INTEGRAL

Revolutionary Engineering

trust | nurture | inspire

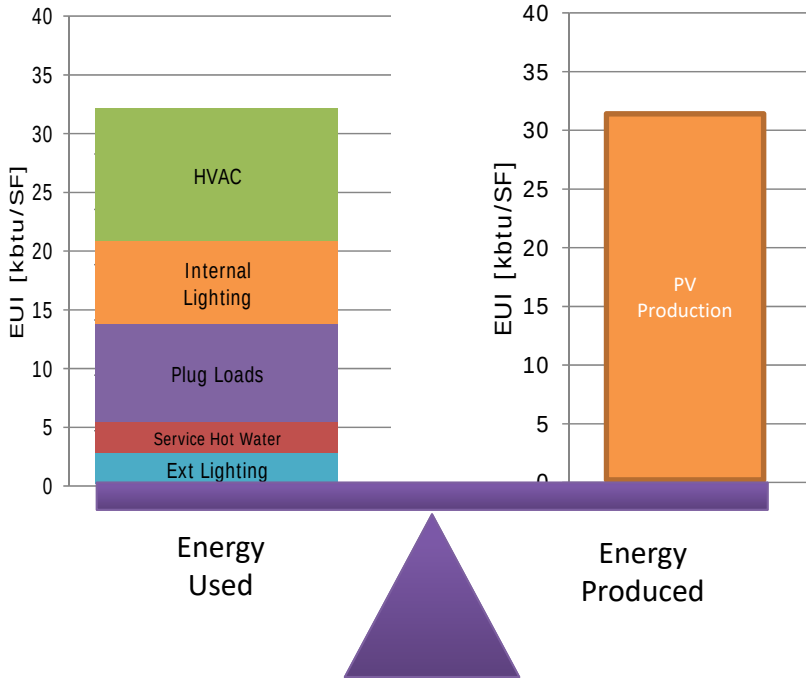
John Andary, PE, LEED AP

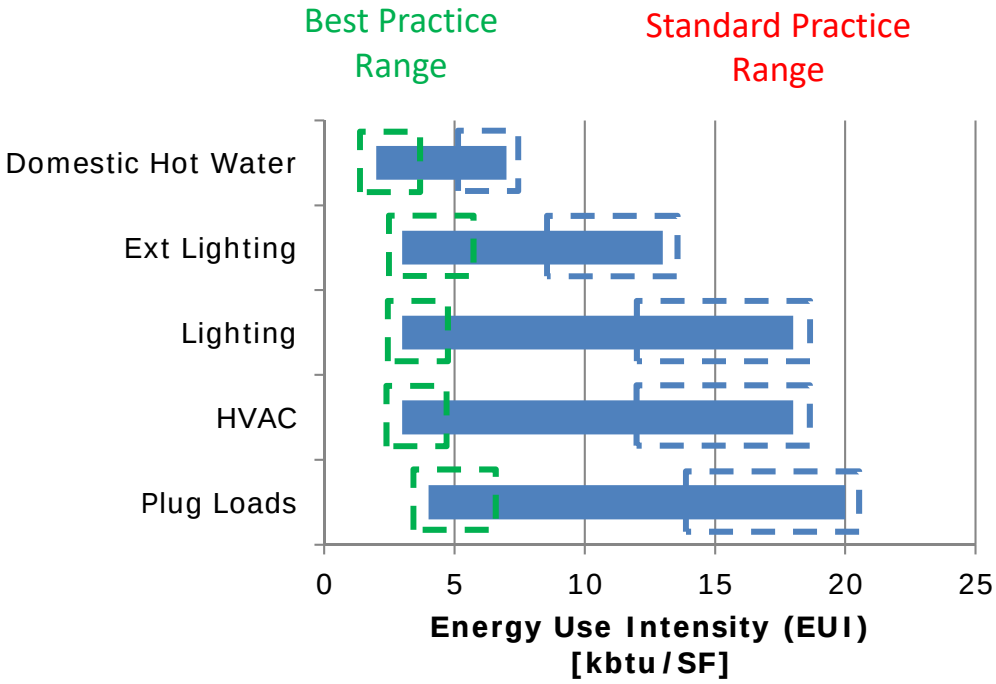
Principal :: Bioclimatic Design Leader

BALANCING THE ENERGY BUDGET

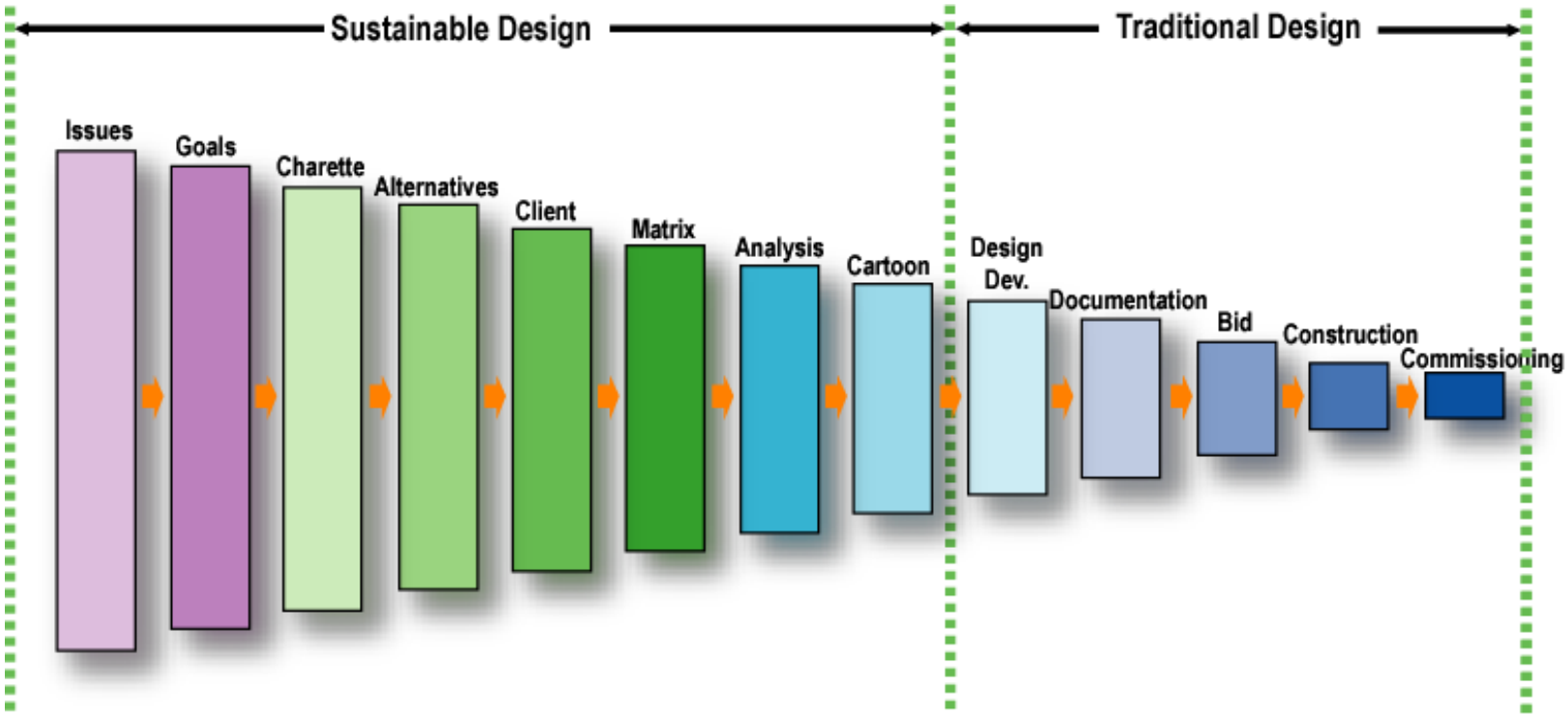
Set a maximum energy budget to help make design decisions.

Understand “Best Practices” in the context of the Energy Budget.

