

# Key Issues in Net Zero Design

Getting to Zero National Forum | September 17, 2013

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# Key Issues

1. What's Your EUI?
2. Push the Envelope
3. Count Every Watt
4. Expect the Unexpected
5. Think Bigger



# The David & Lucile Packard Foundation

Los Altos, California

Year Completed : 2012

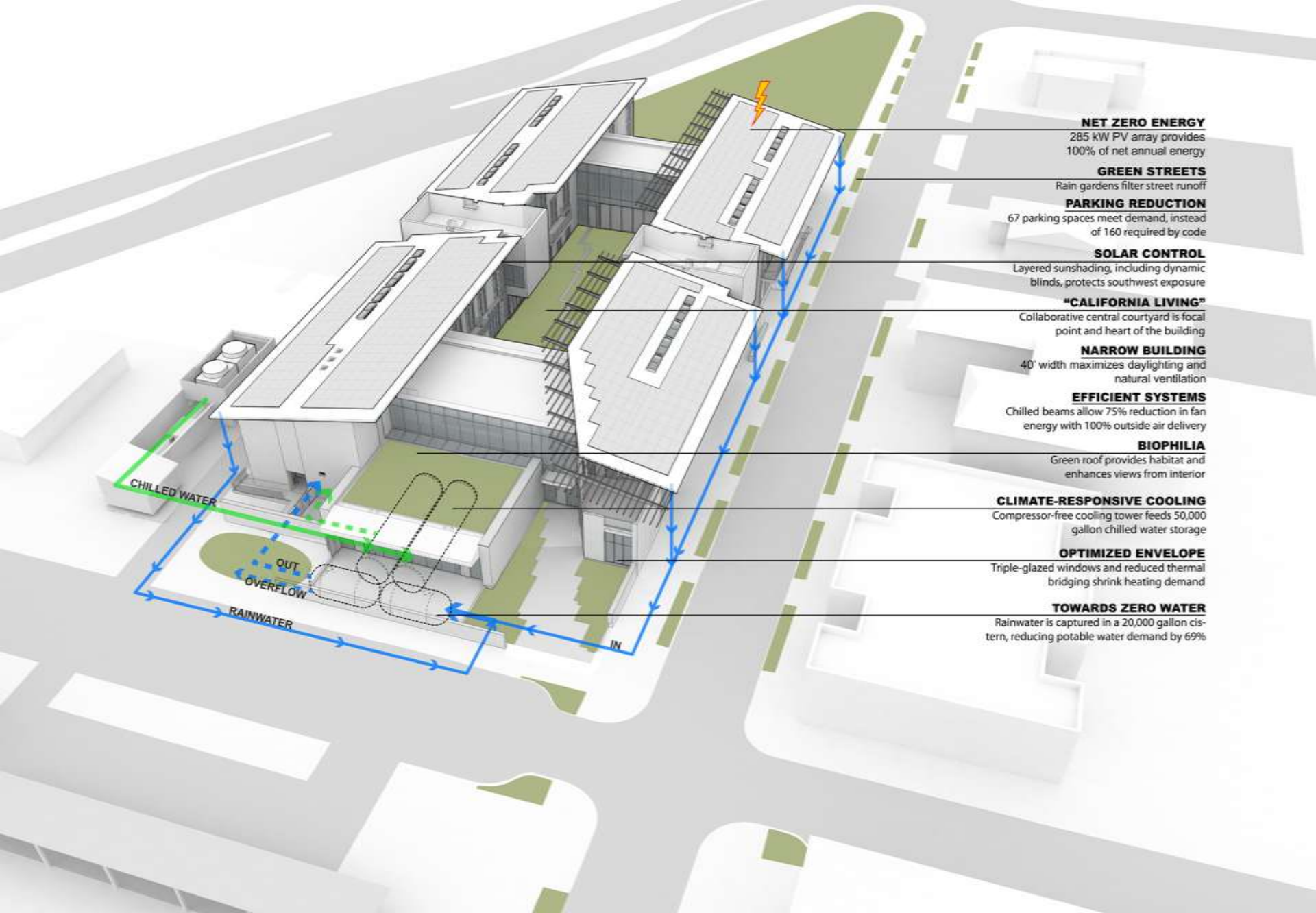
Size : 49,000 SF

EUI : 21.3 kBtu/SF (measured)

Zero Net Energy







**NET ZERO ENERGY**

285 kW PV array provides  
100% of net annual energy

**GREEN STREETS**

Rain gardens filter street runoff

**PARKING REDUCTION**

67 parking spaces meet demand, instead  
of 160 required by code

**SOLAR CONTROL**

Layered sunshading, including dynamic  
blinds, protects southwest exposure

**"CALIFORNIA LIVING"**

Collaborative central courtyard is focal  
point and heart of the building

**NARROW BUILDING**

40' width maximizes daylighting and  
natural ventilation

**EFFICIENT SYSTEMS**

Chilled beams allow 75% reduction in fan  
energy with 100% outside air delivery

**BIOPHILIA**

Green roof provides habitat and  
enhances views from interior

**CLIMATE-RESPONSIVE COOLING**

Compressor-free cooling tower feeds 50,000  
gallon chilled water storage

**OPTIMIZED ENVELOPE**

Triple-glazed windows and reduced thermal  
bridging shrink heating demand

**TOWARDS ZERO WATER**

Rainwater is captured in a 20,000 gallon cis-  
tern, reducing potable water demand by 69%













343 Second Street

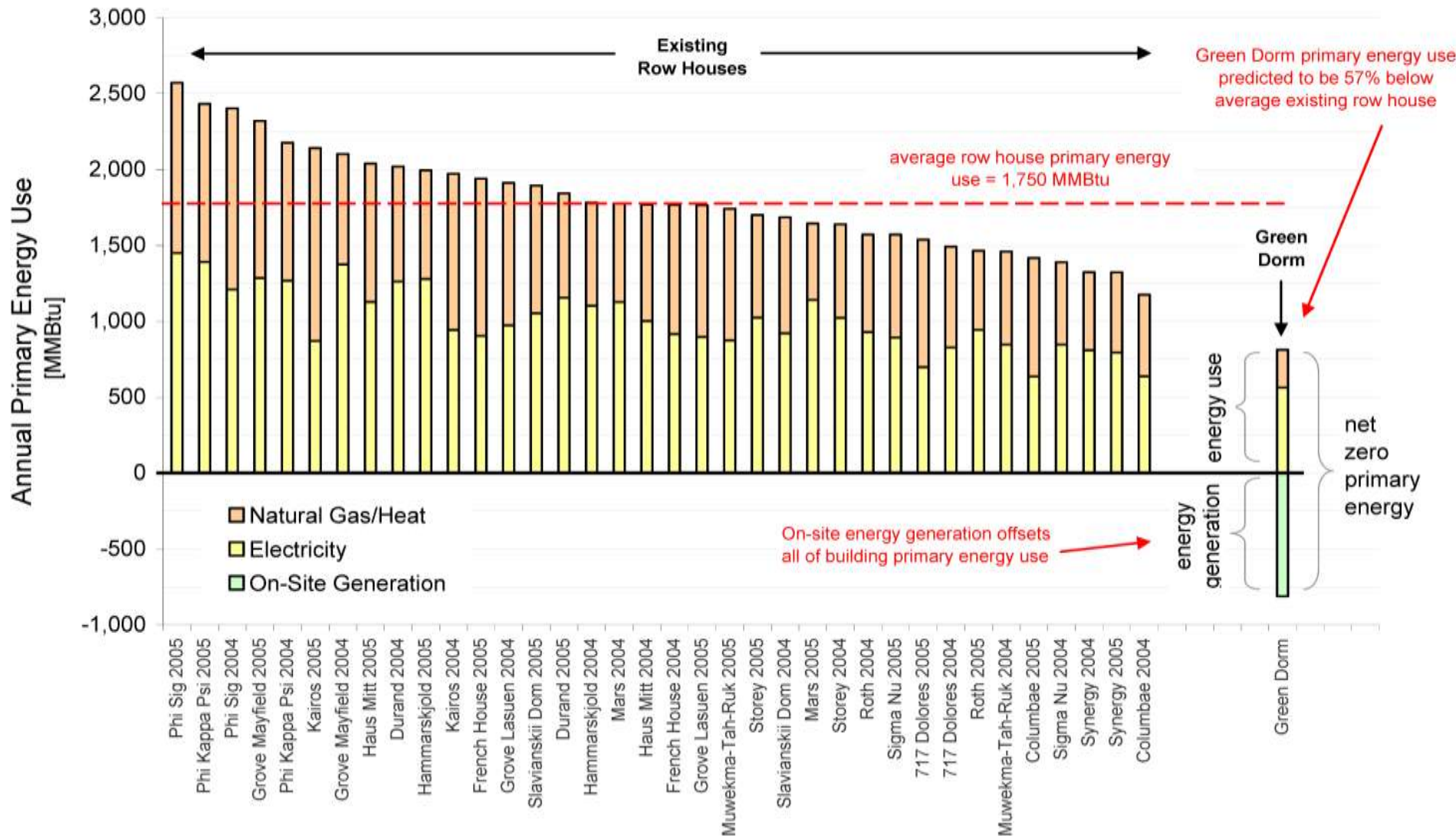
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# Finding the Right Benchmark Data

## Row House Annual Primary Energy Use (All Values Scaled to Green Dorm)



Courtesy of Taylor Engineering



## Define Peer Group

[Back to Metrics & Features](#)

DRAW CHART

Select floor area, vintage,  
and location.

