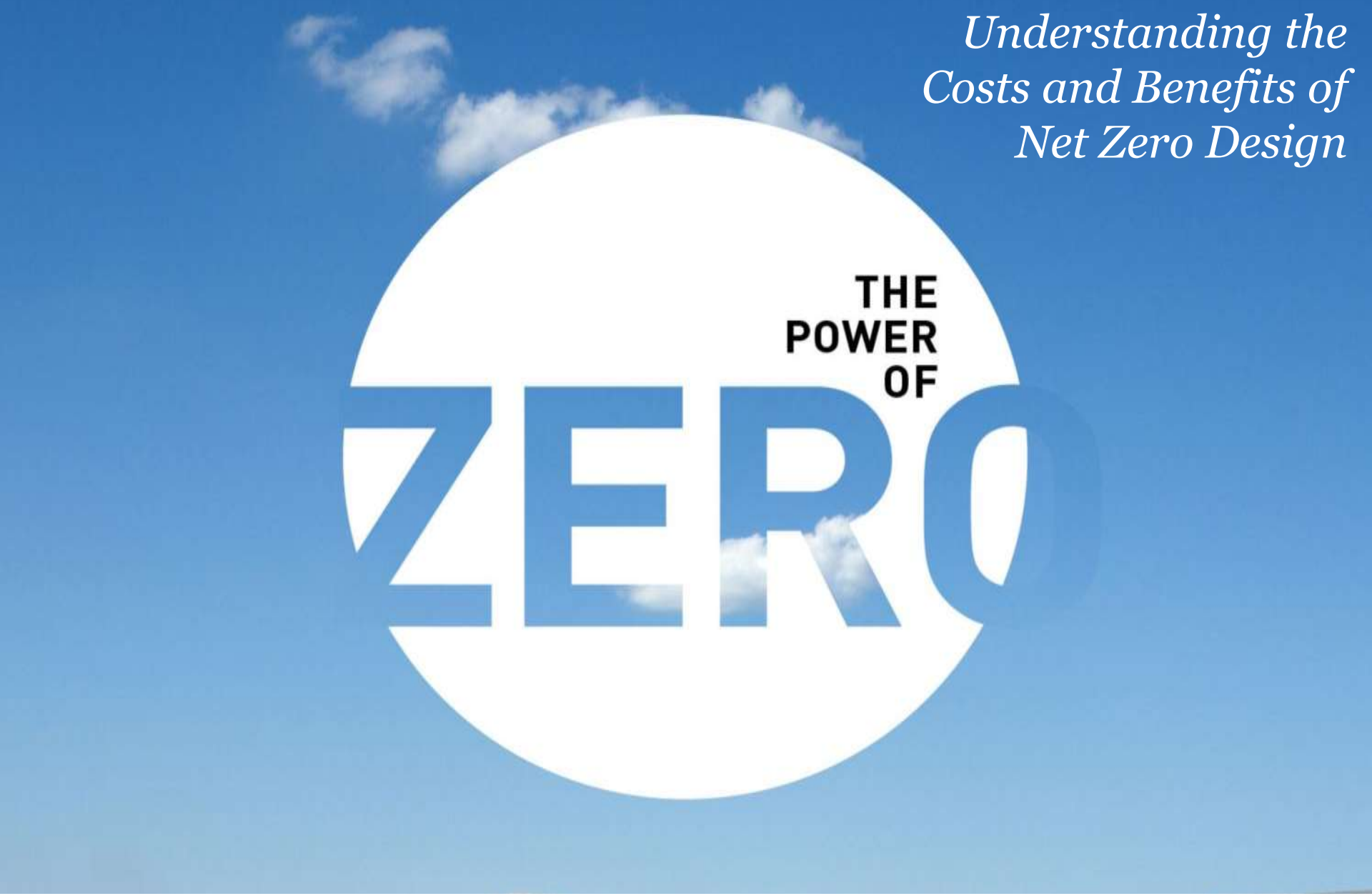
Understanding the Costs and Benefits of Net Zero Design



getting to zero national forum at the
2013 NASEO Annual Meeting
Framing the policies, programs and projects that will drive zero net energy buildings

Lisa Matthiessen, FAIA, LEED Fellow
Laura Lesniewski, AIA
Peter Morris, MRICS

Davis Langdon
An AECOM Company

INTEGRAL GROUP

BNIM

background

background

Packard Sustainability Report and Matrix	*2001, 2002*
Cost of Green I and II	*2004, 2007*
Living Building Study	*2009*

Packard Sustainability Report and Matrix

2001, 2002

Authors:

David & Lucile Packard Foundation
BNIM Architects
Hawley Peterson Snyder Architects
Keen Engineering
Oppenheim Lewis
Holland Design

background

Examining the Cost of Green

2004

Cost of Green Revisited

2007

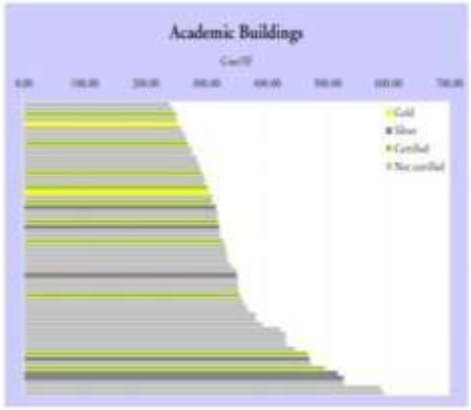
Author:

Davis Langdon

Analyzing the Data – Cost Analysis of Academic Buildings

A total of 60 academic classroom buildings – 17 LEED-seeking and 43 non-LEED – were analyzed. Academic buildings are classroom, computer lab or faculty office buildings in higher education settings. These buildings are located on college and university campuses across the country, and include a range of architectural forms and styles. The higher LEED scoring designs in this category tended to find points in sites, energy efficiency, and indoor environment.

As can be seen, the LEED seeking academic buildings are scattered broadly through the population, with no significant difference in the average costs of LEED seeking and non-LEED seeking buildings. It is worth noting that the Silver buildings do tend to fall in the higher range, both within the population of green buildings and in the overall population, while the Gold buildings are in the lower range, although the sample size for the Gold buildings is too small to draw meaningful conclusions on the cost of Gold within the population. However, it can be said the Gold projects by and large seemed to have kept costs low by using simple approaches to sustainability, rather than adding technologies to achieve green. Both levels achieved similar numbers of points for Credit EA 1, but the Gold projects did not use photovoltaics to achieve fairly high energy efficiency points, and achieved 3 or 4 Innovation Points.



Living Building Financial Study

2009

Authors:

Cascadia Region Green Building Council
Sera Architects
Skanska USA Building
Gerding Edlen
Interface Engineering
New Buildings Institute

statistical analysis

data gathered

statistical analysis

- Project details (program, rating, location, etc)
- Construction cost
- Construction costs detail
- Projected operating costs (energy and water)
- Actual operating costs
- Anecdotal evidence

building types

statistical analysis

- community centers (learning/visitor)
- K-12 schools
- office buildings – low-rise
- wet labs
- libraries
- office buildings – T.I.
- Healthcare
- High rise mixed use/residential

