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Is this enough to save the future?

The added value of buildings
with integrated sustainability concepts

ZEB+, Trondheim

7. November 2019

Matthias Schuler
TRANSSOLAR – Stuttgart, Munich, Paris, New York

Overview

- Transsolar
- Manitob Hydro Building, Winnipeg
- Residence Adelaide Drive, Santa Monica
- School of Design and Environment, Singapore
- Carbon neutral neighborhood Paketposthalle, Munich
- Conclusions

Lektion aus der IEA Task 11 (1990):
Integrales Planen ist der Schlüssel

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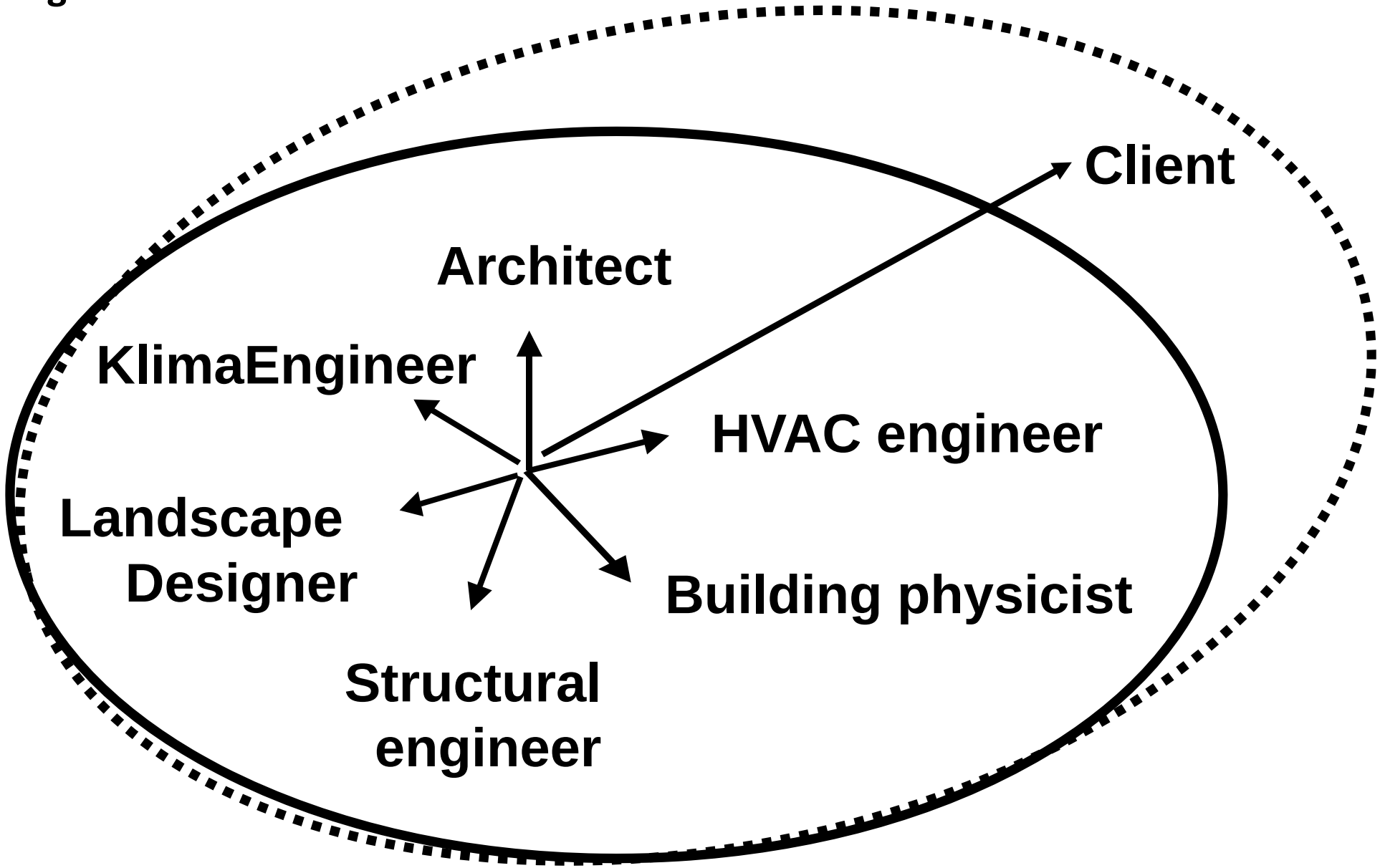

Design team – integral design approach

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Year of foundation: 1992

Managing directors: M. Schuler, T. Auer, S. Holst, V. Bleicher, H. Meyer, D. Schnelle, E. Olsen

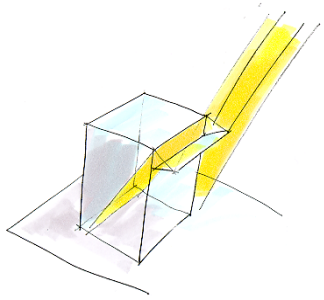
Turnover 2016: 7 Mio €

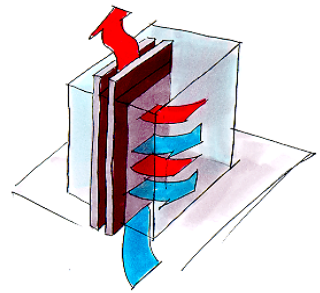
Number of employees and their specialist areas:

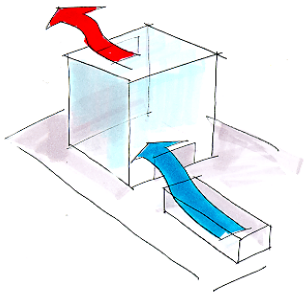
Number of employees:	1	1992
	65	2017

Qualification : Mechanical engineer,
Physicist,
Industrial Process engineer,
Management expert,

Project locations:	Germany	30%
	other Europe	20%
	Asia/Middle East	20%
	North America	30%



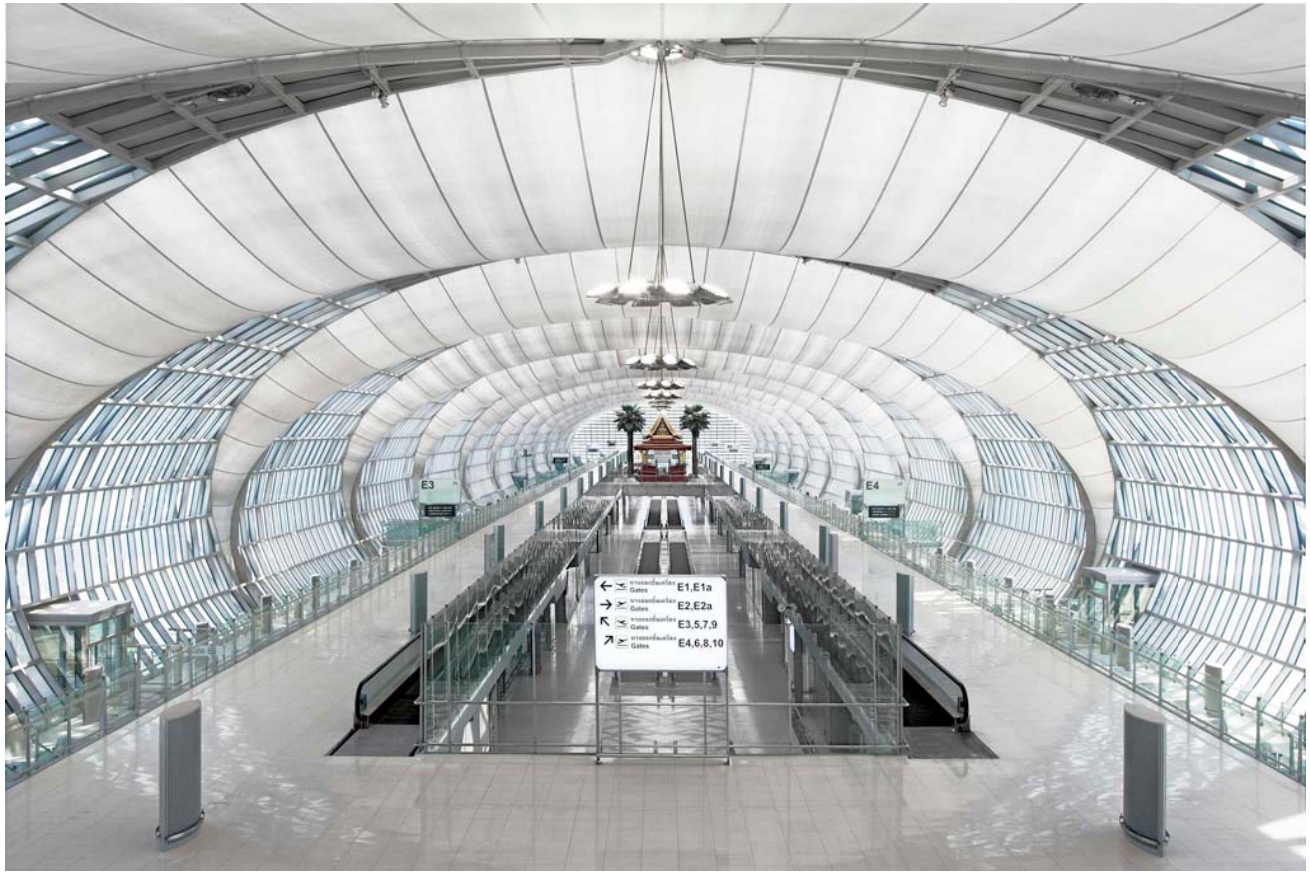


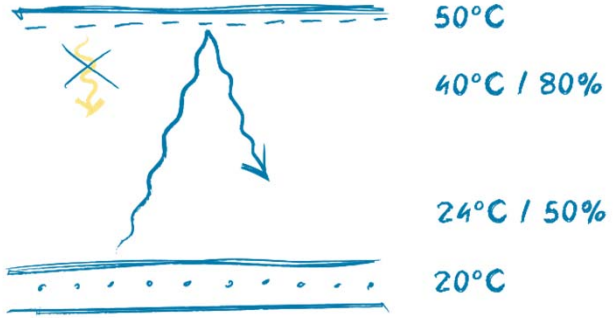


Defining project identities of a new project

- Climate
- Site
  - neighborhood
  - soil
  - water
  - noise
  - air quality
- Transportation/mobility
- Infrastructure
- Local culture
- Local craftsmanship
- Local materials
- Local flora and fauna

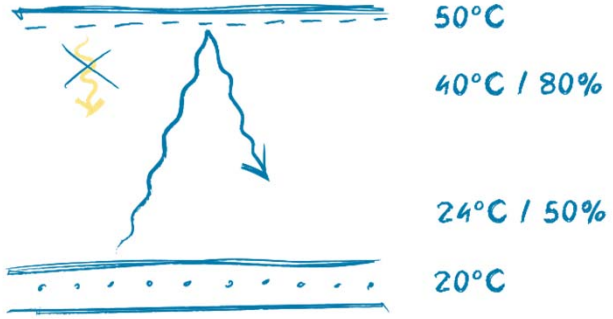
Bangkok International Airport, Bangkok, Thailand, Murphy/Jahn

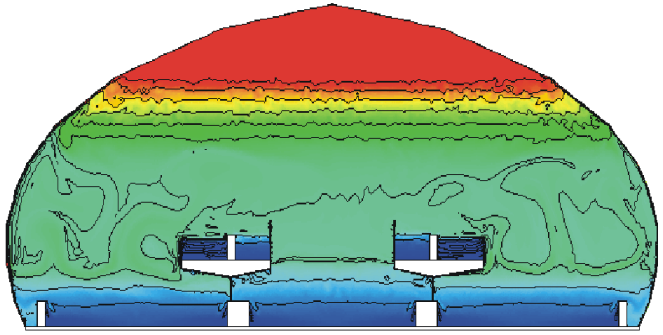




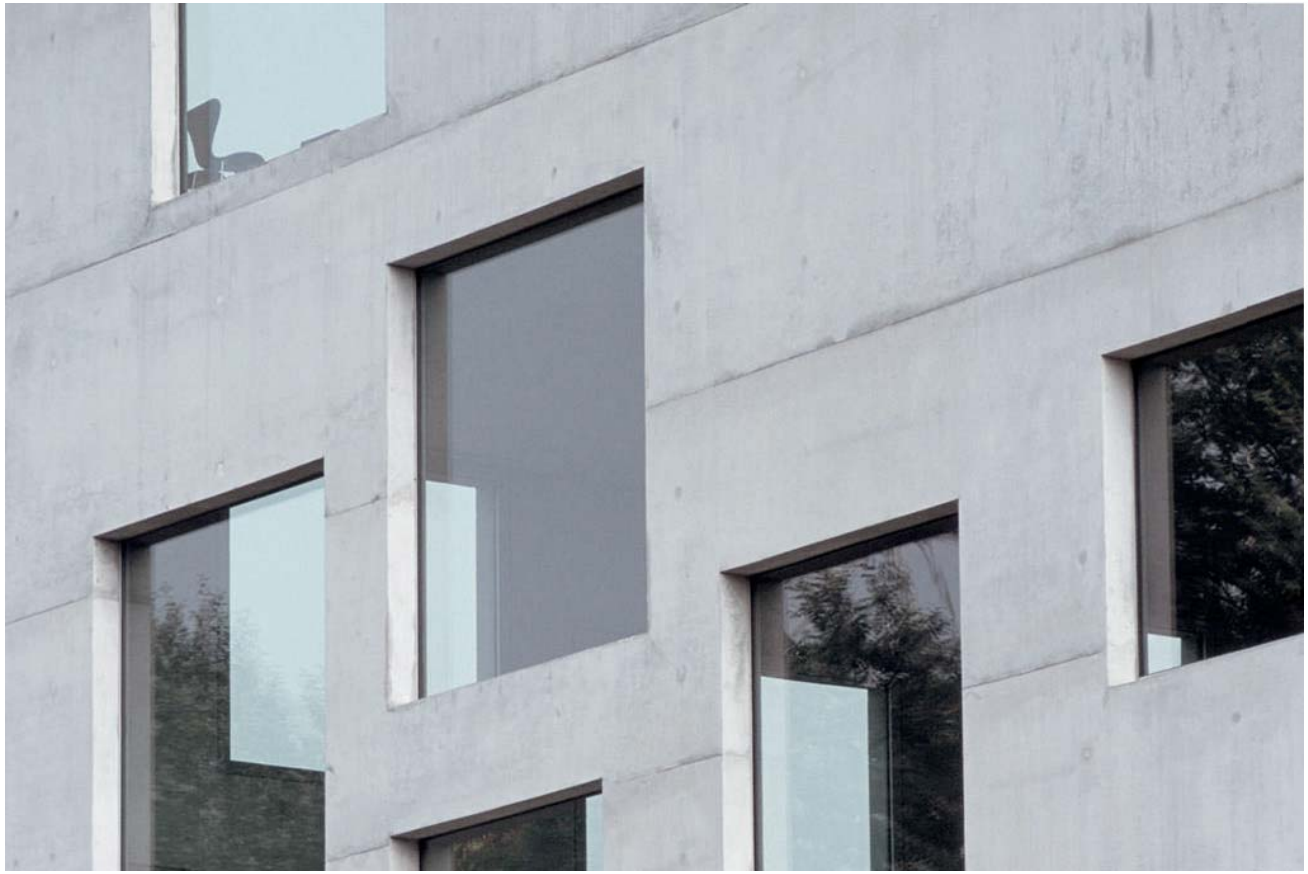
Bangkok International Airport, Bangkok, Thailand, Murphy/Jahn

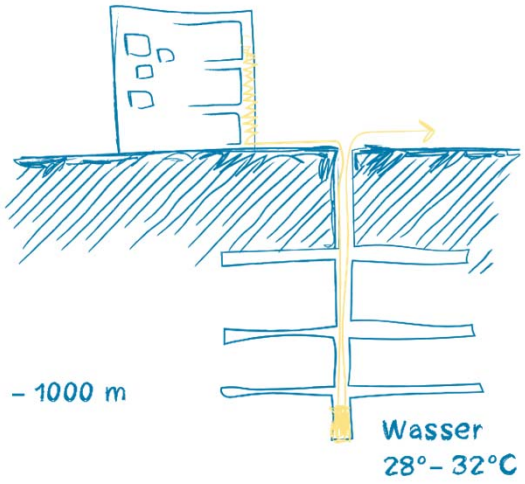
Thermal Mirror: **Hot roof surfaces with low-e-coating do not emit their high temperature but reflect the cool air temperature as a thermal mirror**





Zollverein School, Essen, Germany, SANAA





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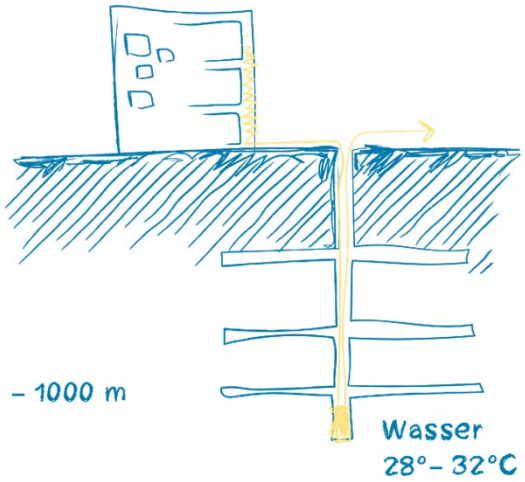
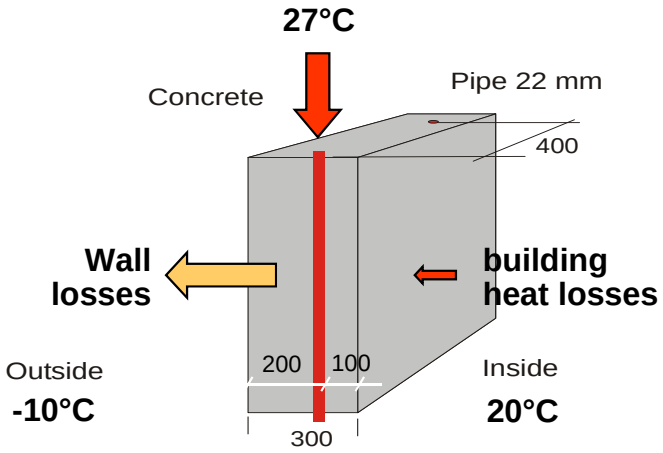
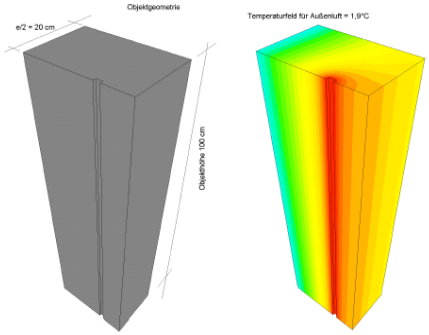
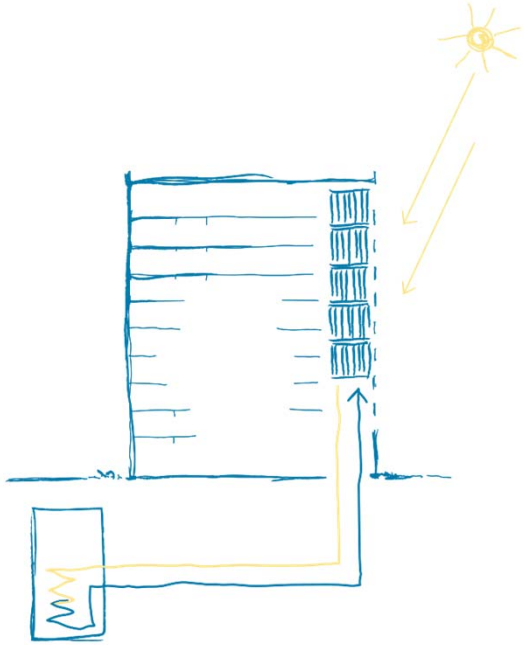


Active Insulation: Active insulation of monolithic concrete walls by embedded water pipes using the local geothermal heat from the old mine to compensate heat losses





