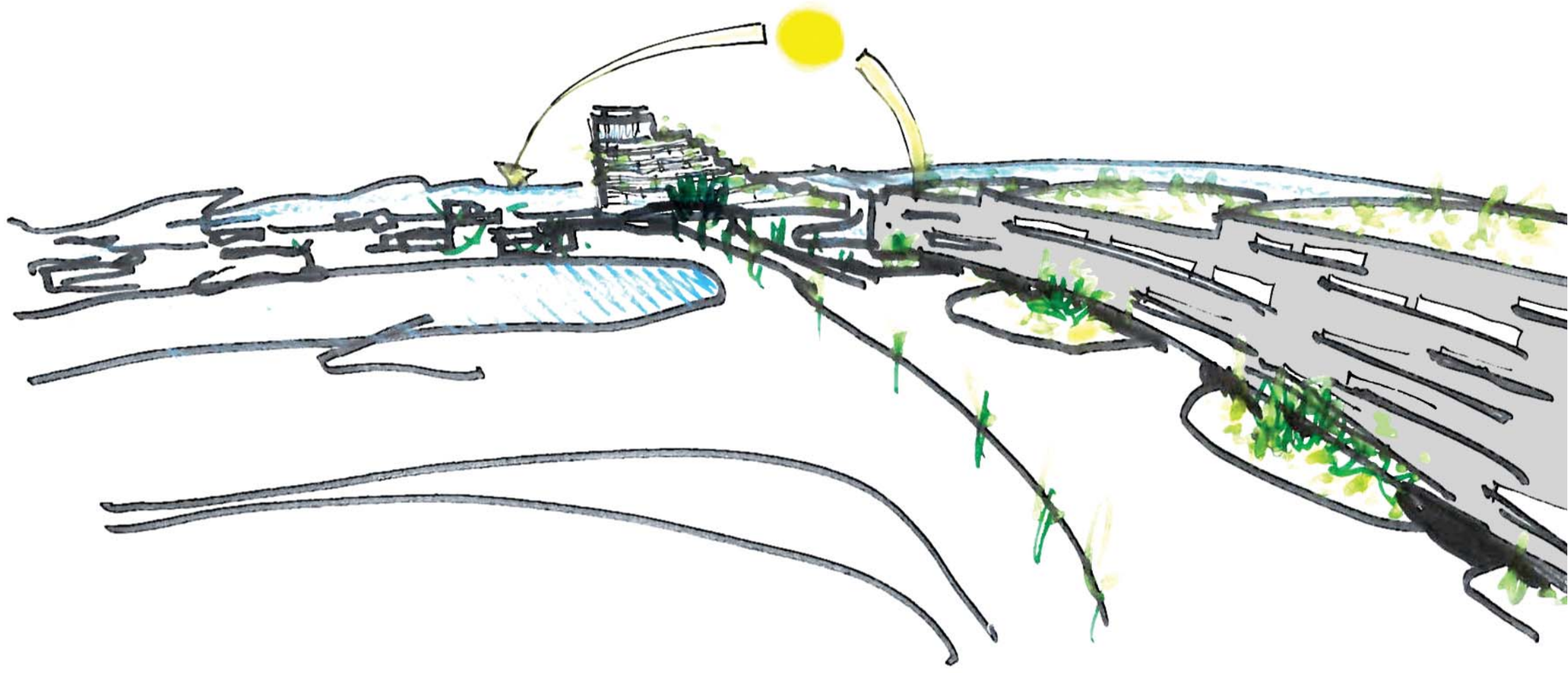
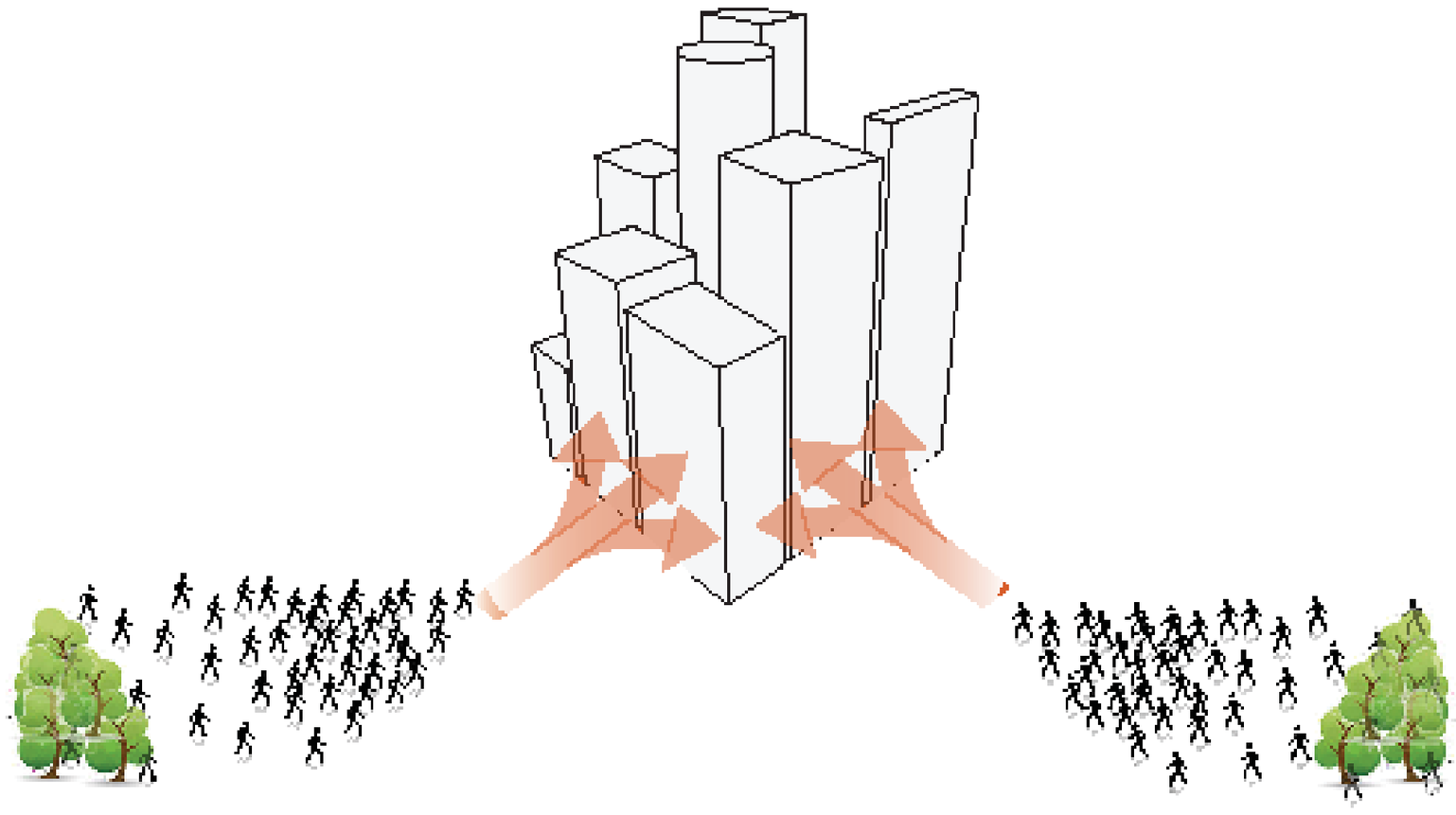
Sustainable Buildings: Intelligent & Beautiful?