approach

statistical analysis

normalize data

- common location
- common time

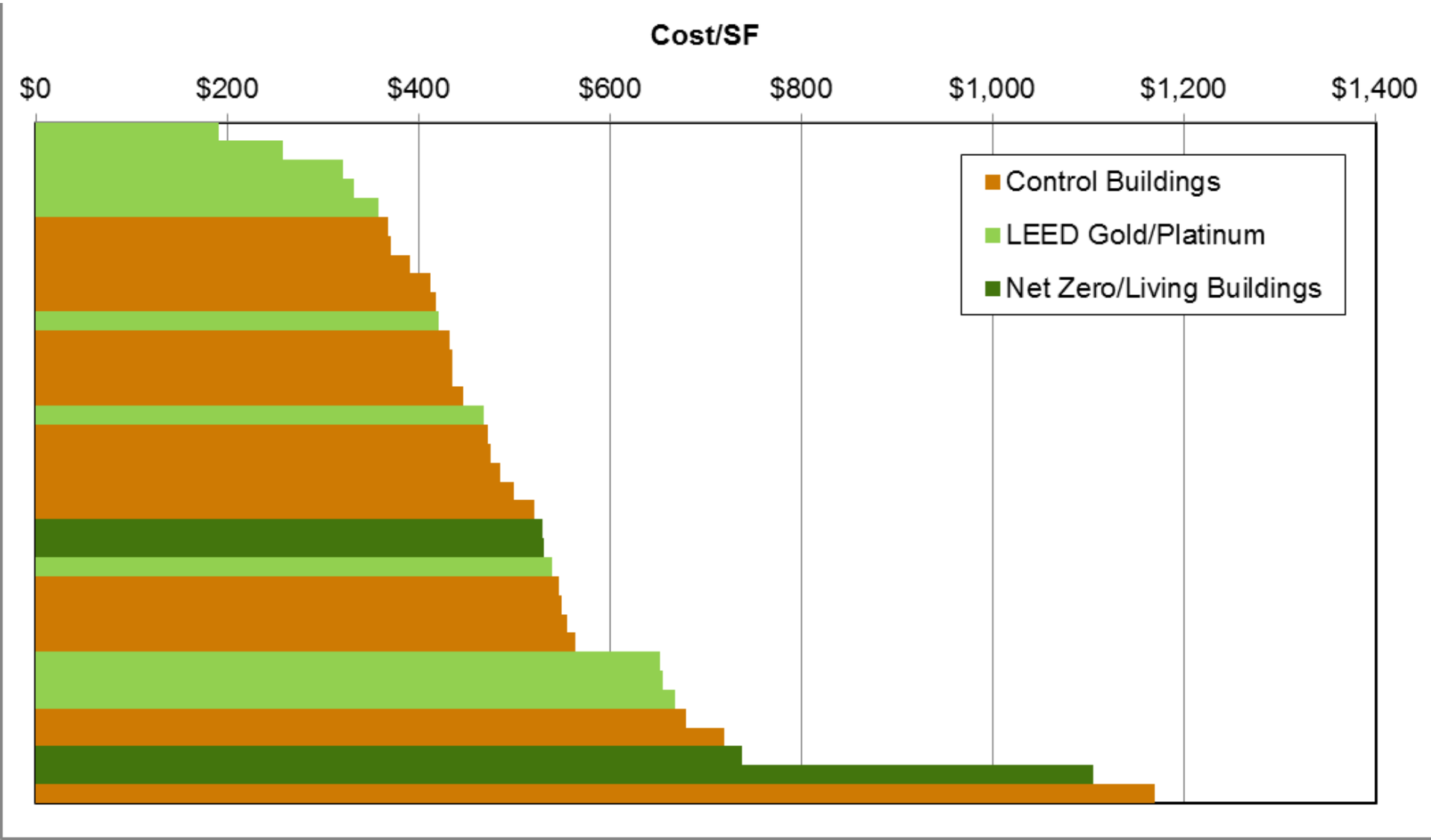
establish comparison baseline

- the project's original budget
- the project itself, without the green elements
- similar projects

