INCLUSIVE & SUSTAINABLE HOUSING IN CAPE TOWN

Inclusive & Sustainable Housing in Cape Town

Prepared by:

Amy Koshy

With the help of:

Tommaso Bitossi

Matthias Rammig

Source : Chim, Dercio. "Cape Town CBD." 2015. JPEG

CONTEXT

POPULATION

3.8
Million

INFORMAL HOUSING

1.2
Million

SOUTH AFRICA

CAPE TOWN

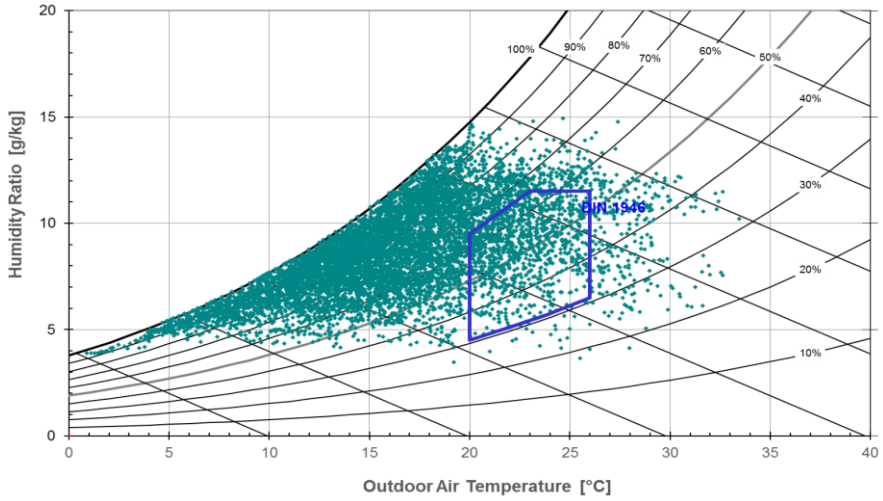
Located at the southernmost tip of the African continent lies Cape Town in the Country, South Africa.

Roughly 25% of the city's population lives in informal housing in locations far from developed areas.

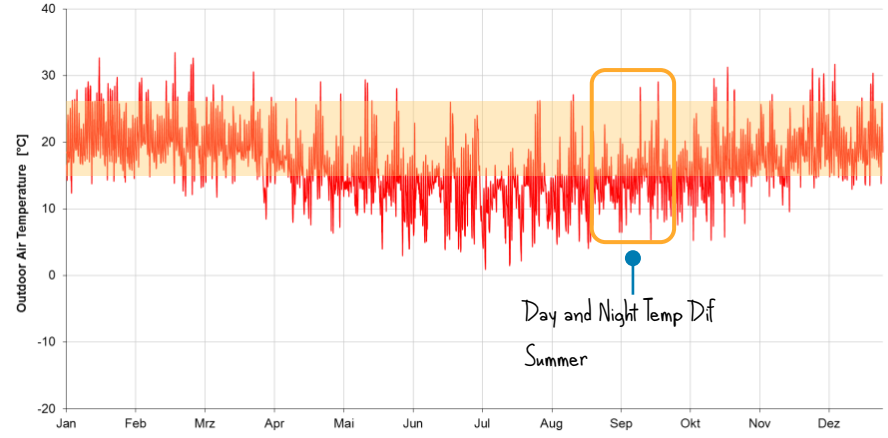
Source Nair Gokul. "Cape Town city center & mountains" 2015. JPEG

CLIMATE ANALYSIS

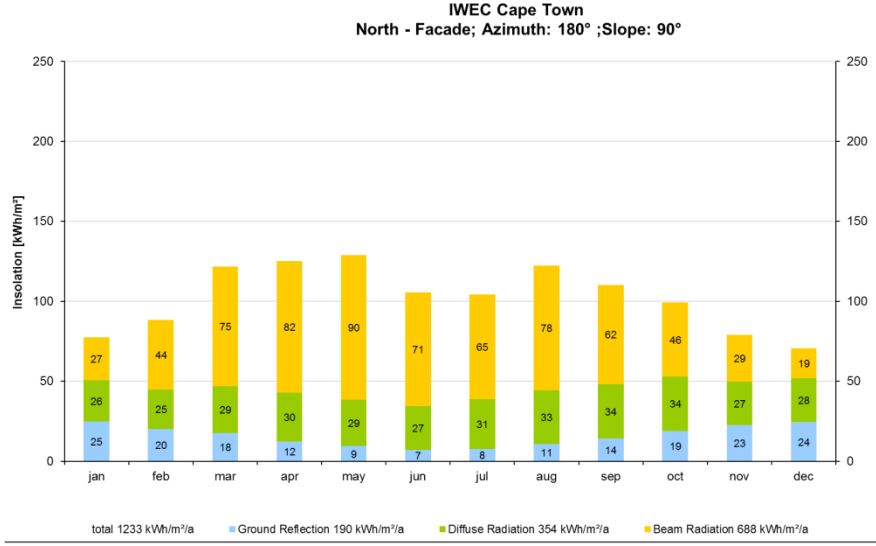
PSYCHROMETRIC CHART : IWEC CAPE TOWN



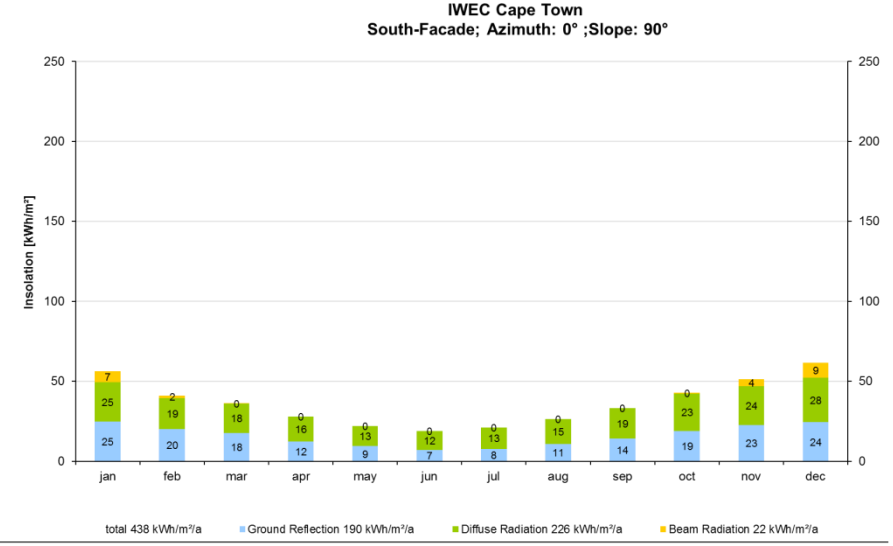
OUTDOOR AIR TEMPERATURE



NORTH FACADE RADIATION



SOUTH FACADE RADIATION



Outdoor Temperatures range from 3°C to 35°C

Humidity is generally not a major issue.

Adequate day and night temperature shifts occur to make use of thermal mass.

More solar radiation occurs on the Northern Surfaces than other horizontal surfaces.

Transsolar "Auswertung excel tool" 2015. Graph

ISSUES

ISSUES facing the City of CAPE TOWN

- City segregated
- Lack of housing
- Inverse densification
- Low densities & safety
- Electricity shortage

Source : Johnny Miller/Millefoto
http://unequalscenes.com

INCLUSIVE AND SUSTAINABLE HOUSING IN THE CITY CENTRE

OFFICE VACANCY REPORT

INCLUSIVE AND SUSTAINABLE HOUSING IN THE CITY CENTRE

Available **UNDERUTILIZED SPACES** in the city.

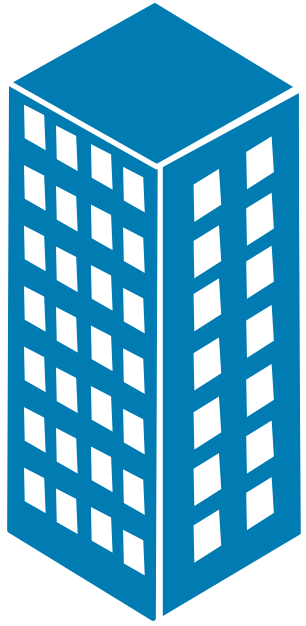
1 006 500 m2 office space.

Built in Contemporary style of Western typologies rather than surrounding conditions.