Larry Malcic
Design Director, HOK London

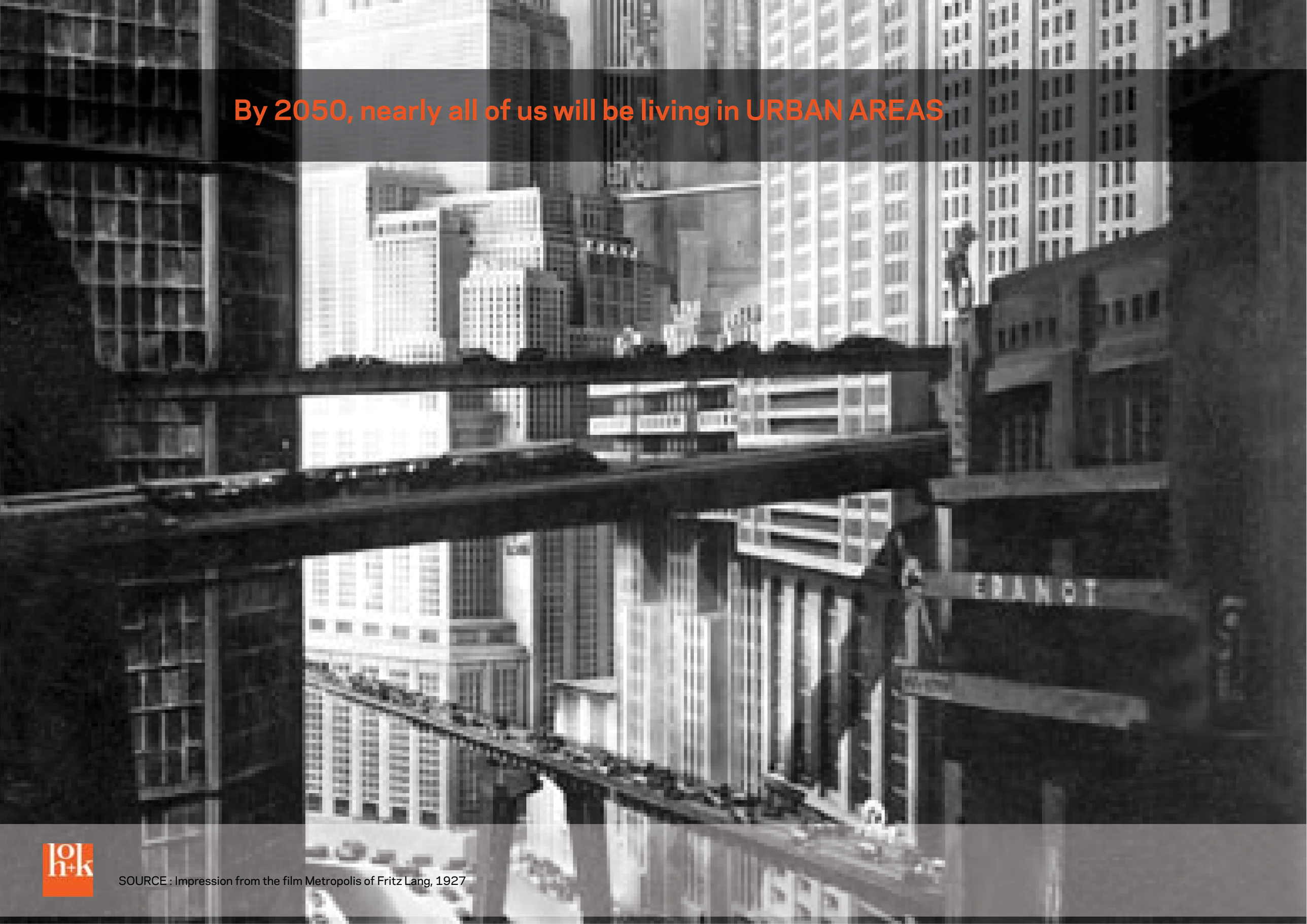
8th July, 2015



100 years ago, only 10% of the world's population lived in cities. Since 2007, this figure has risen above 50%.

