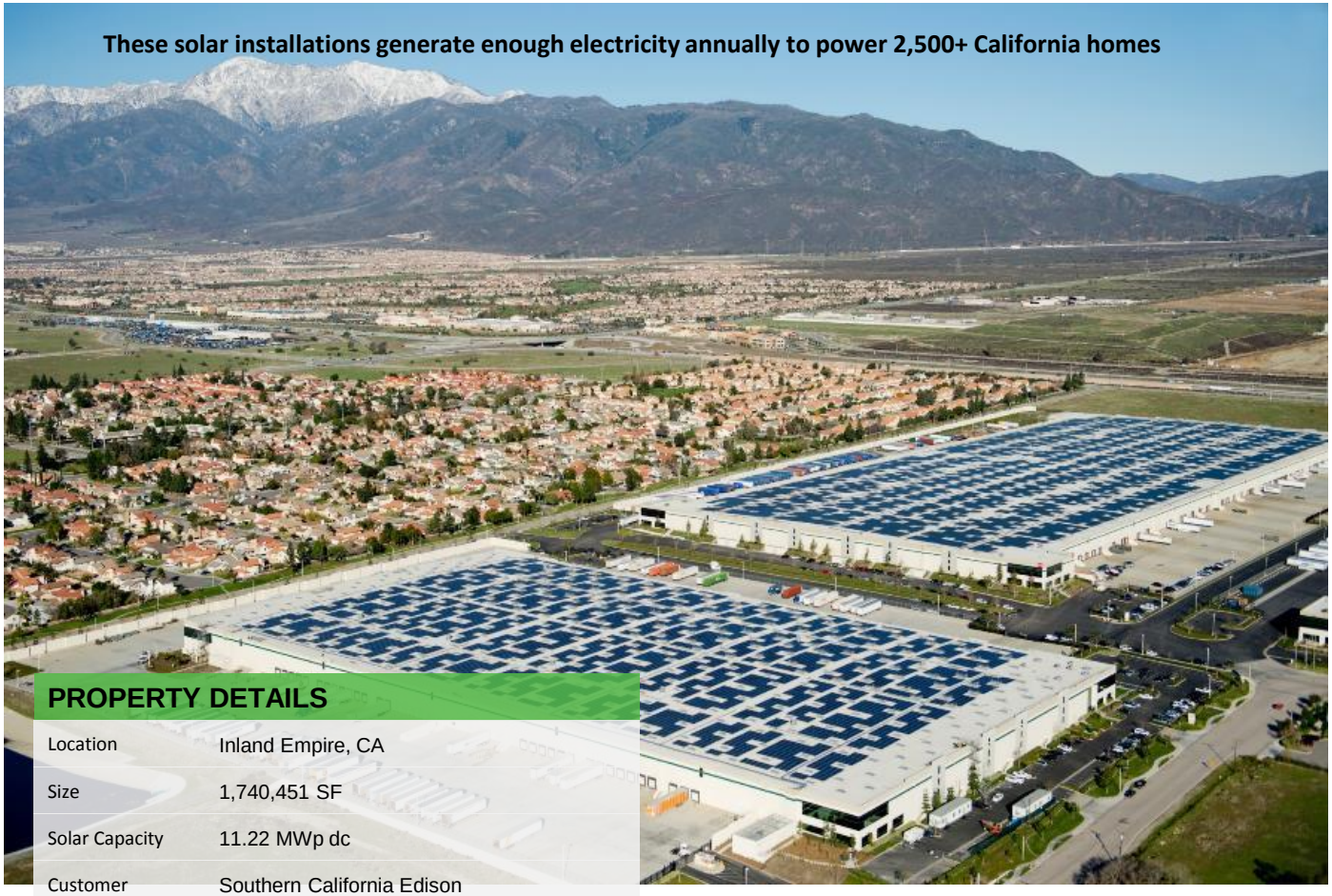
Prologis Rooftop Solar Program

Global Solar Goal

- 200 MW solar by 2020
- As of year-end 2017, 175 MW of solar in 9 countries
- Equates to clean power for 25,900 average homes each year
- 87.5% towards goal



