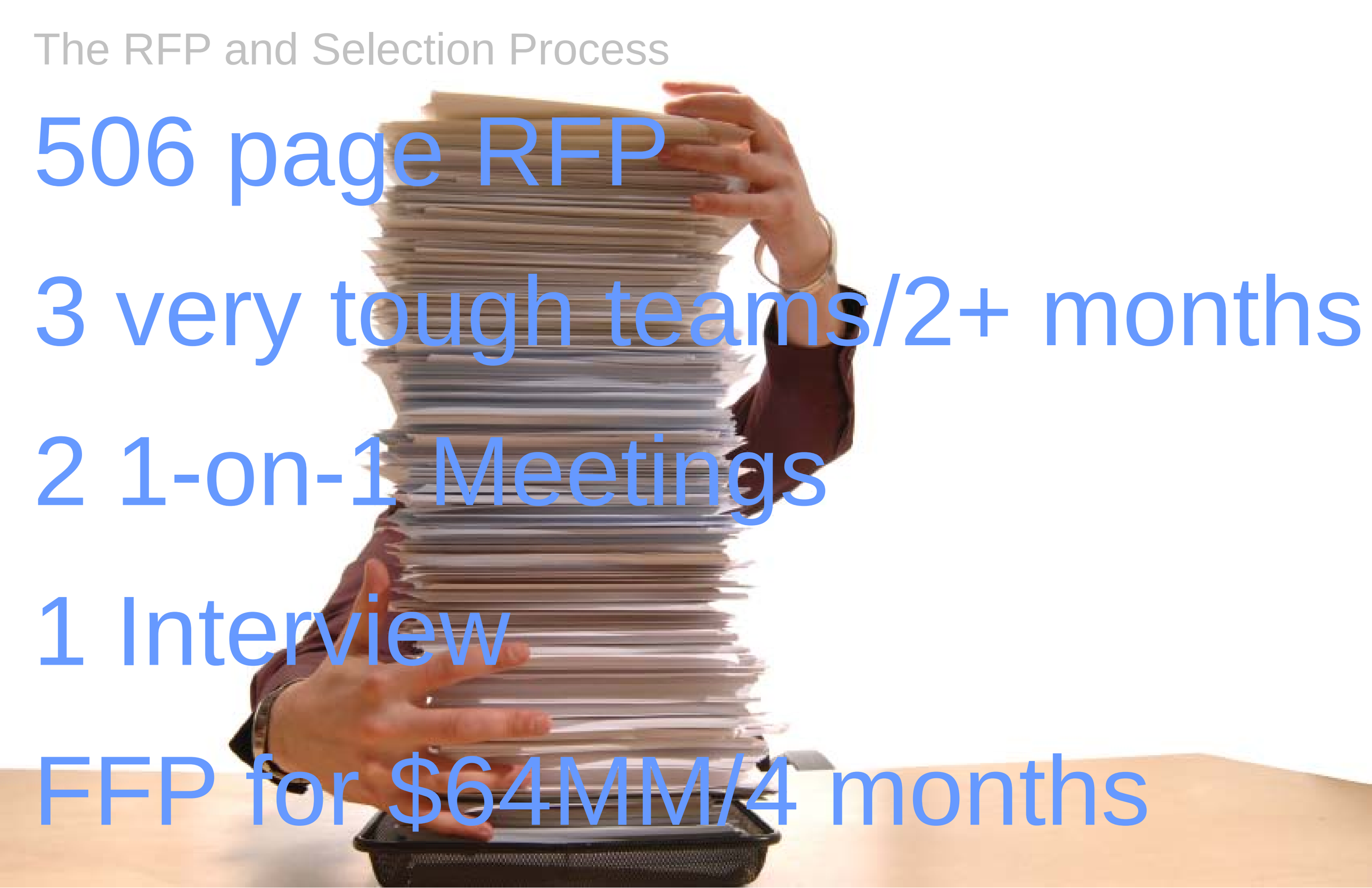
U.S. Department of Energy's

National Renewable Energy Laboratory

Research Support Facilities (RSF)

Zero Energy Building – Moving to Market Ready



506 page RFP

3 very tough teams/2+ months

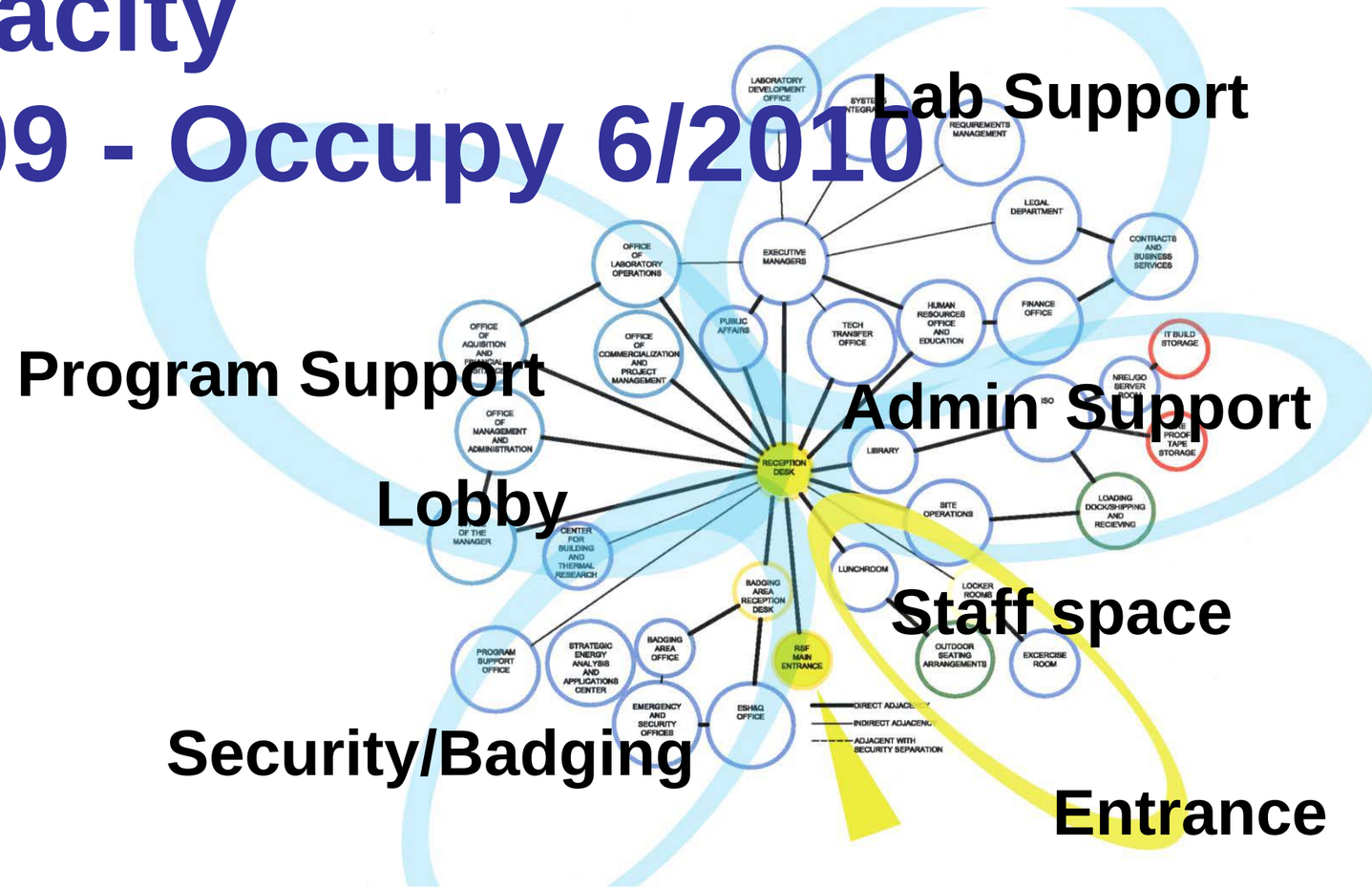
2 1-on-1 Meetings

1 Interview

FFP for $64MM/4 months

The Problem Statement – The Program

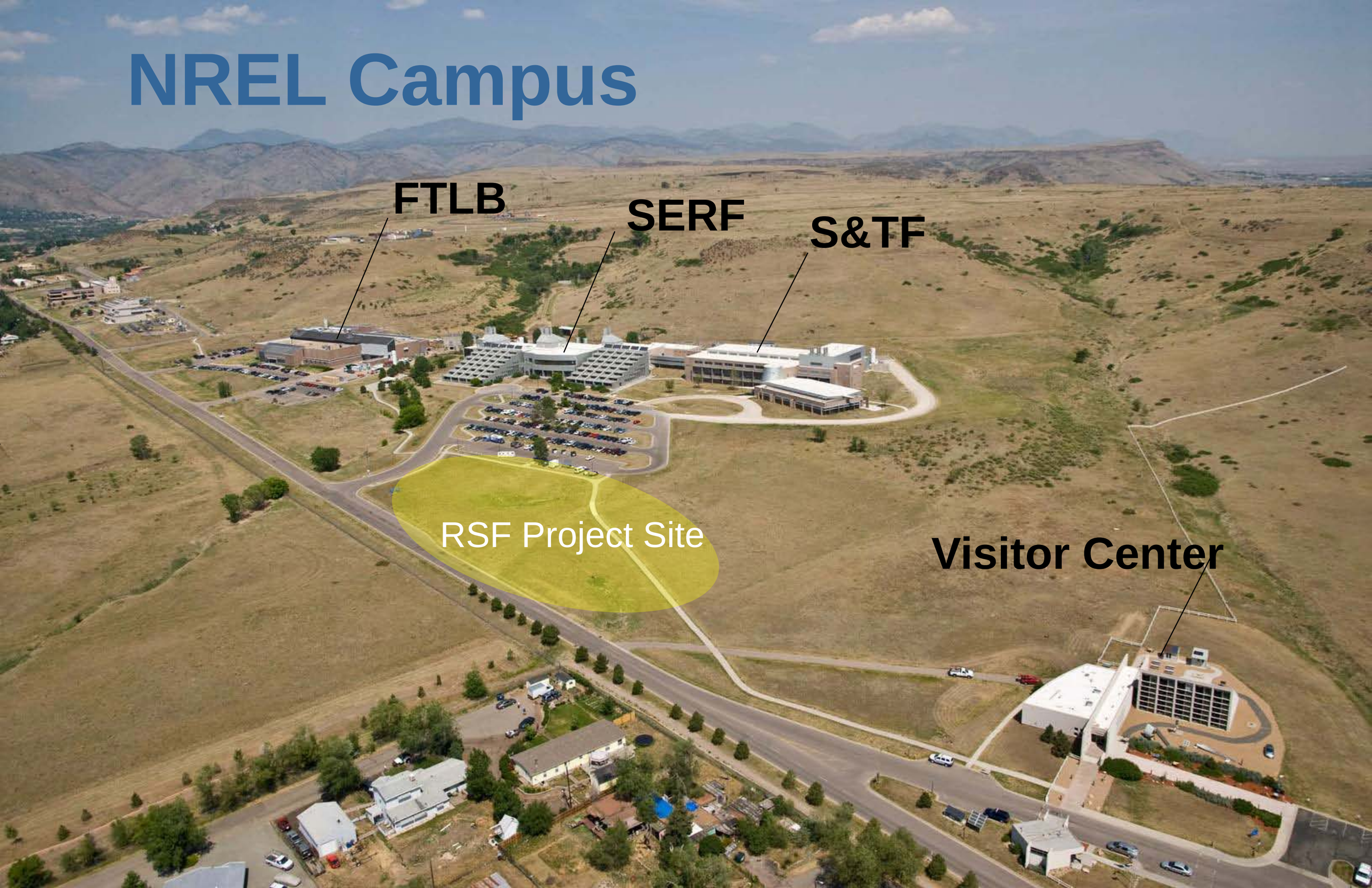
- 218,000 GSF
- $64,000,000 FFP
- 800 Staff Capacity
- Start July 2009 - Occupy 6/2010



The Problem Statement – Performance

- LEED Platinum required
- Natural Ventilation required
- LEED Daylight Credit required
- 50% better than LEED Platinum energy use - required