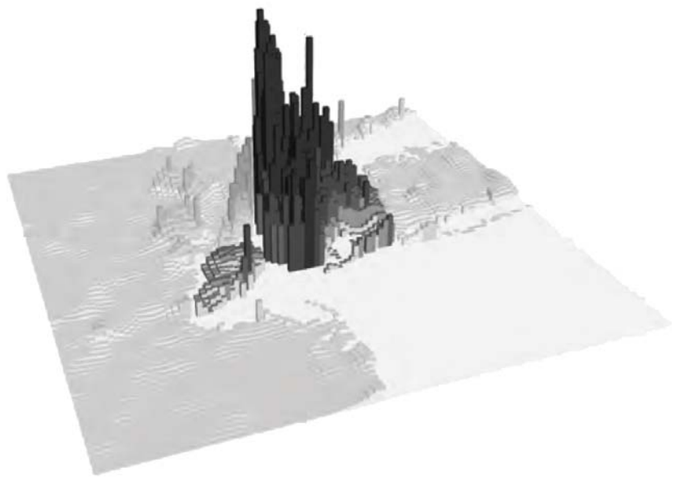


SOURCE : Impression from the film Metropolis of Fritz Lang, 1927

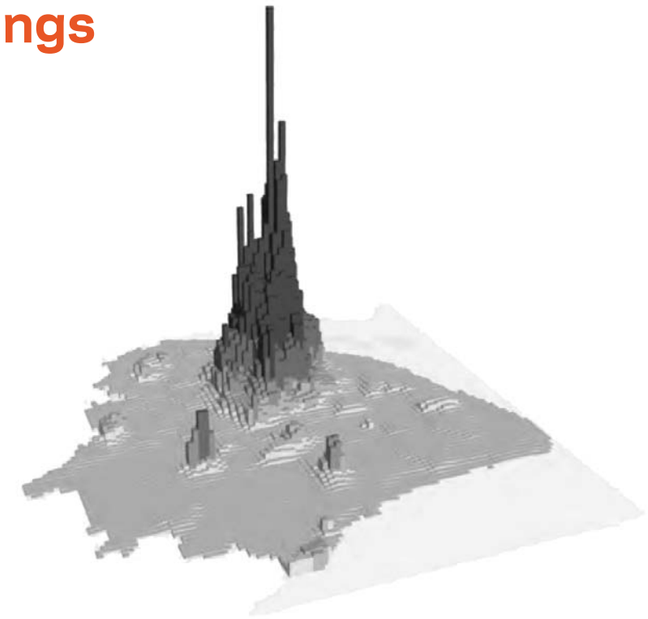


SOURCE : Impression from the film Metropolis of Fritz Lang, 1927

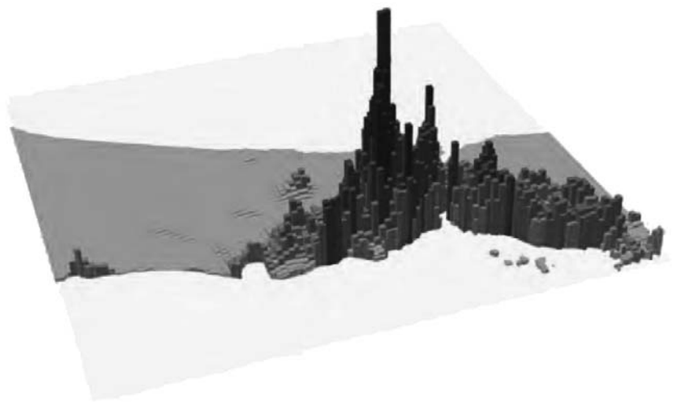
Urbanization and tall buildings



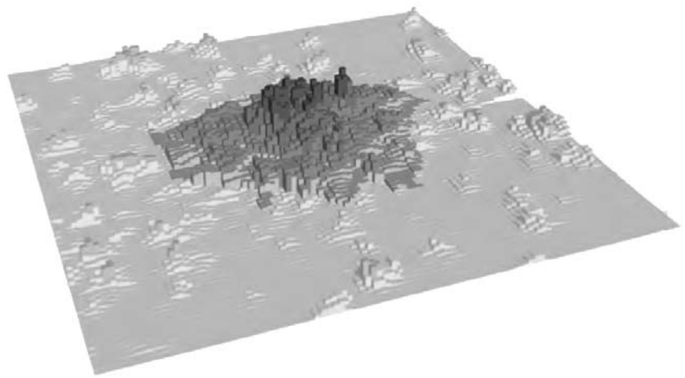
NEW YORK
237 150m+ completed buildings
30 under construction



SHANGHAI
124 150m+ completed buildings
13 under construction



ISTANBUL
33 150m+ completed buildings
10 under construction



LONDON
16 150m+ completed buildings
3 under construction

SOURCE : http://skyscrapercenter.com

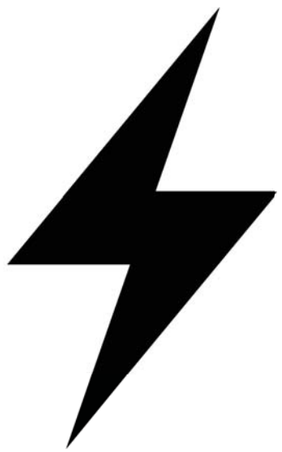
Shanghai is growing 10% per year, it has 3000 tall buildings in the city today compared to 300 in the 1990s'.

SOURCE : Global Cities

*" While **fossil fuels** are being exhausted, Global **energy consumption** continues to increase."*

75%

of the natural resource are consumed by cities



90%

of electricity is consumed by buildings

SOURCE : http://blogs.ucl.ac.uk/energy/2014/03/07/overview-of-building-energy-consumption-in-hong-kong/