PROPERTY DETAILS	
Location	Inland Empire, CA
Size	1,740,451 SF
Solar Capacity	11.22 MWp dc
Customer	Southern California Edison

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Prologis Cool Roofing Initiative

Goal: 100% cool roofing in new development and property improvement where feasible, given climate restrictions

- The term cool roof refers to a roofing product with high solar reflectance and thermal emittance properties, i.e. a roof that is made from a white and/or reflective material
- 40% of global portfolio currently has cool or reflective roofing

Benefits:
- Customer: Energy savings
- Prologis: Reduced roof maintenance cost and replacement cost; no cost premium for cool roof material
- Community: Reduce urban heat island effect, community health benefits

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Rooftop Options: Structural Challenges and Costs

- Structural Challenges to Green Roofs for Industrial Real Estate
  - *"Adding a green roof system to an existing warehouse would probably not be possible based on the weights that I have seen. I am seeing that it would add 30-35 psf to a roof that is only designed for 45 psf total including snow. It is simply not possible to reinforce roof joists for a 66% increase in loads. You would have to tear off all of the roof deck, joists and girders and rebuild. The columns could be reinforced by welding new plates on for the full height, but the footings would be over loaded so the slab would have to be cut out so that the footings could be enlarged. The wall panels could also be a problem. Steel tubes could be bolted on to reinforce the panels at great expense. I have no idea what it would cost but probably much more than building a new building."*
    - *-John Hart, P.E., S.E. (AZ, CO, HI, ID, IL, NE, NV, UT, WA), President, Peak Engineering*

- Sample Roof Material Costs
  - *Green roof: $30-35 SF (+ annual maintenance costs: $18,000)*
  - *Cool roof: $11-12 SF (annual maintenance costs: $1,450)*
  - *BUR: $14-15 SF (annual maintenance costs: $2,500)*
  - *Black Roof EPDM (A): $9-10 SF (annual maintenance costs: $4,000)*
  - *Black Roof EPDM (B): $8-9 SF (annual maintenance costs: $29,200)*

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Solar Costs and Issues

- Base Solar Calculation per 80% Mandate:
  - 150,000 sf x 80% = 120,000 sf stated solar requirement
    - 120,000 sf ÷ 125,000 sf/MWpDC = 0.960 MWpDC solar plant
  - 960,000 WpDC x $1.50/WpDC = $1,440,000 installed cost
  - 1,550 kWh/kWpDC x 960 kWpDC = 1.488 million kWh produced by solar per year (estimated)
  - 1.488 million kWh/yr. ÷ 150,000 SFT =9.92 kWh/sf/yr. or > 2x typical warehouse energy consumption
    - Rooftop PV system would cost approximately $9.60/sf in addition to roofing cost
    - PV system output would far exceed local consumption; grid off-take may not be viable

- Adhering to the language in the Green Roof Ordinance relative to rooftop solar may not be possible (for utility grid management and interconnection reasons) and would be costly compared to costs of the roof or building.
  - Oversizing a PV plant is often not allowed by local utilities for technical and safety reasons. This is separate from potential limitations with the load capacity of existing roof structures and the compatibility of a rooftop PV plant with certain roofing systems and designs.
  - Sizing for behind-the-meter power plants normally considers current and future consumption alongside applicable utility rate structures and net metering rules to conclude a technically-feasible and economically-viable solution.
  - We foresee a likely timing disconnect: behind-the-meter PV plant approvals are typically granted by utilities after a lengthy process (often with technical and commercial components) based on information about the electricity consumption of the building, which would not be available well in advance of applying for a building permit, especially not in the case of a new building.

  - And more….