Source : Emil Koshy. "Typical office buildings." 2016

PROCESS

OFFICE



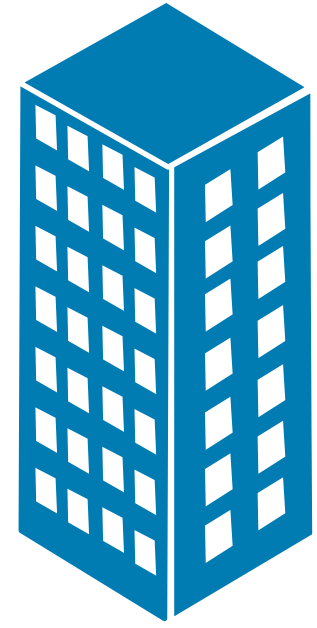
HIGH COMFORT

NO SYSTEM

LOW MAINTENANCE

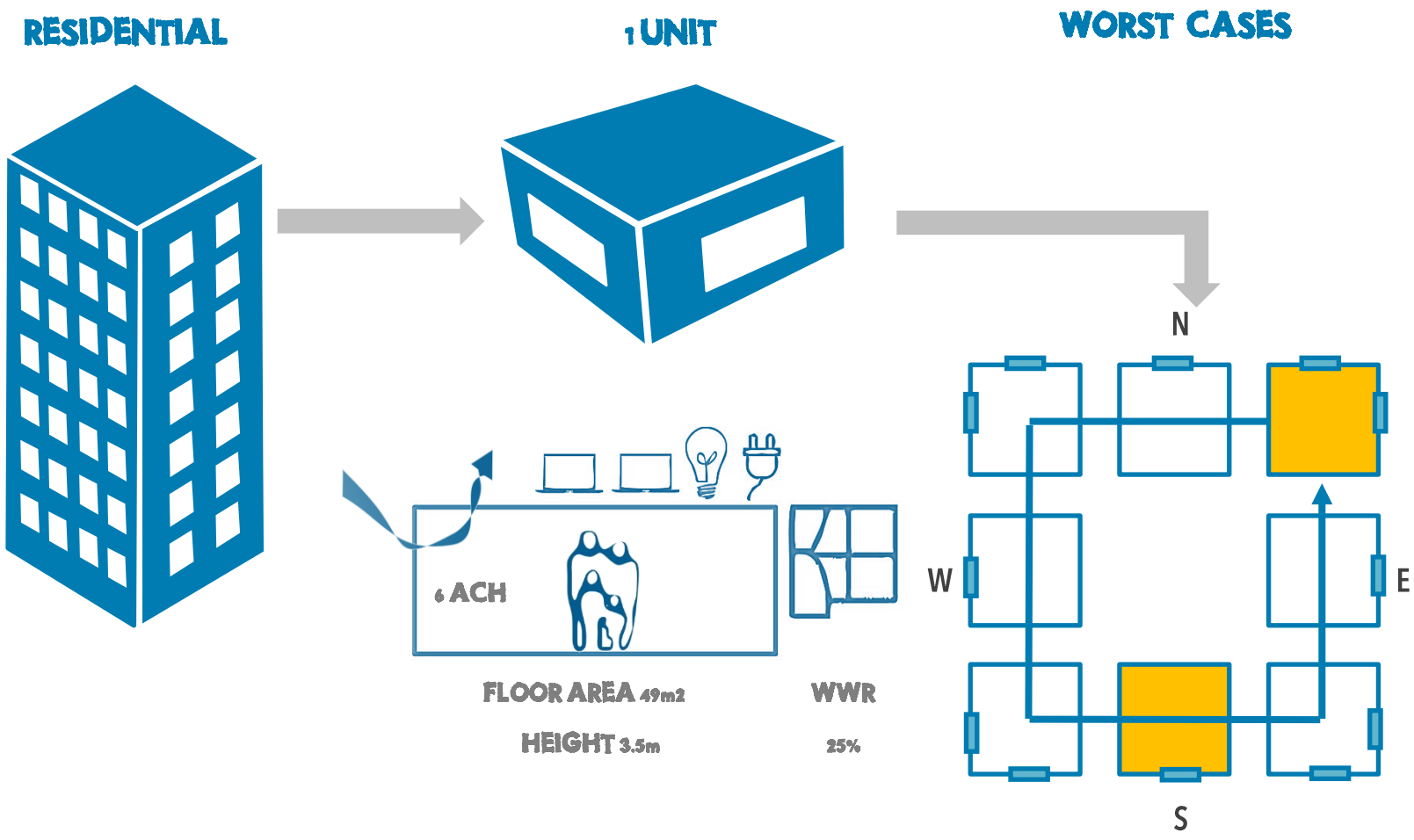
AFFORDABLE

RESIDENTIAL



How can we convert underutilized OFFICE spaces for RESIDENTIAL use and provide high comfort that is affordable and sustainable?

WORST CASE SCENARIO



The smallest/WORST CASE residential unit within an office tower, is tested to establish existing comfort conditions.

If comfort can be achieved on worst performing spaces....

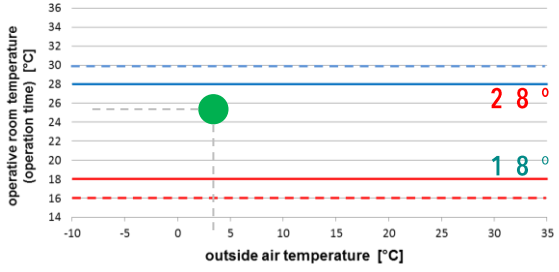
COULD we possibly achieve comfort for ALL ORIENTATIONS ?

COMFORT CRITERIA AND INDICATORS

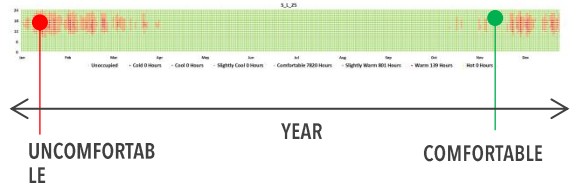
20 Degrees in Germany

20 Degrees in South Africa

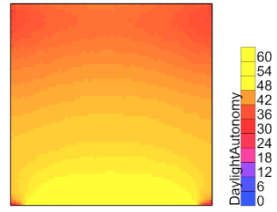
The experience of Comfort may differ from person to person. The average temperature comfort range for a Capetonian ranges between 18° C and 28° C.



< 1 PMV



DA 300 lux target 50%



Sources :
'Chiling on the beach'
http://9gag.com/gag/aPWvNrn
'Freaking Cold'
http://runmygutsout.blogspot.de/2011/12/what-to-wear-winter-running-edition.html

COMFORT RESULTS

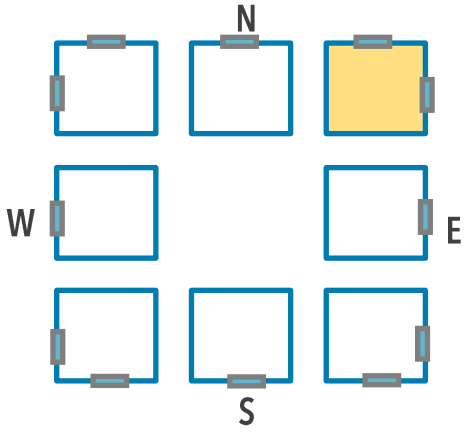
The Indicators used to assess comfort are (as seen on previous page)