Then, select your building types.



## FLOOR AREA

- ☒ All sizes
- ☒ 0 - 25000 sq. ft.
- ☒ 25000 - 150000 sq. ft.
- ☒ over 150000 sq. ft.

## VINTAGE

- ☒ All years
- ☒ 1991 - Present
- ☒ 1979 - 1990
- ☒ 1941 - 1978
- ☒ 1901 - 1940
- ☒ Pre-1900
- ☒ Unknown

## LOCATION [MAP]

- ☒ All Locations
- ☒ Central Coast
- ☒ Central Valley
- ☒ Desert
- ☒ Mountains
- ☒ North Coast
- ☒ South Coast
- ☒ South Inland

☒ OFFICE

- ☒ Administration and Management
- ☒ Financial/Legal
- ☒ Insurance/Real Estate
- ☒ Government Services
- ☒ Software Development
- ☒ Medical/Dental Office
- ☒ Assorted/Multi-tenant
- ☒ Other Office

☐ DATA CENTER☐ LABORATORY☐ RESTAURANT

- ☐ Fast Food or Self Service
- ☐ Specialty/Novelty food service
- ☐ Table Service
- ☐ BAR/Tavern/Nightclub/Other
- ☐ Other Food Service

☐ FOOD STORE

- ☐ Supermarkets
- ☐ Small General Grocery
- ☐ Specialty Ethnic Grocery
- ☐ Convenience Store
- ☐ Liquor Store
- ☐ Other Food Store

☐ RETAIL

- ☐ Department/Variety Store
- ☐ Retail Warehouse/Clubs
- ☐ Shop in Enclosed Mall
- ☐ Shop in Strip Mall
- ☐ Auto Sales
- ☐ Other Retail Store

☐ WAREHOUSE (REFRIGERATED)☐ WAREHOUSE (NON-REFRIGERATED)

- ☐ Unconditioned Warehouse High Bay
- ☐ Unconditioned Warehouse Low Bay
- ☐ Conditioned Warehouse High Bay
- ☐ Conditioned Warehouse Low Bay

☐ HEALTHCARE

- ☐ Hospital
- ☐ Nursing Home
- ☐ Clinic/Outpatient Care
- ☐ Medical/Dental Lab

☐ SCHOOL

- ☐ Daytime or Preschool
- ☐ Elementary School
- ☐ Middle/Secondary School

☐ COLLEGE

- ☐ College or University
- ☐ Vocational or Trade School

☐ LODGING

- ☐ Hotel
- ☐ Motel
- ☐ Resort
- ☐ Other Lodging

☐ PUBLIC ASSEMBLY

- ☐ Library/Museum
- ☐ Conference /Convention Center
- ☐ Religious Assembly (Worship only)
- ☐ Religious Assembly (Mixed use)
- ☐ Health/Fitness Center
- ☐ Theater/Performing Arts
- ☐ Community Center
- ☐ Other Recreation/Public Assembly

☐ MISCELLANEOUS

- ☐ Gas Station
- ☐ Gas with Convenience Store
- ☐ Repair (Non-Auto)
- ☐ Other Service Shop
- ☐ Assembly / Light Mfg.
- ☐ Police / Fire Stations
- ☐ Post Office
- ☐ Other Unlisted Type





Export



Email



Add to Dashboard



Create New Chart

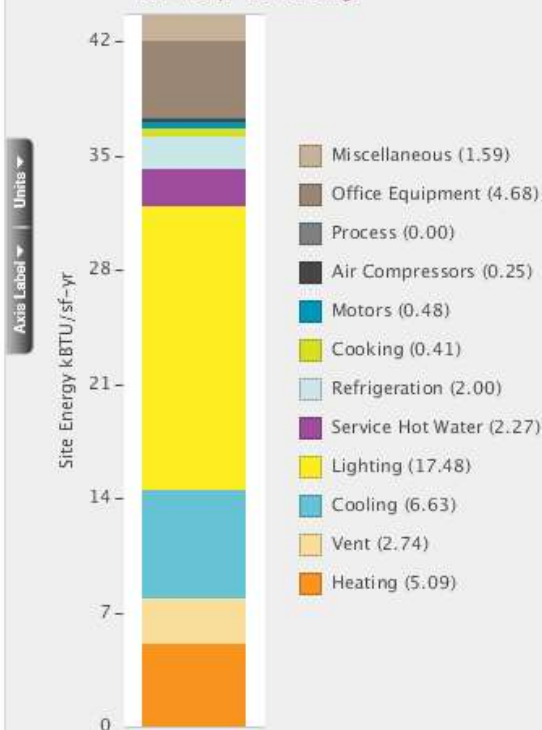


Add a Building

## End Use Breakout - Total Site Energy (kBTU/sf-yr)

Peer Group: 480 buildings

View

[Absolute Value](#) | [By Percentage](#)


## Peer Group Information

**SUMMARY** The Site Energy for typical buildings of the type(s) you've specified is 43.6 kBTU/sf-yr [median value], with a range of 13.8 to 82.3 kBTU/sf-yr [5th to 95th percentiles] for the population. Select "Add a Building" button to see how yours compares. Try other Views for graphical and tabular detail. This analysis includes population weights for each building.

**DATA SET** California only (CEUS)

**LOCATION** California= Central Coast, Central Valley, Desert, Mountains, North Coast, South Coast, South Inland

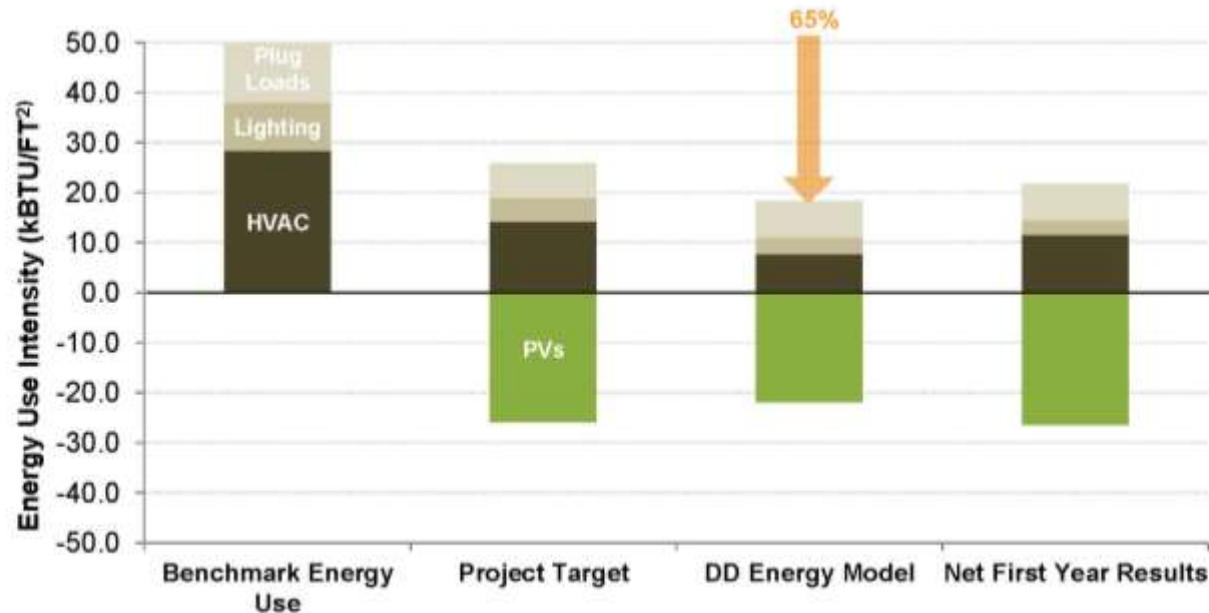
**SIZE** 0 - 25,000 sf, 25,001 - 150,000 sf, Over 150,000 sf

