LITTLE DIPPER ELEMENTARY
AN INTERACTIVE CLIMATE EXPLORATORIUM

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UNIVERSITY OF OREGON TEAM POLARIS

Fig #1 : team photo

Fig #1 : team photo

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PRESENTATION OVERVIEW

STUDIO BEGINNINGS

CONSTRAINTS & OPPORTUNITIES

BIG QUESTIONS

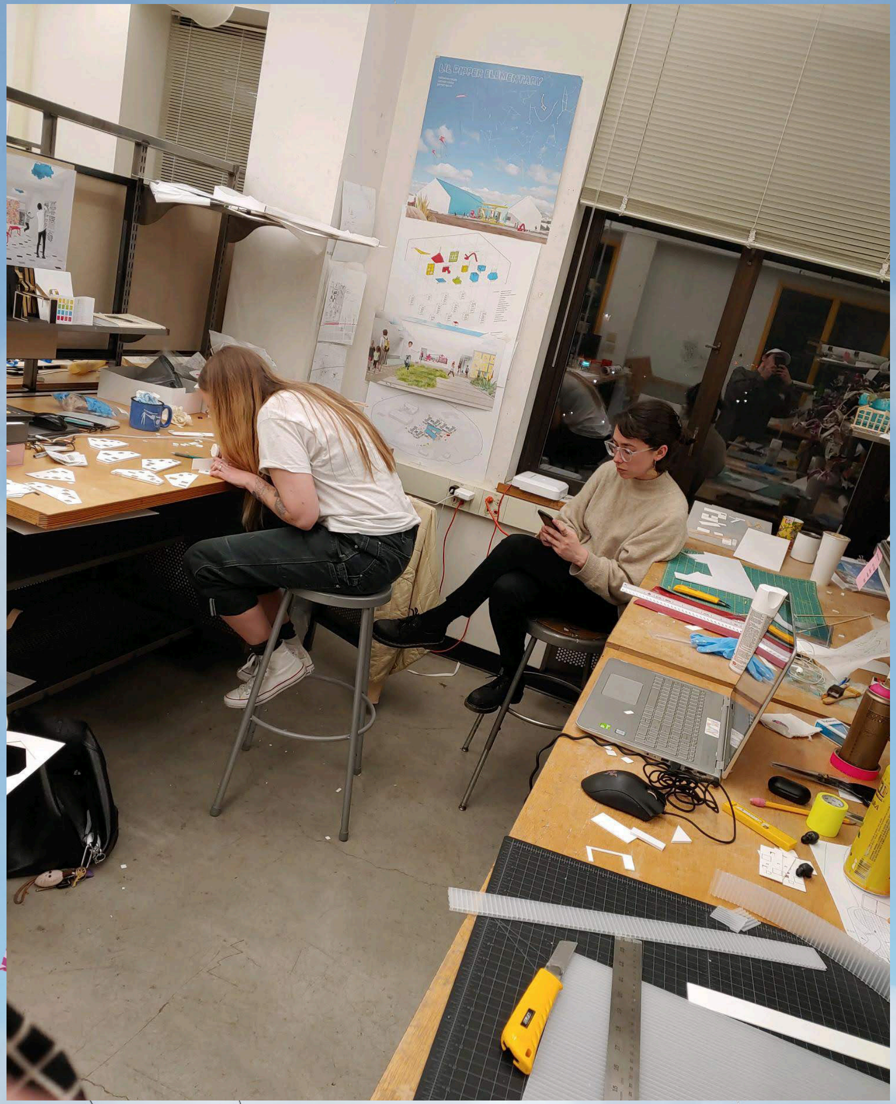
GOALS & GUIDELINES

DECATHLON CONTESTS

REFLECTION

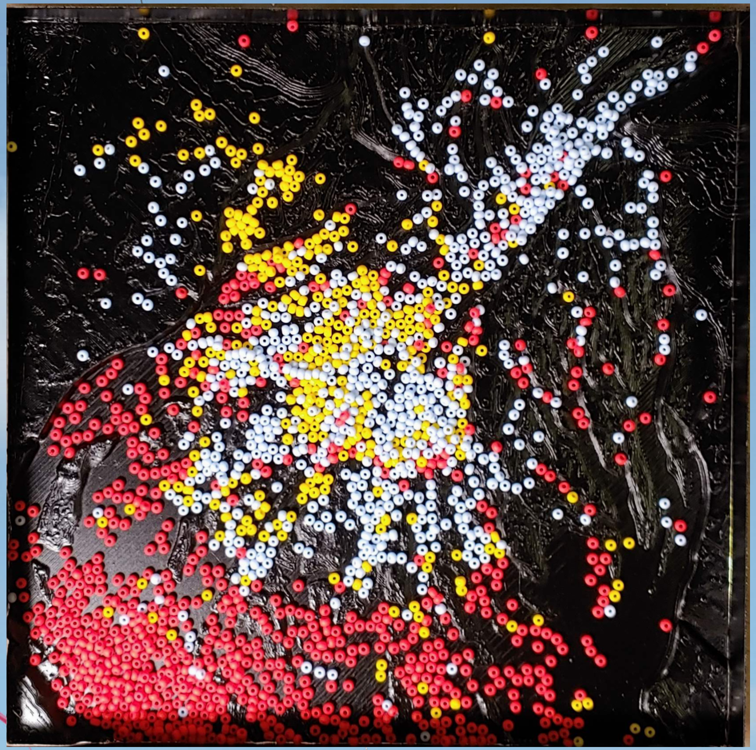
CONCLUSION

UNIVERSITY OF OREGON TEAM POLARIS



UNIVERSITY OF OREGON

TEAM POLARIS



INTRODUCTION

- Constraints & Opportunities
- Big Questions
- Strategy Overview
- Design Goals & Guidelines

COUNTRIES

Fig #7 : neighborhood relationships

CLIMATE (ZONE 3B)

ANNUAL AVERAGES

mean temp	63 F°
design high	100 F°
design low	18 F°
precipitation	16"
humidity	69%
wind	15 mph
snowfall	0"
precipitation days	42 days
hours of sunshine	1000 hrs
heating degree days	2275
cooling degree days	939

Table #4 : climate averages

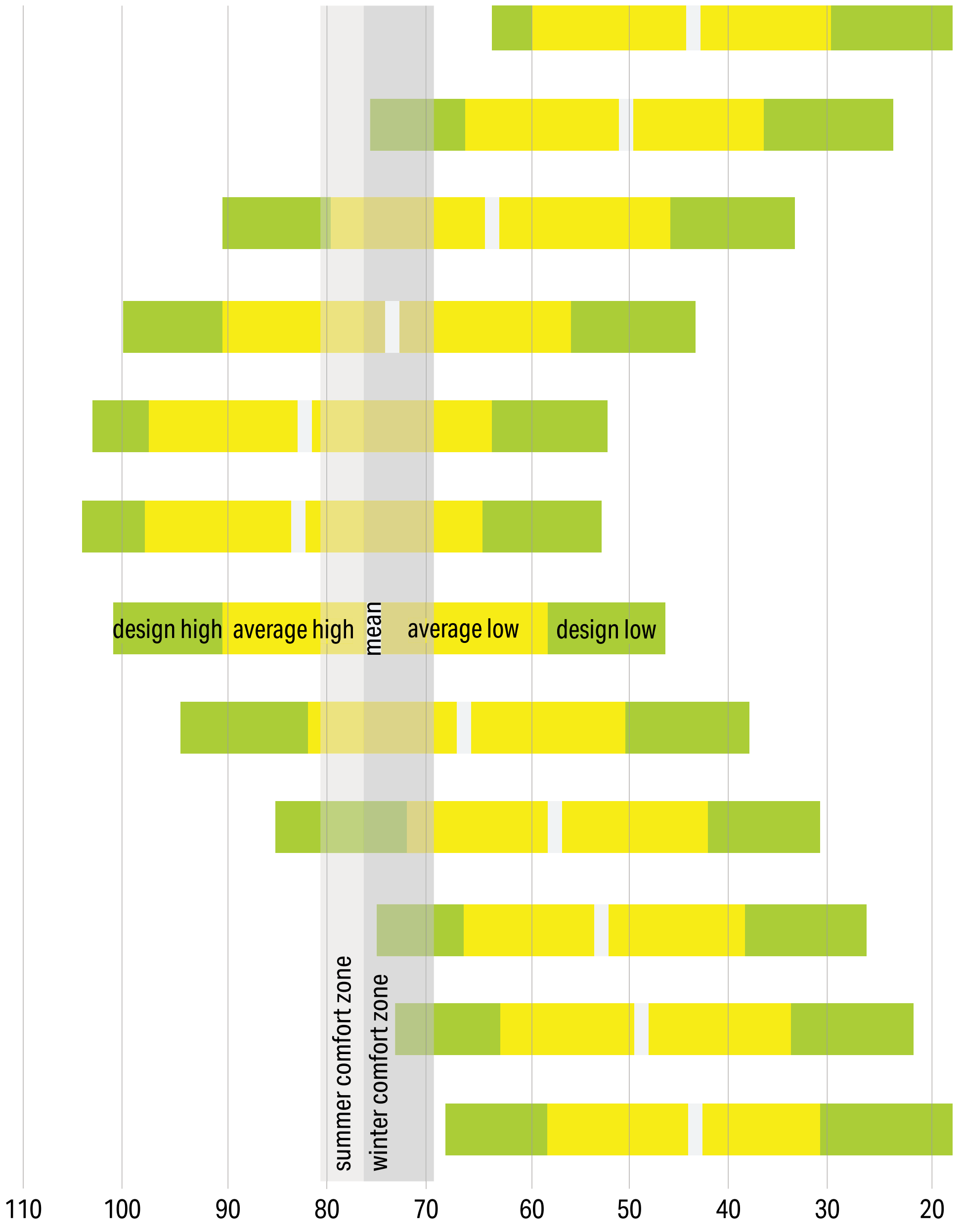
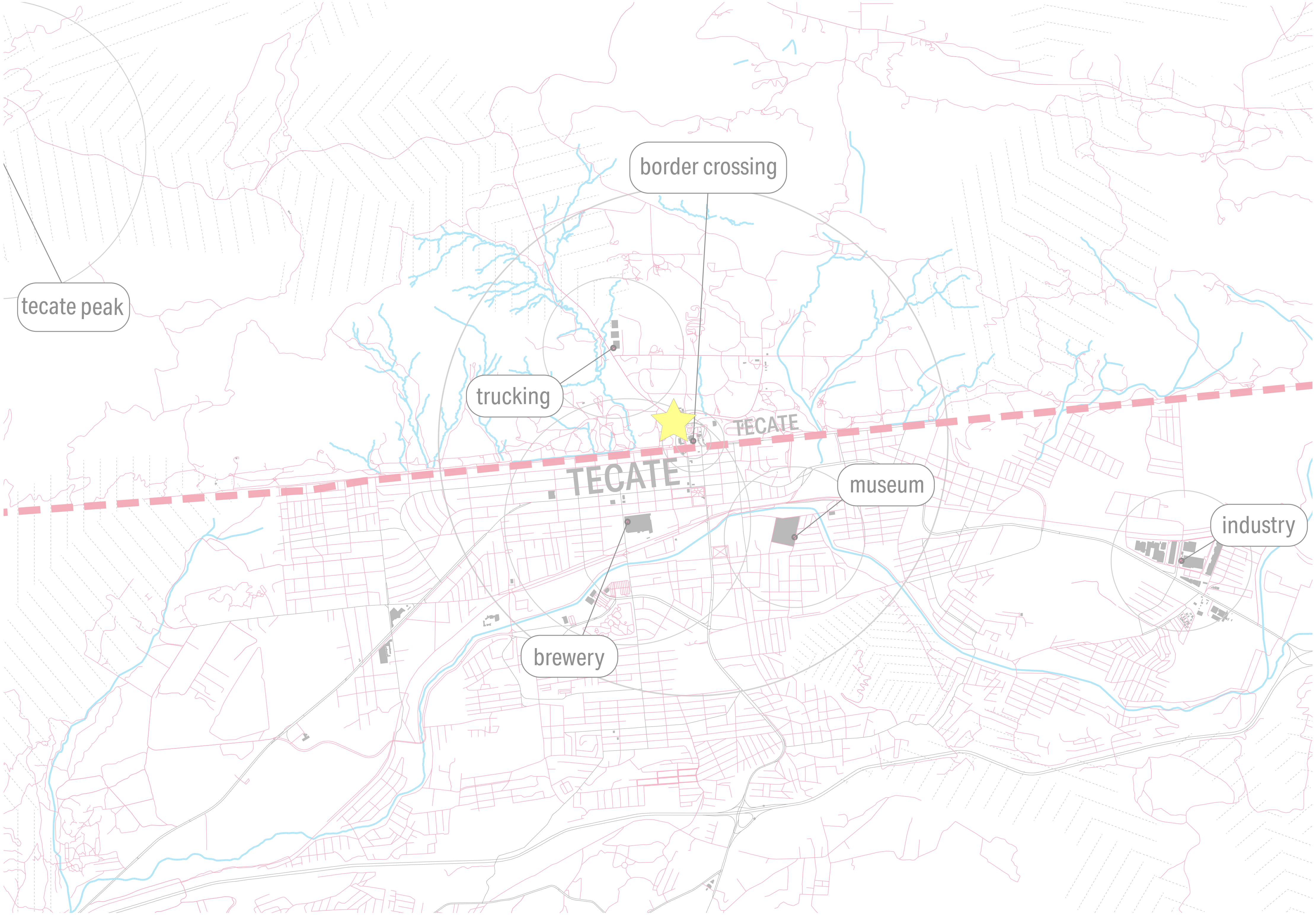


Table #5 : temperature range

SATALLITE


border crossing
tecate peak
trucking
TECATE
TECATE
museum
industry
brewery

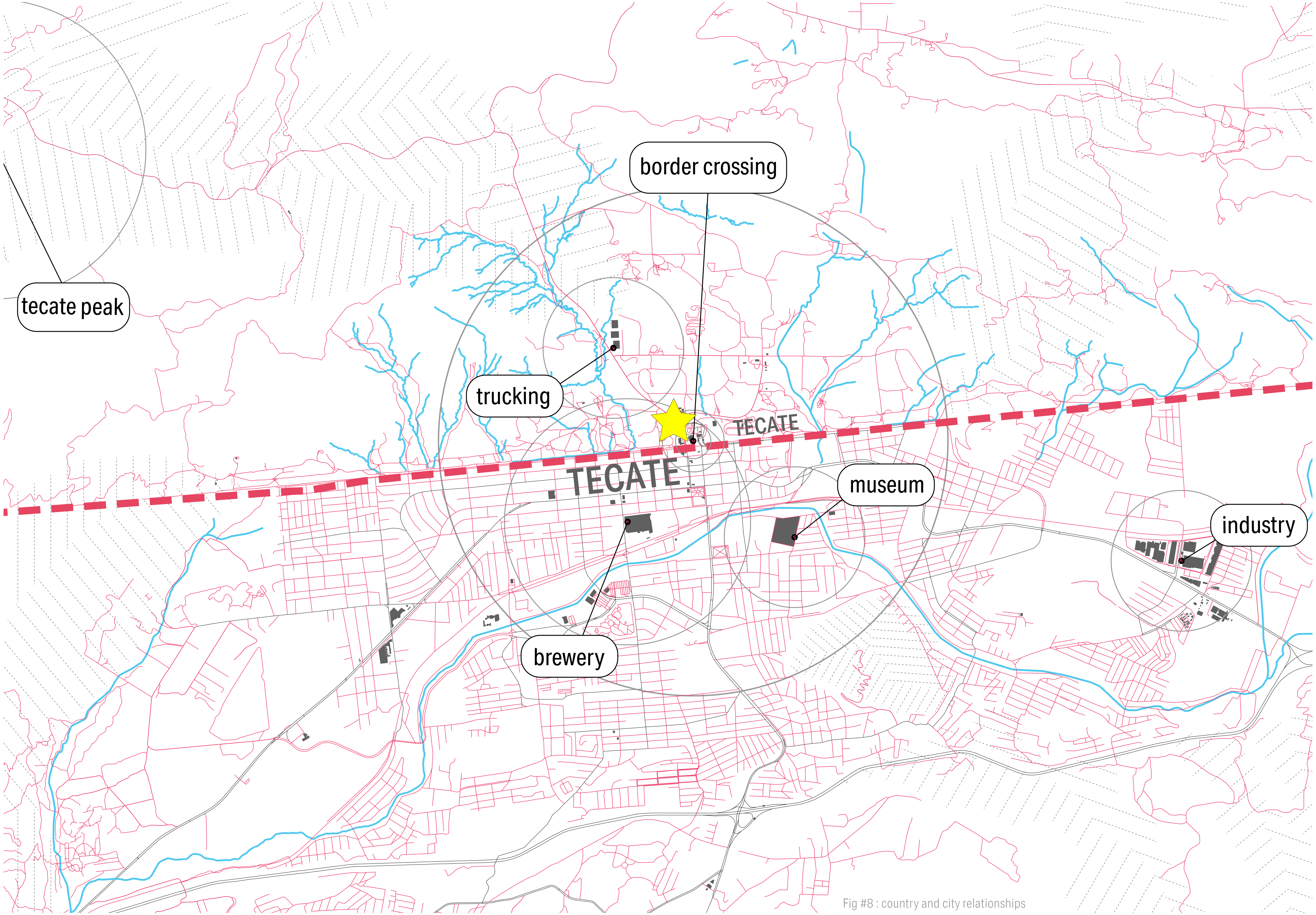


Fig #8 : country and city relationships

PEOPLE

Fig #9 : artwork on Tecate border by JR

Fig #10 : satellite view Tecate, U.S....

Fig #11 : satellite view Tecate, Mexico

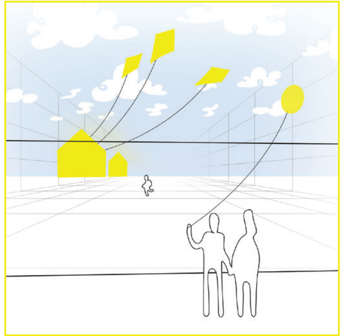


Fig #4: inhabitable threshold

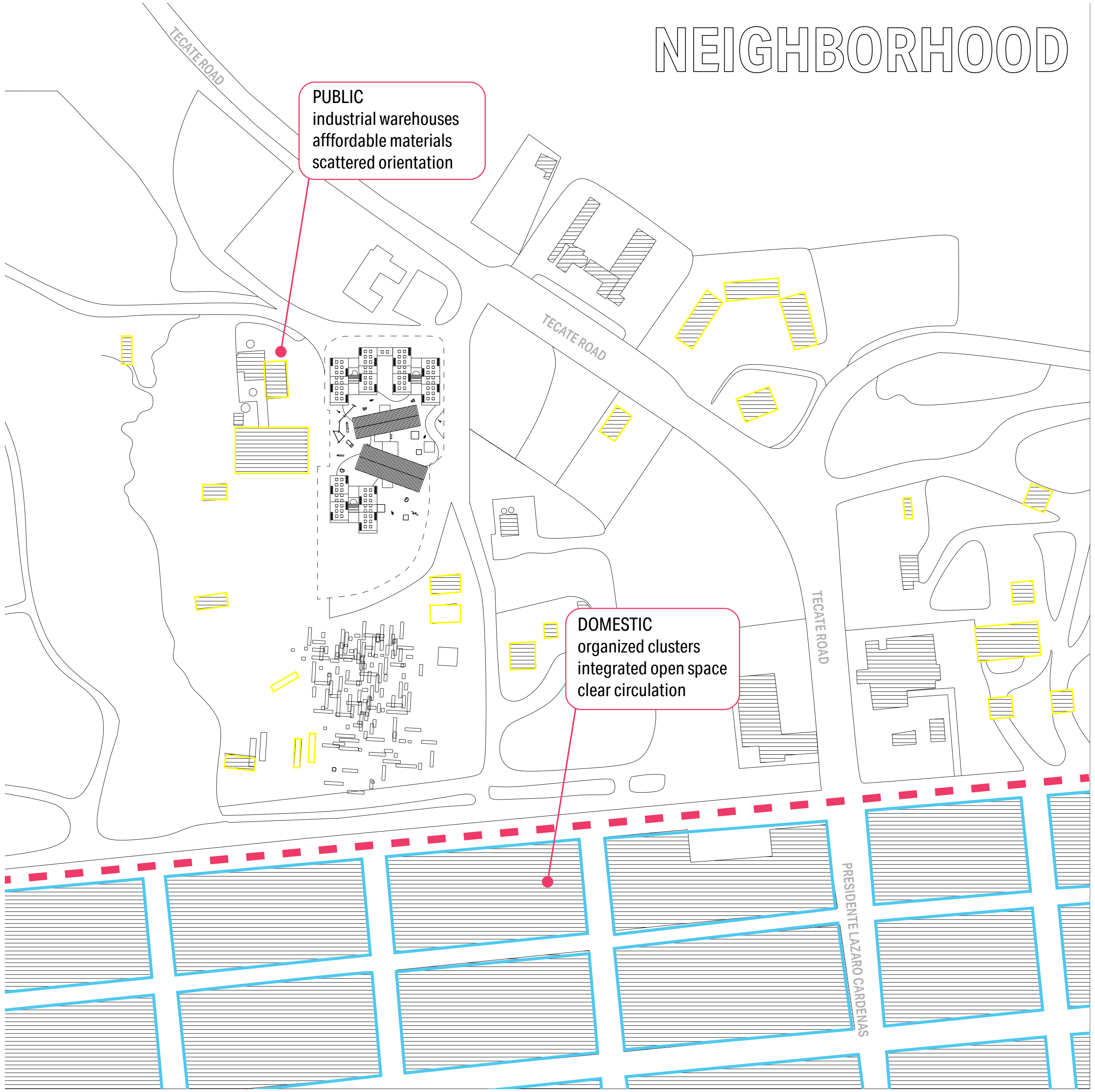
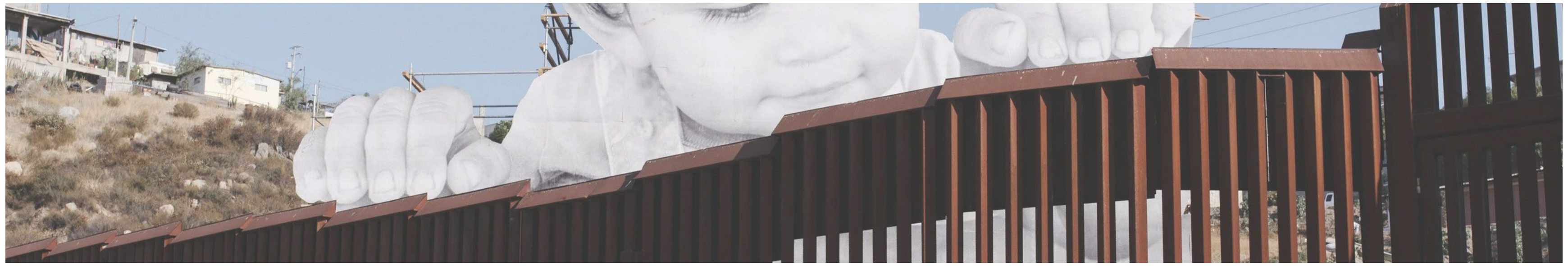
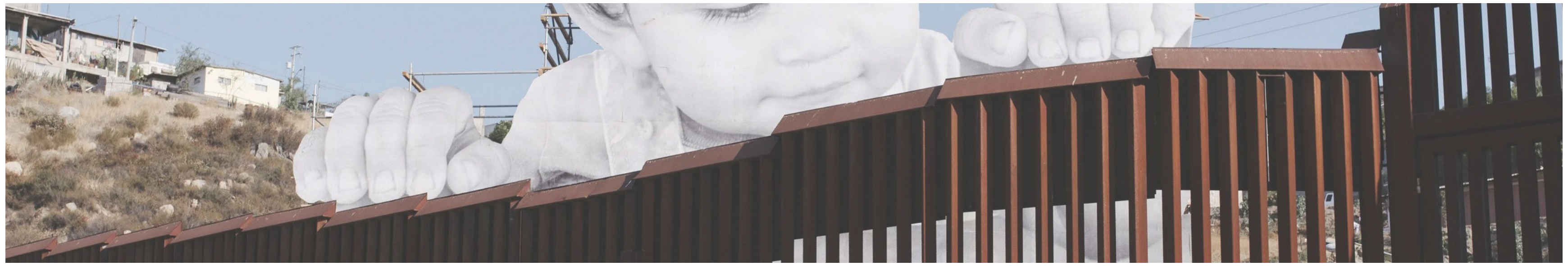
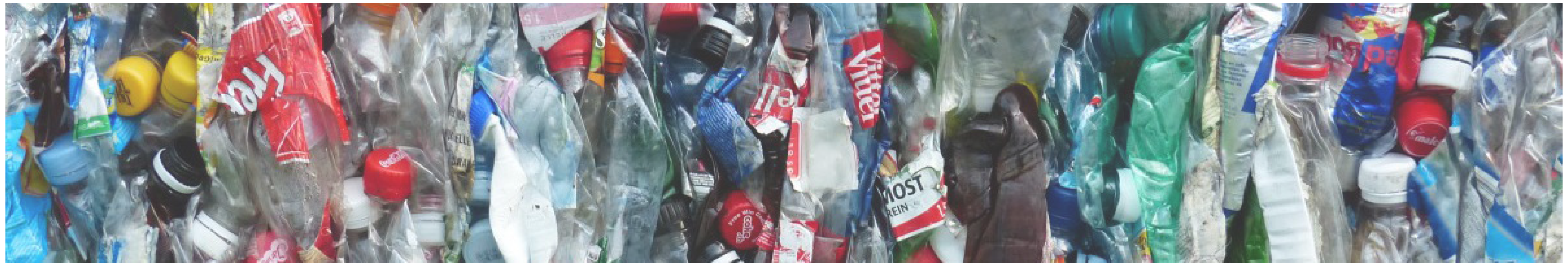


Fig #12 : neighborhood relationships







HOW CAN WE TEACH CHILDREN ABOUT GLOBAL CHALLENGES ?

HOW CAN DESIGN TEACH CHILDREN ABOUT GLOBAL CHALLENGES ?

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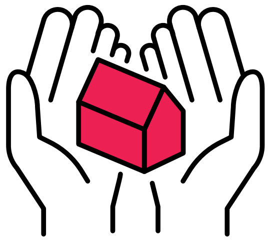
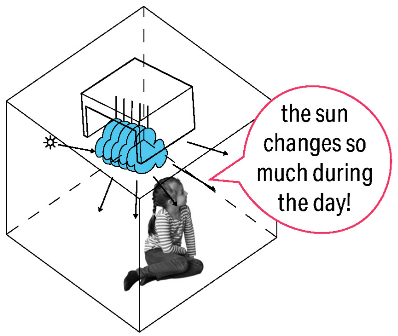
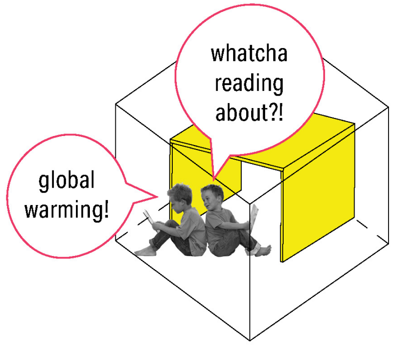
WHAT IF WE BREAK DOWN GLOBAL CHALLENGES INTO "KID-SIZED" LEARNING MOMENTS ?