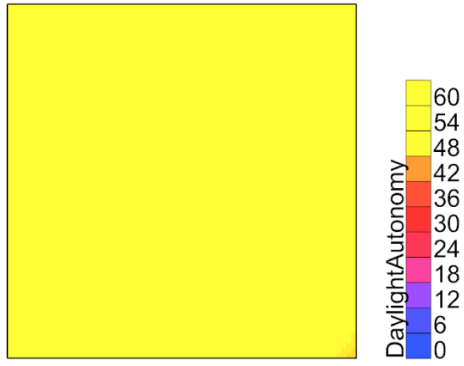
1.) Comfort Chart

2.) PMV Chart

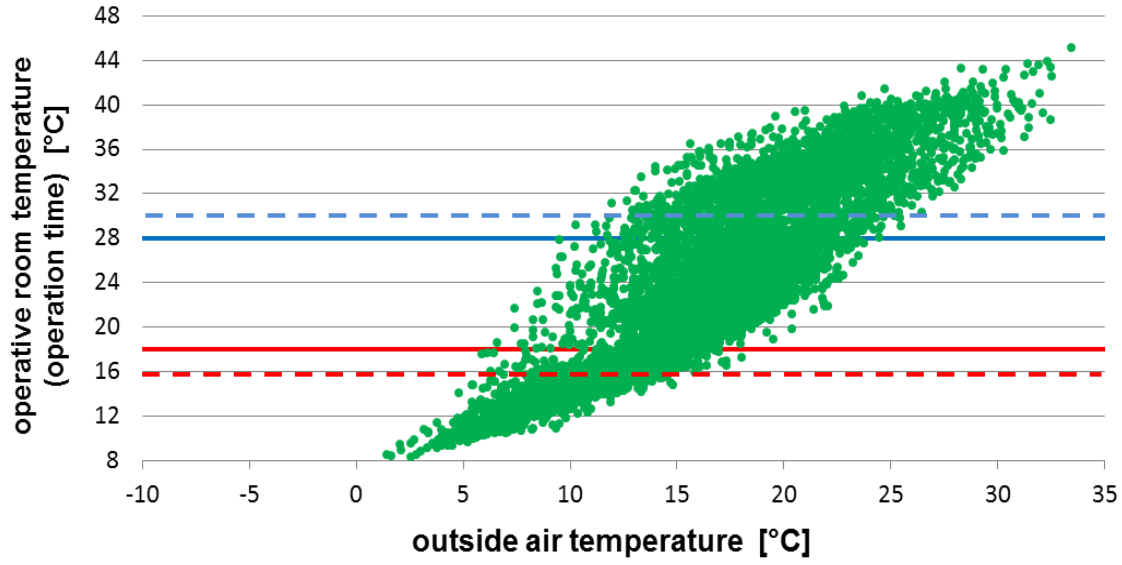
3.) Daylight Autonomy

NORTH EAST

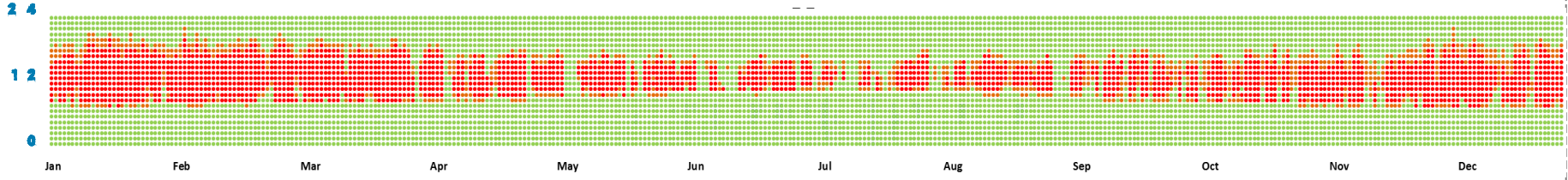




BASE CASE: 75% WWR; NO SHADING



71%, PMV>1



For the WARMEST SPACE :

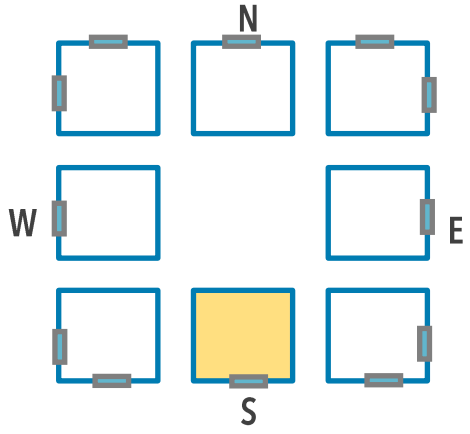
Operative T° : Issue Overheating

PMV : overheating during the day

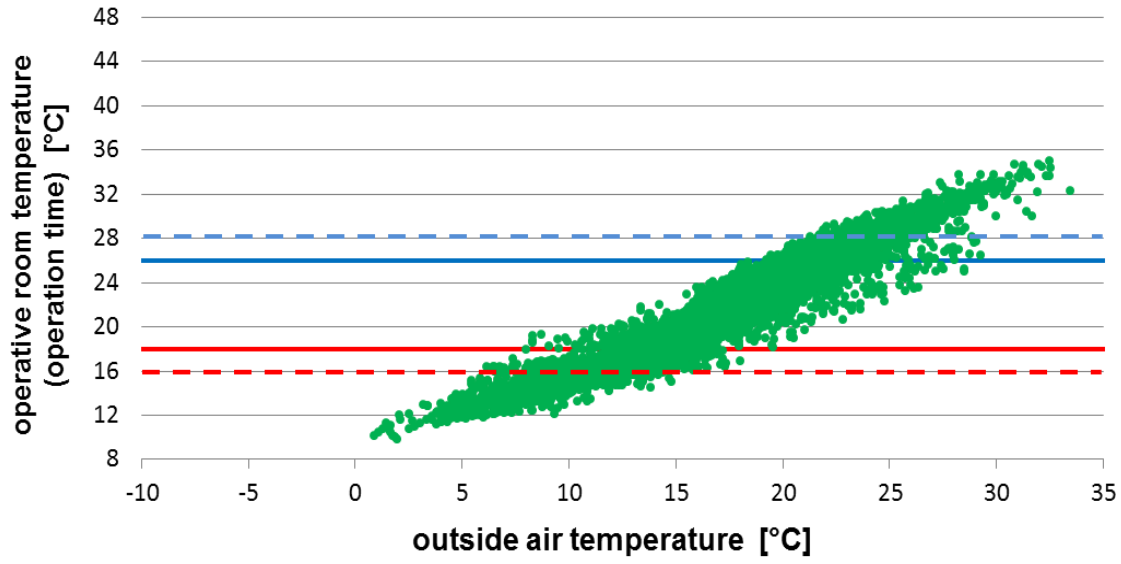
Daylight Autonomy : Achieved

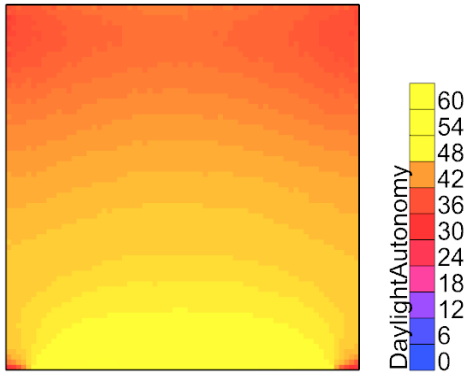
Synthesis : Solar Radiation main concern.

SOUTH

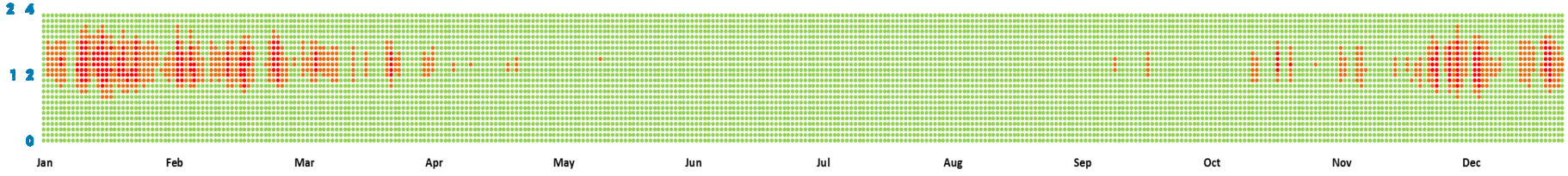


BASE CASE: 75% WWR; NO SHADING





93%, PMV > 1



For the COLDET SPACE

Operative T° : Bit Cold and Bit Warm

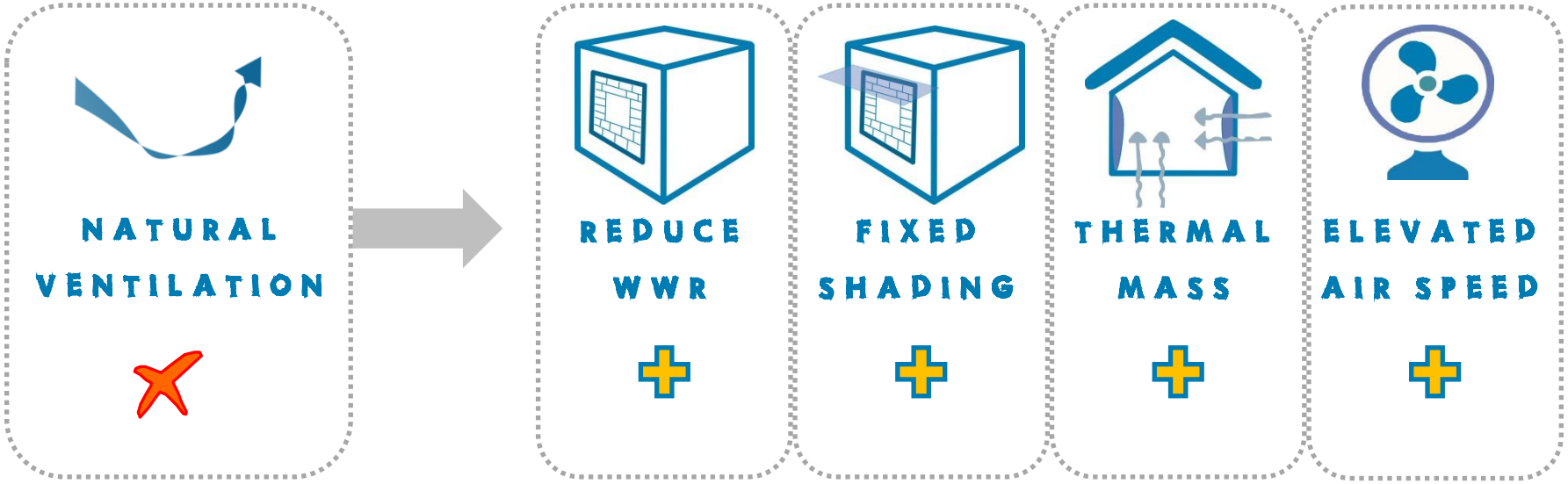
PMV: Warm in summer months but comfortable.