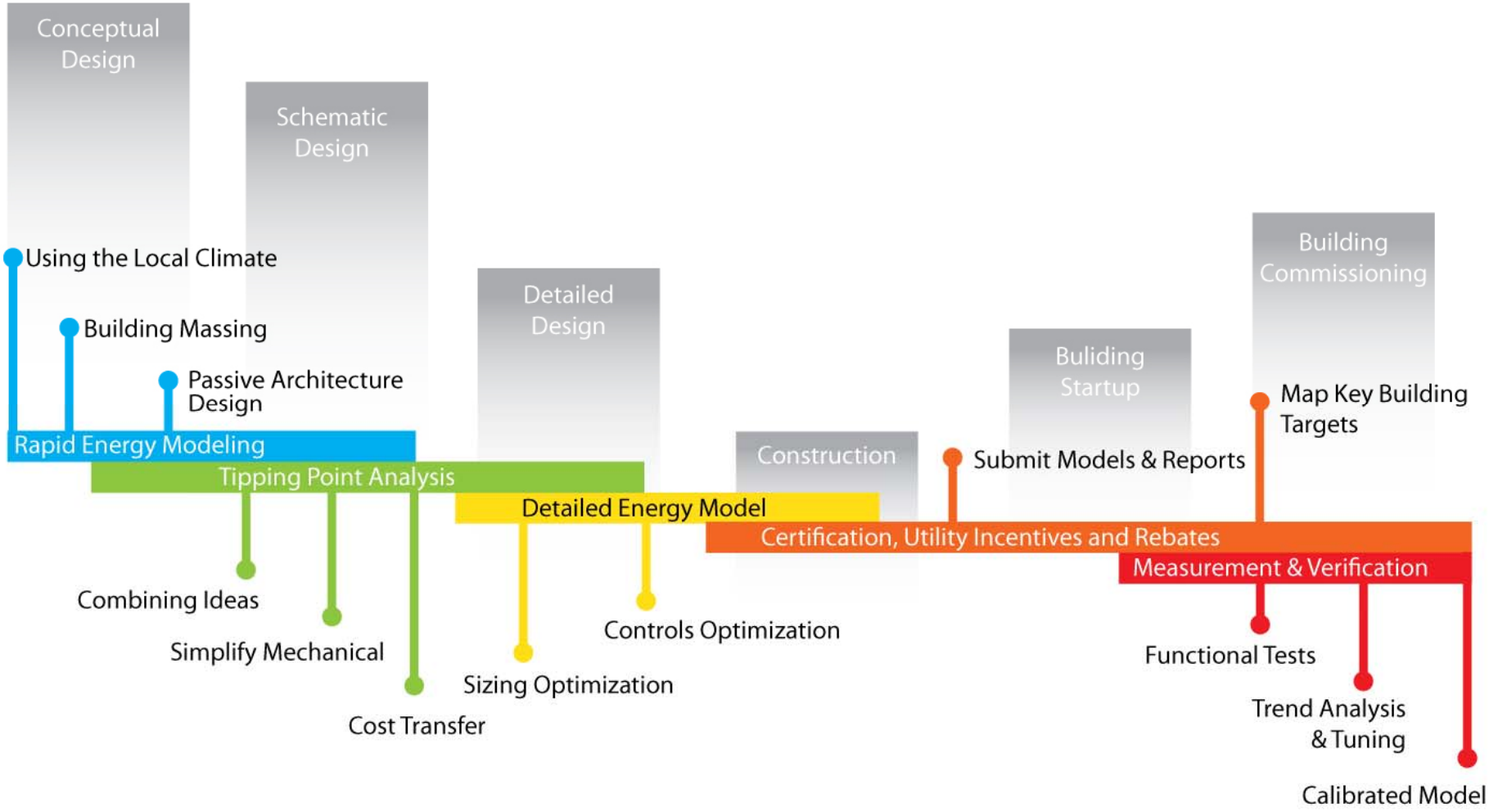




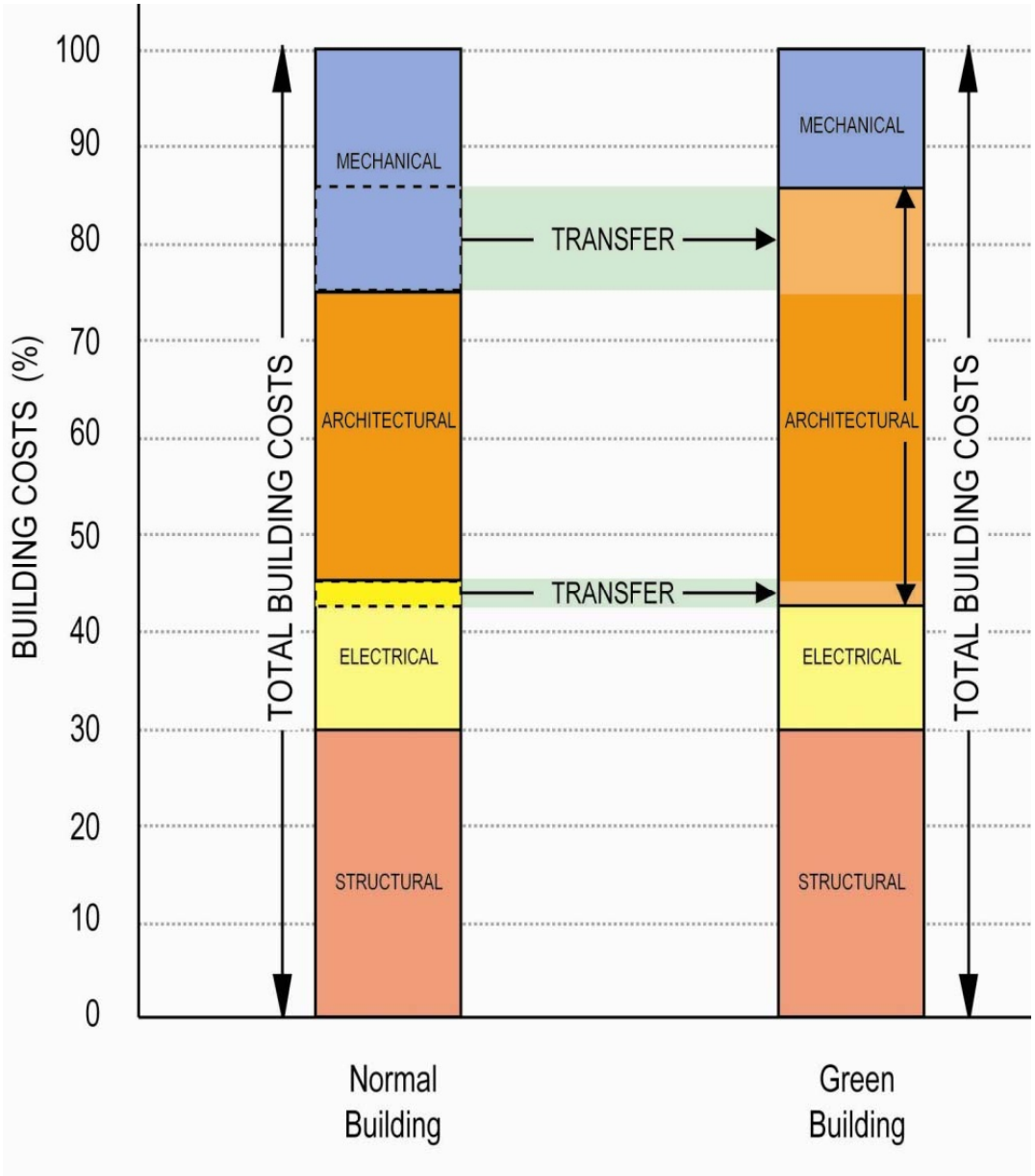
INTEGRATED DESIGN PROCESS



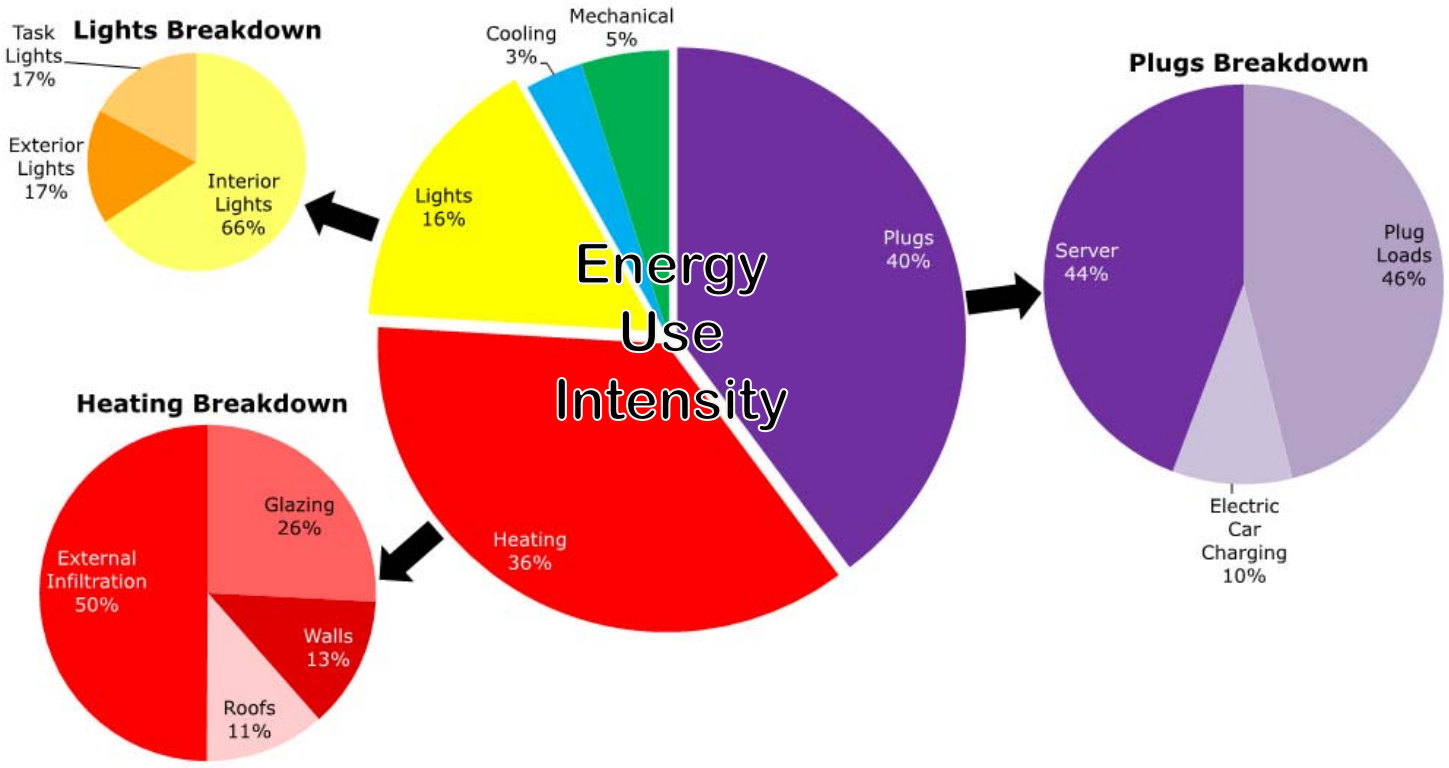
MODELING :: SIMULATION :: ANALYSIS



COST TRANSFER…TUNNELING THROUGH THE COST BARRIER



ENERGY BREAKDOWN BY END USE



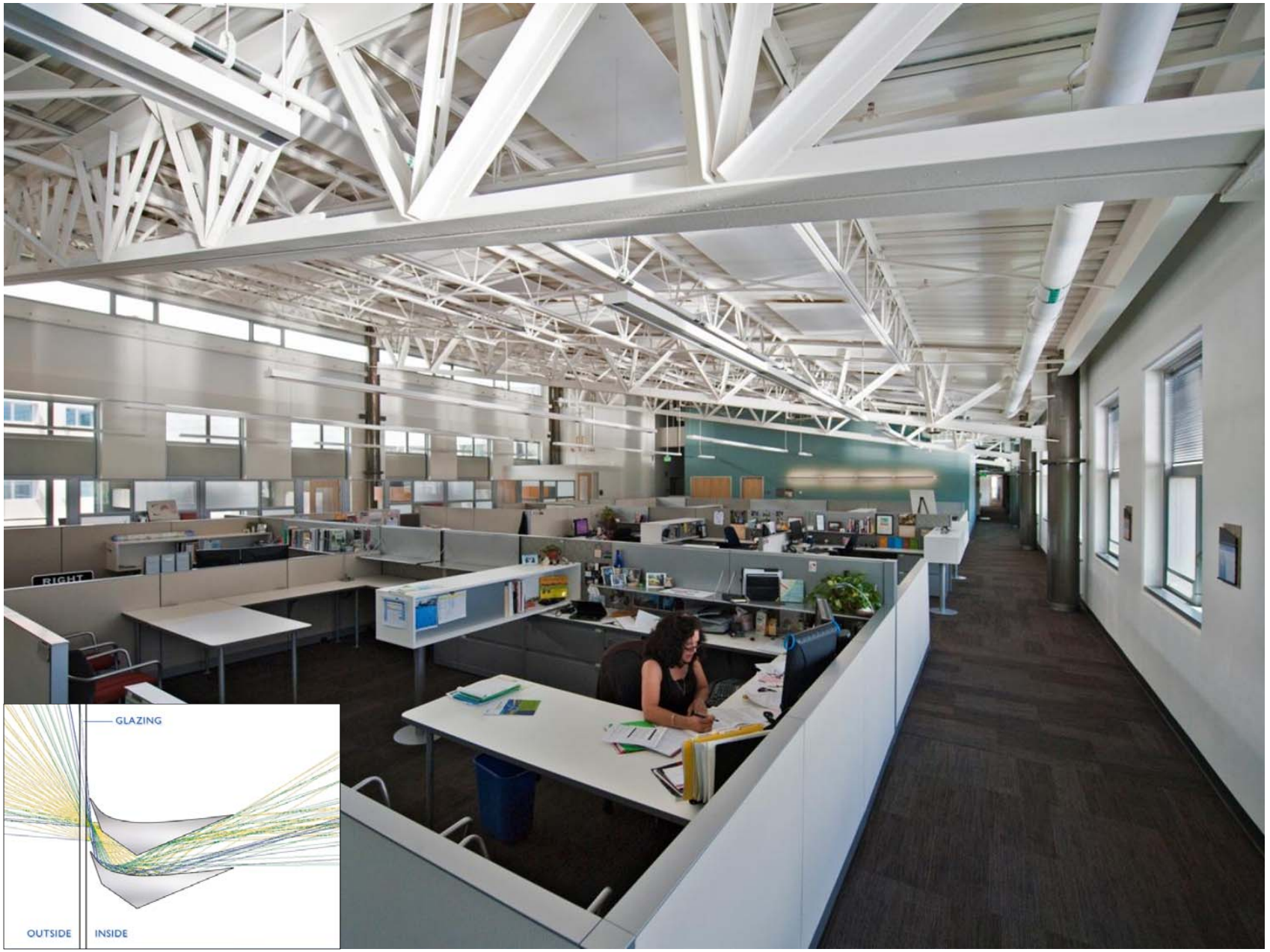
NREL RESEARCH SUPPORT FACILITY :: RNL DESIGN