community centers

statistical analysis

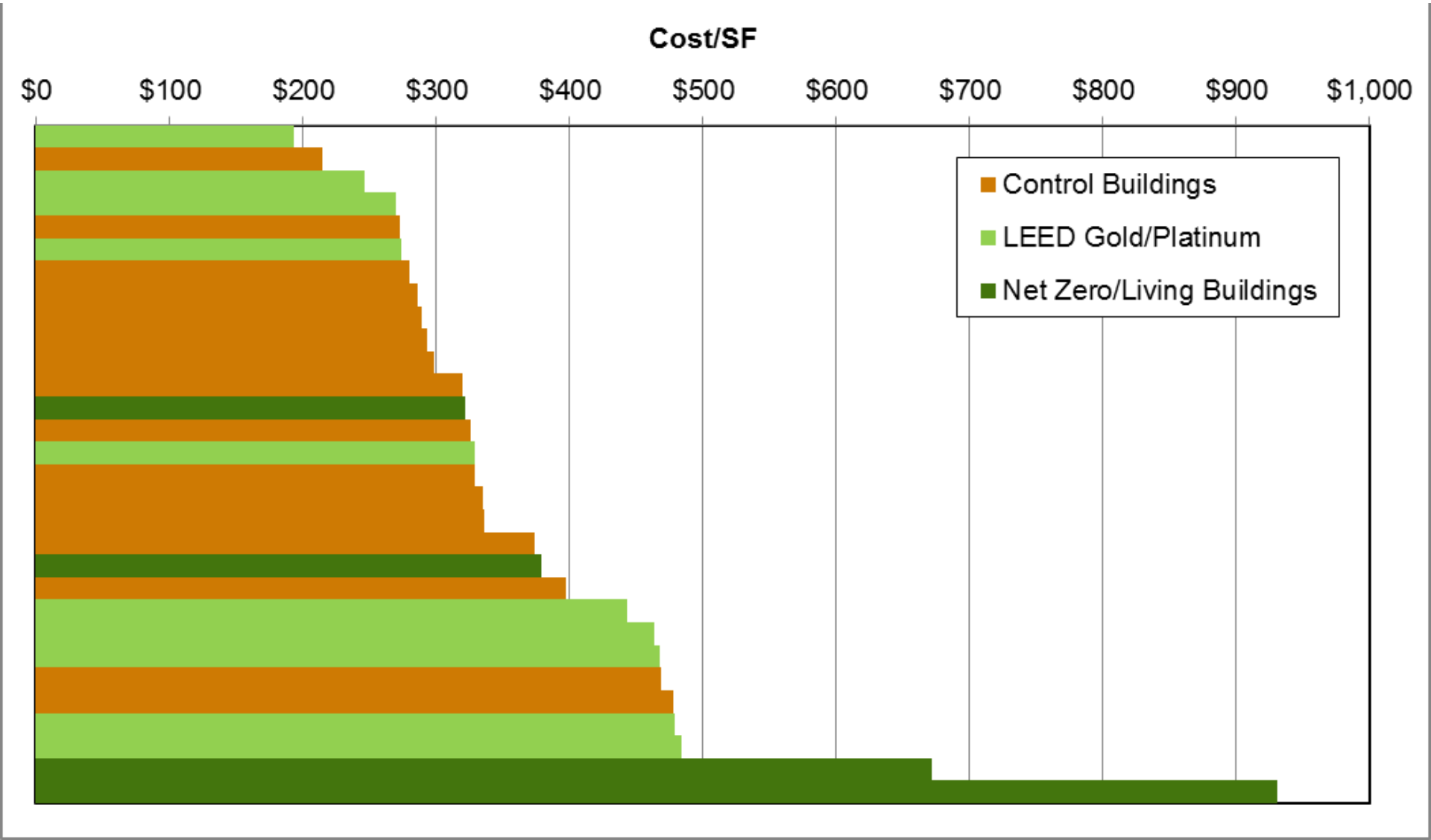
early data



K-12 schools

statistical analysis

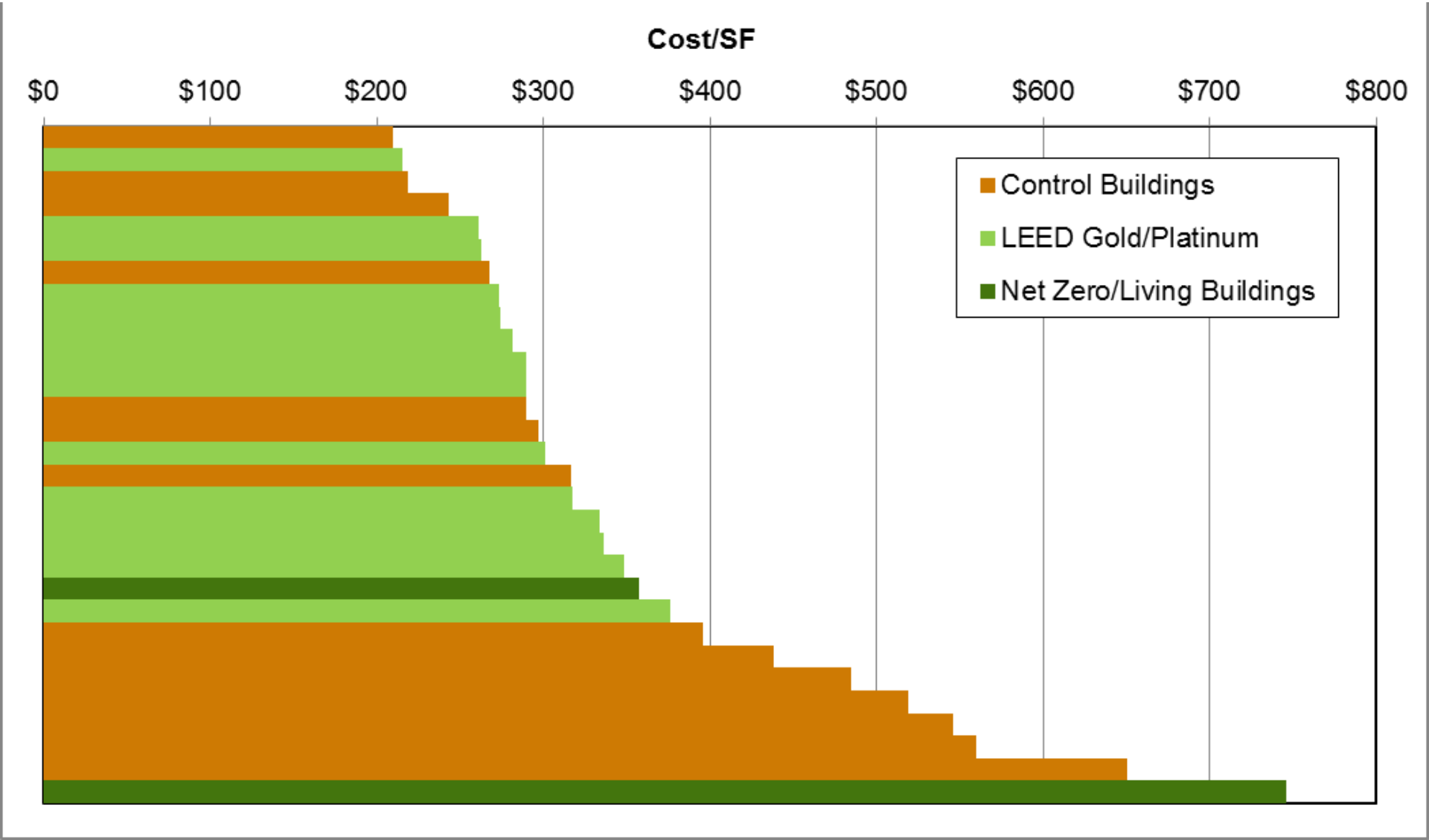
early data



office buildings – low-rise

statistical analysis

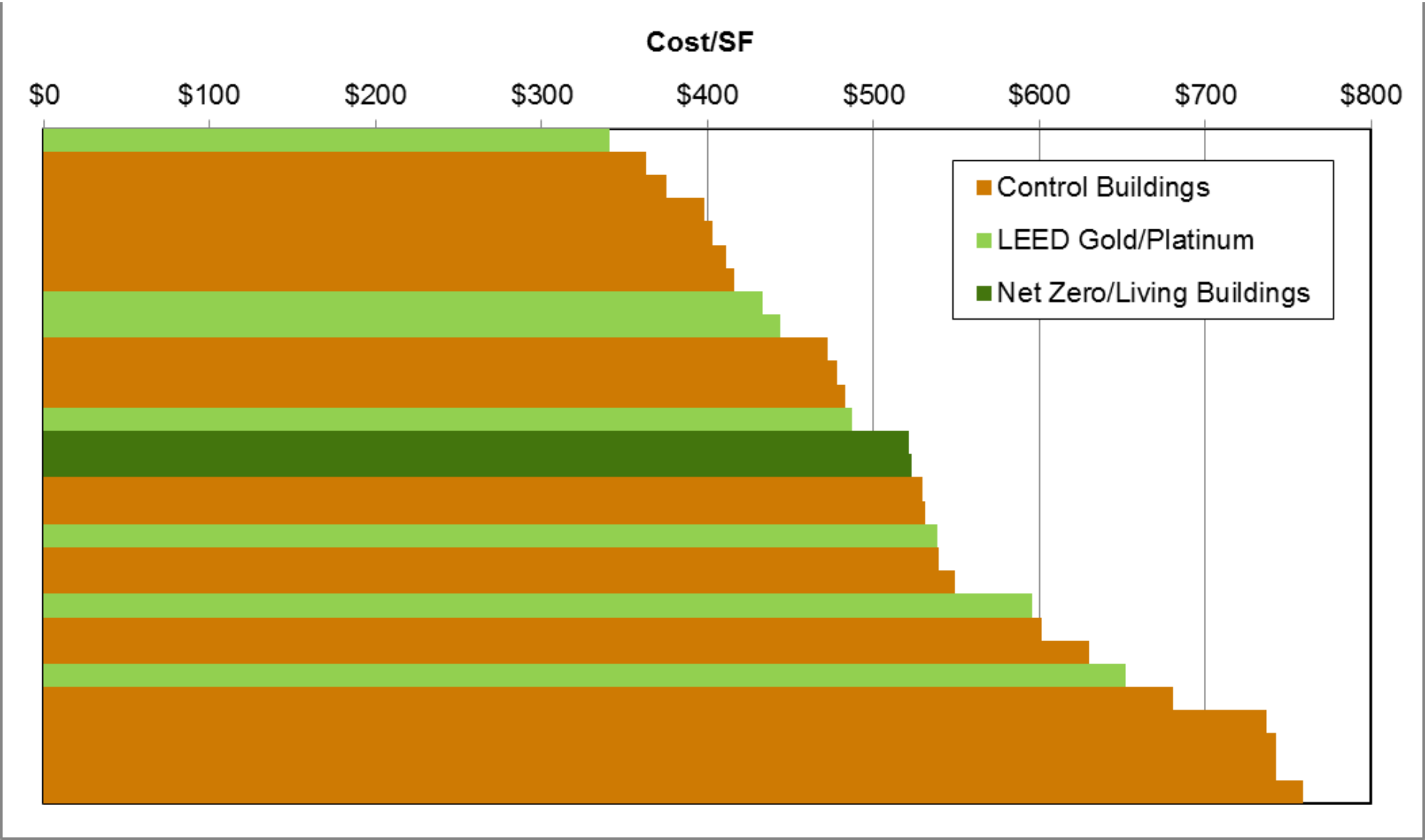
early data



wet lab

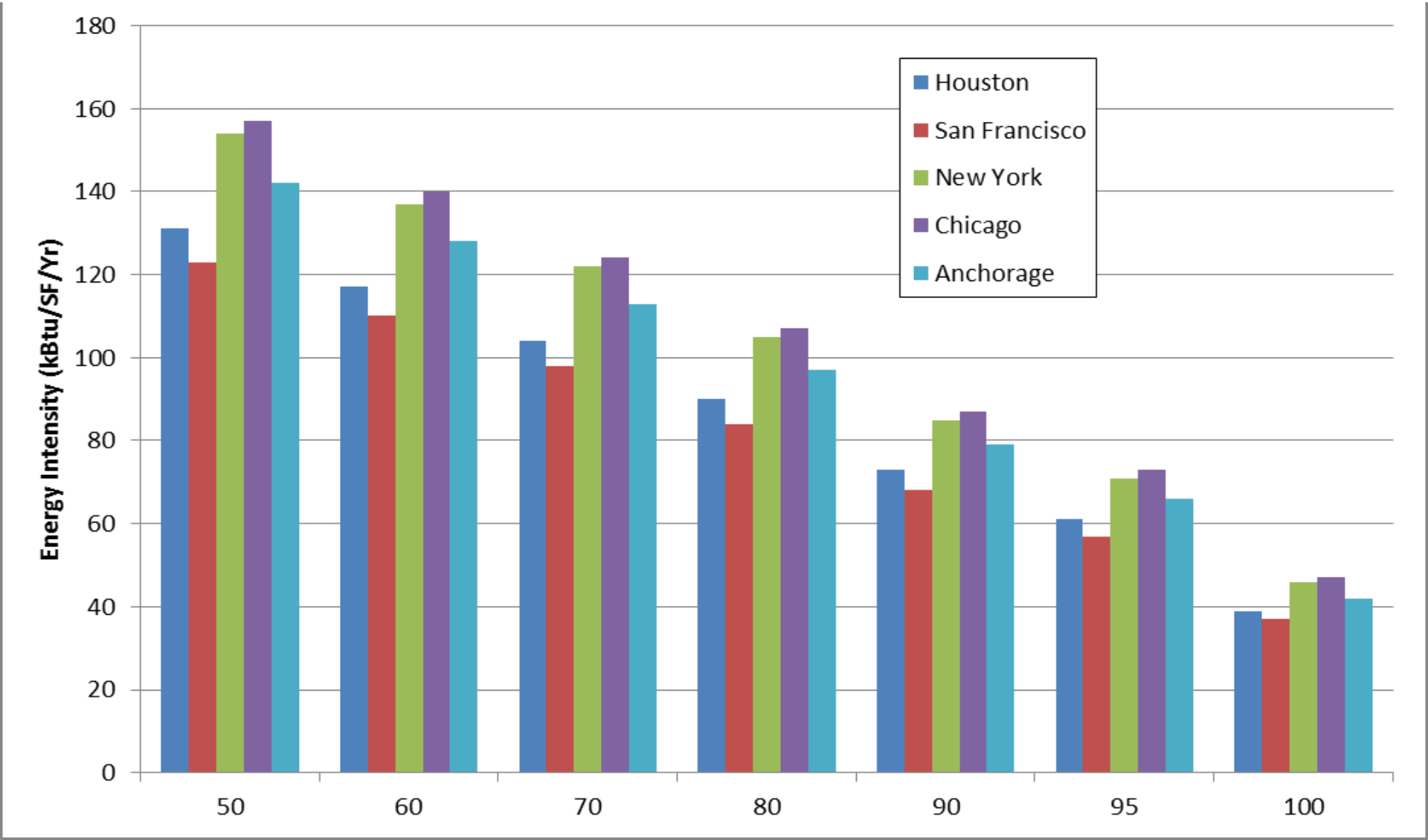
statistical analysis

early data



energy use intensity: energy star rating by city