NREL Campus



SERF

S&TF

Today's Office Building

Range View I

Program

- 55,000 GSF, 4 floors
- $4.7 MM core/shell (2002)
- Design/const +/-18

Today’s Office Building

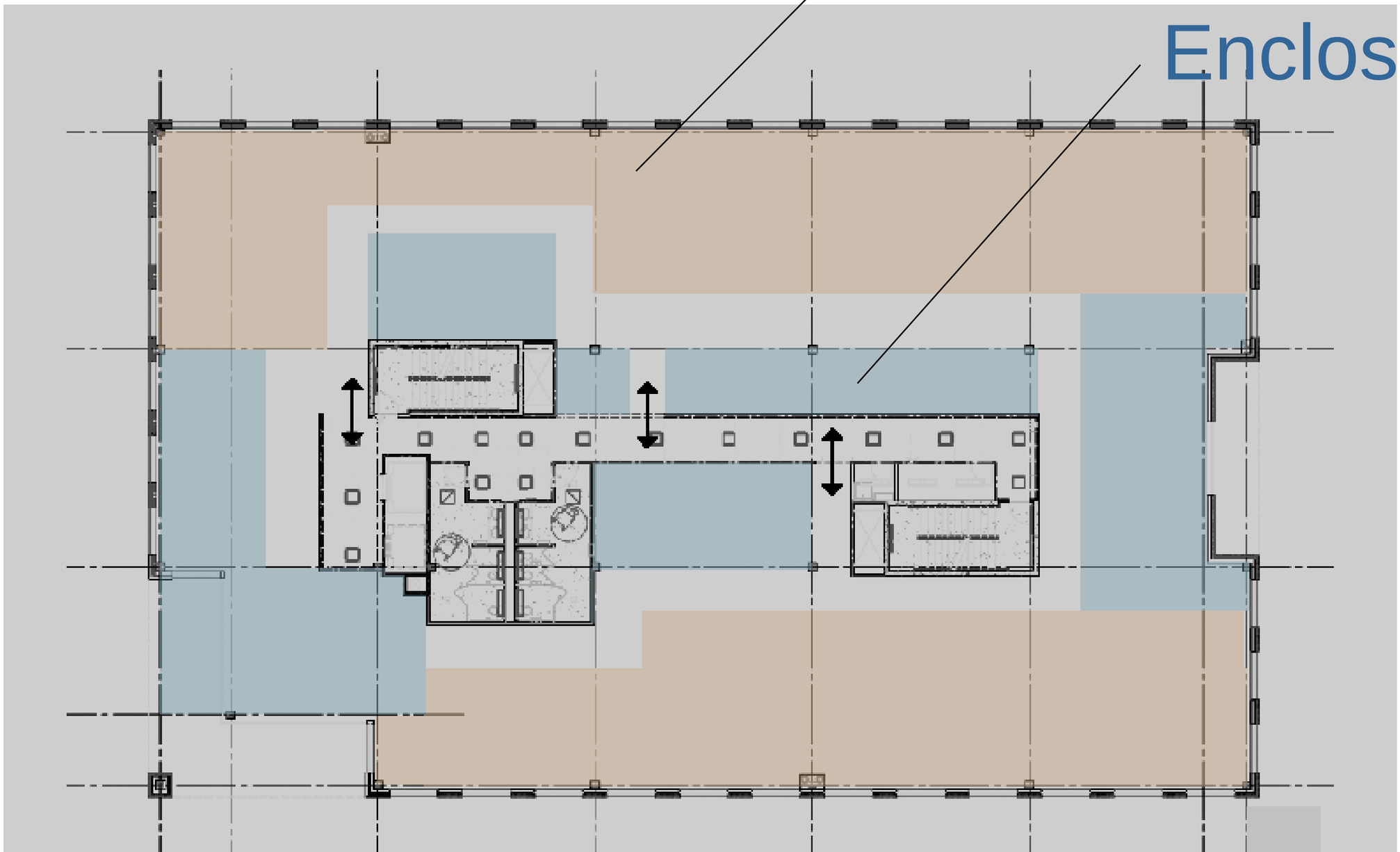
Range View I

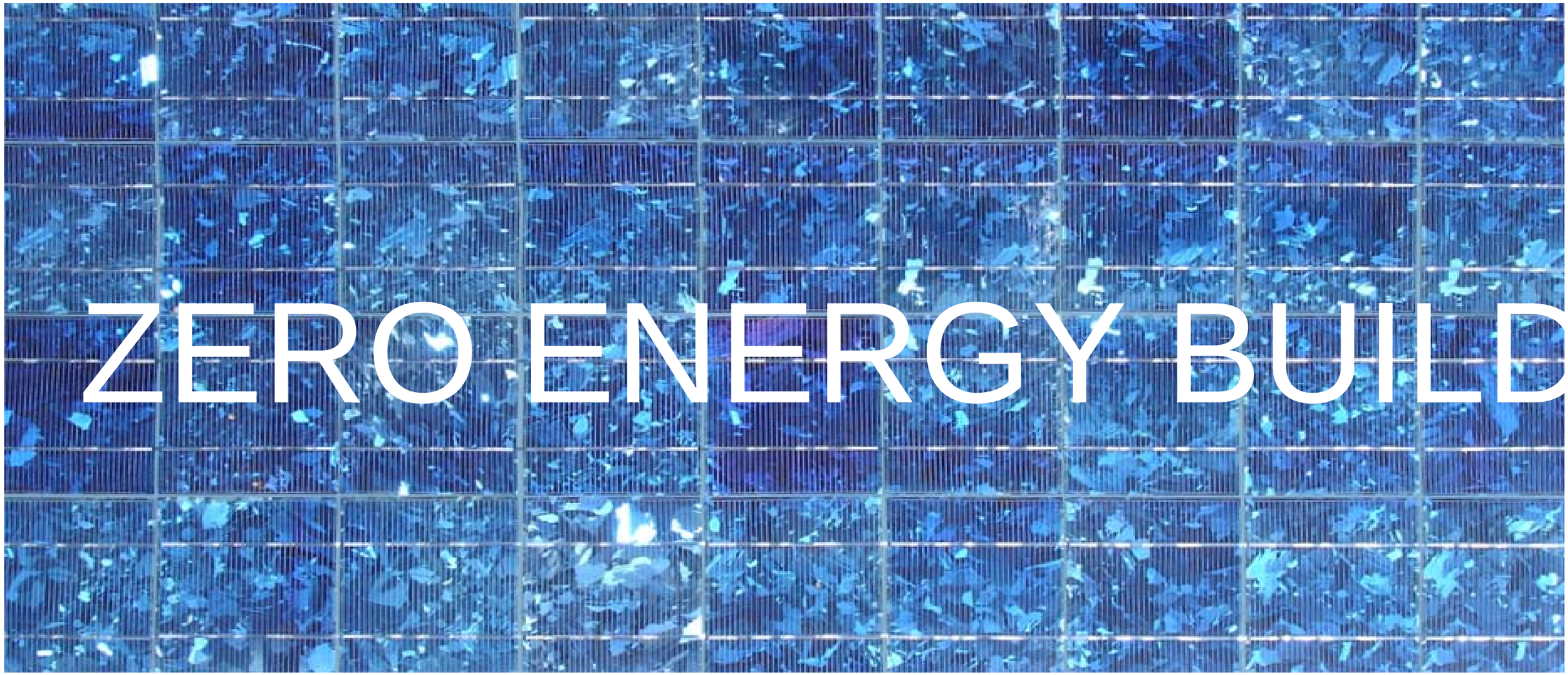
Performance

- LEED Silver Equivalent
- Rooftop Package Units
- Daylight Credit

Today's Office Building

Range View I




ZERO ENERGY BUILD

ZEB Goal

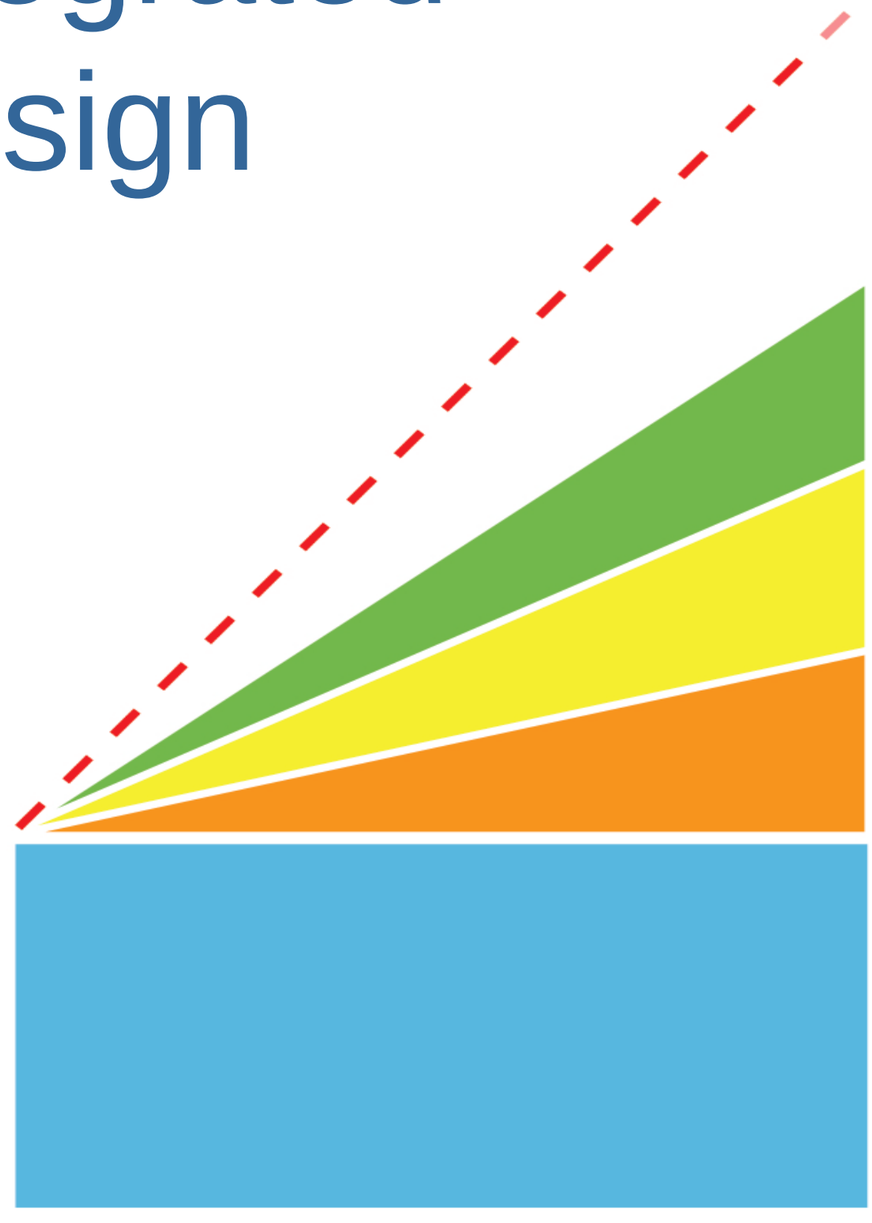
Passive design

Massing, orientation and roof area

Very Efficient MEP and IT

Integrated Workplace Design

Integrated Design



Innovation

Systems
- Thermal — Mechanical + electrical
- Lighting — Efficiency
- Comfort — Systems integration

Passive
- Thermal — Architecture
- Lighting — Effectiveness
- Comfort — Integration

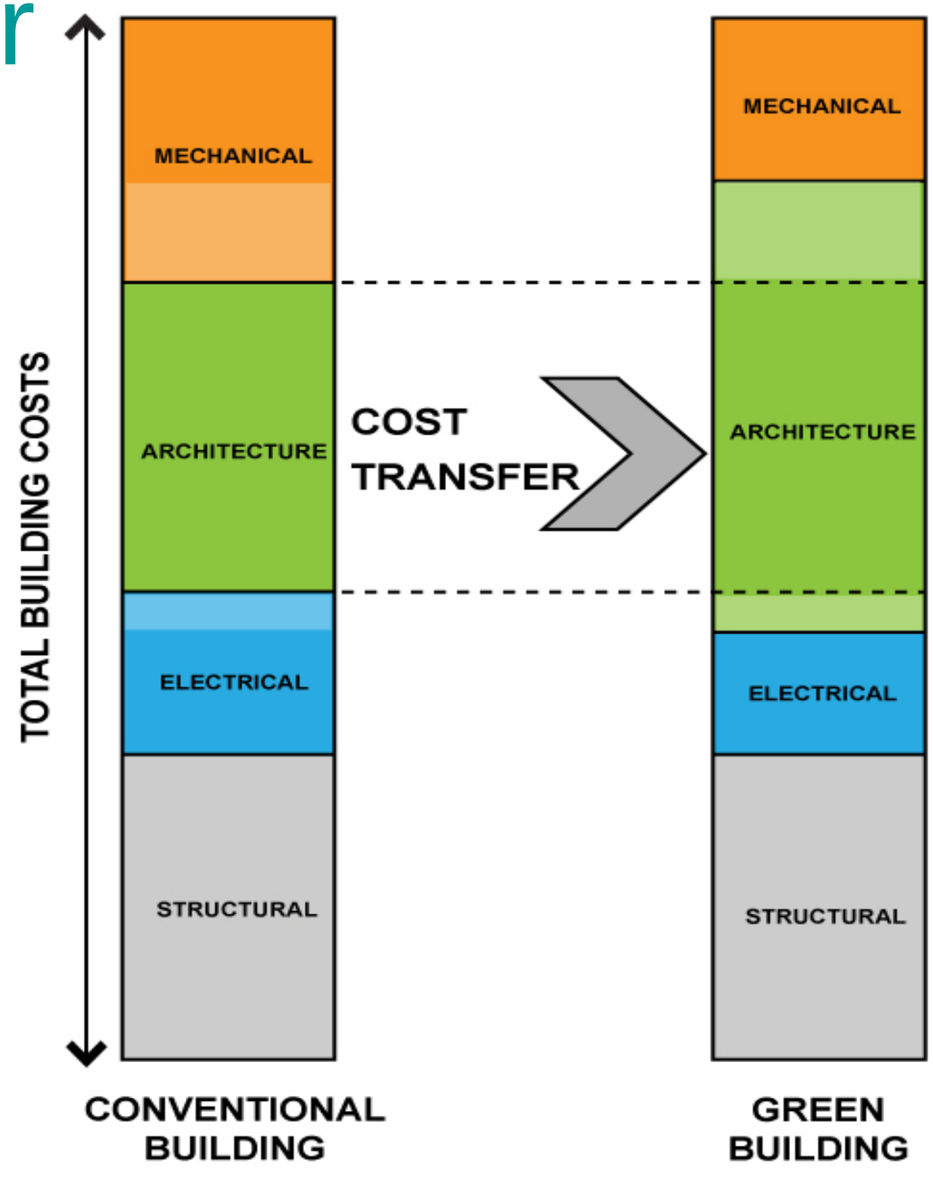
Fundamentals
- Orientation — ASHRAE envelope
- Build depth
- Window to wall ratio

Environmental Context Assessment
- Site
- Climate
- Resources
- Systems

Optimize Energy Performance
(Optimization Wedges)

Integrated Design

Cost Transfer

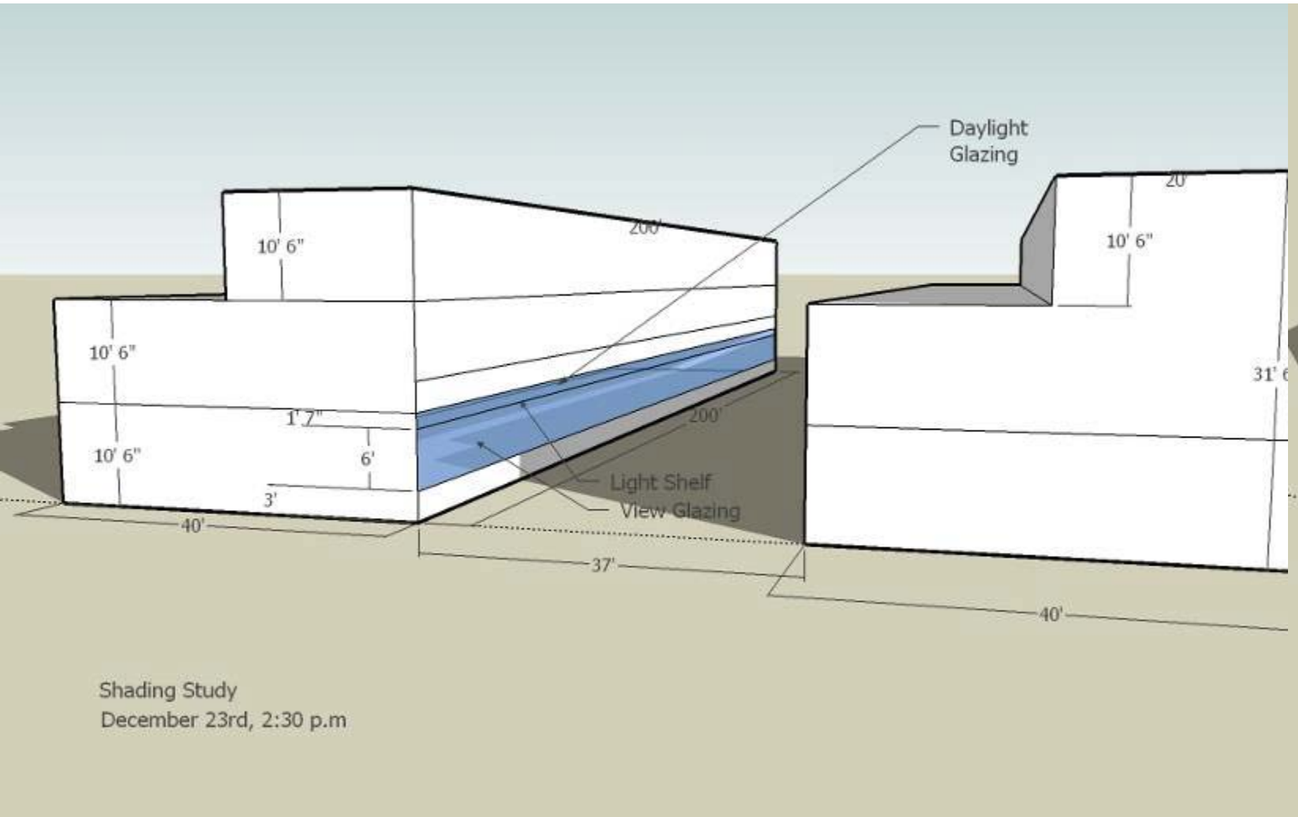


Integrated Design

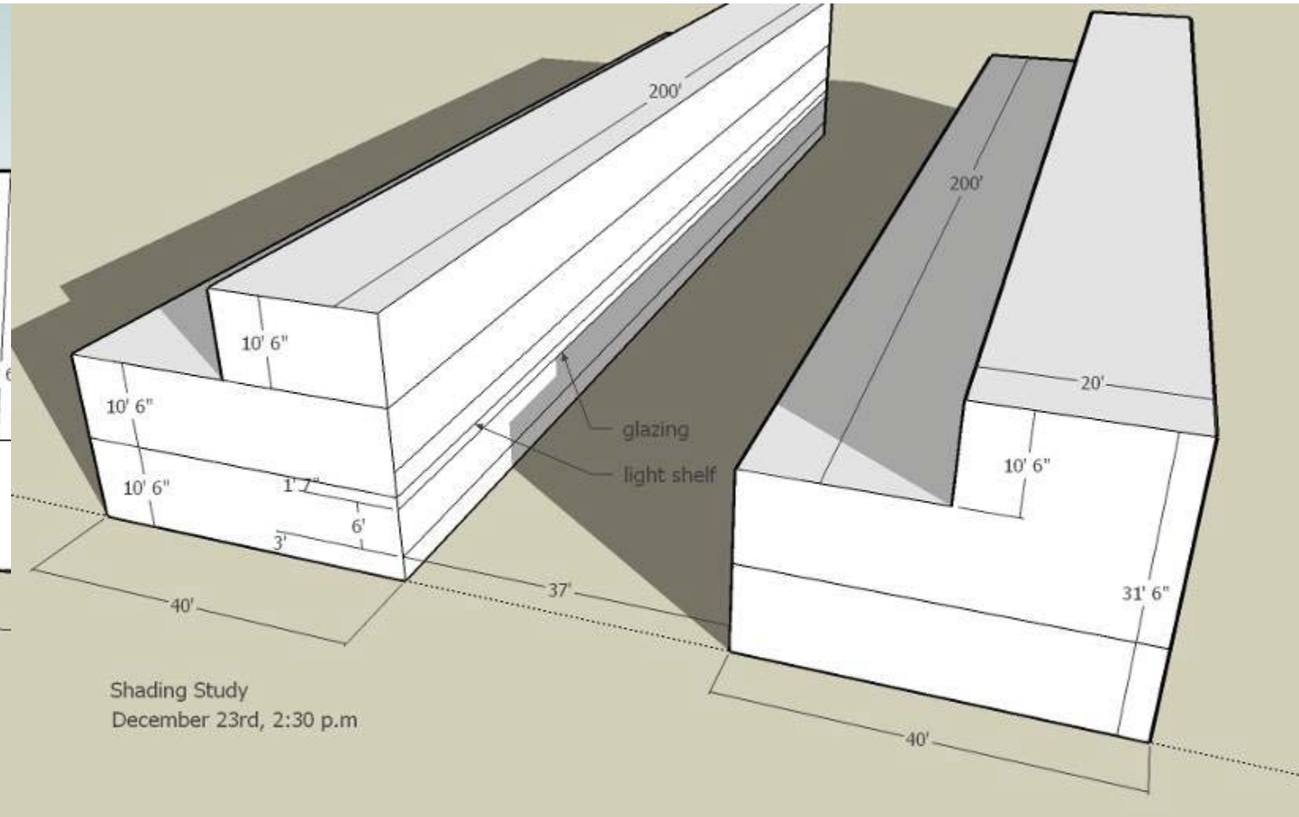
Design Simulations

- Energy modeling
- Daylight modeling
- Natural ventilation modeling
- Thermal mass modeling
- And all must meet the Cost Model