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Conclusions and Recommendations

- Real Estate companies already taking action to address climate change and mitigate environmental impacts should have flexible options for compliance or exemptions
  - Cool roofs
  - LEED certifications
  - Other design features that minimize impacts on energy, water, waste
  - Commitment to sustainability and public goals

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PROJECT EXAMPLES

Living in a High-Performance Green Building: The Story of EPA's Region 8 Headquarters

Cost Tradeoffs: Vegetated Roof

Costs:

- Typical roof costs: approximately $4 psf
- Green roof premium: approximately $12 psf
- EPA green roof premium: approximately $240,000.

Offset Savings:

- Reduced detention vault: $150,000
- Parking revenues: 12 spaces × $25,000/yr = $300,000
- Additional savings:
  - Roof temperature moderation = reduced energy costs
  - Lower stormwater utility fees assessed by local utility
  - Protects roof membrane from ultraviolet rays and hail, prolonging roof lifespan.

EPA Green Roof Research

- Bousselot, J., J. Klett, + R. Koski. 2010. ***Extensive green roof species evaluations using digital image analysis.*** HortScience: 45(8).
- Slabe, T. and Bousselot, J. 2013. ***Implications of the Stefan-Boltzmann law for green roofs.*** Proceedings paper for Green Roofs for Healthy Cities conference.
- Bousselot, J., J. Klett, + R. Koski. 2012. ***Evaluating a natural zeolite as an amendment for extensive green roof substrate.*** J. Env. Hort., 30(4).
- Bousselot, J., T. Slabe, J. Klett, + R. Koski. 2017. ***Photovoltaic array influences the growth of green roof plants***. J. of Living Arch.

Solar + Green Roof Conclusions

- Cooler beneath PV than the exposed area
- Temperature variation was less too
  - Winter – less “in and out” of dormancy
- More plants overwintered near PV
- PV protection = increase in plant cover
- Substrate moisture ↑ in the protected area

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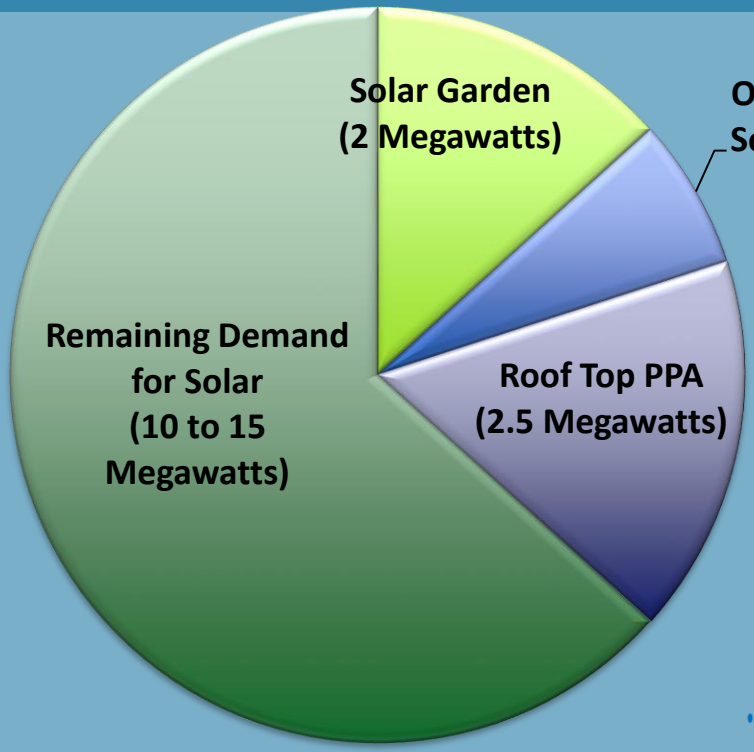
PROJECT EXAMPLES