Total Energy Consumption in Operation

Compliance	Unregulated Energy Use

SOURCE : Carbon Buzz

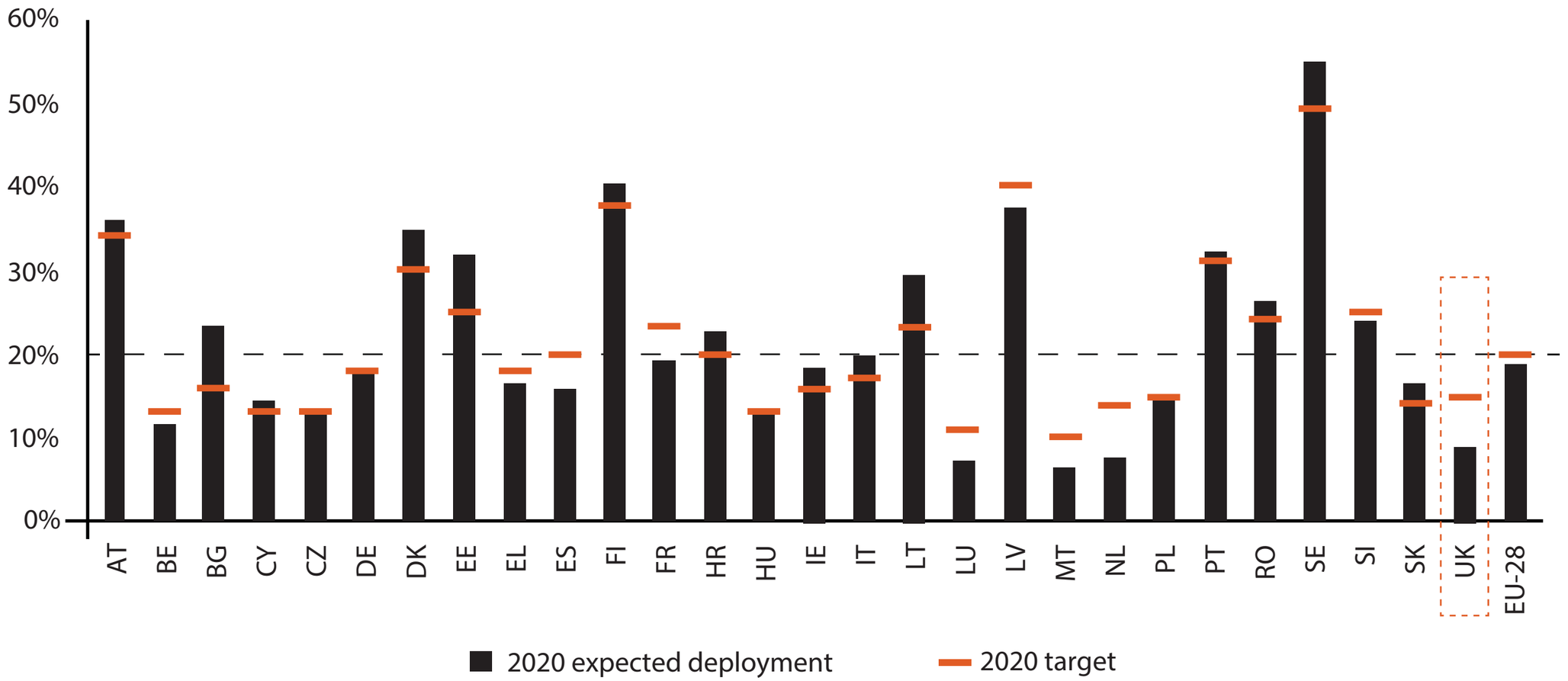
EU Target

20%

of the final energy consumption from renewable sources by 2020

SOURCE : http://ec.europa.eu/energy/en/topics/renewable-energy

UK's Response



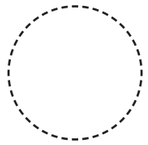
SOURCE : European Commission

Local Council Planning Requirements-Camden

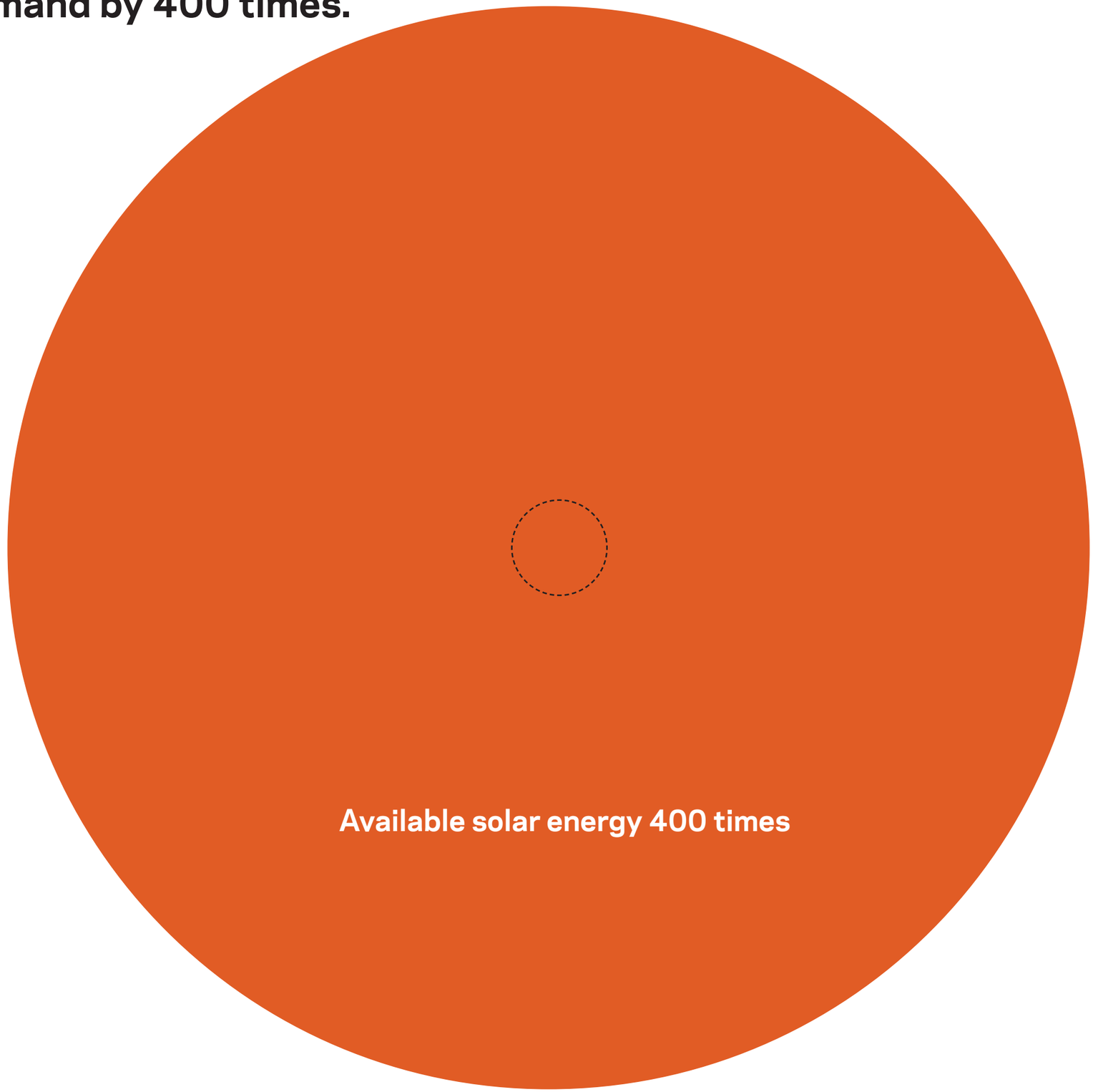
20% reduction
in on-site carbon dioxide emissions
through Renewable Technologies

SOURCE : https://www.camden.gov.uk/ccm/content/environment/planning-and-built-environment/two/planning-applications/making-an-application/supporting-documentation/sustainability-statements-design-and-construction/

The solar energy that is currently available exceeds the annual energy demand by 400 times.



Annual energy demand



SOURCE : Refer to Sapa-solar

Roof 20m² (10 x 1.5 m2 PV Panels)

SOURCE : An aerial view of houses in Leyton, east London, in the borough of Waltham Forest, one of the five so-called Olympic Boroughs. Tom Shaw / Getty Images

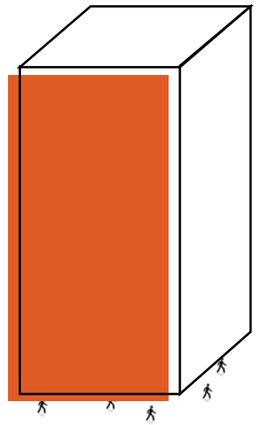
South Facade 900m² (50% of the facade area)

(1500 x 0.6m2 BIPV panels)

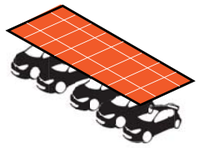
SOURCE : http://www.urban75.org/blog/work-starts-on-the-twisty-45-storey-luxury-baltimore-tower-in-canary-wharf-london/

A typical 30 story building in London. Opaque and transparent BIPVs are applied on the South facade balcony