Energy and Architecture



Shading Study
December 23rd, 2:30 p.m



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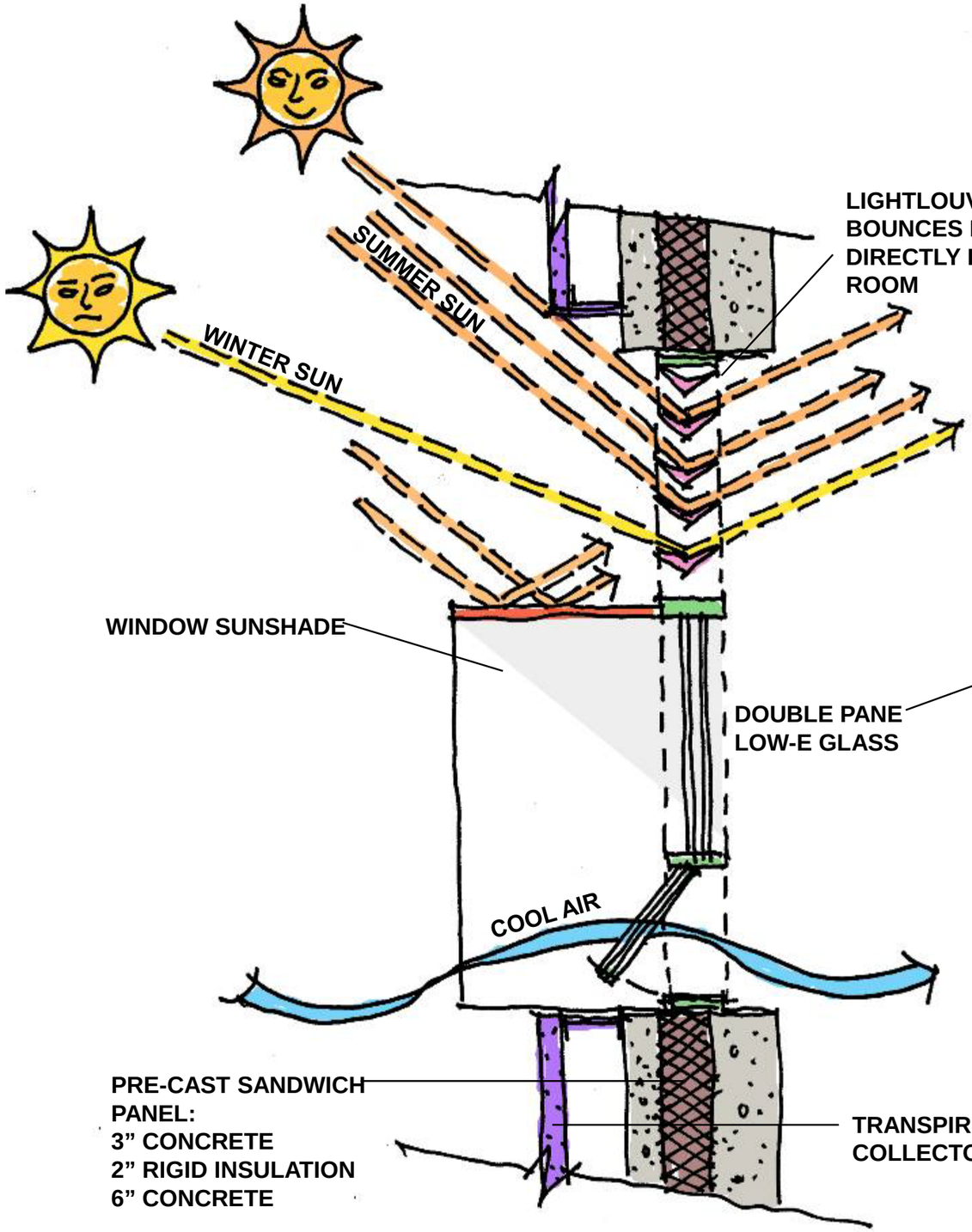
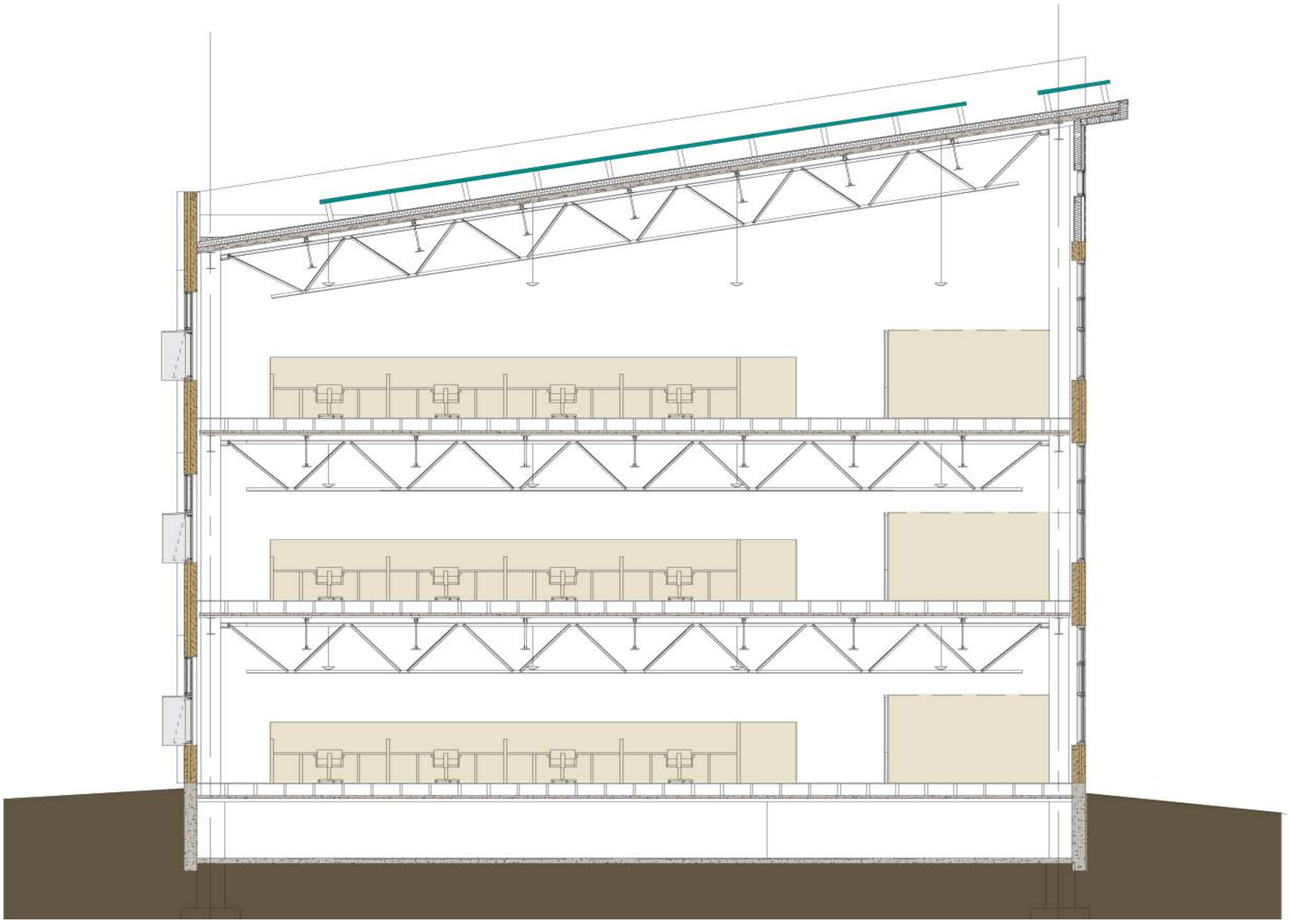
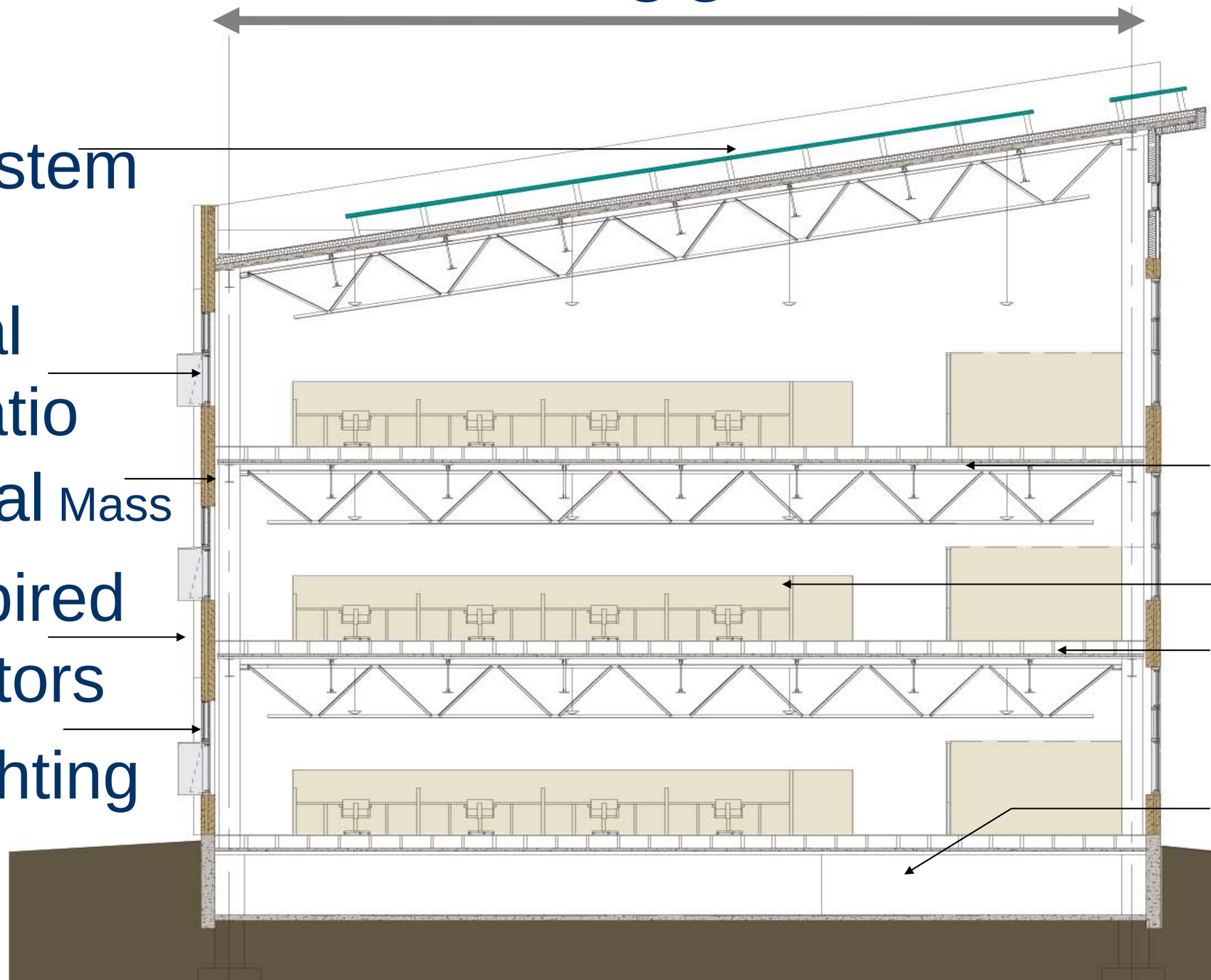