Denver Housing Authority and Sun Valley EcoDistrict

Sustainability Approach

DHA Solar Initiatives



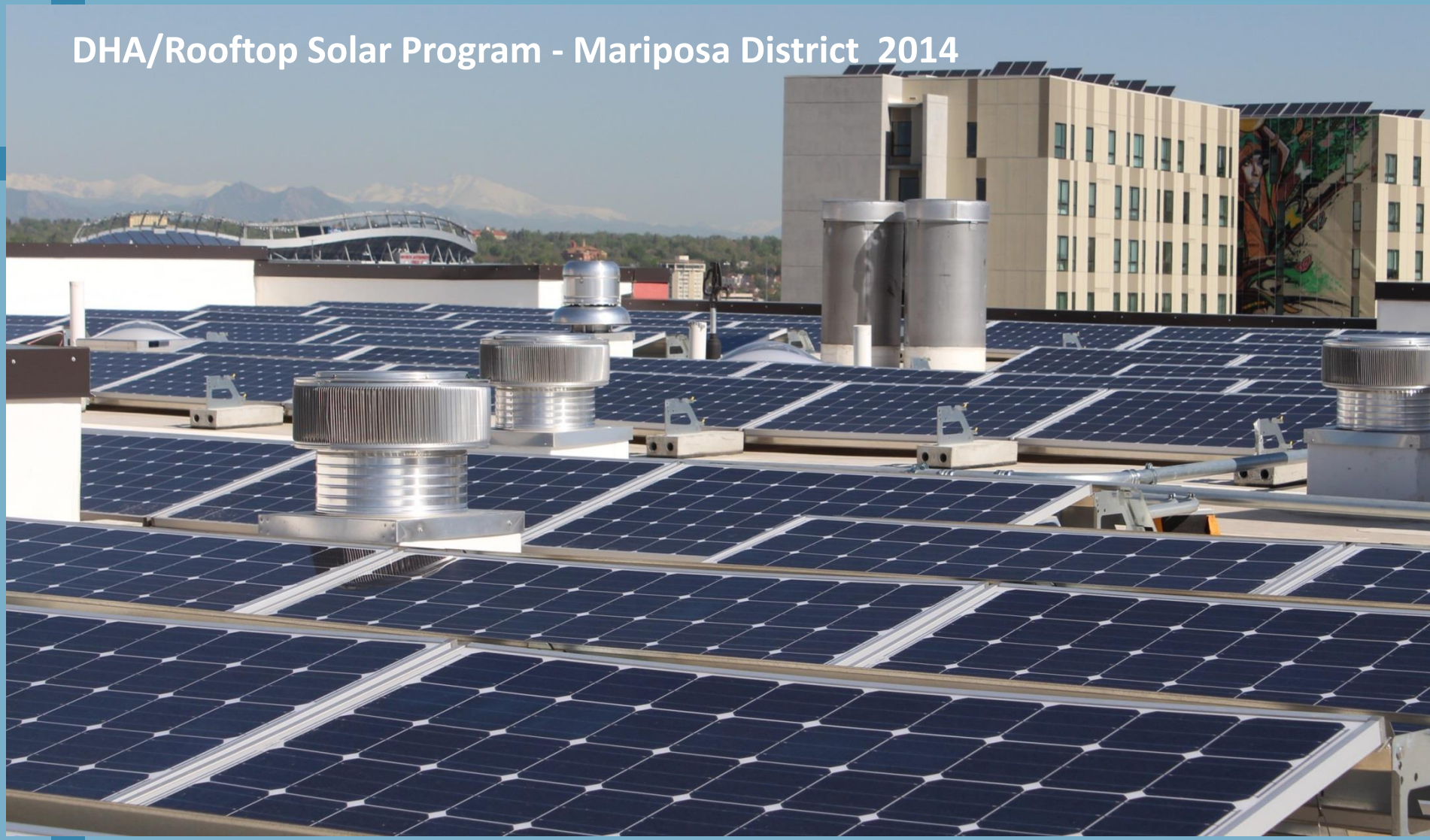
1 Megawatt = 1,000 kilowatts

- Reduction of Operating Costs
  - *10,000 sf of roof space generates $10,000 annual savings or greater*

Benedict Park Place

Solar/Water Quality and Detention

DHA/Rooftop Solar Program - Mariposa District 2014



DHA / Roof top Solar Program – Mariposa District 2015

DHA Community Revitalization and Healthy Food Access

In recent years DHA development has had a direct link to health outcomes.