Gueterstrasse 30, Pforzheim, Germany, Freivogel Architekten



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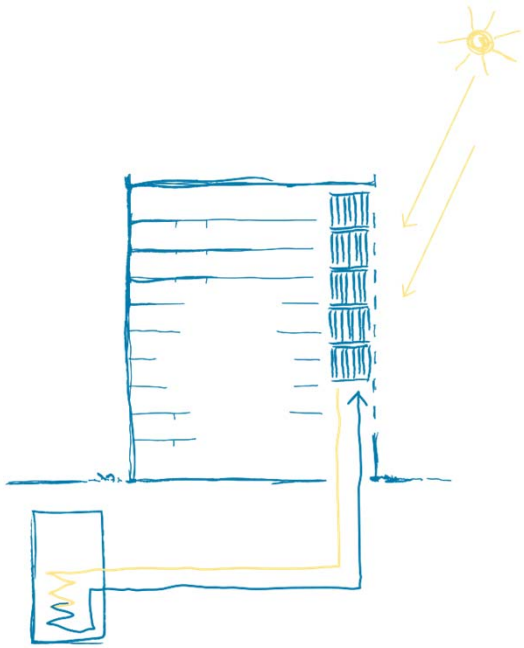
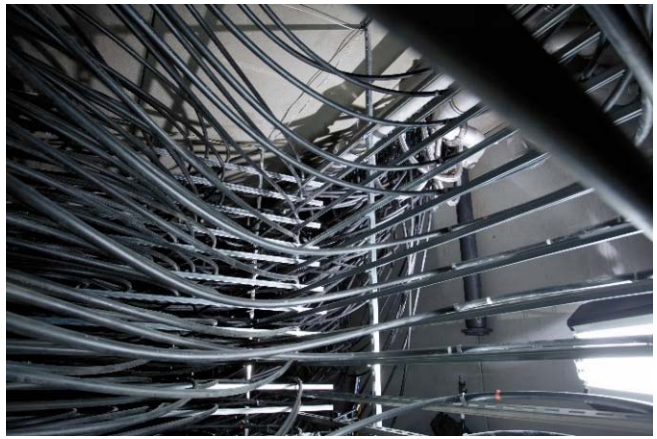
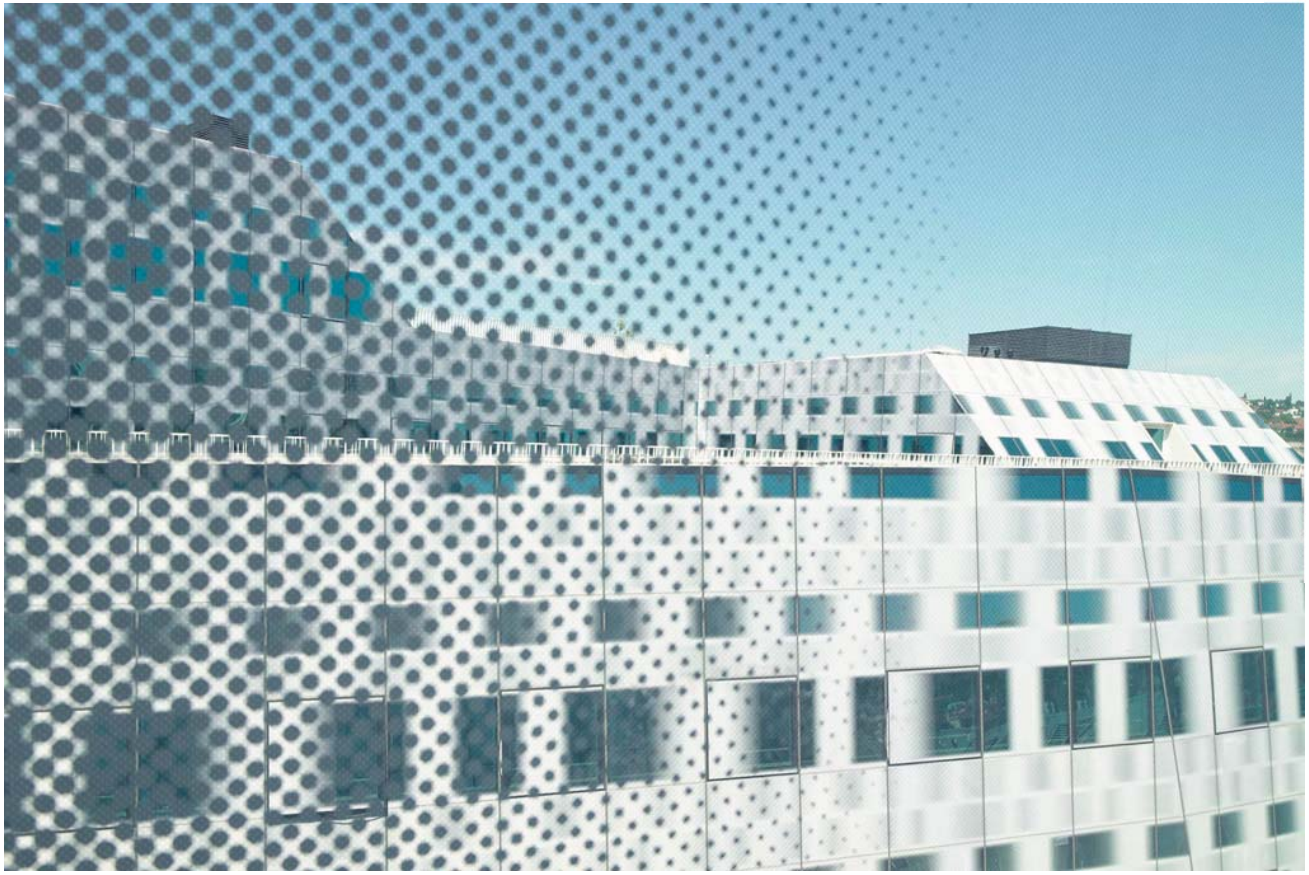
Gueterstrasse 30, Pforzheim, Germany, Freivogel Architekten



Energy refurbishment;
hidden solar façade absorber with ice storage



Dorotheen Quartier, Stuttgart, Germany, Behnisch Architekten



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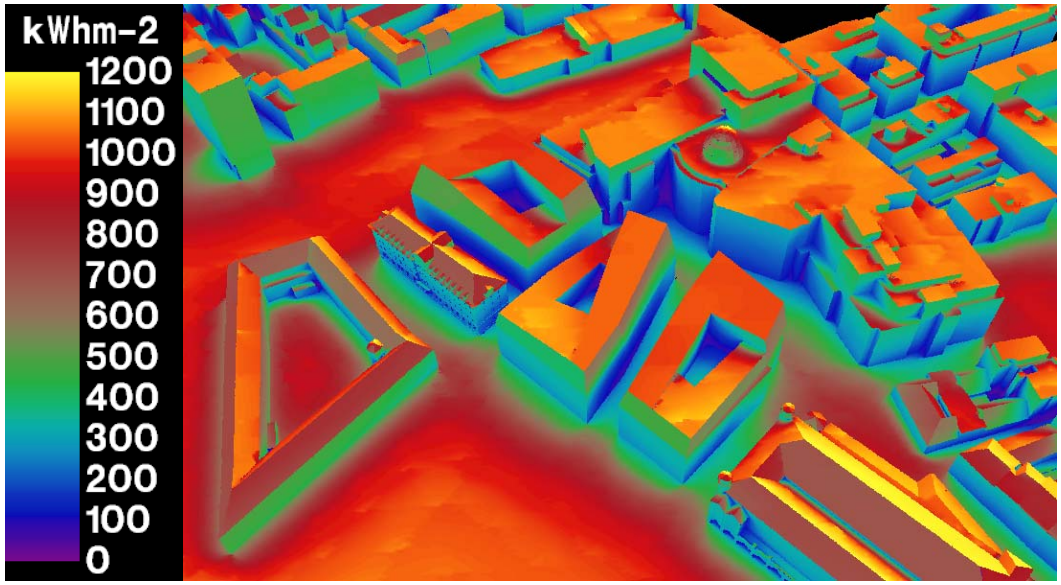
Dorotheen Quartier, Stuttgart, Germany, Behnisch Architekten

Open to the Sky: Roofscapes light design the in-between



Did we (adults) missed the massage or ignore the trues?

- Our kids are aware that we are massing up their future!
  Fridays for future – school strike

- Scientists prove their points!
  Scientists for future

Latest EU report

GLOBAL TRENDS TO 2030 - CHALLENGES AND CHOICES FOR EUROPE”

… An increase of 1.5 degrees is the maximum the planet can tolerate;

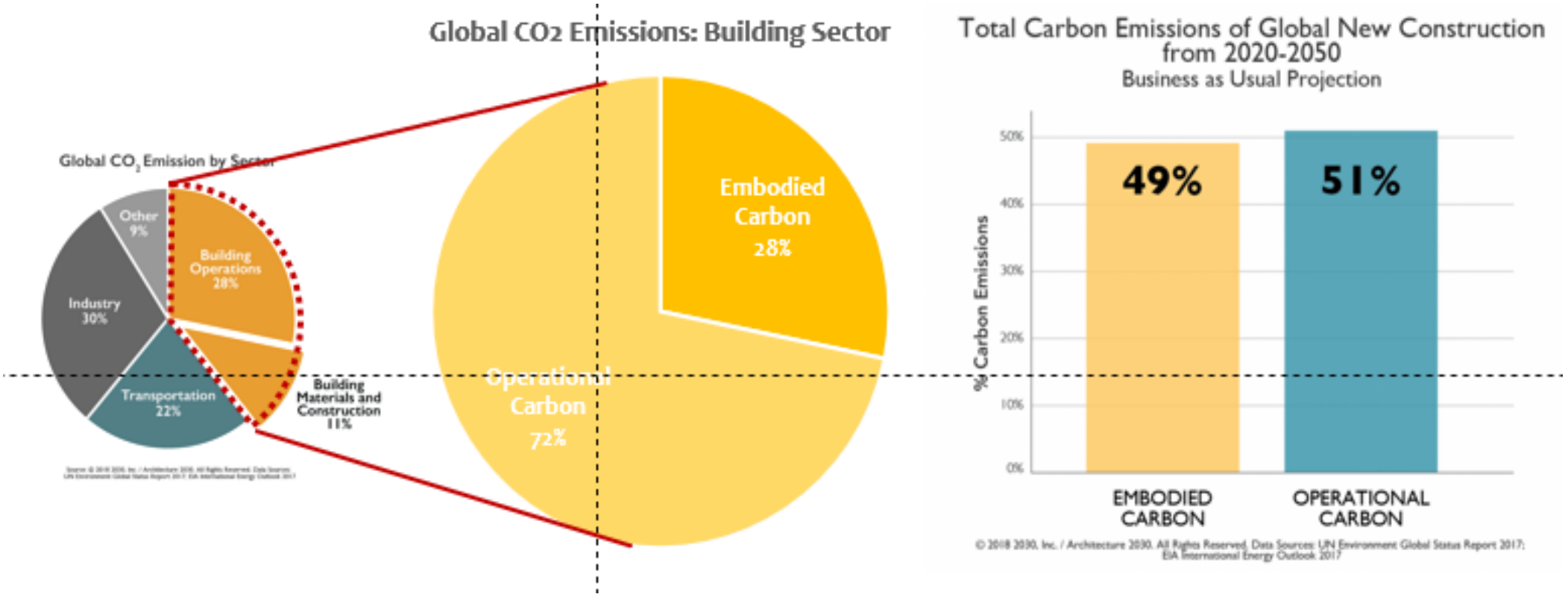
should temperatures increase further beyond 2030, we will face even more droughts, floods, extreme heat and poverty for hundreds of millions of people;

the likely demise of the most vulnerable populations – and at worst,

the extinction of humankind altogether.

And 2030 is in 11 years!

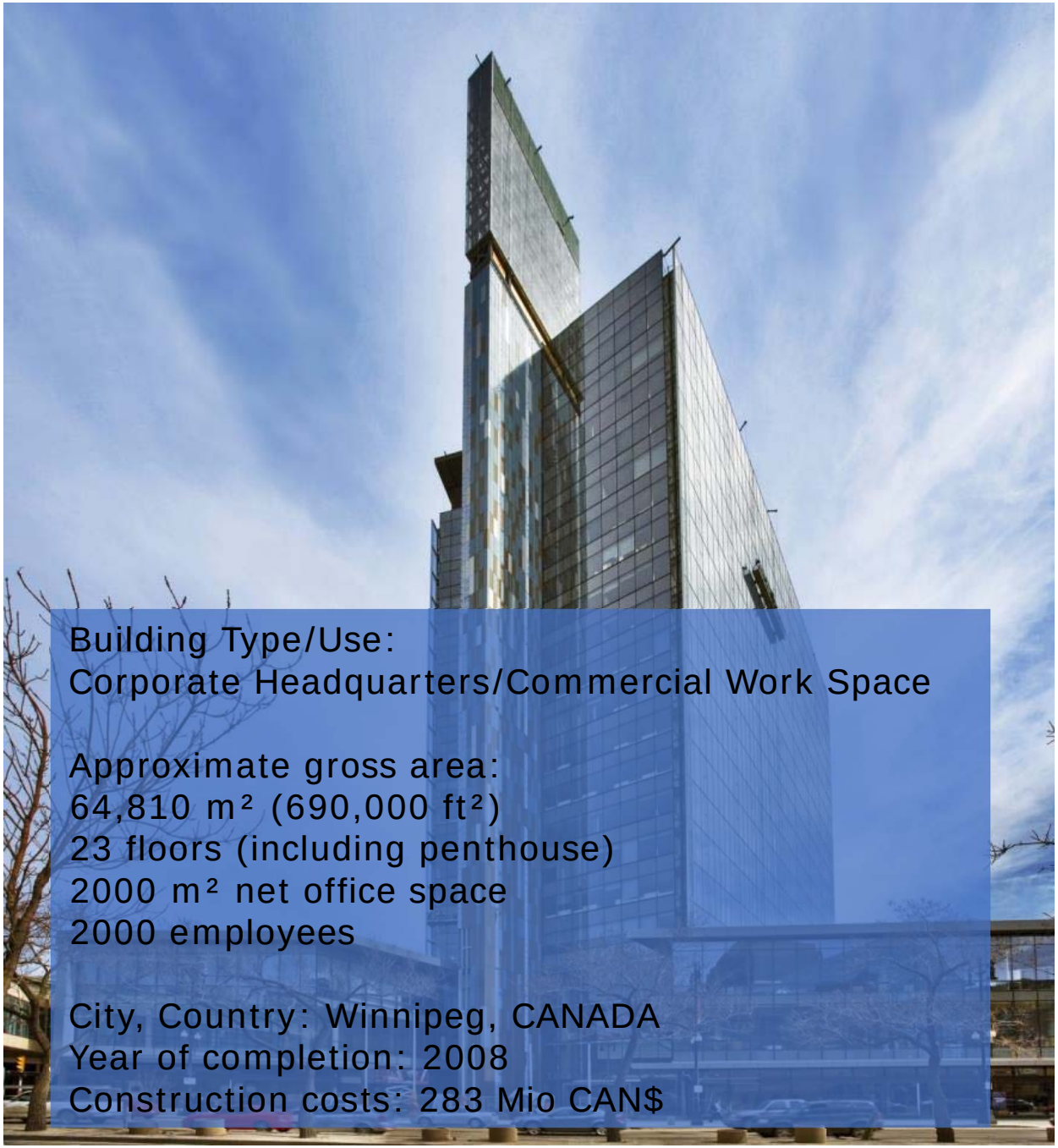
Climate change and building design?



For new buildings with reduced energy consumptions and reduced carbon emission for operation, the embodied carbon for a standard construction correlates to 50 - 100% of the carbon emissions over a 30 year lifetime.

Project examples

Manitoba Hydro, Winnipeg (CAN) by KPMB

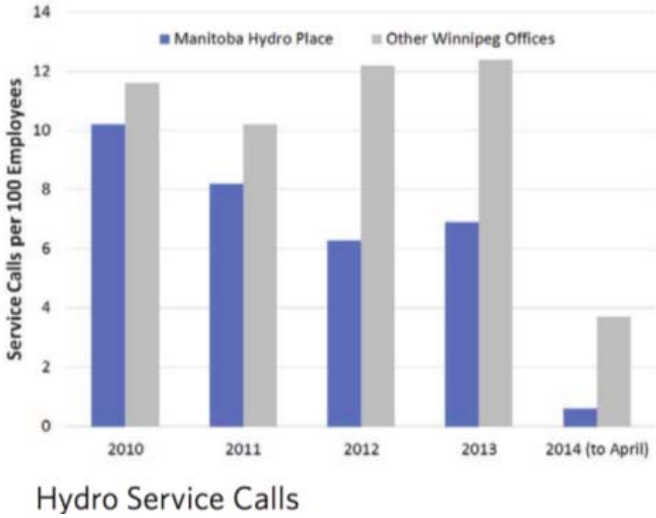


Building Type/Use:
Corporate Headquarters/Commercial Work Space

Approximate gross area:
64,810 m² (690,000 ft²)
23 floors (including penthouse)
2000 m² net office space
2000 employees

City, Country: Winnipeg, CANADA
Year of completion: 2008
Construction costs: 283 Mio CAN$

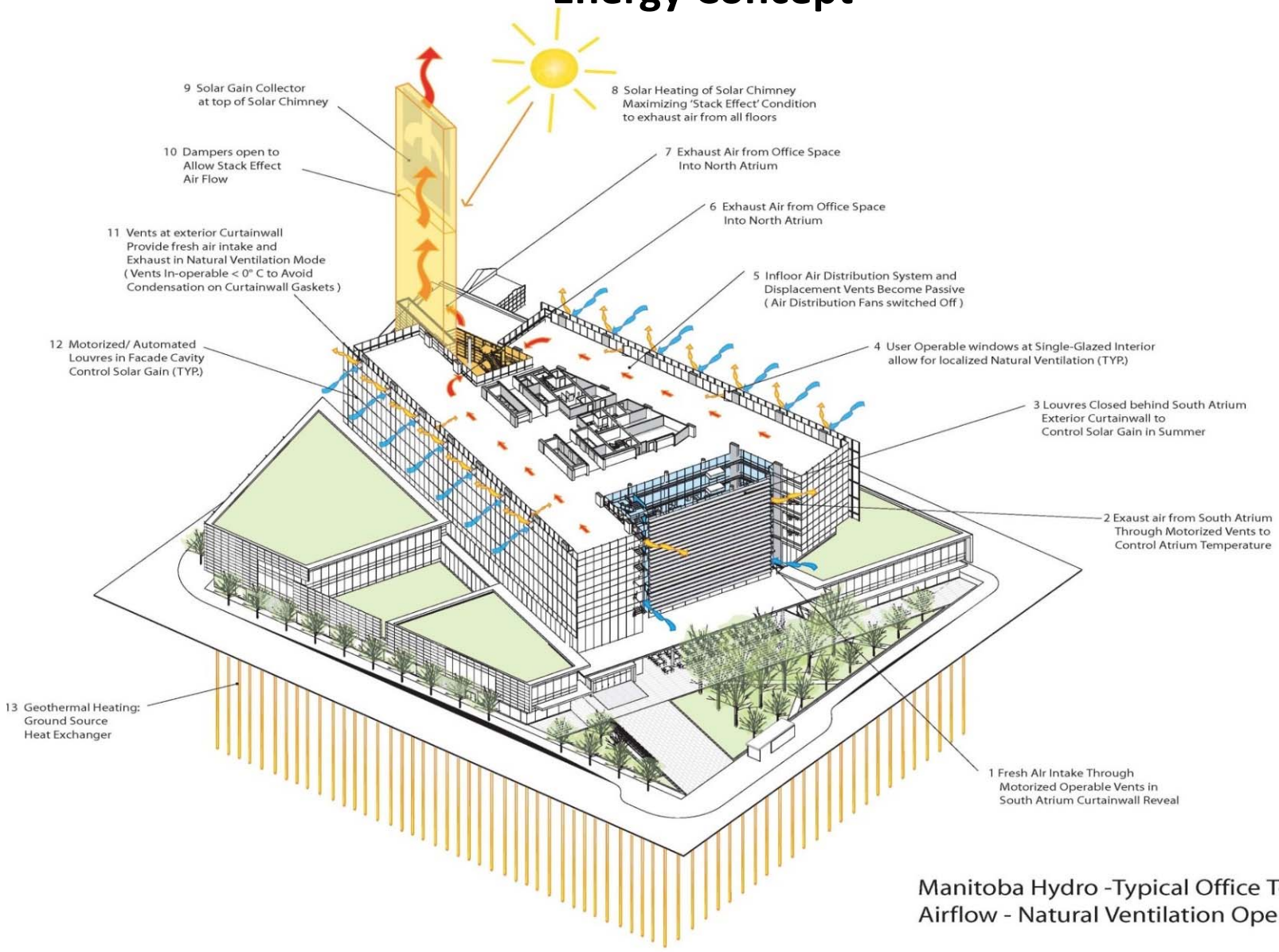
35% in natural ventilation mode



Hydro Service Calls

Satisfied occupants with a individuel control on shading and facade opening, call **50%** less often building management