Daylight Autonomy : 50% floor achieves adequate daylight.

Synthesis : Solar Radiation in summer main concern.

NEXT STEPS

AFFORDABLE STRATEGIES FOR COOLING



HIGH COMFORT ?

Since natural ventilation alone cannot achieve comfort

These 4 affordable strategies are further tested :

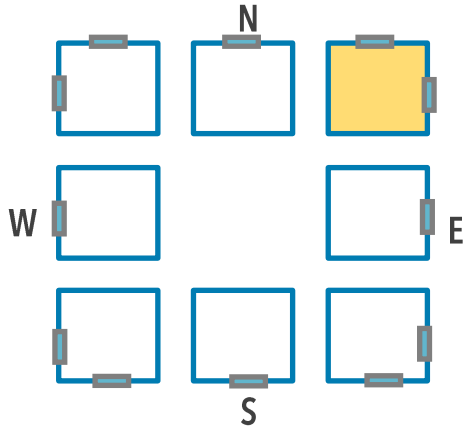
Reduce WWR were windows are larger than 75%.

Apply fixed shading element.

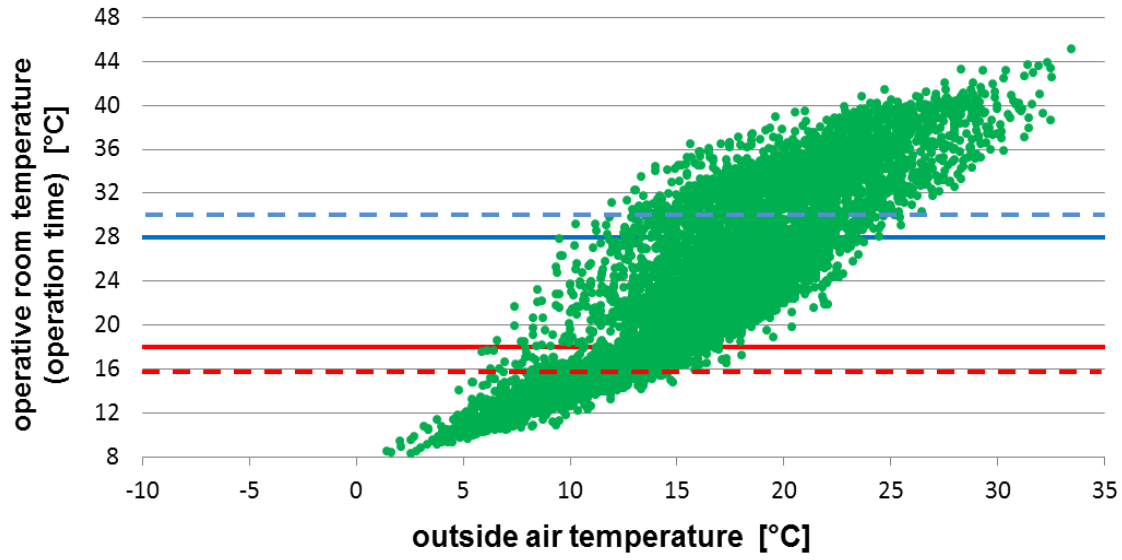
Increase thermal mass were mass is lacking.

Provide fans for increased airflow.

NORTH EAST



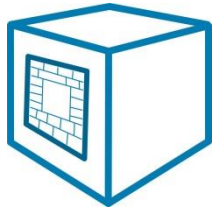
75% WWR



REDUCTION AGAINST BASECASE

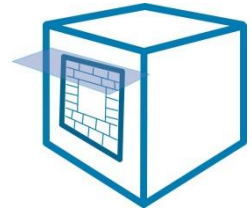
$T^{\circ} > 28^{\circ}$

25% WWR



58%

FIXED SHADING



44%

THERMAL MASS

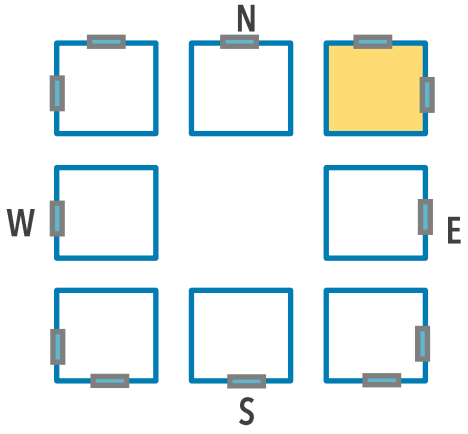
36%

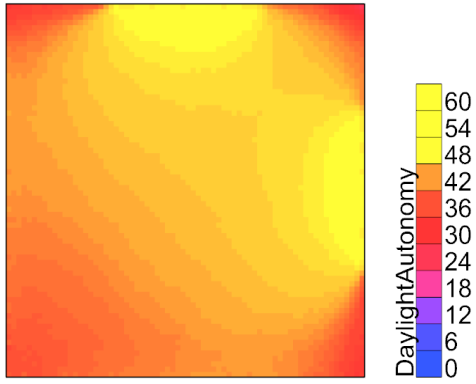
According to base case results . Solar gains are the main cause of overheating.

Each strategy presented was tested to see which strategy has the greatest impact versus the least.....

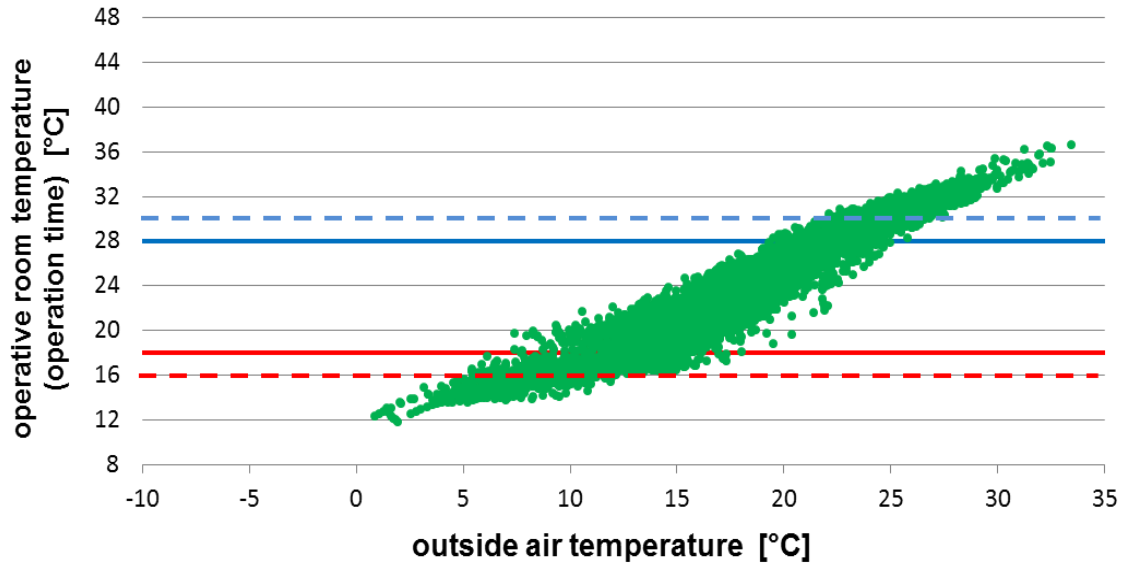
This is done to prioritize strategies for assessment.