- Health Impact Analysis
  - Significant Lack of Access to Healthy Food
  - No Healthy Market/Farmers Market
  - Childhood Obesity
- Looking to development for direct solutions

Solar Thermal Food Production

Green Roofs: Test these Design Assumptions

- Roof top detention, controlled flow
- Require no additional land area for detention?
- Increased roof life? (White roof versus Black roof)
- Lower Energy Costs?
- Water Quality/ Beauty/ Food production
- Calculate 0.7 soft (green) to hardscape ration- user friendly still with value for water quality/capture

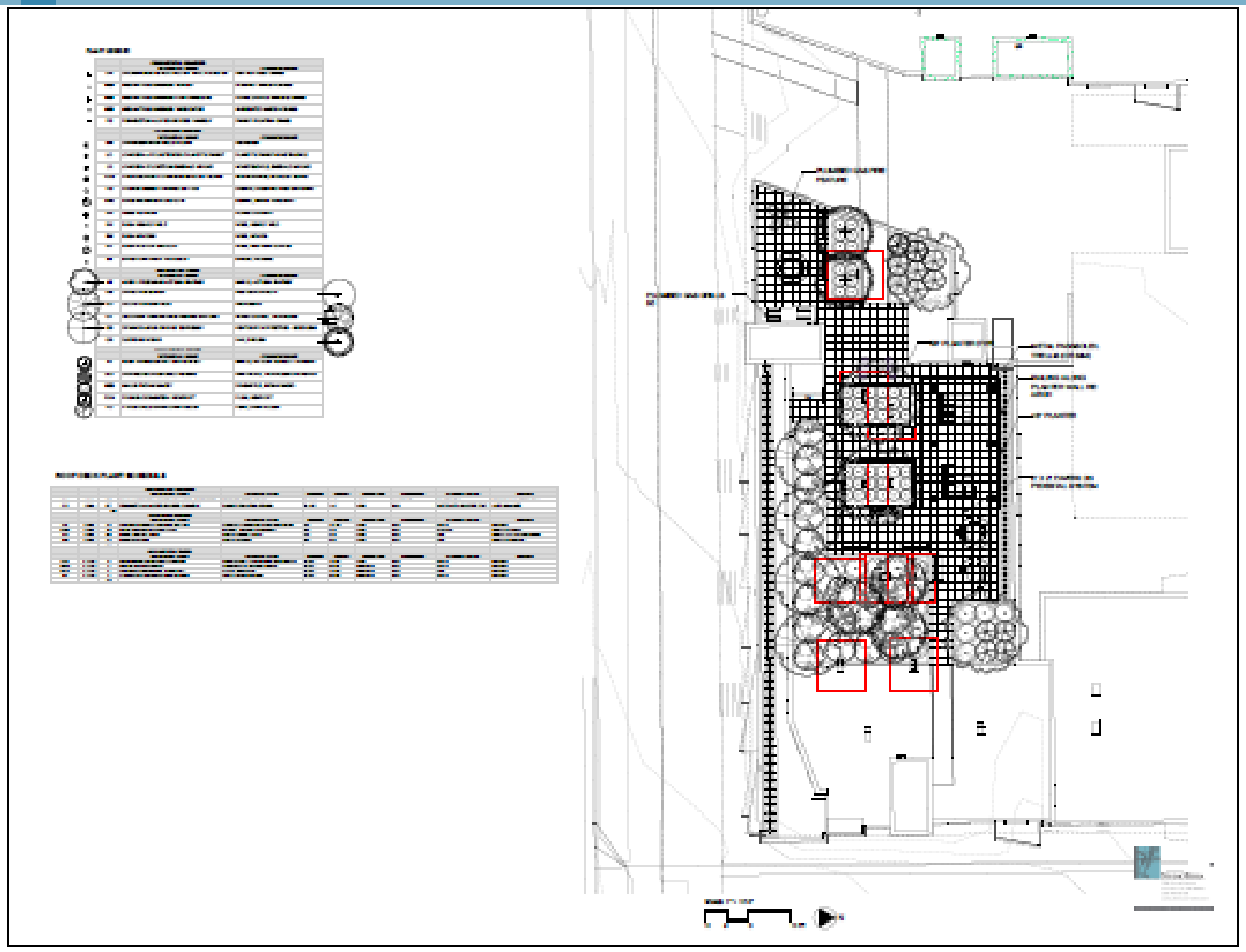
Preferred Option
Green Roof Performance

SUN VALLEY REDEVELOPMENT | GREEN ROOFS: INTEGRATED ULTRA-URBAN GREEN INFRASTRUCTURE 2.5

Van Meter Williams Pollack

BLOCK	SQ. FT.	ACRES	10 YEAR D+WQ 1.54"/AC	FAR	BLDG HT	BLDG AREA (sf)	ROOF AREA	GARAGE BLDG AREA (sf)	GARAGE HT	GARAGE ROOF AREA (sf)	GARAGE ROOF UTILIZATION at .70 OF GARAGE	GARAGE GREEN ROOF UTILIZATION at .70 OF GARAGE ROOF (sf)	GARAGE GREEN ROOF	
													cu. ft.	% of 10yr D+WQ
1	92,700	2.13	at 0.85 imperm = **10,112 cu. ft.**	3.0	5 story	218,060	43,612	60,990	2 story	30,495	21,347	14,943	**479**	4.7%
2	74,000	1.70	at 0.85 imperm = **8,072 cu. ft.**	3.3	5 story	200,050	40,010	42,300	2 story	21,150	14,805	10,364	**332**	4.1%
3	81,000	1.86	at 0.85 imperm = **8,836 cu. ft.**	2.9	5 story	184,794	36,959	50,300	2 story	25,150	17,605	12,324	**395**	4.5%
4	52,700	1.21	at 0.85 imperm = **5,749 cu. ft.**	2.5	5 story	108,680	21,736	24,710	2 story	12,355	8,649	6,054	**194**	3.4%