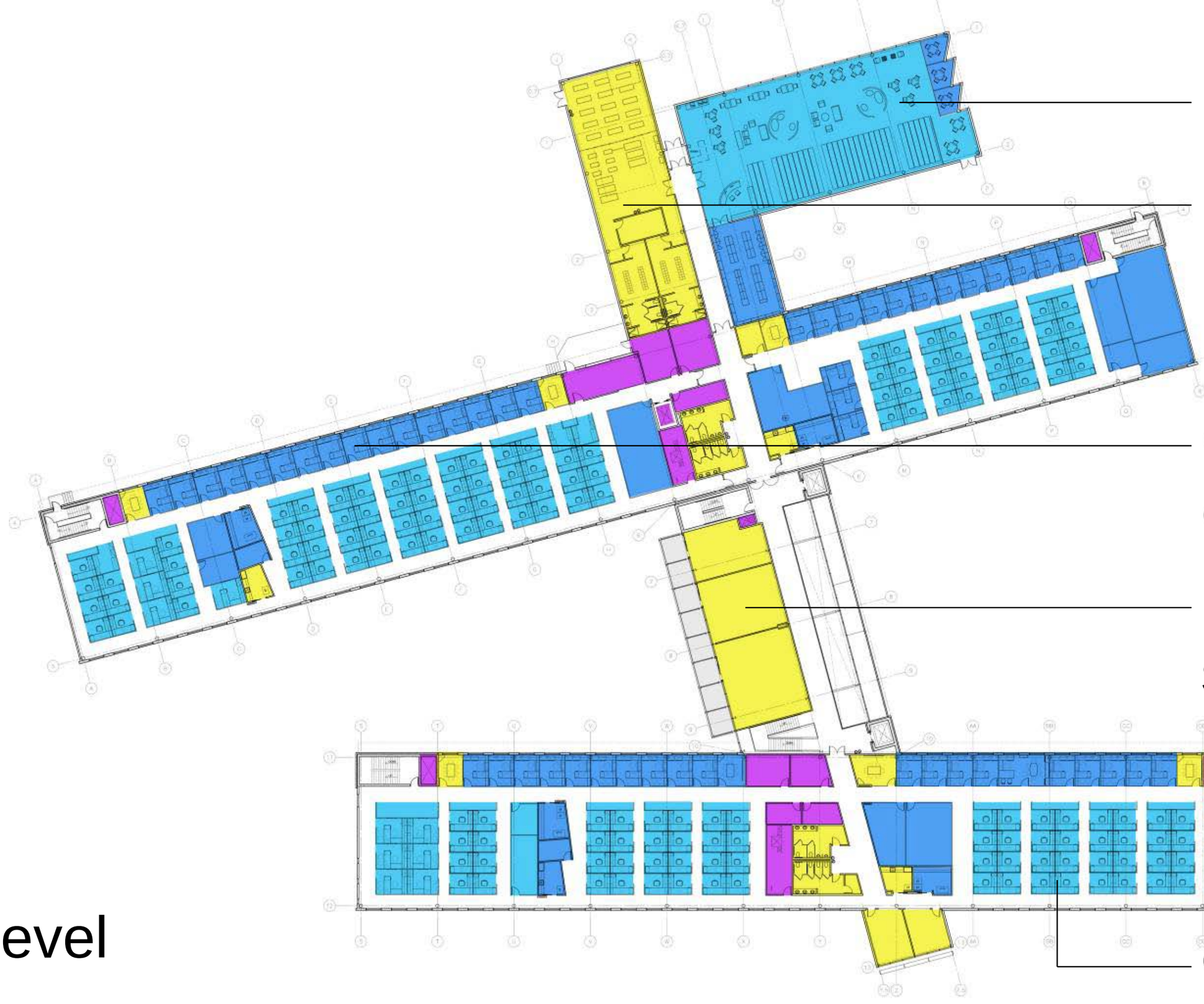
FIGURE #1
NREL

The Section



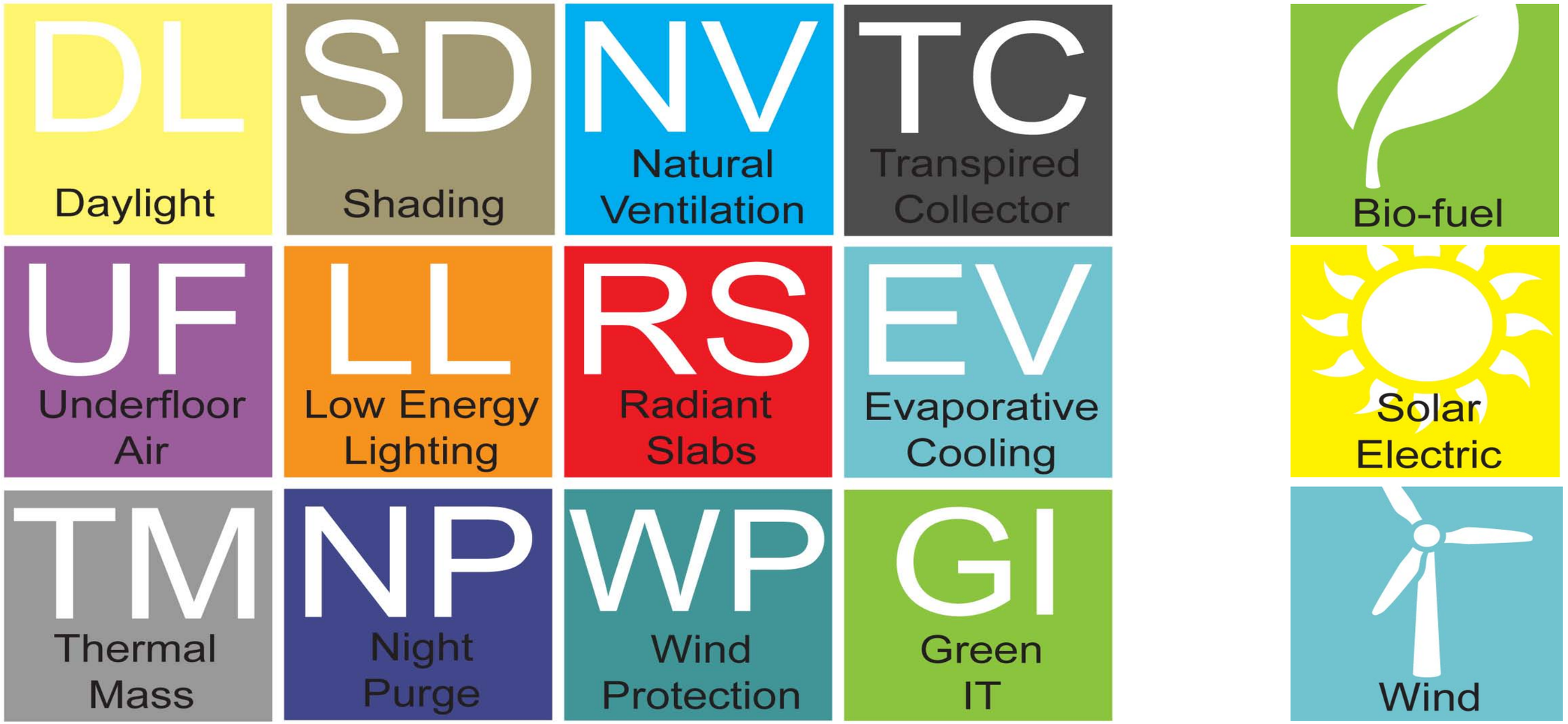
The Section


60’
PV System
Natural Ventilatio
Thermal Mass
Transpired Collectors
Daylighting
Radiant Coolin
Radiant Heatin
Workplace
UFAD
Labyrinth