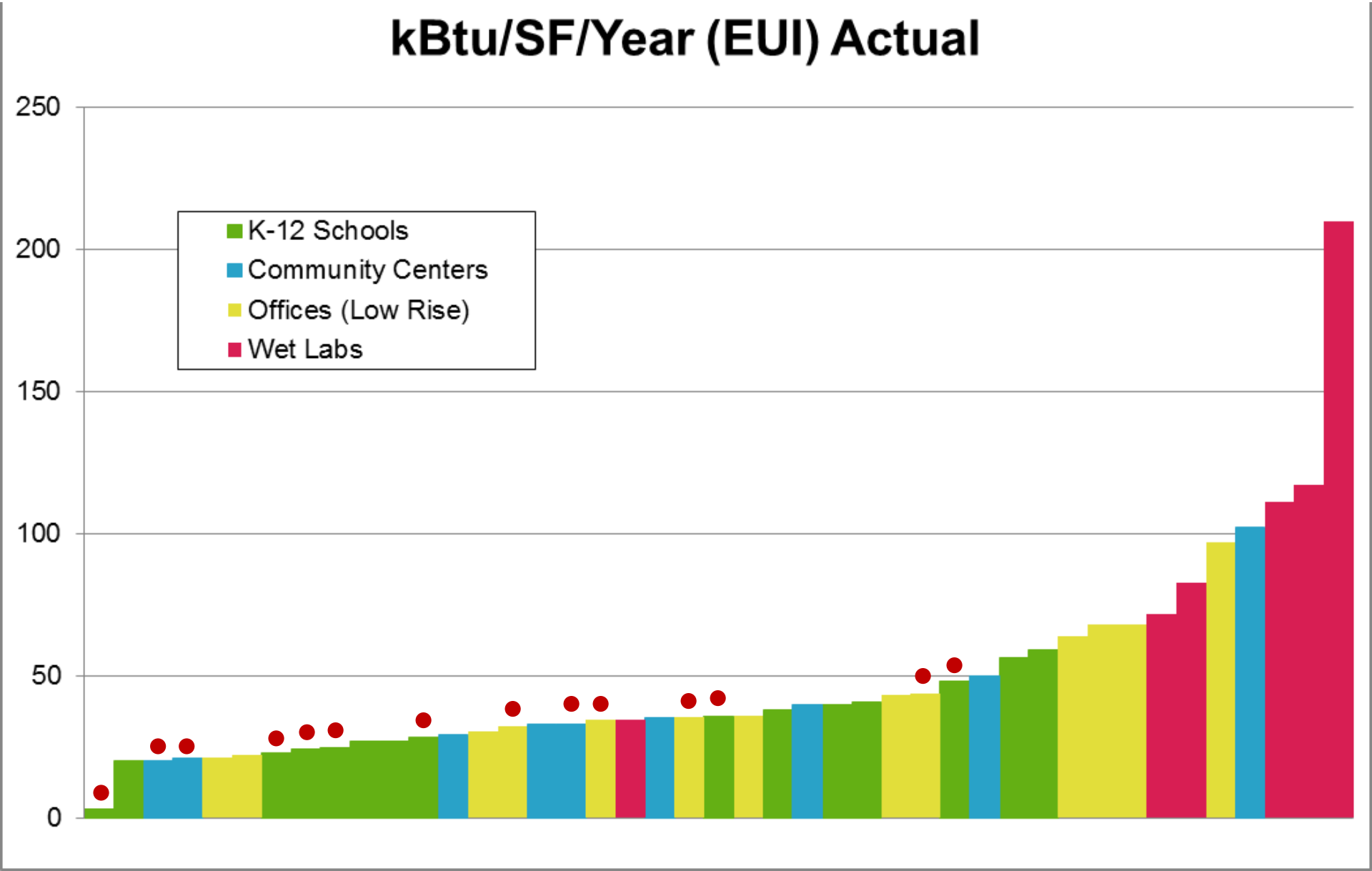
statistical analysis



energy use intensity

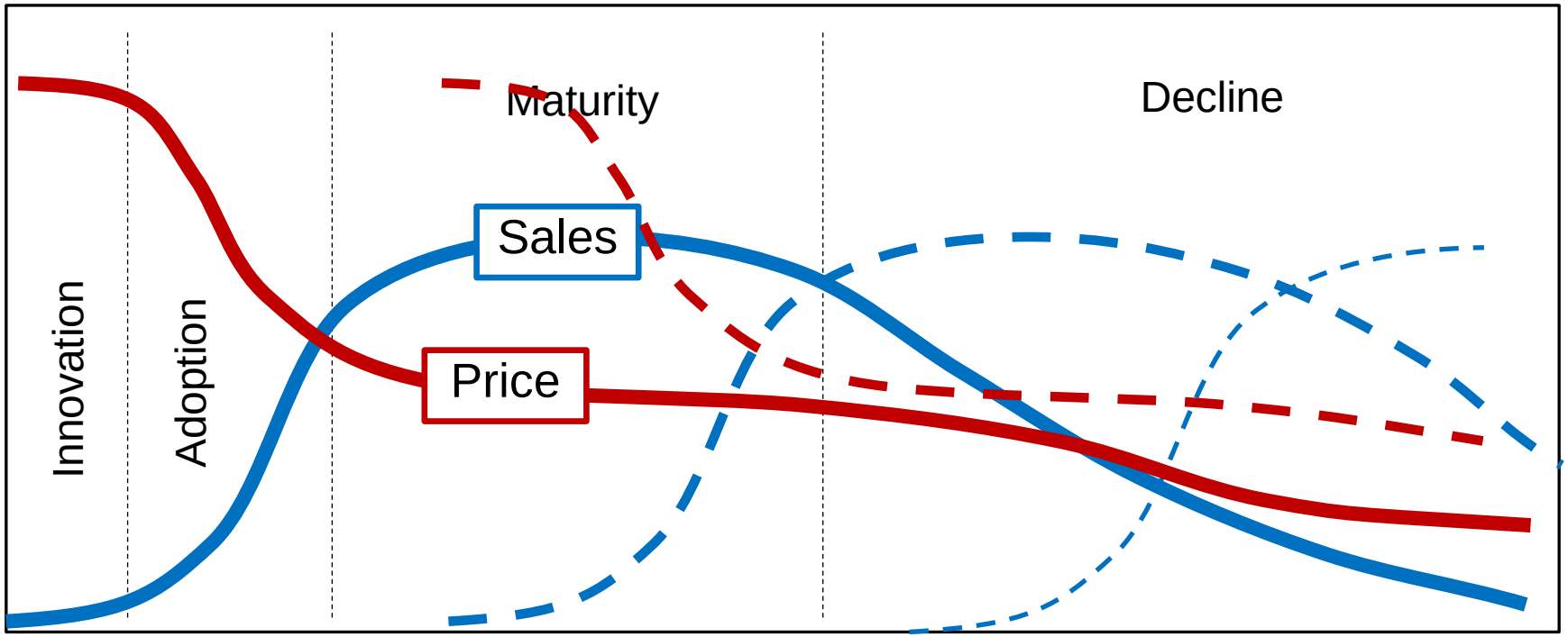
statistical analysis

early data



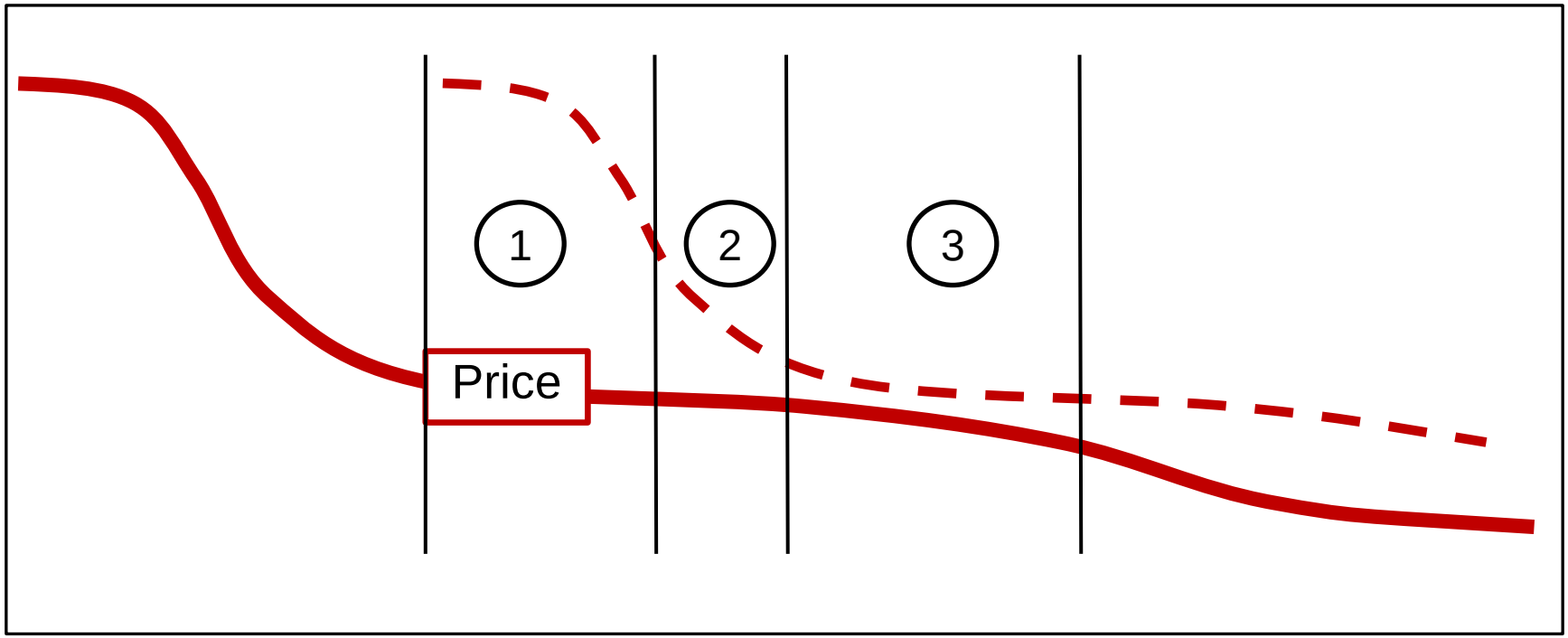
value discovery

statistical analysis



value discovery

statistical analysis



design thinking
at the building scale

J. CRAIG VENTER INSTITUTE

GOALS & ASPIRATIONS

PROGRAM

- Flexible laboratories for molecular and cutting edge computational biology