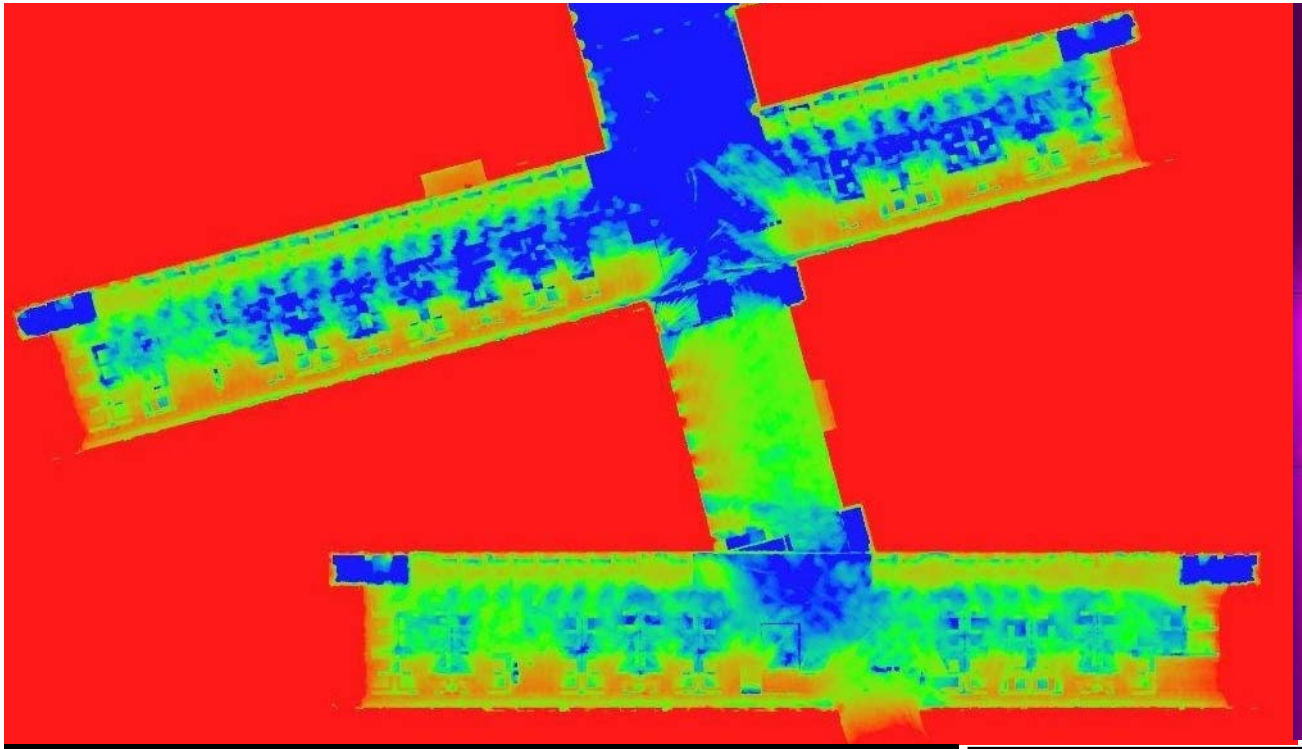
INTEGRATED DESIGN-BUILD SOLUTION

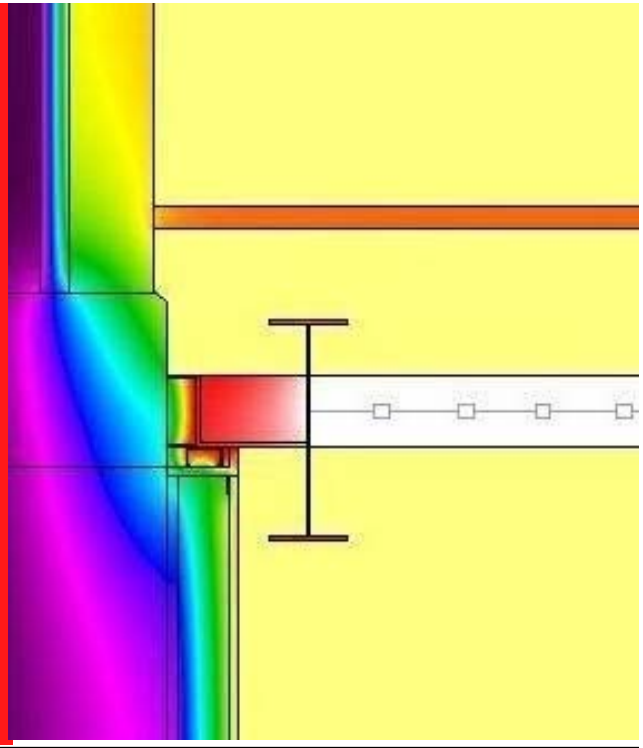
ENVELOPE :: INTENTIONAL APERTURES

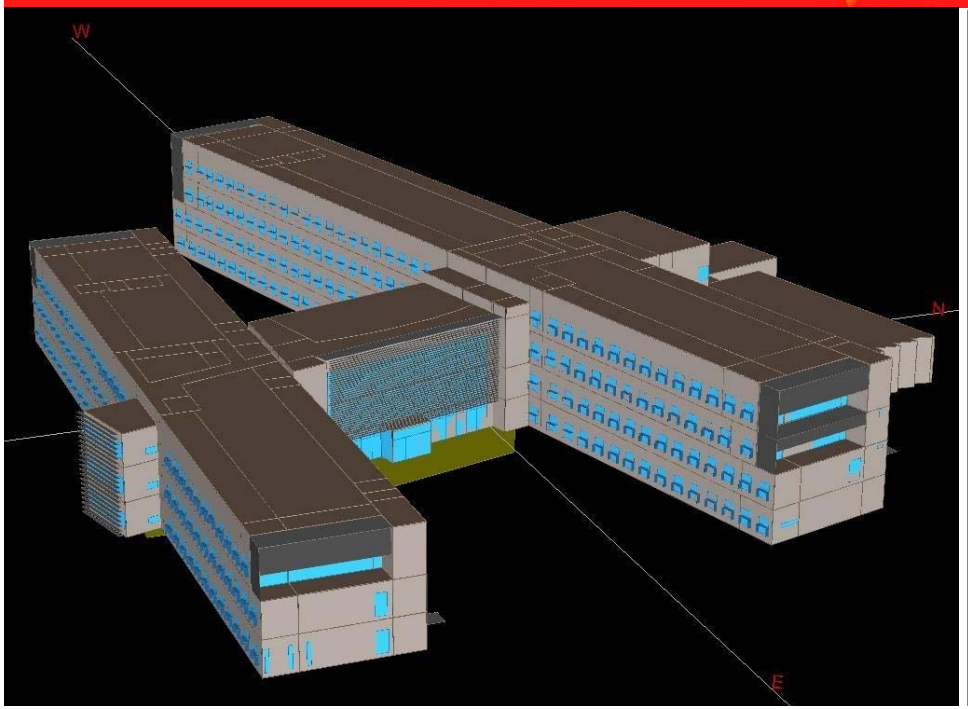
COST MODEL VS. ENERGY MODEL

DAYLIGHT DESIGN :: SIDELIGHTING + REDIRECTING





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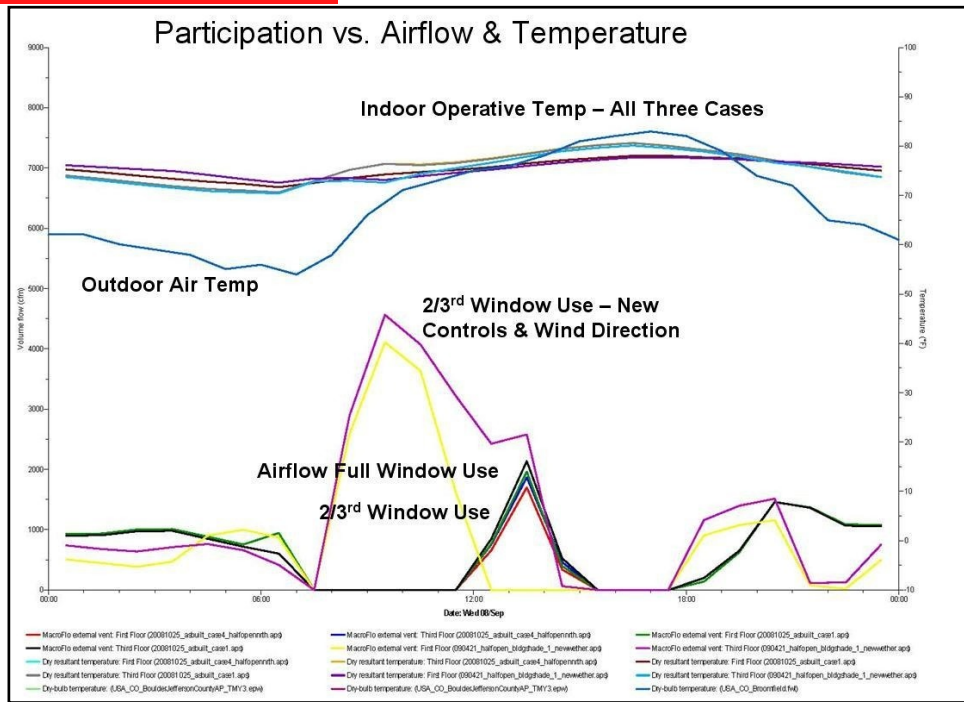
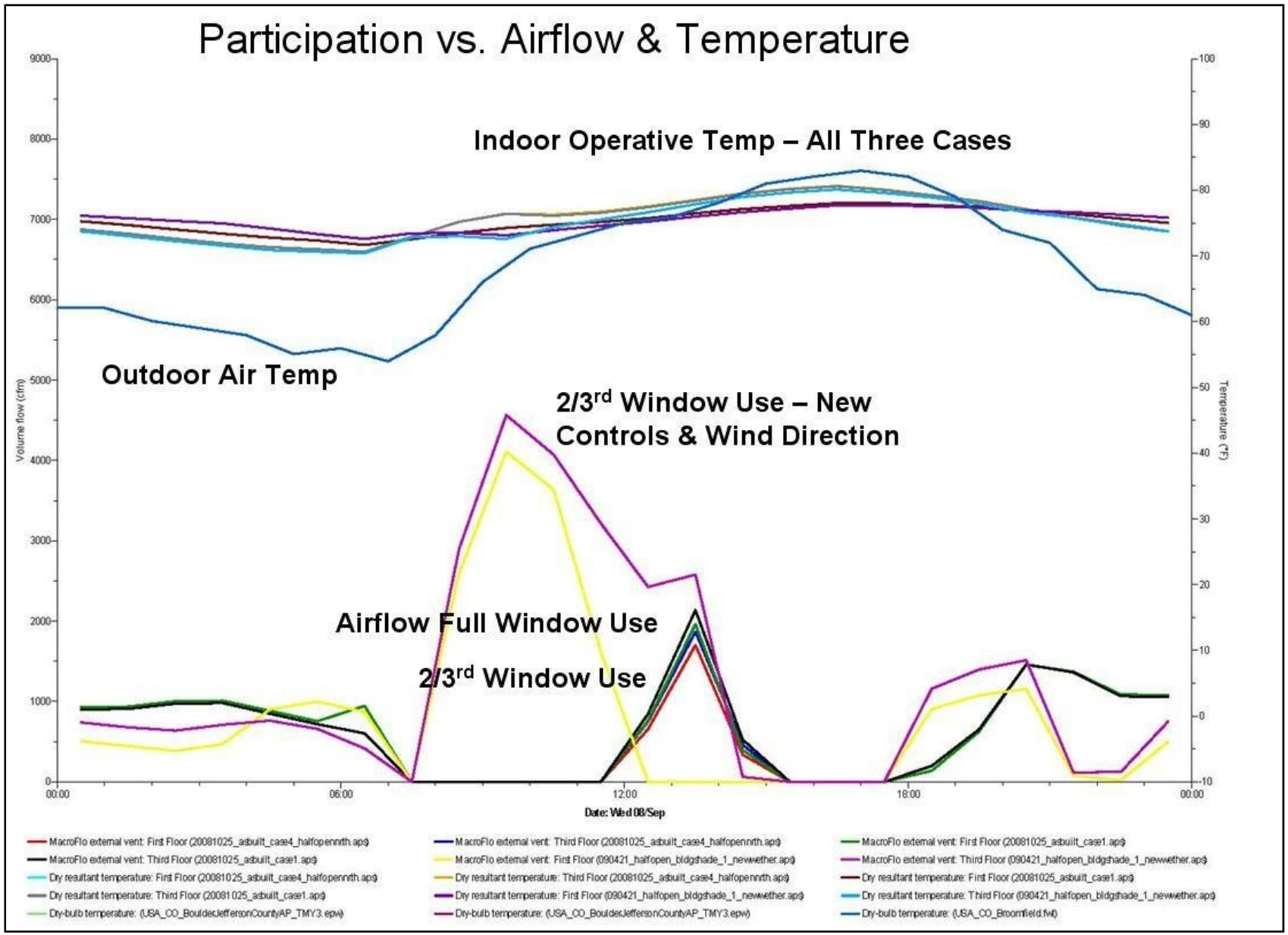