5	59,100	1.36	at 0.85 imperm = **6,447 cu. ft.**	2.5	5 story	120,930	24,186	29,180	2 story	14,590	0	0	**0**	0.0%
6	76,250	1.75	at 0.85 imperm = **8,318 cu. ft.**	3.0	5 story	168,990	33,798	58,500	2 story	29,250	0	0	**0**	0.0%
7	81,700	1.88	at 0.22 imperm = **2,307 cu. ft.**	0.7	2&3 story	53,140	N/A	6,400	N/A	N/A	N/A	N/A	N/A	
8	60,800	1.40	at 0.85 imperm = **6,632 cu. ft.**	2.2	5 story	103,200	20,640	28,510	2 story	14,255	0	0	**0**	0.0%
9	78,500	1.80	at 0.85 imperm = **8,563 cu. ft.**	2.7	5 story	154,170	30,834	54,620	2 story	27,310	0	0	**0**	0.0%
10	84,950	1.95	at 0.38 imperm = **4,143 cu. ft.**	0.8	2&3 story	48,920	N/A	20,880	N/A	N/A	N/A	N/A	N/A	
11	65,600	1.51	at 0.85 imperm = **7,156 cu. ft.**	2.4	5 story	123,940	24,788	34,680	2 story	17,340	0	0	**0**	0.0%
13	47,050	1.08	at 0.85 imperm = **5,132 cu. ft.**	3.4	5 story	121,800	24,360	38,400	2 story	19,200	0	0	**0**	0.0%
15	32,300	0.74	at 0.85 imperm = **3,523 cu. ft.**	2.9	5 story	66,700	13,340	27,600	2 story	13,800	0	0	**0**	0.0%
16	49,800	1.14	at 0.85 imperm = **5,432 cu. ft.**	2.3	5 story	94,020	18,804	21,200	2 story	10,600	0	0	**0**	0.0%
17	67,950	1.56	at 0.85 imperm = **7,412 cu. ft.**	2.4	5 story	131,310	26,262	28,840	3 story	9,613	6,729	4,711	**151**	2.0%
18	68,300	1.57	at 0.60 imperm = **5,259 cu. ft.**	2.6	8 story	154,520	19,315	25,200	3 story	8,400	0	0	**0**	0.0%
19	94,200	2.16	at 0.30 imperm = **3,627 cu. ft.**	0.3	1 story	29,420	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
20	74,850	1.72	at 0.60 imperm = **5,763 cu. ft.**	2.6	8 story	163,440	20,430	34,500	3 story	11,500	8,050	5,635	**181**	3.1%