- Support for cutting-edge computational biology

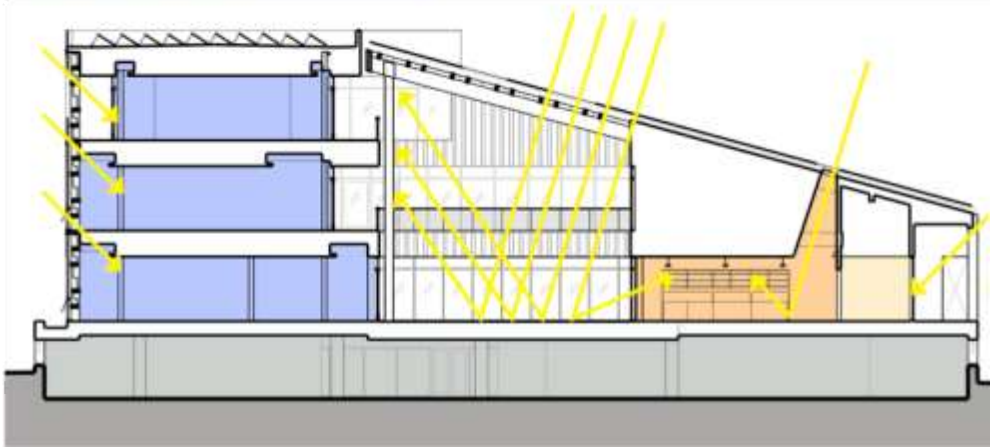
SUSTAINABILITY GOALS

- “The most sustainable lab building in the world”
- Minimum 50% less energy use and on-site power generation
- Carbon neutral – without "buying” carbon offsets
- Capture 100% rainwater on site
- Reduce domestic water demand 50%
- Net-zero waste water
- Natural ventilation and light in all occupied spaces