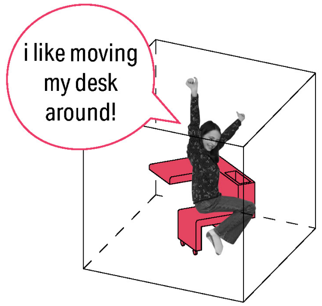


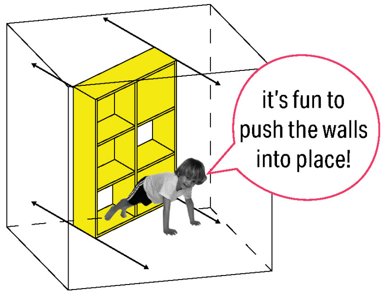
LEARNING MOMENTS ON A NEUTRAL FIELD

LEARNING MOMENTS









LEARNING MOMENTS TO CLASSROOM

CLASSROOM UNIT

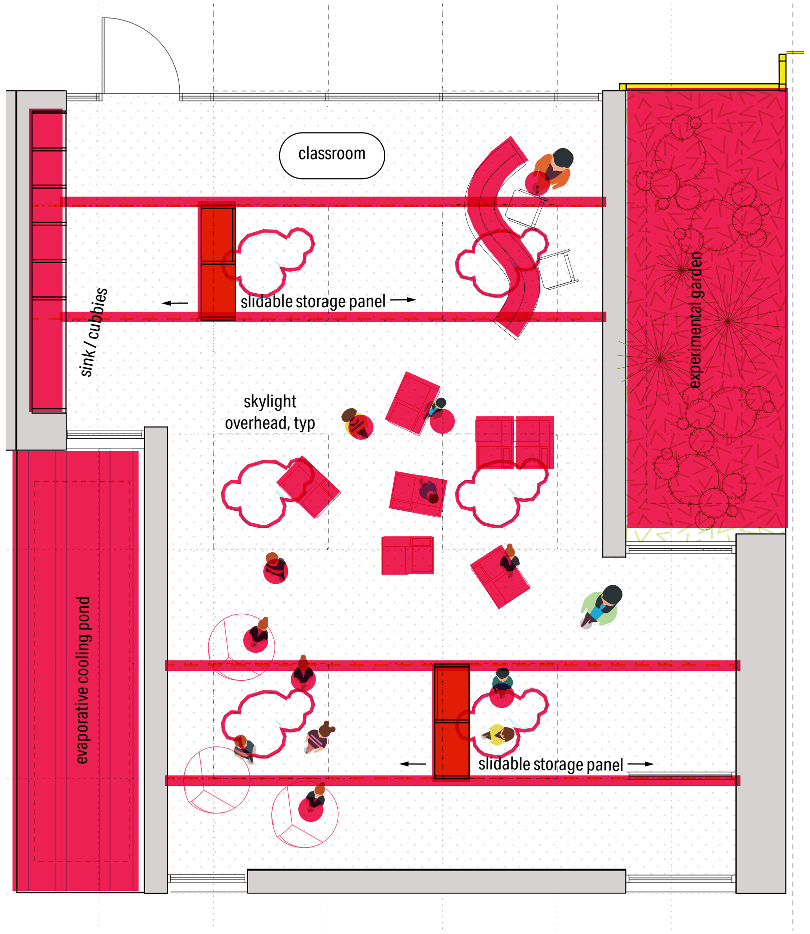


Fig #23 : relationships in the classroom unit

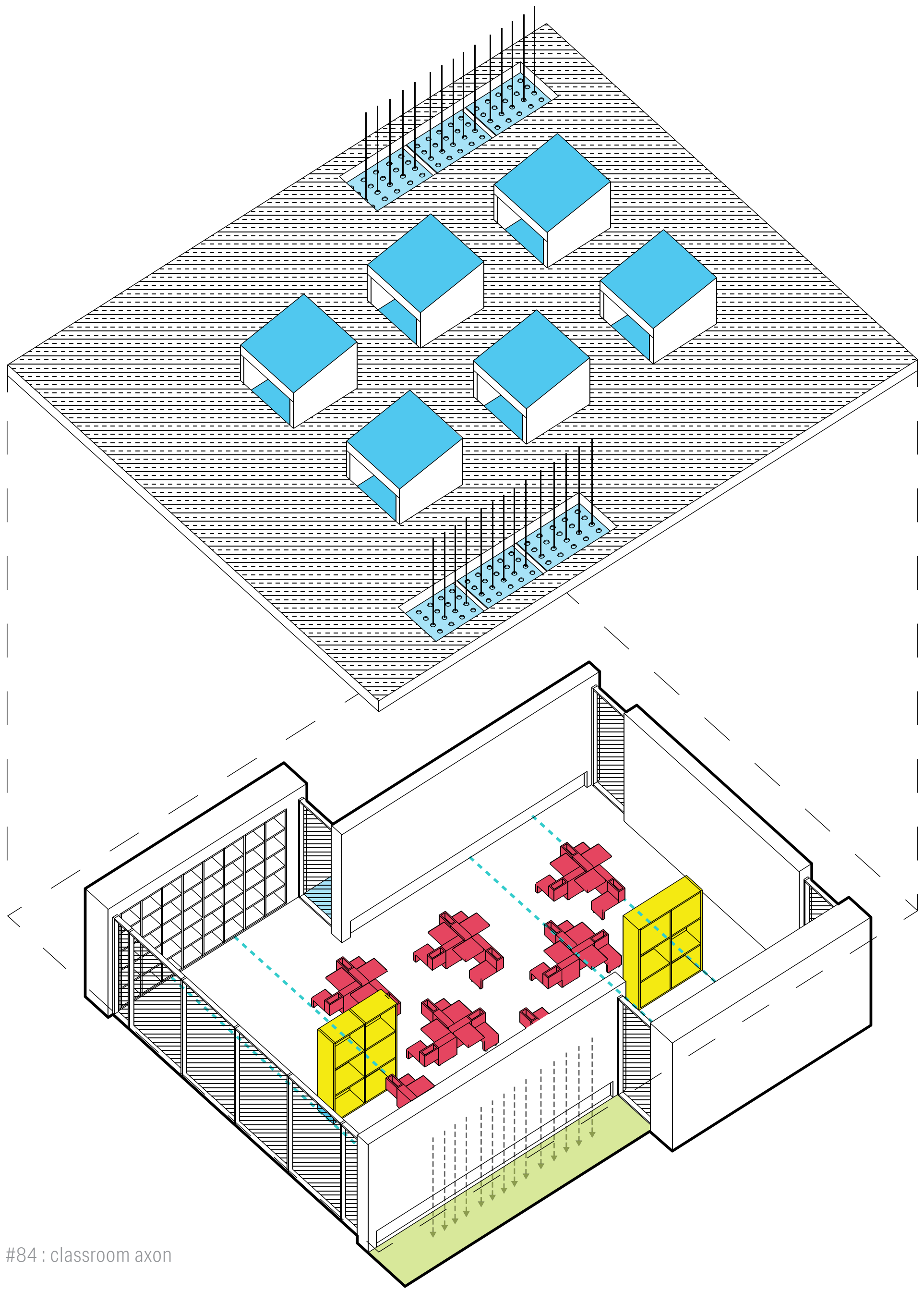


Fig #84 : classroom axon

INTERACTIVE SYSTEMS TO BUILDINGS

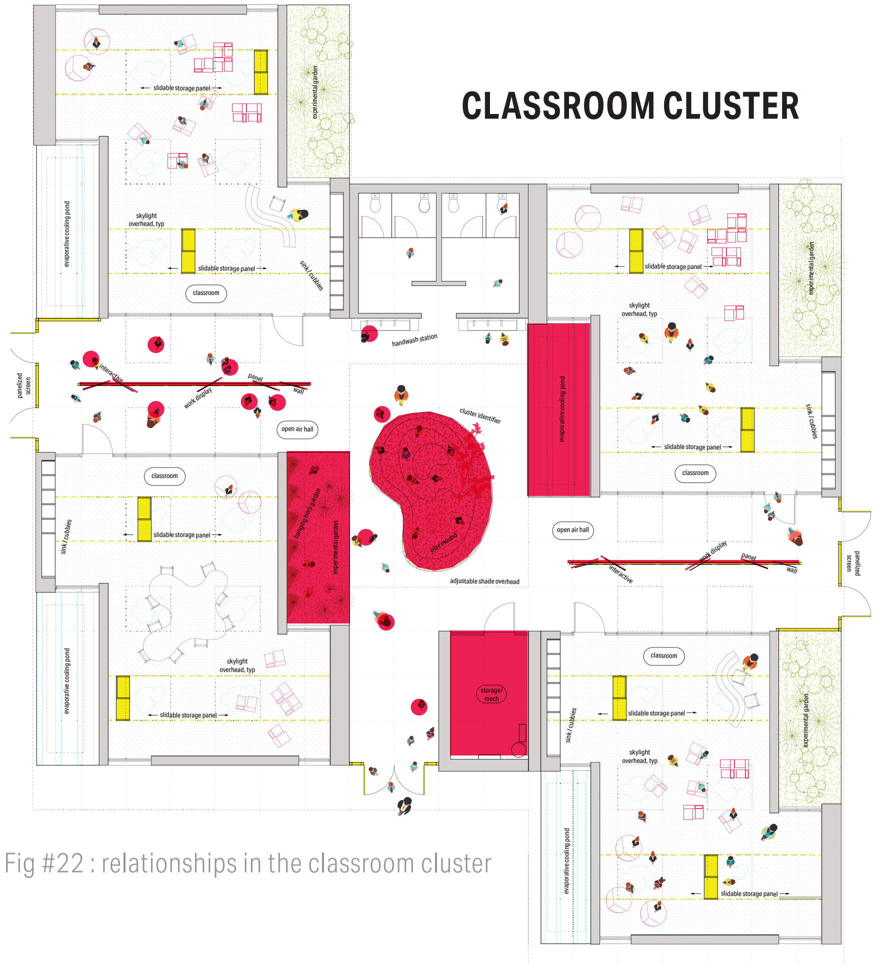


Fig #22 : relationships in the classroom cluster

BUILDINGS TO SITE

Fig #10 : satellite view Tecate, U.S.

Fig #11 : satellite view Tecate, Mexico

OVERALL SITE

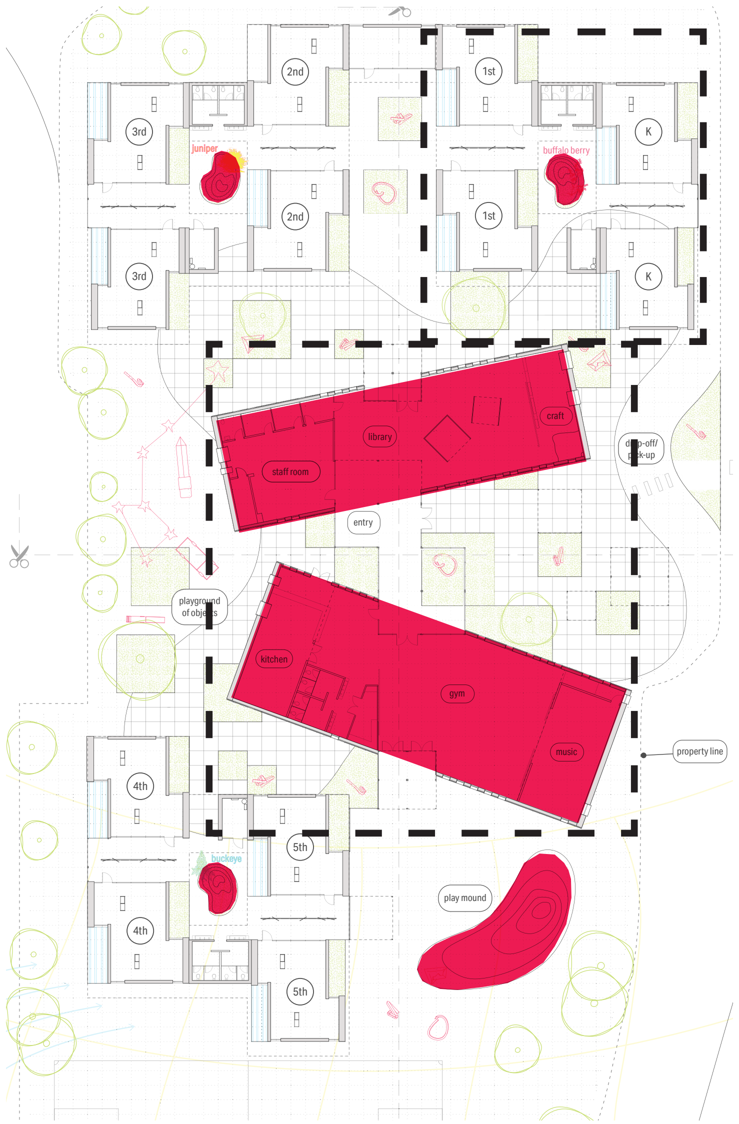


Fig #20 : relationships on the site

A KIT OF PARTS

Unboxing the pieces of a responsive architectural and conceptual system. The project is organized by this conceptual kit of parts.

SPECIMENS ON A FIELD

Like samples on a petri dish, students learn about passive climate systems, culture, and play through vibrant objects on a neutral field.

INTERACTIVE RELATIONSHIPS

Students take an active role in controlling their environment by interacting with educational elements.

RECIPROCAL ENERGY

KIDS AS STEWARDS

INHABITABLE THRESHOLD

EMERGENT PLAY

BEAUTY IS FOR EVERYONE

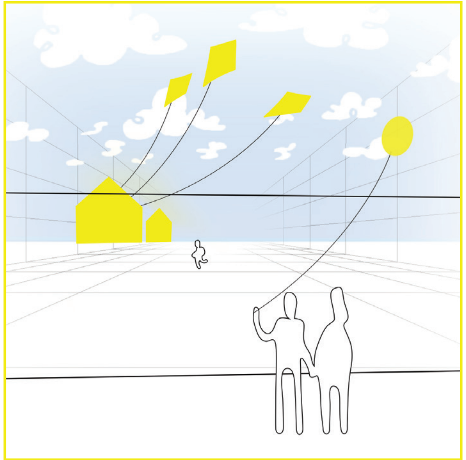


Fig #4 : inhabitable threshold

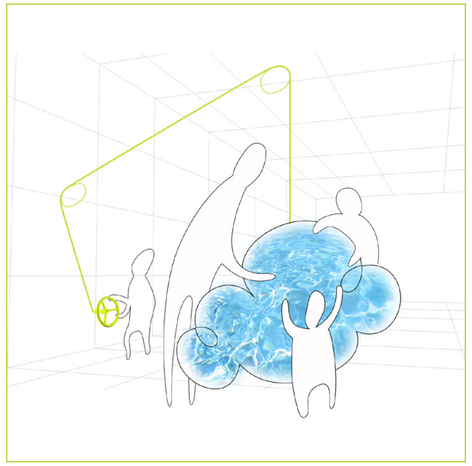
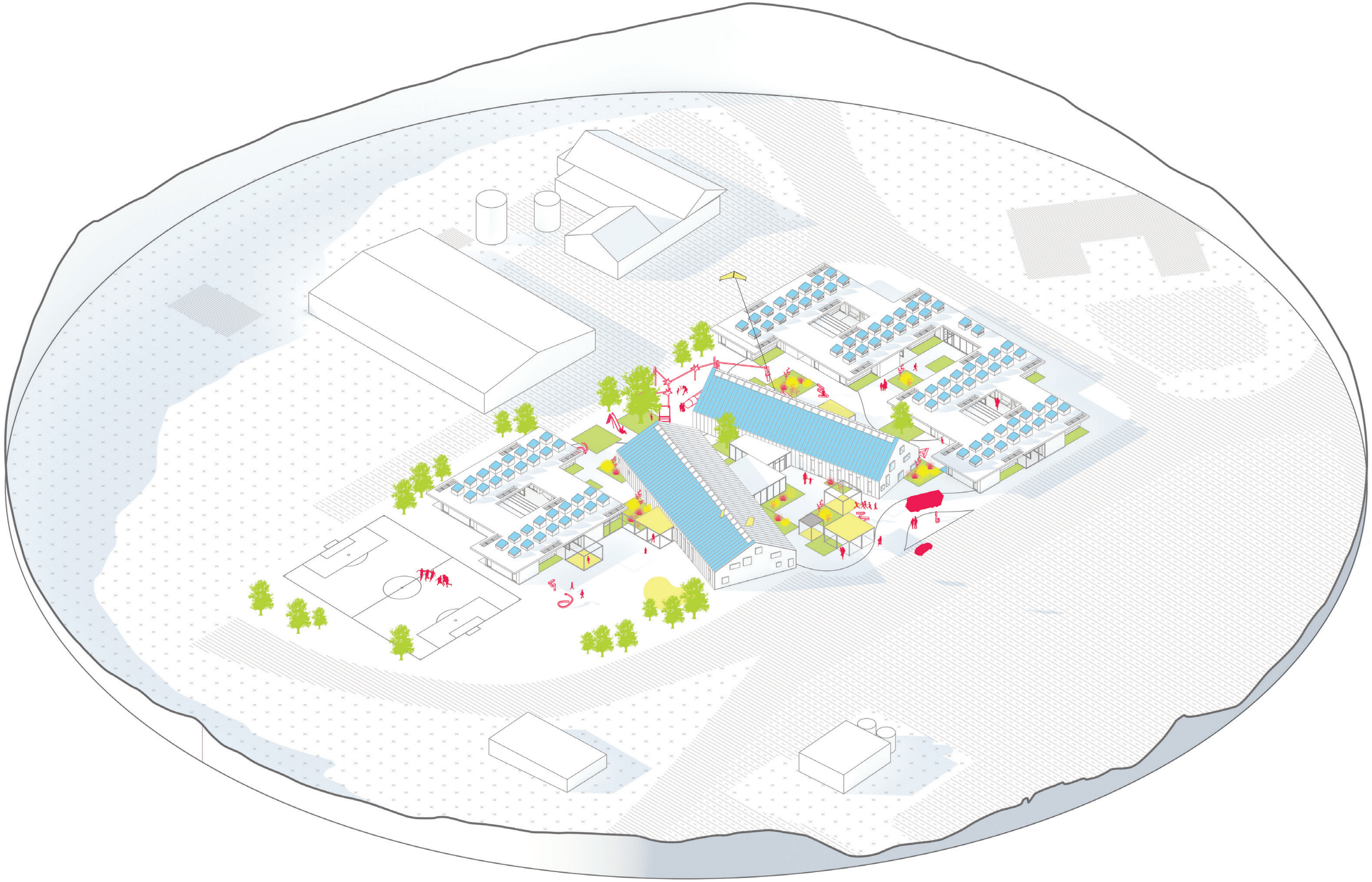


Fig #5 : kids as stewards

Fig #6 : emergent play



RECIPROCAL ENERGY

EUI TARGET

competition requirement	57 kBtu/ft^2 / yr
max target site energy	17.5 EUI
estimated school site energy	13 EUI **
estimated produced site energy	23 EUI
estimated total energy	-10 EUI **

Table #2 : EUI target

** based on IESVE estimations with a radiant floor heating system and passive chilled beams.

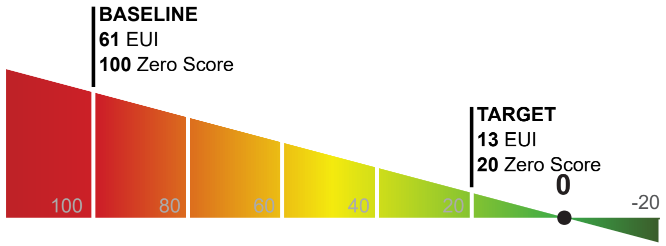


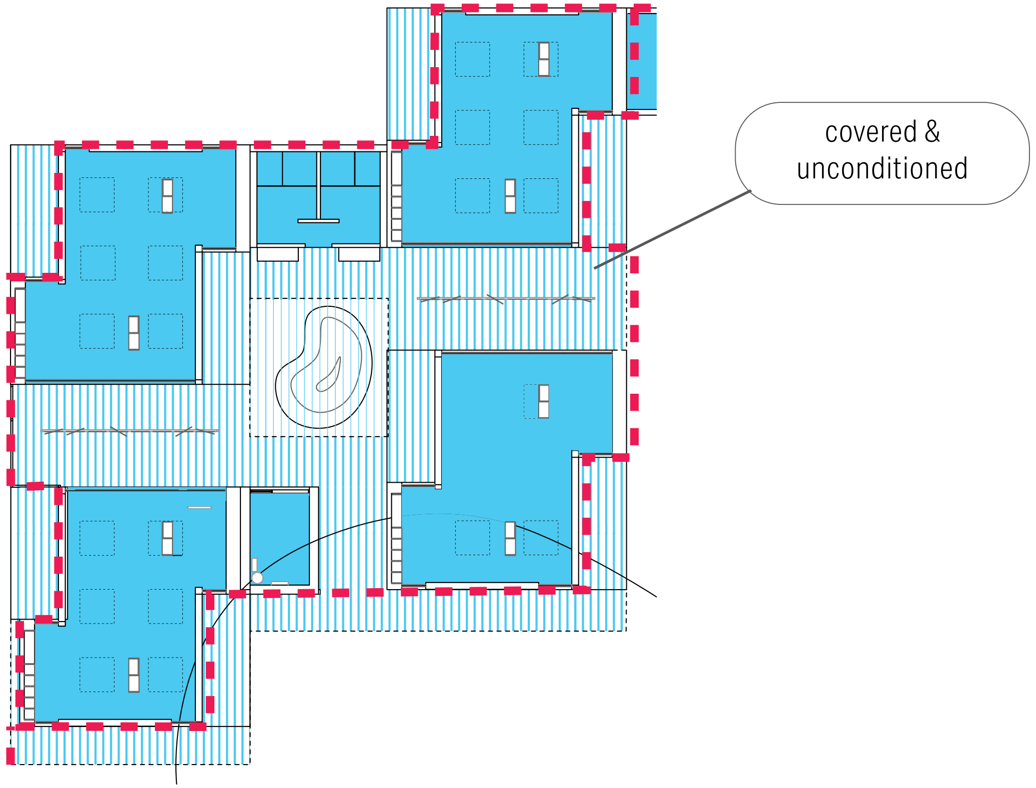
Table #6 : Zero Tool output

MINIMIZE CONDITIONED SPACE

AREA ANALYSIS

sheltered outdoor area	8,516 sf
conditioned area	22,600 sf
conditioned space / covered space	73%

Table #15 : area analysis



RADIATION ANALYSIS - EXTERIOR

winter solstice | equinox | summer solstice

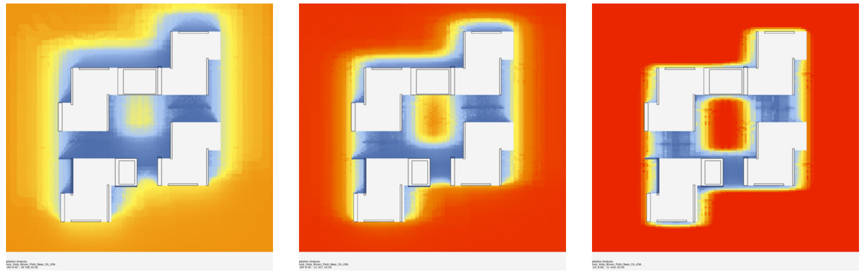


Fig #25 : classroom radiation analysis

0 kWh/m² — 300 kWh/m²

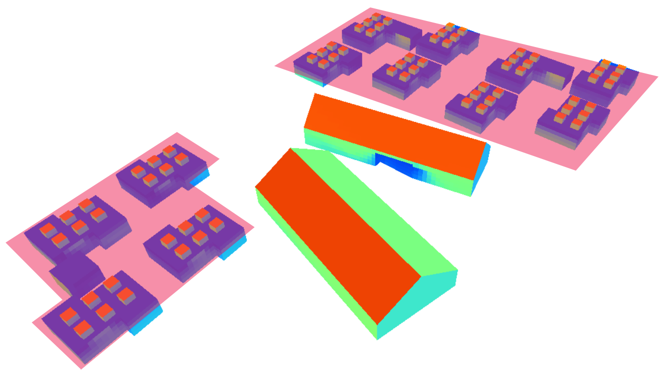
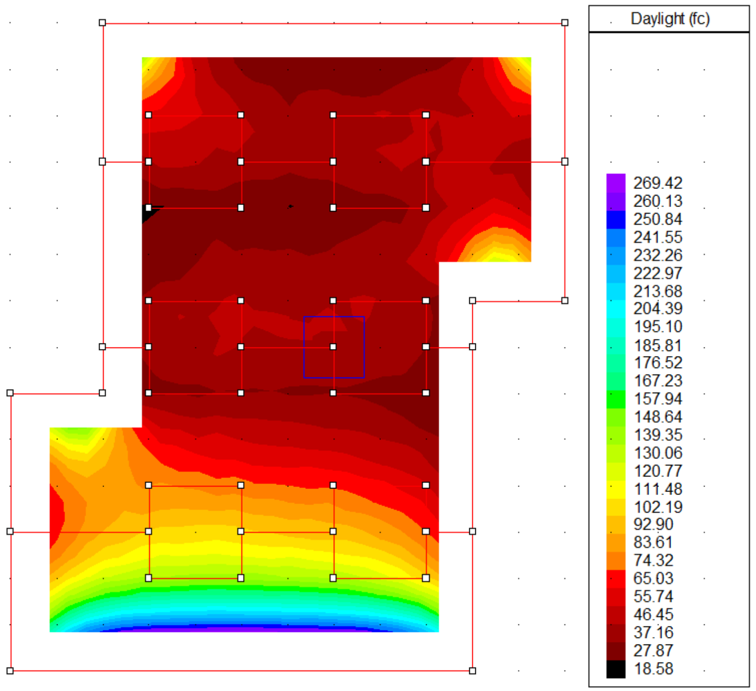
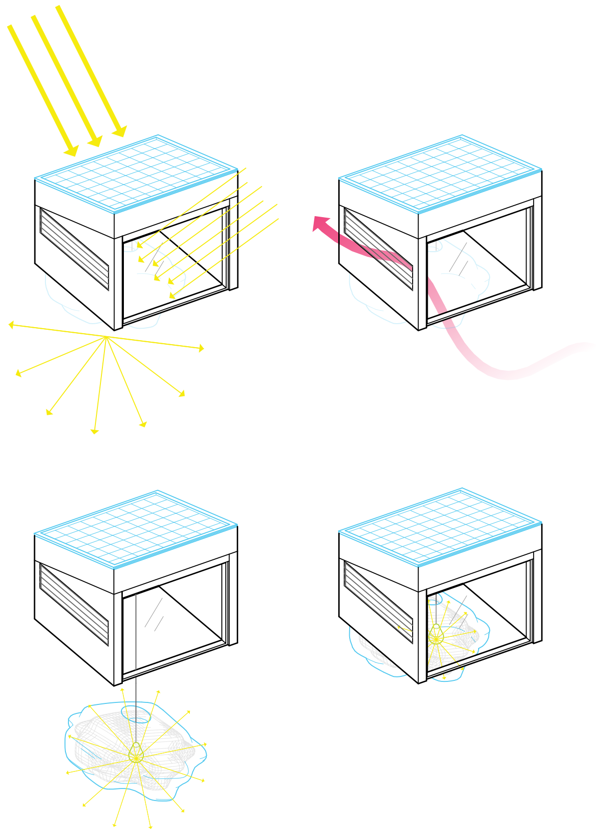