**VINTAGE** 1901 through 1940, 1941 through 1978, 1979 through 1990, 1991 through Present, Unknown

**TYPE** Administration and Management, Assorted/Multi-tenant, Financial/Legal, Government Services, Insurance/Real Estate, Medical/Dental Office, Other Office, Software Development

# EHDD Performance Tracking Process

	Whole Building kBTU/FT <sup>2</sup>	By End Use					Renewable Energy	
		HVAC kBTU/FT <sup>2</sup>	Hot H2O kBTU/FT <sup>2</sup>	Lighting kBTU/FT <sup>2</sup>	Plug Loads kBTU/FT <sup>2</sup>	[Other] kBTU/FT <sup>2</sup>	PVs kBTU/FT <sup>2</sup>	Thermal kBTU/FT <sup>2</sup>
Pre-Design								
Benchmark Energy Use	51.7	28.4	0.0	9.6	13.7			
AIA 2030 Target	20.7							
Project Target	25.8	14.2	0.0	4.8	6.9		-25.8	
Design								
DD Energy Model	18.3	7.7	0.0	3.3	7.2		-21.9	-0.4
Occupancy								
Net First Year Results	21.8	11.6	0.0	2.8	7.4		-26.5	

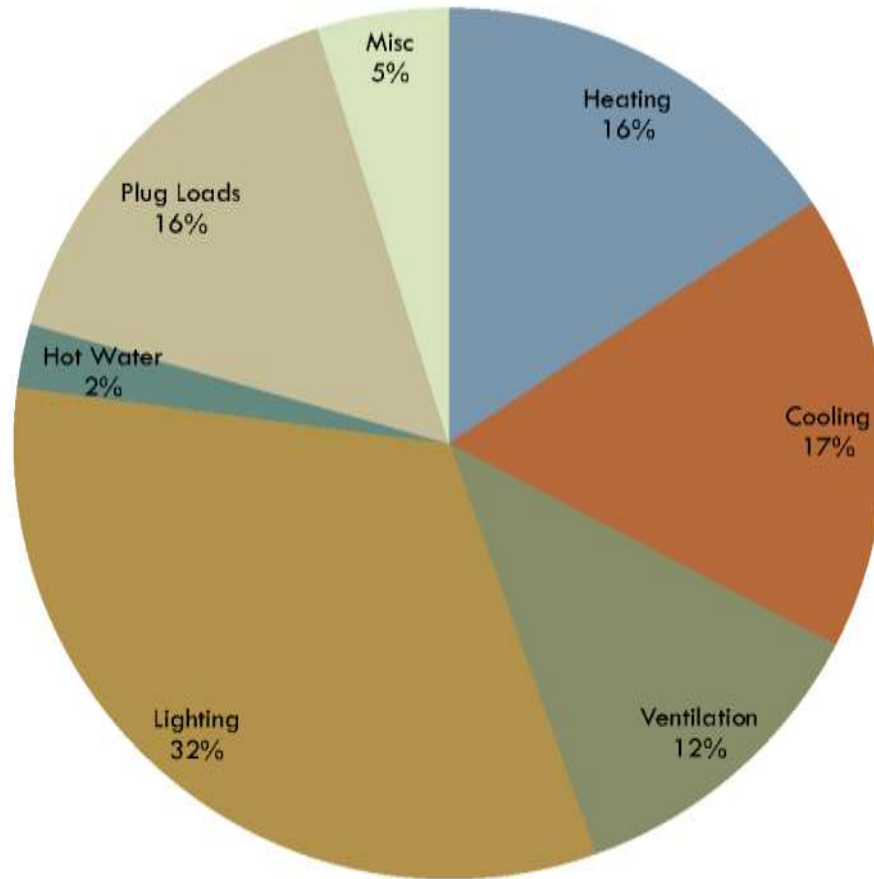




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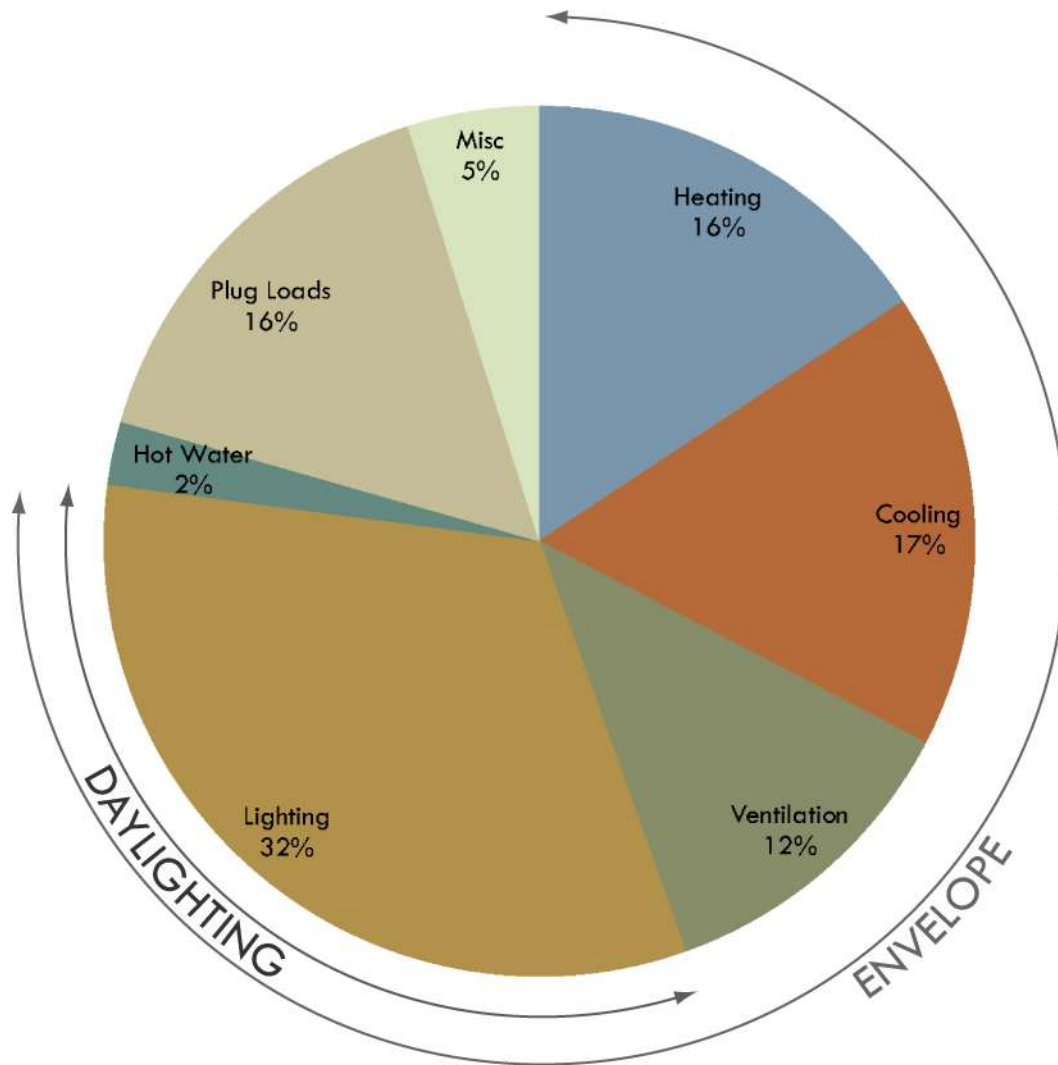
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# TYPICAL CALIFORNIA OFFICE BUILDING