Energy Concept



Manitoba Hydro -Typical Office Tower Floor
Airflow - Natural Ventilation Operation

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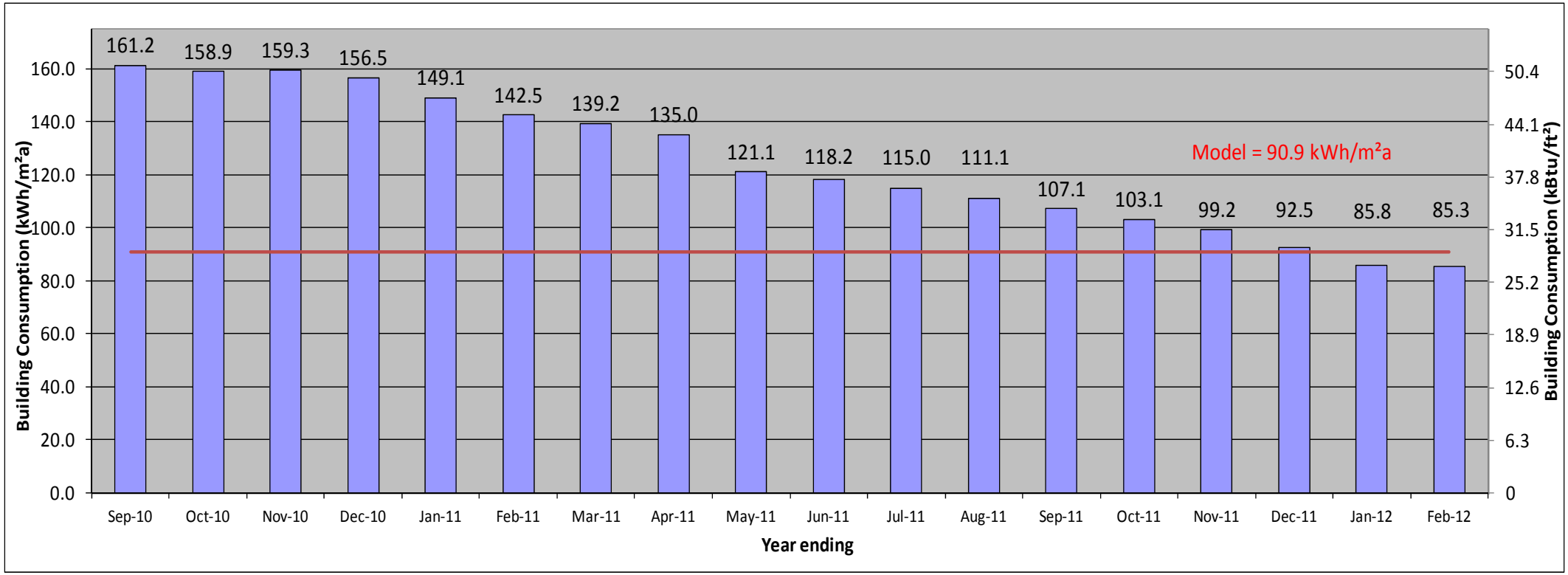
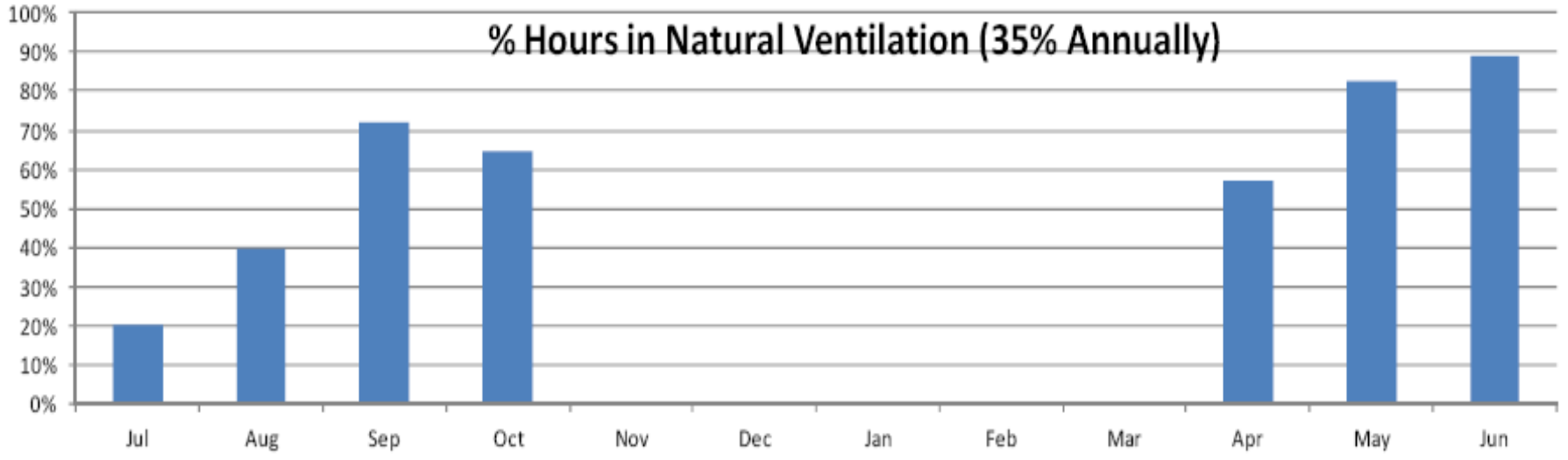
3 year of optimization during operation

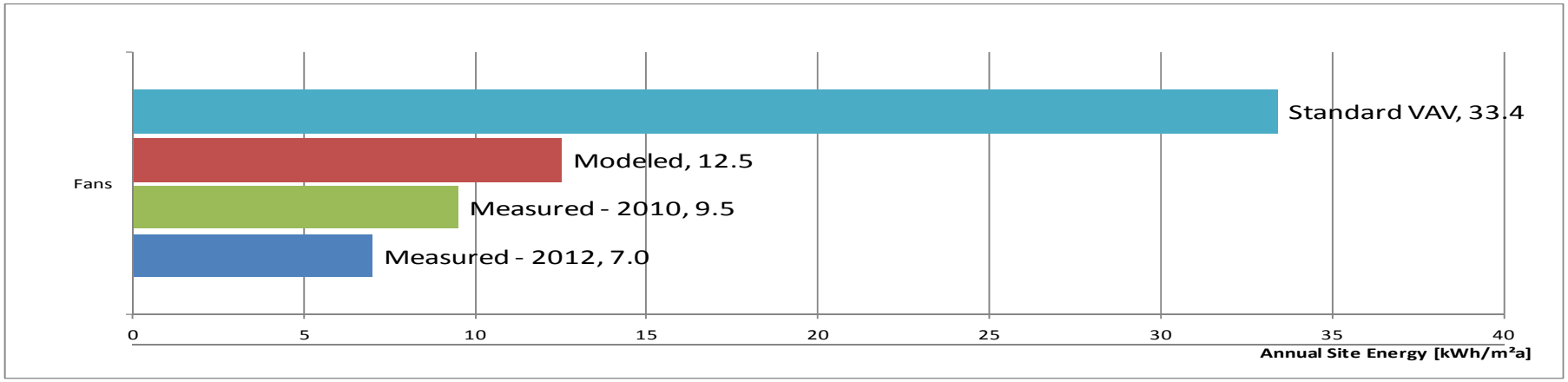
LEED Platinum based on real energy performance after 3 years operation



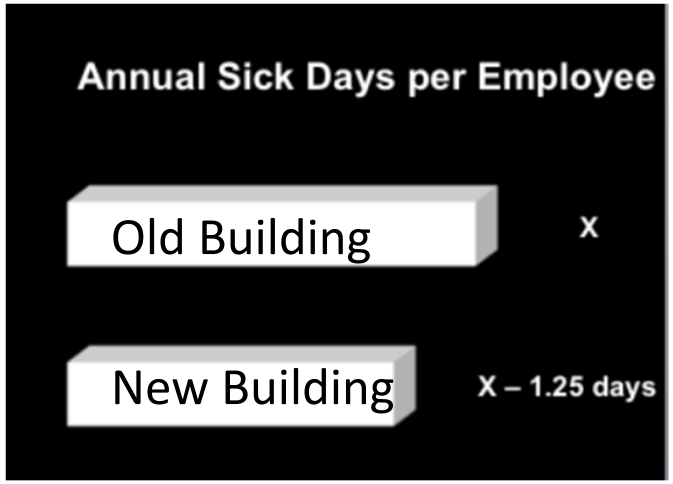
Manitoba Hydro, Using Natural Ventilation

	Modeled	Year ending Sept 2010	Year ending Feb 2012
Vent Fan Energy	12.5 kWh/m²a 1.3 kWh/ft²a	9.5 kWh/m²a 1.0 kWh/ft²a	7.0 kWh/m²a 0.7 kWh/ft²a





Manitoba Hydro, Winnipeg (CAN) KPMB



2000 Employees
Cost: 1000 $/workday
Total cost savings:
$ 2.5 mio per year

Recognized as one of Canada's Top 100 Employers

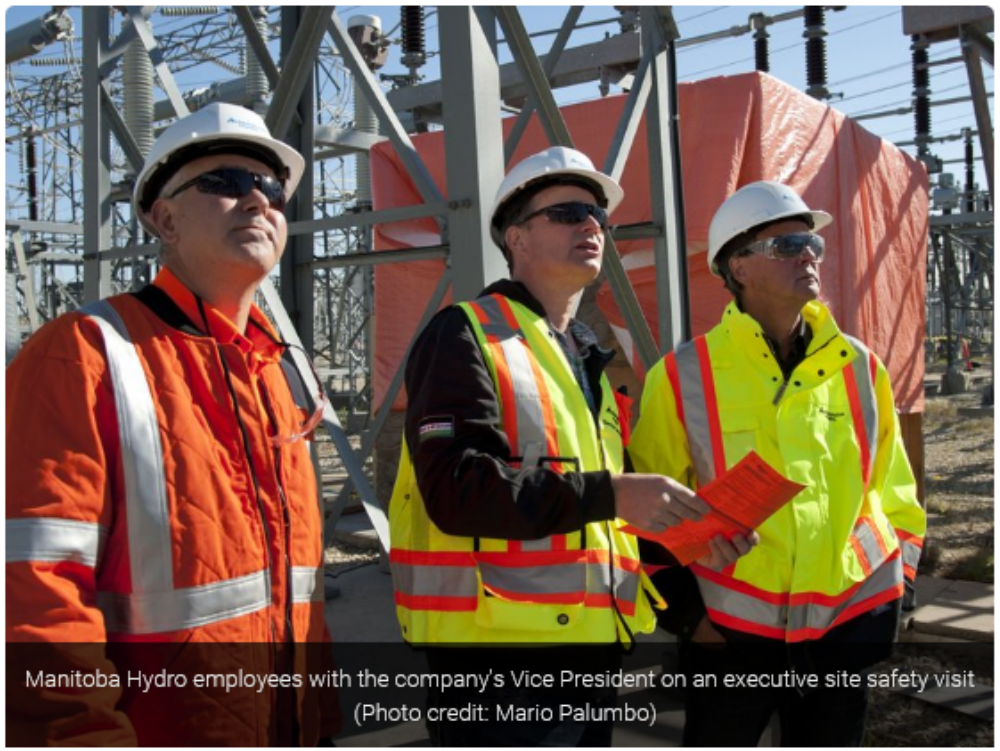
2017 WINNER

HOME TOP 100 YOUNG DIVERSITY GREEN NEW GR

plan

- Manitoba Hydro encourages employees to get involved in activities outside of work through the support of an employee-led social committee that has been active since the 1950s -- every year, employees enjoy various social events and can keep fit by participating in a number of sports leagues, including in-house baseball, curling and hockey leagues

Employer Background	
Physical Workplace	RATING: A
Work Atmosphere & Communications	RATING: A+
Financial Benefits & Compensation	RATING: A
Health & Family-Friendly Benefits	RATING: B+
Vacation & Personal Time-Off	RATING: B+
Employee Engagement & Performance	RATING: B
Training & Skills Development	RATING: A
Community Involvement	RATING: A



Manitoba Hydro employees with the company's Vice President on an executive site safety visit (Photo credit: Mario Palumbo)

Recognized as one of Canada's Top 100 Employers

LEED Platinum certified head office building (first and only office tower in Canada to achieve this designation), features 3 six-story glass atriums that function as solar collectors and air exchangers, a 24-metre waterfall that moderates humidity, a green roof (with native prairie plantings), a geothermal heating system, extensive original art collection throughout that features the work of over 130 Manitoban artists, nap room, religious observance room, self-serve lunchroom, outdoor barbecue, outdoor patio, discounts at local restaurants

2017 WINNE

SITY GREEN

Employer B

Physical Wo

Comm

Work

	outdoor barbecue, outdoor patio, discounts at local restaurants
Employee lounge amenities	comfortable seating, landscaped public courtyard with bistro style tables, three accessible rooftop terraces (with barbecues), for employees only, subsidized membership, instructor-led classes (cardio kick-boxing, yoga, bootcamp, weight training, zumba fusion), weights, shower facilities

Manitoba Hydro employees with the company's Vice President on an executive site safe
(Photo credit: Mario Palumbo)

The local climate as the concept base

Adelaide Residence for Frank Gehry

Net zero as a target

By Frank and Sam Gehry

2014 - 2017

Background - Frank Gehry and his architecture

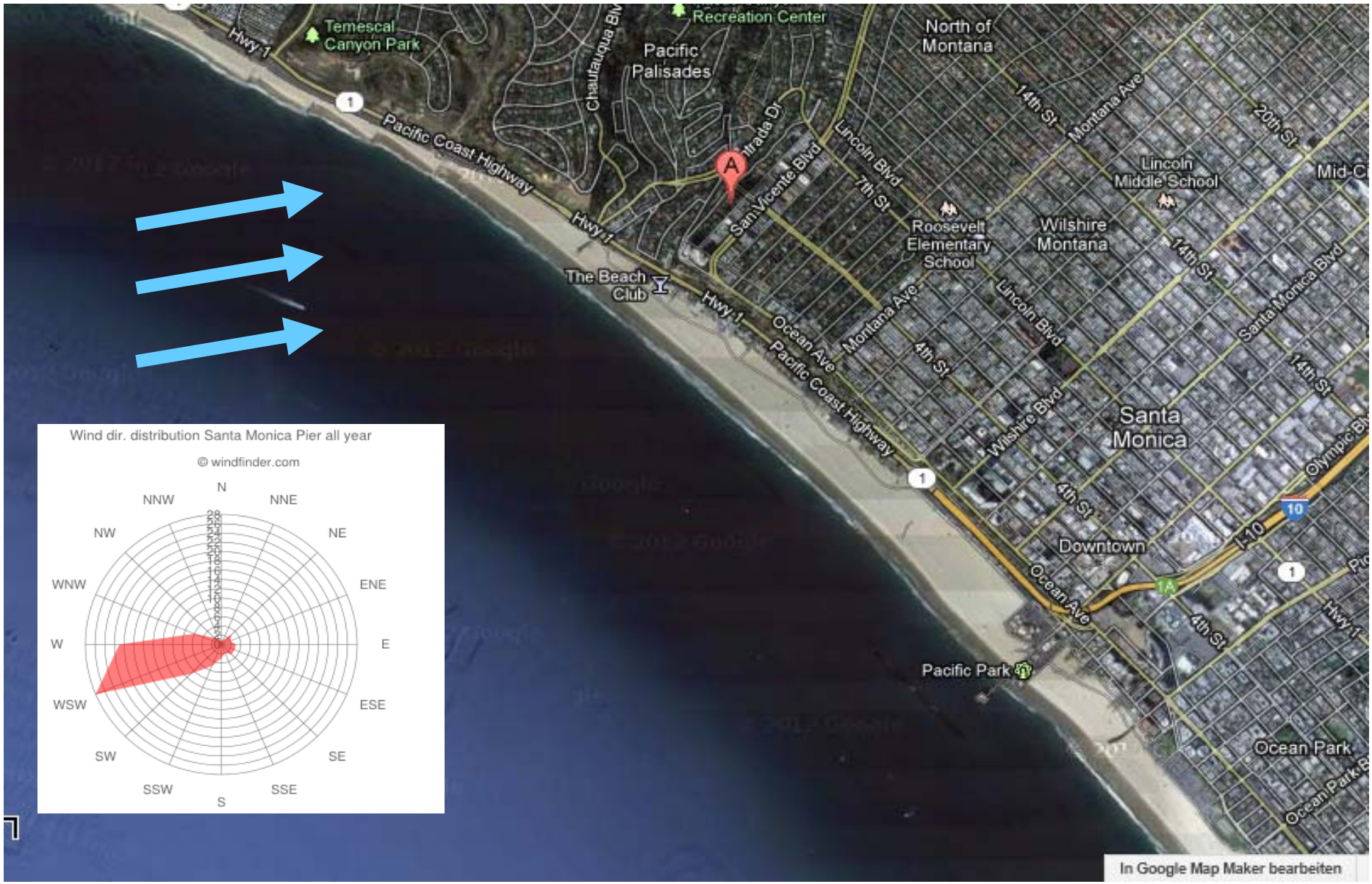
Collaboration since 15 years

Luo Ruvo Clinic, Las Vegas,

Novartis Fabrikstrasse 15, Basel

Fondation Louis Vuitton, Paris

Santa Monica, CA



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Aerial view with main wind direction

Project site

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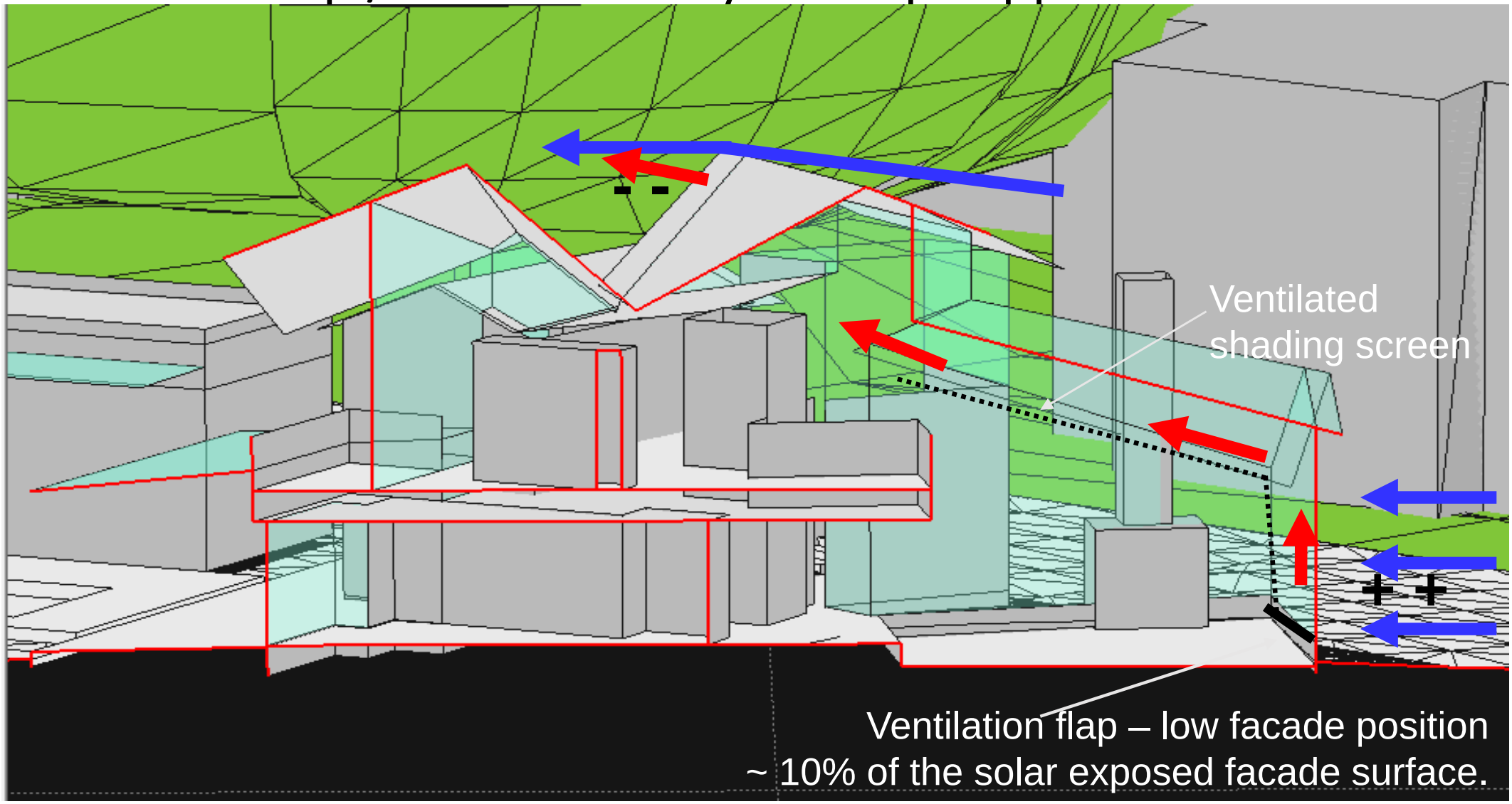
Adelaide Residence – Concept model

Wind Scoop / Solar Chimney Concept Approach



Wind and sun driven cross ventilation to protect the fully glazed spaces from overheating.
A unique local solution for Santa Monica, with a natural ventilated internal screen.