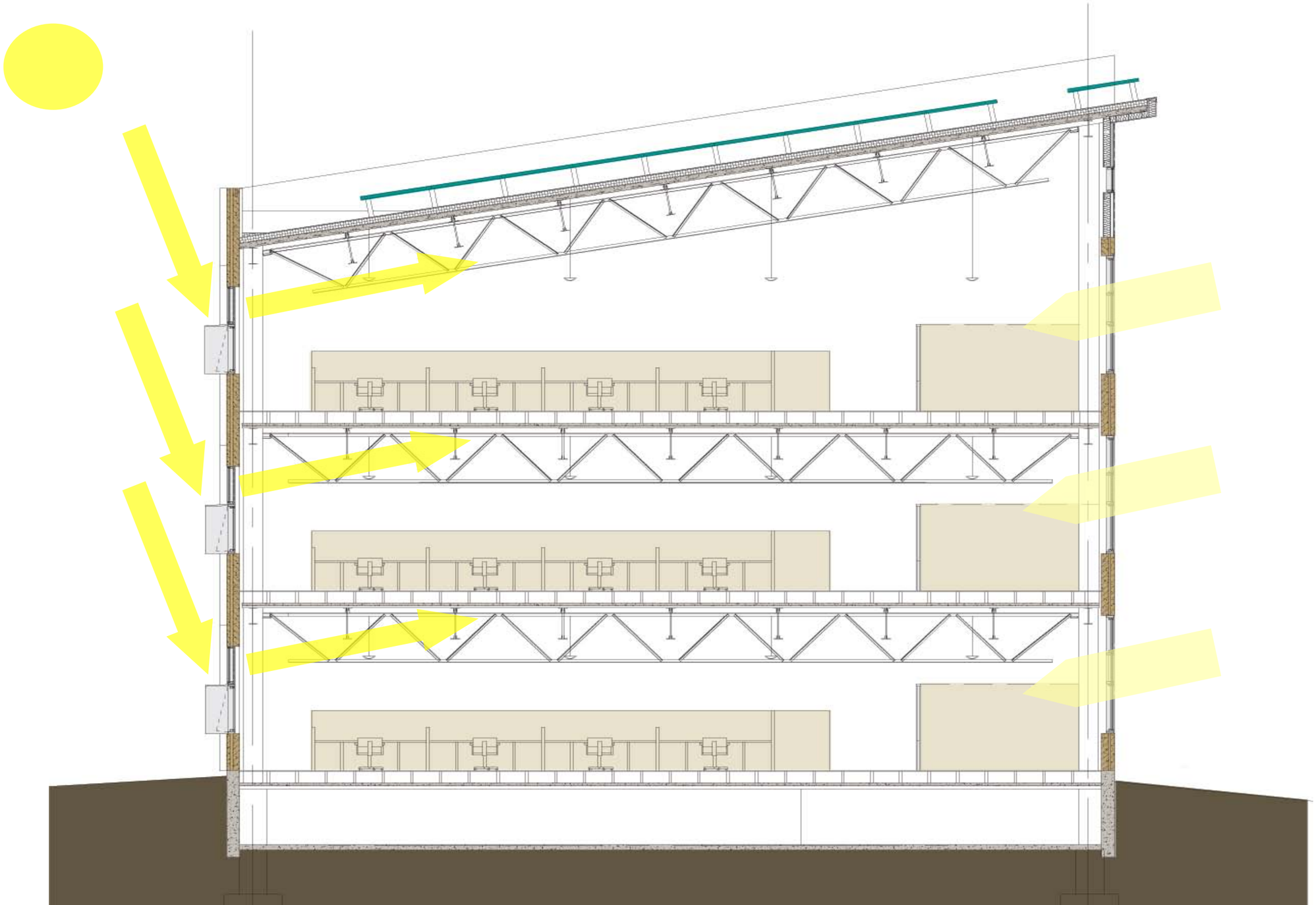

Library
Fitness
Closed offices
Meeting spaces
Open offices

2nd Level

Zero Energy Strategies



The Section - Daylighting



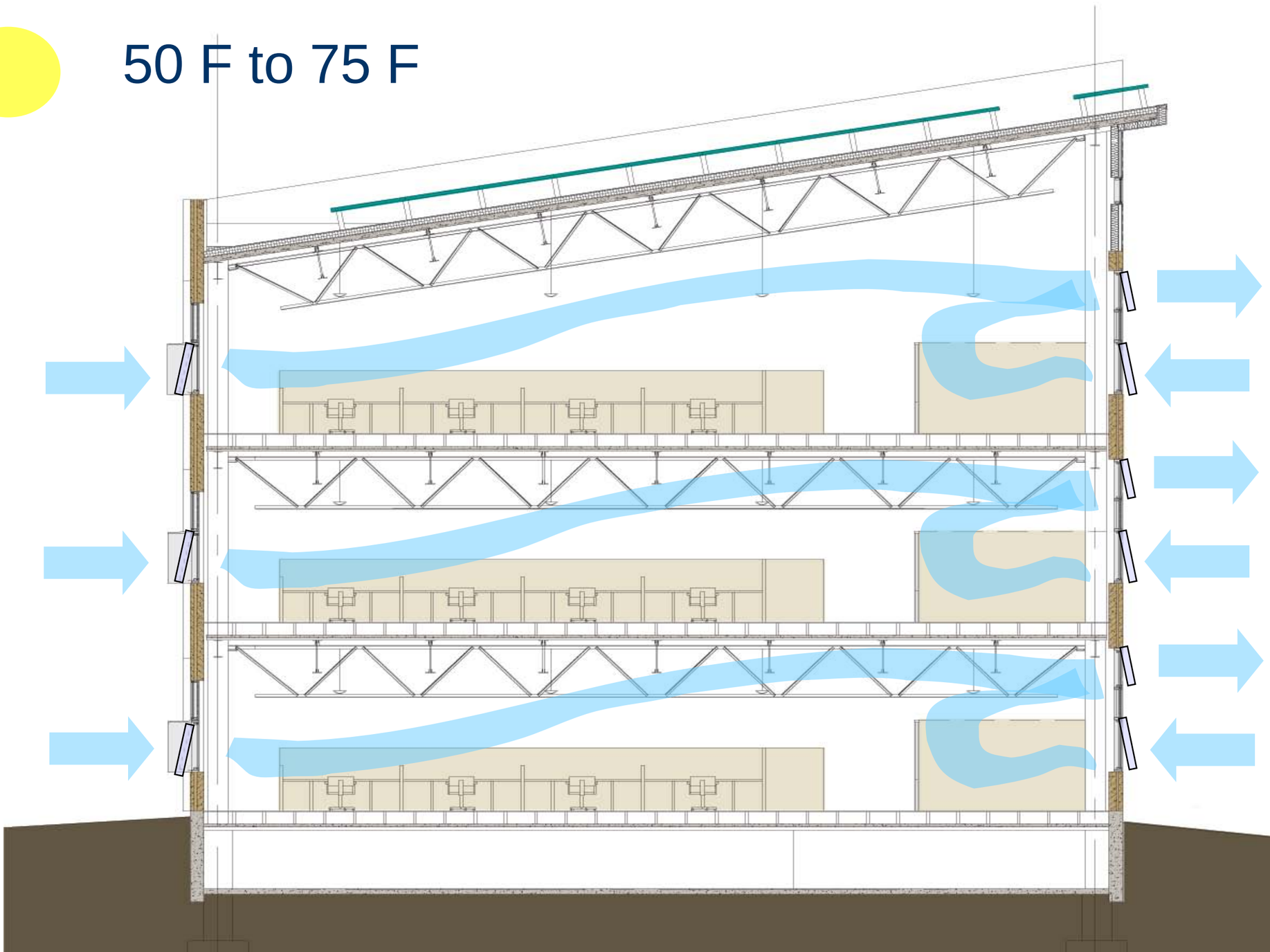
Workplace - Interiors

Top Floor

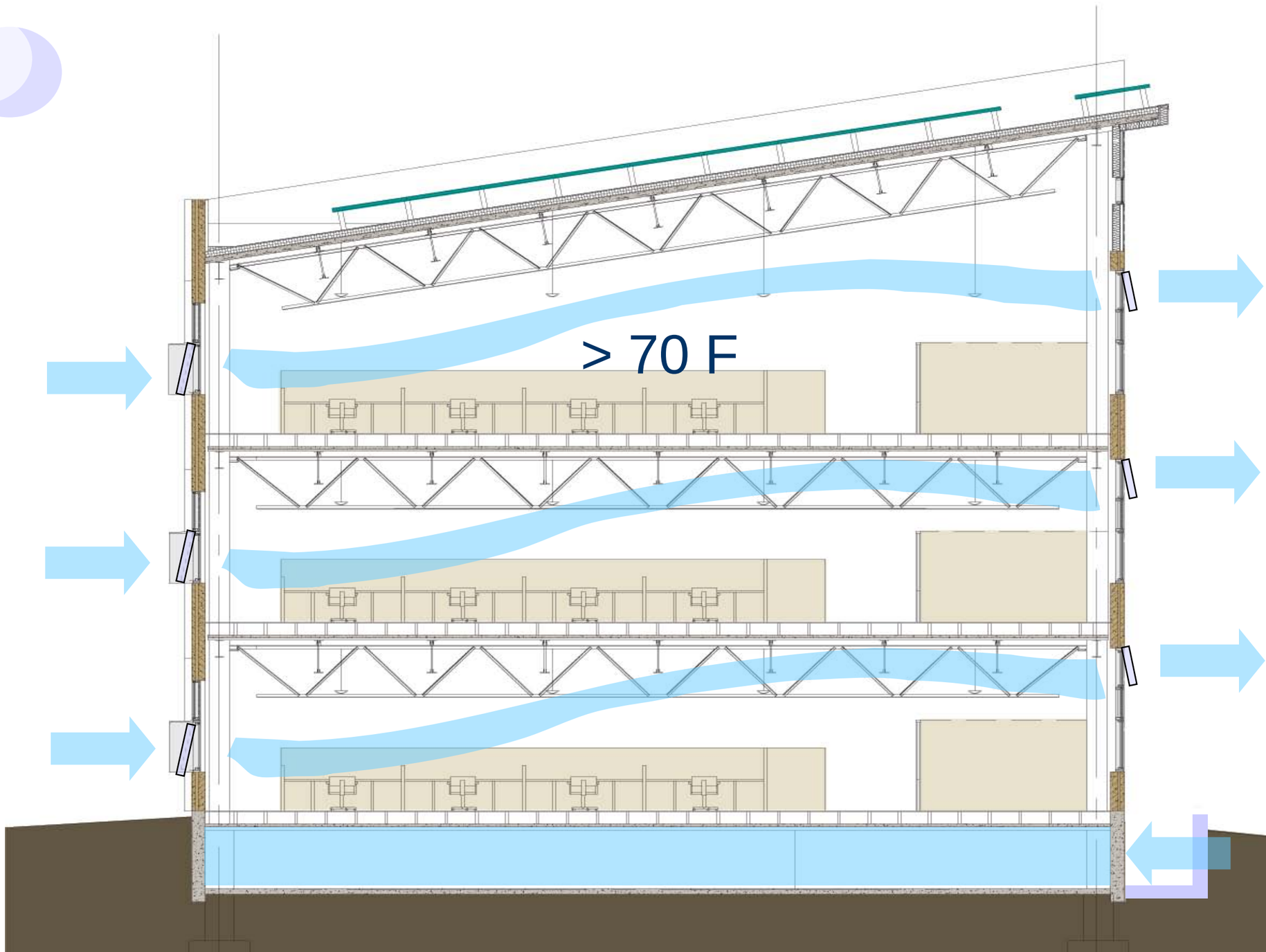
Typical Floor

Natural Ventilation - Summer Day

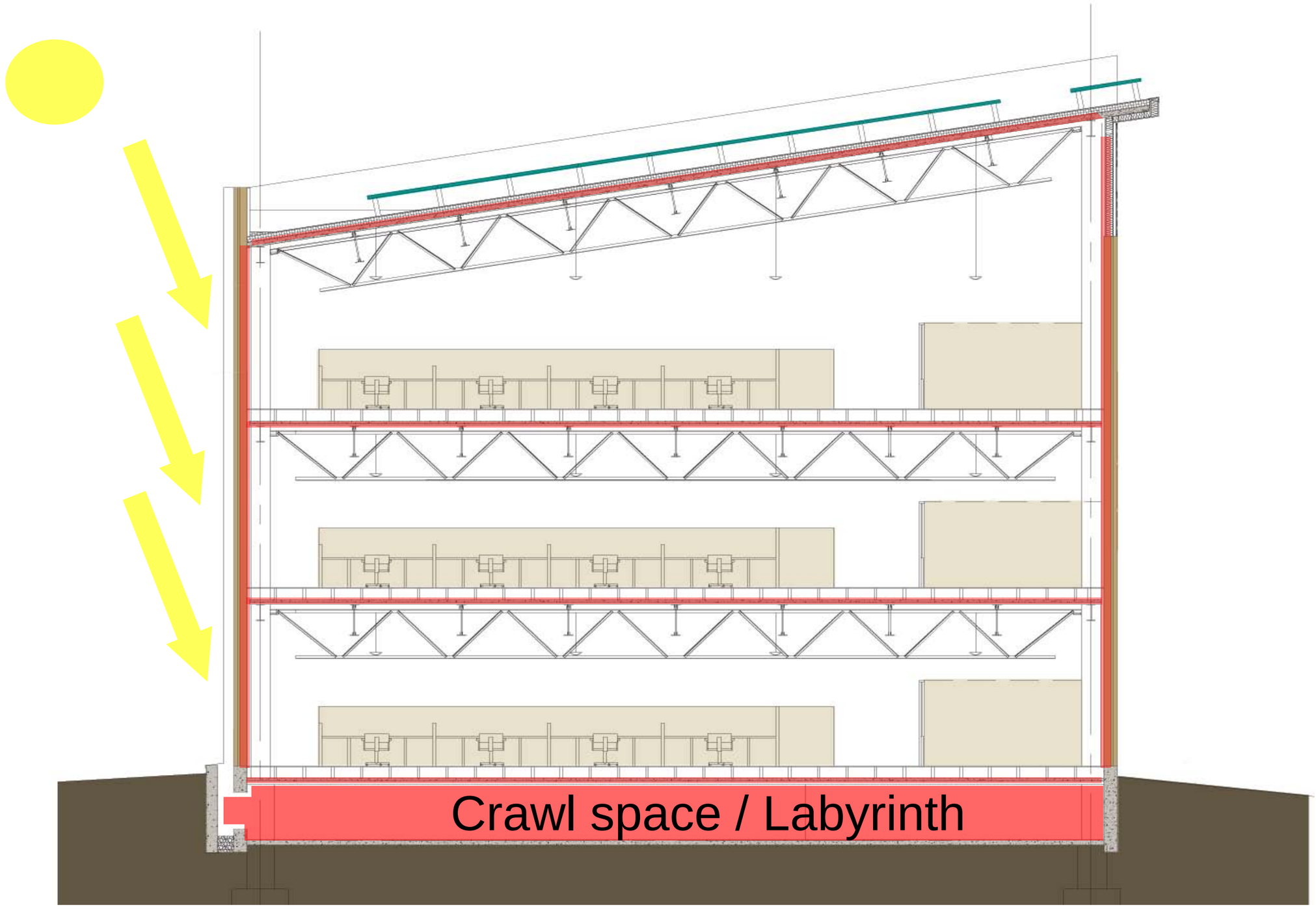
50 F to 75 F

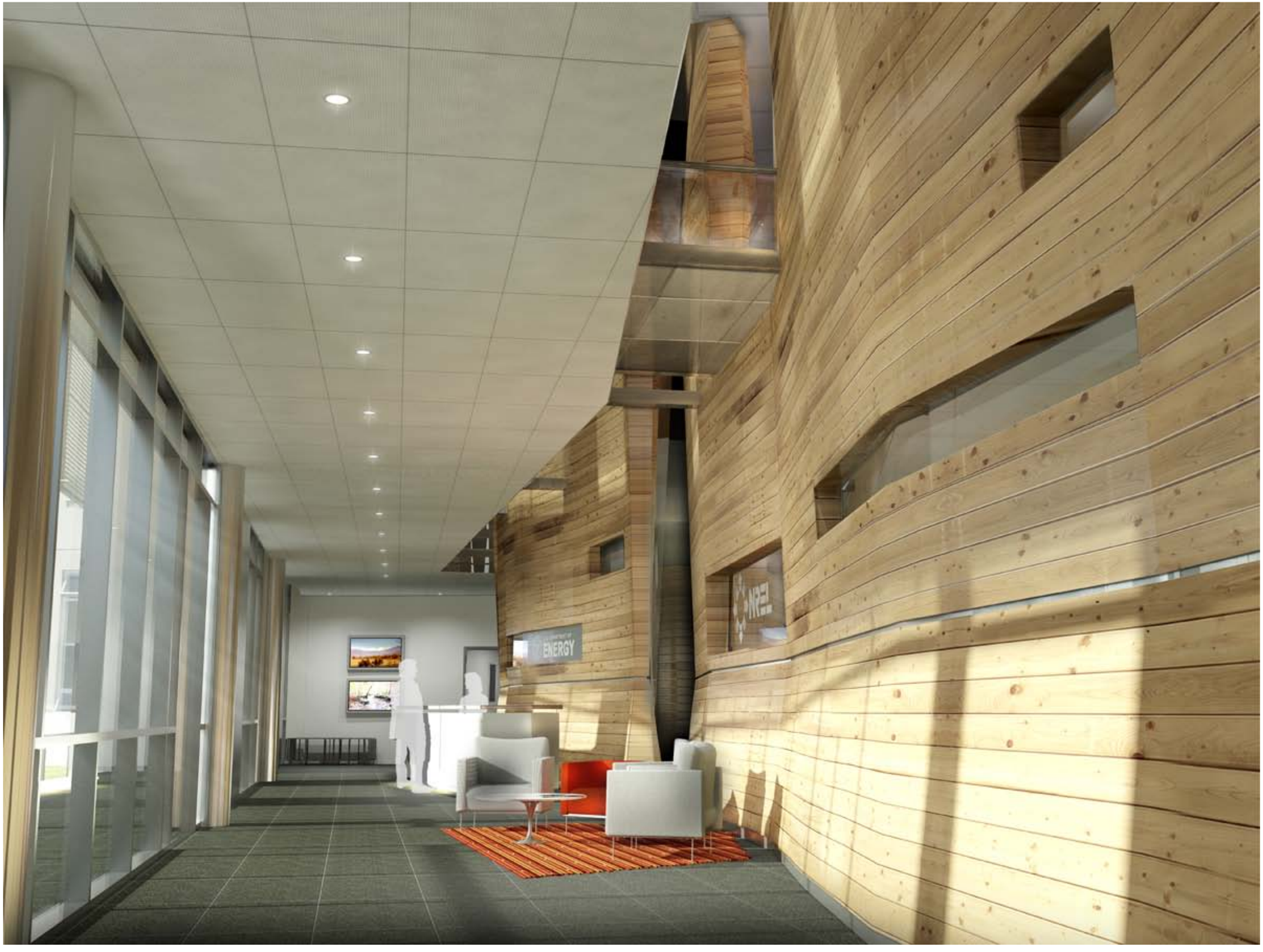


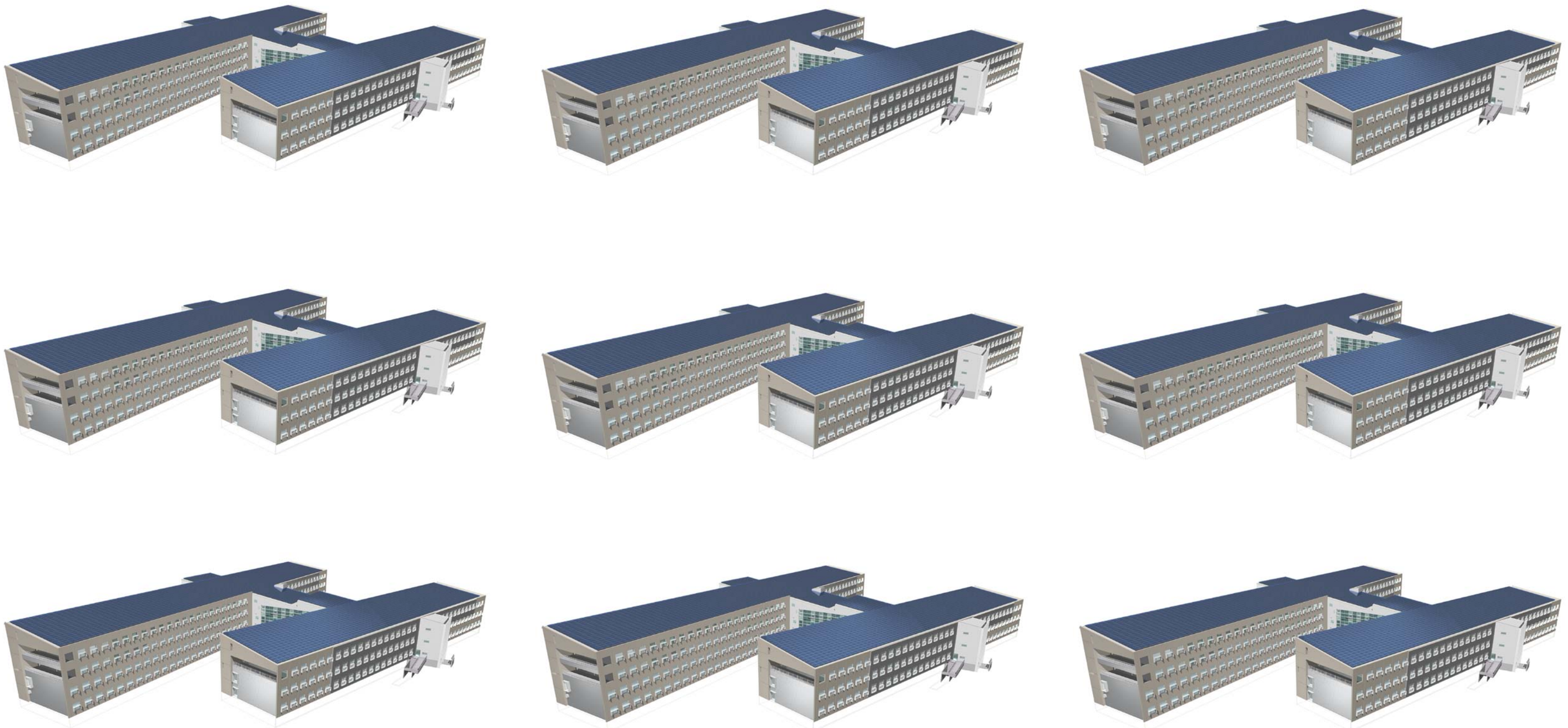
Natural Ventilation - Summer Night



The Section – Thermal Mass




ENERGY

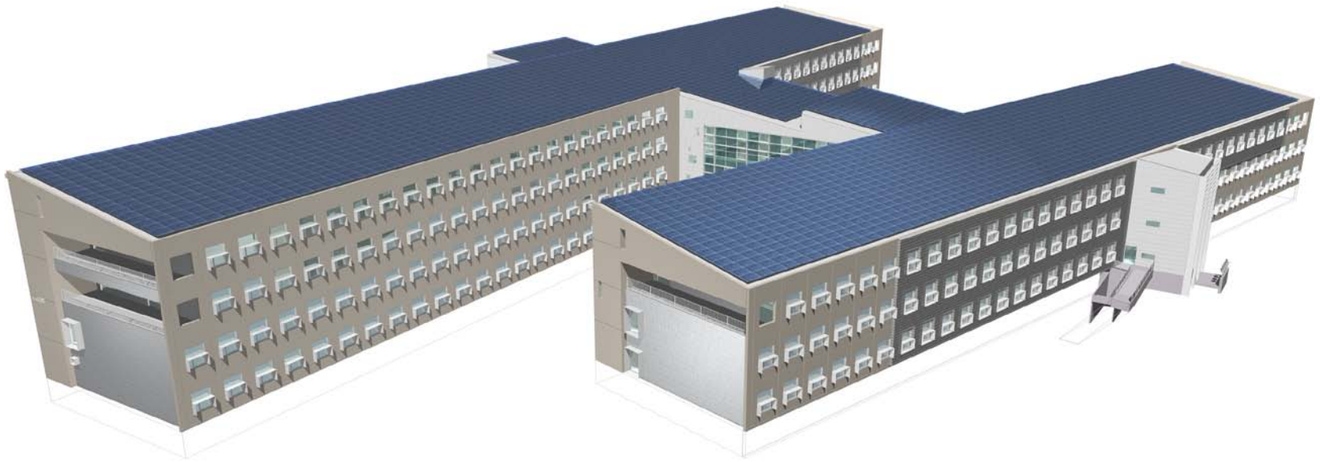


Is it replicable?