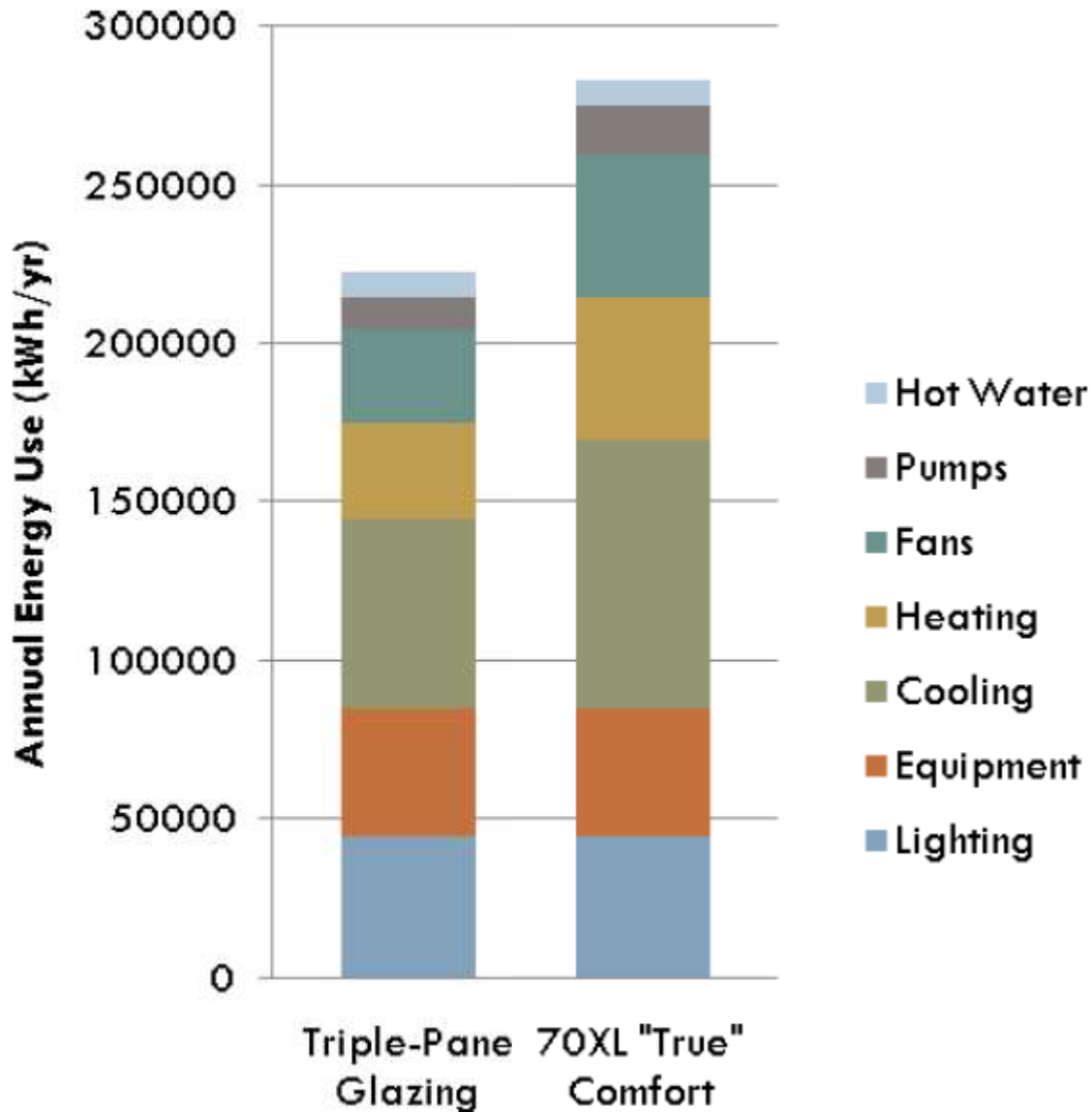




# The Envelope Really Matters



# Window Type & Energy



Courtesy of Integral Group



# Upgrade to High-Performance Windows



**+ \$75,000 Premium for installed glazing**

**- \$150,000 Eliminate perimeter heating**

**= \$75,000 first cost *savings***

**+ \$200,000 in *PV system downsizing***



# Multiple Shading Strategies

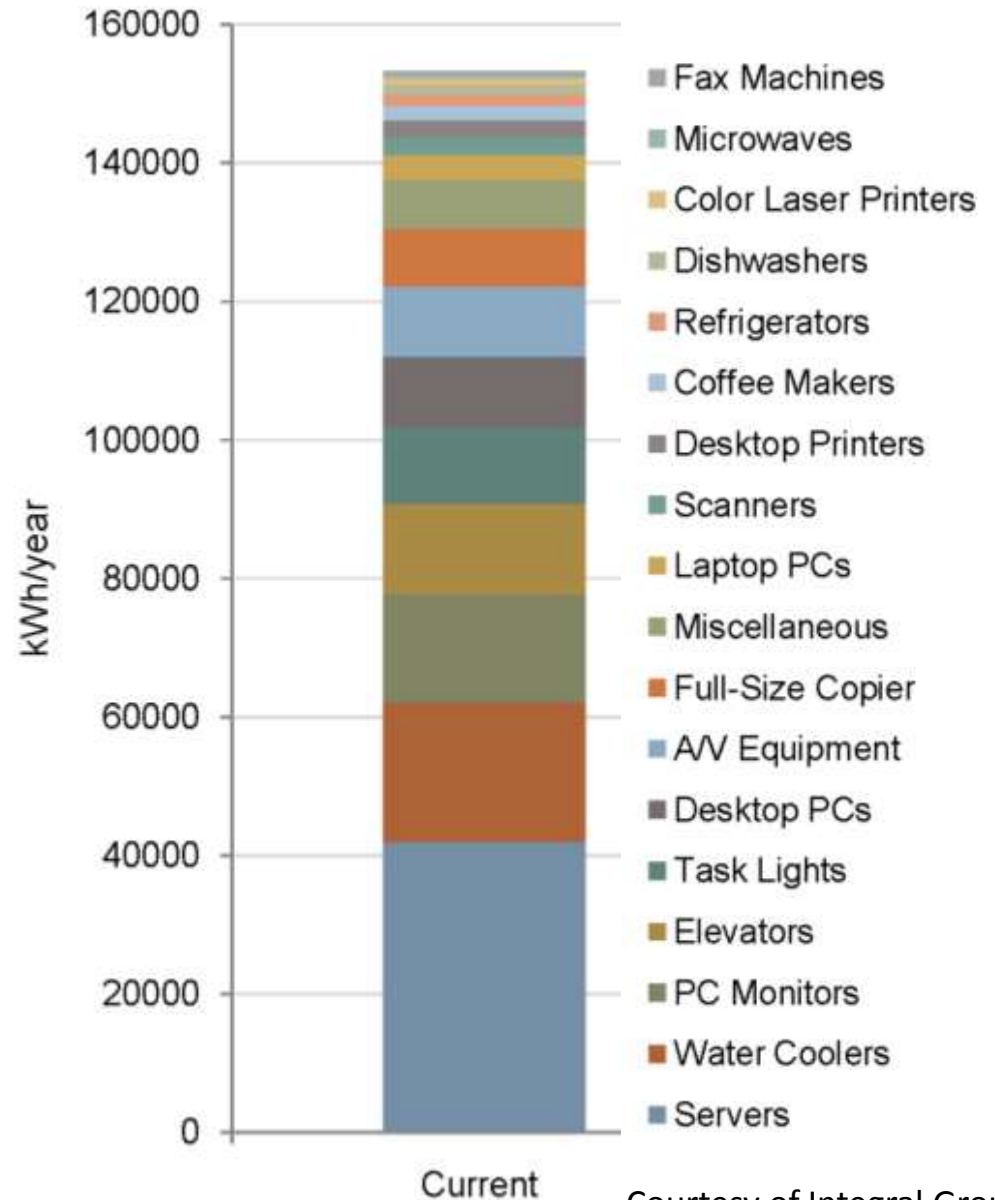


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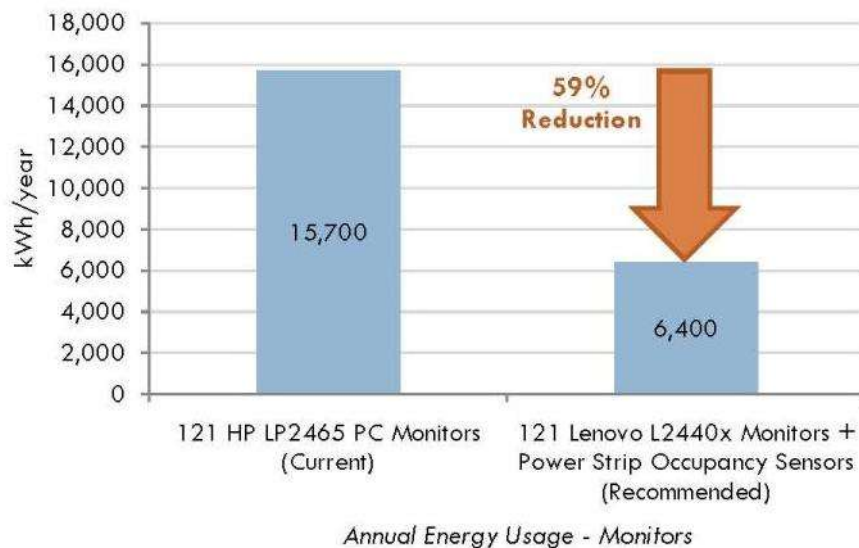