Sun Valley P1 Green Roof



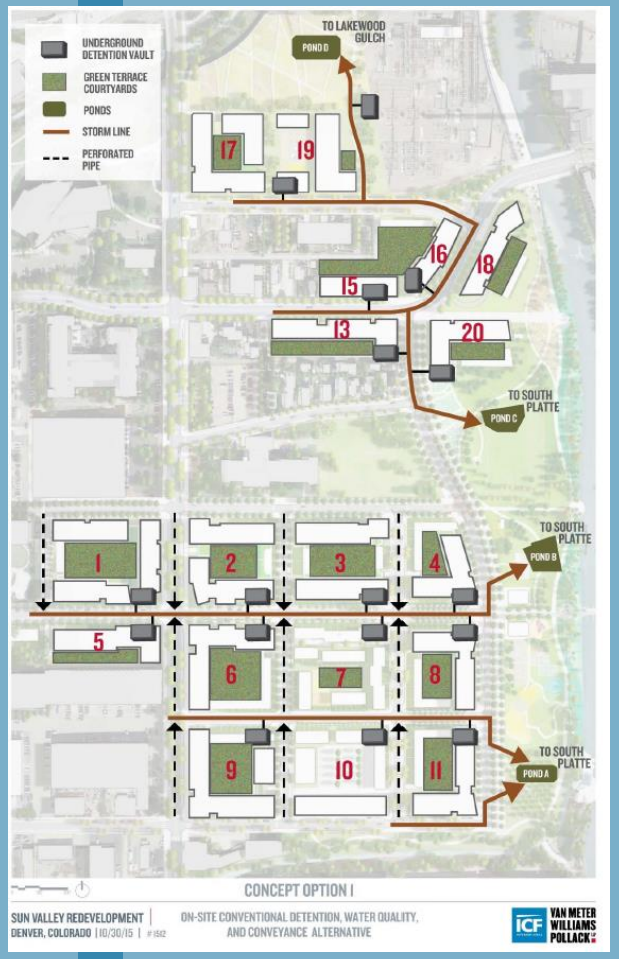
Options:

Preferred Option

Off-Site Detention and Water Quality:
Integrated Ultra-Urban Green Infrastructure