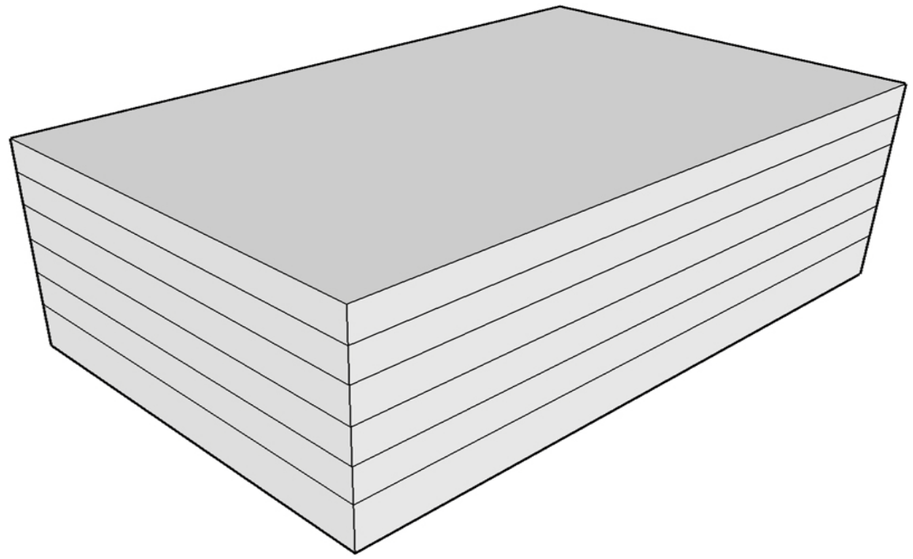
How to Design and Build a

ZEB

Cost / Construction – Envelope



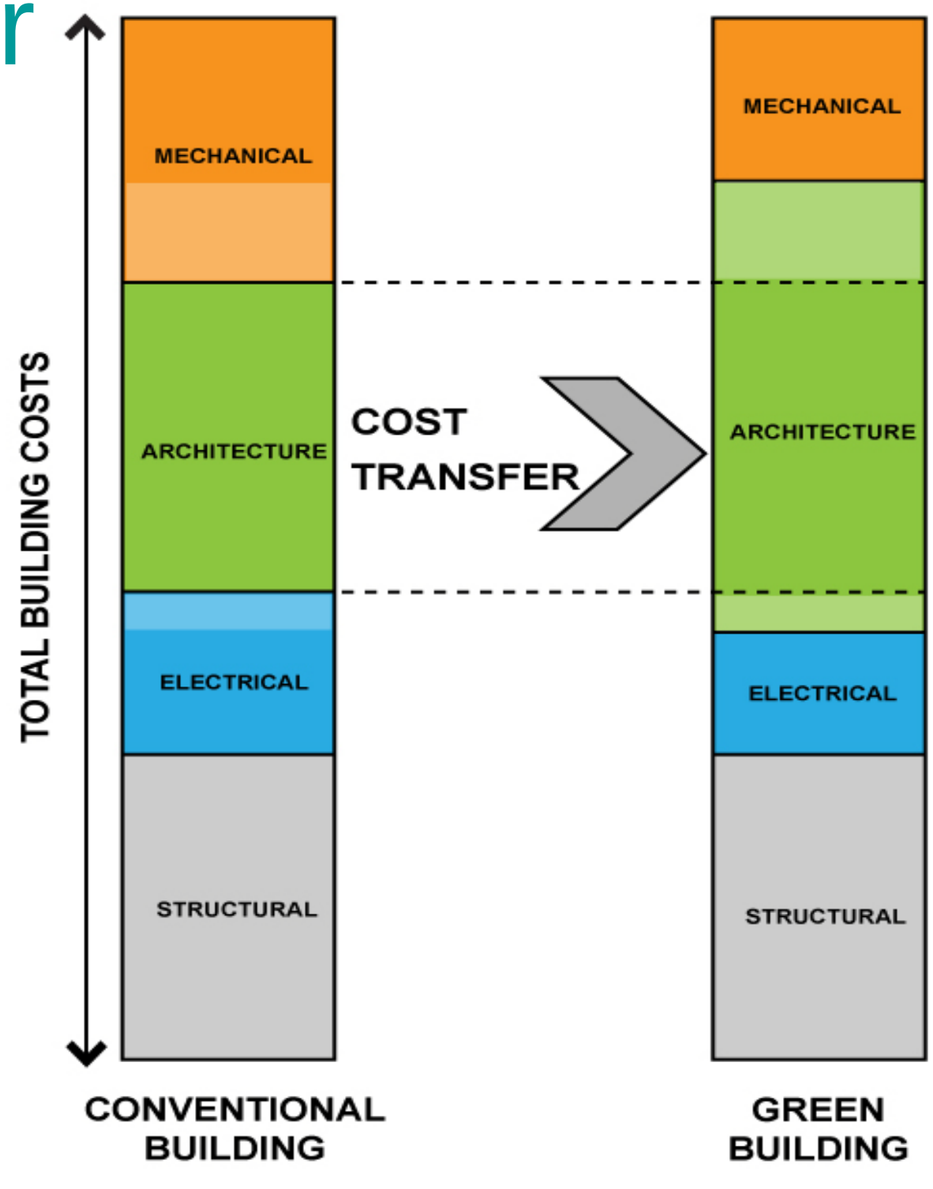
Energy driven form
145,000 SF



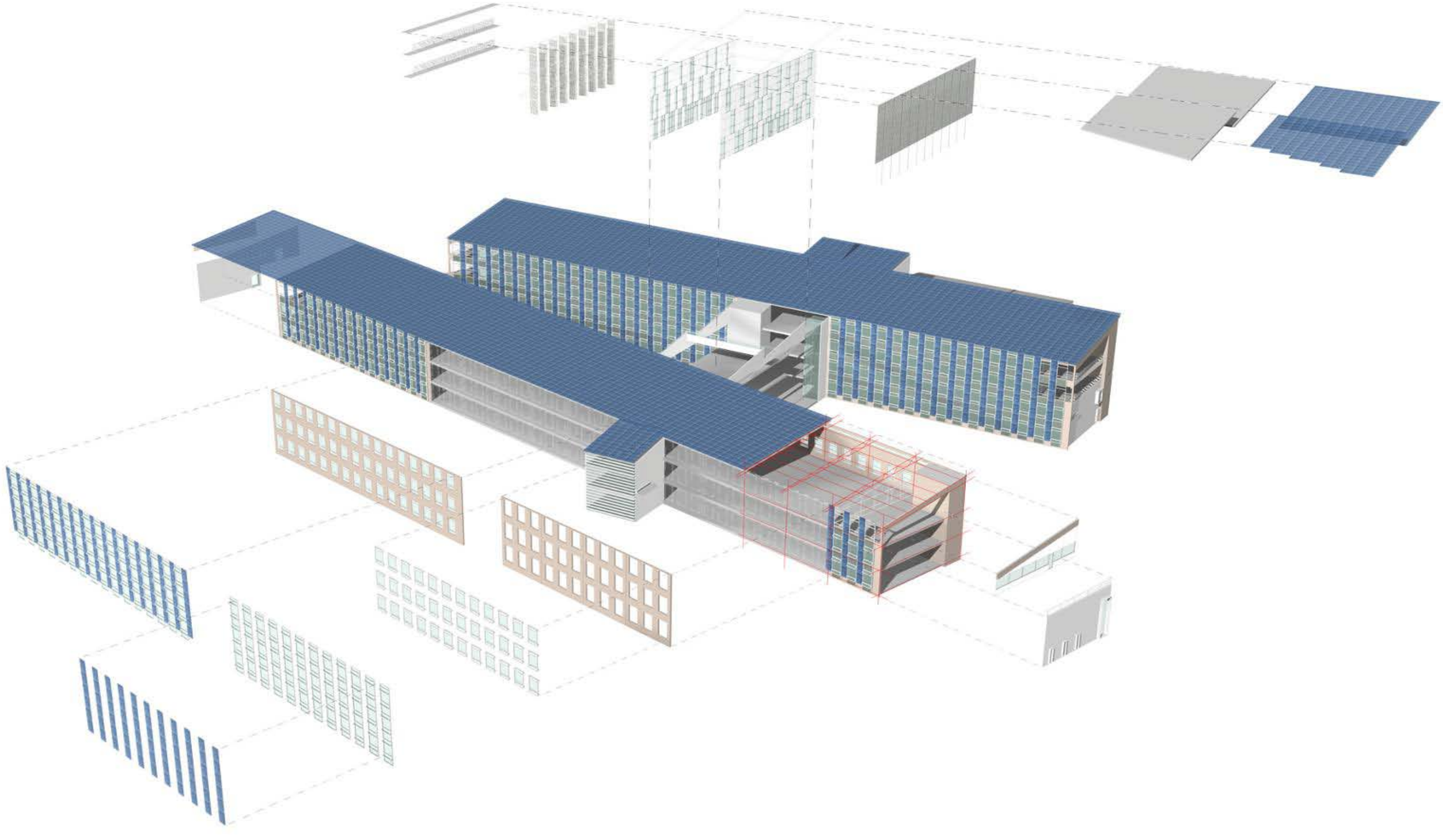
Conventional form
65,000 SF

Integrated Design

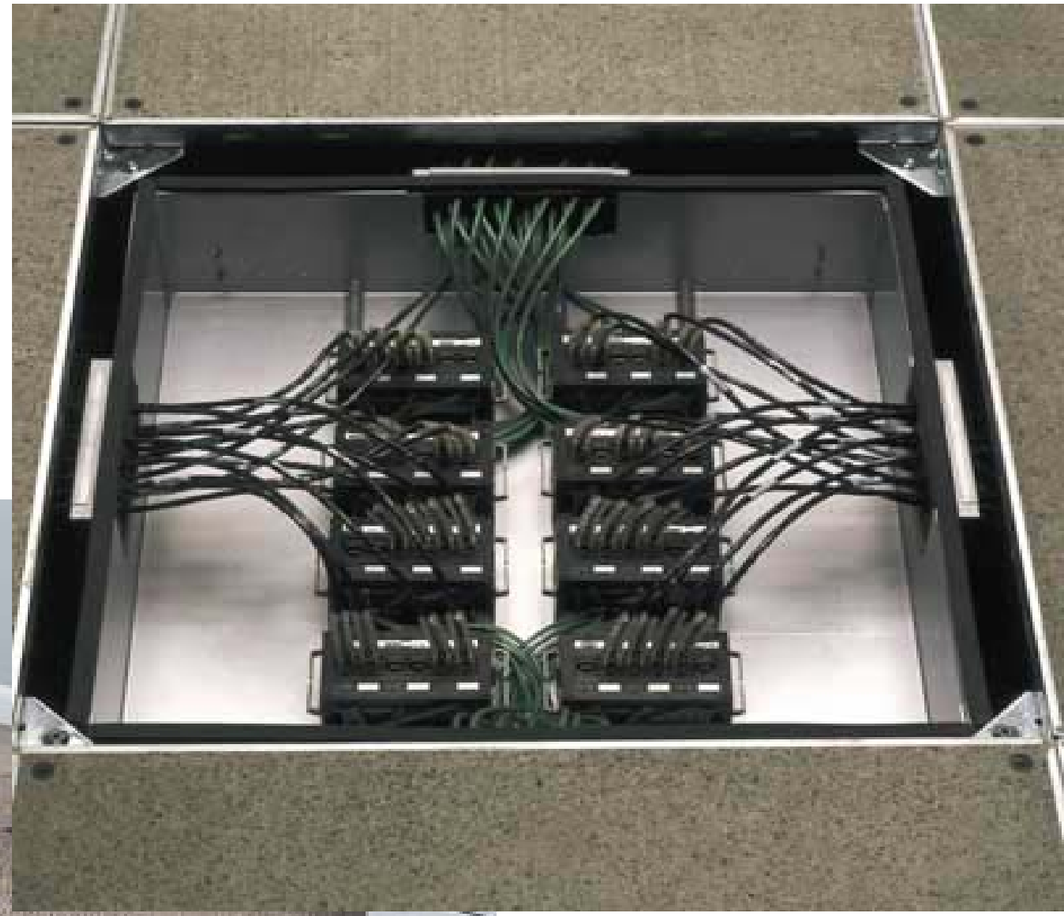
Cost Transfer



Cost / Construction – Modularity



Cost / Construction – Modularity

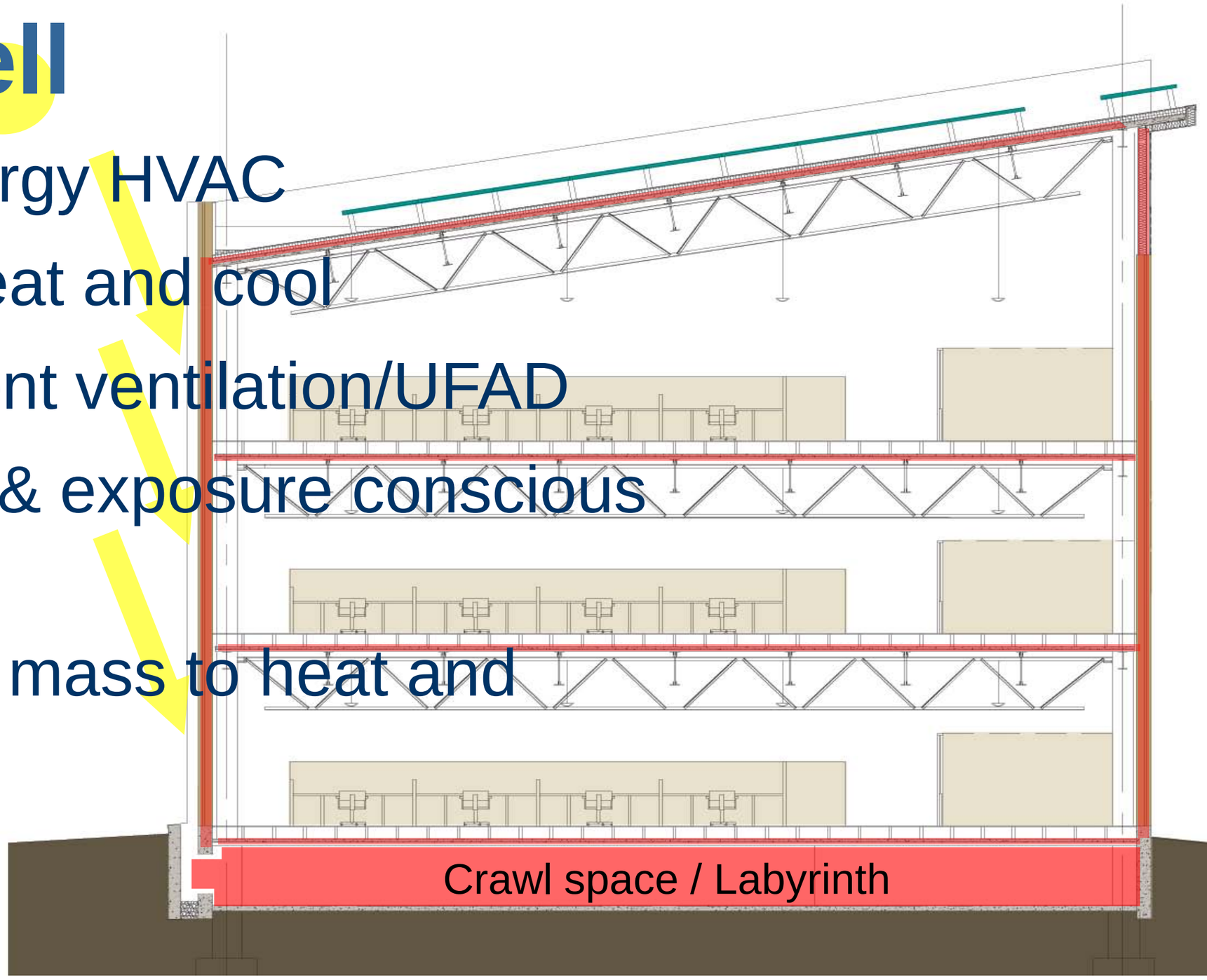


Replicable - Cost

- $54.5 Million construction cost
- Excludes site work
- Includes interiors including furniture
- 218,000 SF
- $250 / SF

The Moves – changing the Core/Shell

- Use low energy HVAC
  - Hydronic heat and cool
  - Displacement ventilation/UFAD
- Use climate & exposure conscious glazing
- Use thermal mass to heat and cool



The Moves – changing the Core/Shell – even more

- Operable windows (!) to support night cooling.
- Low energy Data Centers
- Bias toward south/north exposure

The Moves – changing the interior

- More open interior design – design for daylighting and natural ventilation
- In-board offices & modest pa heights
- Minimize the use of ceilings
- Material selections to enhanc daylighting

What we're hoping for

- Higher performing and lower cost photo-voltaic panels
- Cost neutral electro-chromic glass
- A building envelope as good as a leaf (!)

Problem Definition – Proposal Objectives Checklist

MISSION CRITICAL

Attain safe work performance/Safe Design Practices
LEED Platinum
Energy Star first “Plus”

HIGHLY DESIRABLE

800 staff Capacity
25kBTU/sf/year
Architectural integrity
Honor future staff needs
Measurable ASHRAE 90.1
Support culture and amenities
Expandable building
Ergonomics
Flexible workspace
Support future technologies
Documentation to produce a “How to” manual
“PR” campaign implemented in real-time
Allow secure collaboration with outsiders
Building information modeling
Substantial Completion by 2010

IF POSSIBLE

Net Zero/design approach
Most energy efficient building in the world
LEED Platinum Plus
ASHRAE 90.1 + 50%
Visual displays of current energy efficiency
Support public tours
Achieve national and global recognition and awards
Support personnel turnover

NREL Building Delivery & Real Estate

- Build to own
- DB Delivery
- Bldg. Orientation/Glazing Area
- Power Purchase Agreement

ZEB Definitions

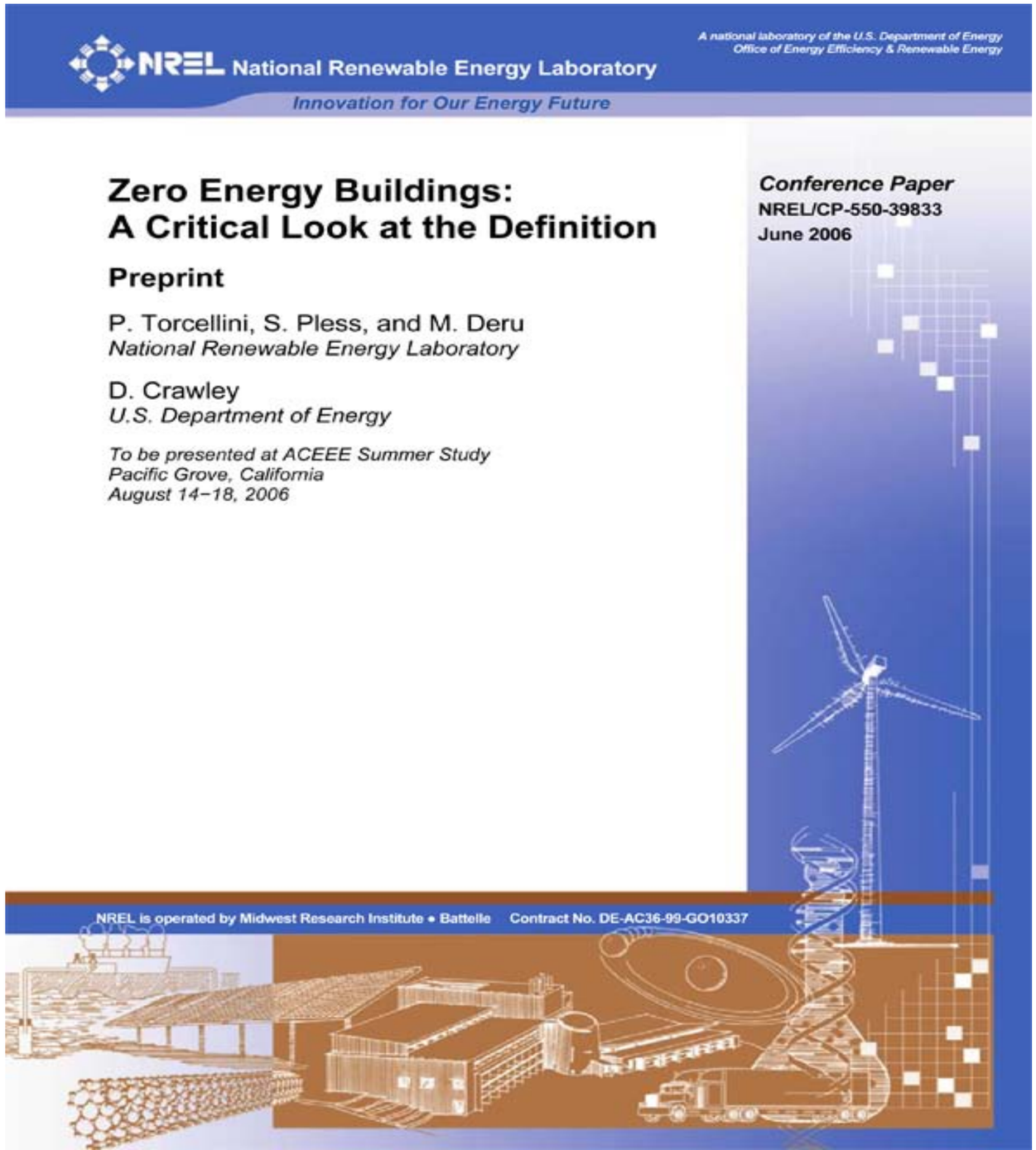
Net Zero Site Energy Building

Net Zero Source Energy Building

Net Zero Energy Cost Building

Net Zero Energy Emissions Building

ZEB Definitions



National Renewable Energy Laboratory

Innovation for Our Energy Future

A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

Zero Energy Buildings:
A Critical Look at the Definition

Preprint

P. Torcellini, S. Pless, and M. Deru
National Renewable Energy Laboratory

D. Crawley
U.S. Department of Energy

To be presented at ACEEE Summer Study
Pacific Grove, California
August 14–18, 2006