# Plug Load Study



Courtesy of Integral Group

# Computer Monitor Energy Use



Current Monitor: HP LP2465 24"

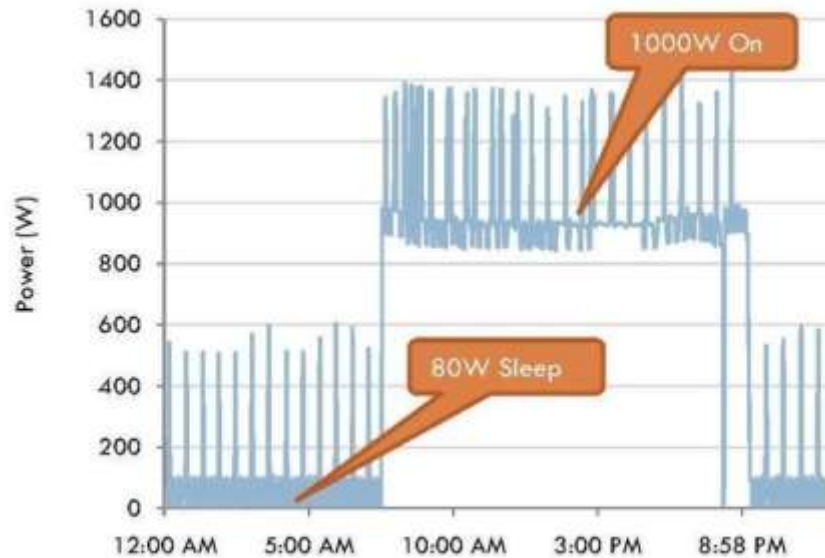


Recommended Monitor: Lenovo L2440x 24"

	Current	Recommended
<b>Specifications</b>		
Model	HP LP2465	Lenovo L2440x
Screen Size	24" LCD	24" LCD
Brightness	500	300
Contrast Ratio	1000:1	1000:1
Resolution	1920 x 1200	1900 x 1200
Bulb Type	CCFL	LED
<b>Energy Usage Per Unit</b>		
On (W)	65	28
Standby (W)	1	0.9
Used w/ Occupancy Sensor?	No	Yes
Avg. Plug Load (W)	21	9
Annual Consumption (kWh)	134	56

Courtesy of Integral Group

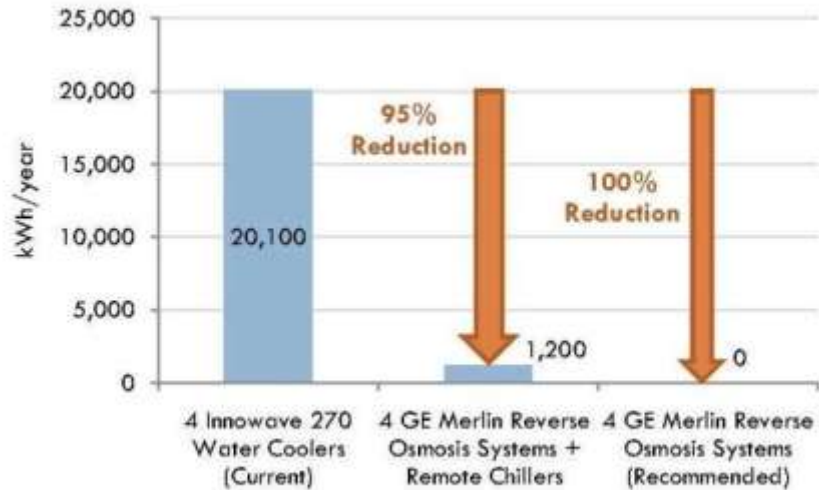
# Filtered Water Cooler Energy Use



Daily Power Usage of Current Water Cooler (Innowave 270)