Option 1

On-Site Conventional Detention, Water Quality, and Conveyance Alternative

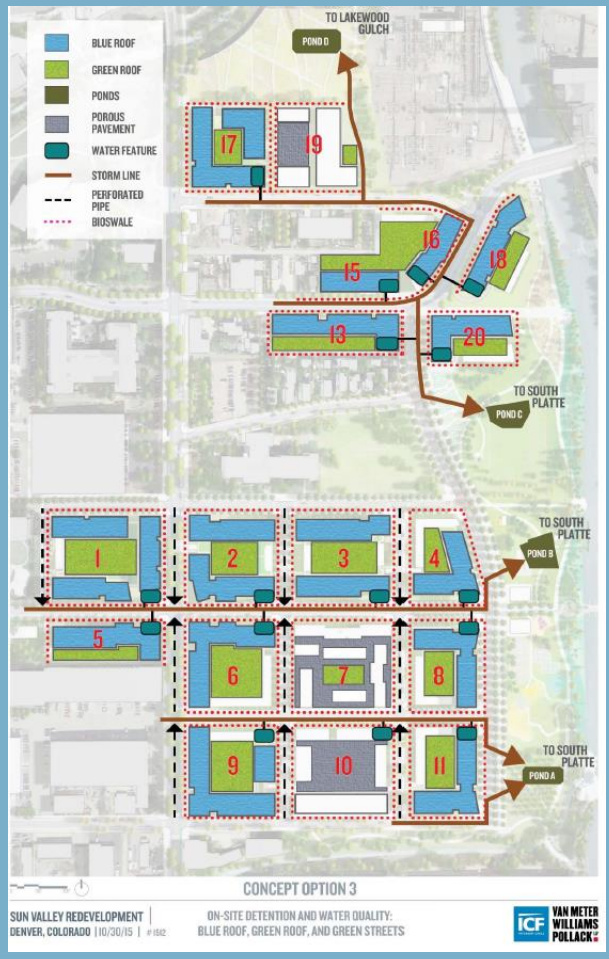


Option 2

Off-Site Detention and Water Quality:
Green Streets and Ponds

Option 3

On-Site Detention and Water Quality:
Blue Roof, Green Roof, and Green Streets



Integrated

Ultra-Urban

Green Infrastructure

- Stormwater infrastructure system within the public ROW
- Consider Green Roofs

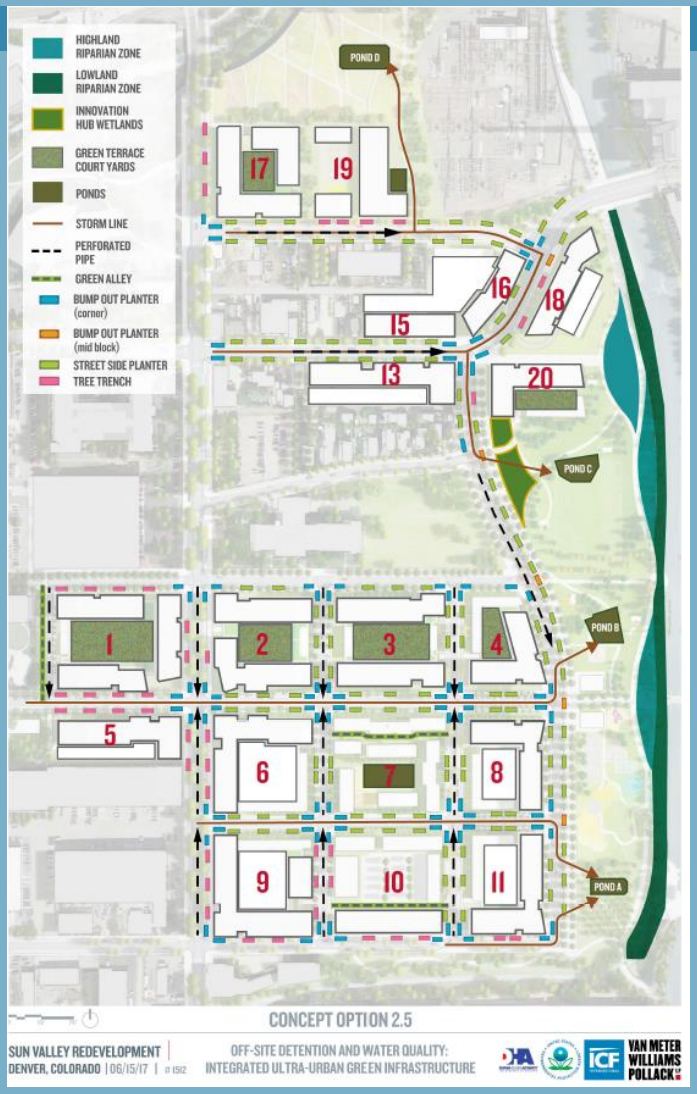
(roof top detention on top of the structured parking facilities, semi-public space)

- 2 Green Alleys

(service private development blocks)

- District(project)-scale stormwater management strategy in place

(development parcels do not need to meet requirements)



Sun Valley Master Plan