Participation vs. Airflow & Temperature
Indoor Operative Temp – All Three Cases
Outdoor Air Temp
2/3rd Window Use – New Controls & Wind Direction
Airflow Full Window Use
2/3rd Window Use
Volume flow (cfm)
Temperature (°F)
Date: Wed 08/Sep

Participation vs. Airflow & Temperature



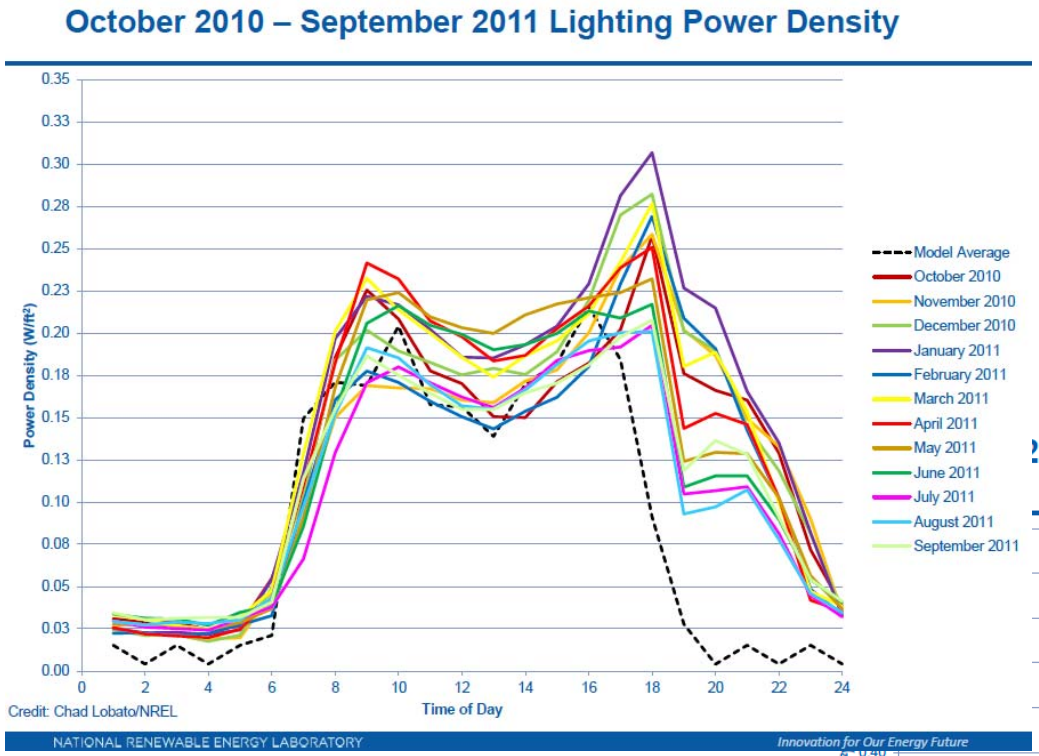
HVAC :: RADIANT HEATING/COOLING

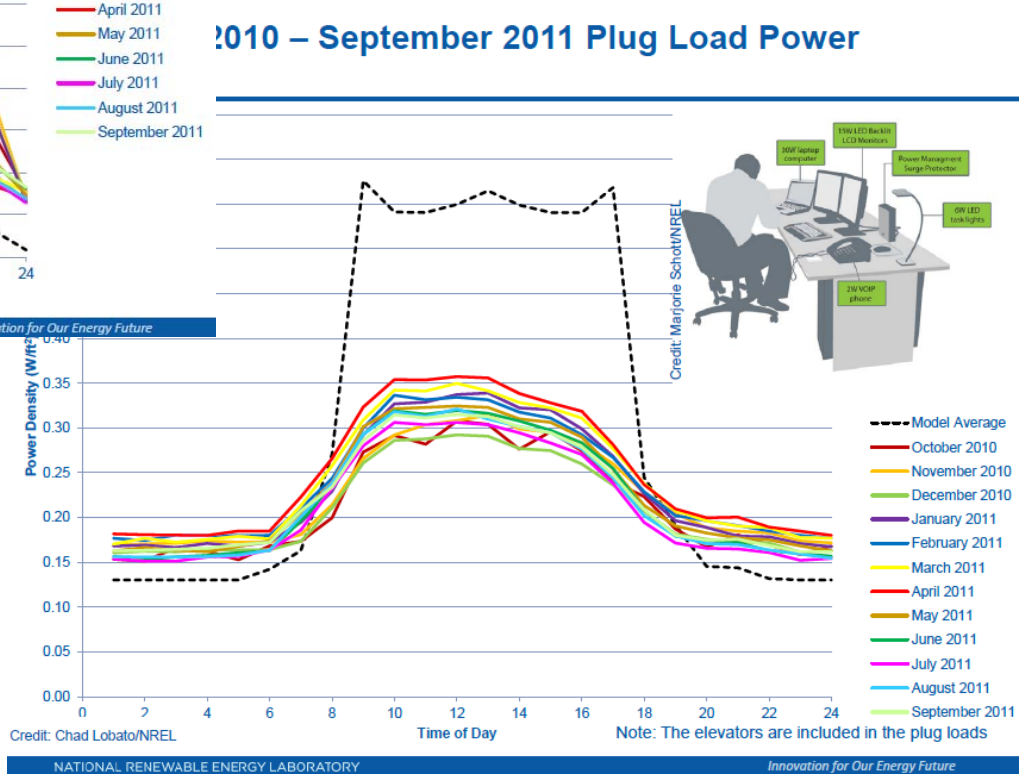
Measured Versus Modeled Monthly and Cumulative EUI

ENERGY USE BREAKDOWN
OCT. 2010 – SEPT. 2011 (KBTU/FT²)

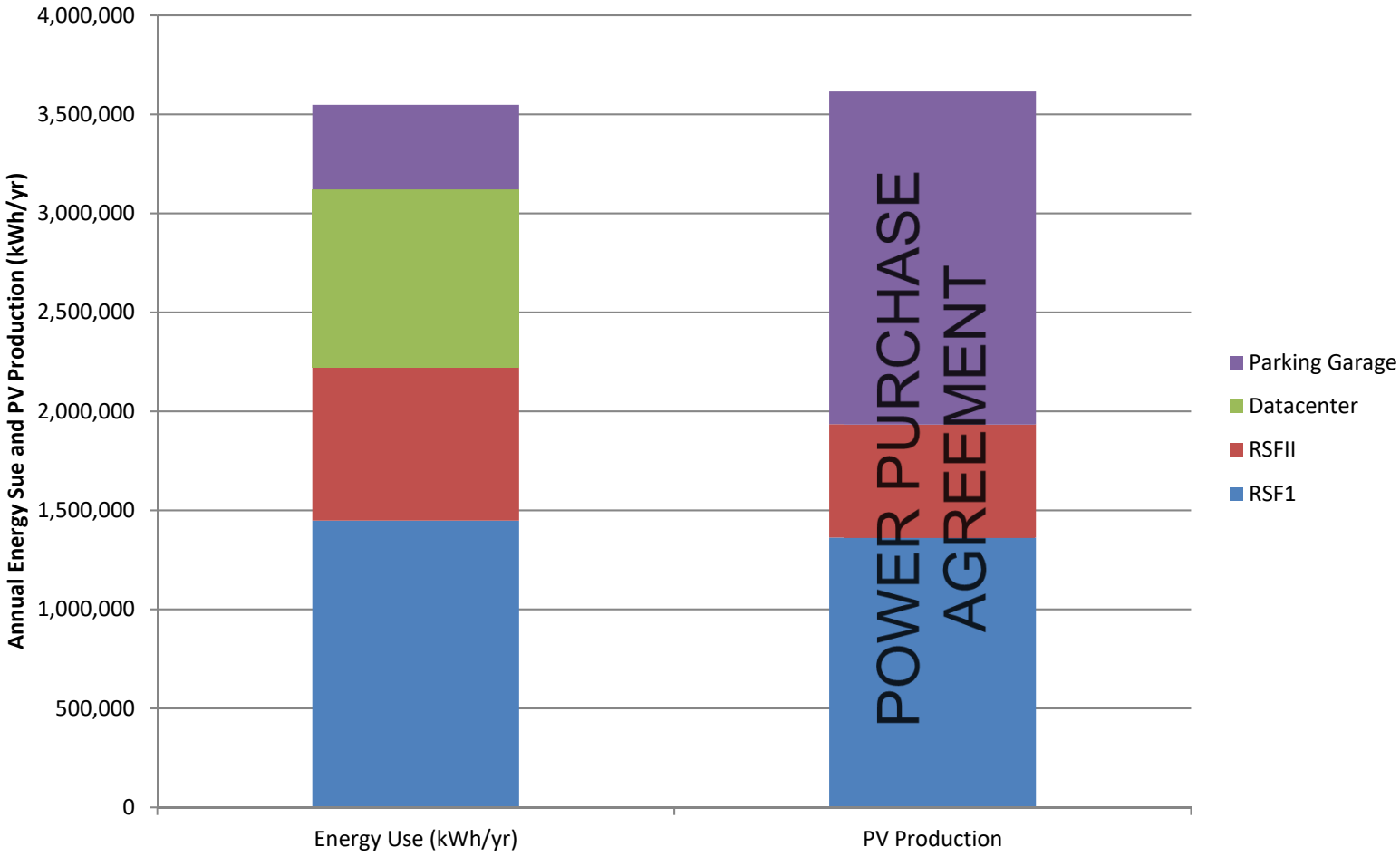
Cooling	0.46
Heating	[illegible]
Mechanical Systems	2.19
Lighting	2.83
Plug Loads	5.76
Data Center	14.43
Building Total	**35.35**

LESSONS LEARNED





ENERGY USED VERSUS PRODUCTION



2013 ASHRAE TECHNOLOGY AWARD CASE STUDIES

NREL applied its own research and best practices for net zero energy performance when building a new facility at its Golden, Colo., campus. The LEED Platinum facility was built for $259/ft² ($2,788/m²) and operates with an energy use intensity of 35.4 kBtu/ft²·yr (112 kWh/m²·yr).