Current Water Cooler: Innowave 270



Annual Energy Consumption - Water Coolers

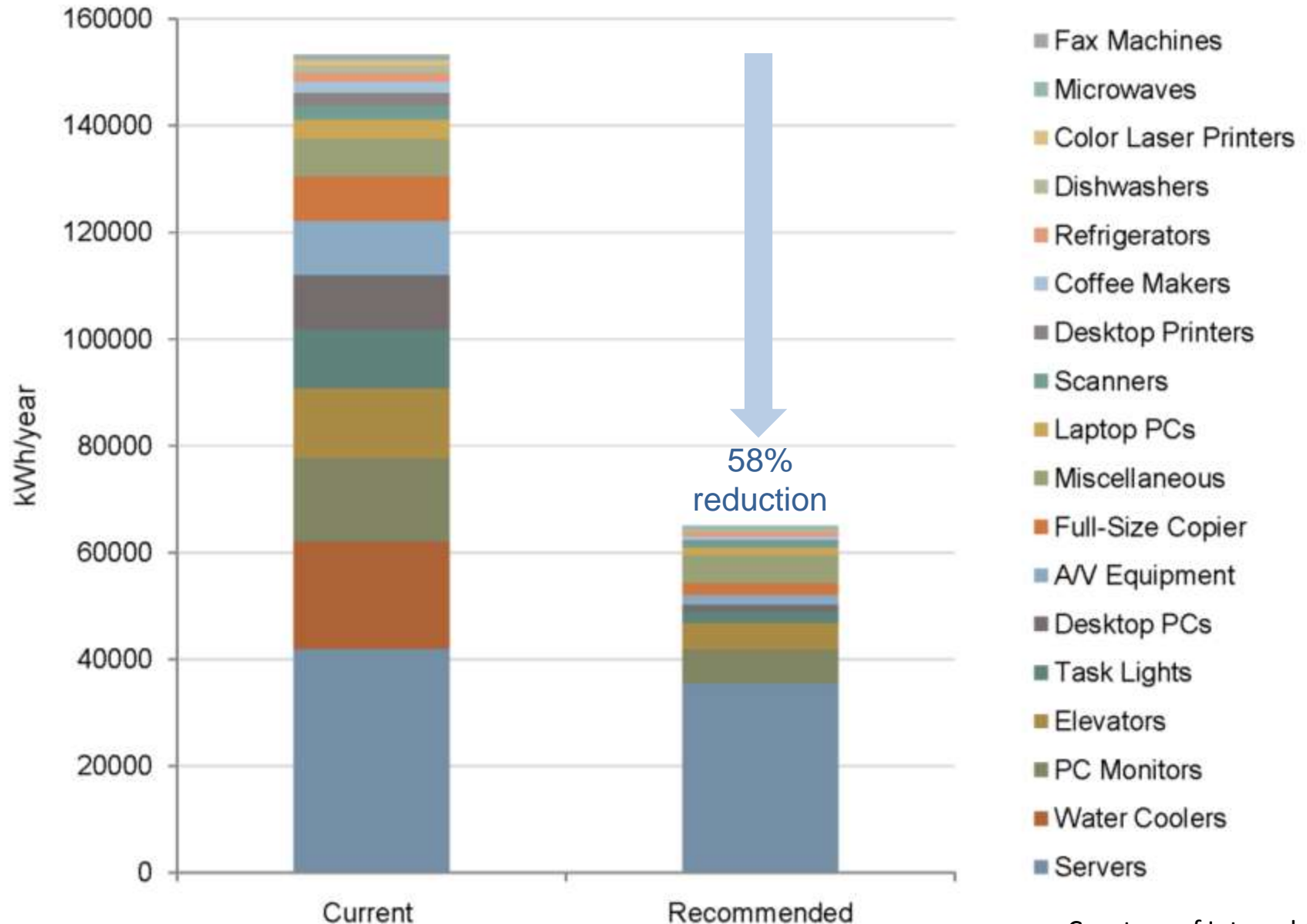


Recommended: GE Merlin Reverse Osmosis System

Courtesy of Integral Group

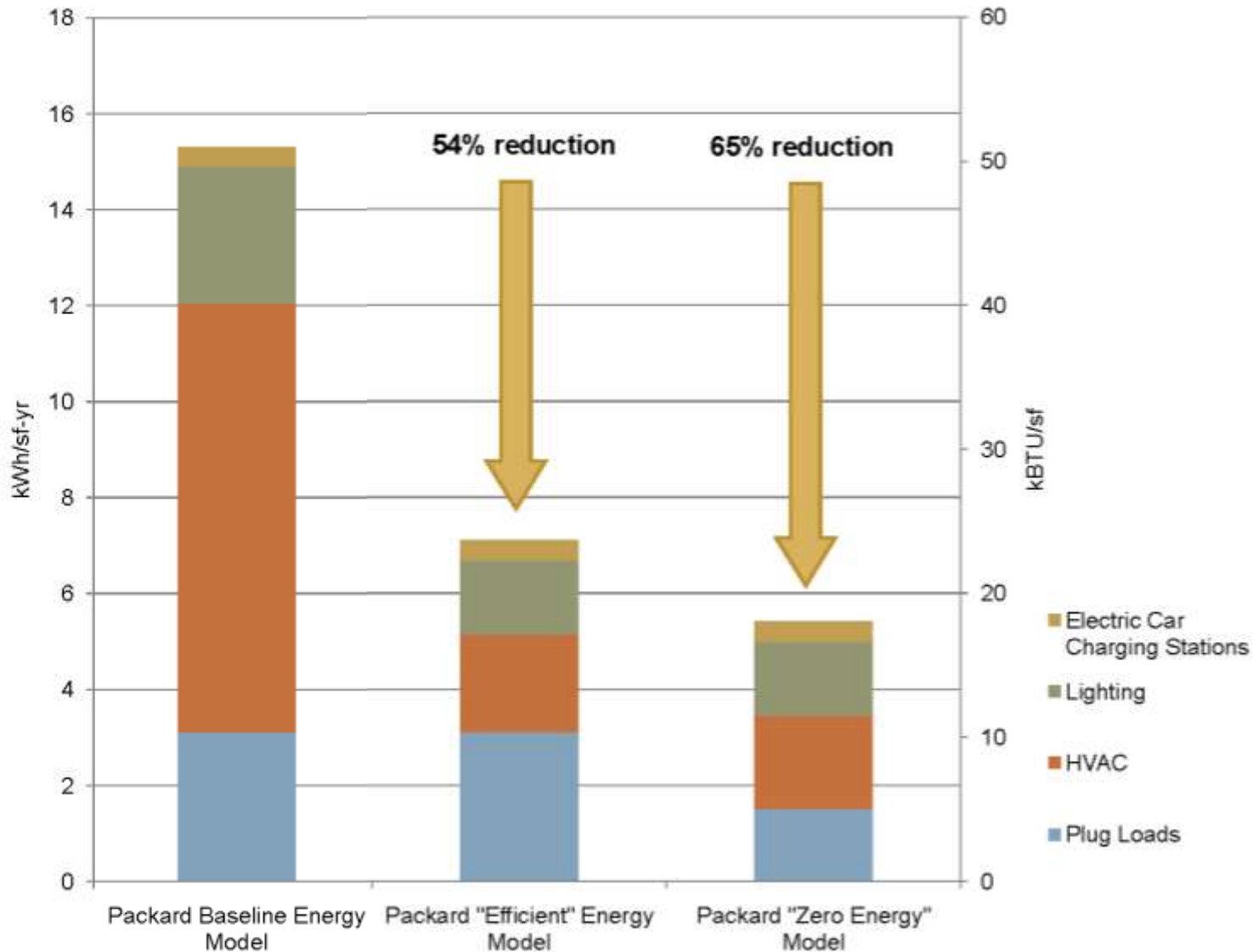


# Plug Loads Annual Energy Consumption



Courtesy of Integral Group

# Estimated Annual Energy Use



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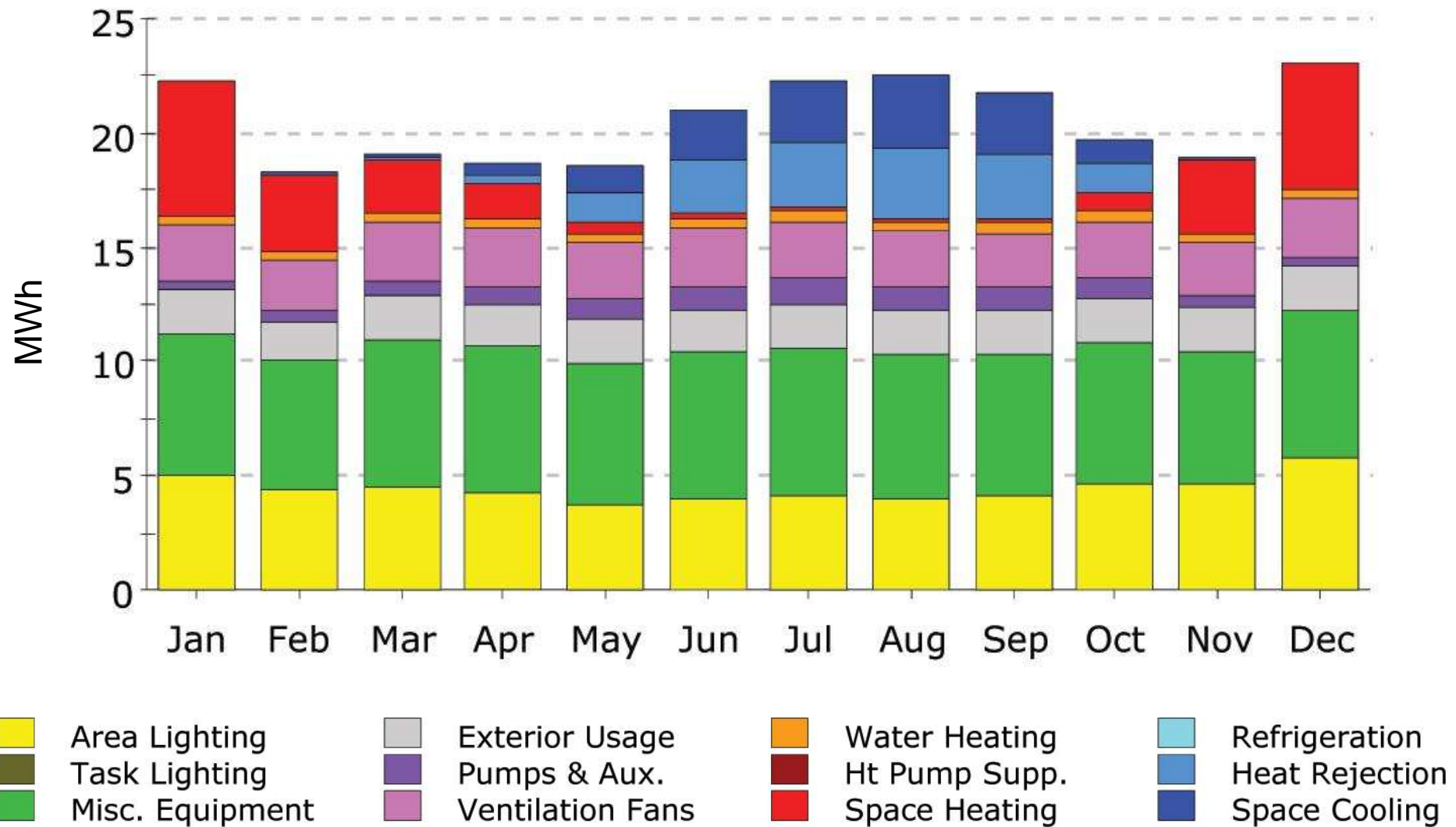
# Factors That Determine Energy Use