Fig #24 : site radiation analysis

UTILIZE PASSIVE CLIMATE SYSTEMS





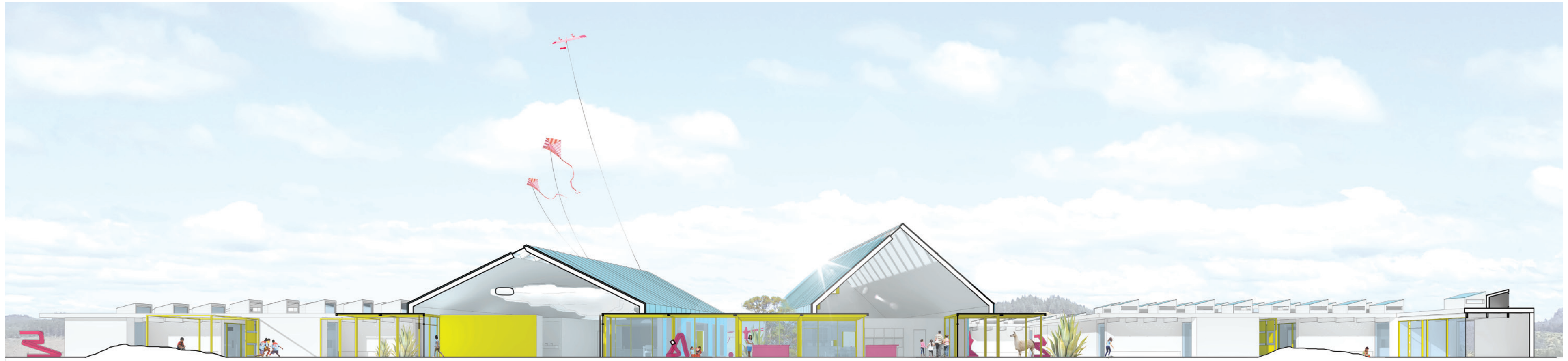
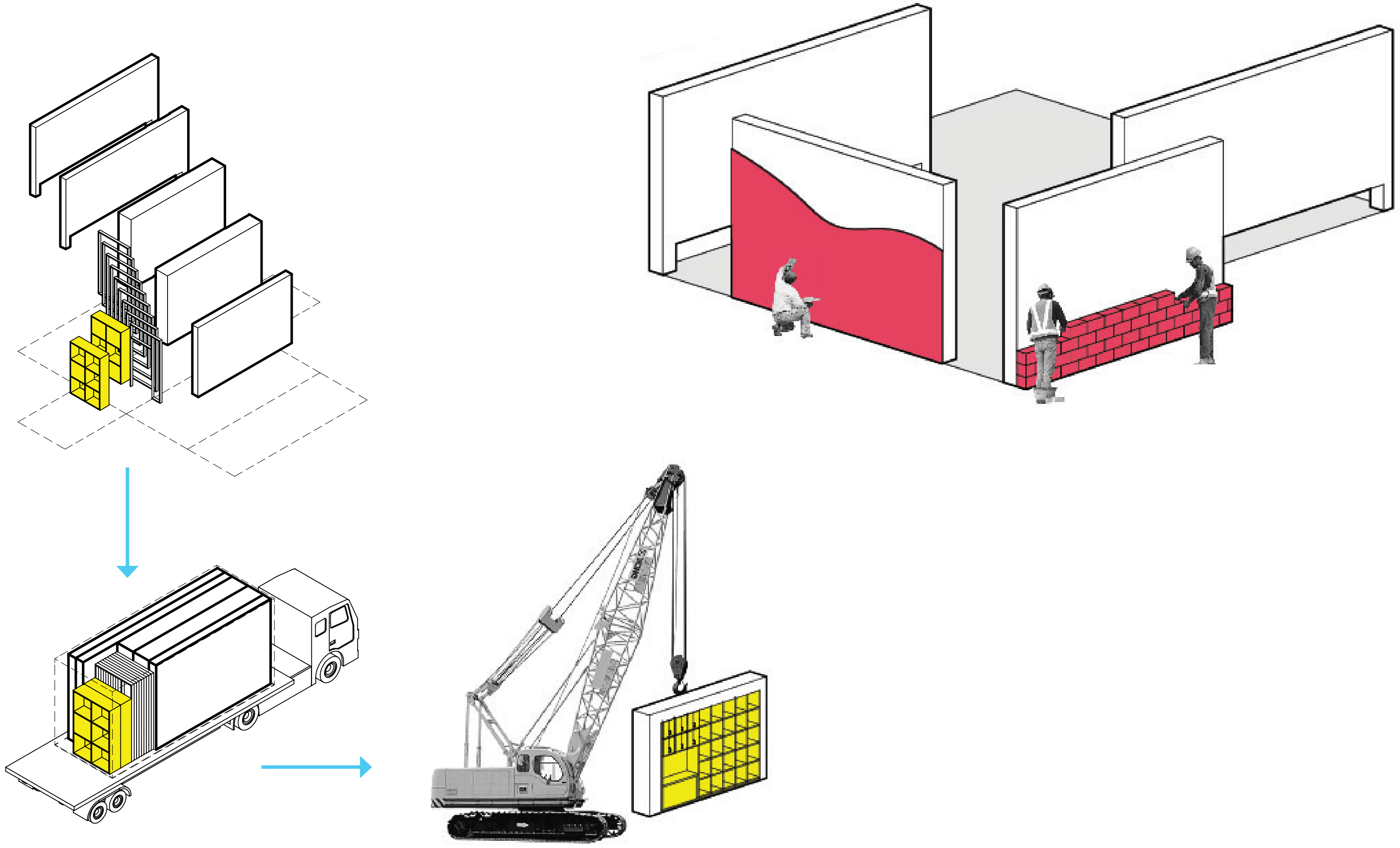


Fig #26 : north/ south site section

1 ENERGY PERFORMANCE
Energy Overview
Energy Analysis
Interaction with the Grid
2 ENGINEERING
3 FINANCIAL FEASIBILITY
4 RESILIENCE
5 ARCHITECTURE
6 OPERATIONS
7 MARKET POTENTIAL
8 COMFORT & ENV. QUALITY
9 INNOVATION

SIMPLIFY CONSTRUCTION, MATERIAL USE, AND OPERATIONS



ENERGY ANALYSIS

INTEGRATED ENVIRONMENTAL SOLUTIONS

Site Energy Use Intensity

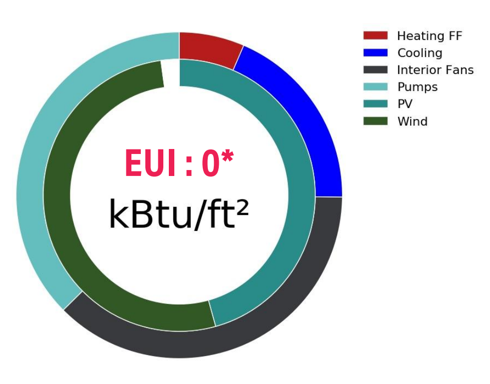


Table #7 : site energy use intensity

Site Energy Flows – Sankey Diagram

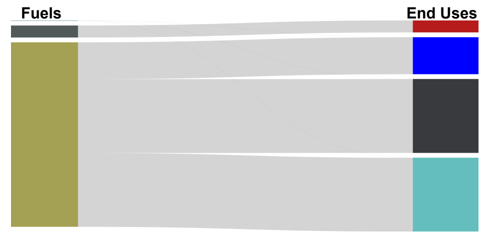


Table #8 : site energy flows

* based on typical school, this school will be 80% lower due to passive systems

EUI TARGET

competition requirement	57 kBtu/ft² / yr
max target site energy	17.5 EUI
estimated school site energy	13 EUI **
estimated produced site energy	23 EUI
estimated total energy	-10 EUI **

Table #2 : EUI target

** based on IESVE estimations with a radiant floor heating system and passive chilled beams.

Site Energy Dashboard (MBtu)

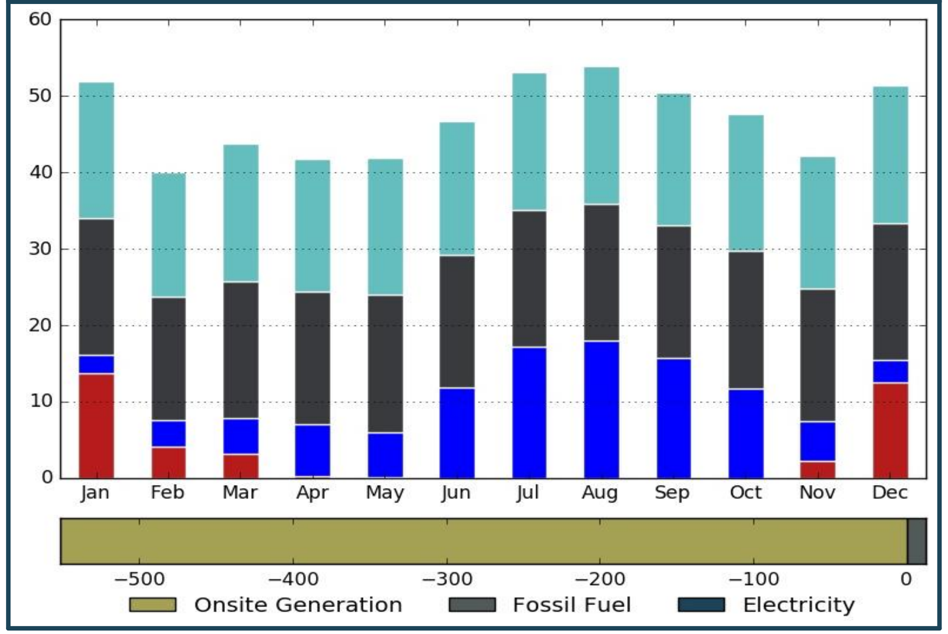


Table #13 : site energy dashboard

Annual Fuel Costs and Peak Demands

Fuels	Cost (£)	Peak Day	Peak Time	Peak Demand
Electricity	12,496.00	24-Sep	13:00	42.9 kW
Fossil Fuel	318.00	12-Dec	5:00	119.4 kBtu/h
Total	12,814.00	24-Sep	13:00	

Table #14 : fuel costs peak demands

ON-SITE GENERATION

SOLAR ENERGY

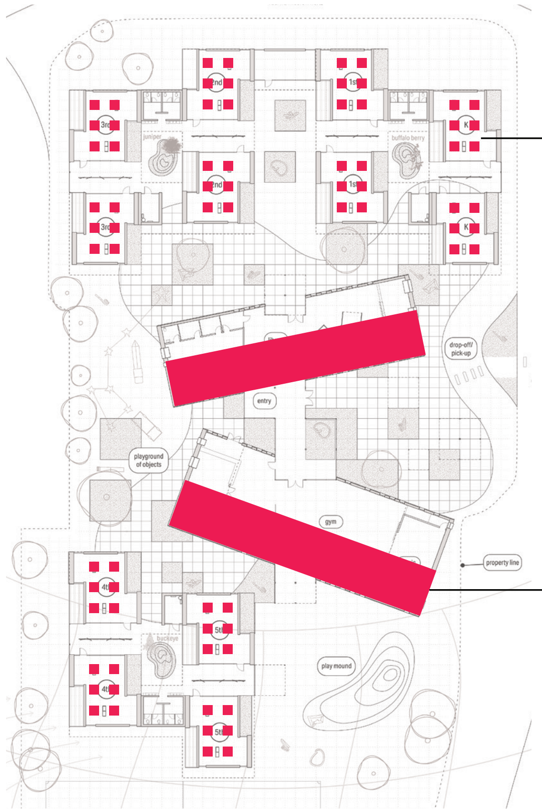


Fig #27 : PV collection areas

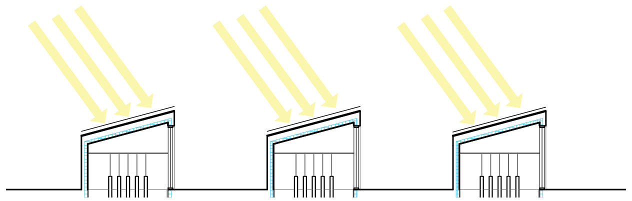


Fig #28 : classroom roof monitor solar

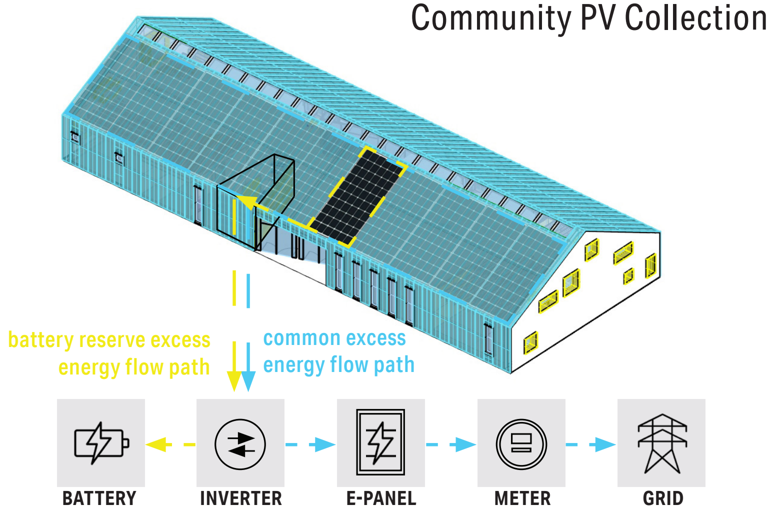


Fig #29 : community roof solar panels

PV SYSTEM

total collection area	6030 sf
efficiency	18.3 %
power rating	355 W
estimated total energy	23 EUI

Table #17 : PV system

NEO SOLAR POWER

D6M355E4A 355W
Mono-Crystalline Photovoltaic Module

ON-SITE GENERATION

WIND ENERGY

Fig #30 : Makani Kite

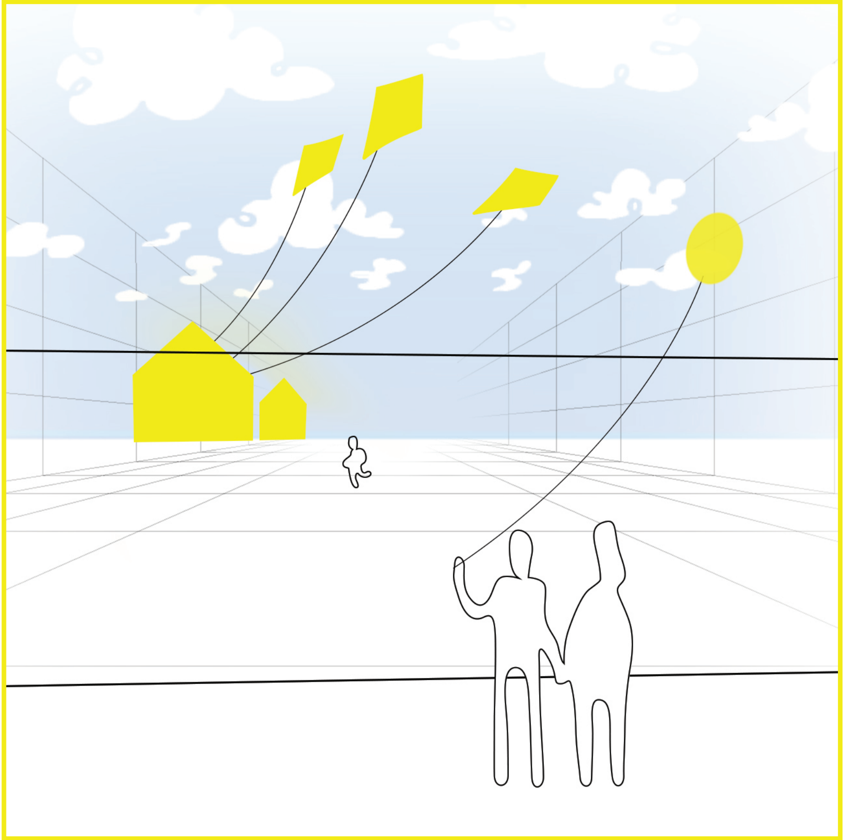


Fig #4 : inhabitable threshold

INTERACTIVE RELATIONSHIPS

RECIPROCAL ENERGY

KIDS AS STEWARDS

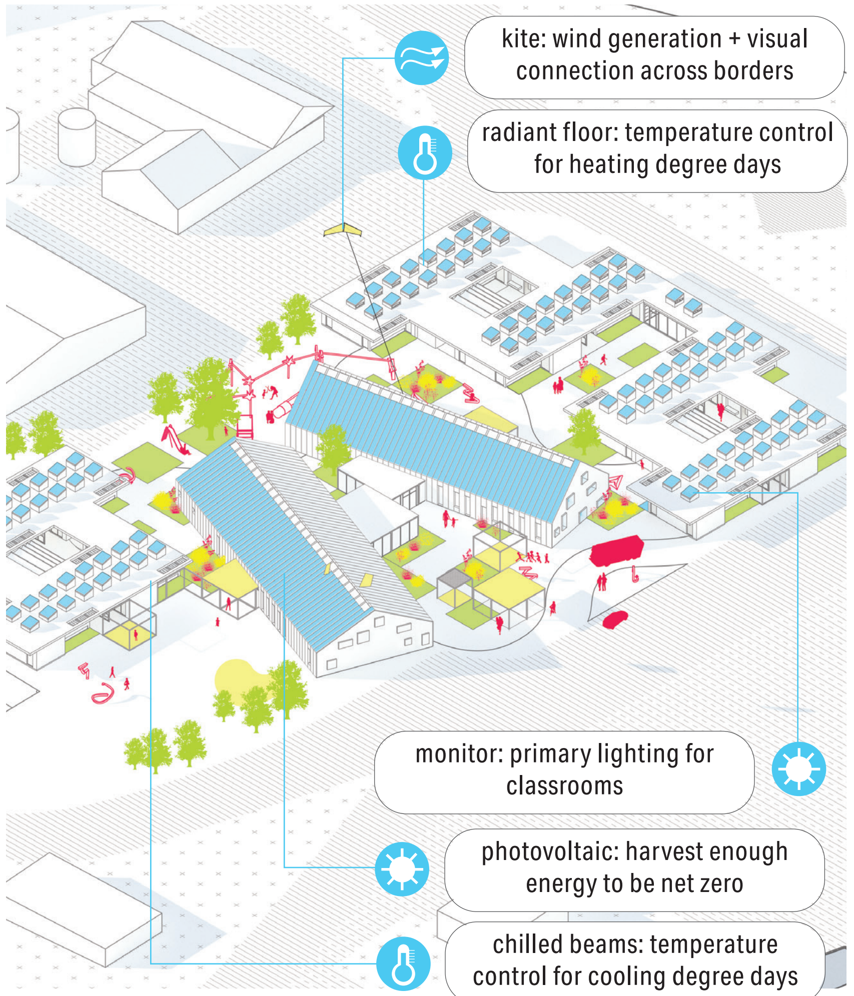
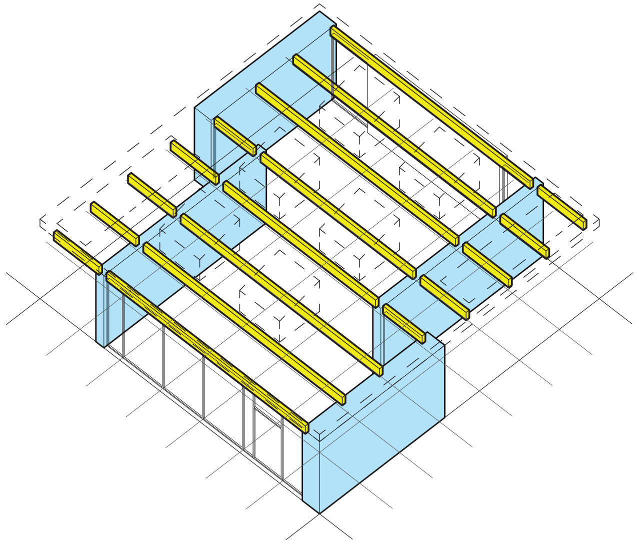


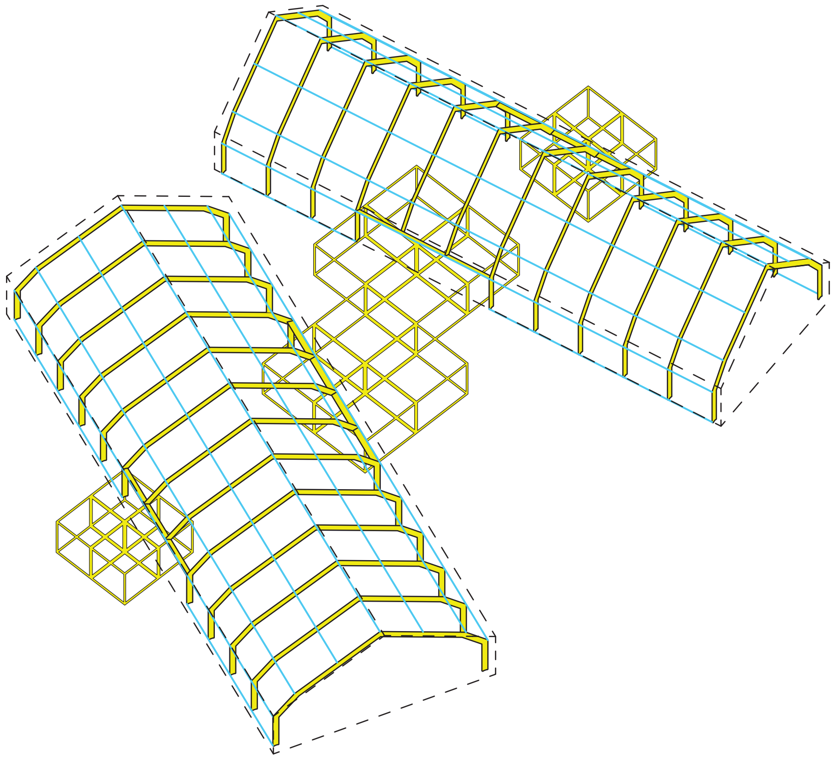
Fig #31 : engineering strategy overview

ENGINEERED SYSTEMS ON DISPLAY SHOW STUDENTS THE REALITY OF HOW BUILDINGS PROVIDE SHELTER, ONE PART OF THE STUDENTS' JOURNEY TO BECOME RESPONSIBLE STEWARDS OF THE ENVIRONMENT.