NORTH EAST

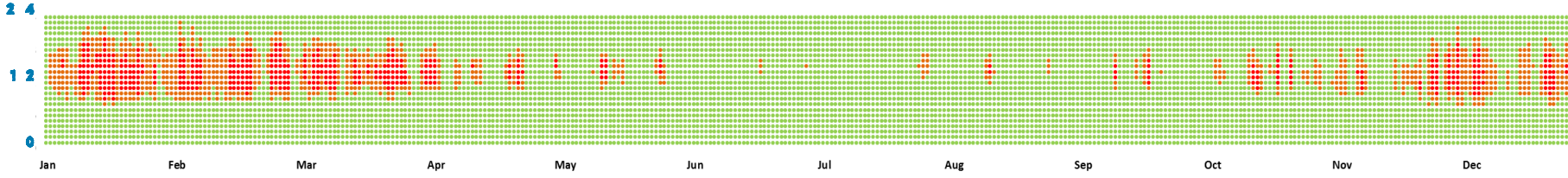




25 % WWR



87 % PMV > 1



Based on the best performing STRATERGY

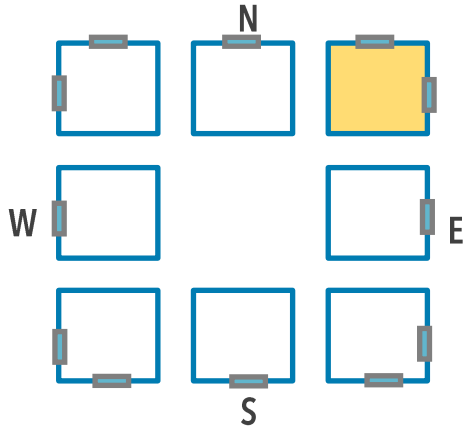
What happens if we have LESS GLAZING?

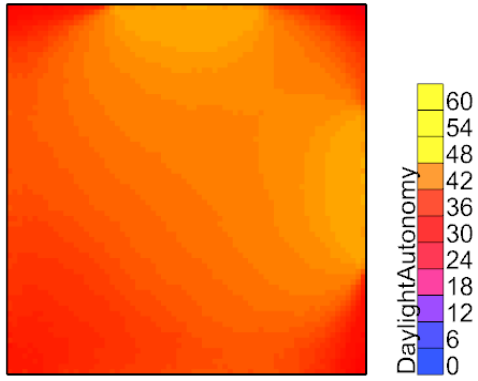
Daylight Autonomy : 50% floor achieves adequate daylight.

SYNTHESIS : Improvement in Thermal comfort.

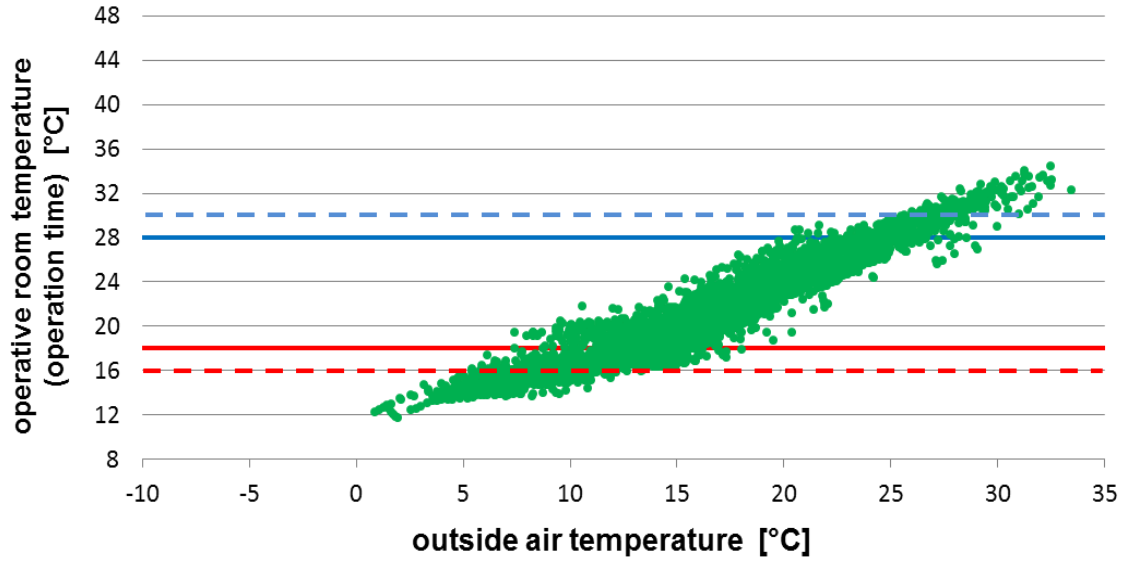
Daylight rooms designed closer to windows.

NORTH EAST

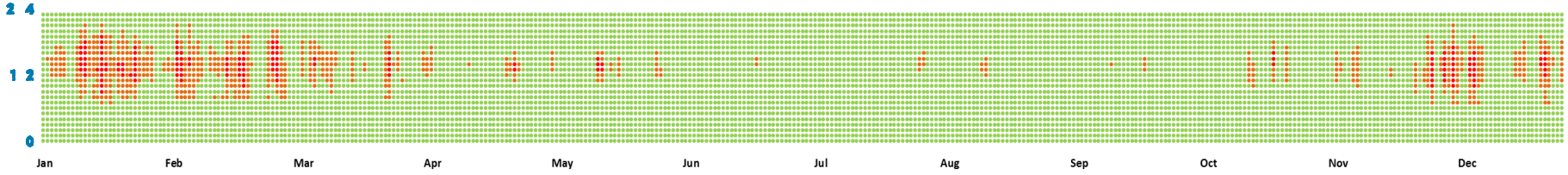




+ SHADING



94 % PMV > 1

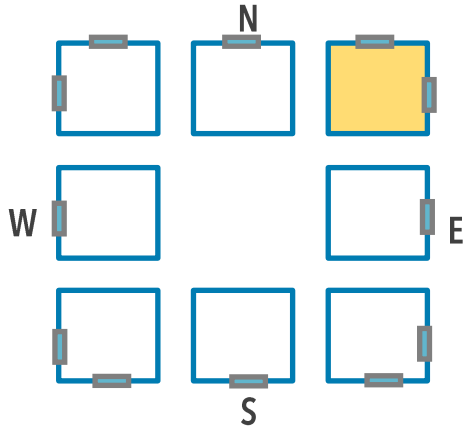


What happens if we reduce the window size and ADD SHADING ?

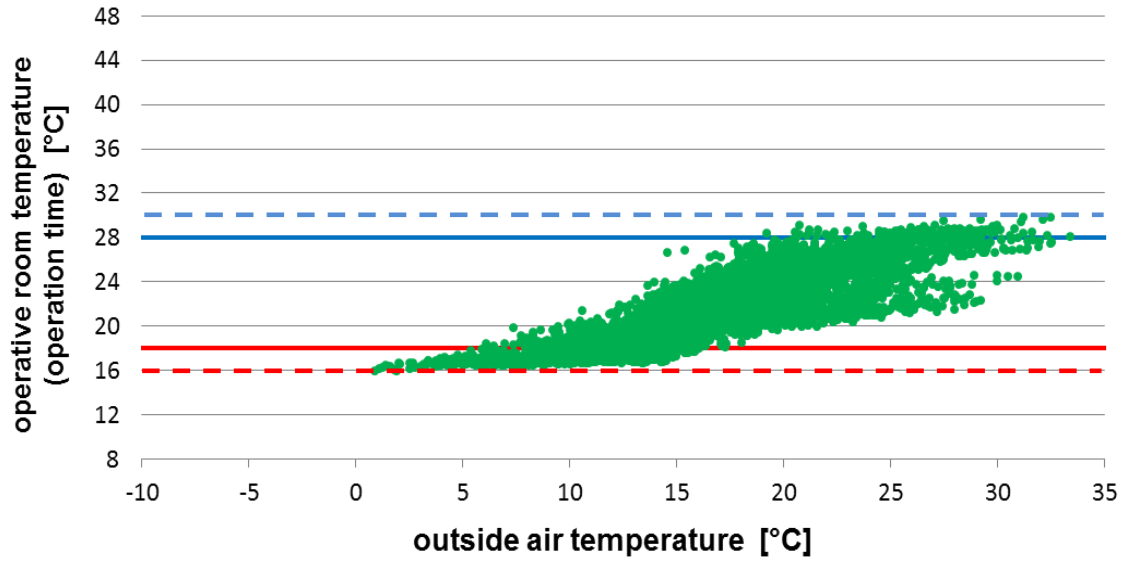
A Simple fixed external overhang is assumed.