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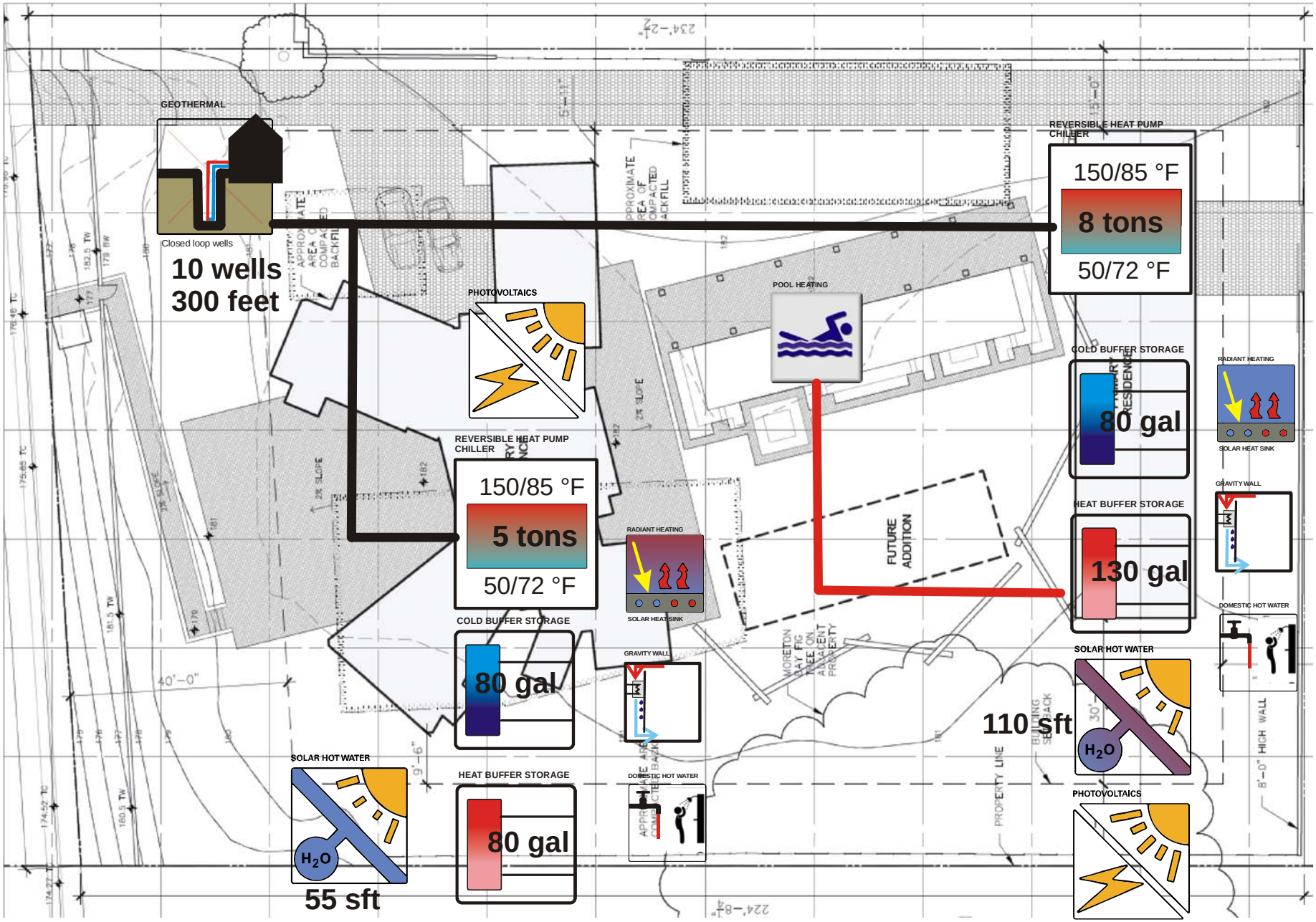

System sizing for a zero energy balance house

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Adelaide Residence

View from Northwest

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Solar system on the guest house

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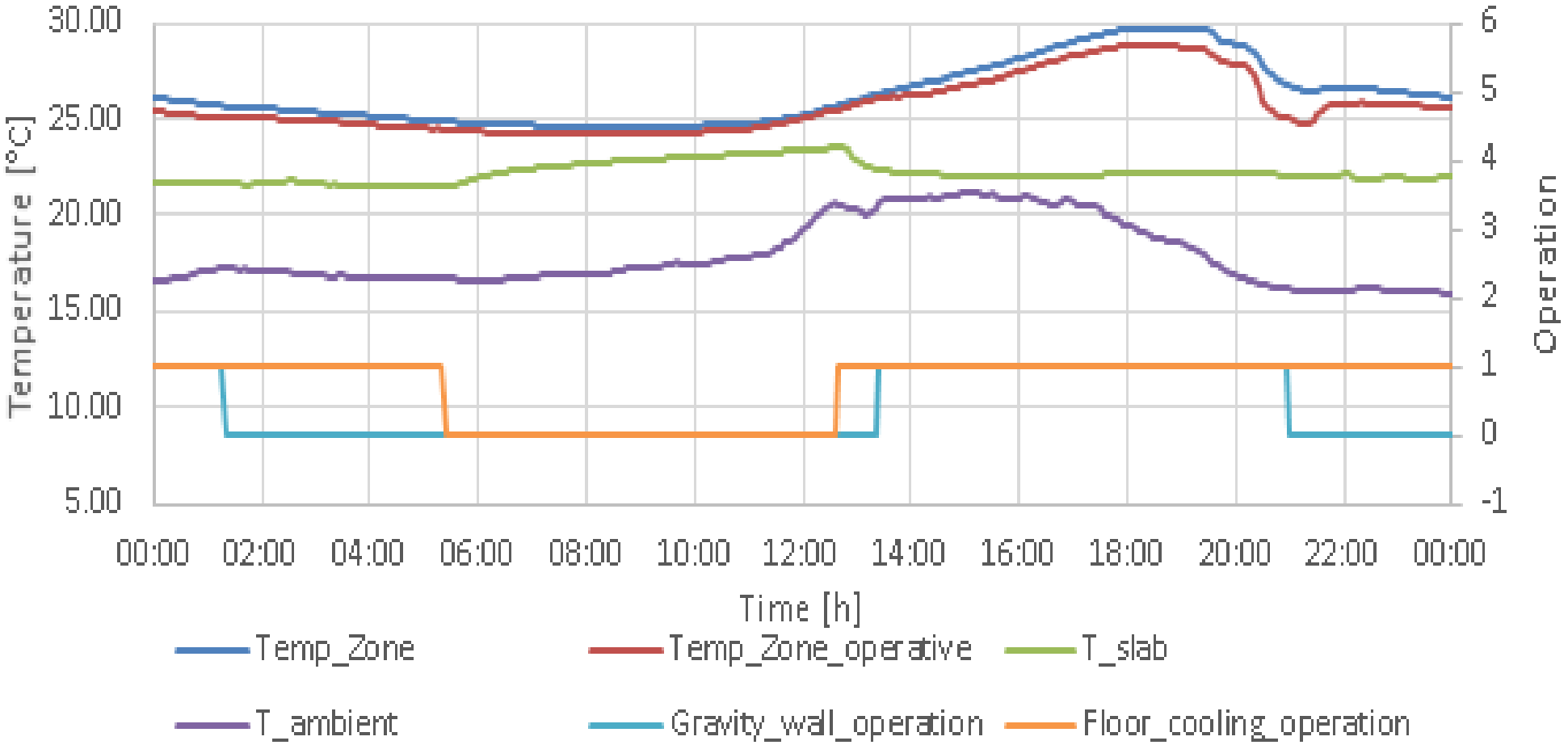
Dining room facing Northwest

Soundless conditioning by radiation and gravity cooling

Operation evaluation



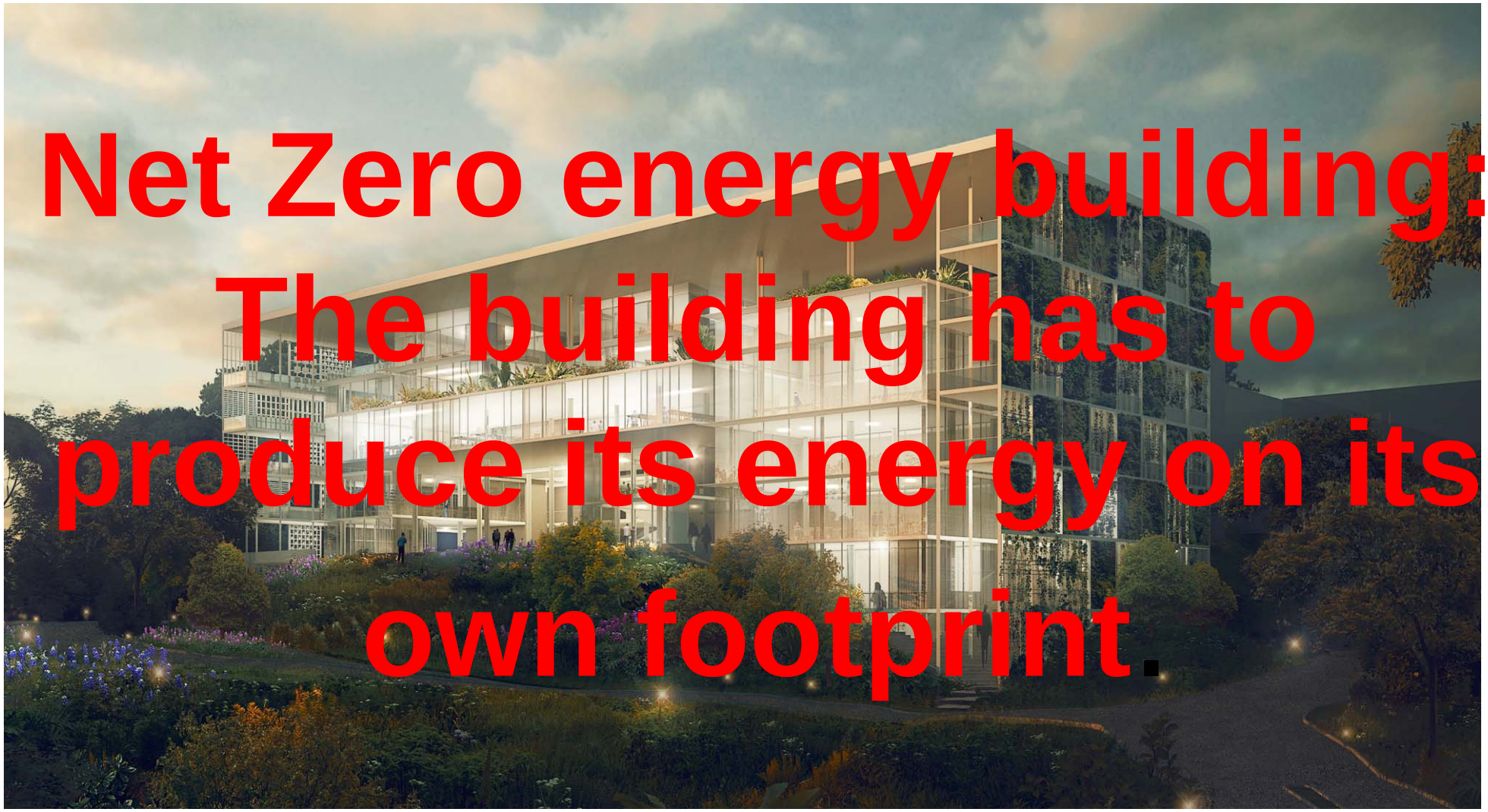
Lessons learned

- System sizing and performance confirmed
- Energy consumption not balanced in the first year of operation
- Final commissioning is key to concept verification
- Operation review during occupancy necessary to find further mistakes
- Control optimization in real operation
- Craftmenship is important **not** only the design
- It takes time to convince an architect

Frank Gehry likes the building, but not:

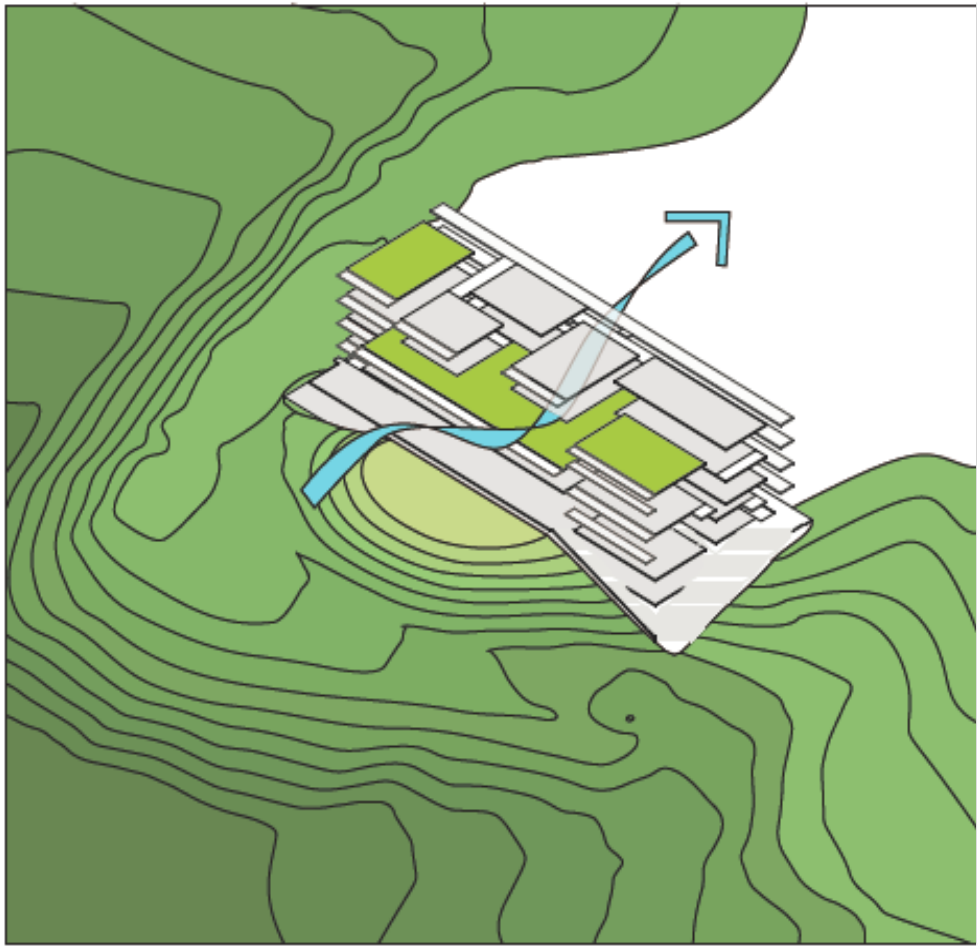
- Noisy window motors
- Night flushing of his bedroom
- Broken pumps
- Failing heat pumps

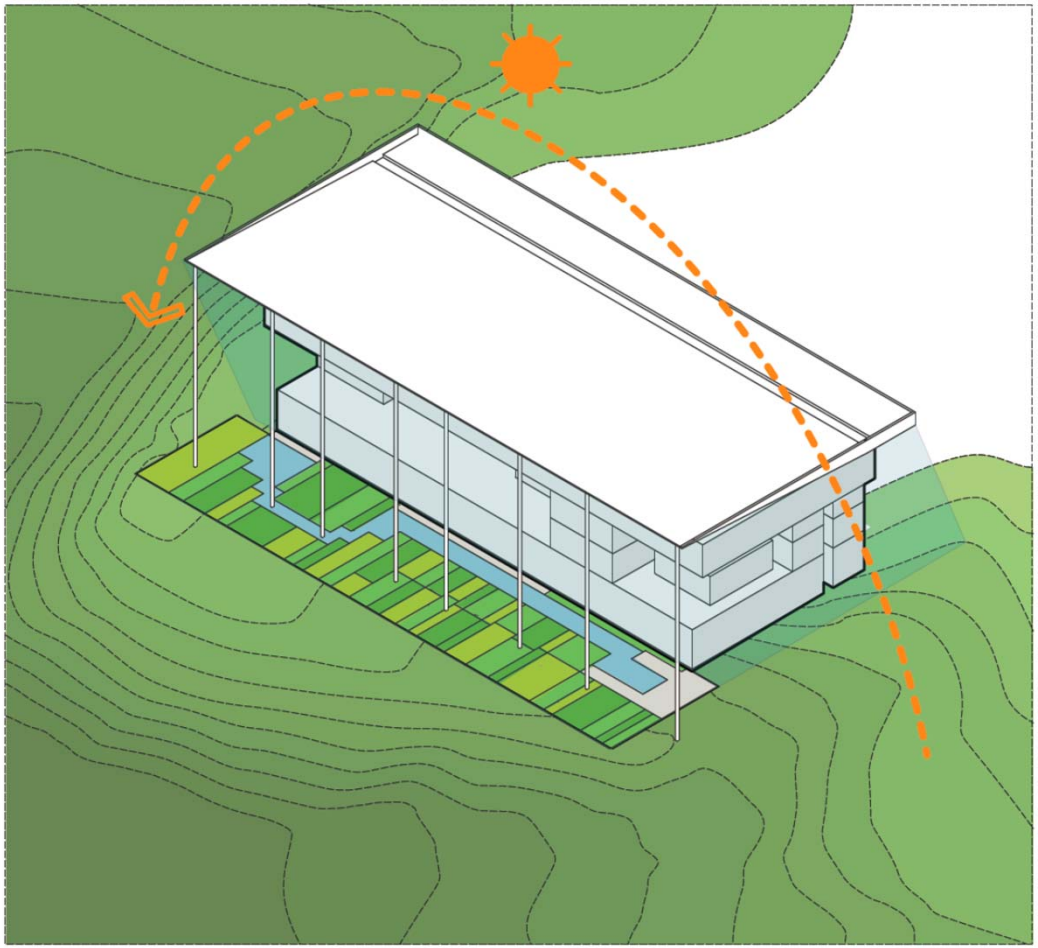
NUS School of Design and Environment, Singapore,
Multiply architects
zero energy, no full air conditioning, occupancy 2019



NUS School of Design and Environment, Singapore, Multiply architects
zero energy, no full air conditioning, occupancy 2019