Glazing performance building orientation cooling efficiency infiltration operating hours climate weather occupant density heating efficiency duct design fan size window area HVAC control sophistication building mass interior shading occupant habits data centers kitchen equipment lighting power density filter condition wall color lighting controls furniture configuration exterior vegetation operable window use insolation glazing orientation wall insulation ventilation rate exposed interior surface characteristics domestic hot water use number of computers copiers and printers elevators exterior lighting occupant gender ratio elevation photovoltaics development density register location cooling distribution system roof insulation building manager training cool roof building surface to volume ratio building use type janitorial services metering strategies commissioning structural system acoustic treatment slab edge detailing night setback temperature ground water temperature humidity occupant dress code lamp replacement strategy roof slope daylight controls sensor calibration school culture lease terms utility meter characteristics parking garage ventilation HVAC system capacity number of separate tenants kitchen use age of equipment ceiling height heating fuel shade position window mullion pattern terms of maintenance contract wall thickness building height lighting fixture layout overhangs thermostat location exit lighting private or open offices refrigerators solar hot water utility meter load diversity

# Factors That Determine Energy Use

Glazing performance building orientation cooling efficiency infiltration operating hours  
climate weather occupant density heating efficiency duct design fan size window  
area HVAC control sophistication building mass interior shading occupant habits data  
centers kitchen equipment lighting power density filter condition wall color lighting  
controls furniture configuration exterior vegetation operable window use insolation  
glazing orientation wall insulation ventilation rate exposed interior surface characteristics  
domestic hot water use number of computers copiers and printers elevators exterior  
lighting occupant gender ratio elevation photovoltaics development density register  
location cooling distribution system roof insulation building manager training cool roof  
building surface to volume ratio building use type janitorial services metering strategies  
commissioning structural system acoustic treatment slab edge detailing night setback  
temperature ground water temperature humidity occupant dress code lamp  
replacement strategy roof slope daylight controls sensor calibration school culture  
lease terms utility meter characteristics parking garage ventilation HVAC system capacity  
number of separate tenants kitchen use age of equipment ceiling height heating fuel  
shade position window mullion pattern terms of maintenance contract wall thickness  
building height lighting fixture layout overhangs thermostat location exit lighting private  
or open offices refrigerators solar hot water utility meter load diversity