SYNTHESIS : slight improvement in overheating – Moveable Affordable Shading should be investigated.

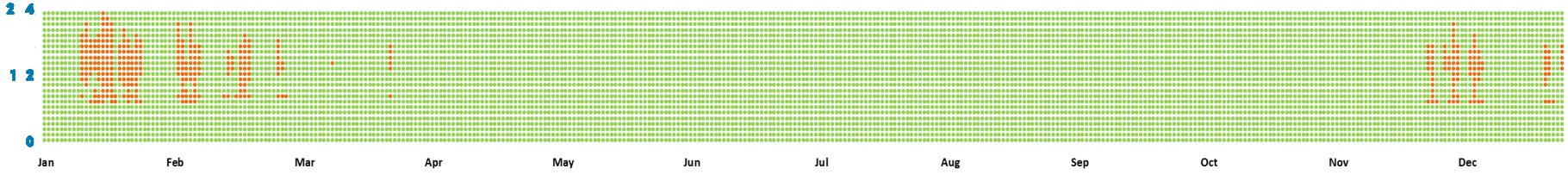
NORTH EAST



+ THERMAL MASS



98 % COMFORT

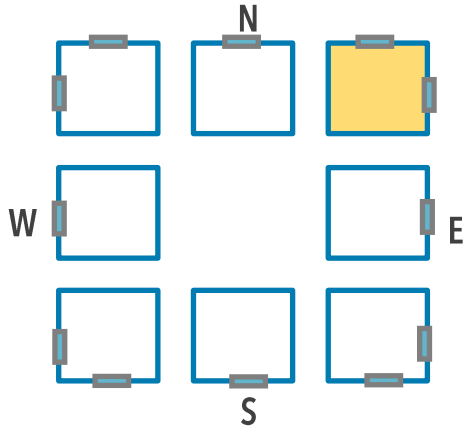


What happens when we reduce the glazing, add shading and INCREASE THERMAL MASS(See report for details)

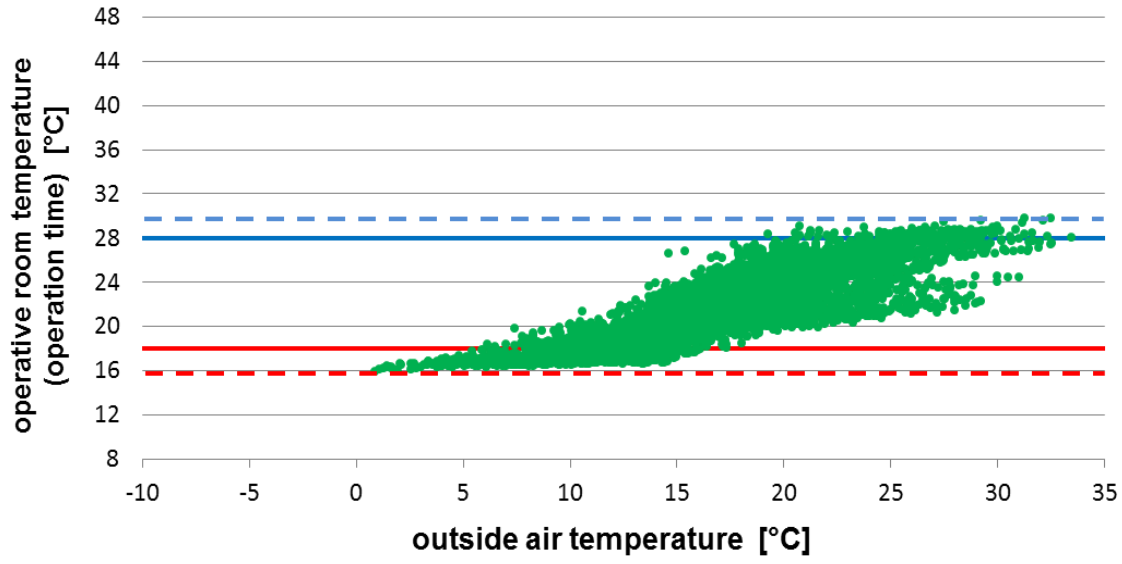
SYNTHESIS :

Comfort Achieved

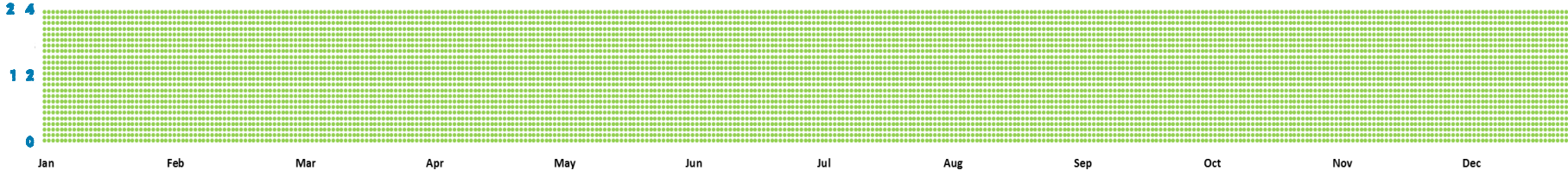
NORTH EAST



+ FAN



100 % PMV > 1



What happens when we reduce the glazing, add shading, increase thermal mass, and

ADD A FAN

SYNTHESIS :

Comfort is at 100 % but not necassary : may be used for peak days.

SUMMARY NORTH EAST

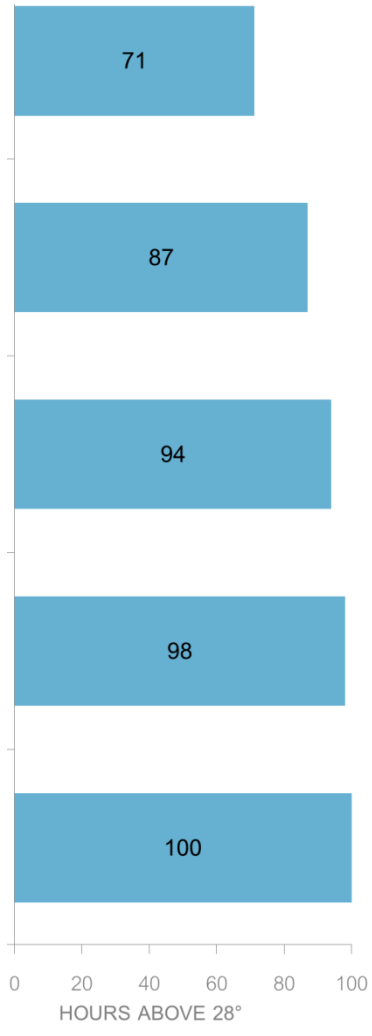
BASE CASE

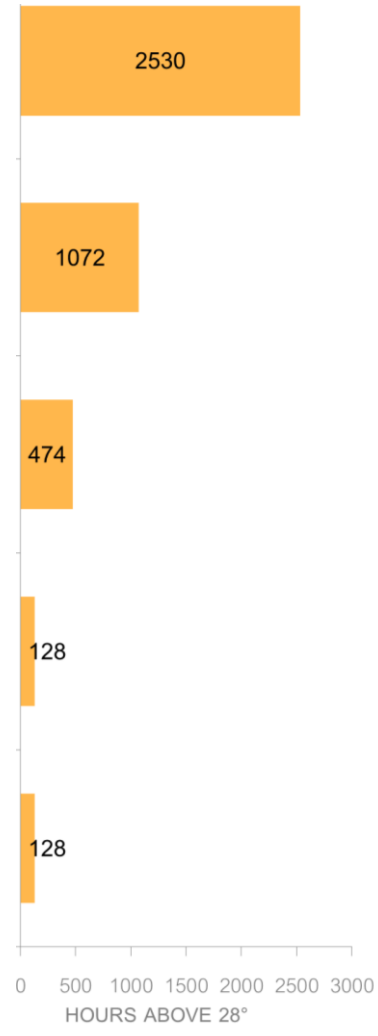
25% WWR

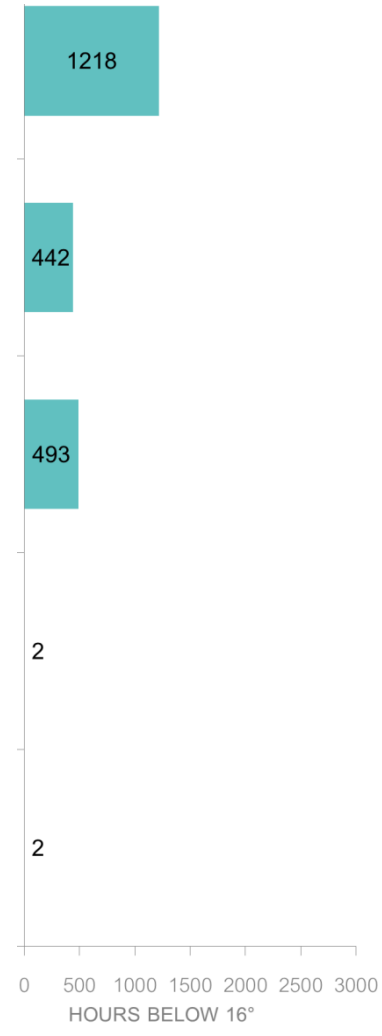
FIXED SHADING

THERMAL MASS

FANS







The strategies applied based on most beneficial strategies work in favor of achieving high comfort within the space.