Conference Paper
NREL/CP-550-39833
June 2006

NREL is operated by Midwest Research Institute • Battelle Contract No. DE-AC36-99-GO10337

The Design-Build Team

Designer

RNL

Builder

Haselden Construction, LLC

MEP + Energy

Stantec

Daylighting + LEED

ARCHITECTURAL ENERGY CORPORATION
Integrated Engineered Solutions

Structural

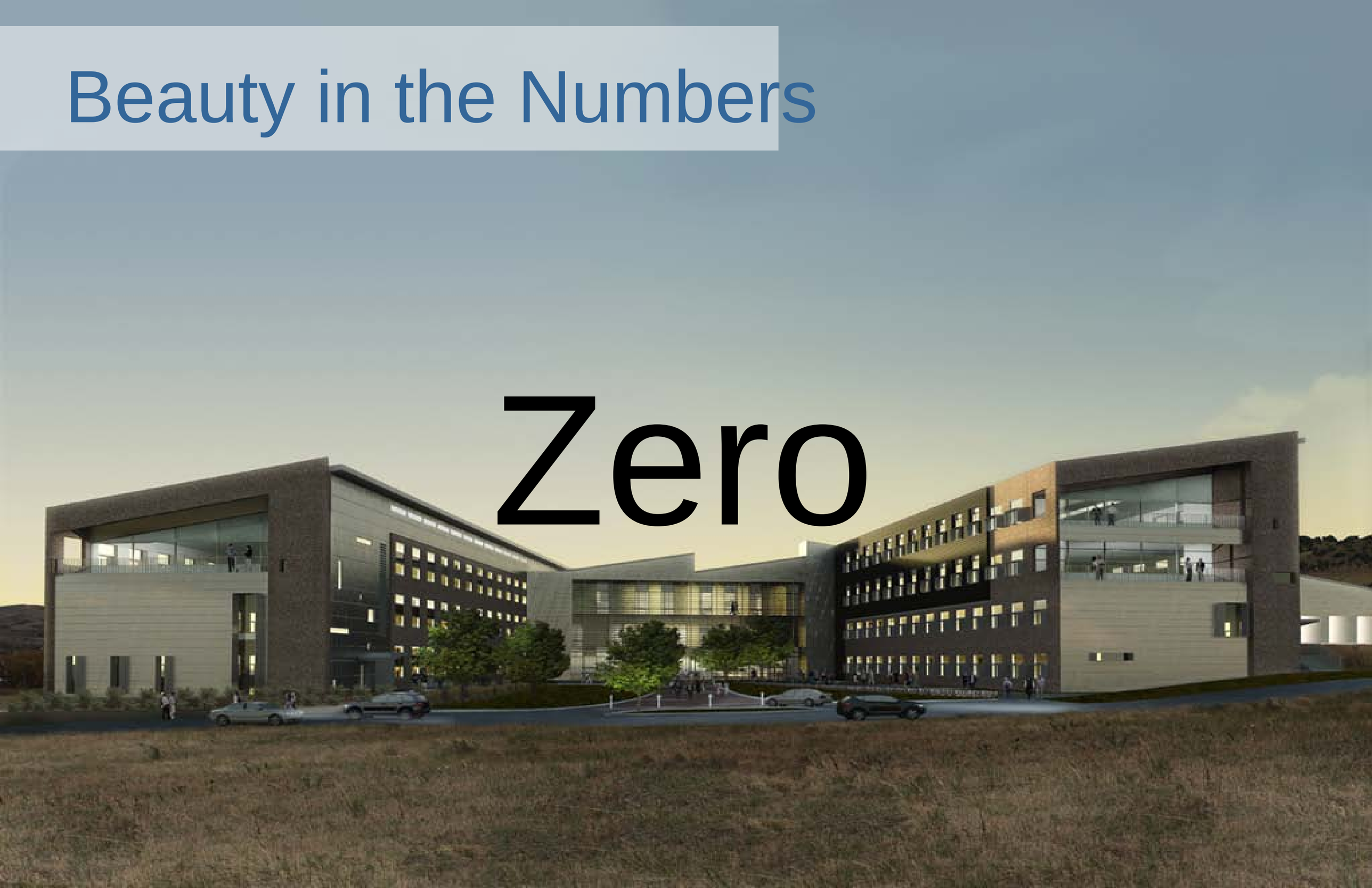
K L&A, Inc.

Civil

MARTIN / MARTIN
CONSULTING ENGINEERS

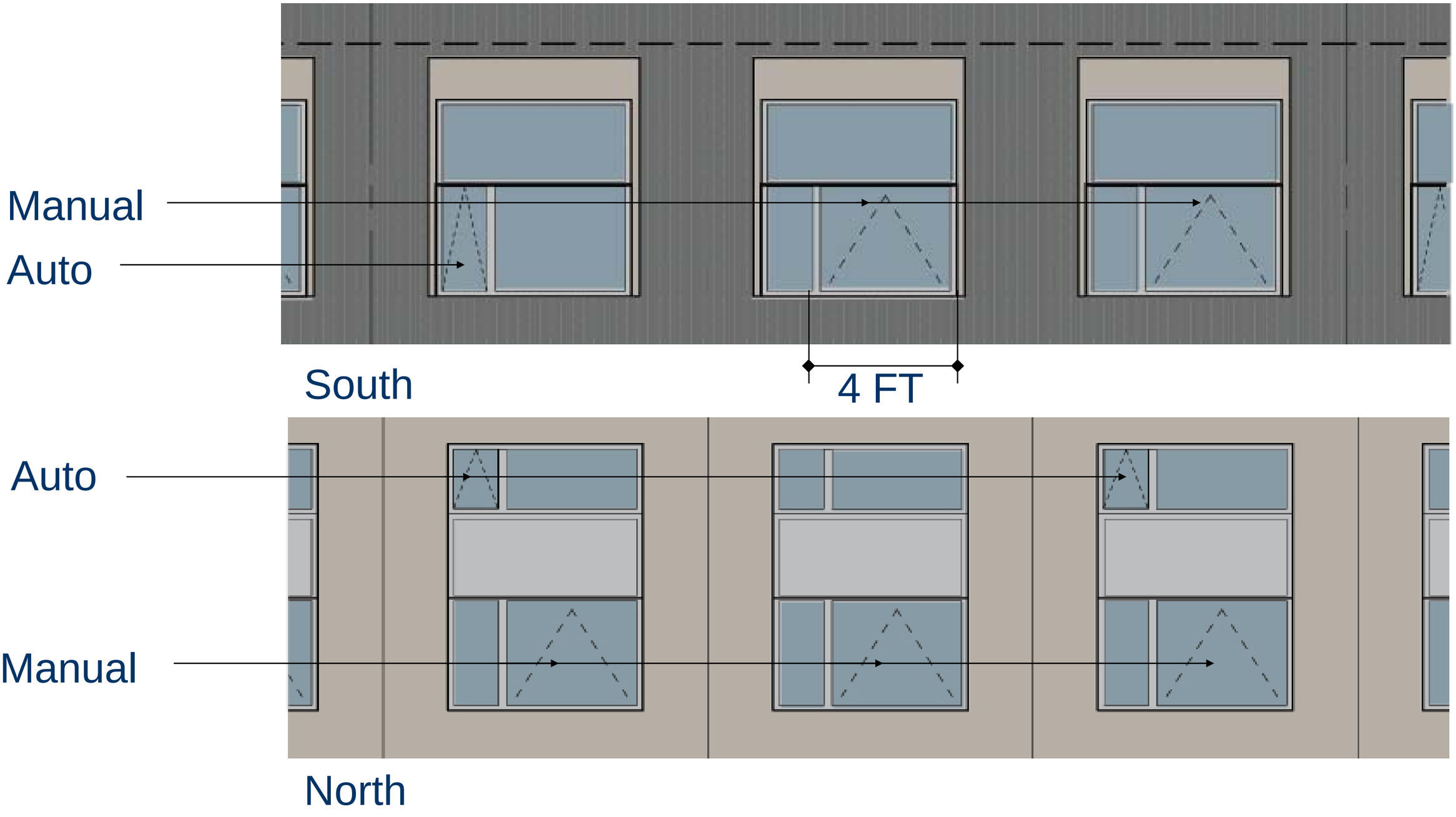
Beauty in the Numbers

Zero



Questions?

Natural Ventilation

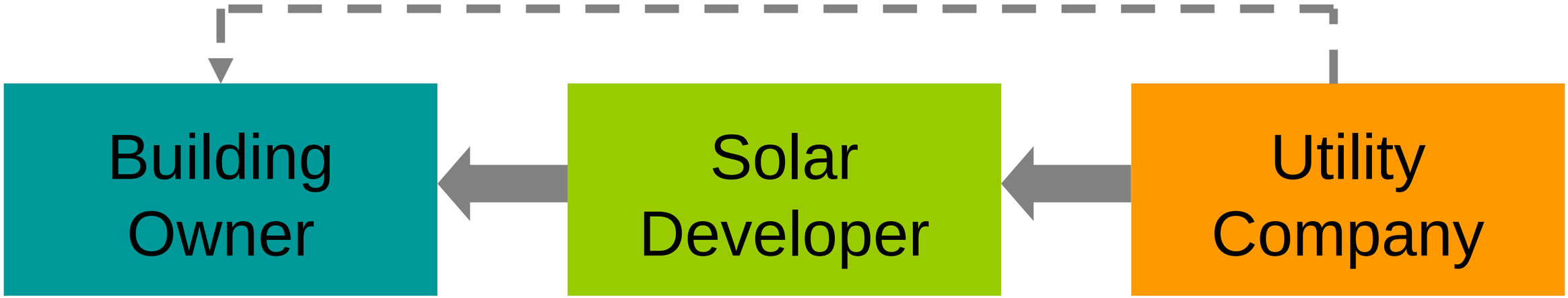


Photovoltaic System

787 KW

332 KW

Power Purchase Agreement (PPA)



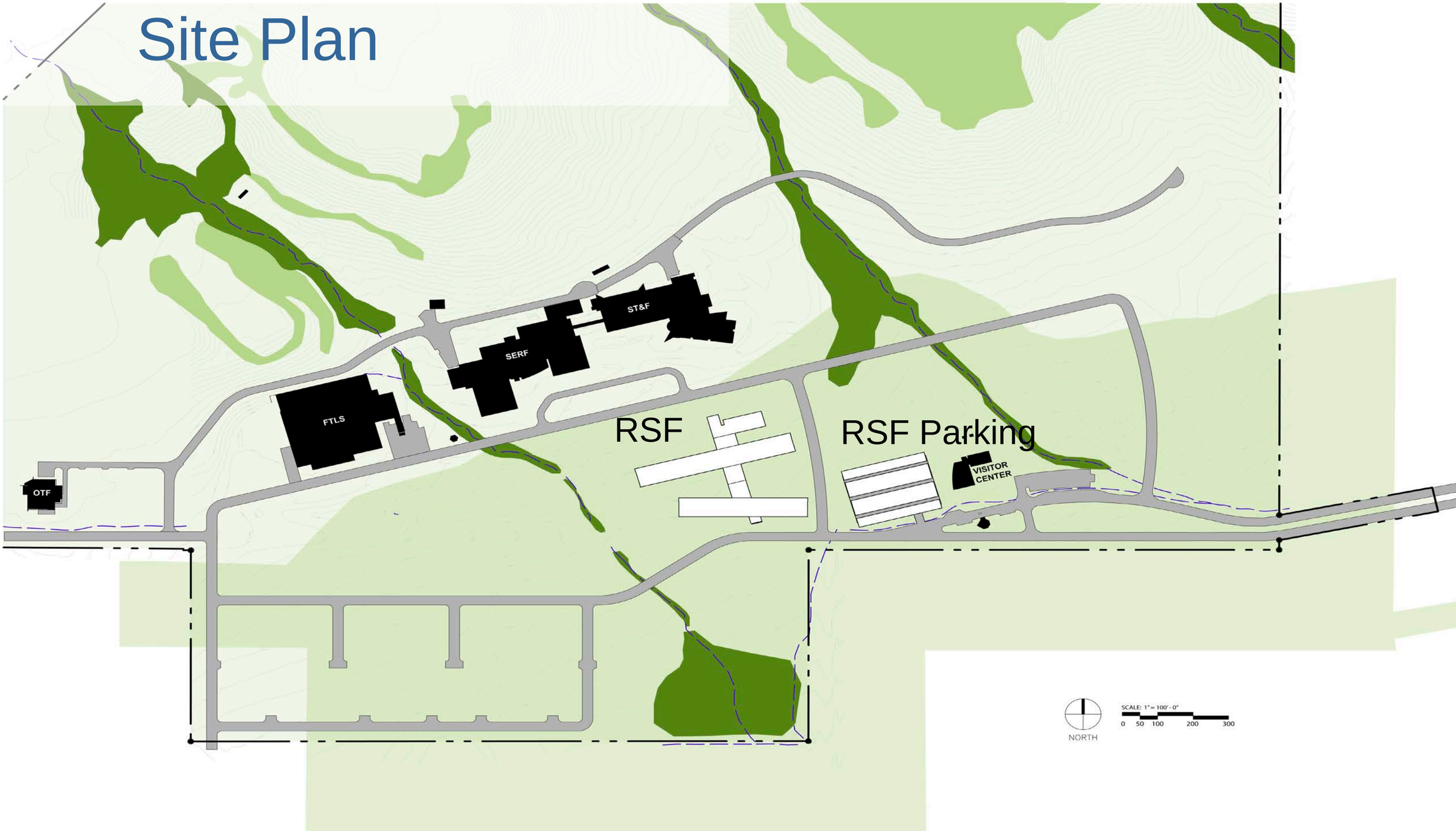
- Gets clean, renewable energy
- Gets a competitive long term power contract
- Provides roof or site area for PV

- Gets 30% Federal tax credit
- Gets Solar RECS from Utility
- Gets 20 year contract for power
- Installs and maintains equipment

- Gets to claim renewable energy toward renewable portfolio standard
- Provides net metering


RSF Project Site

Site Plan


ST&F
SERF
FTLS
OTF
RSF
RSF Parking
VISITOR CENTER
NORTH
SCALE: 1" = 100' - 0"
0 50 100 200 300

View looking from the Lunchroom into the West Courtyard

Indoor & Outdoor Café Space

Solar Parking Lots and Bio-swales

ZEB – RENEWABLE ENERGY

ZEB - CLASSIFICATIONS

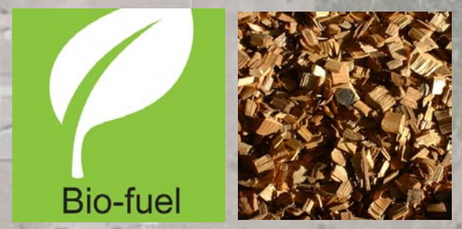
AA	Off-grid
A+	Low-energy building, 100% RE within building footprint
A	Low-energy building, >50% RE within building footprint, remainder RE within site
A-	Low-energy building, <50% RE within building footprint, remainder RE within site and campus
B+	Low-energy building, >50% RE within building footprint, site or campus, remainder RE off site