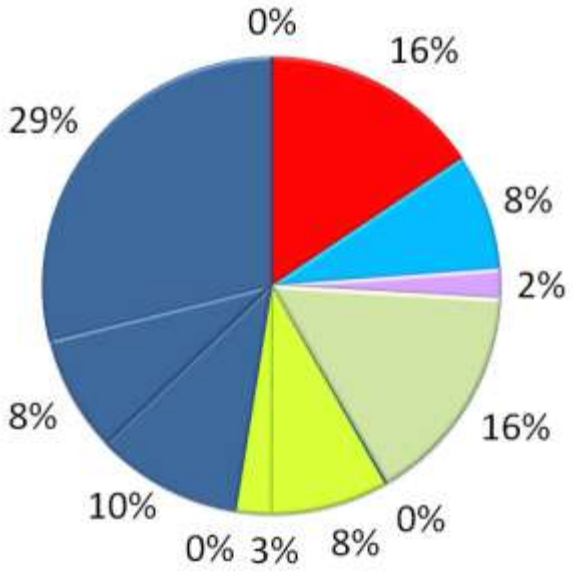
J. CRAIG VENTER INSTITUTE

DESIGN PROCESS

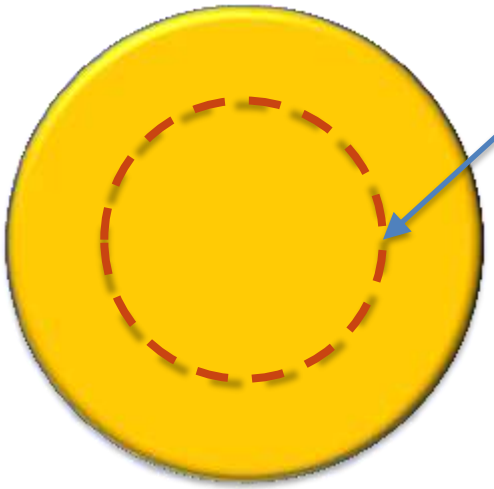
Images courtesy of JCVI



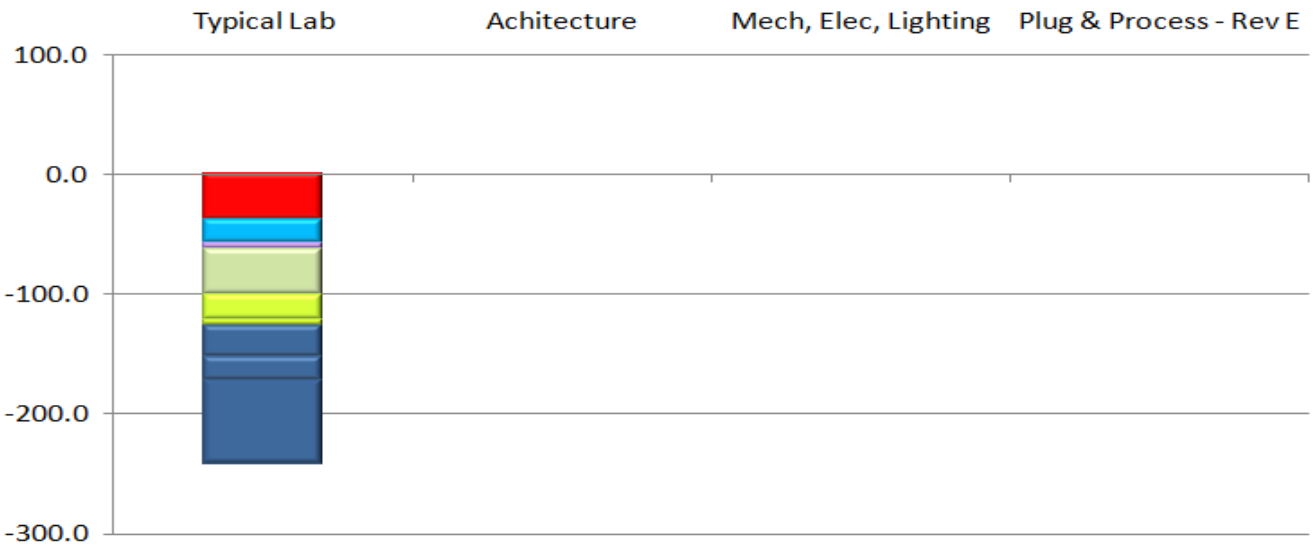
1. **Identify unique opportunities of location**
2. **Organize Program (Occupancy Use and Time)**
3. **Analyze Actual Loads (Right-size everything)**
4. **High Performance Architecture (Envelope, Sunshading, Daylighting)**
5. **Decouple Thermal & Ventilation (Utilize the most efficient systems and equipment available / heat recovery)**
6. **Select Renewable Sources of Energy**



PV Output Required = 4x Roof Area Available



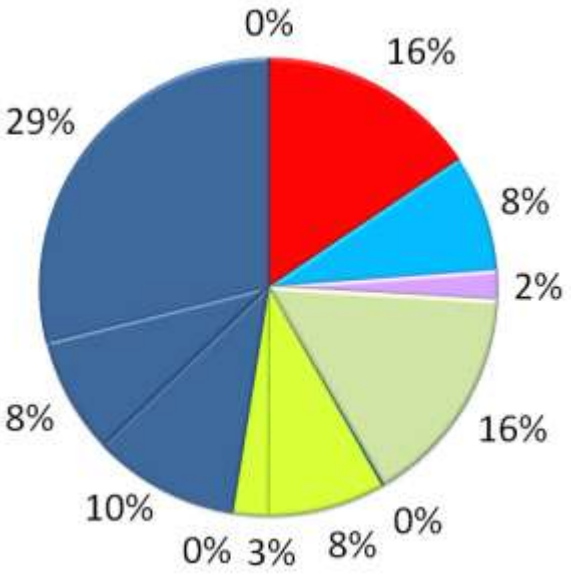
Area Available = "Energy Budget"

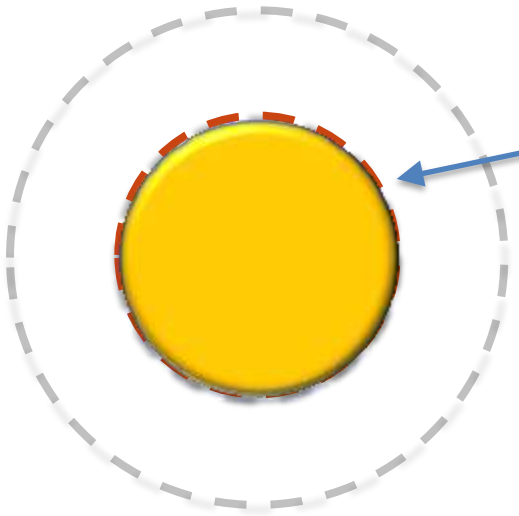


- Heating
- Cooling
- Pumps
- Fans
- DHW
- Lighting
- Exterior Lighting
- Vehicles
- Office Plug Loads
- Lab Plug Loads
- Freezers
- PV Output

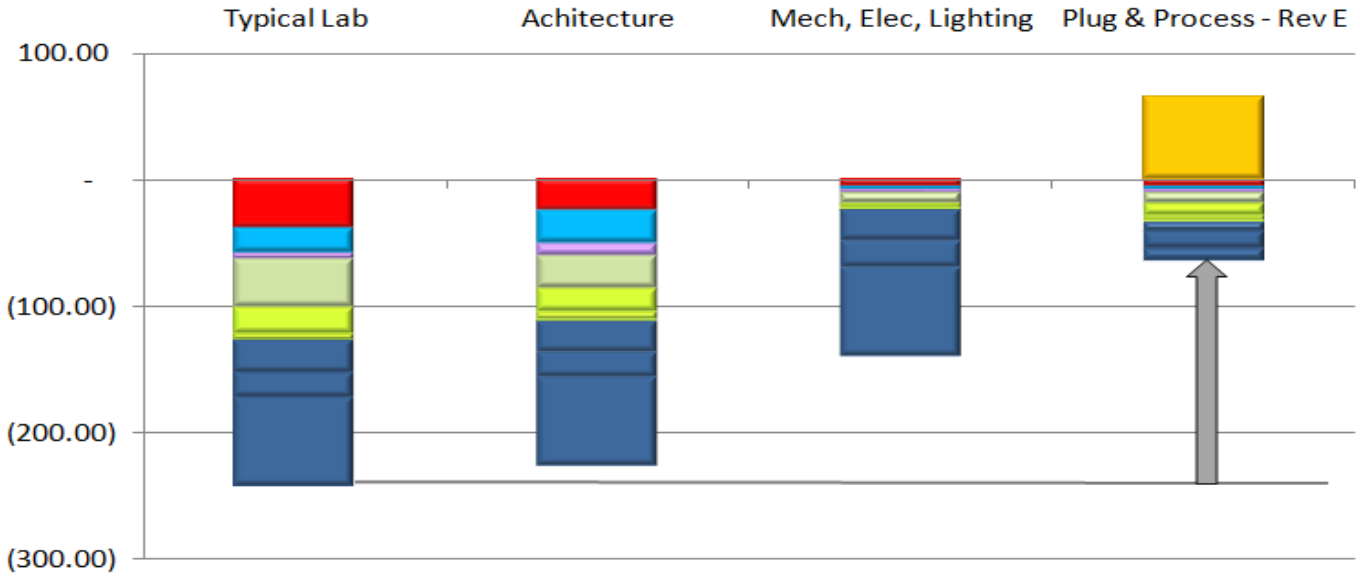
J. CRAIG VENTER INSTITUTE

ON-SITE PHOTOVOLTAICS





"Energy Budget"