SUMMARY SOUTH

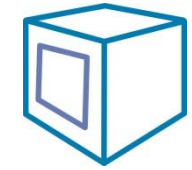
BASE CASE

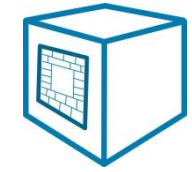
25% WWR

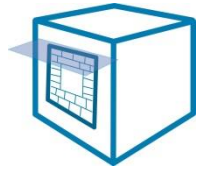
FIXED SHADING

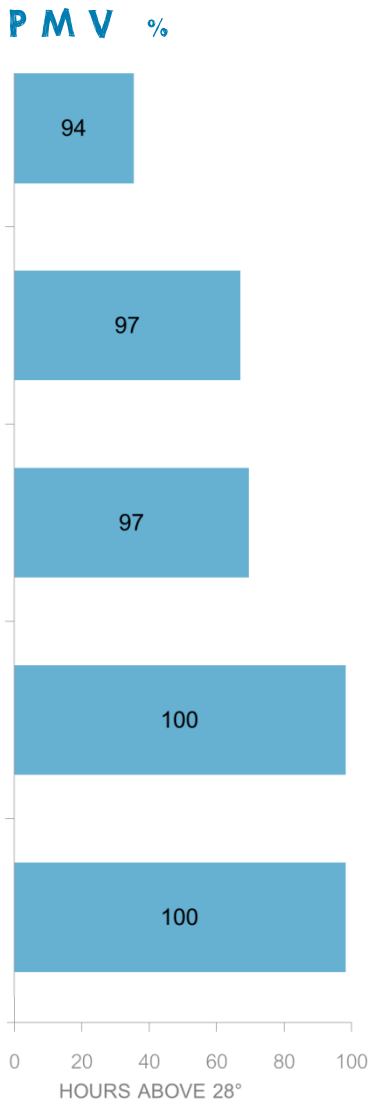
THERMAL MASS

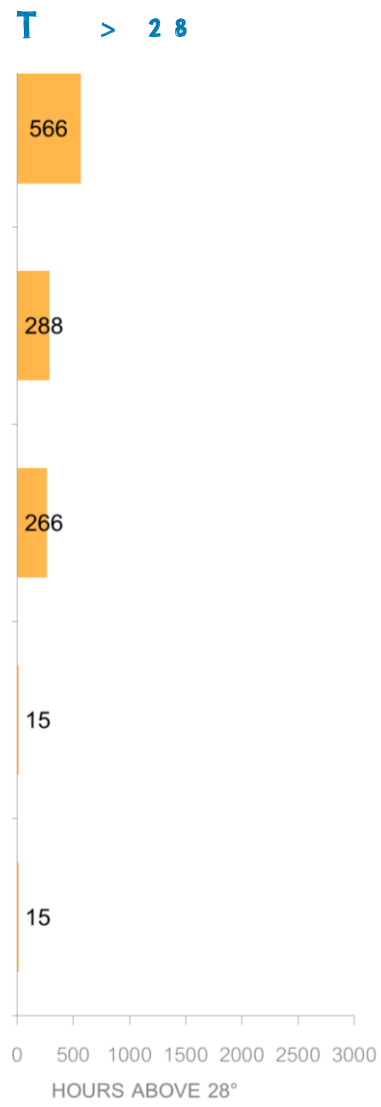
FANS

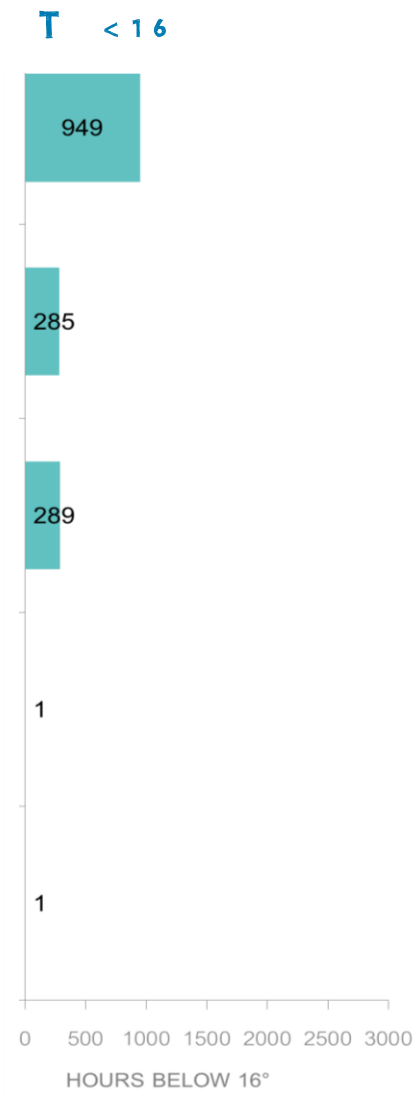






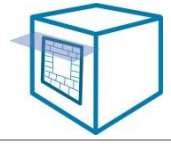






Even within the colder space overheating and overcooling problems can be resolved using these passive strategies.

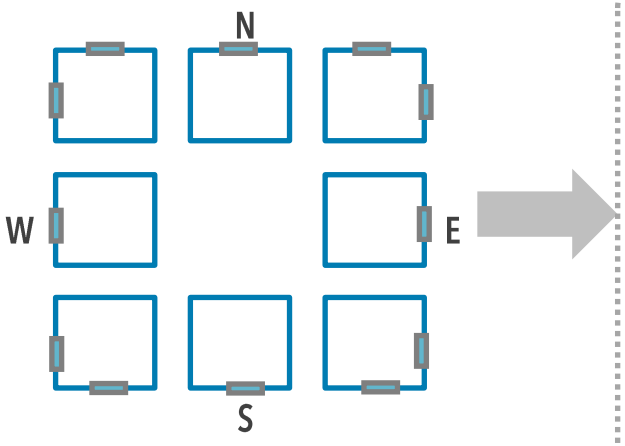
STRATEGIES FOR DIFFERENT ORIENTATIONS

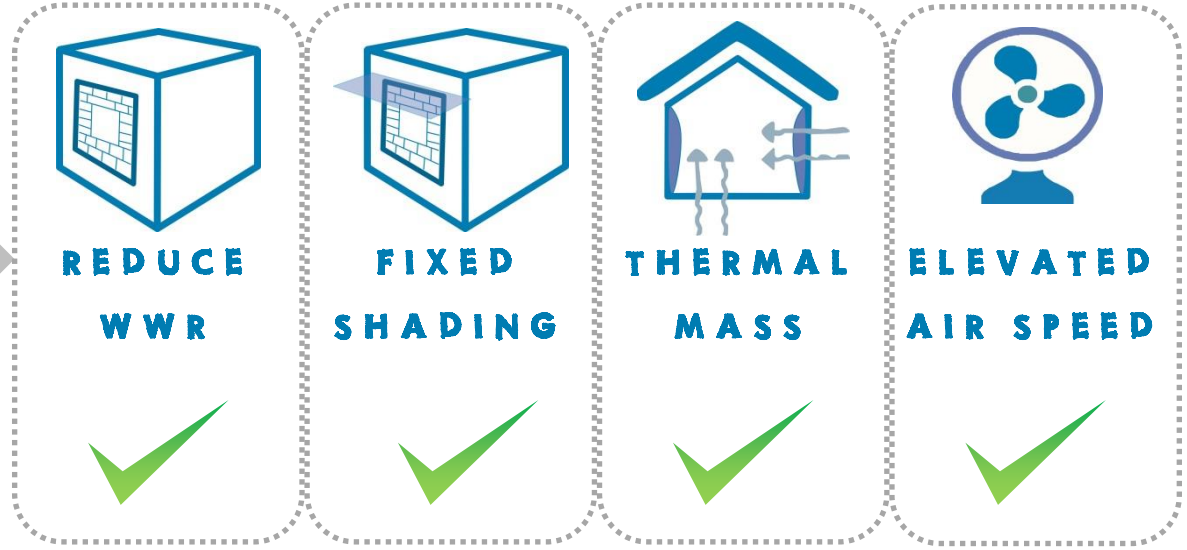
	NE	NW	SE	SW	N	S	W	E
BASE CASE 								
25% WWR 	✓	✓	✓	✓	✓	✗	✓	✓
FIXED SHADING 	✓	✓	⑂	⑂	✗	✗	✗	✗
THERMAL MASS 	✓	✓	✓	✓	✓	✓	✓	✓
FANS 	⑂	⑂	⑂	⑂	✗	✗	✗	✗

What comfort can we achieve with the lowest amount of money for which space type?