- Concept





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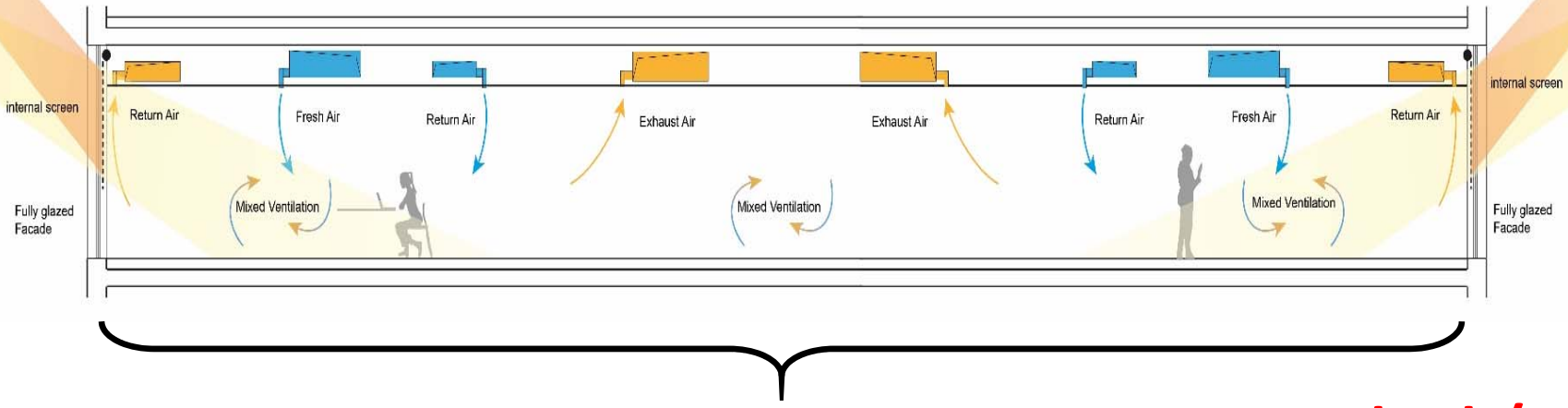
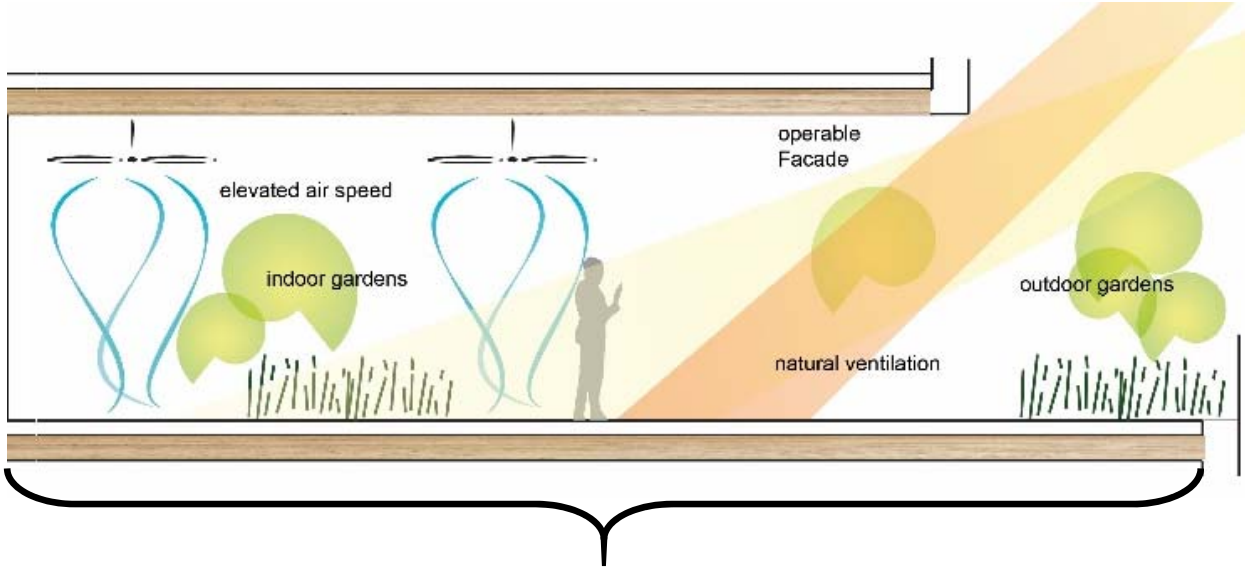
Conventional air conditioning system



Full air conditioned floors

260 kWh/m²a
= 120 kg CO2/m²a

Innovative concept (based on locally increased air velocity and natural ventilation)



65 kWh/m²a
= 30 kg CO2/m²a
Substitute by site electricity

Fully passive conditioned floors (elevated air speed, evaporative cooling, natural ventilation through breezing façade…)

NUS School of Design and Environment, Singapore, Multiply architects zero energy, no air conditioning, occupancy 2019

- Concept

conventional approach

operative Temperature 24°C

adaptive comfort approach

operative Temperature 29°C tempered air + elevated air speed

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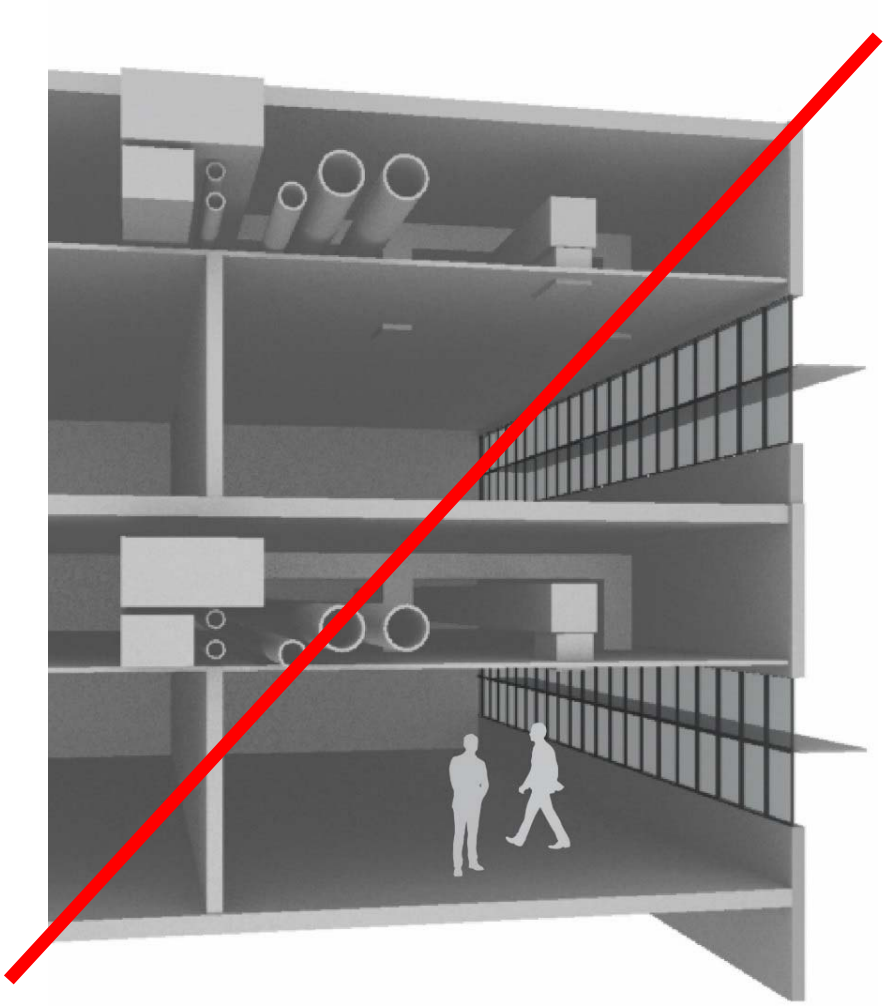
Full AC

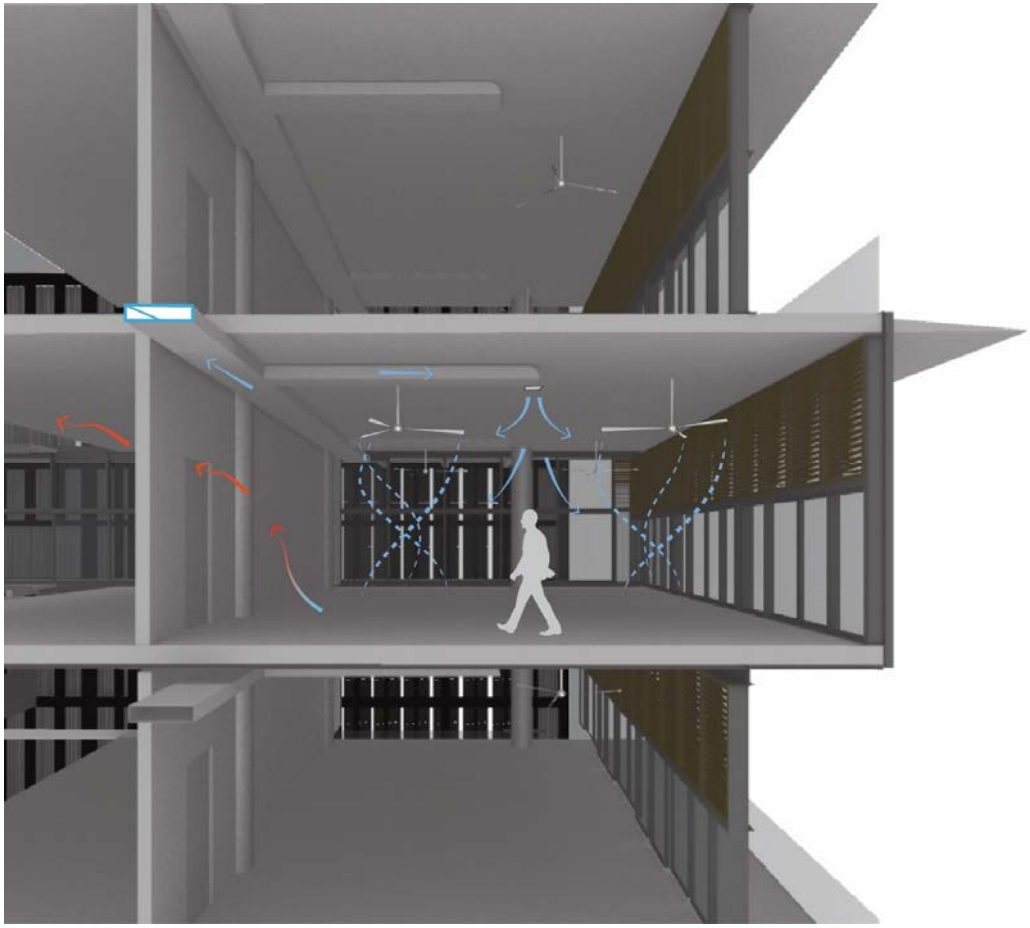
typical conventional design in Singapore



- fresh air supply with heat recovery to be energy efficient
- return air system for cooling, central mech rooms
- substantial space in false ceiling
- closed façade is required

Adaptive Comfort

Simple and effective design for School of Design 4



- supply air system with tempered air
- ceilings fan
- no return air, spill over
- window opening is possible

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Photovoltaic
renewable energy

Hybrid Tempered, 26%
library, design studios
Theatre, offices

Full AC,17%
green building technology lab
energy lab, computer lab

Natural Cross Ventilated, 46%
with elevated air speed
social Plaza and social
interaction spaces
modeling areas, work shops
smart green home

Circulation
micro climate, wind
vegetation, green and blue

mech and aux rooms 10%

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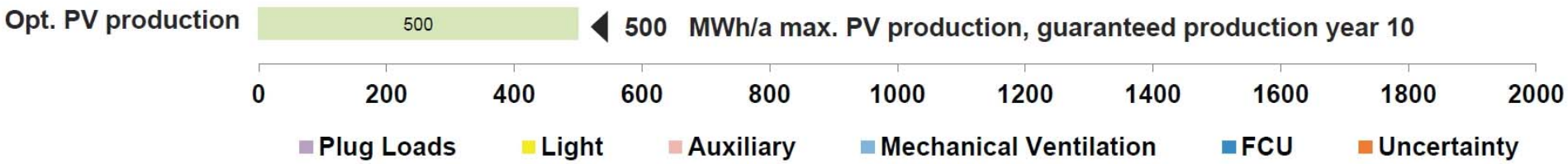
NET ENERGY STORY

NUS School of Design and Environment, Singapore



⇨ Maximal renewable energy production with PV system defines the available electrical energy to operate the building on net zero.

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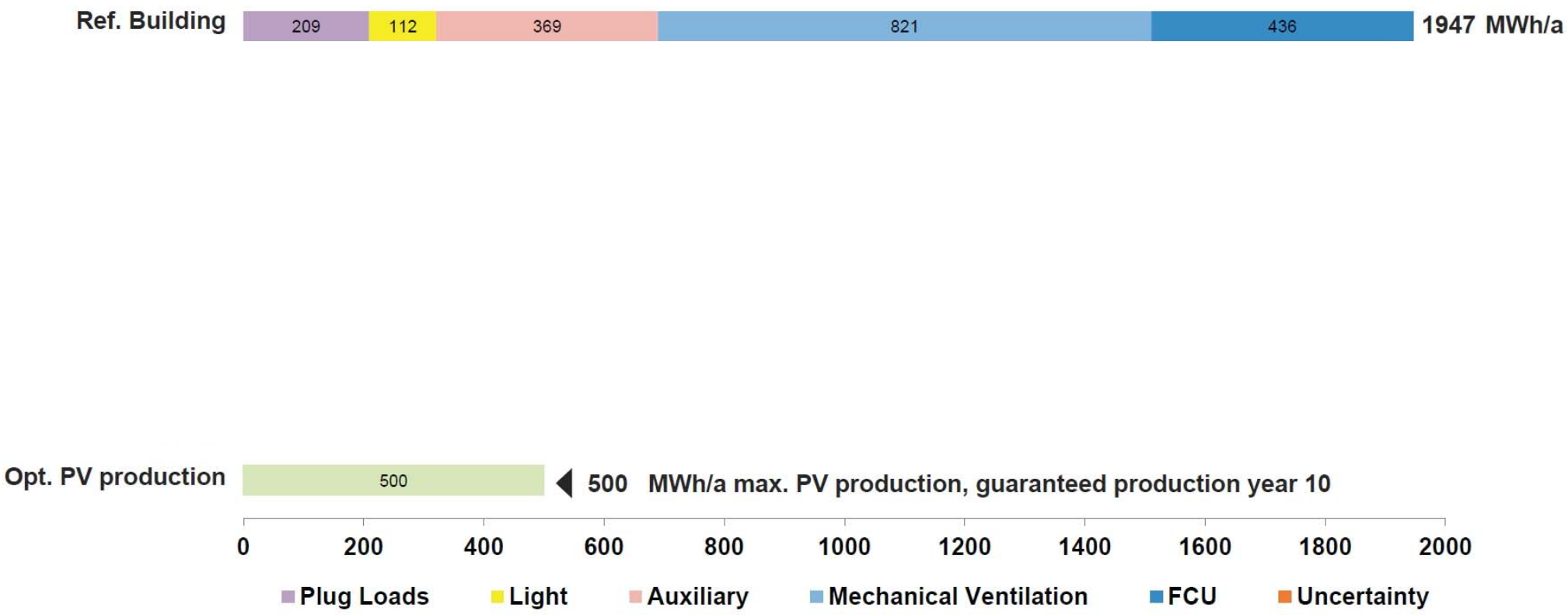
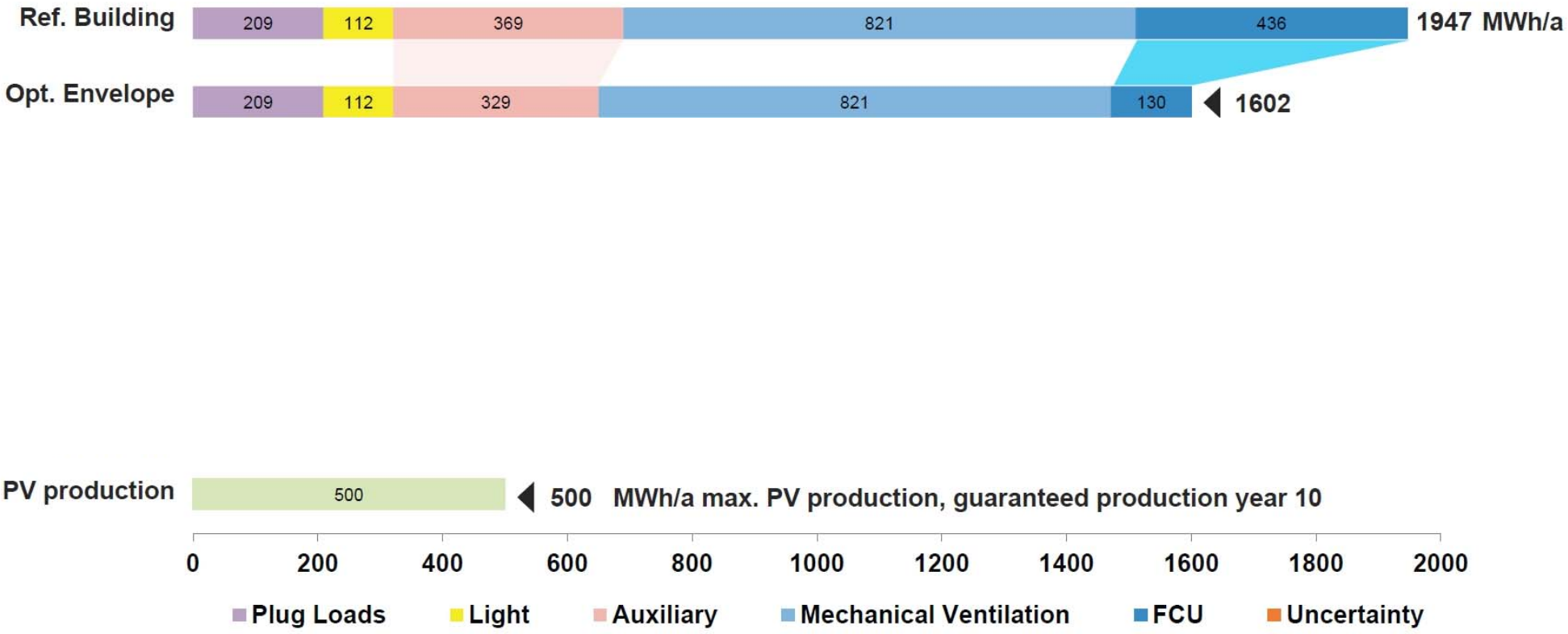
NUS School of Design and Environment, Singapore