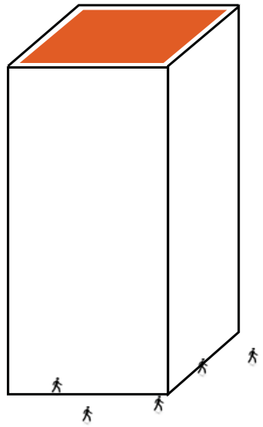
BIPV applications



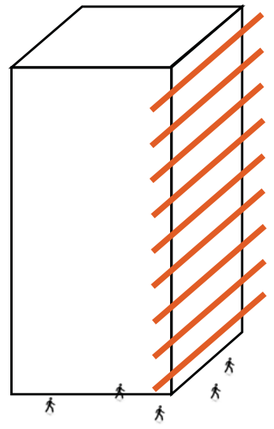
Double skin facade



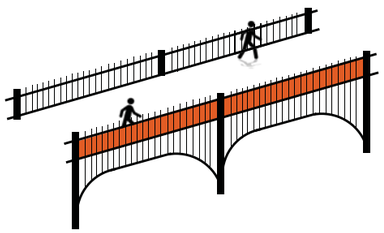
Infrastructure canopy



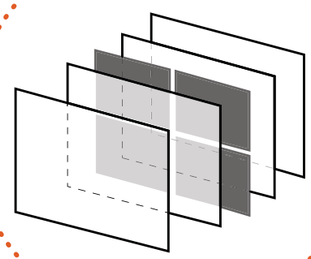
Roof

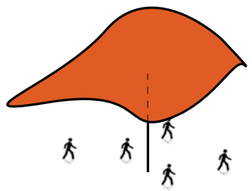


Building shading device

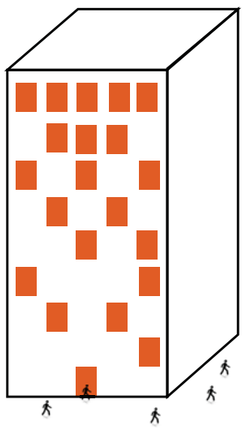


Infrastructure



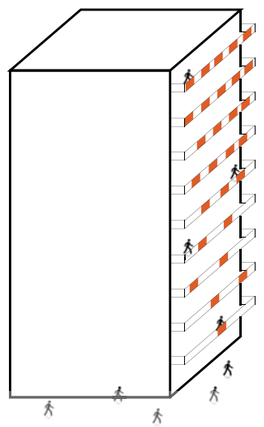


Canopy



Facade

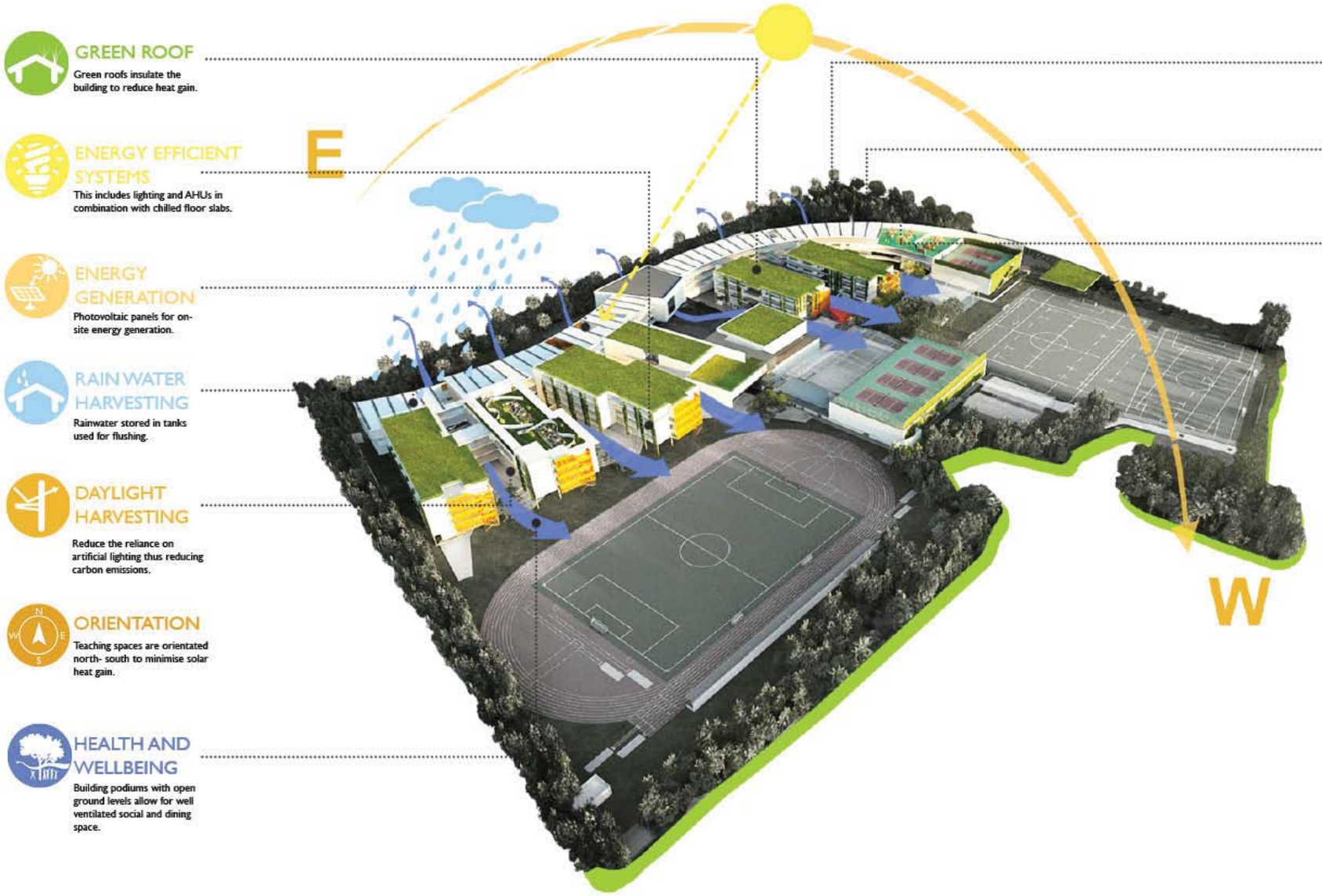
Street furniture



Building elements

Outdoor pavement tiles

Holistic approach



GREEN ROOF
Green roofs insulate the building to reduce heat gain.

ENERGY EFFICIENT SYSTEMS
This includes lighting and AHUs in combination with chilled floor slabs.

ENERGY GENERATION
Photovoltaic panels for on-site energy generation.

RAIN WATER HARVESTING
Rainwater stored in tanks used for flushing.

DAYLIGHT HARVESTING
Reduce the reliance on artificial lighting thus reducing carbon emissions.

ORIENTATION
Teaching spaces are orientated north- south to minimise solar heat gain.

HEALTH AND WELLBEING
Building podiums with open ground levels allow for well ventilated social and dining space.

SUSTAINABLE URBAN DRAINAGE SYSTEMS
Replicating the natural system in combination with bioswale to reduce the environmental impact.

BIODIVERSITY
Ecology zone to provide habitats for animals and introducing indigenous flora.

WASTE RECYCLING

WASTE WATER MANAGEMENT
Recycling waste water on site and using it for flushing and irrigation reduces water demand.

GREEN TRAVEL PLAN
Reduce carbon emissions by up to 50%.

ENERGY FOOTPRINT
Energy footprint 50kWh/m²/year.

ECO- SCHOOL
Using the building and its systems as an integrated part of the curriculum.