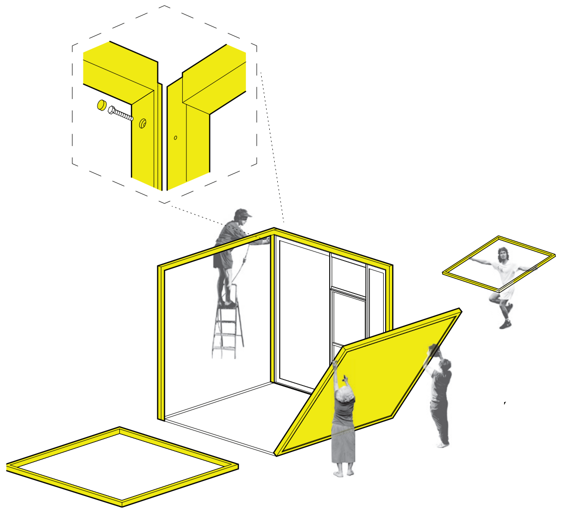
CELEBRATING SIMPLE CONSTRUCTION



CLASSROOMS



COMMUNITY BUILDINGS



MODULAR PAVILIONS

CELEBRATING SIMPLE CONSTRUCTION

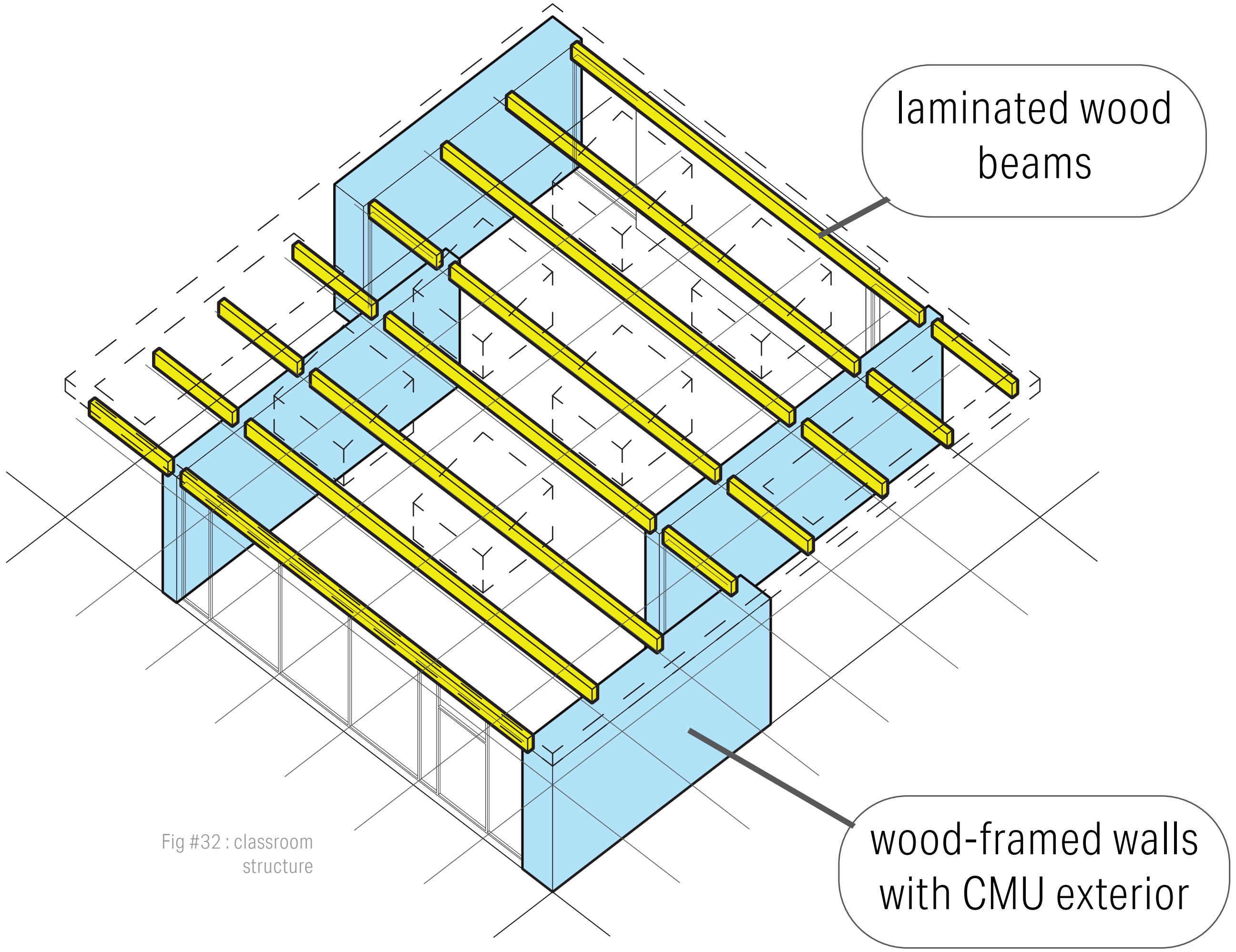


Fig #32 : classroom structure

CLASSROOMS

CELEBRATING SIMPLE CONSTRUCTION

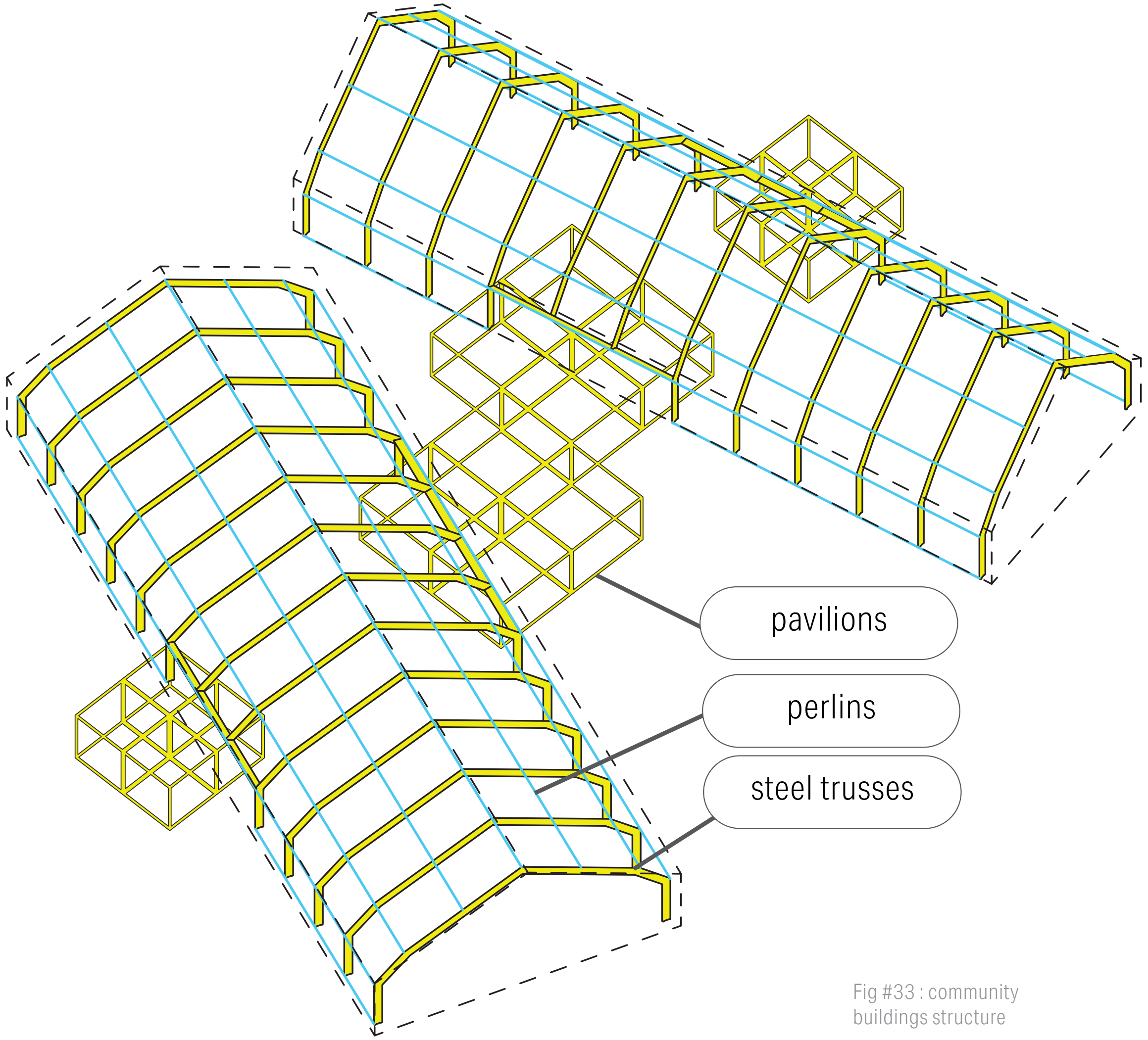


Fig #33 : community buildings structure

COMMUNITY BUILDINGS

CELEBRATING SIMPLE CONSTRUCTION

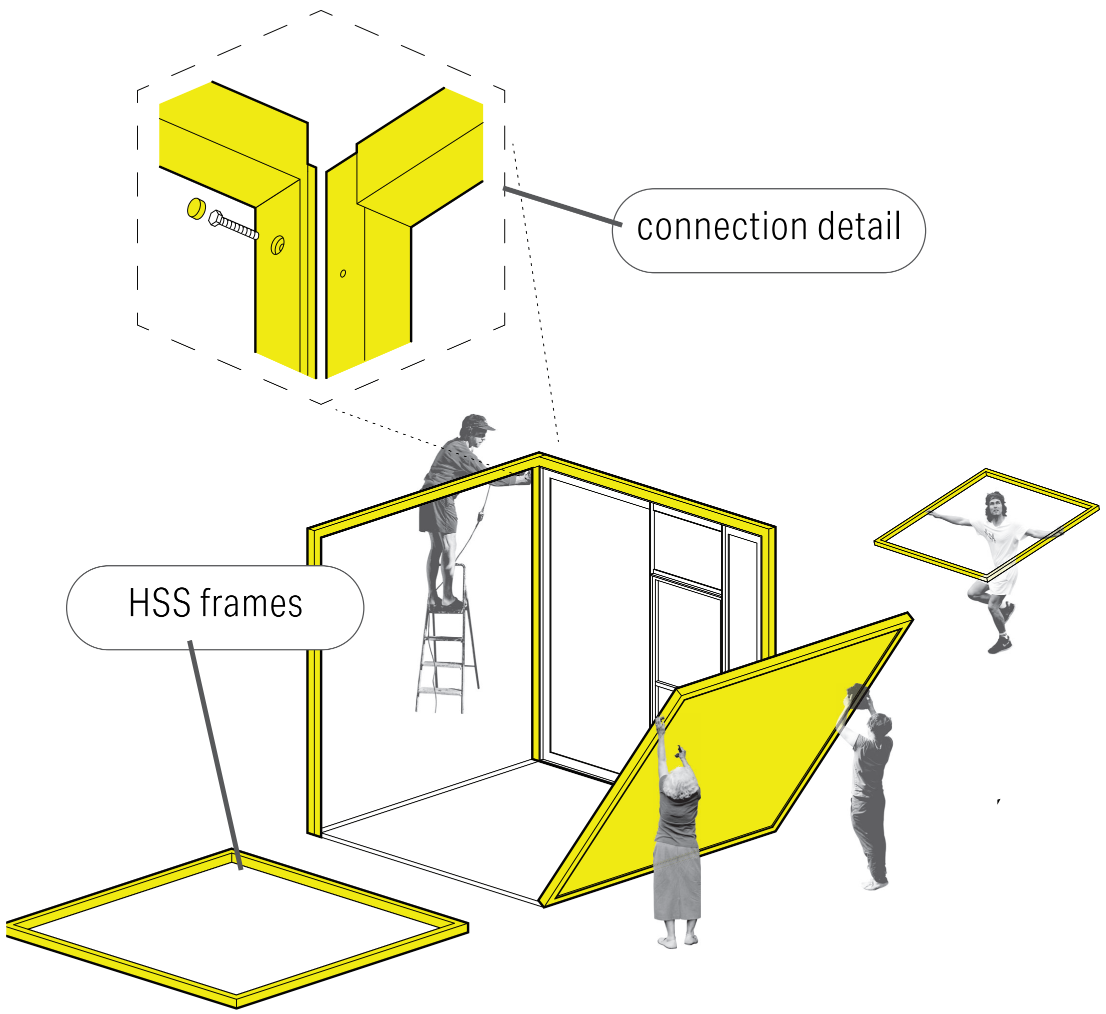
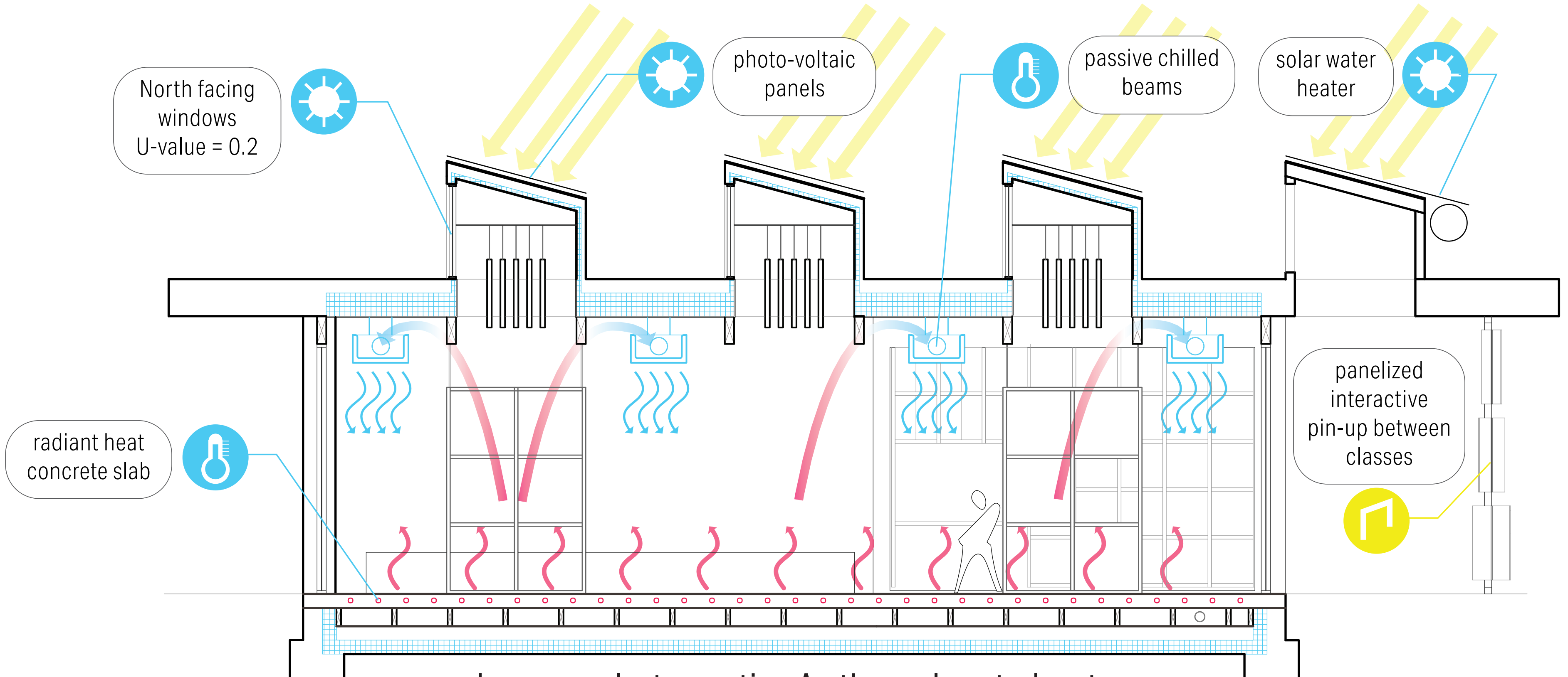


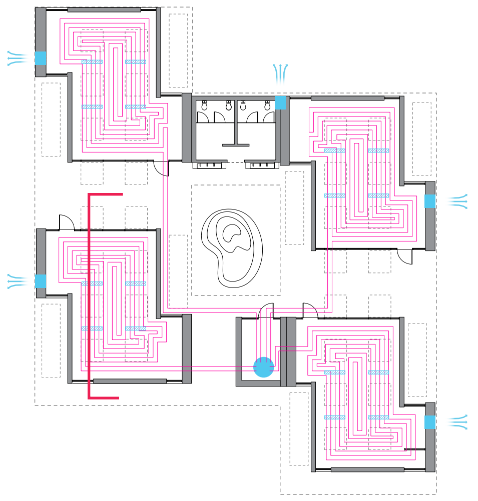
Fig #34 : pavilion structure

MODULAR PAVILIONS

CLASSROOM MECHANICAL SYSTEMS



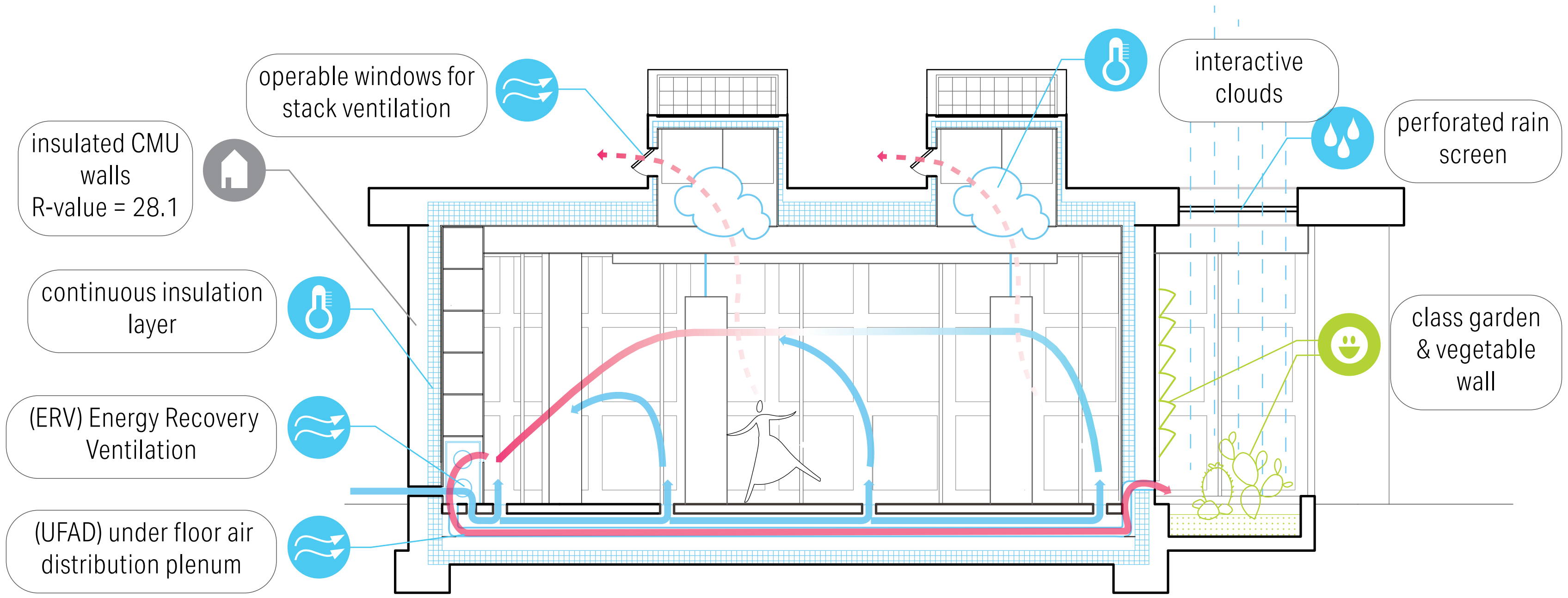
classroom cluster section A - thermal control systems



Passive Chilled Beams :
The Linear Passive Chilled Beam (PCBL)

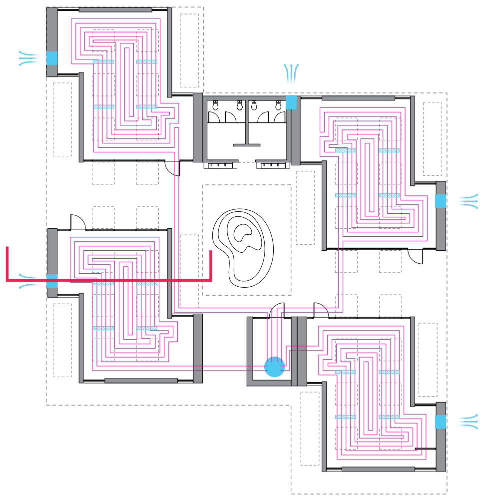
Hot Water Boiler :
QAHV Hot Water Heat Pump
capacity : 136480 Btu/hr

CLASSROOM MECHANICAL SYSTEMS



classroom cluster section B - ventilation systems

(ERV) Energy Recovery Ventilator LZ-H080GBA5
470 CFM



COMMUNITY BUILDINGS MECHANICAL SYSTEMS

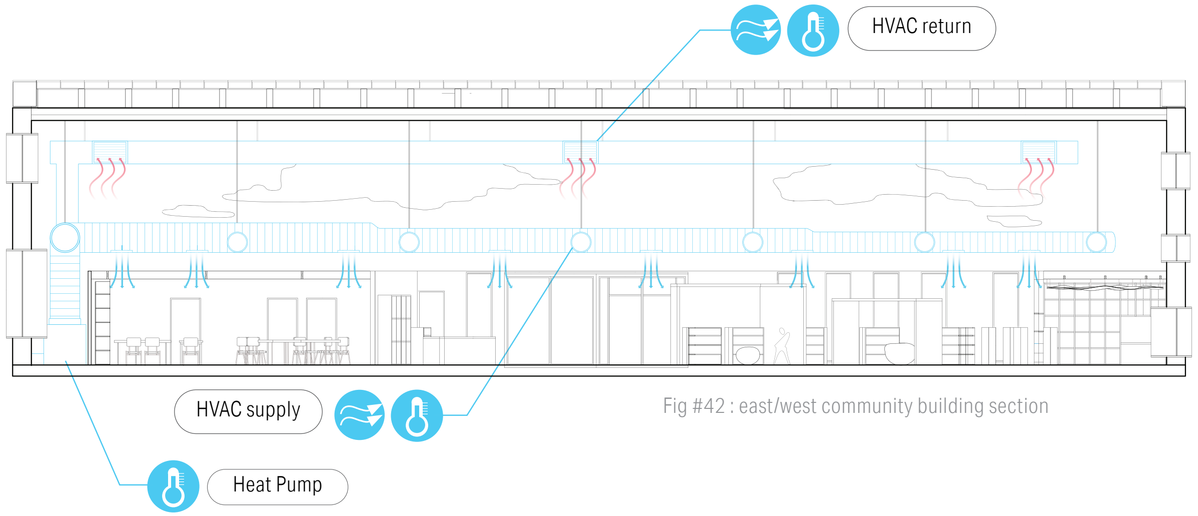


Fig #42 : east/west community building section

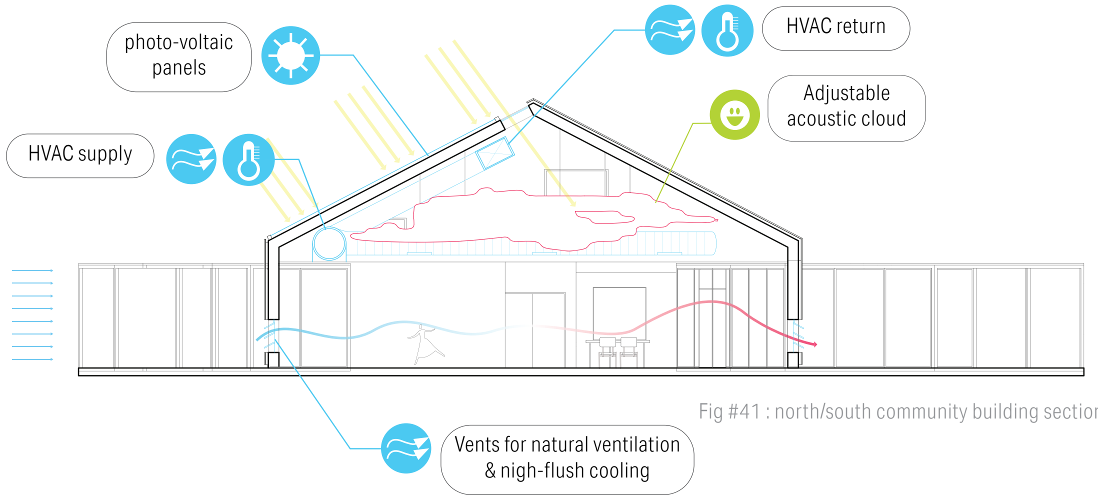


Fig #41 : north/south community building section

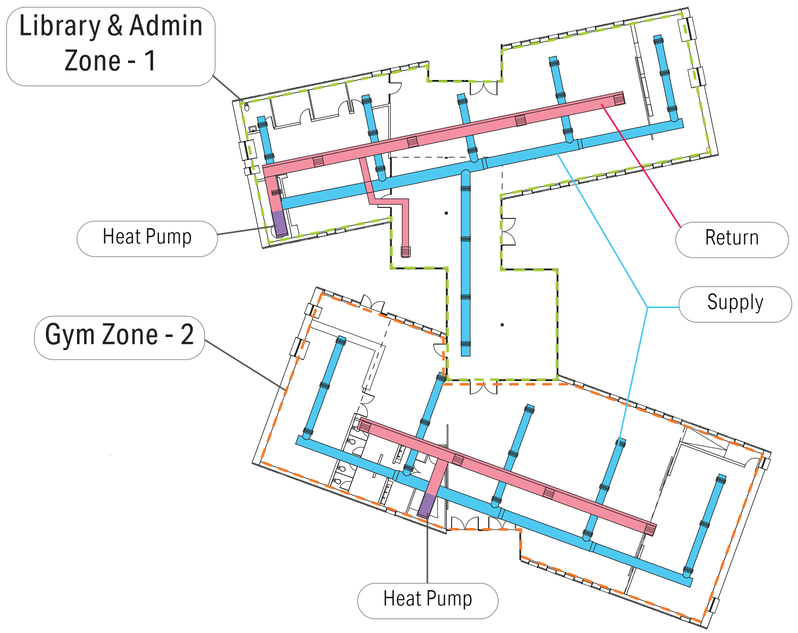


Fig #43 : community HVAC plan

SECTIONS: CONTINUOUS LAYER OF INSULATION

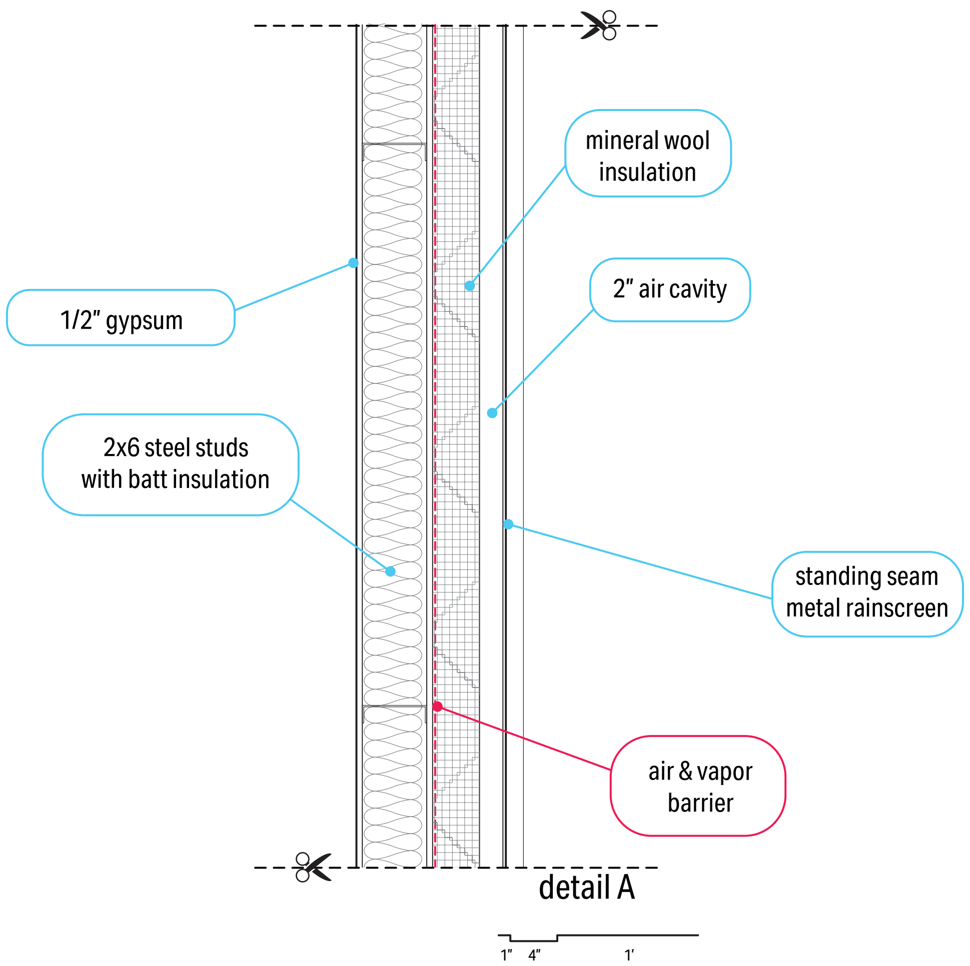


Fig #47 : community wall section

COMMUNITY WALL

R-value = 31 $ft^2 \cdot °F \cdot h/Btu$
U-value = 0.032 $Btu/h \cdot ft^2 \cdot F$

SECTIONS: CONTINUOUS LAYER OF INSULATION

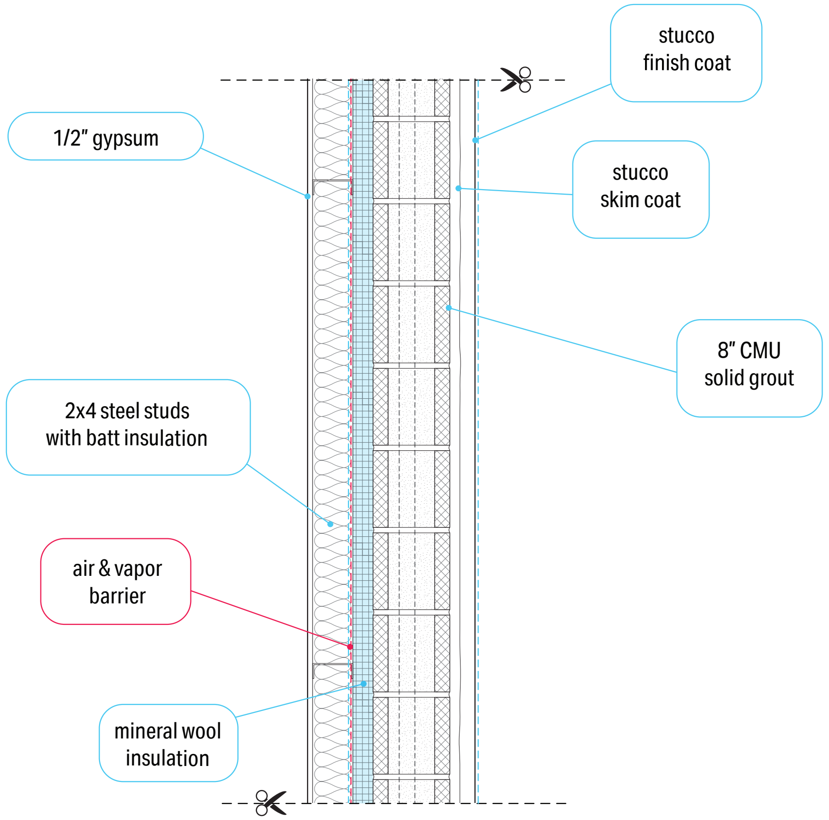
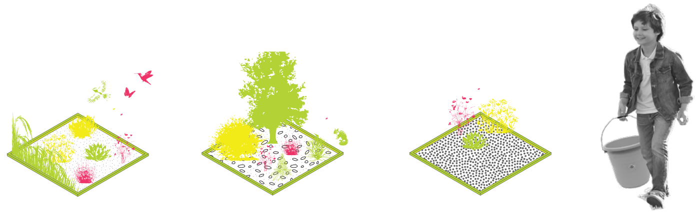


Fig #44 : typical classroom wall section

CLASSROOM WALL

R-value = 28.1 ft²·°F·h/Btu
U-value = 0.036 Btu/h·ft²·F

RAINWATER CAPTURE & REDUCED WATER USE



WATER CYCLE & RAINWATER COLLECTION

collection surface: 23.000 sq.ft
Avg. annual rainfall: 10.34 inches
Total rainwater collection potential: **148.000 gallons/yr**

Rainwater collected on the roofs of clusters and community buildings runs off into water cisterns below the mechanical room of each cluster.