⇨ Challenge the client design brief

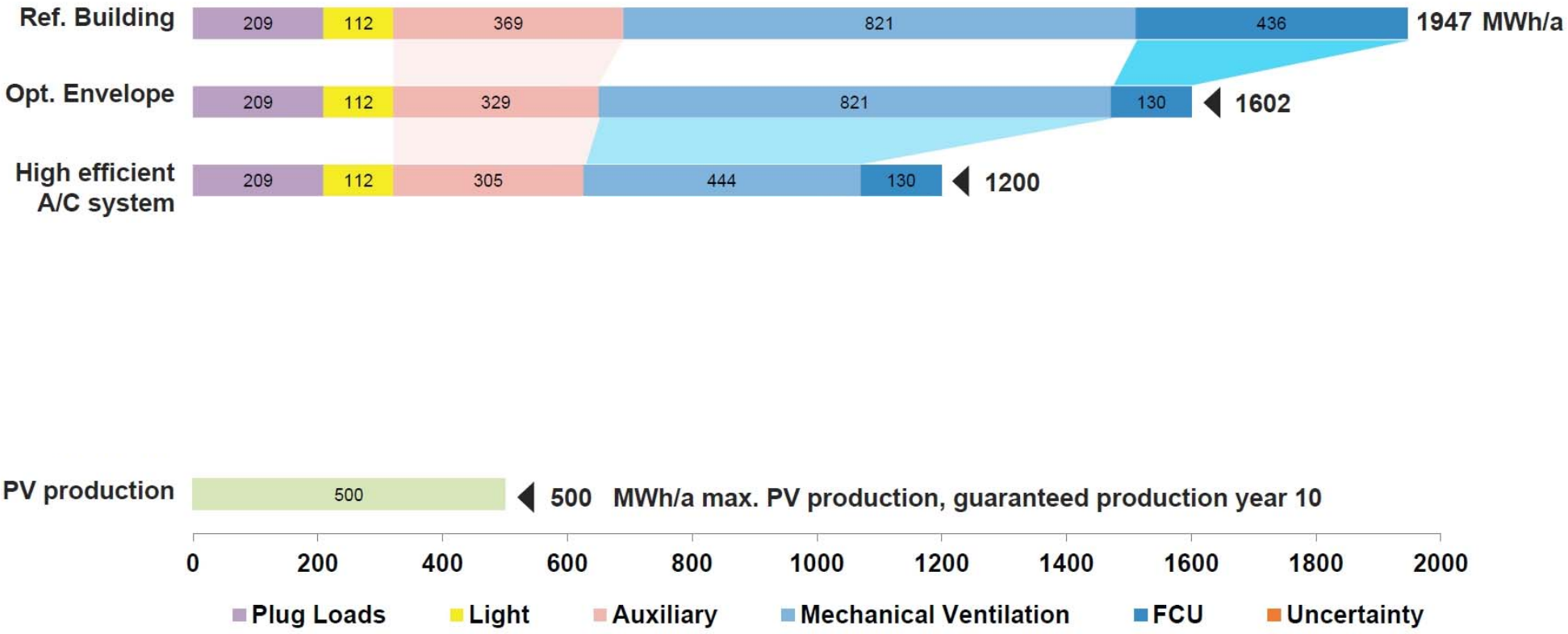
Transsolar KlimaEngineering

NUS School of Design and Environment, Singapore



⇨ Optimize the envelope for thermal comfort and energy and glare and daylight

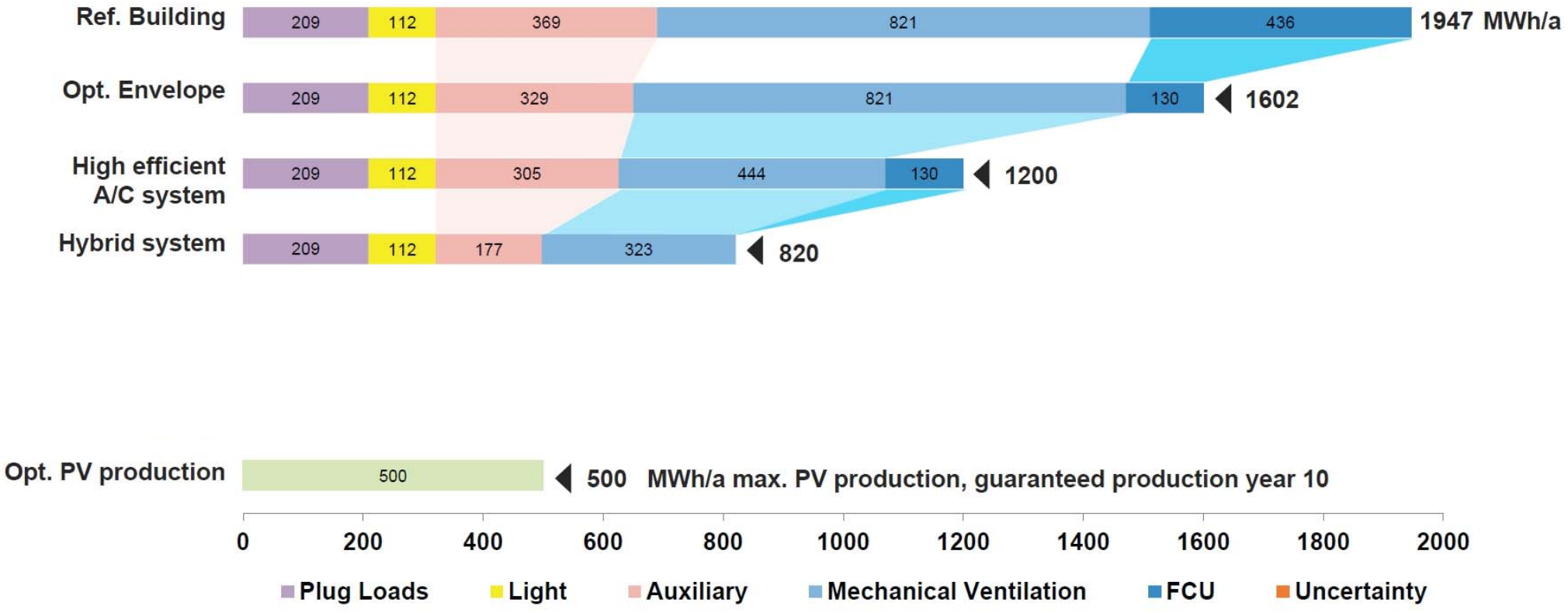
NUS School of Design and Environment, Singapore



⇨ Maximal energy efficiency of a/c systems

Transsolar KlimaEngineering

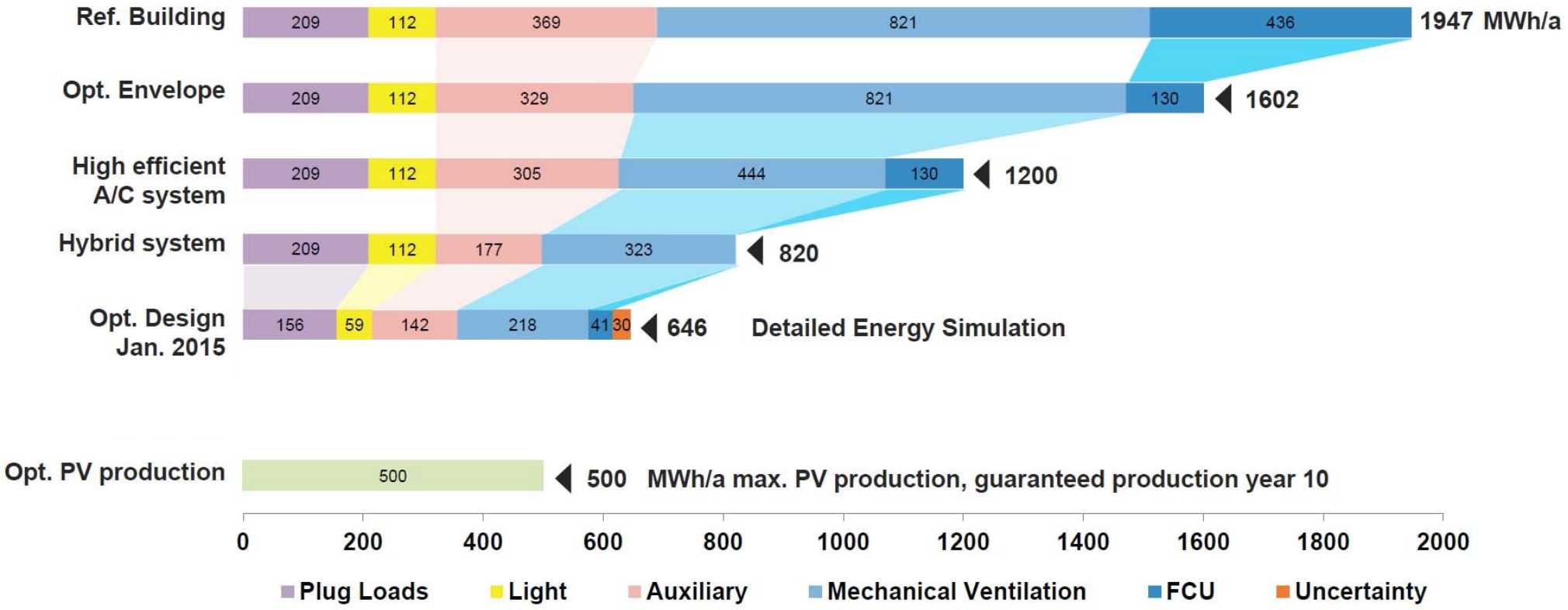
NUS School of Design and Environment, Singapore



Design for adaptive comfort with hybrid system
great fresh air, tempered and elevated air speed

Transsolar KlimaEngineering

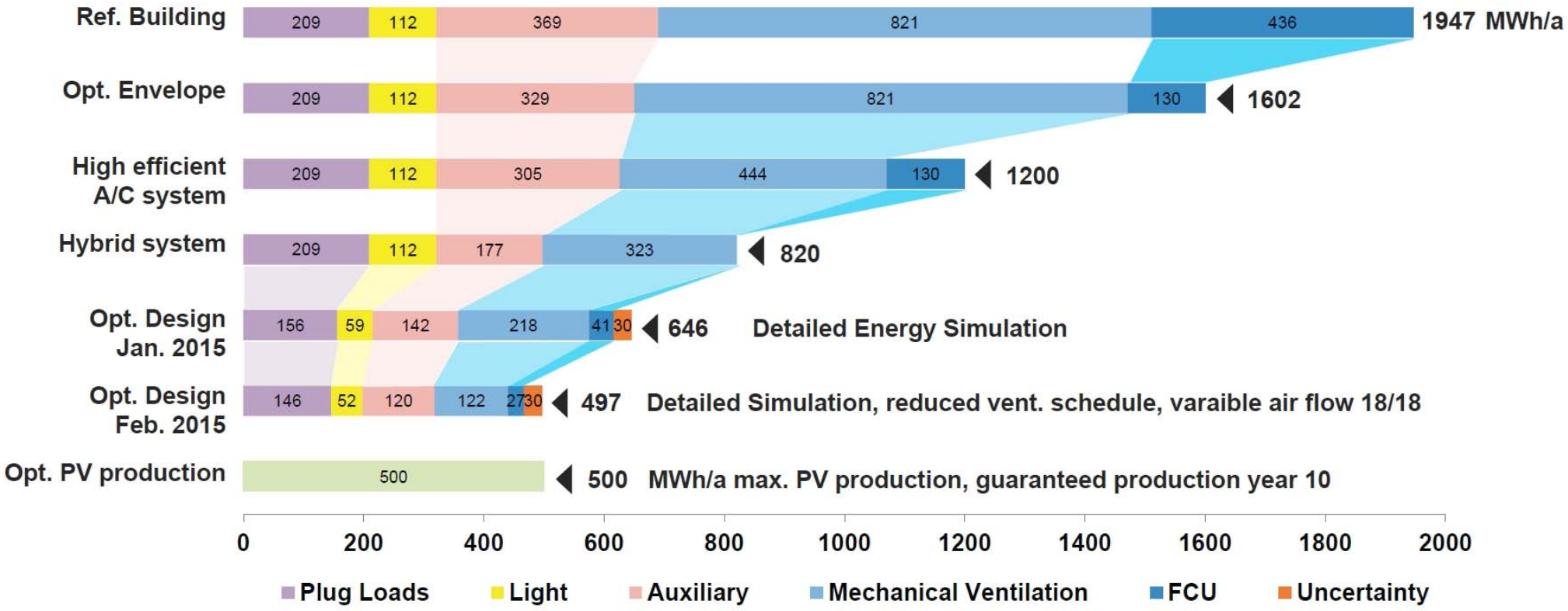
NUS School of Design and Environment, Singapore



⇨ Get the details right

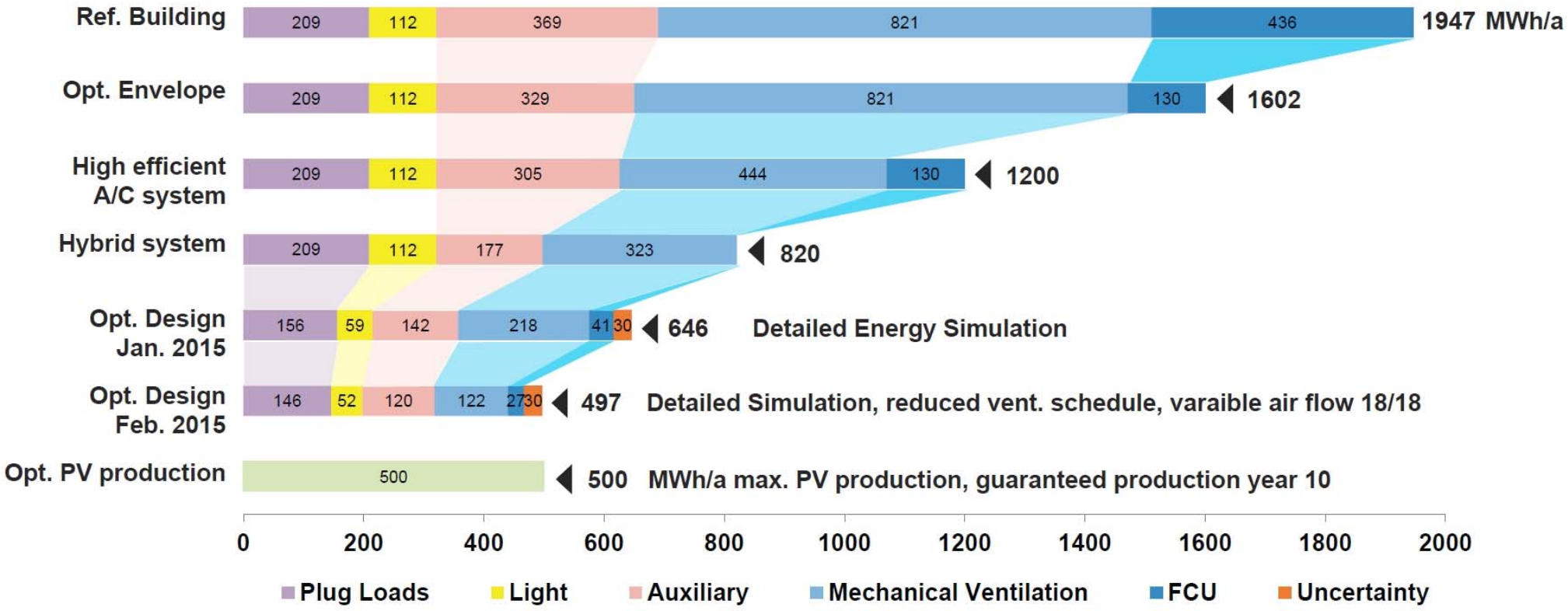
Transsolar KlimaEngineering

NUS School of Design and Environment, Singapore



⇨ Inform and improve the building design step by step with design charrettes

NUS School of Design and Environment, Singapore



This is a process in a team!

The zero energy design process

- Challenge the client design brief
- Optimize the envelope for thermal comfort and energy, glare and daylight
- Maximal energy efficiency of a/c systems
- Design for adaptive comfort with hybrid system great fresh air, tempered and elevated air speed
- Get the details right
- Inform and improve the building design step by step with design charrettes

NUS School of Design and Environment, Singapore, Multiply architects
zero energy, no air conditioning, occupancy 2019

- Building

NUS School of Design and Environment, Singapore

Sydney based CEO of large software company for their new highrise during visit July 25th, 2019:

- External conditions were 32 degree C, relative humidity about 85%
- humidity of about 50-55%, temperature of 26-27C, CO2 of about 470ppm
- Fans were on "low" speed (regulated by controller)
- After 10-15 minutes I was totally comfortable, not cool, not hot (I had shorts and light l/s shirt)
- for the next 3-4 hours I was very comfortable
- I enjoyed the slight breeze produced by the fan
- I left the space 3-4 times and went outside (5-10min). Every time I returned I felt very comfortable immediately

Transsolar
KlimaEngineering

München, Paketposthalle

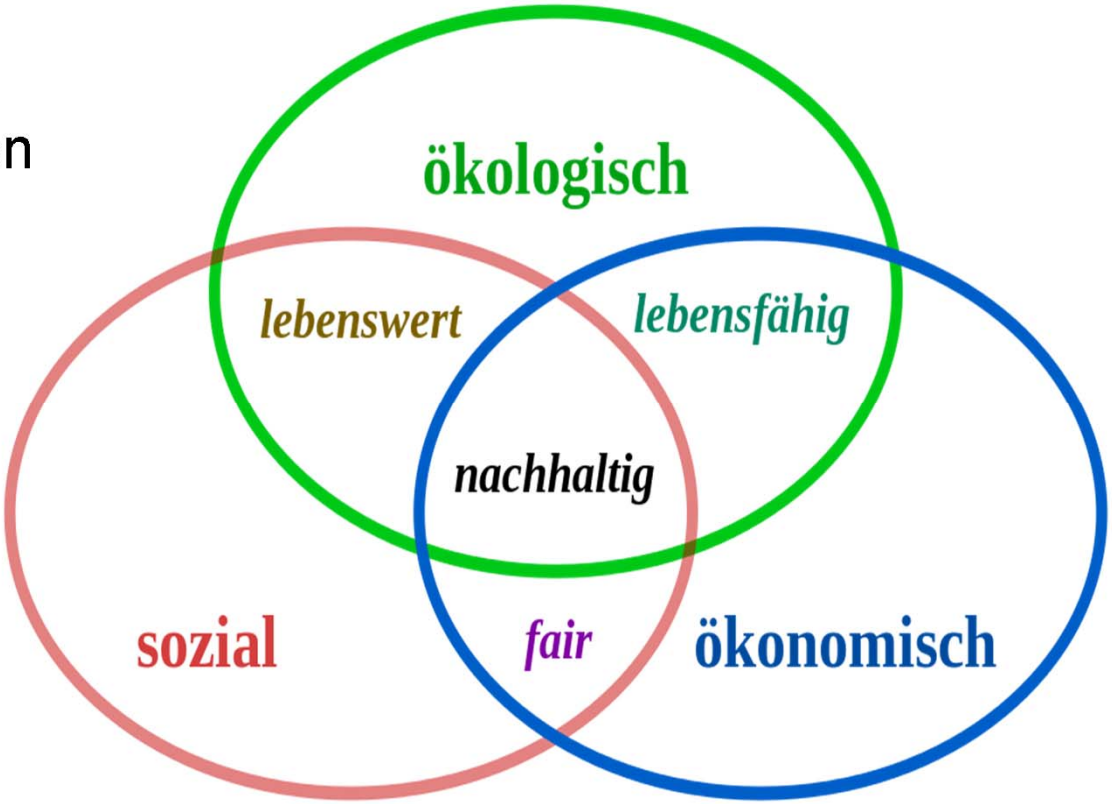
Optimize Comfort
Maximize Energy Efficiency
Minimize CO2

Quartier Paketposthalle München
Feasibility Study
In collaboartion with Herzog de Meuron

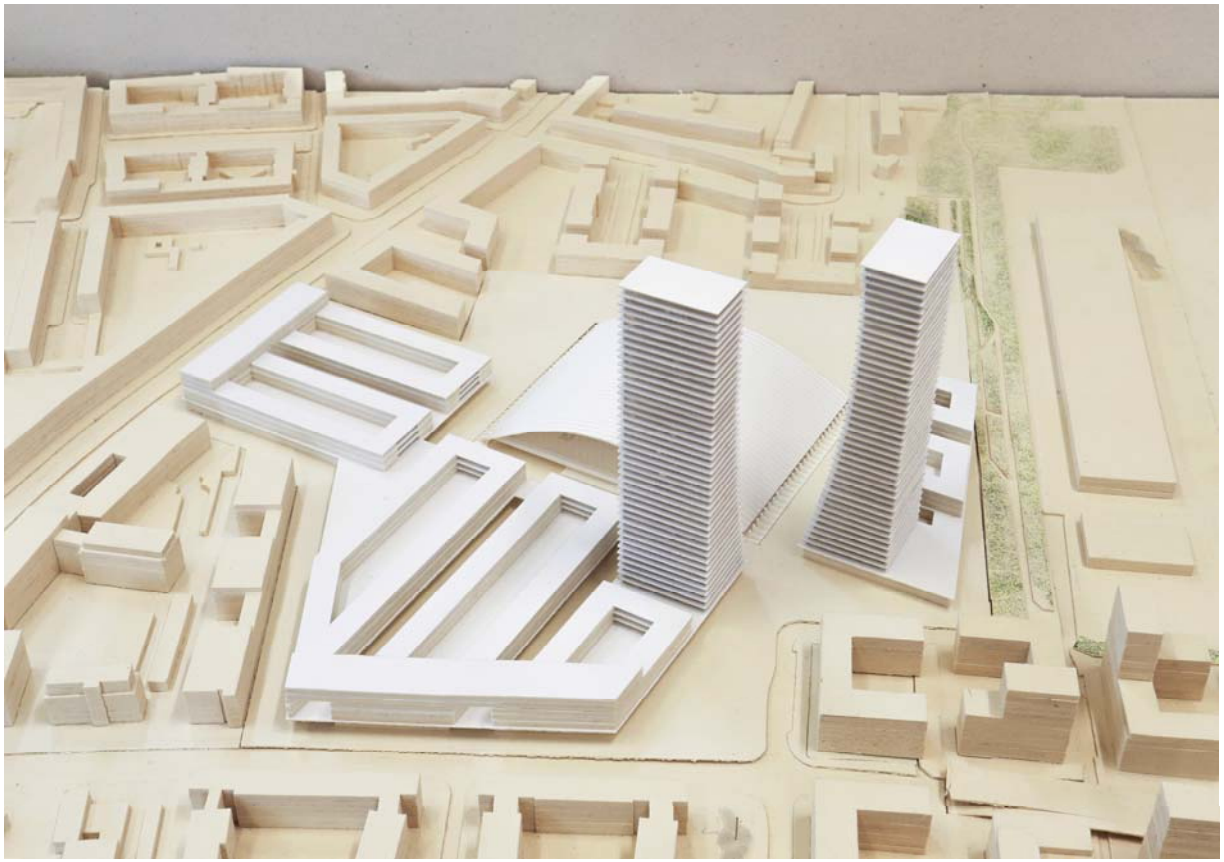
Munich, Paketposthalle

Taregt to realize an exemplary
sustainable neighborhood development

- CO2 – neutral in operation
- Minimize CO2 for construction



Entwurf und Projektdaten



Wohnen	105000	m²
Büro	92600	m²
Hotel	17700	m²
Gewerbe	11600	m²
soz. Infrastr	19600	m²
Kultur	52800	m²
öffentl. Raum	12000	m²
Tiefgarage	124600	m²
	435900	**m²**