AWARD OF ENGINEERING EXCELLENCE/FIRST PLACE

COMMERCIAL BUILDINS, NEW

NREL: Largest *Net Zero Building*

BY CHUCK-KWAN JOSEPH TAI, P.E., P.ENG., MEMBER ASHRAE; MATT GRINBERG, P.E., ASSOCIATE MEMBER ASHRAE; PORUS ANTIA, MEMBER ASHRAE

BUILDING AT A GLANCE

DOE's NREL

Research Support Facility (RSF)

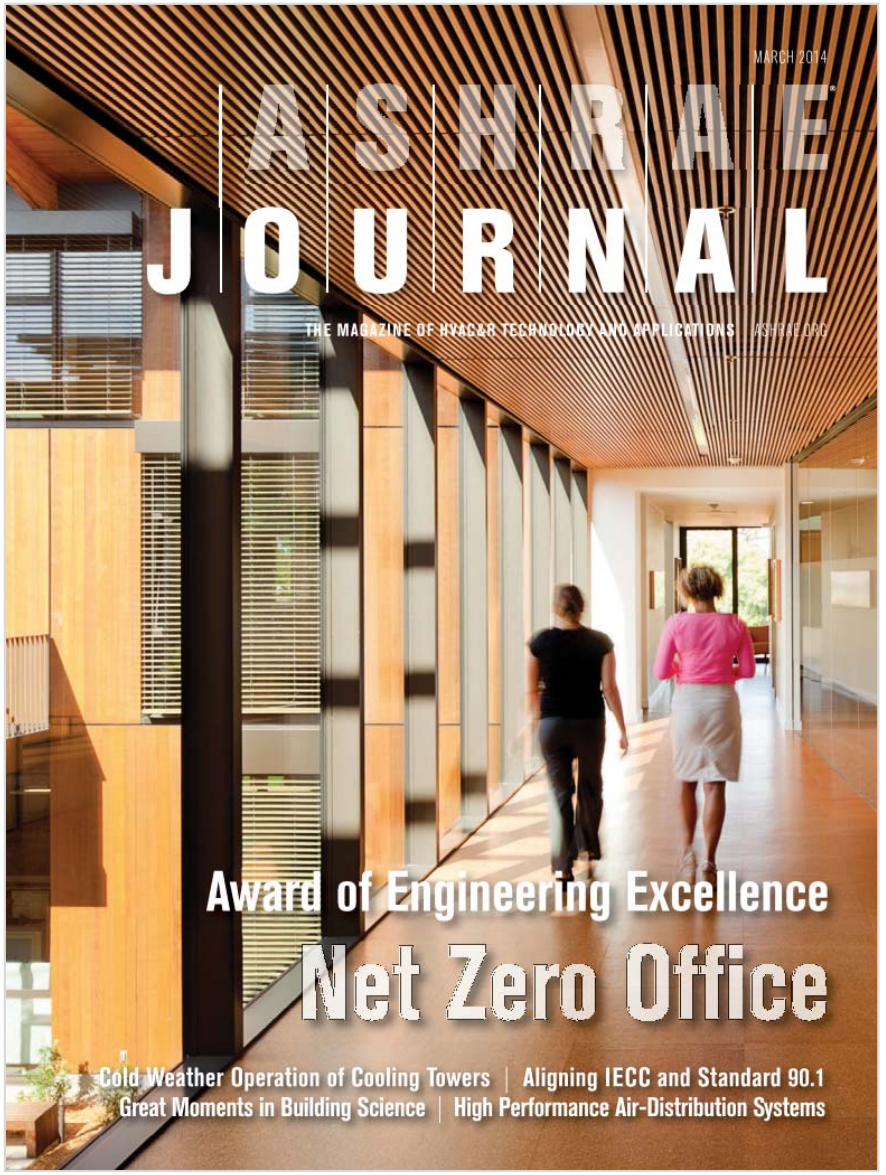
- **Location:** Golden, Colo.
- **Owner:** U.S. Department of Energy and the National Renewable Energy Laboratory
- **Principal Use:** Headquarters Office
- **Includes:** Data Center
- **Employees/Occupants:** 822
- **Gross Square Footage:** 220,000
- **Conditioned Space:** 220,000 ft²
- **Substantial Completion/Occupancy:** June 2010
- **Occupancy:** 100%
- **National Distinctions/Awards:** LEED-NC Platinum, 2011; Sustainable Sites Pilot; AIA COTE Top Ten Green Project, 2011; GreenGov Presidential Award, Green Innovation (RSF Data Center), 2011; McGraw Hill Construction Outstanding Green Building, 2010; American Institute of Steel Construction IDEAS2 Award, 2011; Design-Build Institute of America, Merit Award, 2011

The world's largest net zero energy building did not happen overnight, but it did start with an ambitious vision. When our team first pursued the design of a new Research Support Facility (RSF) at the National Renewable Energy Laboratory (NREL) in 2008, the stipulated objective in the request for proposal (RFP) was an annual energy consumption of 25 kBtu/ft² (79 kWh/m²).

Rather than just meeting this aggressive requirement, we submitted a plan to deliver what NREL had on their wish list, a building that would use as much energy as it would produce—a net zero design. The idea was we could do this within a typical design-build (DB) schedule and a rigid $64.3 million cost budget.

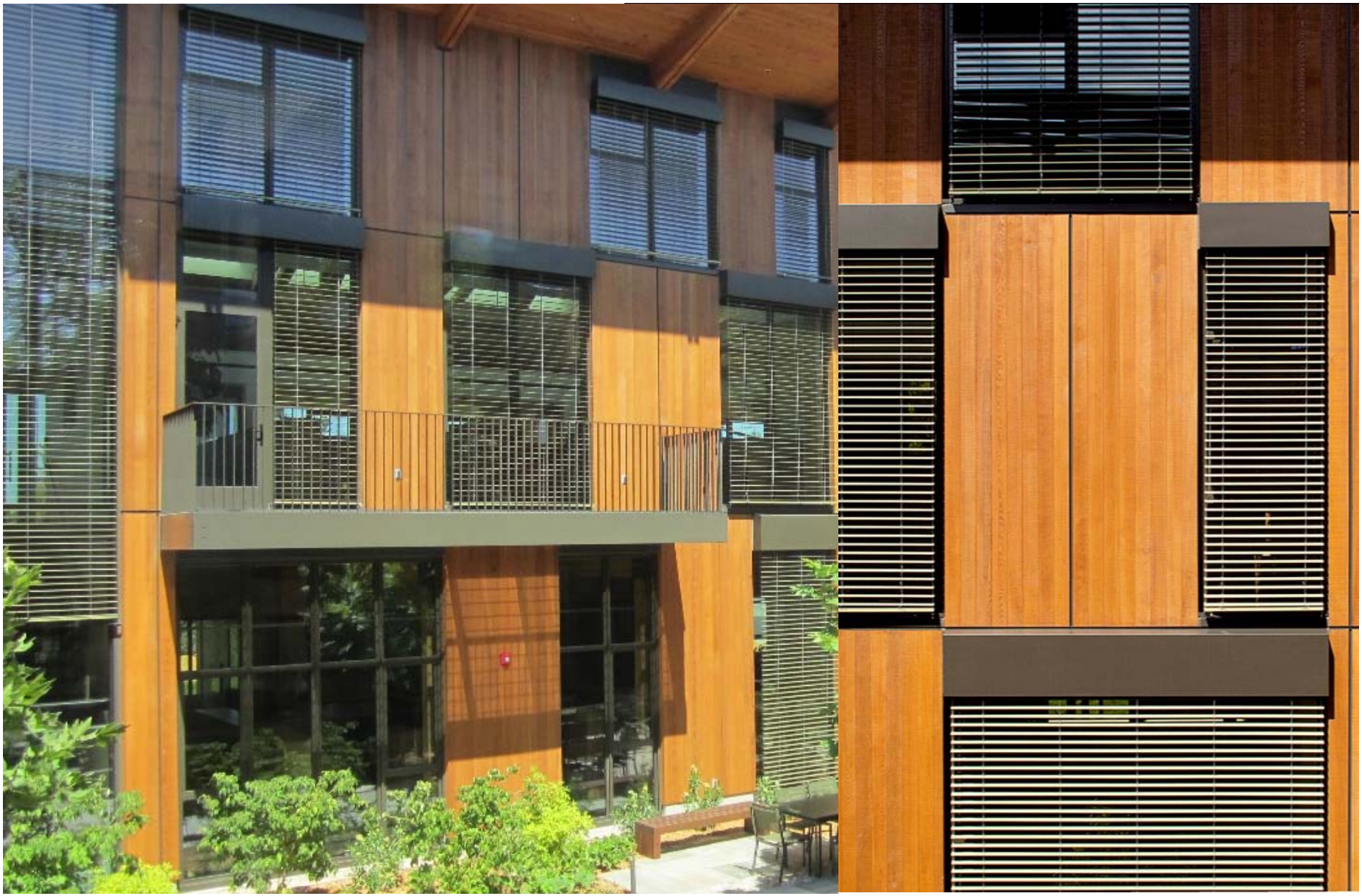
ABOUT THE AUTHORS

Chuck-Kwan Joseph Tai, P.E., P.Eng., is senior associate at Stantec Consulting, Inc. He was engineer of record and project manager of the NREL Research Support Facility. Matt Grinberg, P.E., is a mechanical engineer, and Porus Antia is building simulation - project manager, Stantec Consulting, Inc. Grinberg and Antia are ASHRAE certified Building Energy Modeling Professionals.