BASE CALCULATION

for schools with a cafeteria, a gym, no showers :

20 gallons/user x 380 users	= 7,600 gallons
7.600 gallons x 180 school days in CA	**= 1,368,000 gallons/yr**

LITTLE DIPPER ELEMENTARY

Sinks:

380 users x 5 (amount of hand washes per user/day)	= 1,900 (daily uses)
1.900 (daily uses) x 0.2 (duration) x 0.5 (flow rate)	= 190 gallons
190 gallons x 180 (school days in CA)	= 34.200 gallons/yr

Drinking + Cooking:

380 users x 180 (school days in CA) x 2 gallons	= 136,800 gallons

TOTAL (per year) :

34,200 gallons + 136,800 gallons	**= 171,000 gallons/yr**

TOTAL (per day) :

171,000 g/y / 180 (school days in CA) / 380 users	**= 2.5 gallons/user/day**

Composting toilets : https://www.go-gba.org/resources/green-building-methods/composting-toilets/
https://bullittcenter.org/2012/06/14/composting-toilets-at-the-bullitt-center/
https://www.sun-mar.com.au/2017/01/20/composting-toilets-vs-regular-toilet-need-know/
https://serc.carleton.edu/integrate/teaching_materials/energy_sustain/student_materials/composting_toil.html
https://living-future.org/lbc/case-studies/perkins-seed-classroom/#place
Kitchen appliances : https://unifiedbrands.net/equipment-by-brand/

Fig #48 : water use summary

BEAUTY IS FOR EVERYONE

RECIPROCAL ENERGY

KIDS AS STEWARDS

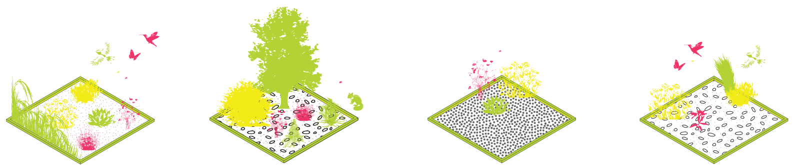


Fig #50 : Native species

SAVINGS KEY
$ 15-25%
$$ 26-50%
$$$ 50%+

Fig #49 : financial feasibility strategy

PARTICIPATION IN DAILY MAINTENANCE AND OPERATIONS SHOW STUDENTS HOW THEIR ACTIONS SAVE ENERGY, ONE PART OF THE STUDENTS' JOURNEY TO BECOME RESPONSIBLE STEWARDS OF THE ENVIRONMENT.

COST ESTIMATE

material cost

$2-3M

+

systems cost

$700K-1M

+

on-site labor + transportations cost

$500-800K

−

off-site labor savings

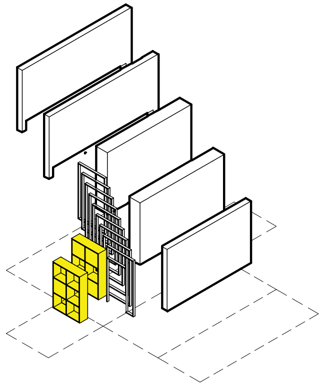
$75-150K

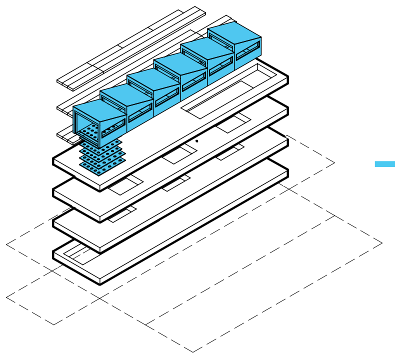
=

CONSTRUCTION COST ESTIMATE

$3-4.75M

$130-207/sf





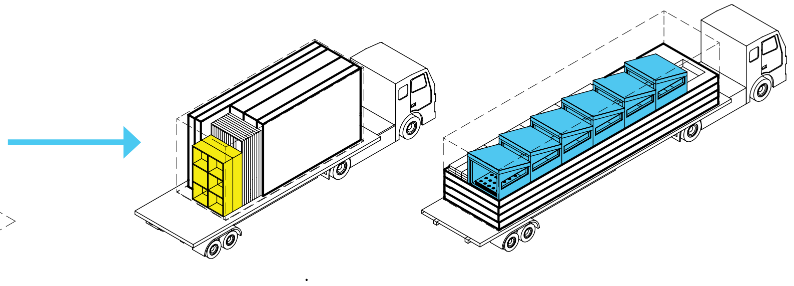


Fig #61 :Prefabricated classroom (see appendix)

=

PREFABRICATED CLASSROOM

In addition to using easily sourced, low-cost materials, classrooms are prefabricated off-site. This results in a significant reduction in labor and material cost.

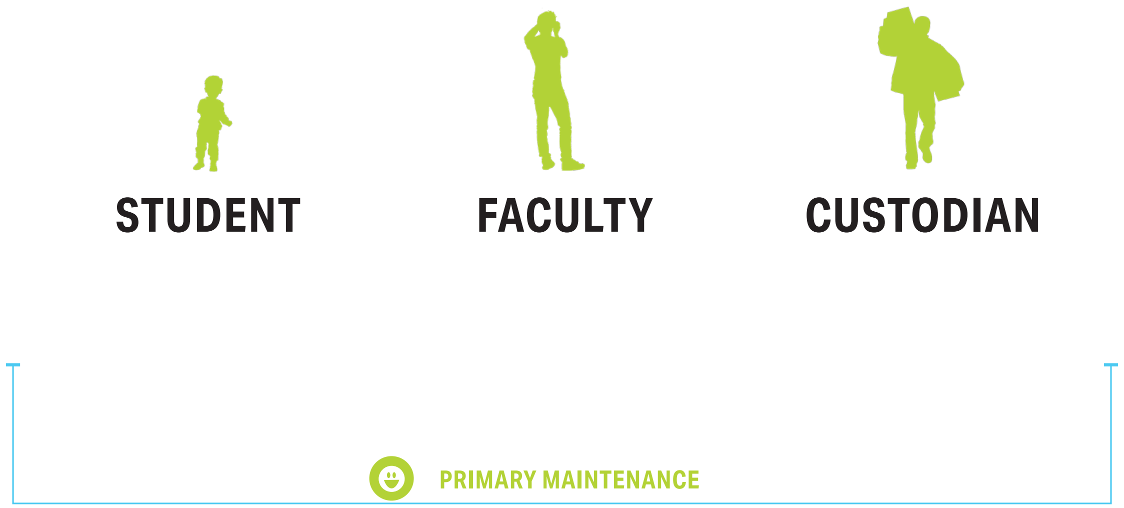


Fig #62 : primary maintenance

Fig #63 : secondary maintenance

THE SITE FUNCTIONS UNDER DIVERSE CIRCUMSTANCES, THIS CAPABILITY TO ADAPT EDUCATES USERS ON HOW TO SUPPORT EACH OTHER DURING DIFFICULT TIMES, ONE PART OF THE STUDENTS' JOURNEY TO BECOME RESPONSIBLE STEWARDS OF THE ENVIRONMENT.

SHELTER FOR COMMUNTIY

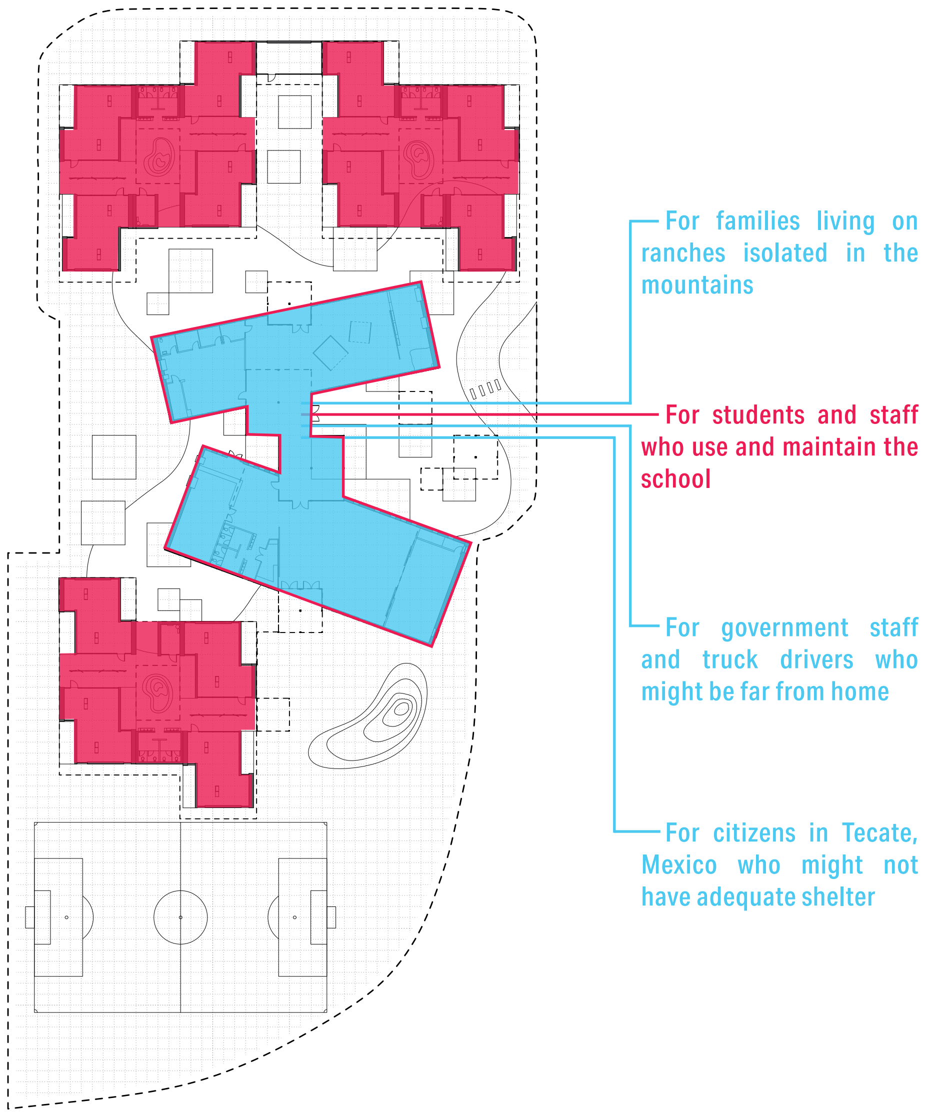
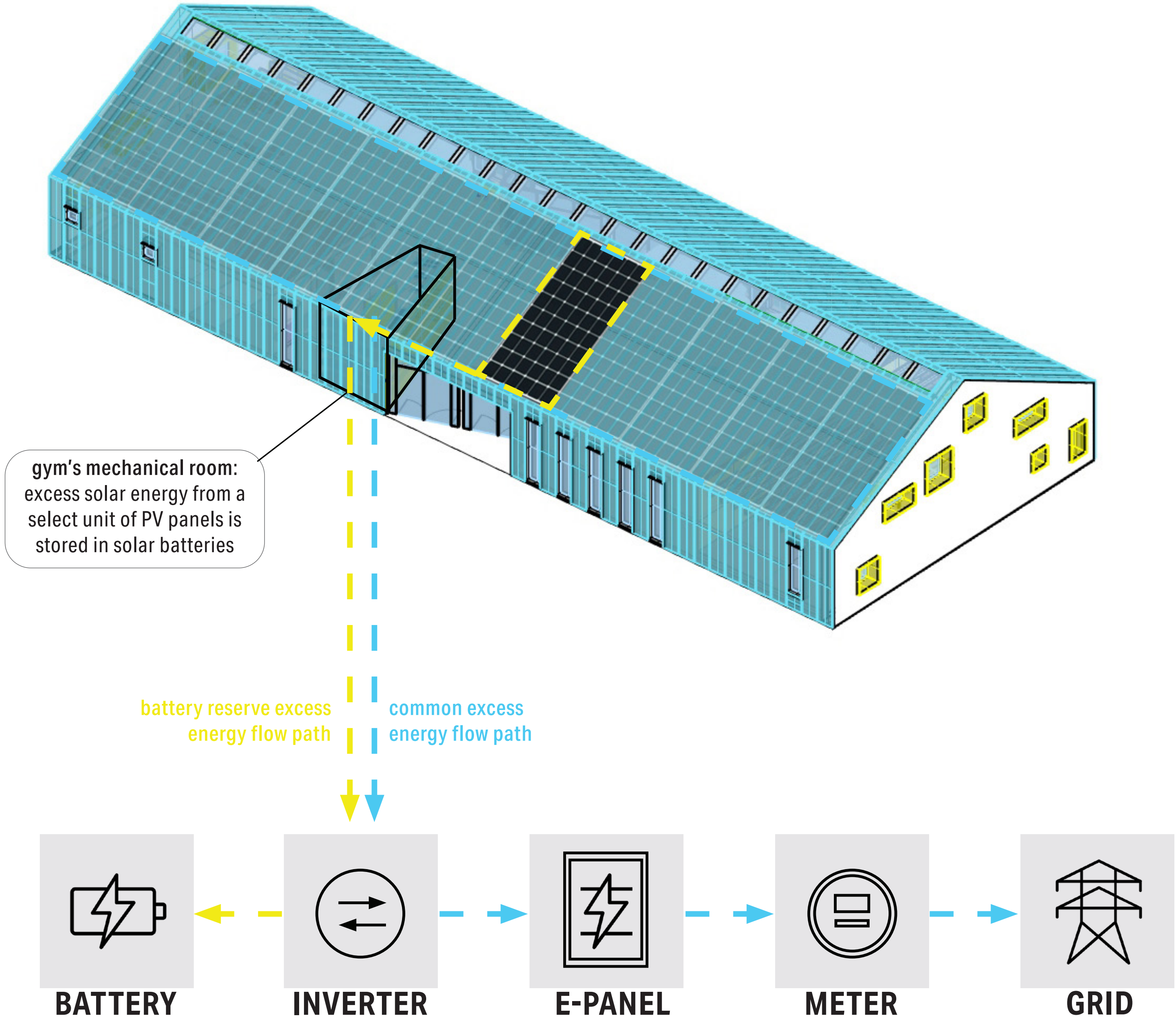


Fig #64 :community routes to the site

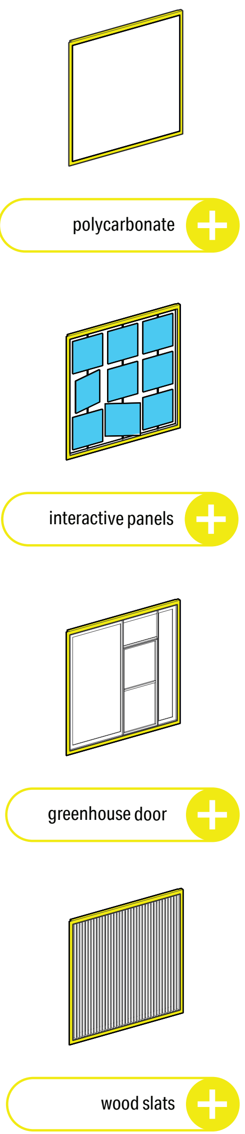
STORING ENERGY

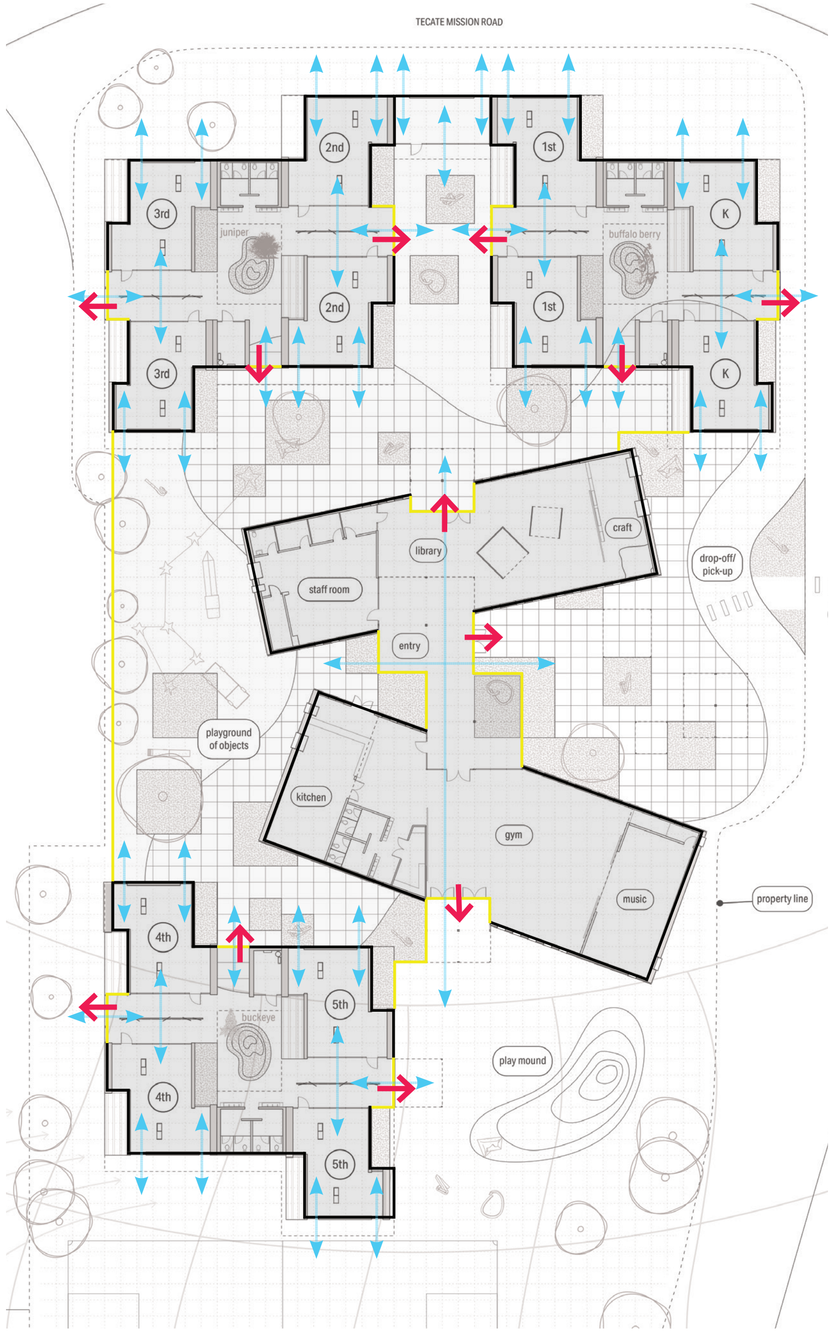
SOLARWATT®



SITE SECURITY

site security: various panel ends can be chosen to provide security to the clusters.





secure wall edges: the solid edges of the clusters act as the primary security barrier. These planes do not allow for any type of egress or entry, therefore making points of access clear and monitor-able.

indicates secure cluster
indicates secure site

optional end panels: Constructed from a modular system of simple frames, various frame infill panels can be chosen depending on what is desired by the users to secure unenclosed edges.

indicates secure egress location

visual transparency: monitoring the students and the surroundings is an important method of security, not only in the case of outside threat, but for daily safety of students. Limiting places to hide or narrow hallways, a sense of safety through transparency is created.

IMPACT ON GLOBAL WARMING

Measured in kg CO2e, Fig# describes the distribution of greenhouse gas (GHG) emissions by life cycle stages. Fig# describes the distribution of GHG emissions by material classification and Fig# by specific material. These two metrics are combined in Fig# for a holistic view of global warming contribution within the project.

One Click LCA
Product of Bionova Ltd

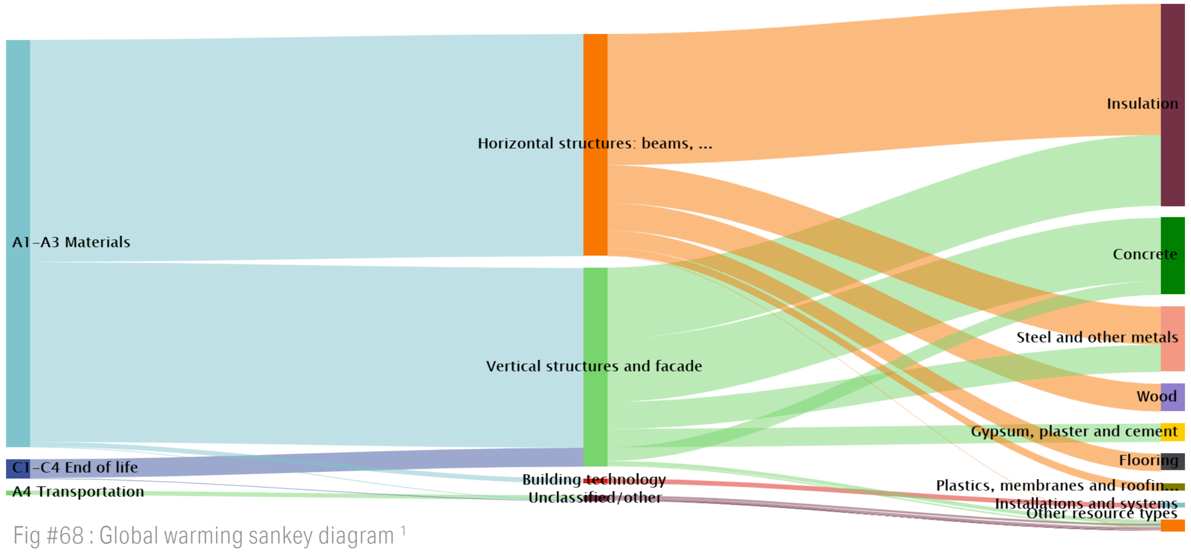


Fig #68 : Global warming sankey diagram [1]

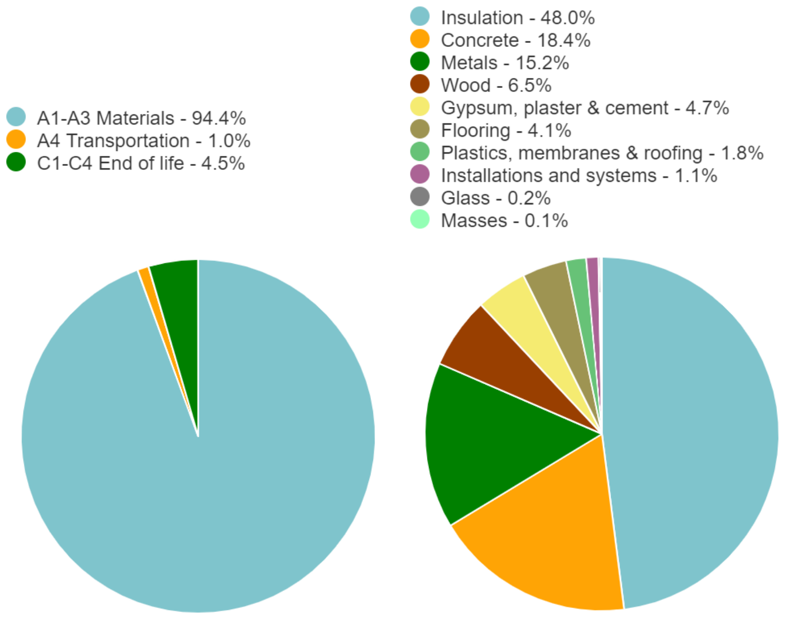


Fig #69 : Global warming pie charts [1]

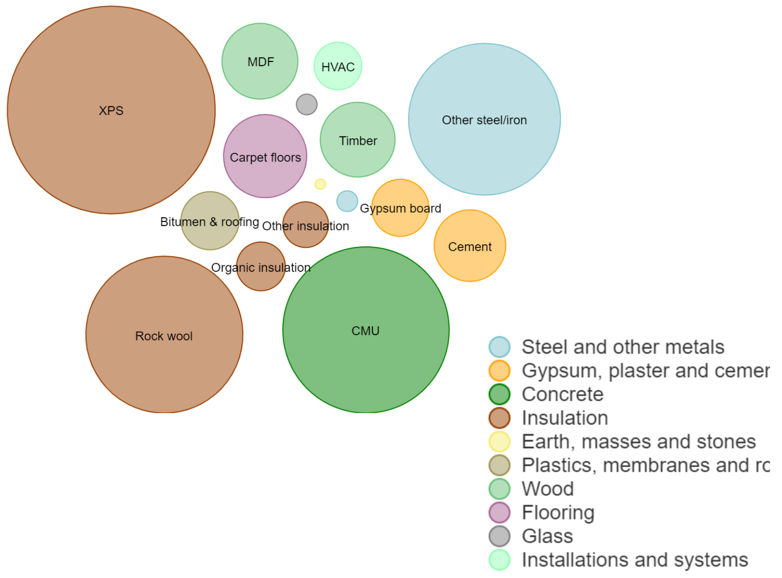


Fig #70 : Global warming bubble chart [1]

BEAUTY IS FOR EVERYONE
EMERGENT PLAY
KIDS AS STEWARDS
INHABITABLE THRESHOLD
RECIPROCAL ENERGY

INTENTIONAL RELATIONSHIPS BETWEEN BUILDING AND OBJECTS TEACH STUDENTS THE VALUE OF INTERACTION AND COLLABORATION, ONE PART OF THE STUDENTS' JOURNEY TO BECOME RESPONSIBLE STEWARDS OF THE ENVIRONMENT.