- Heating
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- Lab Plug Loads
- Freezers
- PV Output

IDeAs Z Squared Design Facility EUI = 22.6

projects | 435 Indio

predicted EUI = 22.5

concepts: mechanical/architectural

- Automatically controlled passive night cooling
- Upgraded exterior insulation allows precooling of thermal mass walls
- Ceiling fans extend comfort temperature range
- Custom operable skylights use prevailing breezes to induce internal airflow
- High efficiency/ low cost rooftop package units used only as needed (rarely)
- High performance glazing – no need for external shades

concepts: financial

- Performance based lease provides carrot (and stick) for good occupant behaviour
- Added construction cost = $44/sf including 32,000 sf PV array
- Drastically reduced reserve requirements for maintenance and HVAC
- Reduced operating expenses – utilities, landscape, etc
- Demisability to reduce churn costs
- Unanticipated cost reductions (e.g. no mechanical screen)

- IF actual energy use meets predicted, than the financial model is more profitable than standard practice (build to code)

- Future projects – higher rents and lease rates

DOE GOAL : PROOF OF CONCEPT

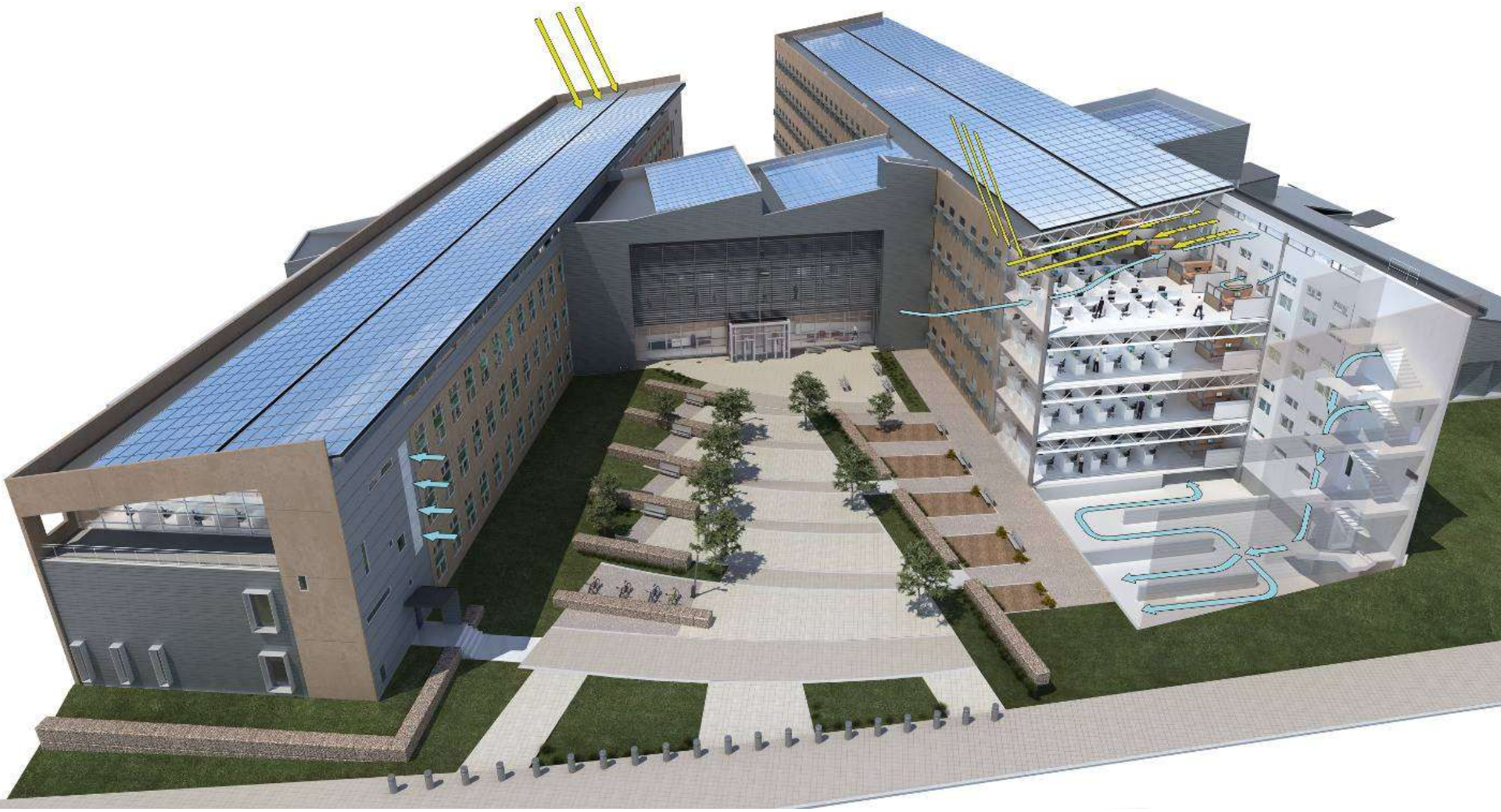
Large Scale Net Zero Energy At Market Rate