PACKARD FOUNDATION HEADQUARTERS :: EHDD

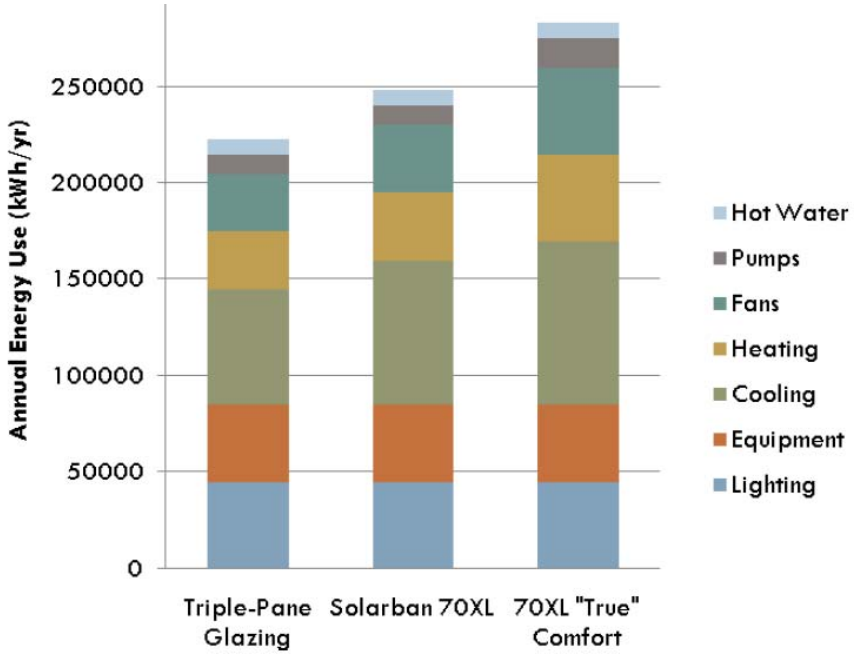
ENVELOPE :: SOLAR CONTROL



NATURAL VENTILATION

DAYLIGHT DESIGN :: SIMPLE SIDELIGHTING

GLAZING ENERGY IMPACTS



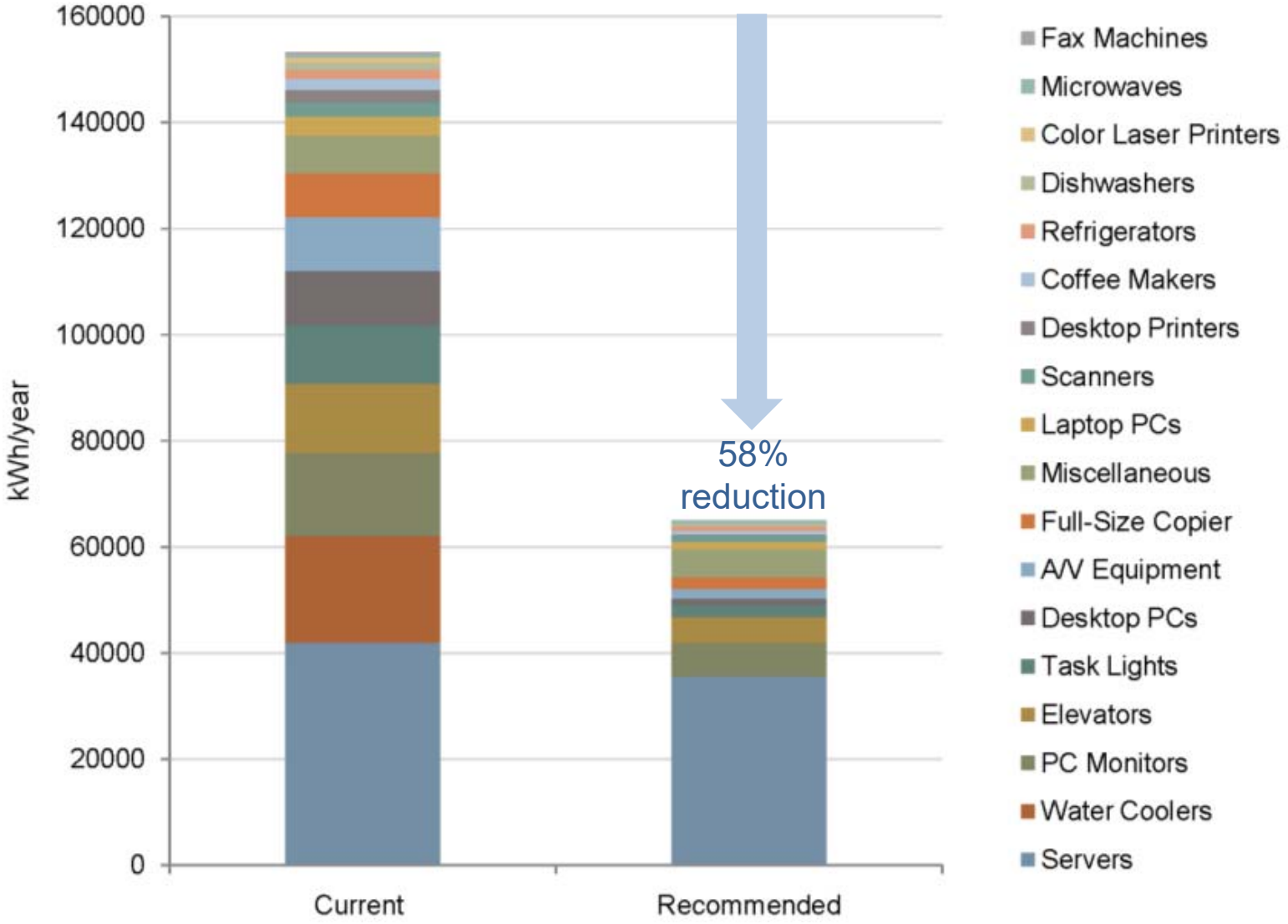
+ $75,000 Premium for installed glazing
- $150,000 Simplify heating system