ZONES OF USE

student learning area	+/- 36,795 sf
staff only area	1,567 sf
community use area	+/- 26,232 sf

Fig #73: zones of use diagram

SPATIAL ZONES

sheltered exterior area	8,516 sf
interior area	22,600 sf

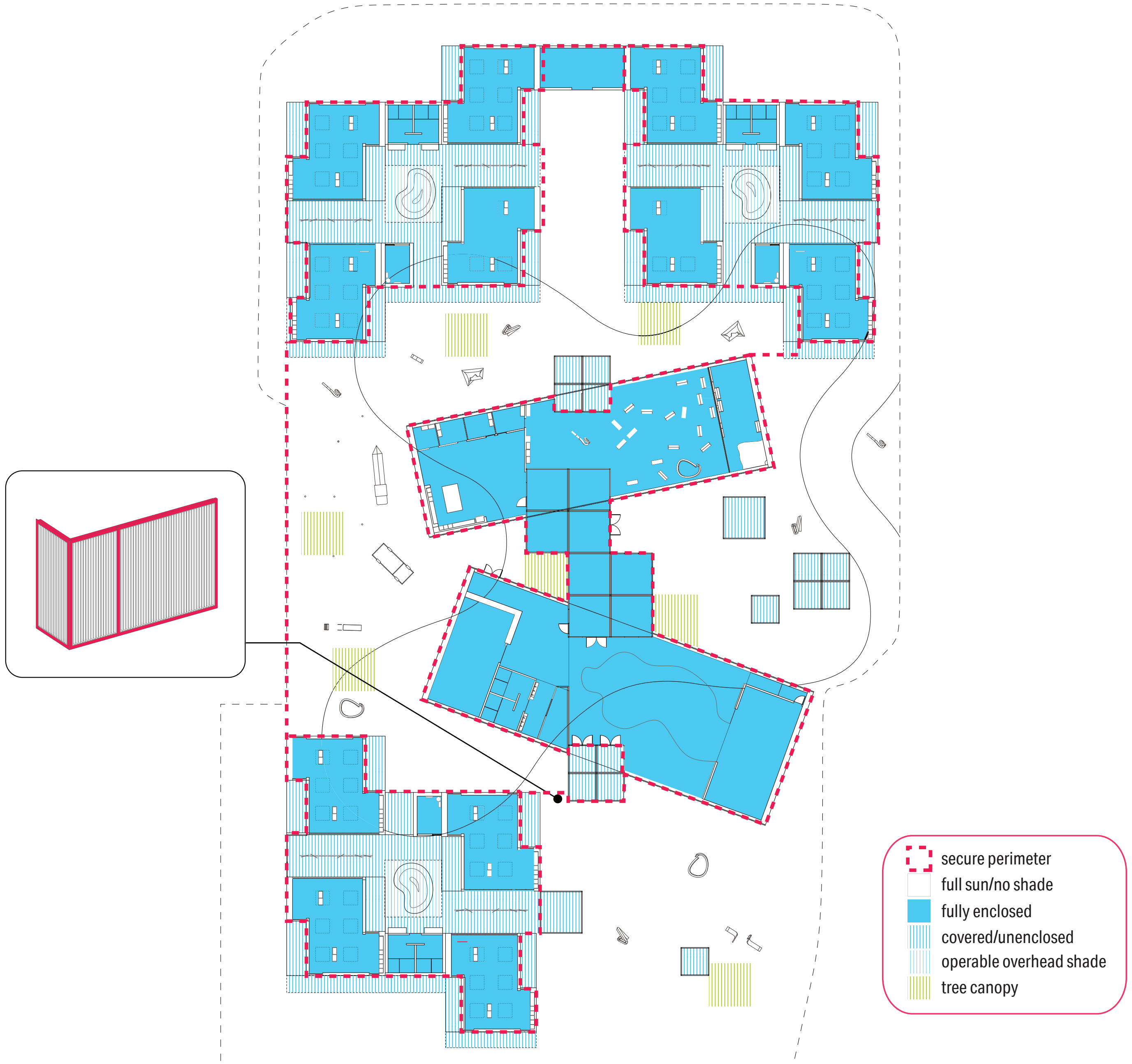


Fig #74: spatial zones diagram

GROUND COVER

total site area	101,577 sf
foundation area	25,674 sf
hardscape area	13,940 sf

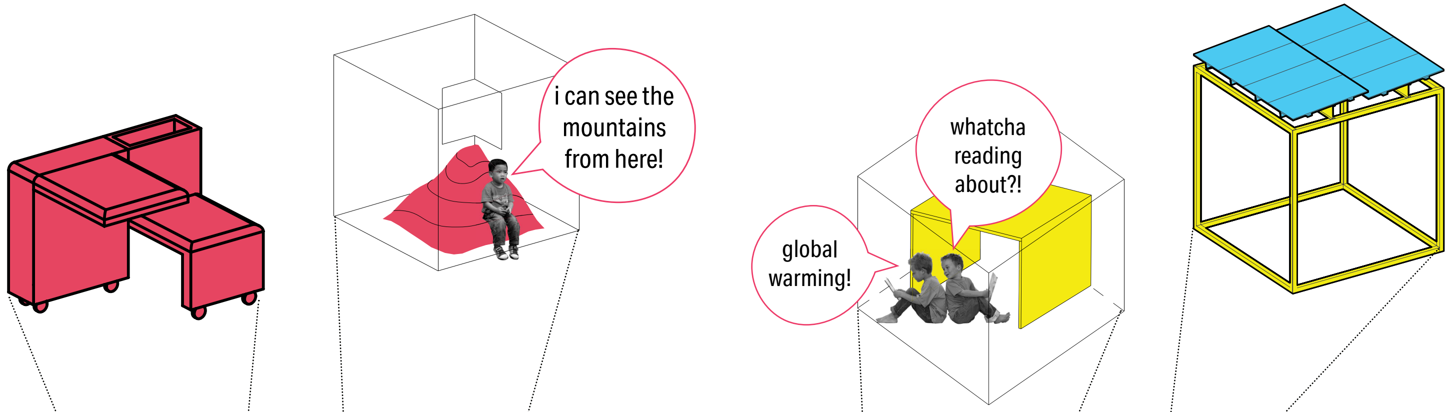
Fig #75: ground cover diagram

CREATING PLACE FOR COMMUNITY

envelope area	39,968 sf
volume	226,055 ft^3
window area	2,493 sf
wall area	9,590 sf
skylight area	612 sf
floor area	11,682 sf

Table #18 : community cluster metrics

Fig #78: community cluster plan



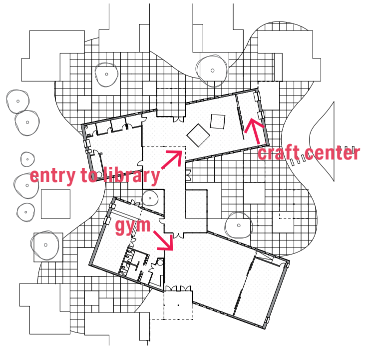


fig #: view locator

Fig #79: view of craft center

flexible elements: things like sliding walls, movable storage, and flippable panels give students and staff the opportunity to adapt their learning space to fit their needs while being simple to use.

Fig #80 : view of entry to library

photovoltaic: pv panels on the roof of the clusters provide enough energy to send power to the grid during low occupancy times like summer, allowing net zero to be achieved even if power has to be taken from the grid during peak hours. Select panels send energy to battery storage in case of disaster or power outage.

Fig #81 : view of gym

skylight: ample daylighting allows for users to enjoy light filled spaces while reducing energy loads.

INTERACTIVE RELATIONSHIPS

exterior circulation	2,153 sf
total enclosed area	3,486 sf
(1) classroom	782 sf
mechanical room	116 sf
restroom	242 sf

Table #19 : classroom cluster metrics

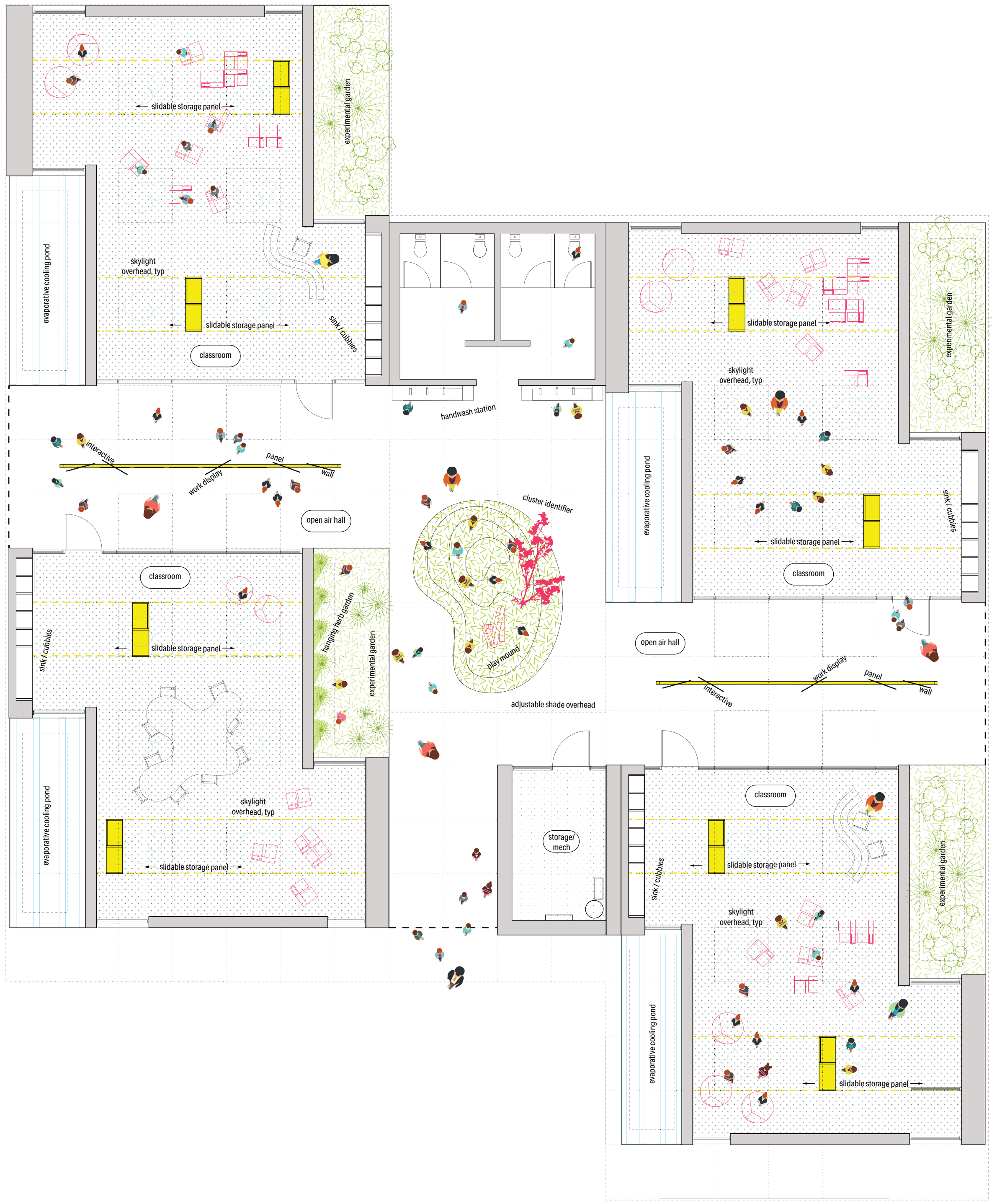


Fig #82: classroom cluster plan

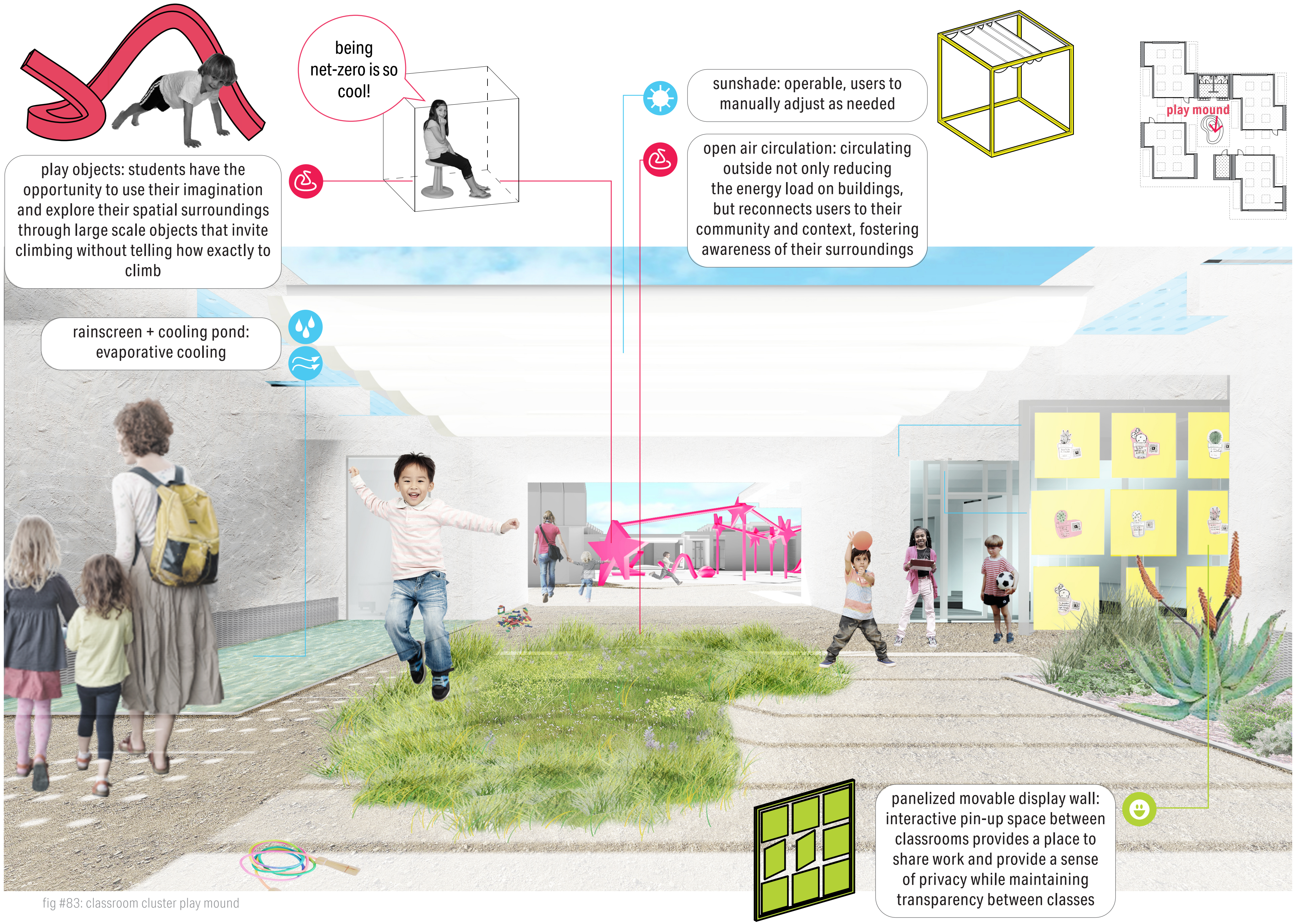


fig #83: classroom cluster play mound

CELEBRATING PASSIVE SYSTEMS

envelope area	2,761 sf
volume	9,345 ft^3
window area	332 sf
wall area	865 sf
skylight area	150 sf
floor area	782 sf

Table #20 : classroom unit metrics

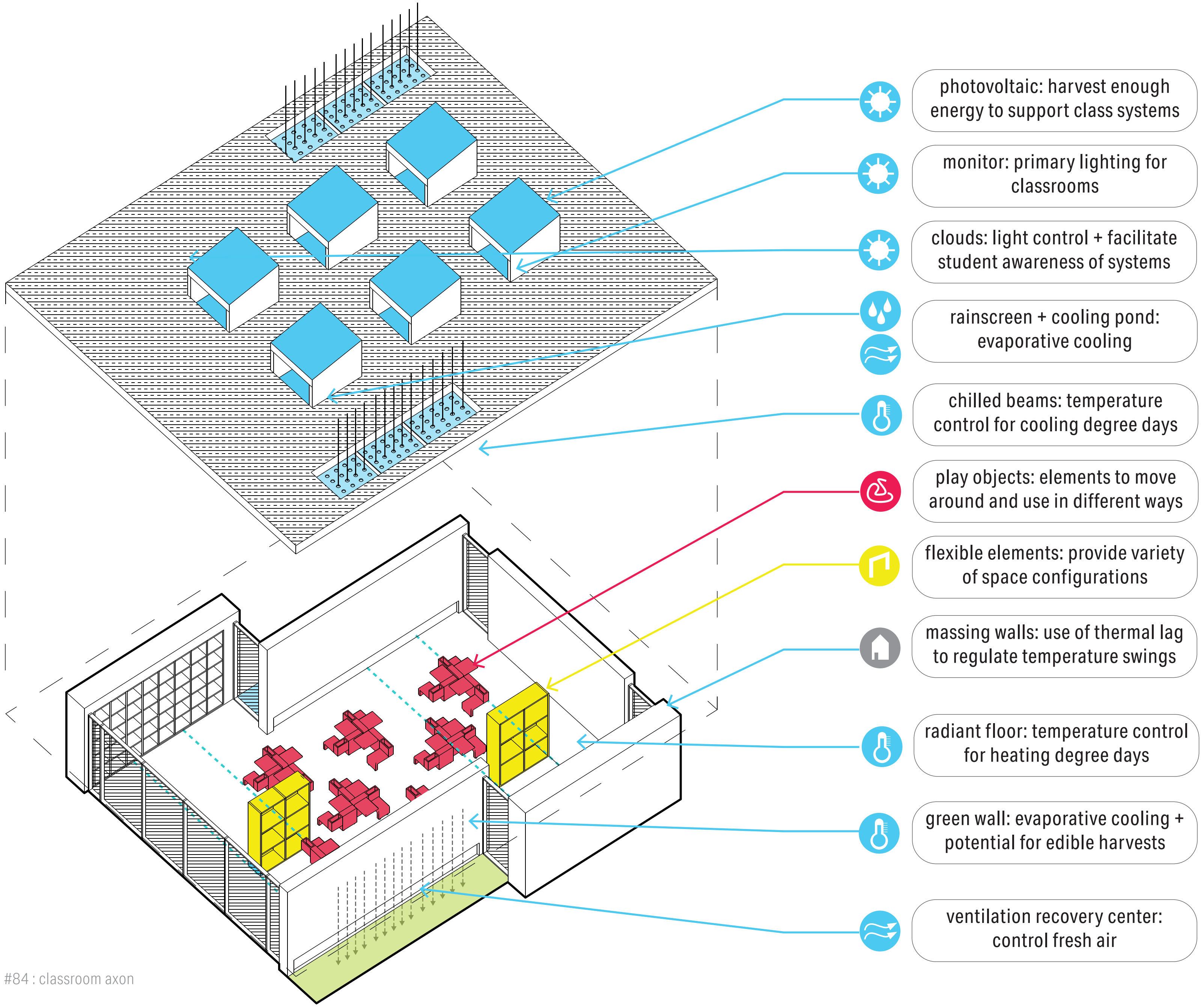
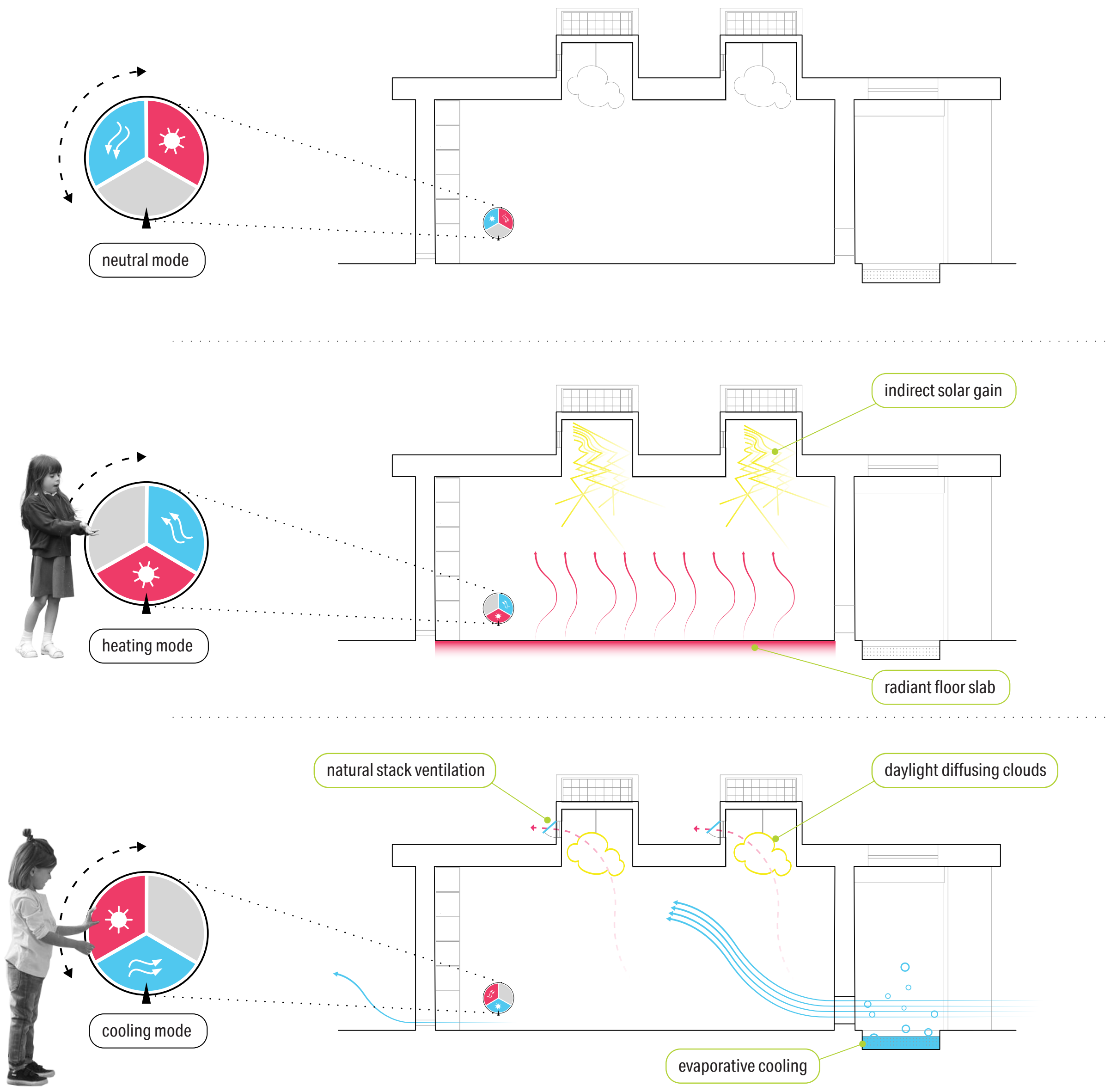


Fig #84 : classroom axon


classroom
i like moving my desk around!
it's fun to push the walls into place!
the sun changes so much during the day!



INTERACTIVE RELATIONSHIPS

EMERGENT PLAY

KIDS AS STEWARDS

RECIPROCAL ENERGY

ENGAGING OPERATIONS, STUDENTS LEARN HOW CLIMATE CONTROL WORKS BY DIRECT INTERACTION, ONE PART OF THE STUDENTS' JOURNEY TO BECOME RESPONSIBLE STEWARDS OF THE ENVIRONMENT.

REGULAR CONTROLS

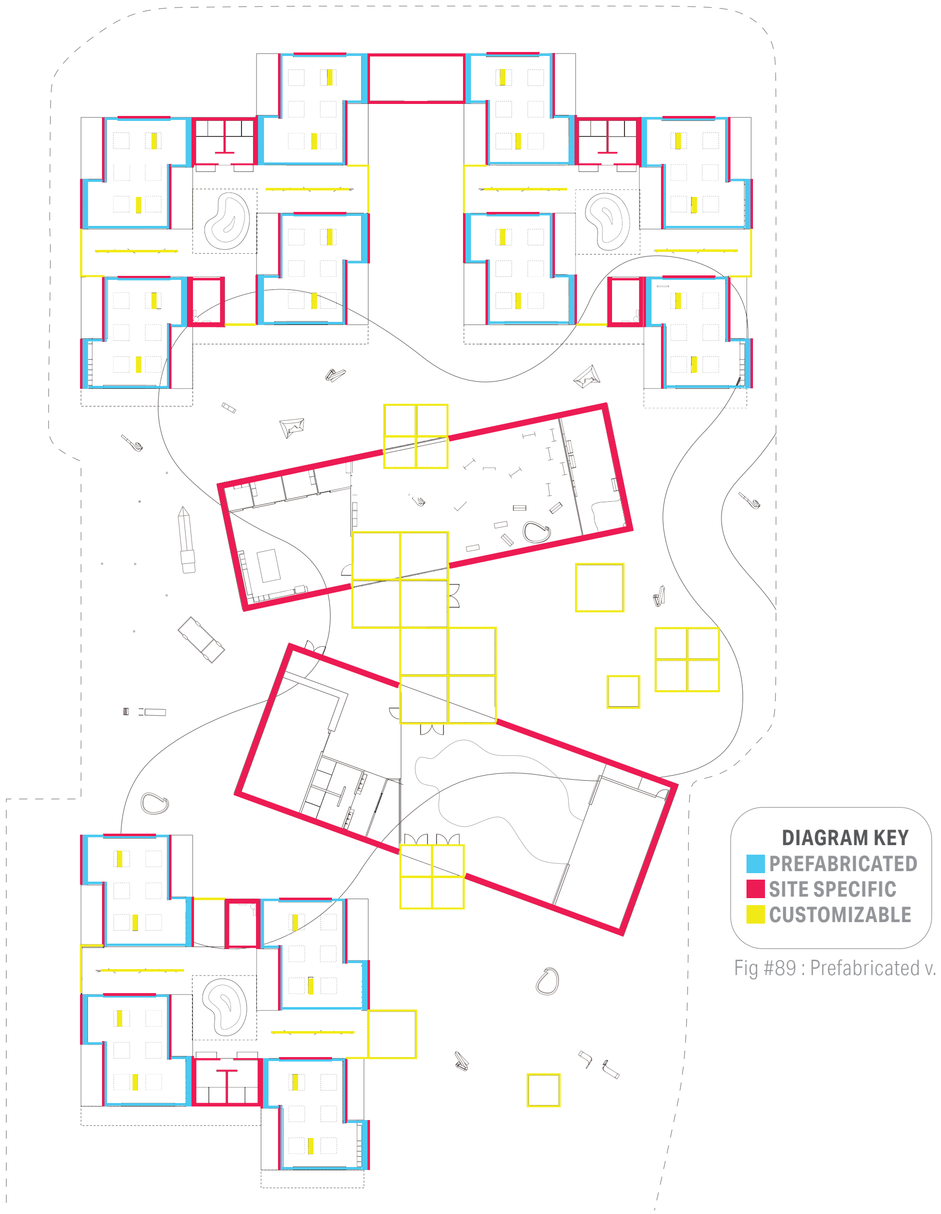


Fig #89 : Prefabricated v. local diagram

A CONNECTION WITH THE LOCAL COMMUNITY BENEFITS EVERYONE WHEN ALL STAKEHOLDERS AIM TO BECOME RESPONSIBLE STEWARDS OF THE ENVIRONMENT.