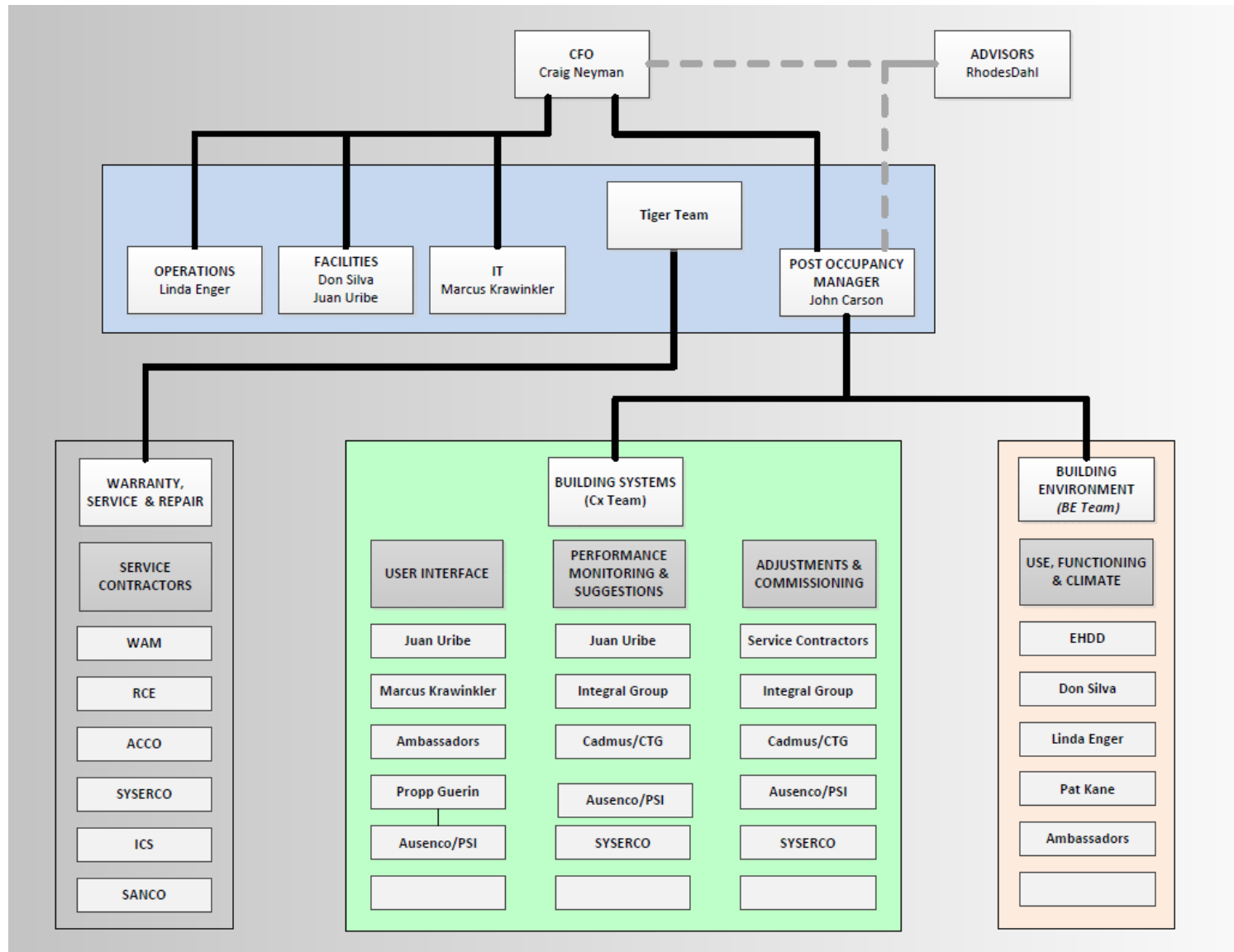
# A “Real Energy” Model



Courtesy of Integral Group

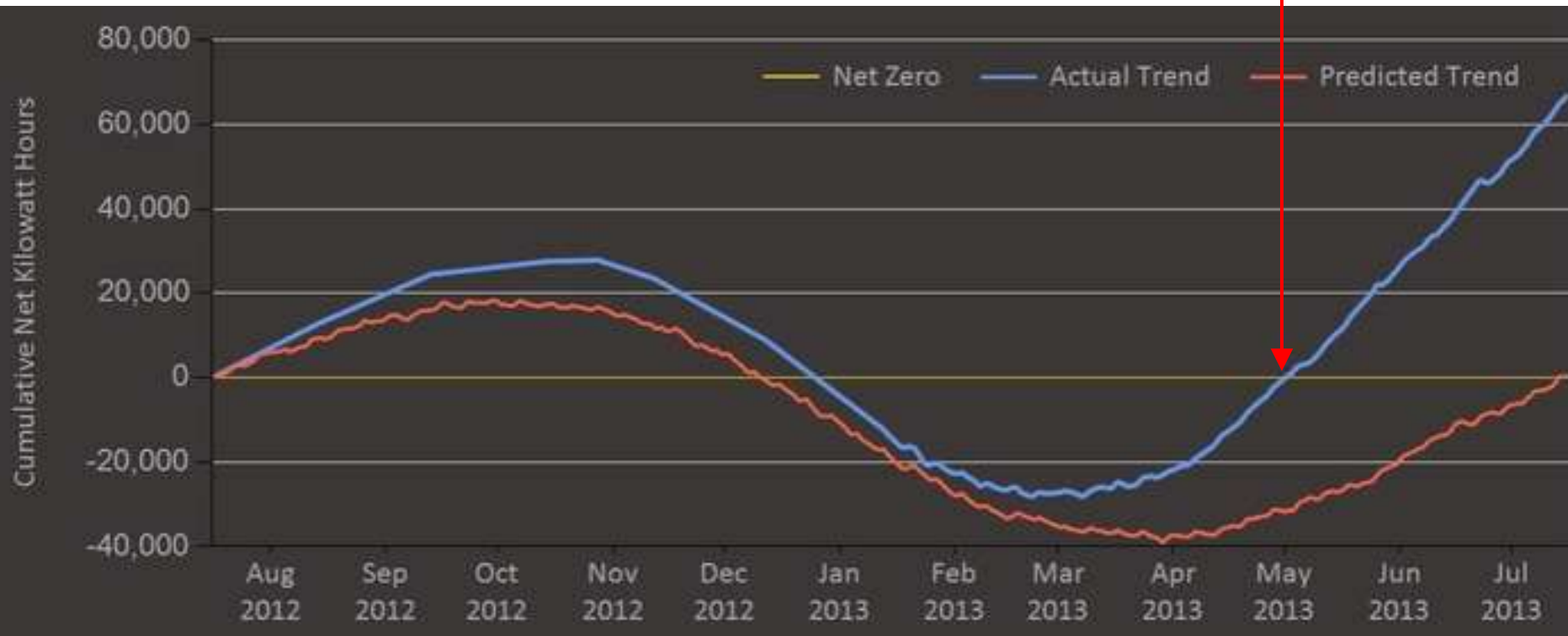


# Post-Occupancy Phase Services



# Net Zero Year : July 2012 to July 2013

Reached  
Net Zero

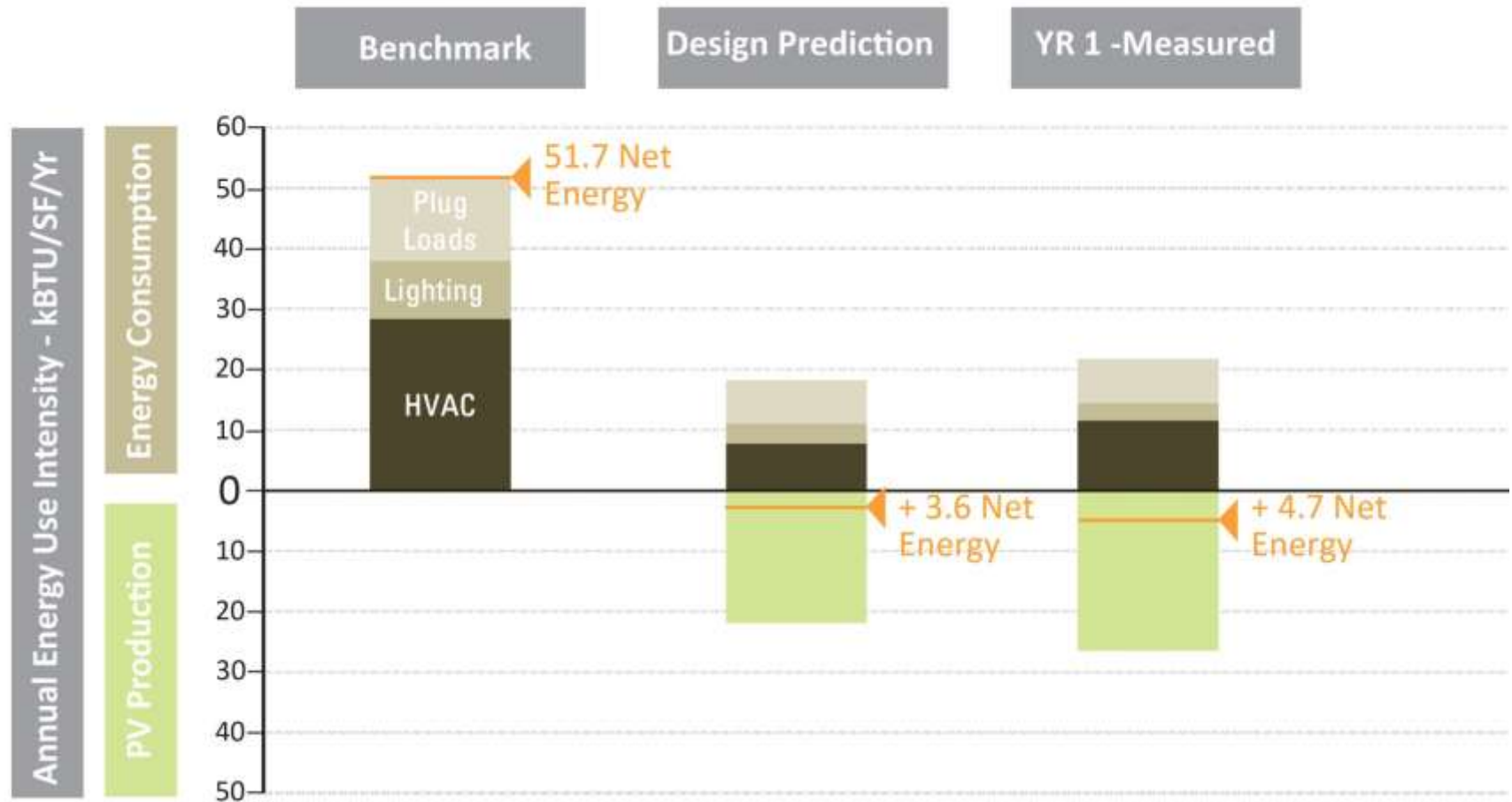


# Net Zero Year : July 2012 to July 2013





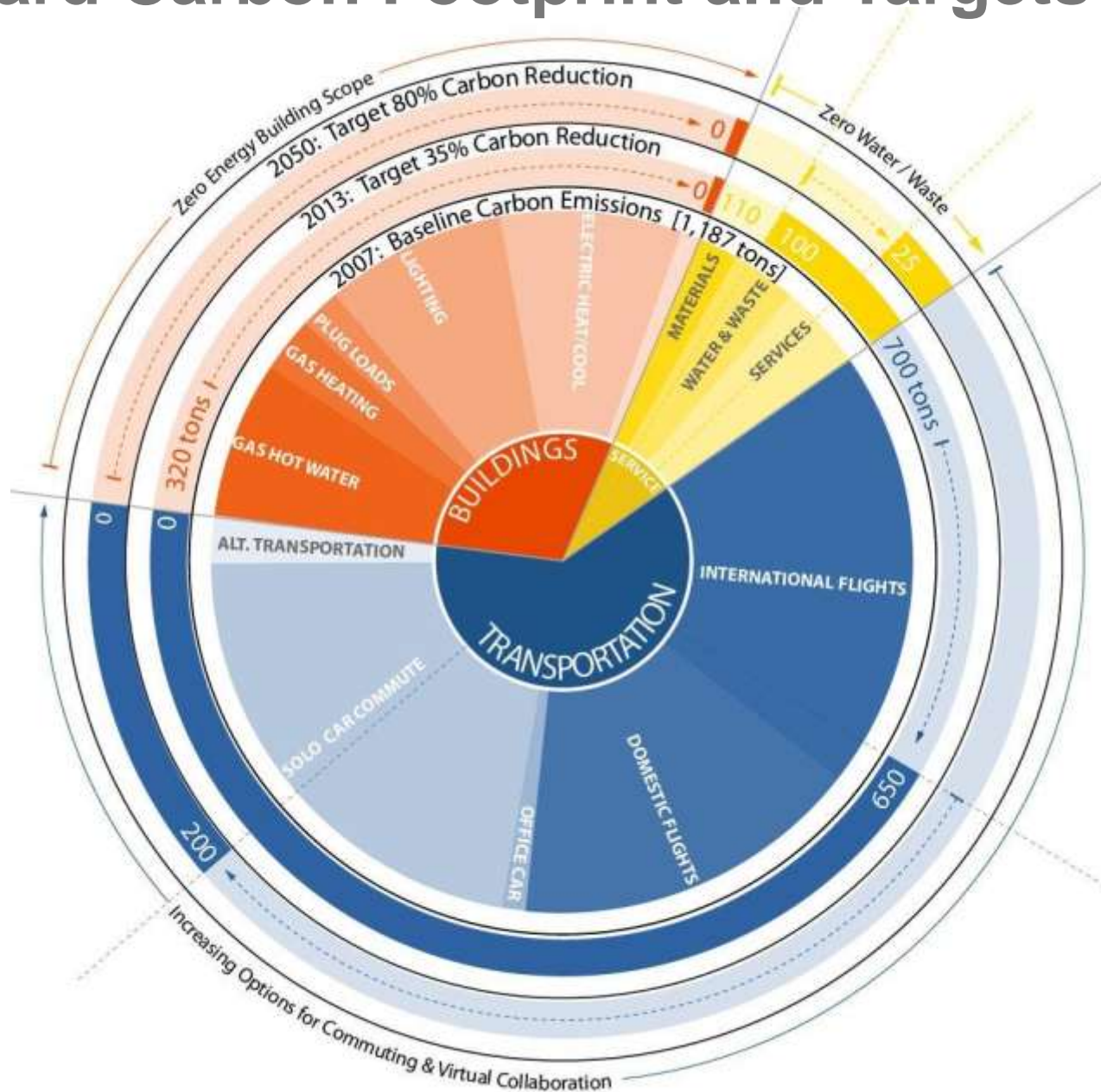
# Net Zero Year : July 2012 to July 2013



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# Packard Carbon Footprint and Targets





# Remote Collaboration to Reduce Flights







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