$260/sf

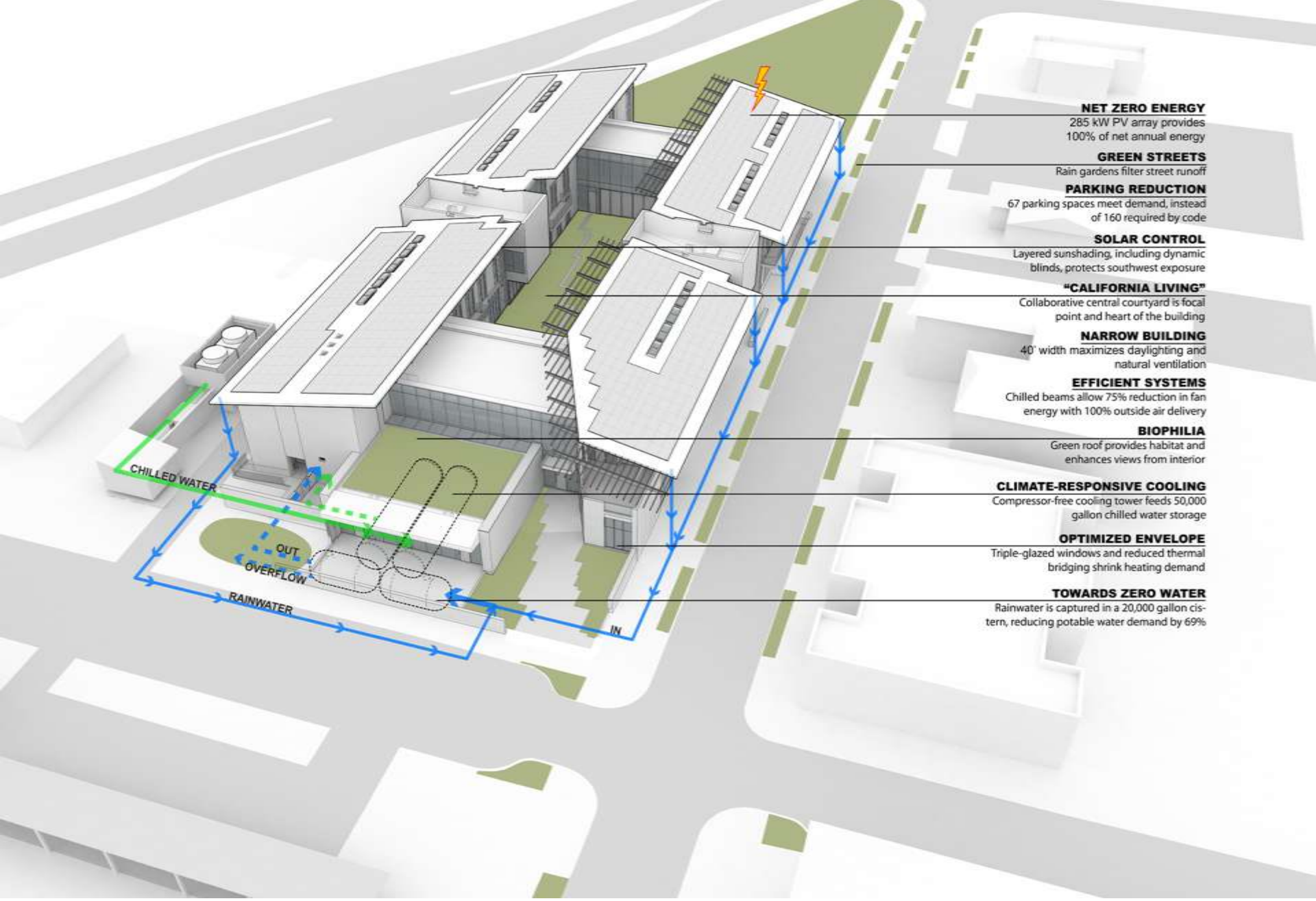
EUI = 25 kBTU/sf

NREL Research Support Facility
"World's Largest Net Zero"
LEED Platinum Certified : AIA COTE Top 10
RNL Design

INTEGRATED



Packard Foundation
LEED Platinum Certifed
EHDD Architects



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

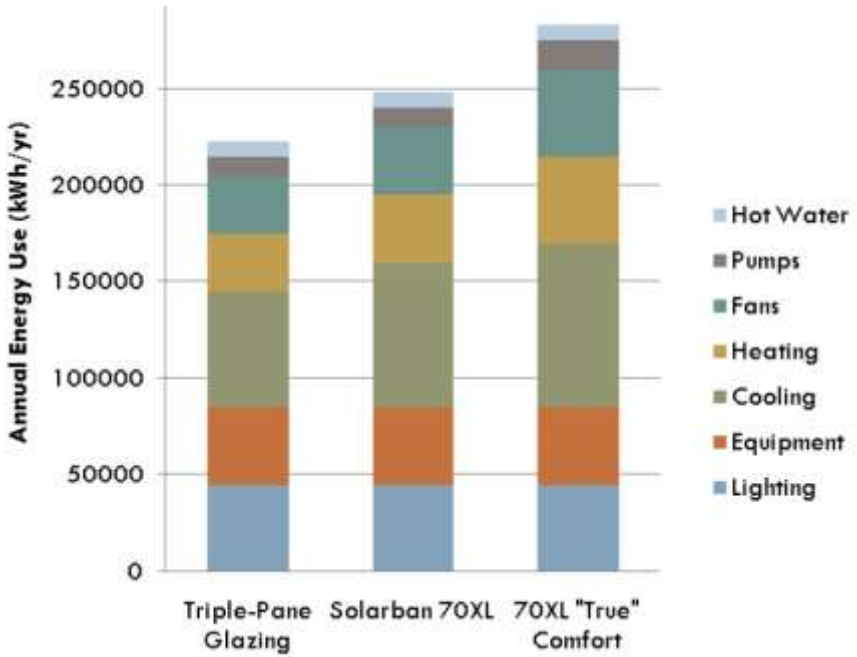
BIOPHILIA
Green roof provides habitat and enhances views from interior

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 cistern, reducing potable water demand by 69%

Glazing Energy Impacts

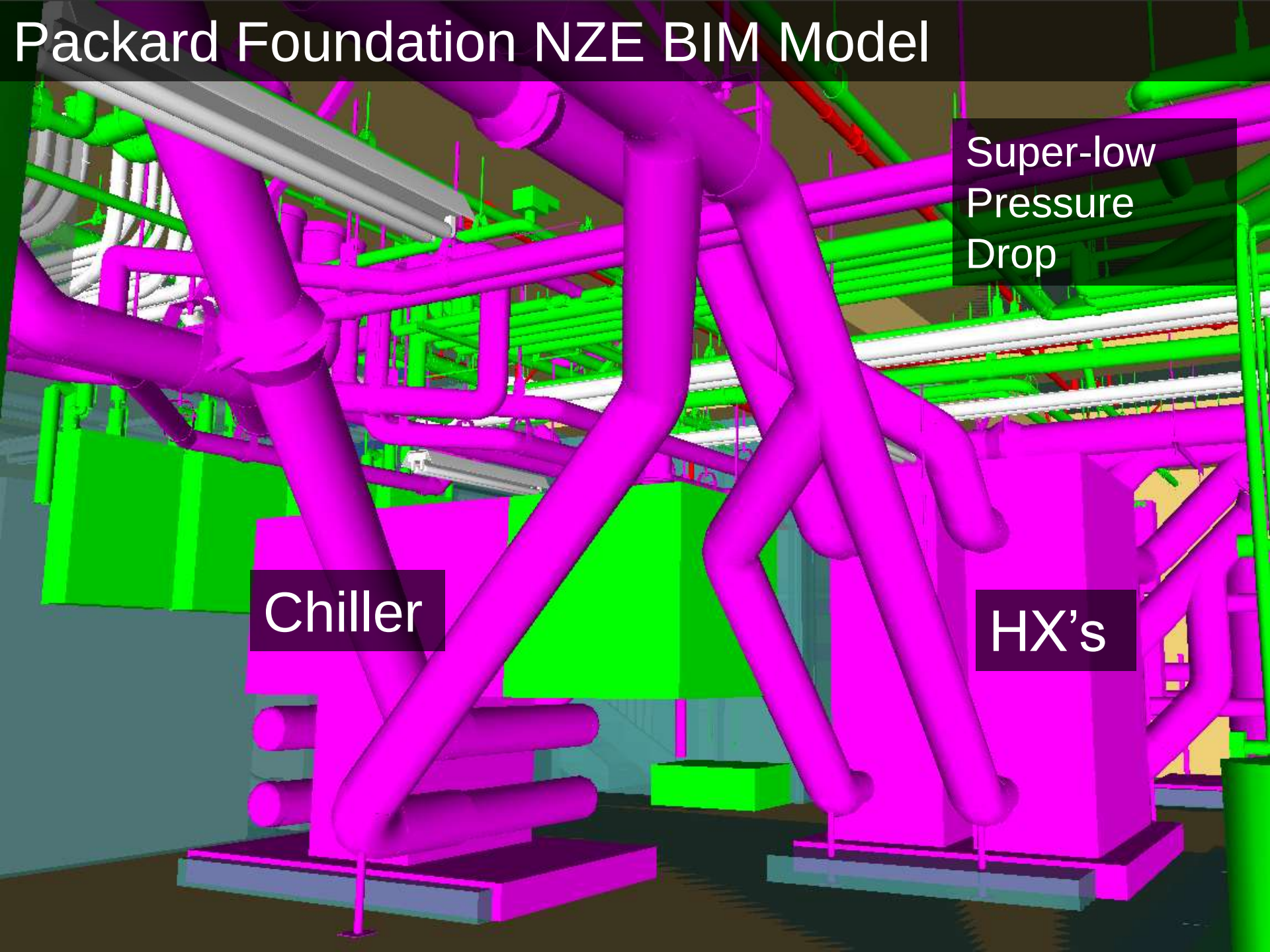


+ $75,000 Premium for installed glazing
- $150,000 Simplify heating system

= $75,000 first cost *savings*

Plus $300,000 savings in fewer PVs

Packard Foundation NZE BIM Model



cost drivers and tools

Location
Program
Site conditions
Climate
Delivery
Team
Client values

Team
Client values
BIM
Modeling
Targets

GREEN IS NOT A PRIMARY COST DRIVER!