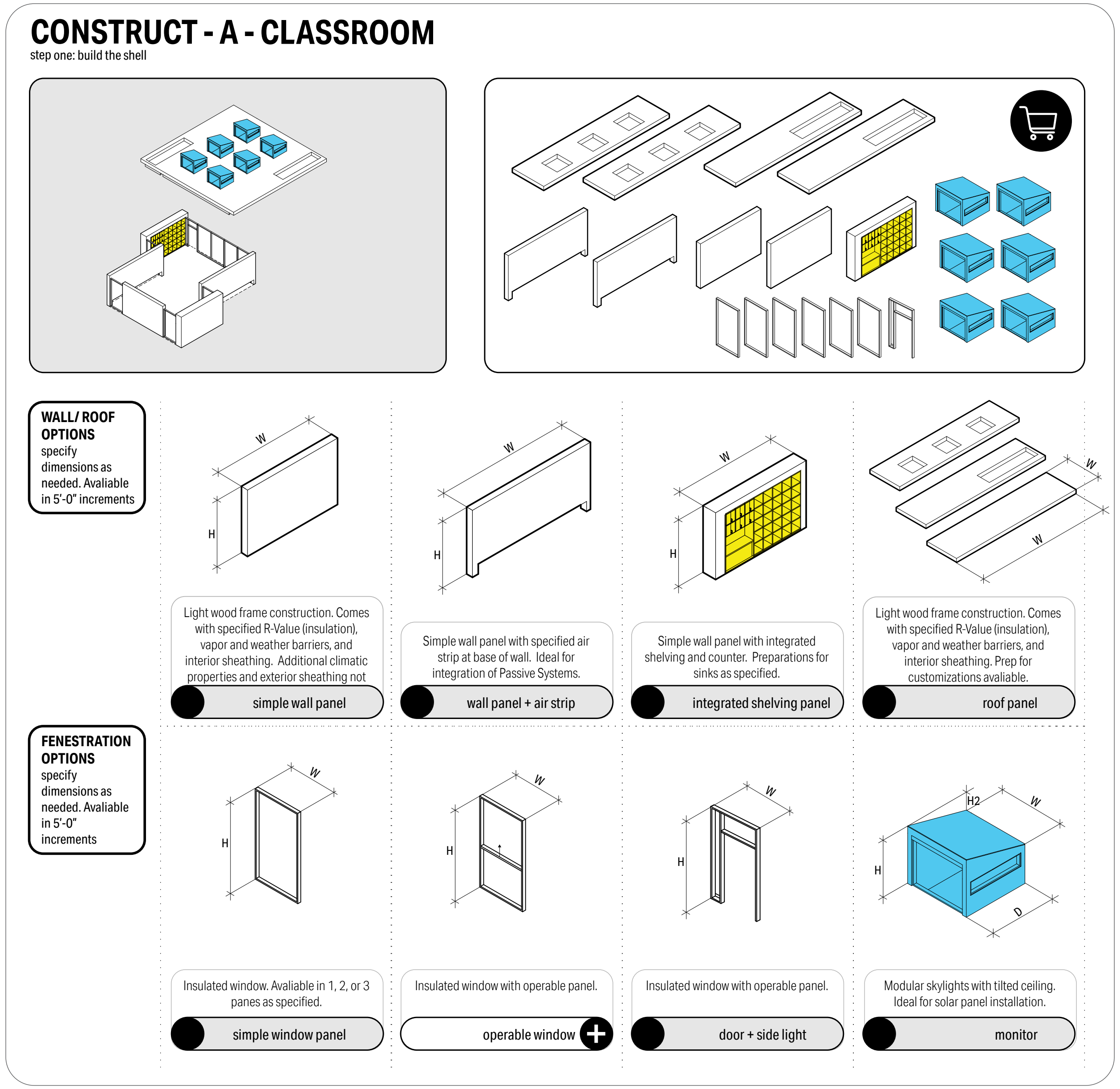


Fig #91 : Classroom catalog (see appendix)

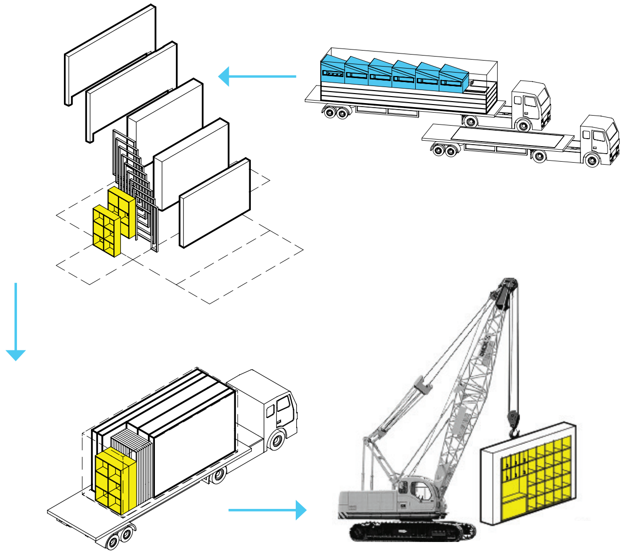
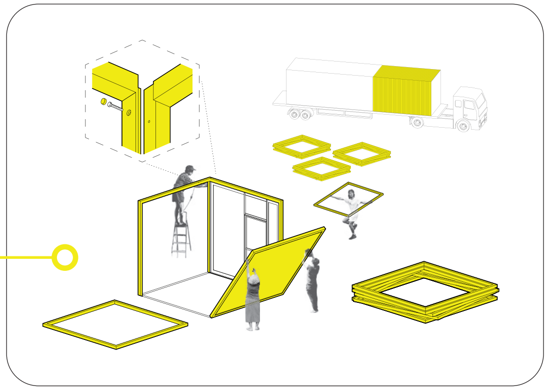


Fig #90 : Classroom construction (see appendix)

1 ENERGY PERFORMANCE
2 ENGINEERING
3 FINANCIAL FEASIBILITY
4 RESILIENCE
5 ARCHITECTURE
6 OPERATIONS
7 MARKET POTENTIAL
Prefabricated
Site Specific
Community Engagement
8 COMFORT & ENV. QUALITY
9 INNOVATION



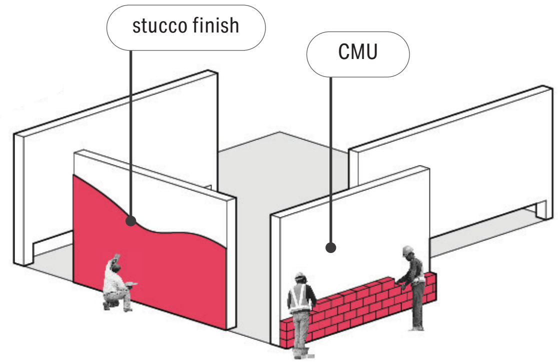


Fig #92 : Site specific classroom materials (see appendix)

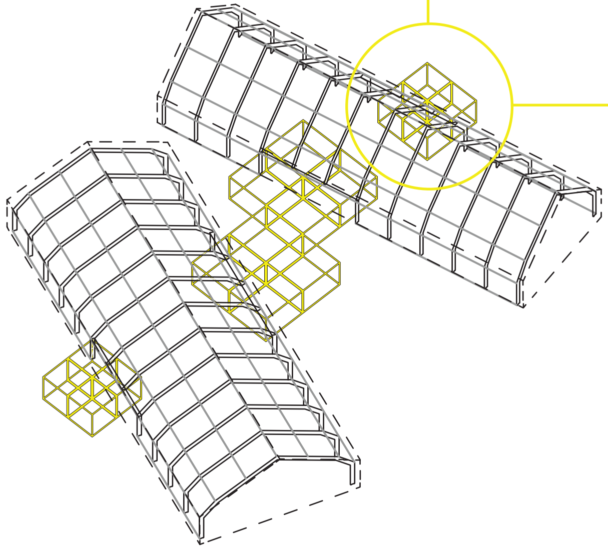


Fig #91 : Site specific community buildings + pavilions

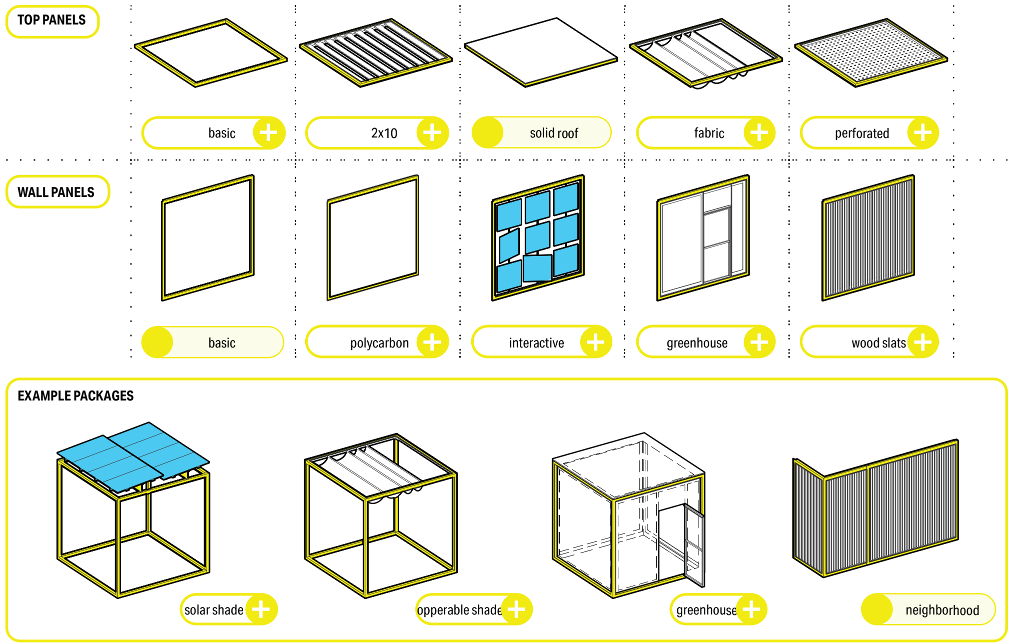


Fig #93 : Pavilion catalog (see appendix)

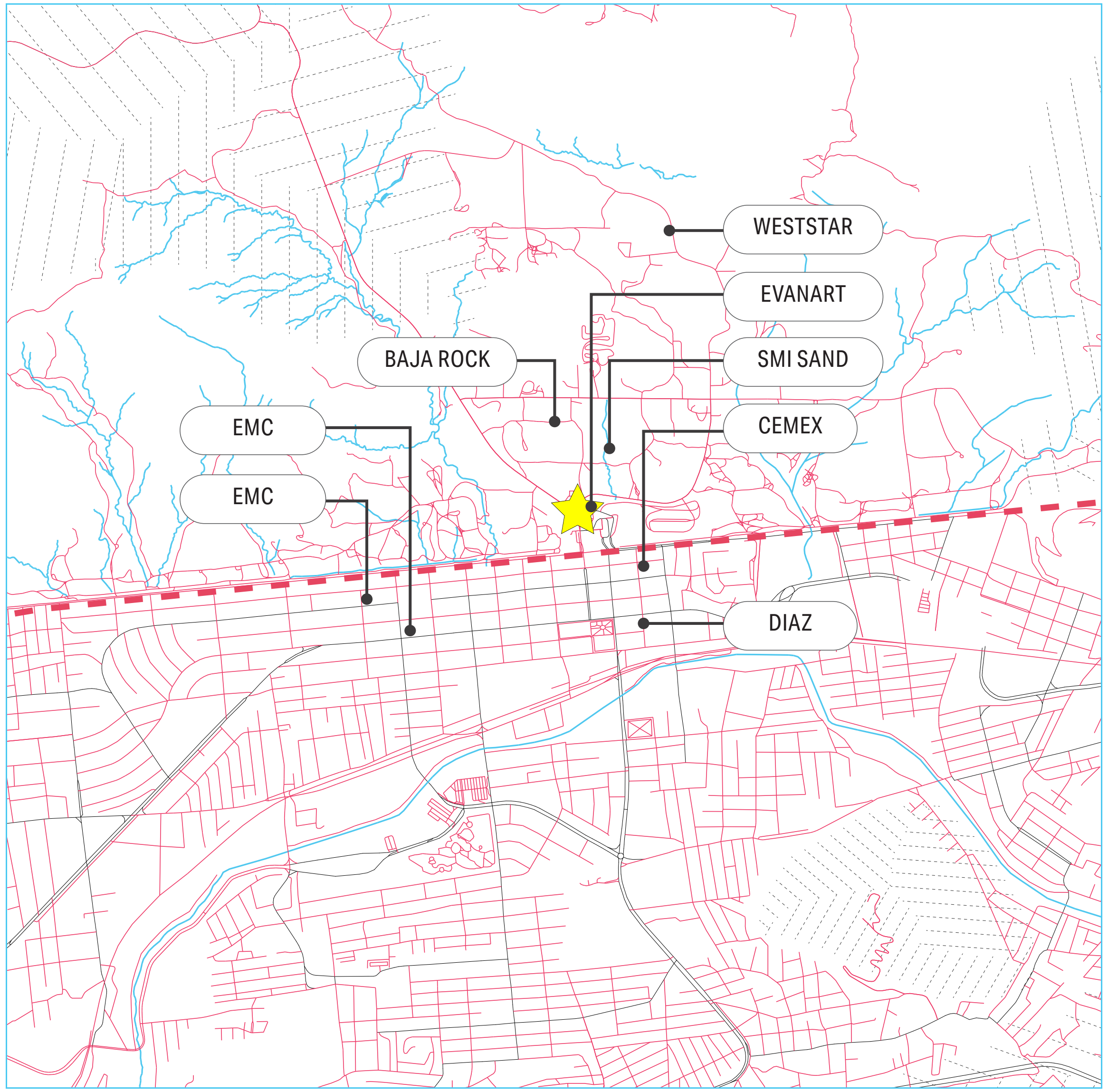


Fig #94 : potential ollaborators

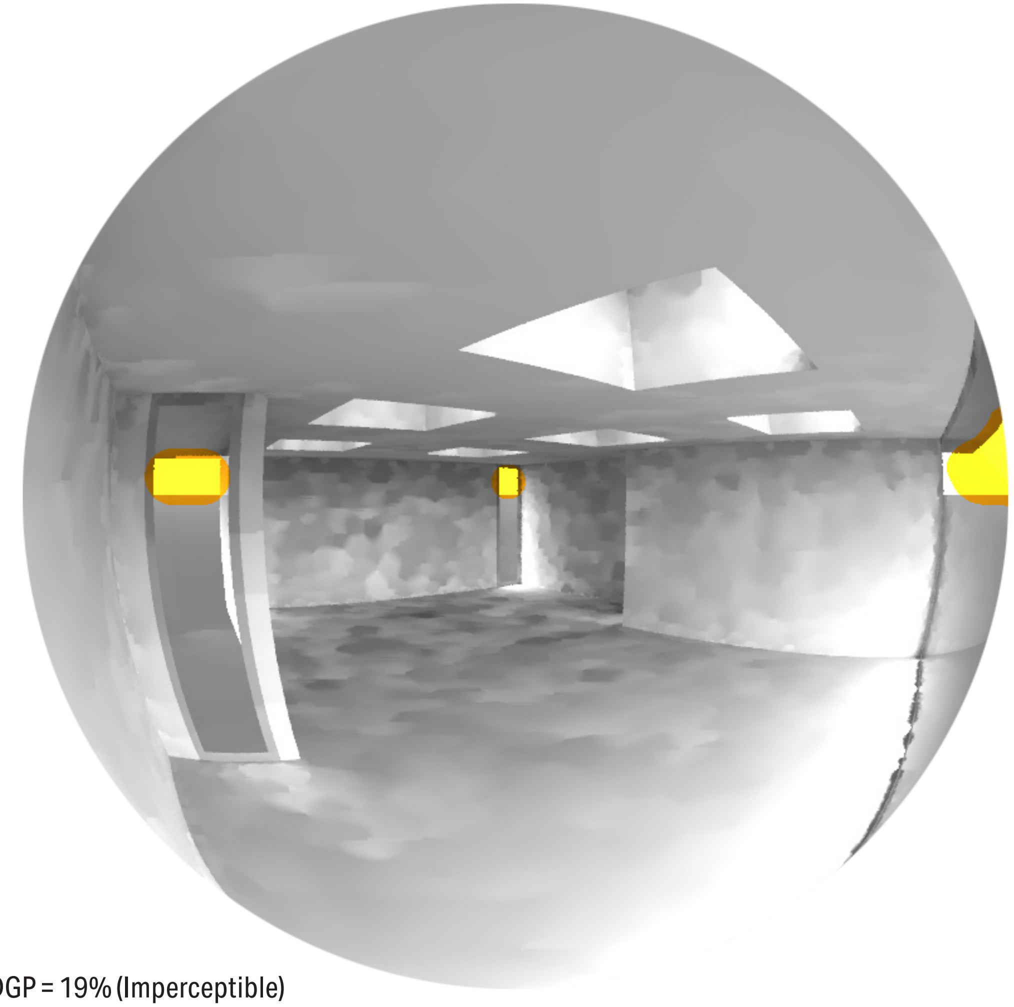
BUSINESSES KEY

394 FT EVANART: Steel fabricator
1.2 MI CEMEX: Concrete manufacturer + supplier
1.3 MI SMI SAND: Building materials supplier
1.4 MI BAJA ROCK: Landscape designers
1.6 MI DIAZ CONSTRUCTION: Building materials supplier
2.1 MI EMC: Commercial HVAC contractor
2.3 MI MG TALLER: Electrician
4.1 MI WESTSTAR: General contractors

INTERACTIVE RELATIONSHIPS

RECIPROCAL ENERGY

KIDS AS STEWARDS



DGP = 19% (Imperceptible)

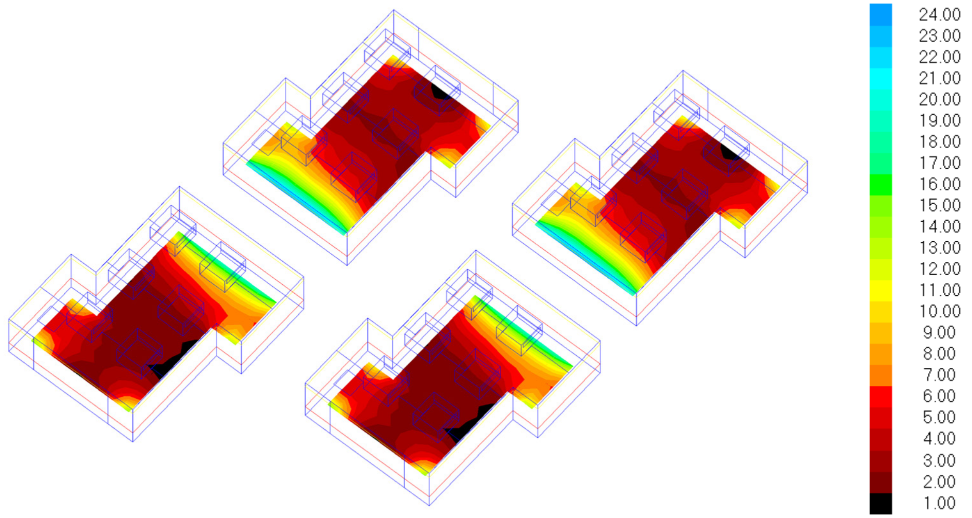
Fig #95 : classroom daylighting

ENGINEERED SYSTEMS ON DISPLAY TEACH STUDENTS THE REALITY OF HOW BUILDINGS PROVIDE SHELTER, ONE PART OF THE STUDENTS' JOURNEY TO BECOME RESPONSIBLE STEWARDS OF THE ENVIRONMENT.

CLASSROOM CLUSTERS

DAYLIGHT FACTOR % ANALYSIS

100% workplane area above DF threshold (5%)



RADIATION ANALYSIS - EXTERIOR

winter solstice

equinox

summer solstice

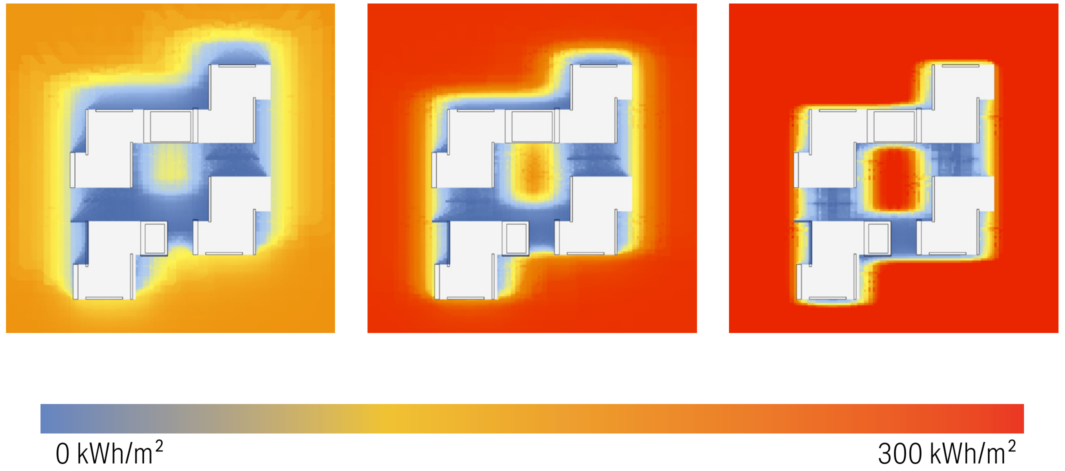
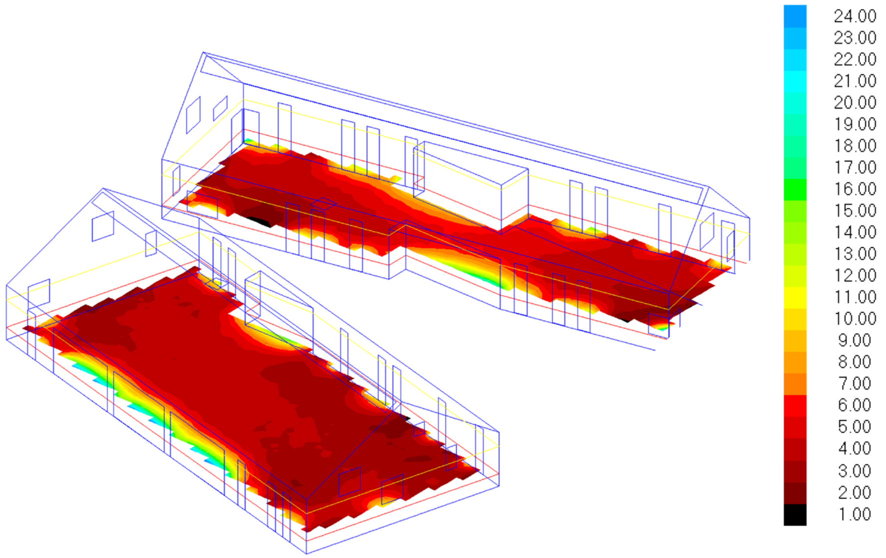


Fig #96 : classroom radiation analysis

COMMUNITY CLUSTER

DAYLIGHT FACTOR % ANALYSIS

100% workplane area above DF threshold (5%)

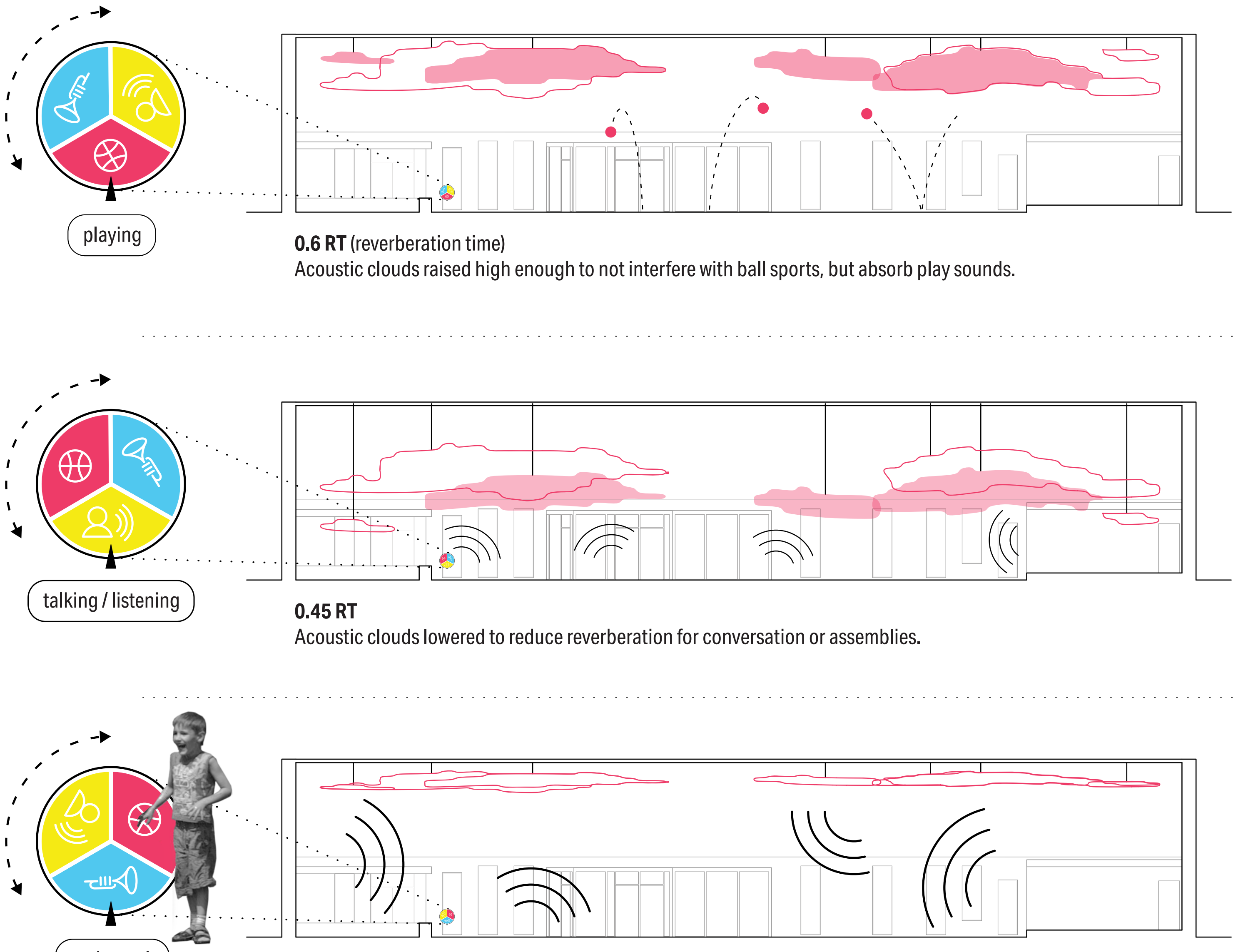


RADIATION ANALYSIS - EXTERIOR

winter solstice | equinox | summer solstice

Fig #97 : community cluster radiation analysis

AUDIBLE EXPERIMENTS



0.6 RT (reverberation time)
Acoustic clouds raised high enough to not interfere with ball sports, but absorb play sounds.