= $75,000 first cost *savings*

Plus $300,000 savings in fewer PVs

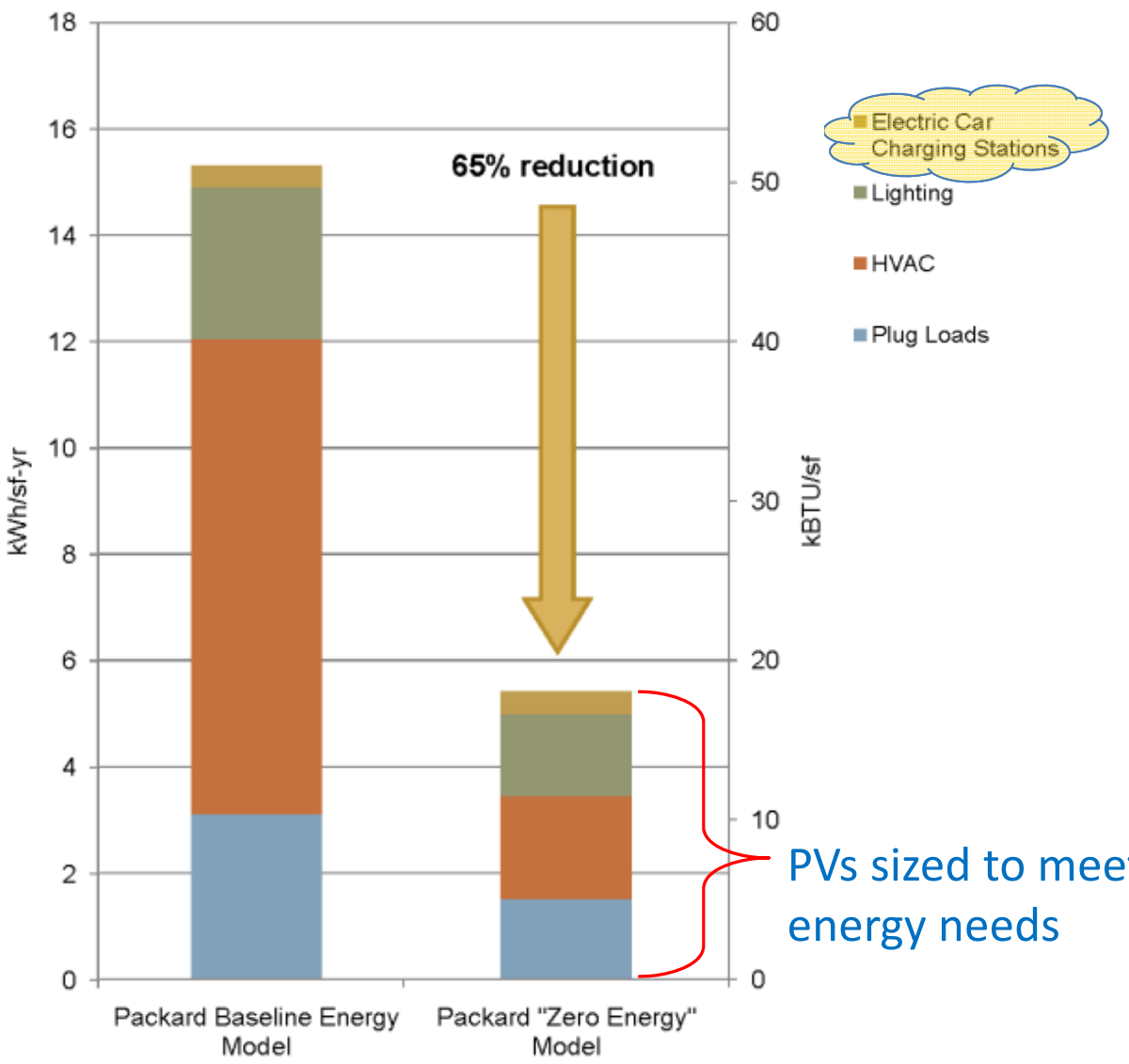
HVAC :: CHILLED BEAMS

PLUG LOADS ANNUAL ENERGY CONSUMPTION



More efficient equipment = $120,000 savings in PV array

ESTIMATED ANNUAL ENERGY USE



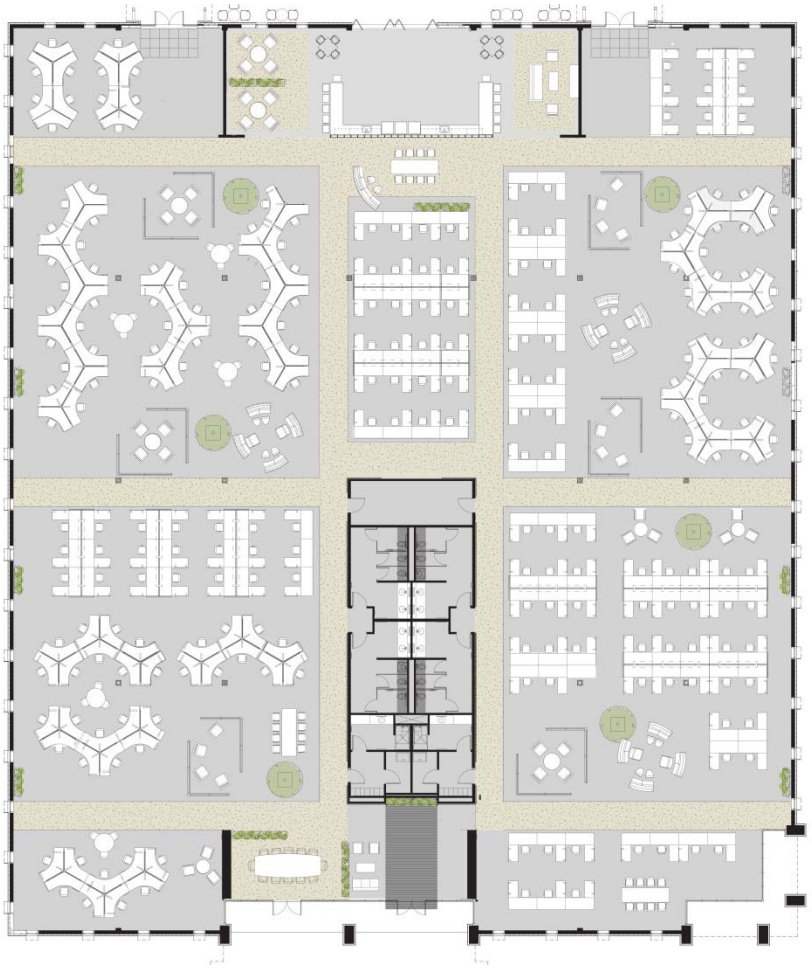
PVs sized to meet 100% of energy needs

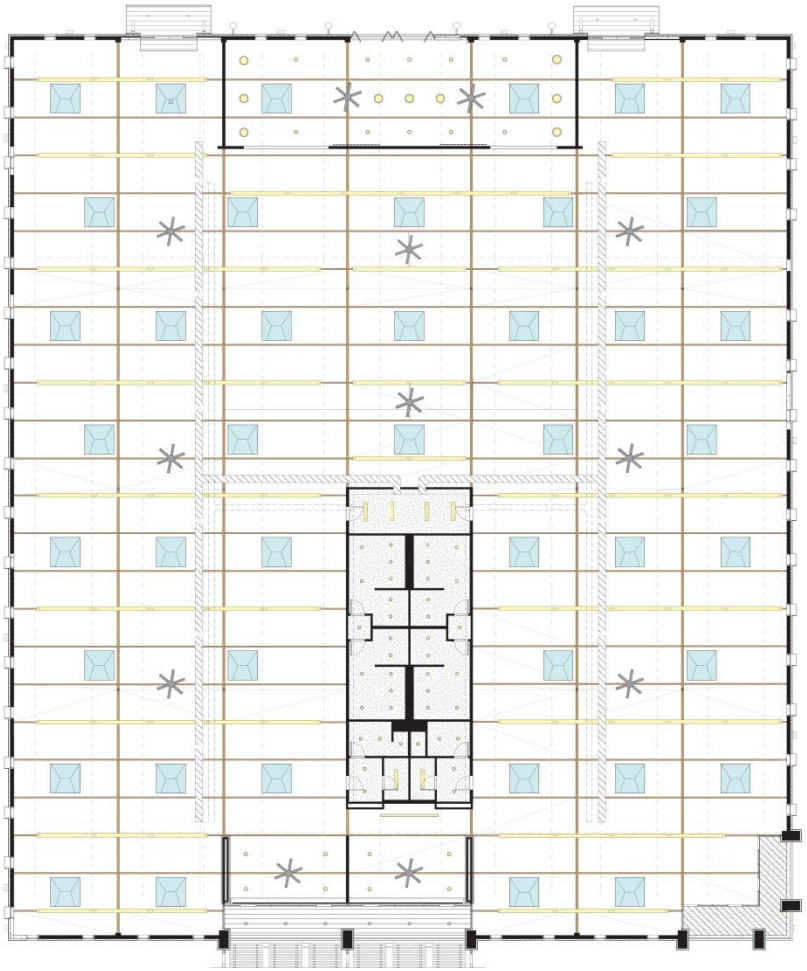
INDIO BUILDING :: RMW ARCHITECTS

EXISTING CONDITIONS

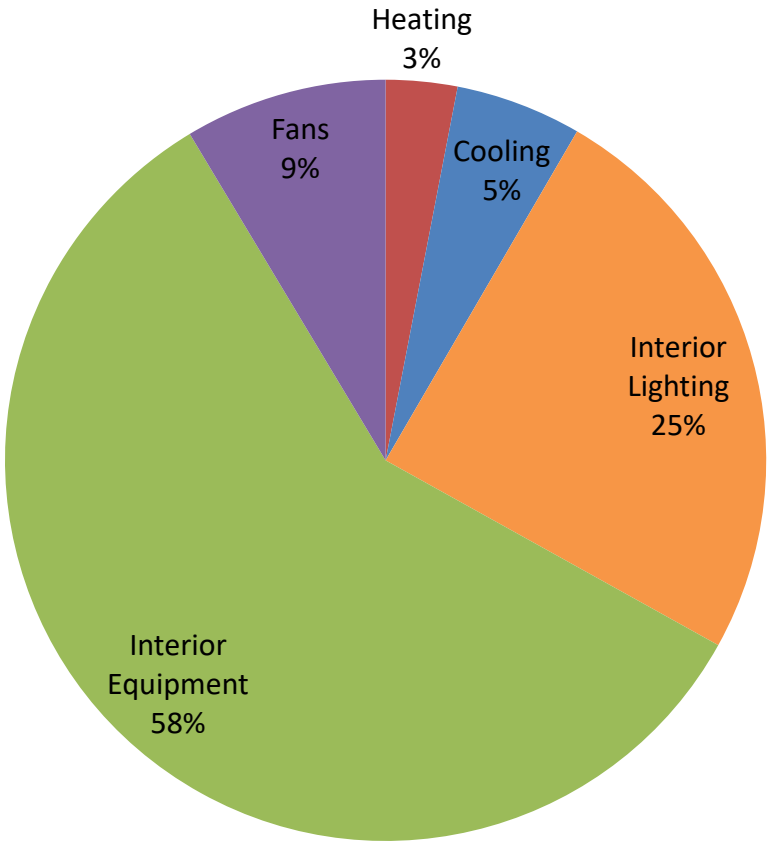
- 30,000 SF square one-story office warehouse circa 1970
- Uninsulated concrete walls, wood roof and single pane windows
- DARK, DINGY, DERELICT and UNRENTABLE!

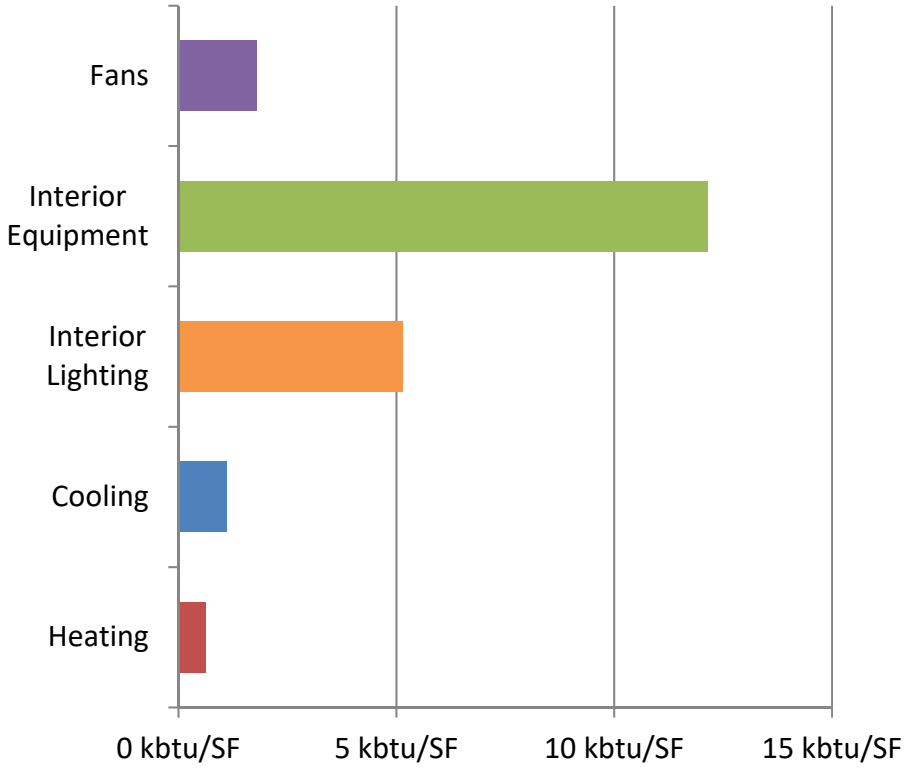
FIXED EXISTING FLOORPLATE





INDIO NET ZERO ENERGY BUDGET

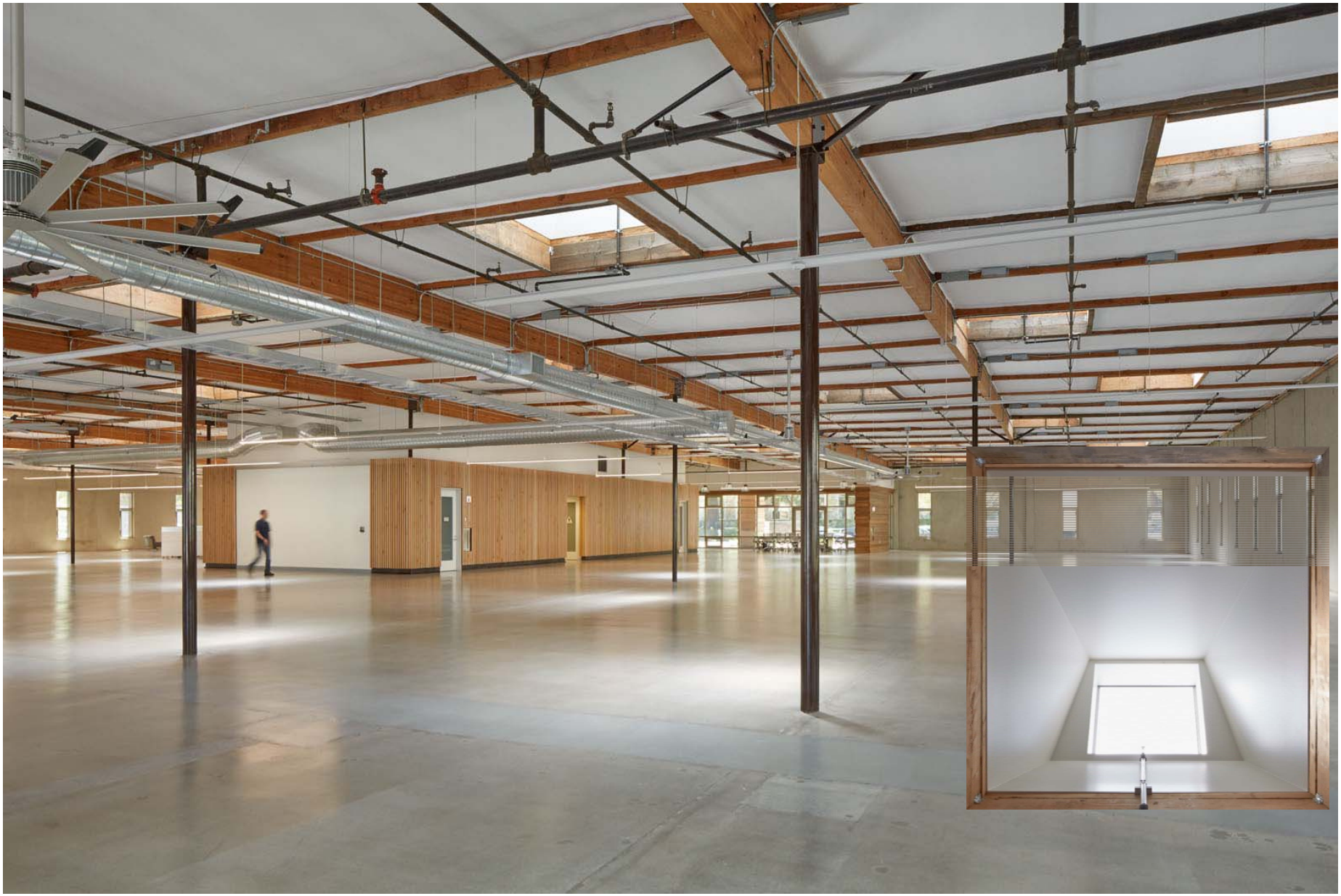




- The Interior Equipment Demand is Based on 1 W/SF of Plug Load
- Annual Energy Use is 22.5 kbtu/SF