SOURCE : http:///research-tools/e-dialogues/e-dialogues

HOK's 6 Steps to integrate sustainable design

1 DISCOVERY & DEFINITION

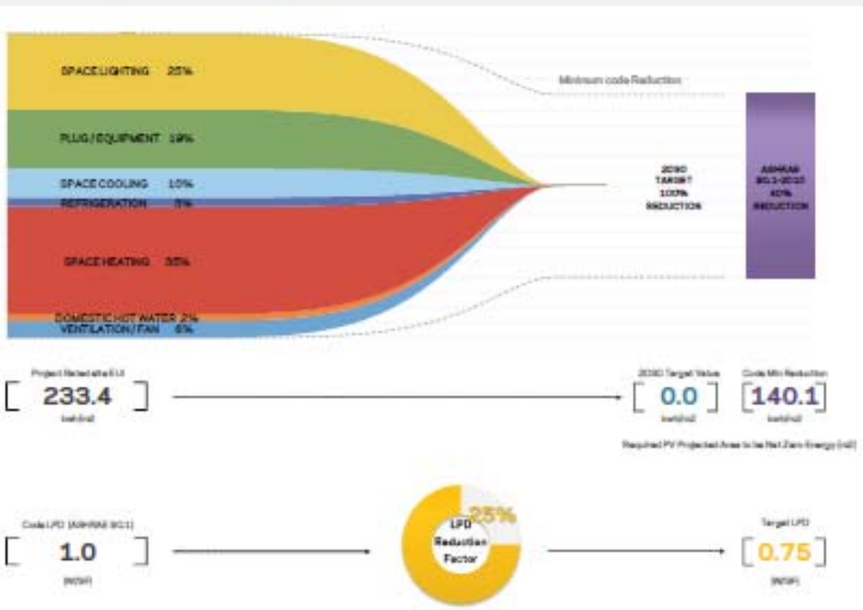
2 CLIMATE & PLACE

3 LOAD REDUCTION

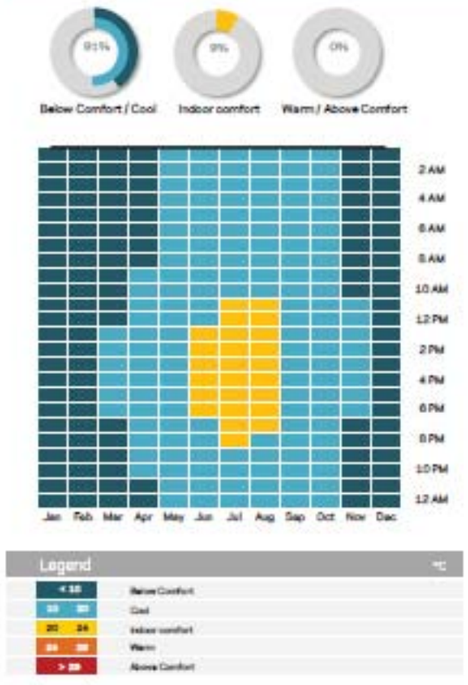
4 INTEGRATED SOLUTIONS

Typical Energy Use Intensity (EUI) & Lighting Power Density (LPD)

Office - 10,000 sf



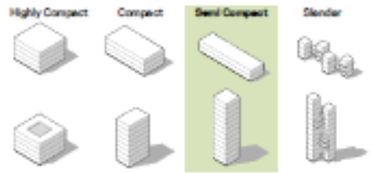
Dry Bulb Temperature



Massing

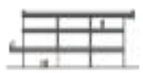
Ideal massing options try to find the right balance between exterior surface area that fits the climate zone and daylight requirements.

SemiCompact Geometry



Aspect ratio of roughly 1 to 2 (height:width).
Medium surface to volume ratio provides natural light and solar heat gain as well as limiting conductive losses.

Earth sheltering: Not feasible

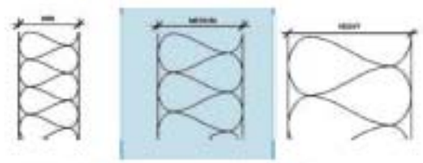


Limited or No benefit to in exposure of the external envelope with a thermally significant volume of soil or substrate.

Material Considerations

Strive for the levels recommended below, but verify feasibility with whole-building payback analysis that includes insulative effects on building systems.

Insulation Level: Increased



Warm summers and cool winters increase the cooling loads in this climate. Consider a slight increase in insulation values to keep the cooling load down.

No Reflectivity Preferences

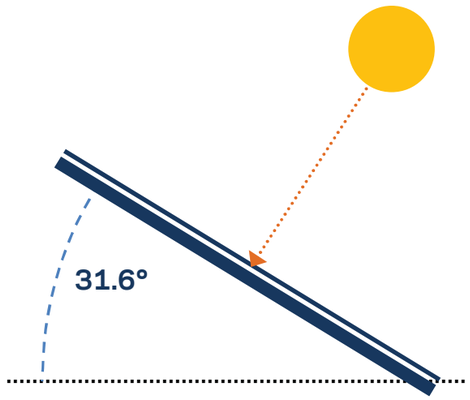
Due to low radiation or mild temperatures, there are no preferences for envelope reflectivity.