0.45 RT
Acoustic clouds lowered to reduce reverberation for conversation or assemblies.

1.2 RT
Acoustic clouds pulled to the very top of the space to create a live sound, good for orchestral concerts.

Fig #98 : community acoustic operations

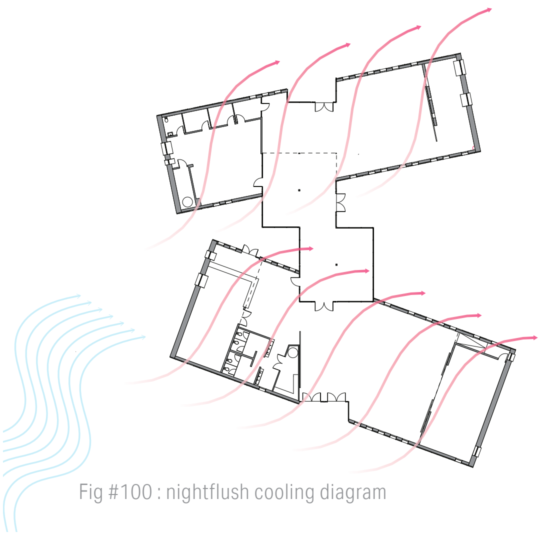


Fig #100 : nightflush cooling diagram

NIGHT FLUSH

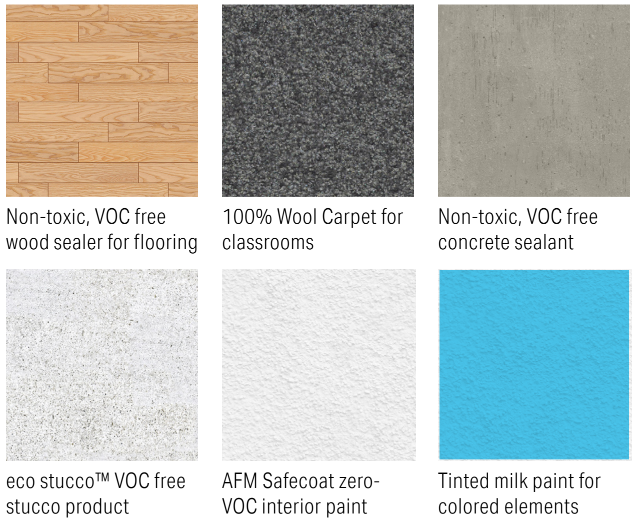


Fig #101 : material swatches

RED LIST

Living Building Challenge
RED LIST MATERIALS & CHEMICALS

- Alkylphenols
- Asbestos
- Bisphenol A (BPA)
- Cadmium
- Chlorinated Polyethylene and Chlorosulfonated Polyethylene
- Chlorobenzenes
- Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs)
- Chloroprene (Neoprene)
- Chromium VI
- Chlorinated Polyvinyl Chloride (CPVC)
- Formaldehyde (added) • Halogenated Flame Retardants (HFRs)
- Lead (added)
- Mercury
- Polychlorinated Biphenyls (PCBs)
- Perfluorinated Compounds (PFCs)
- Phthalates
- Polyvinyl Chloride (PVC)
- Polyvinylidene Chloride (PVDC)
- Short Chain Chlorinated Paraffins
- Wood treatments containing Creosote, Arsenic or Pentachlorophenol
- Volatile Organic Compounds (VOCs) in wet-applied products

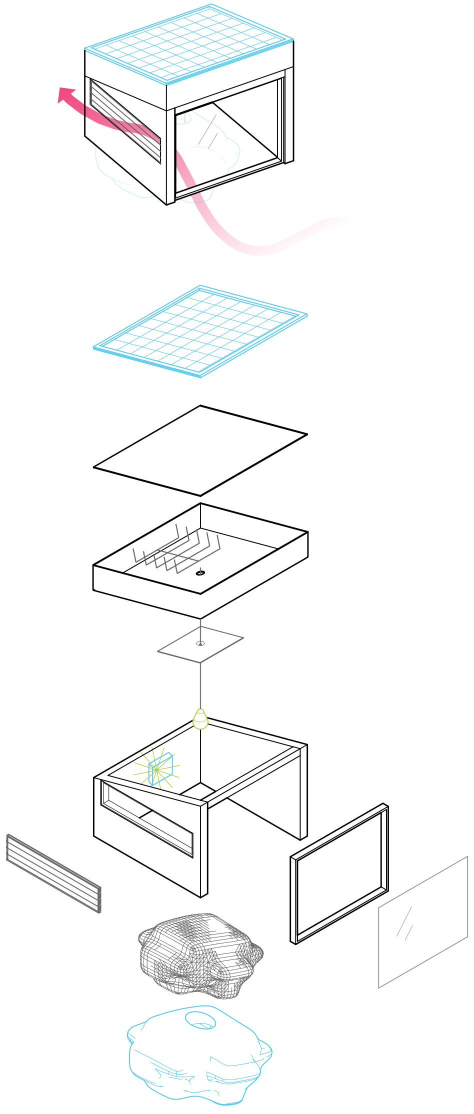
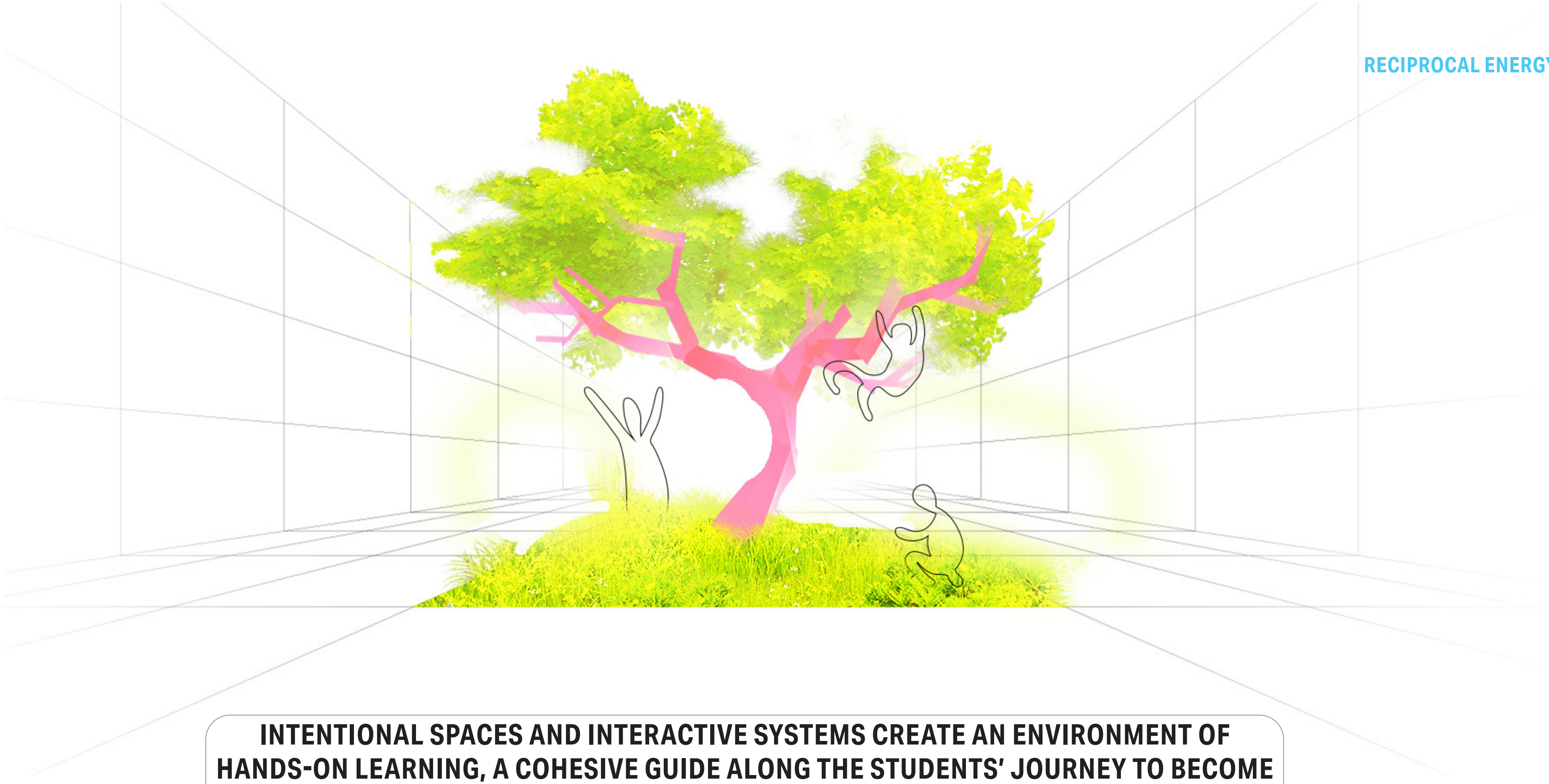


Fig #102 : monitor axon - ventilation

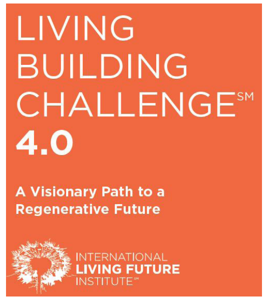
BEAUTY IS FOR EVERYONE
EMERGENT PLAY
KIDS AS STEWARDS
INHABITABLE THRESHOLD
RECIPROCAL ENERGY



INTENTIONAL SPACES AND INTERACTIVE SYSTEMS CREATE AN ENVIRONMENT OF HANDS-ON LEARNING, A COHESIVE GUIDE ALONG THE STUDENTS' JOURNEY TO BECOME RESPONSIBLE STEWARDS OF THE ENVIRONMENT.

1 ENERGY PERFORMANCE
2 ENGINEERING
3 FINANCIAL FEASIBILITY
4 RESILIENCE
5 ARCHITECTURE
6 OPERATIONS
7 MARKET POTENTIAL
8 COMFORT & QUALITY
9 INNOVATION
Living Building Challenge
Kit of Parts
Specimens on a Field
Interactive Relationships

INSPIRED BY SUCCESS



MATERIALS
Responsible Materials
No Red List Materials
Responsible Sourcing
Living Economy Sourcing
Net Positive Waste

WATER
Responsible Water Use
Net Positive Water

HEALTH & HAPPINESS
Healthy Indoor Environment
Healthy Interior Performance
Access to Nature

ENERGY
Energy + Carbon Reduction
Net Positive Carbon

PLACE
Ecology of Place
Urban Agriculture
Habitat Exchange
Human-Scaled Living

BEAUTY
Beauty + Biophilia:
Inspiration + Education:

EQUITY
Universal Access
Inclusion

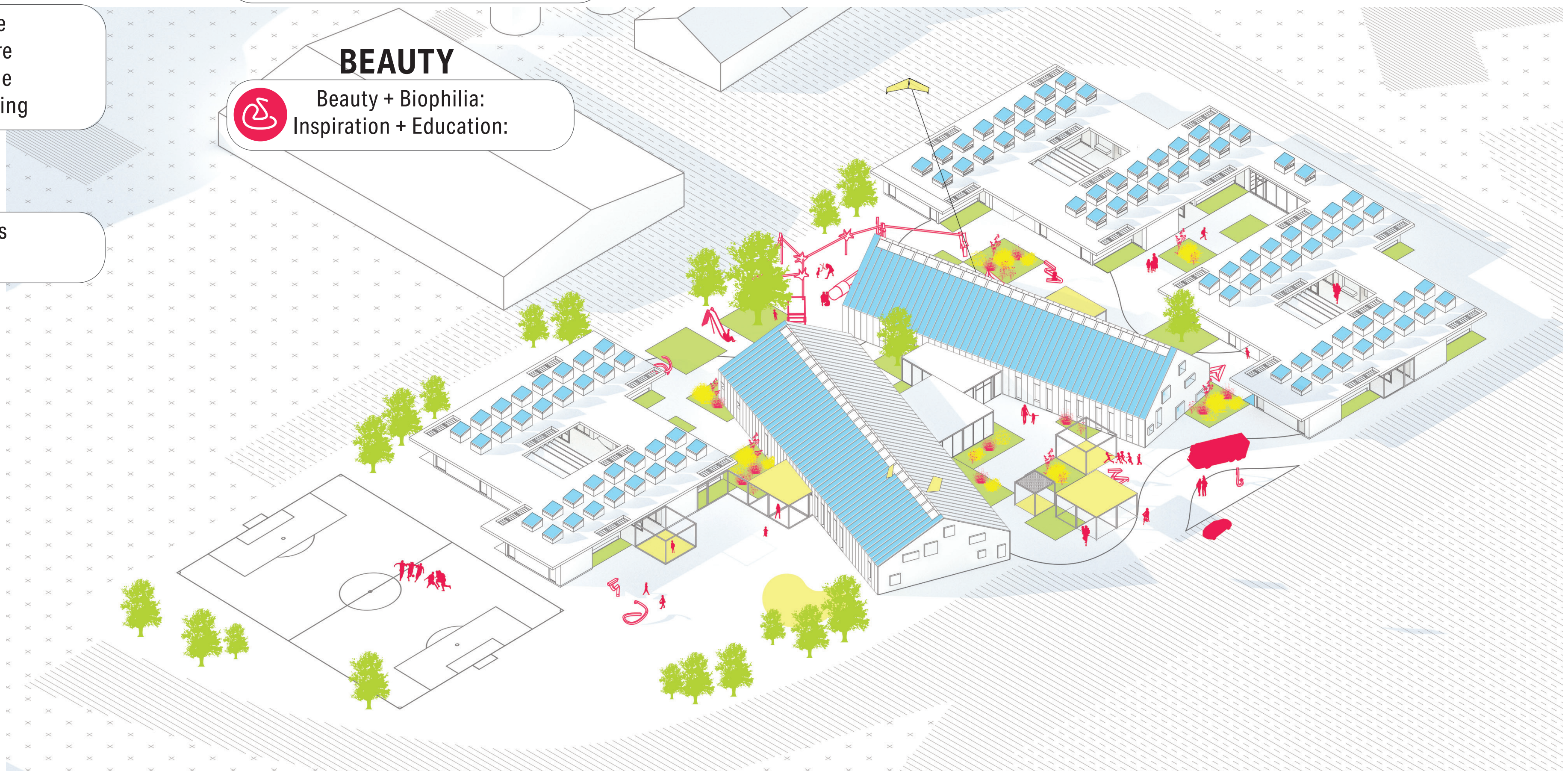


Fig #103: living building challenge axon

PRE-FAB VS SPECIFIC

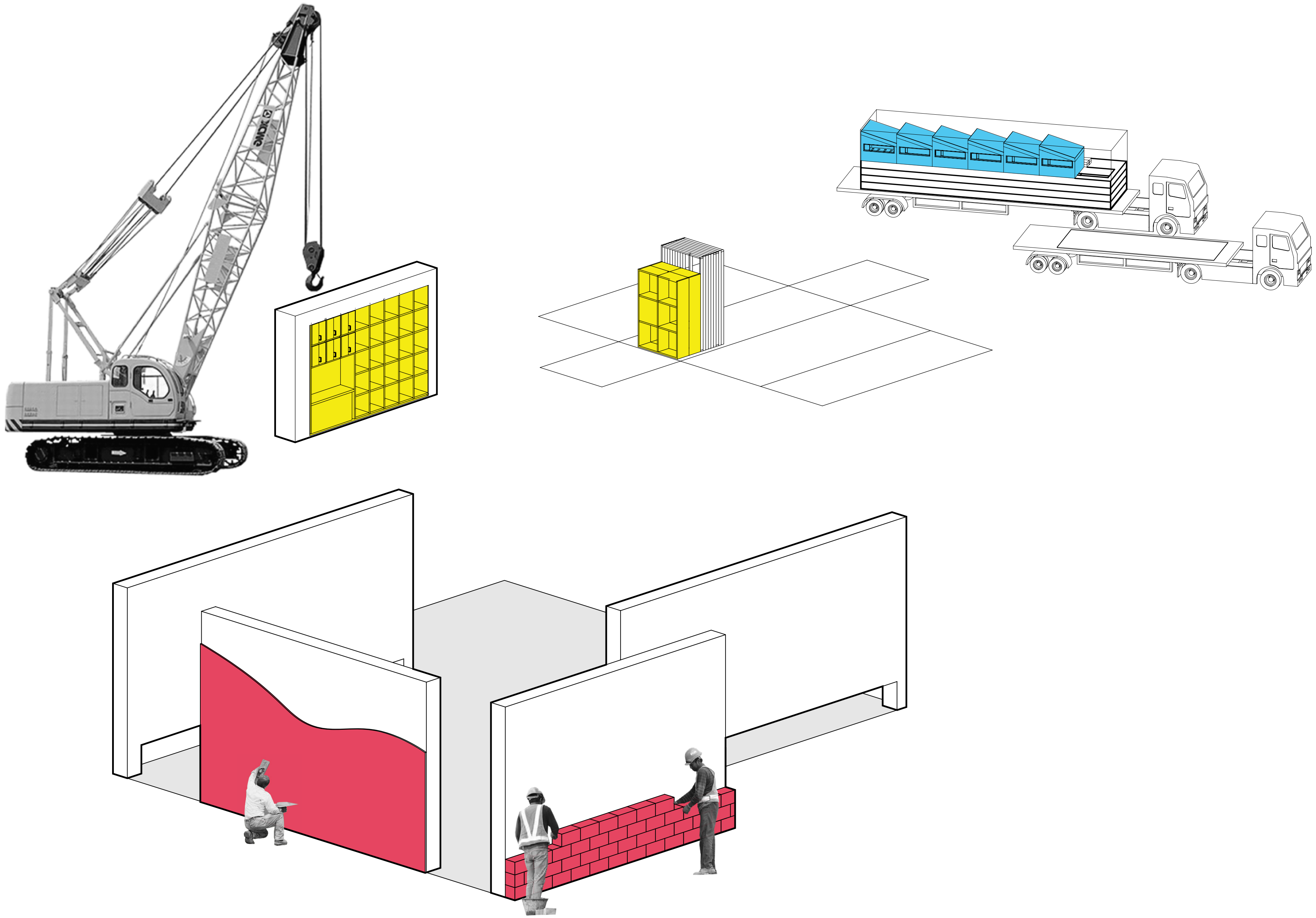
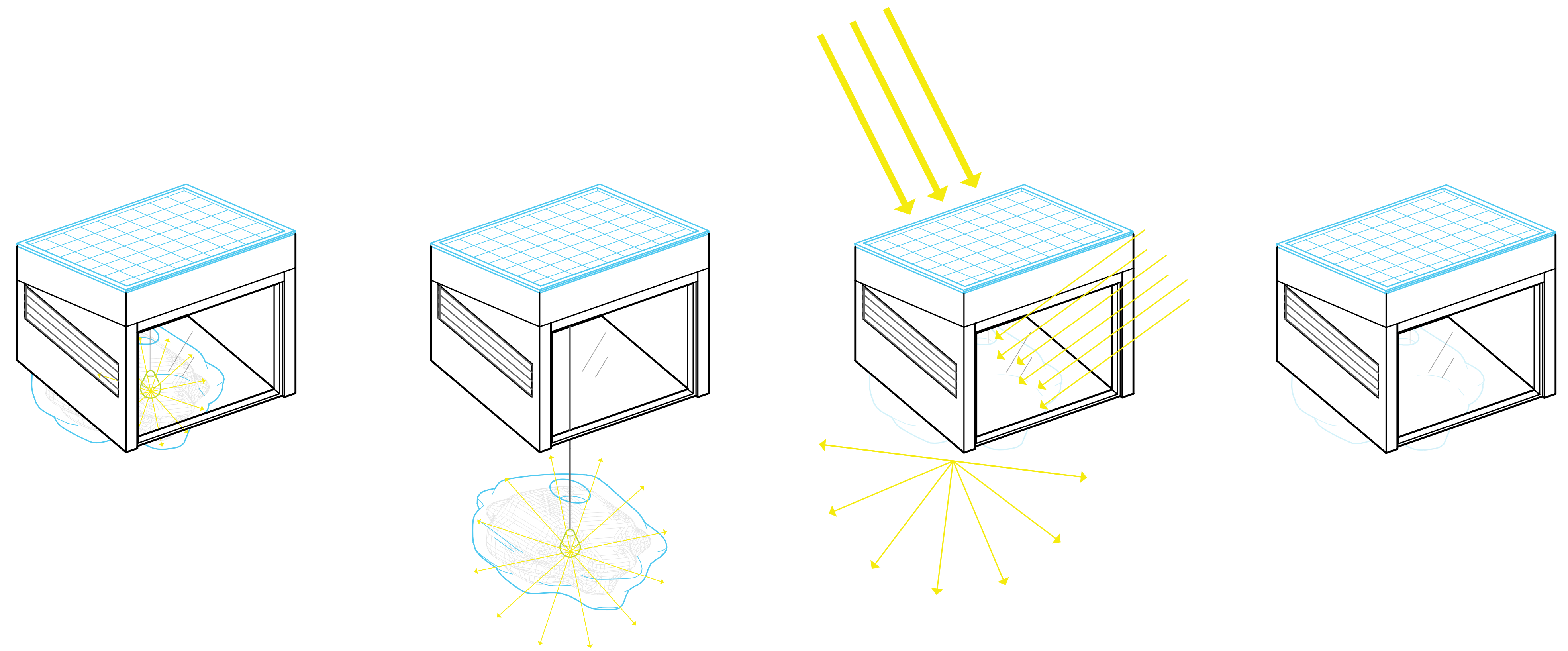


Fig #105: pre-fab vs site specific construction

BREAKING DOWN COMPLEX IDEAS



CLOUD UP + LIGHT ON

Maintain general lighting conditions in response to daylighting

CLOUD DOWN + LIGHT ON

Illuminate detail oriented tasks with more direct light

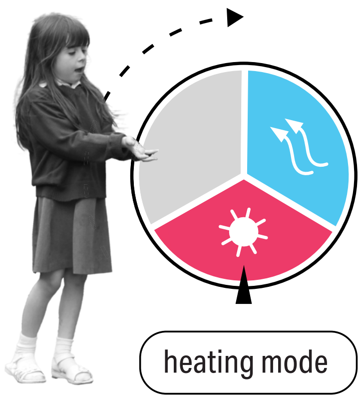
CLOUD UP + LIGHT OFF

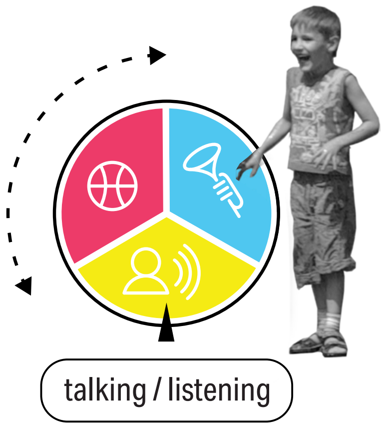
Diffuse daylighting with cloud for even interior illumination

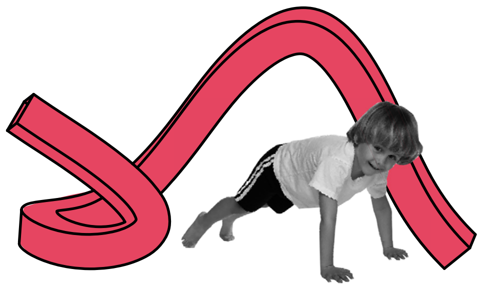
VENTS OPEN

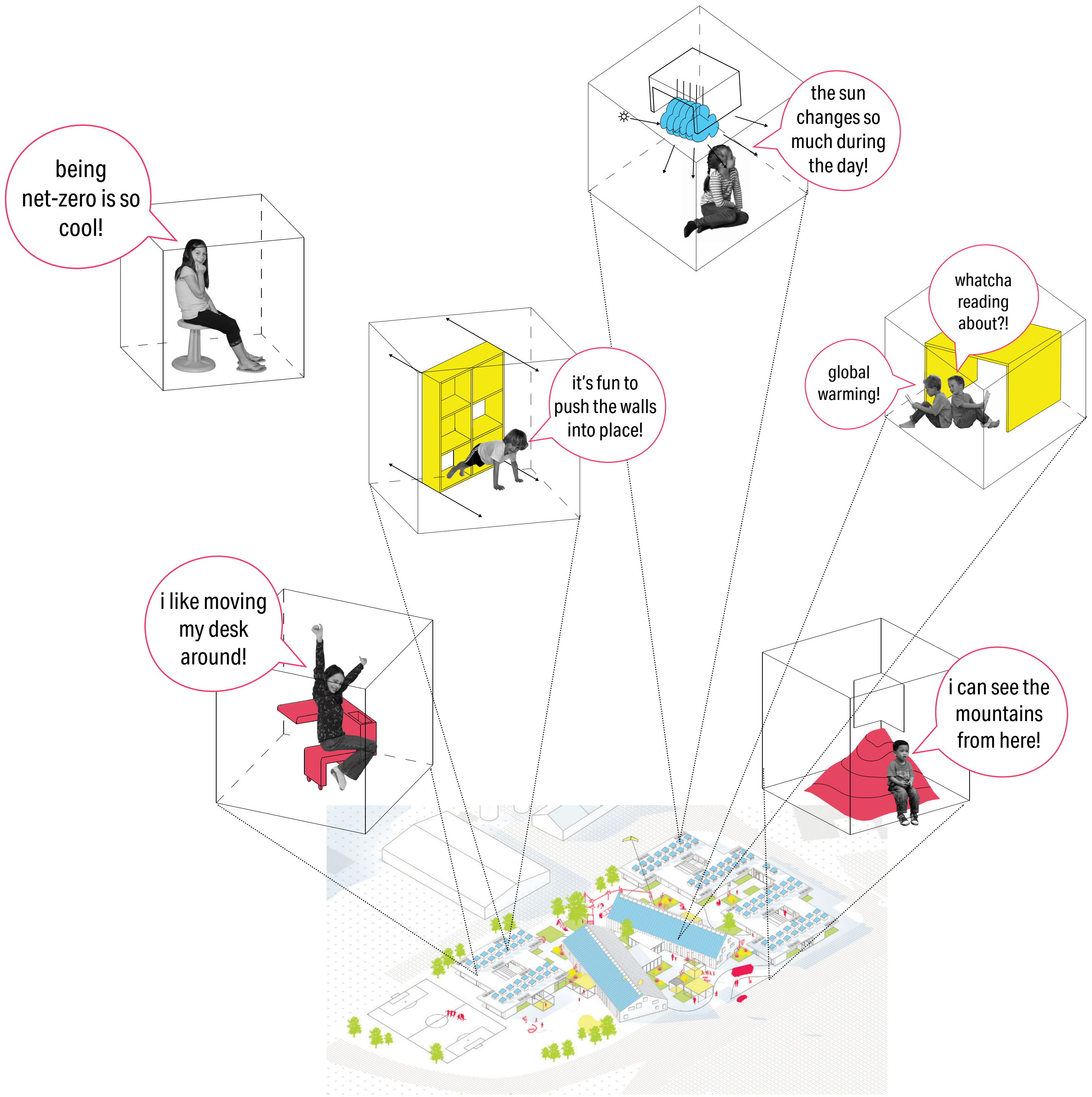
Facilitate ventilation and heating through vents

HANDS-ON EXPERIENCE



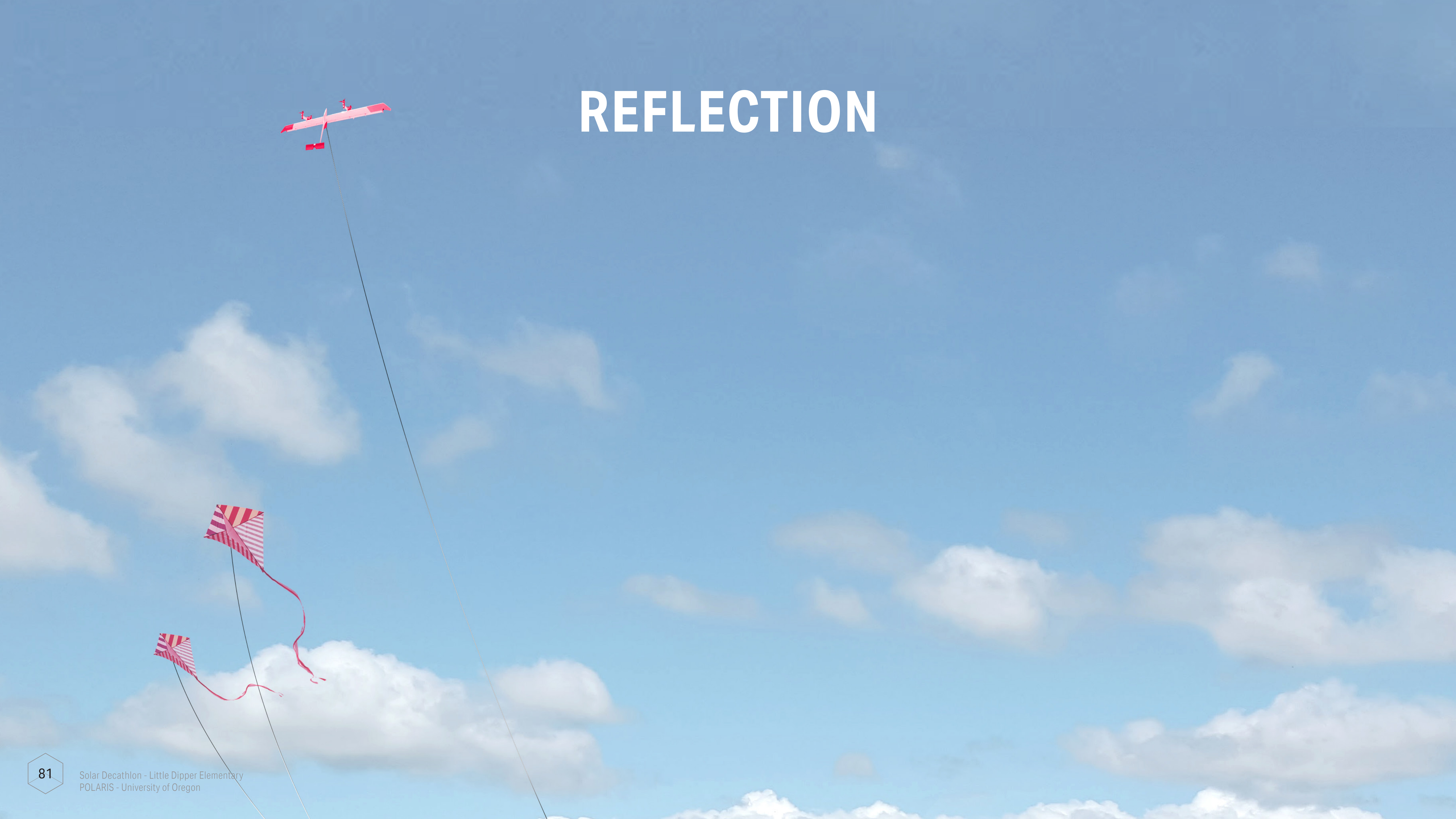






REFLECTION

REFLECTION



HOW CAN DESIGN INSPIRE CHILDREN TO BE RESPONSIBLE STEWARDS ?

Thank You

U.S. Department of Energy
Solar Decathlon Organizers
Solar Decathlon Jurors

Ihab Elzeyadi
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