HIGH PERFORMANCE ENVELOPE

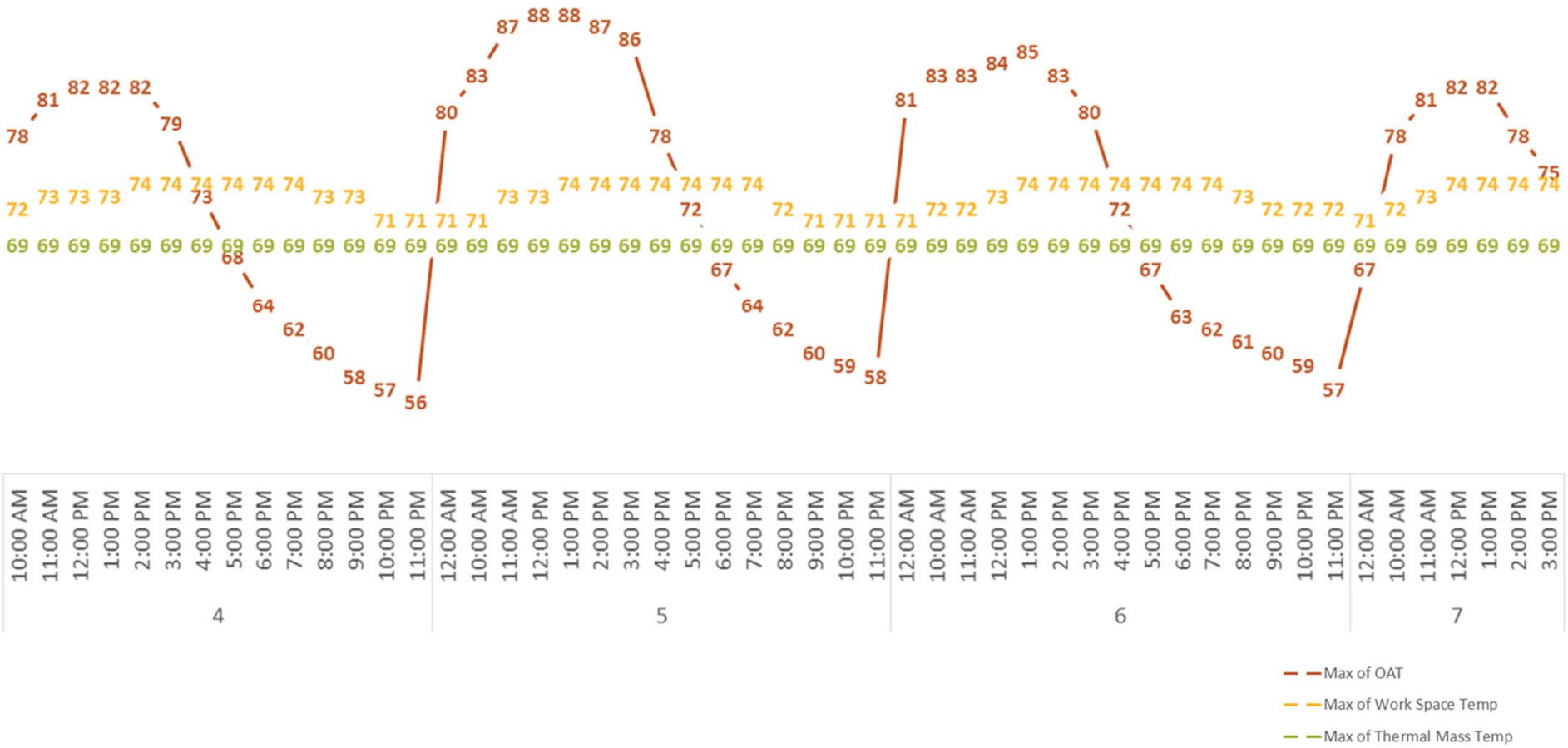
DAYLIGHTING DESIGN



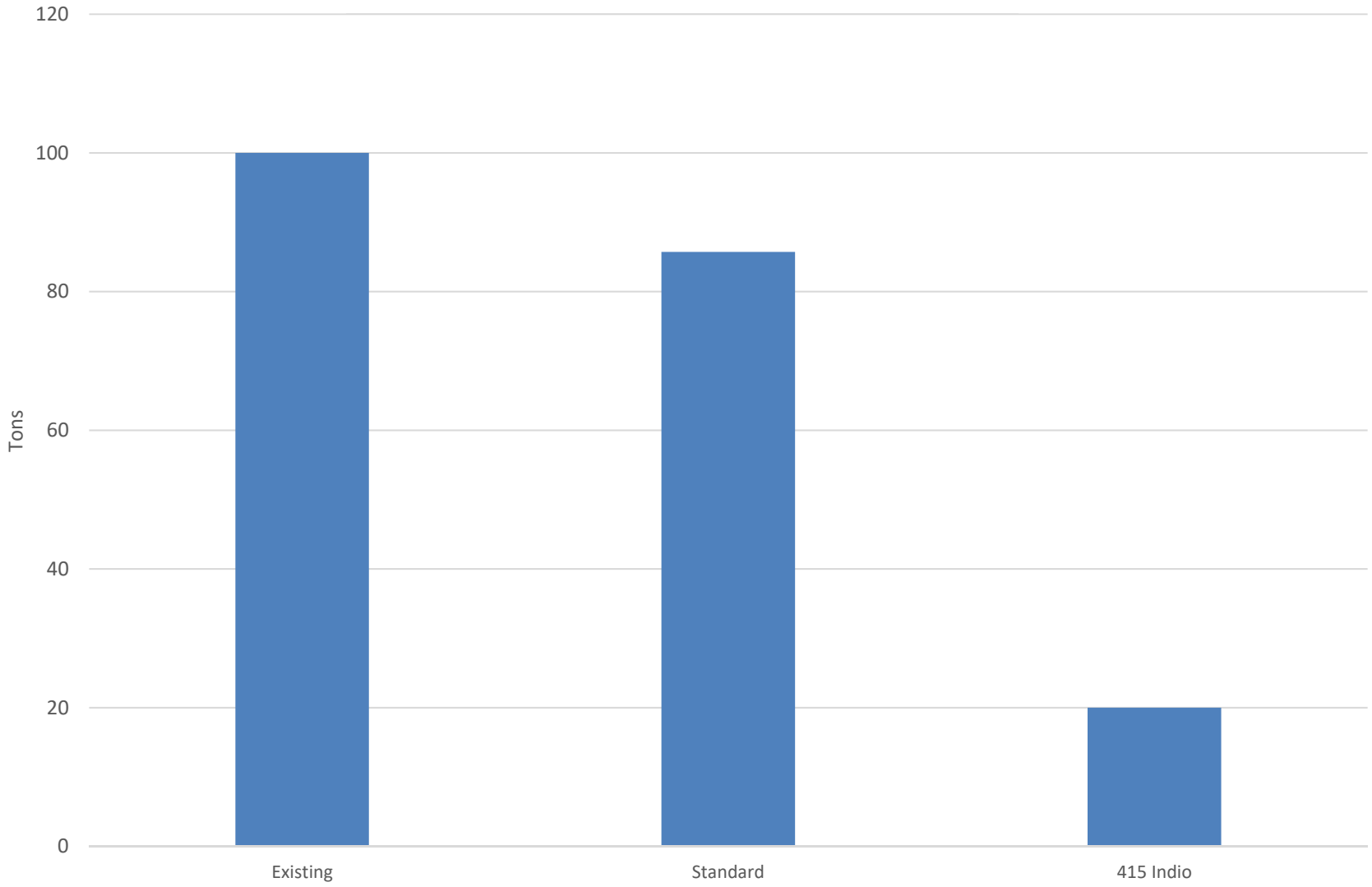
LIGHTING DESIGN

PASSIVE THERMAL COMFORT

MEASURING PASSIVE PERFORMANCE



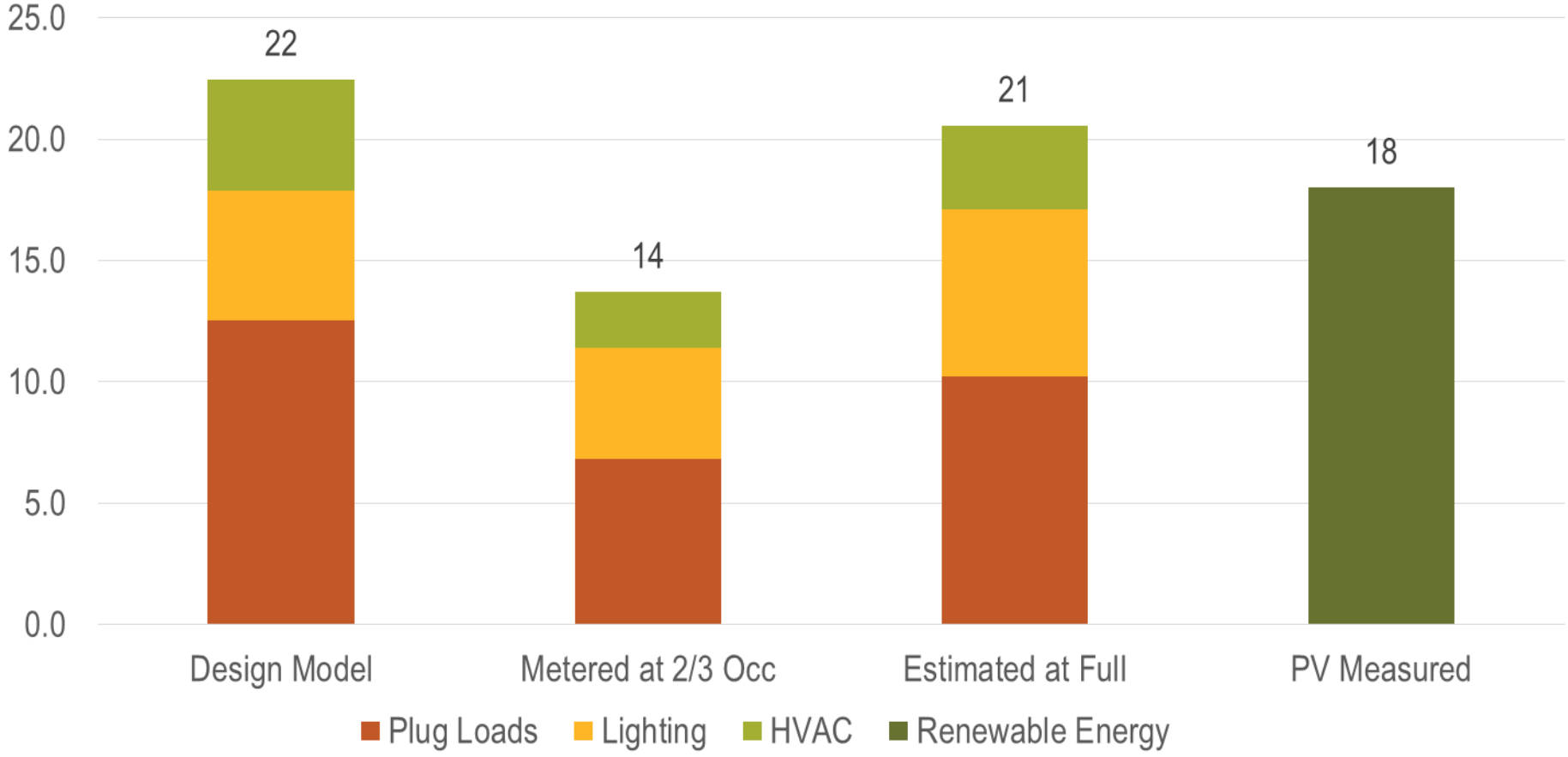
REDUCED HVAC SIZE



1,200 SF / TON!

INTEGRATED ROOF PLANNING

MEASURED ENERGY USE AND PRODUCTION

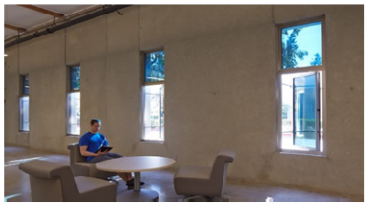


LESSONS LEARNED

ACCELERATE

Taking Net Zero Energy from Replication to *Production*

INDIO — 2014

SILICON VALLEY BUSINESS JOURNAL BEST REUSE PROJECT AWARD 2014 • ASHRAE TECHNOLOGY AWARD 2015

MATHILDA — 2015




SILICON VALLEY BUSINESS JOURNAL GREEN PROJECT OF THE YEAR 2015 • ENR AWARD OF MERIT 2016

AP + I — 2016




SILICON VALLEY BUSINESS JOURNAL GREEN PROJECT OF THE YEAR 2016

PASTORIA — 2017





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MOLLY MILLER