The minimum amount of strategies is assessed for each orientation.

CONCLUSION





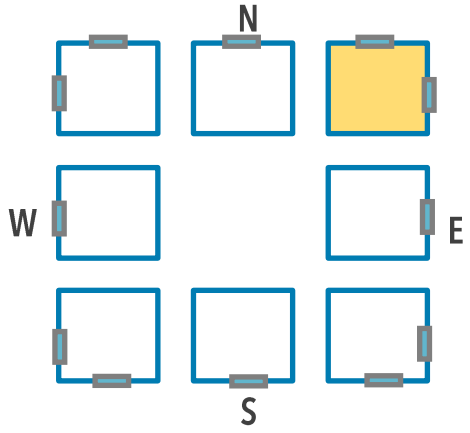
HIGH COMFORT NO SYSTEM

YES we Can achieve high comfort with no systems for existing office buildings converted into residential spaces.

RESILIANCY &

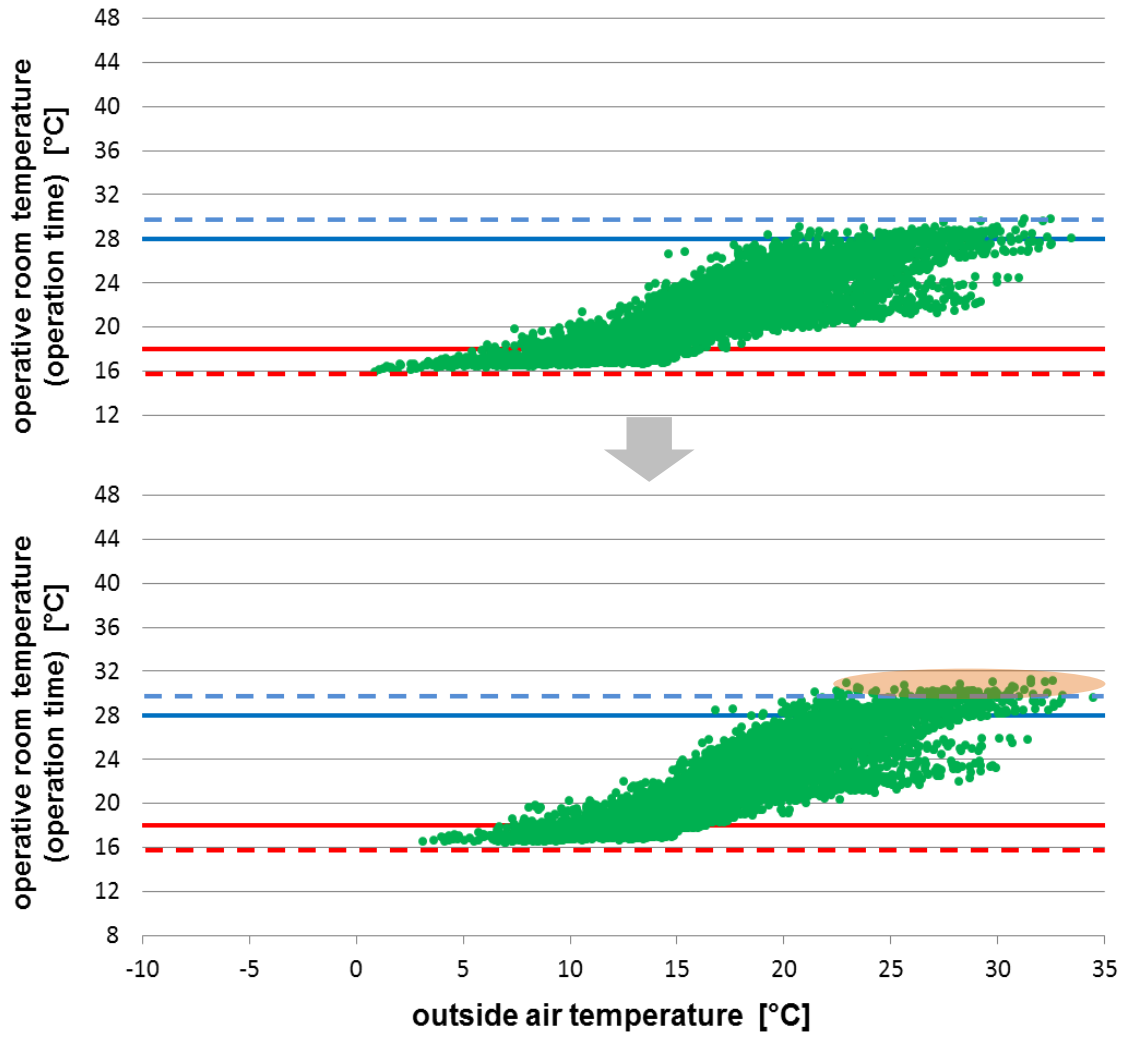
URBAN HEAT ISLAND

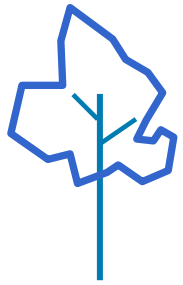
NORTH EAST UHI



+ 1 ° ~ +3 °C

25% WWR+SHADING+THERMALMASS+FAN





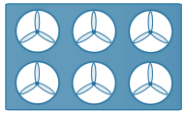
If we further increased temperatures by 1 -3 degrees to factor in the effect of UHI :

SLIGHTLY WARMER

Synthesis : Improve outdoor conditons for functioing buildings on a macro scale, and reduce urban heat isalnd effect.

COSTS

CONVENTIONAL REFURBISHMENT



SPLIT UNITS
CHILLERS

$$$

GLARE
PROTECTION

$$

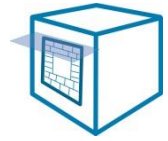
MAINTENANCE AND
OPERATING COSTS

$$$$$

PROPOSAL

WWR

$



SHADING

$

THERMAL MASS

$

FAN

$$

PLANTS

MAINTENANCE AND
OPERATING COSTS

$

As opposed to conventional cooling and heating systems the proposed strategies if applied correctly will reduce energy consumption are cheap to install and are low maintenance therefore reducing costs in the long run:

INCLUSIVE AND SUSTAINABLE HOUSING IN CAPE TOWN

HIGH COMFORT AND AFFORDABLE

With reduced window sizes, shading elements, addition of thermal mass and improved outdoor conditions we can achieve **HIGH COMFORT** that is **AFFORDABLE** for an **INCLUSIVE** housing stratergy. We therfore makes use of existing infrastructure and **CLOSE** the **GAP** between rich and poor.

OVERVIEW

OBJECTIVE	INCLUSIVE AND SUSTAINABLE HOUSING IN CAPE TOWN.
WHY	SEGREGATED CITY I URBAN SPRAWL I LACK OF AFFORDABLE HOUSING I ELECTRICITY SHORTAGE.
HOW	THROUGH RETROFIT AND REUSE OF EXISTING UNDERUTILIZED OFFICE SPACES INTO RESIDENTIAL UNITS.
CHALLENGE	HIGH COMFORT & AFFORDABLE & NO SYSTEMS.
PROCESS	EVALUATE EXISTING COMFORT I PROPOSE PASSIVE STRATEGIES FOR WORST CASE UNIT I APPLY STRATEGIES FOR ALL ORIENTATIONS AND SEE IF COMFORT IS ACHIEVED.
CONCLUSION AND OUTCOMES	COMFORT IS ACHIEVED USING AFFORDABLE LOW TECH STRATEGIES

THE END .....

THANK YOU !!!

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