HOK's 6 Steps to integrate sustainable design

5 RENEWABLE SYSTEMS

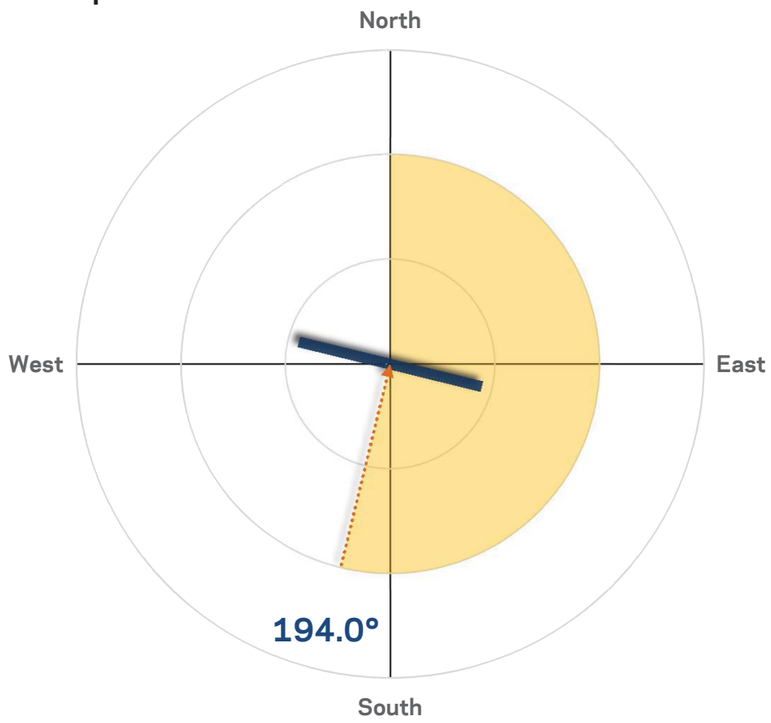
PV Tilt Angle

Optimum Tilt Angle

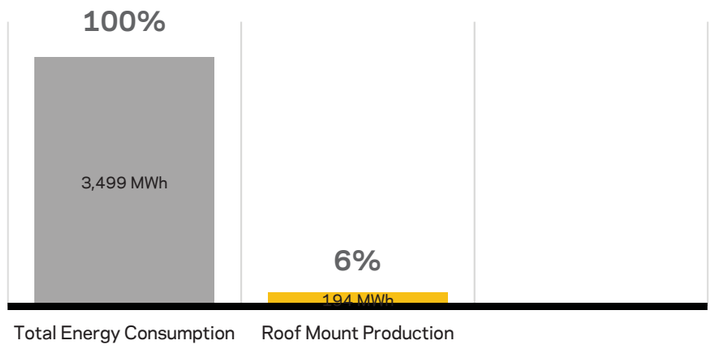


PV orientation angle

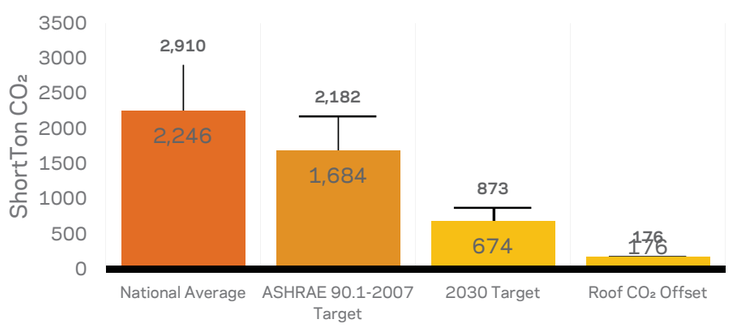
Optimum Orientation



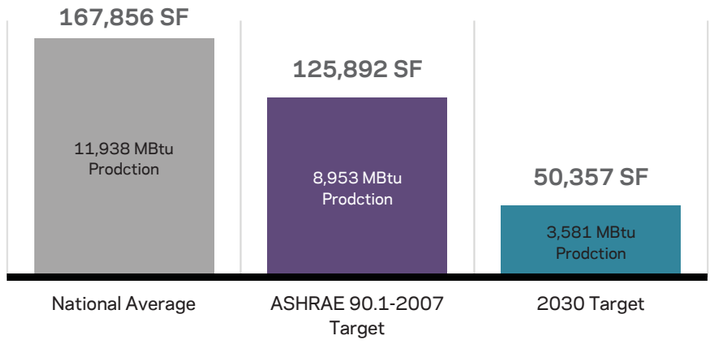
Roof Mount Production



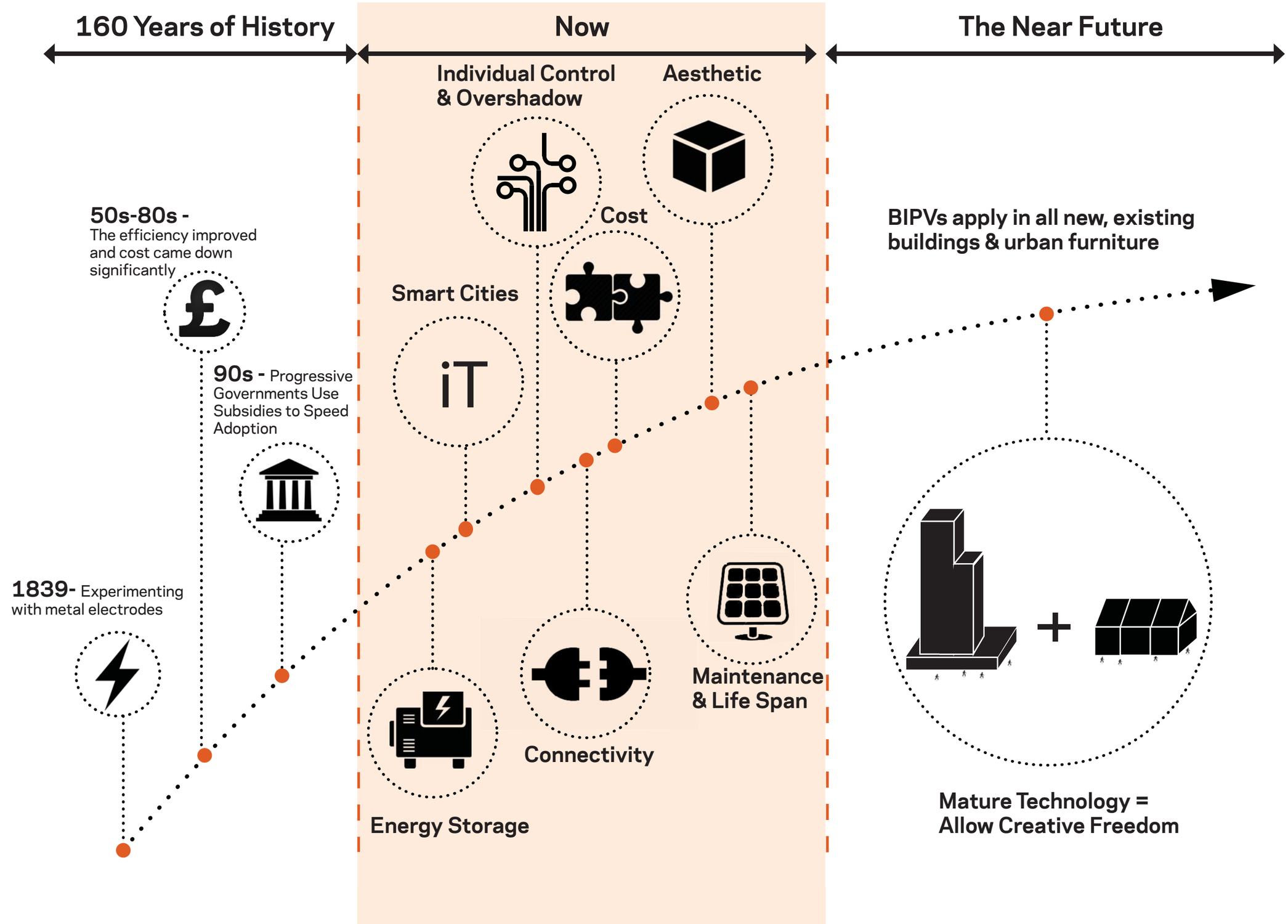
CO_2 Offset



PV Area To Achive NetZero

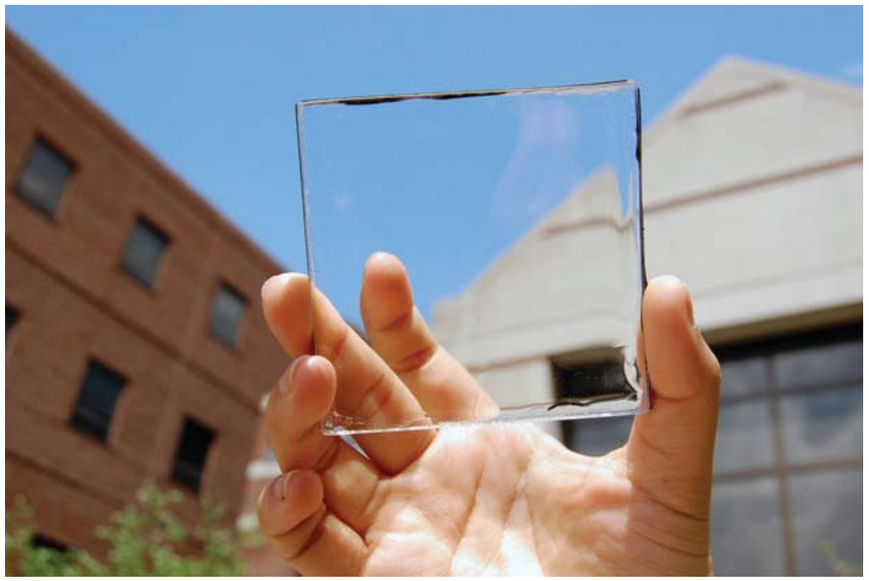


Our Vision



SOURCE : http://sunlightelectric.com

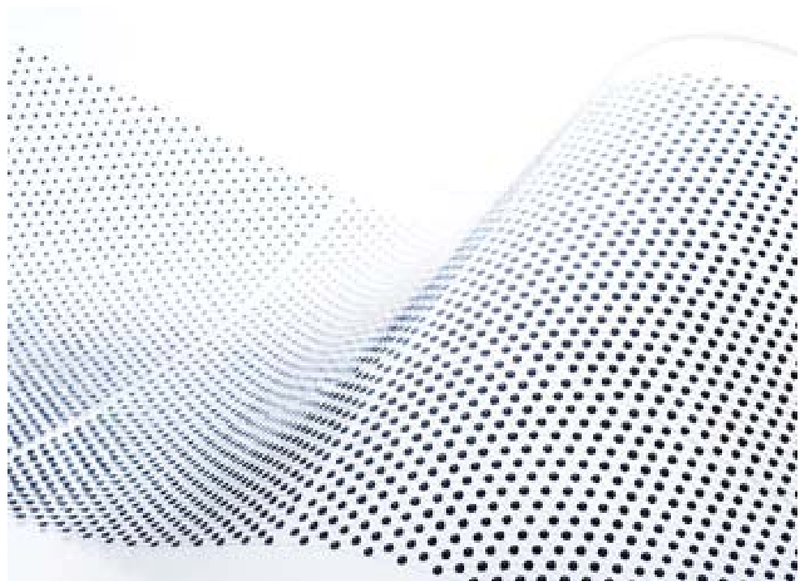
BIPV & Transparency