ZEB - CLASSIFICATIONS

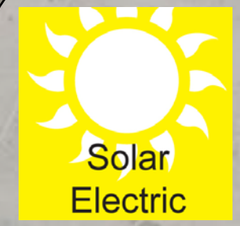
B	Low-energy building, <50% RE within building footprint and site, remainder RE off site
B-	Low-energy building, 100% RE off site
C+	Low-energy building, >50% RE within building footprint, site or campus, remainder green power
C	Low-energy building, <50% RE within building footprint, site or campus, remainder green power
C-	Purchase green power

SITE ZEB/B= -503

MBTU/yr



HEATING PLANT (WOOD CHIP)
1768
MBTU/YR



RSF ROOF
787 KW
3537
MBTU/YR

RSF PARKING
332 KW
1490

SOURCE ZEB/A493

MBTU/yr

Solar Electric

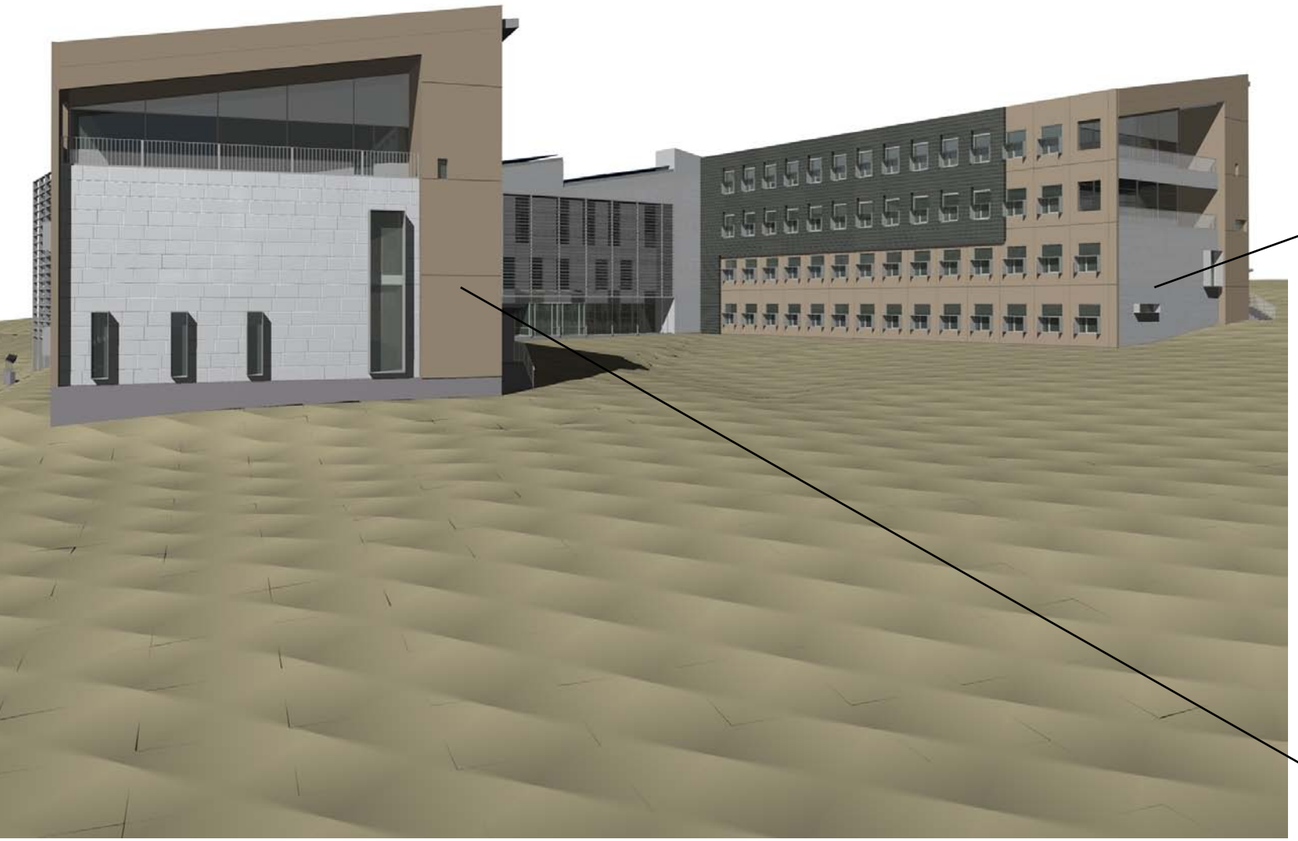
RSF ROOF
787 KW
3537
MBTU/YR

Solar Electric

RSF
PARKING
332 KW
1490

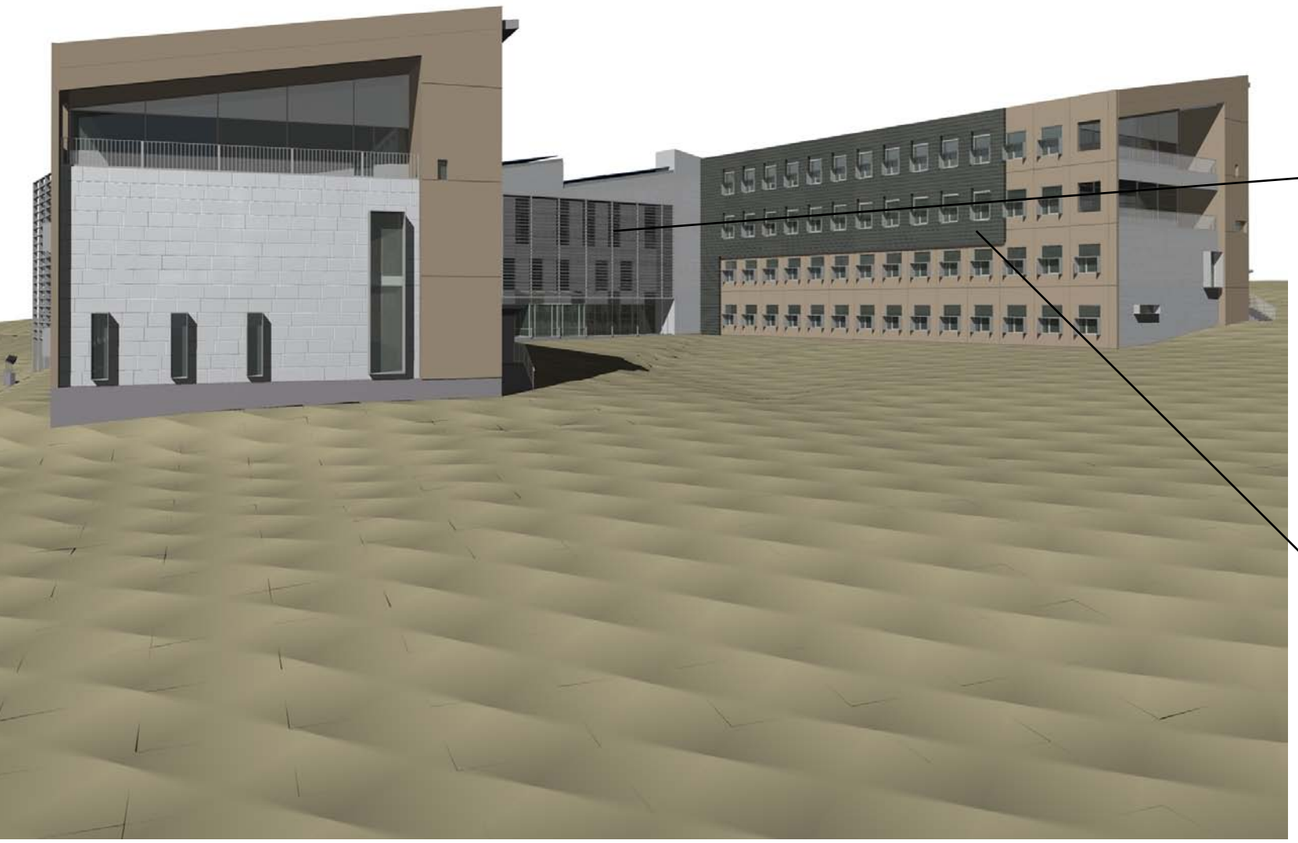
EMISSIONS ZEB/A = 383 Tons CO_2/yr

COST ZEB/~~A~~ -11,381 $/yr

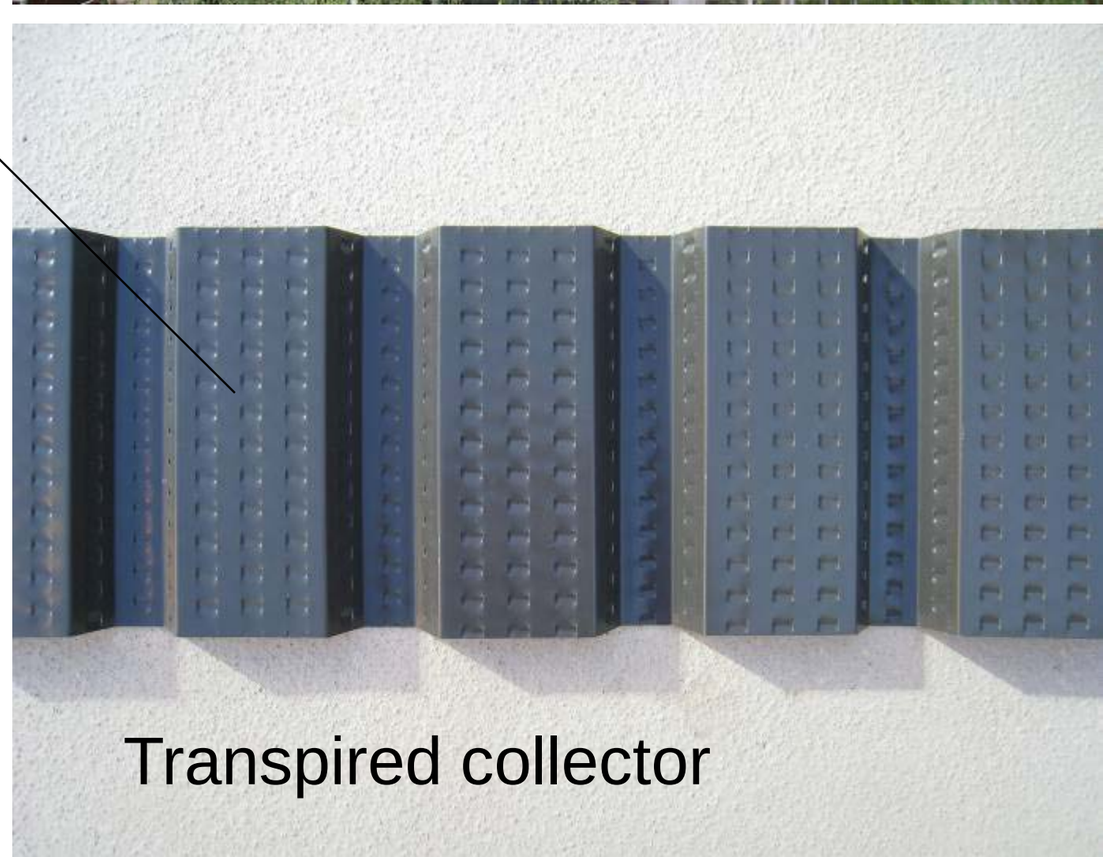



Zinc


Pre-cast Concrete




Sunscreen


Transpired collector

Integrated Design

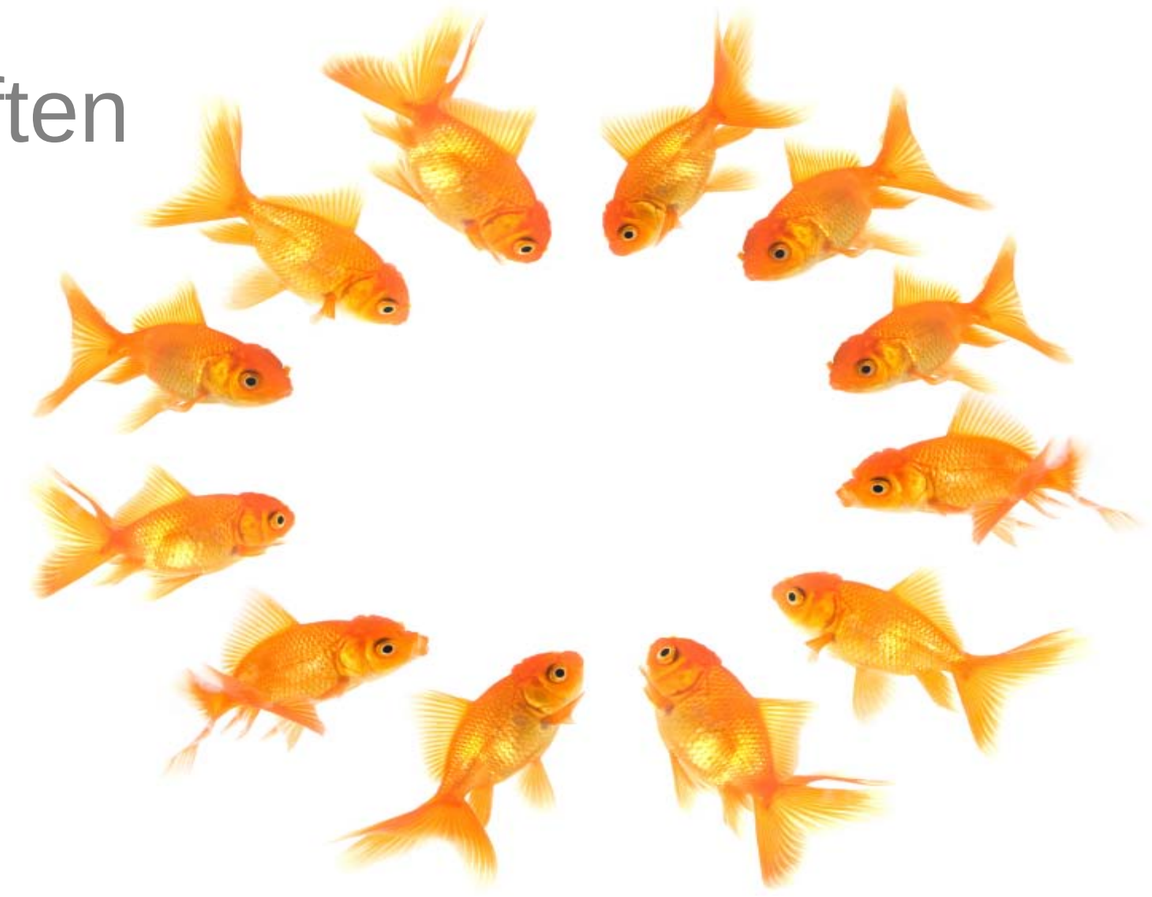
The Traditional Model is Fragmented!

- Separate disciples act in silos – over the wall approach
- Hierarchal organization
- Team is separated over time
- True cost identified late

Integrated Design

The Integrated Model is Multidisciplinary!

- Collaboration among disciplines
- Flat networks and alliances
- Team begins together
- Cost identified early and often

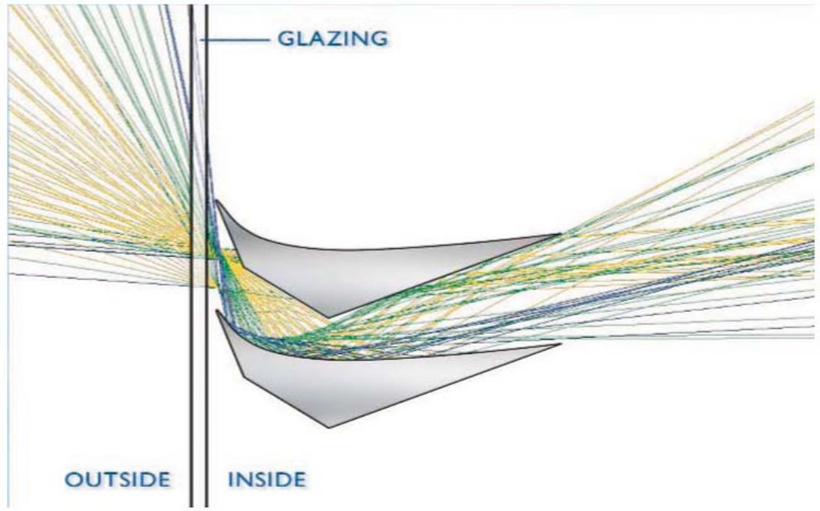


Integrated Design

An Integrated Start

- Set project and sustainability goals and performance targets
- Eco-charrette – integrate energy/form/site/program
- Brainstorming – think: big, elegant, simple; follow nature
- Research – take the time to identify the issues and opportunities

Daylighting



Glare Control + View Window

Daylight Control + Daylight Window

Daylight Enhancement