1. Construction CO2-Emission

CO2 – Reduzierung, Erstellung

Konventionell: UGs+OGs Beton
Hybrid: UGs Beton, OGs (inkl Türme) Holz
Reduziertes UG: 86.900m² statt 189.400 m² UG aus Beton, OGs (inkl Türme) Holz
-> Dimensionierung der reduzierten TG, so daß CO2-Neutralität entsteht
Turm in Beton: 86.900m² statt 189.400 m² UG aus Beton, OGs Holz, Türme Beton

Wohnen	105000	m²
Büro	92600	m²
Hotel	17700	m²
Gewerbe	11600	m²
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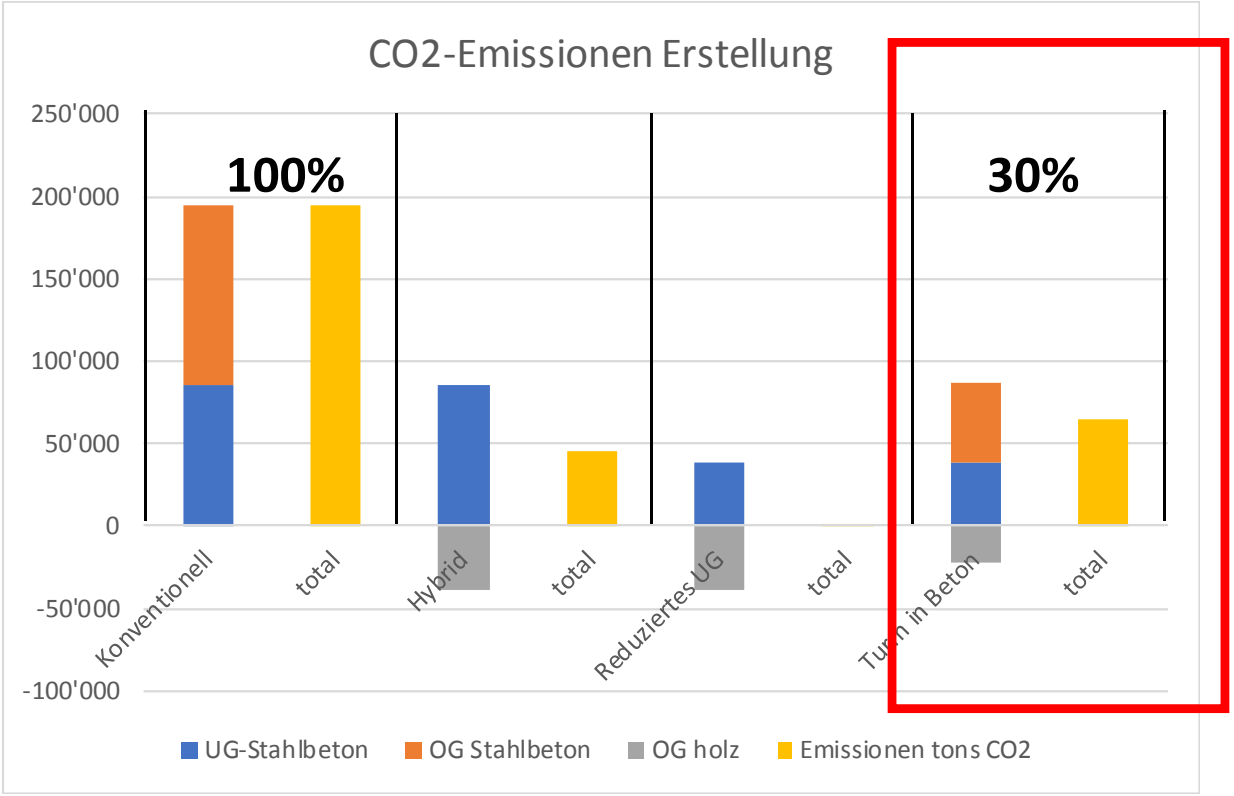


CO2-Emissionen für Erstellung entspricht in etwa denen für
10 (optimierte Energieversorgung/ nur Turm in Beton)
– 18 (Standard-Energieversorgung /konventionelle Bauweise)
Jahre Betrieb

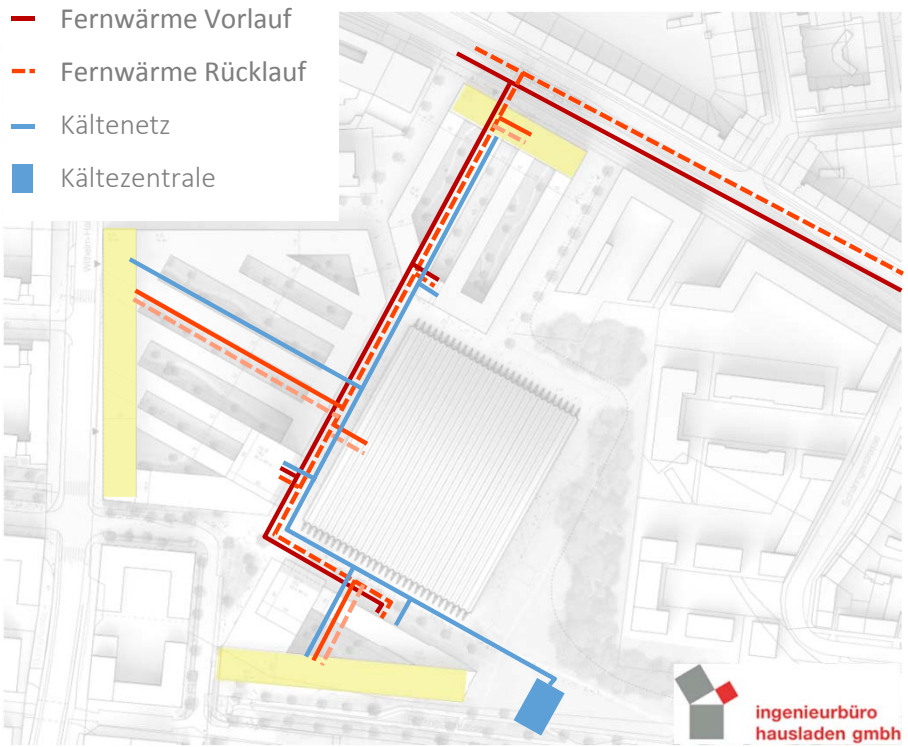
Even with reduced parking and wood low rise housing the project still starts with 60.000 ton CO2 load

Transsolar KlimaEngineering

1. Energy supply / CO2-Emission

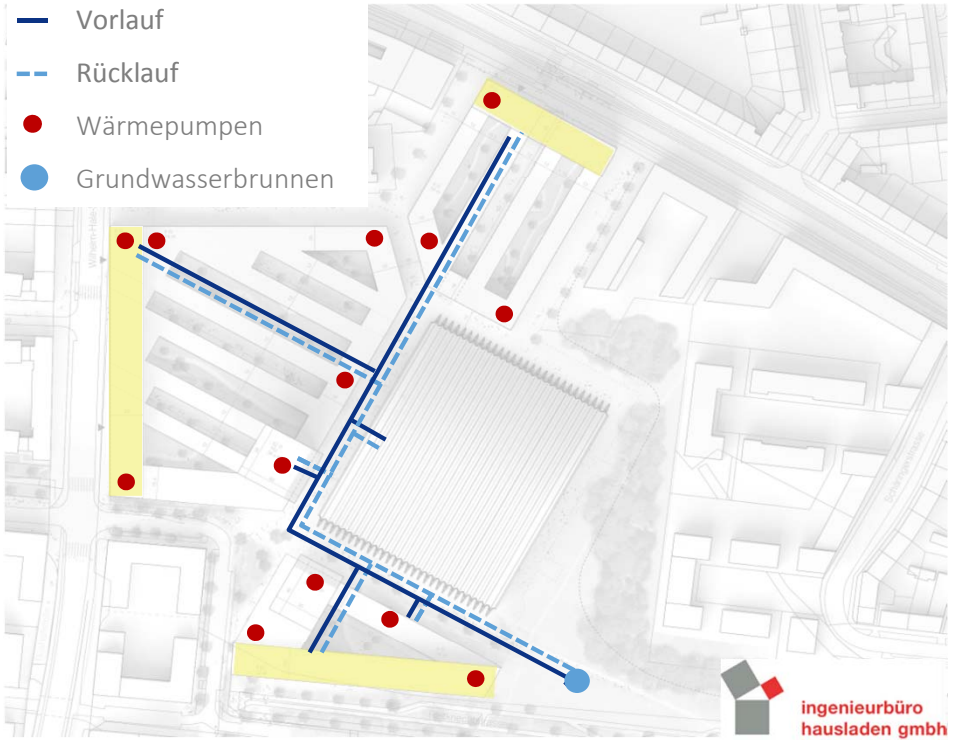
Energieversorgung

Anschluss zentrales städtisches Netz



+ connection existing infrastructure
+ district heating with low PEF
- Conventionel cooling

Quartiersnetz mit Umweltenergie



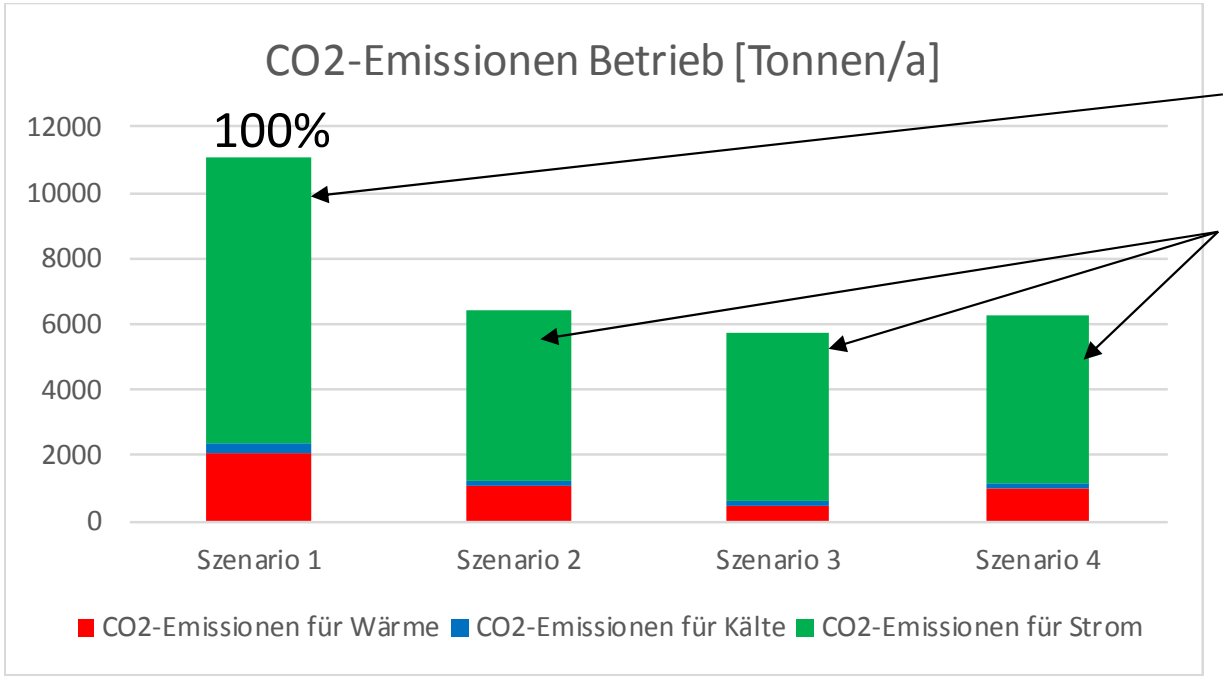
+ free cooling from ground water
+ low temperature anergy network
- Heat pumps in each building

1. Energy supply / CO2-Emissionen

CO2 – Emissionen, Gebäudebetrieb

Szenario 1: Dämmung nach EnEV, **Fernwärme,** Kältenetz
z.B. 55 kWh/m²a HWB Wohnen, 20 kWh/m²a WW, 35 kWh/m²a Strom
40 kWh/m²a HWB Büro, 2 kWh/m²a WW, 50 kWh/m²a Strom

Szenario 3: Dämmung nach EnEV+, verringerter Strombedarf, **Fernwärme-Rücklauf,** Kältenetz



17 557 MWh/a Strom
2 916 MWh/a Kälte
19 420 MWh/a Wärme

10 395 MWh/a Strom
1 396 MWh/a Kälte
10 313 MWh/a Wärme

Wohnen	105000	m²
Büro	92600	m²
Hotel	17700	m²
Gewerbe	11600	m²
soz. Infrastr	19600	m²
Kultur	52800	m²
öffentl. Raum	12000	m²
Tiefgarage	124600	m²
	435900	**m²**

Electricity consumption dominates the CO2 emissions
Target: further electricity consumption reduction

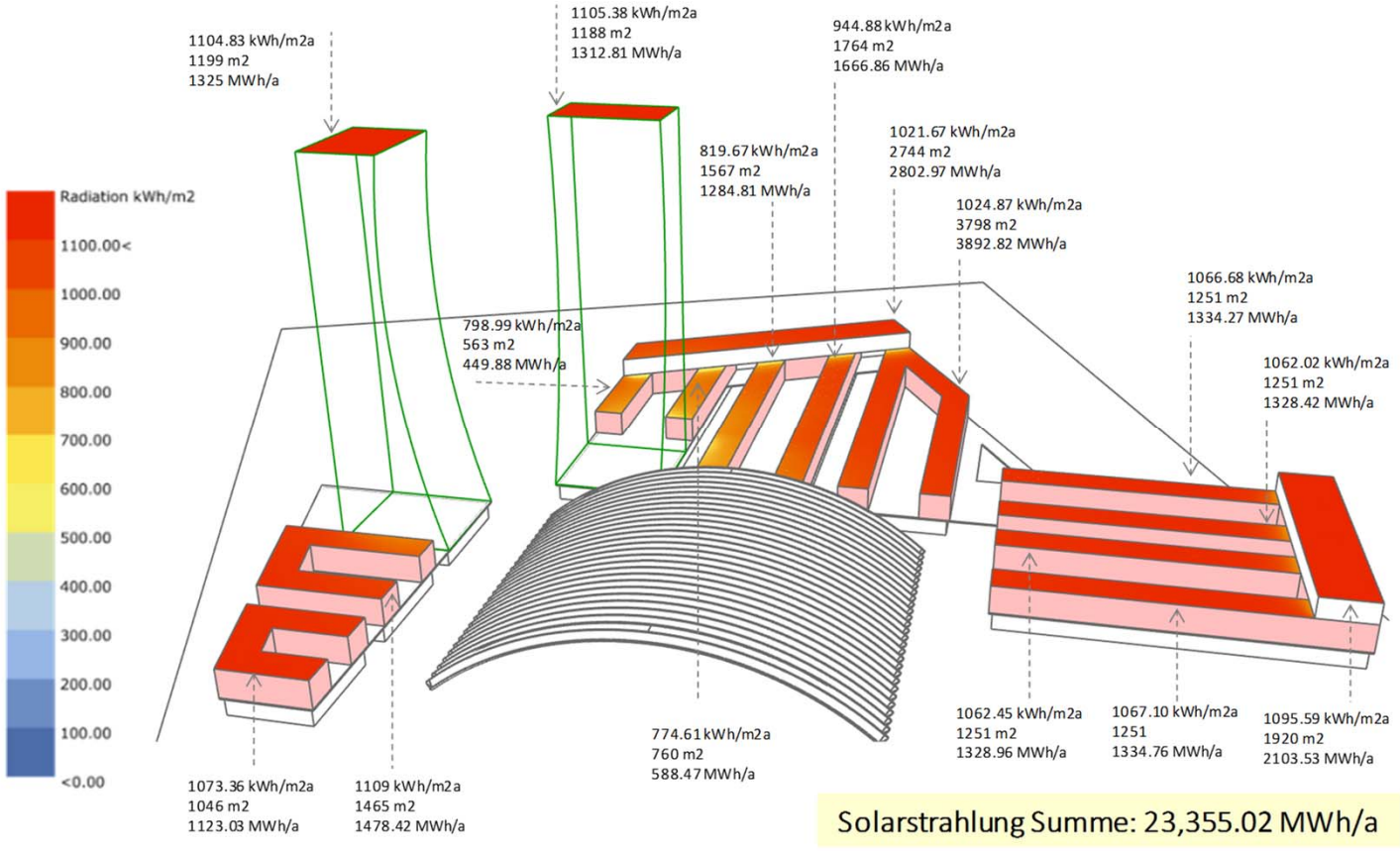
Transsolar KlimaEngineering

1. Energy supply / CO2-Emission

PV-Potential - Dächer

Conflict between accessible roof, green roofs and PV

Auf den insgesamt 22 258 m² Dachfläche kann mit einem angenommenen Wirkungsgrad von 2% 4 671 MWh Strom pro Jahr erzeugt werden.
Dies entspricht einer Vermeidung von 2 312 Tonnen CO2 – Emissionen jedes Jahr, etwa einem Drittel der im Betrieb entstehenden CO2-Emissionen.



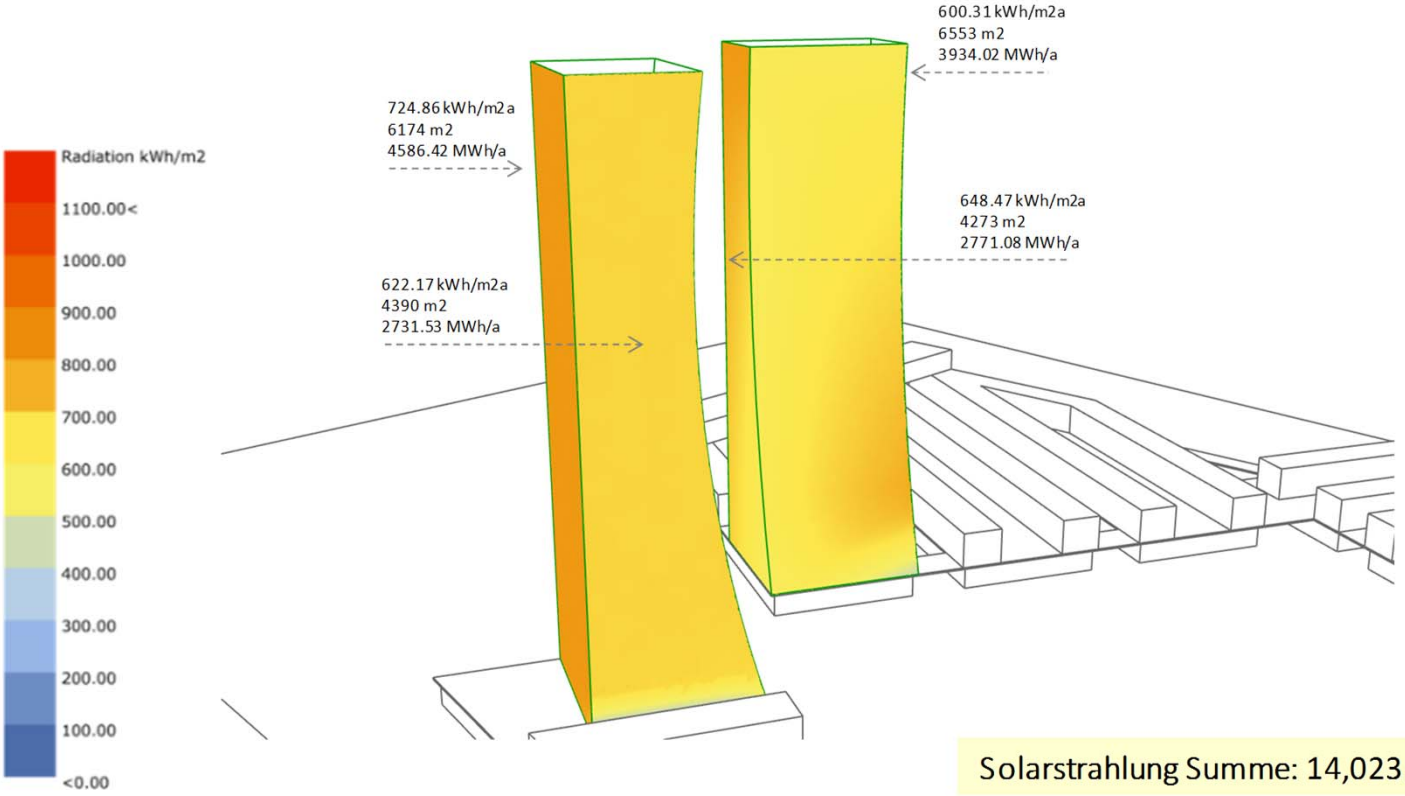
Solarstrahlung Summe: 23,355.02 MWh/a

Solare Pergola

1. Energy supply / CO2-Emission

PV-Potential – Fassaden Türme

Werden auch die beiden Südfassaden der Türme zu 50% mit Photovoltaik belegt, so steigt die erzeugte Strommenge auf den nun insgesamt 32 952 m² potentieller Photovoltaikfläche auf 6 073 MWh pro Jahr. Dies entspricht einer Vermeidung von 3 006 Tonnen CO2 – Emissionen jedes Jahr, etwa der Hälfte der im Betrieb entstehenden CO2-Emissionen.

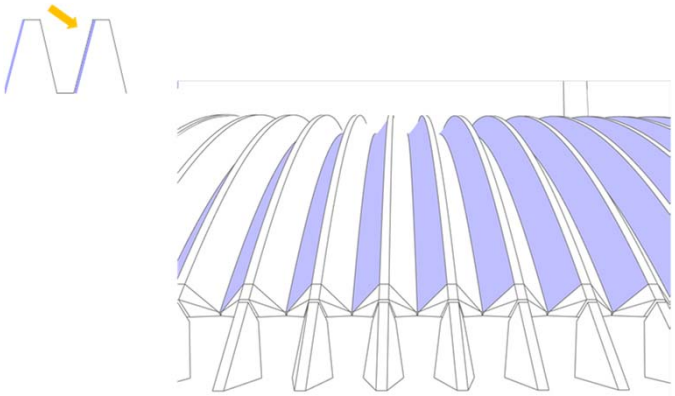


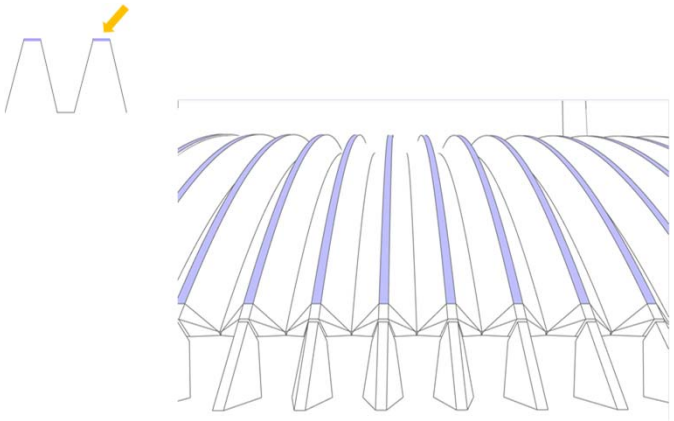
Solarstrahlung Summe: 14,023.06 MWh/a

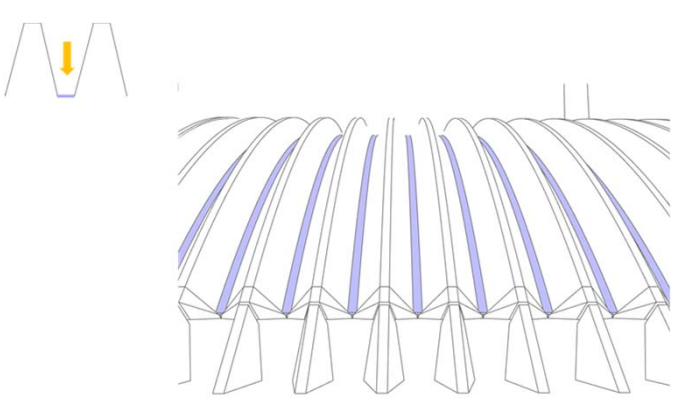
1. Energy supply / CO2-Emissionen

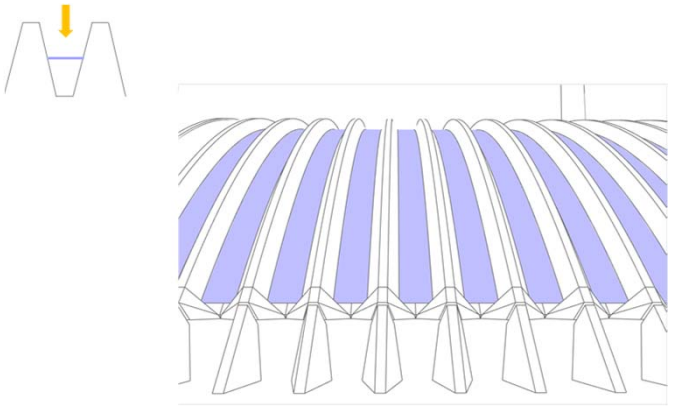
PV-Potential – Dach Paketposthalle

Als weitere Fläche für die Installation von Photovoltaik kann das Dach der Paketposthalle aktiviert werden. Hier könnte zum einen der süd-ost-orientierte Teil der Dachhaut-Rippen genutzt werden.
Weitere Alternativen wäre die Installation horizontaler PV entweder auf den oberen Flächen, in der Rippensenke oder etwas erhöht in der Mitte der Rippen-Vertiefung.

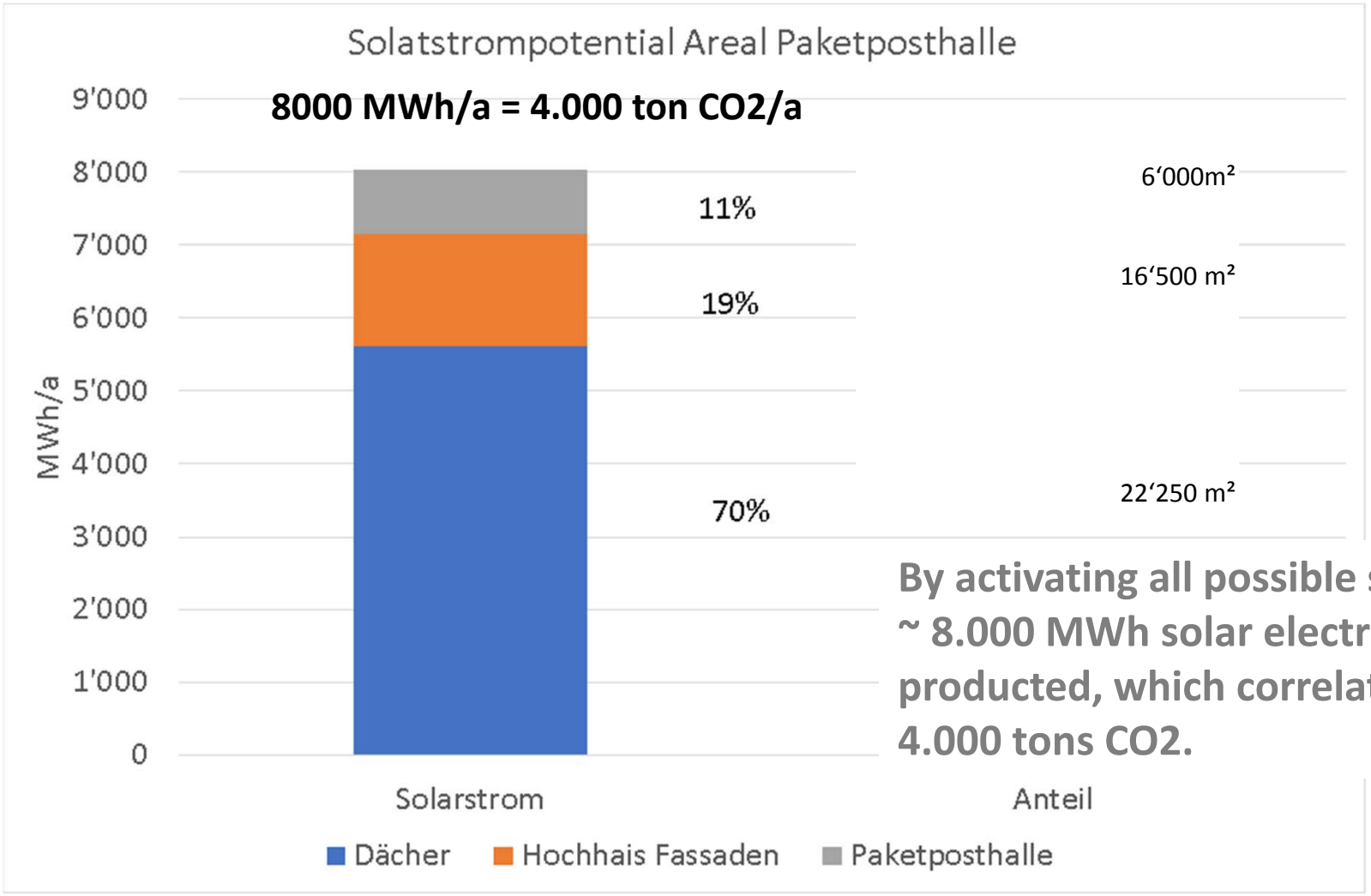








Solar electricity potential

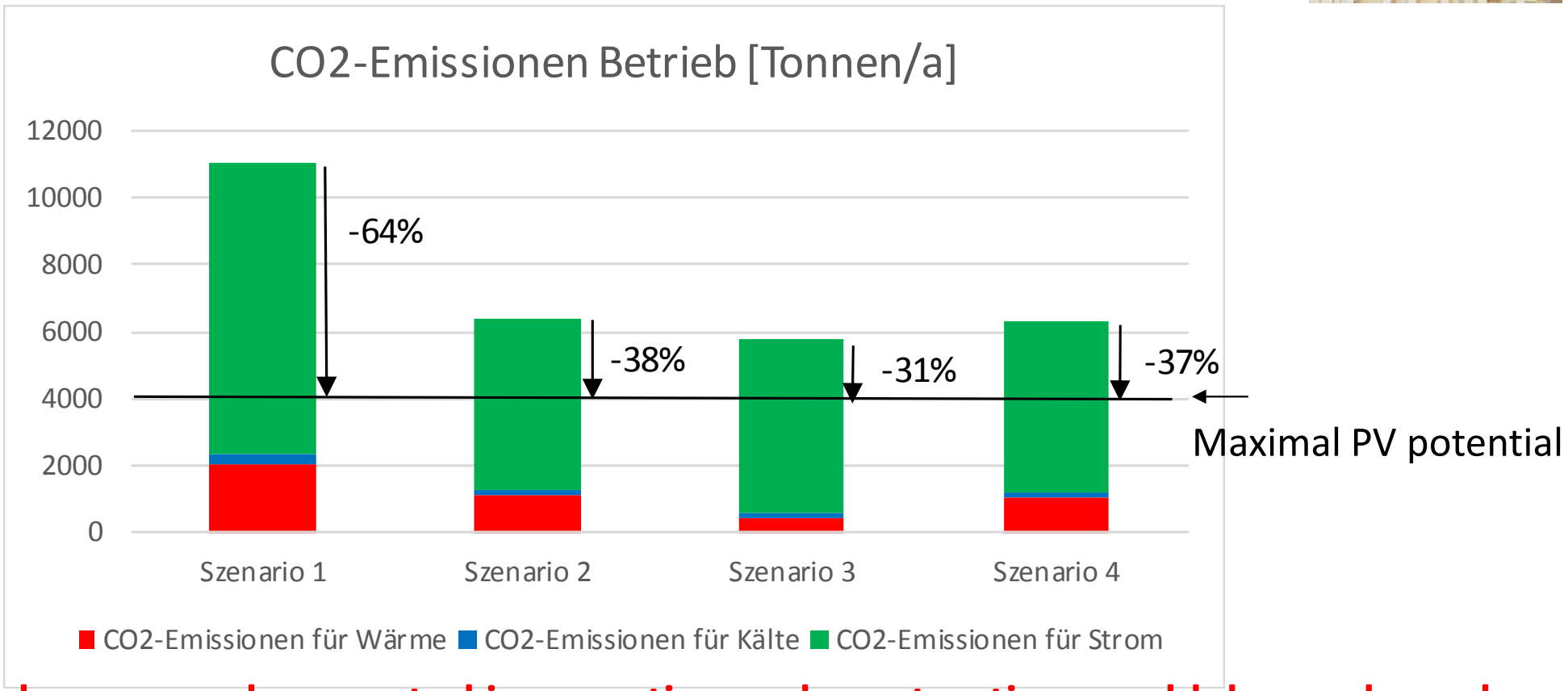


By activating all possible surfaces ~ 8.000 MWh solar electricity can be producted, which correlates to 4.000 tons CO2.

1. Energy supply / CO2-Emissionen

PV-Potential versus Verbrauch

Um im Betrieb der Gebäude eine ausgeglichene CO2-Bilanz zu erreichen, müssten die Energie-Verbrauchswerte weiter gesenkt werden oder zusätzliche Flächen für Photovoltaik aktiviert werden.
Die notwendige Einsparung im Stromverbrauch beträgt 35% (Szenario 3) bis 47% (Szenario 2).
Dies entspricht einer Verringerung mittleren Stromverbrauchs (gemittelt über alle Nutzungen) von 24 kWh/m²a auf 16 kWh/m²a (Szenario 3) bis 13 kWh/m²a (Szenario 2).

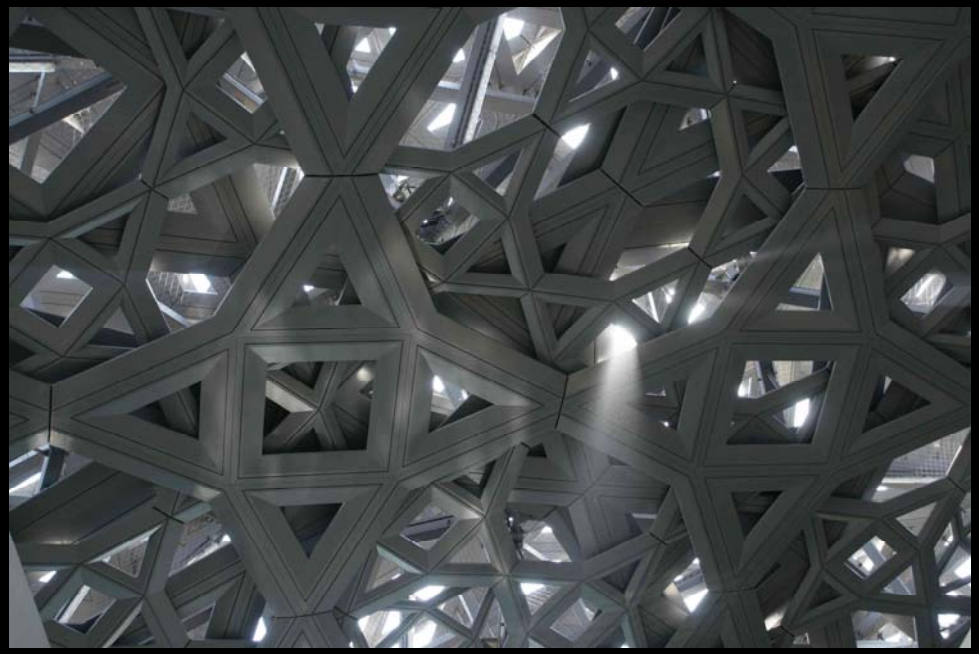


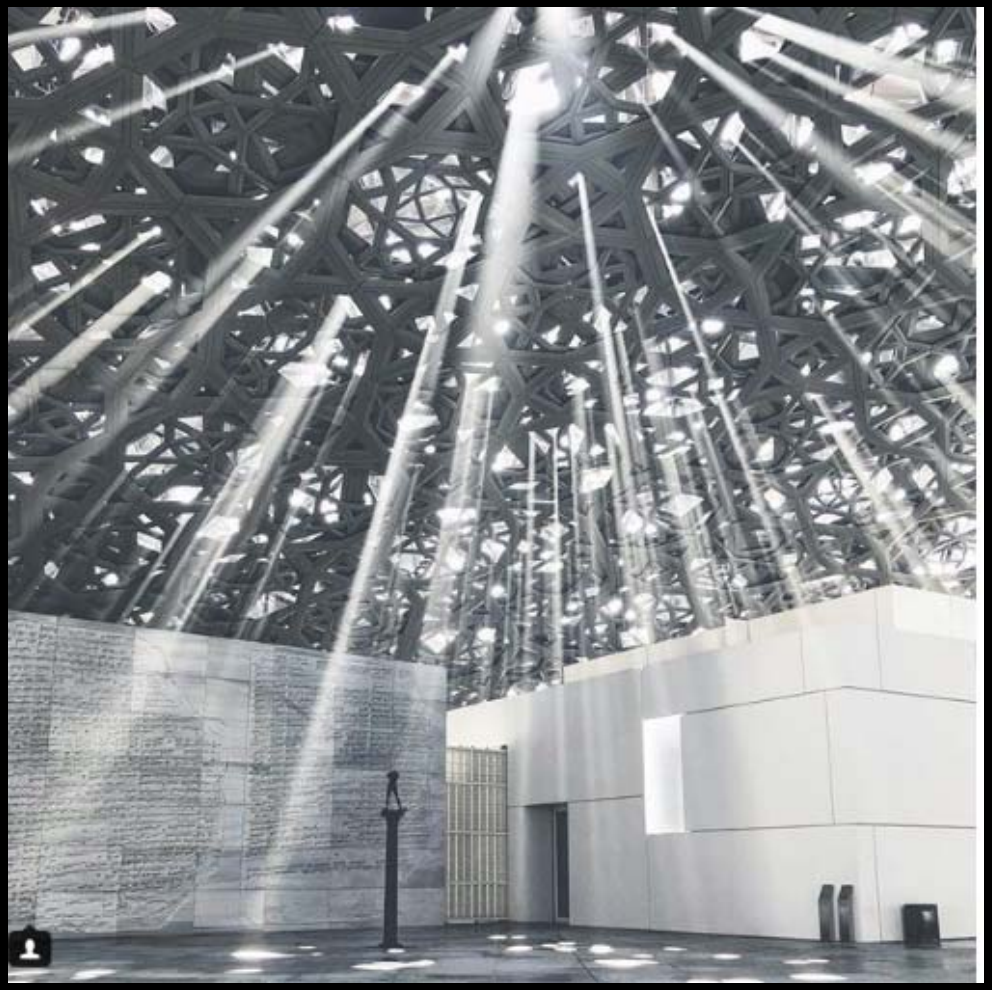
To become carbon neutral in operation and construction would demand a carbon positive operation, which needs lower consumption and higher production

Added value more than energy and carbon savings

- Identity
- Higher occupants satisfaction
- Higher productivity
- Less sick leaves
- reduced employee fluctuation
- Recruiting argument
- Increased tenant stability
- Increased market value
- Increased rents and rates
- Unique feature in the real estate market

The „ rain of light“ as a local identity





Louvre Abu Dhabi, Atelier Jean Nouvel
January 16th, 2018

Conclusion

CO2 neutral construction and operation

– Reduce energy consumption especially electricity consumption is a precondition – today typical German household 2.500 – 3.500 kWh/a Target must be 1000 kWh/a which will not work without personal limitations

– Limitation of personal living area, today 47 m²/Person,
in 2030 expected 60 m²/Person, but in 1965 it was 25 m²/Person

! Demands high architectural quality inside and outside

– Underground parkings are CO2 dumps and should be limited to absolut minimum

– Above ground constructions in wood

– 4 to 6-floor buildings for a good roof area/programm area ratio

– CO2 neutral operation and construction buildings deamnd energyplus buildings, to compensate for the CO2 loads during construction.

– Immediate action by each of us: Stop eating meat!