Michigan State University researchers believe that their transparent solar power-generating cell's flexibility will prove a hit with the solar industry

Onyx Solar Photovoltaics Transparent Glass installed into San Anton Market, Madrid (Spain)

Oxford PV



Sphelar® by Sphelar Power
Based on crystalline silicon balls, ® module

The Francis Crick Institute

PLP Architecture was invited to collaborate with HOK architects on the development of the design with a particular focus on external massing, public realm design and elevational treatment.

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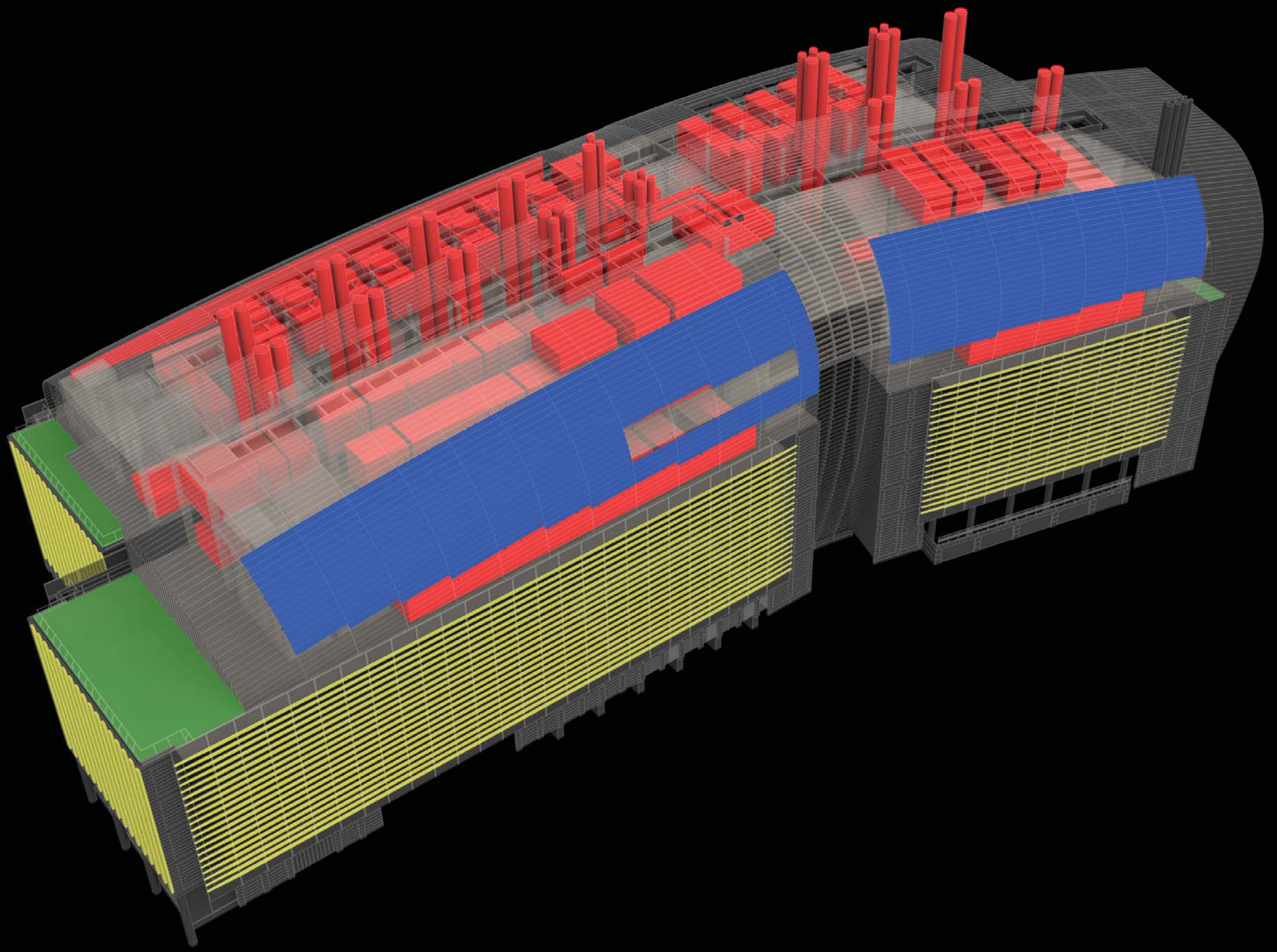

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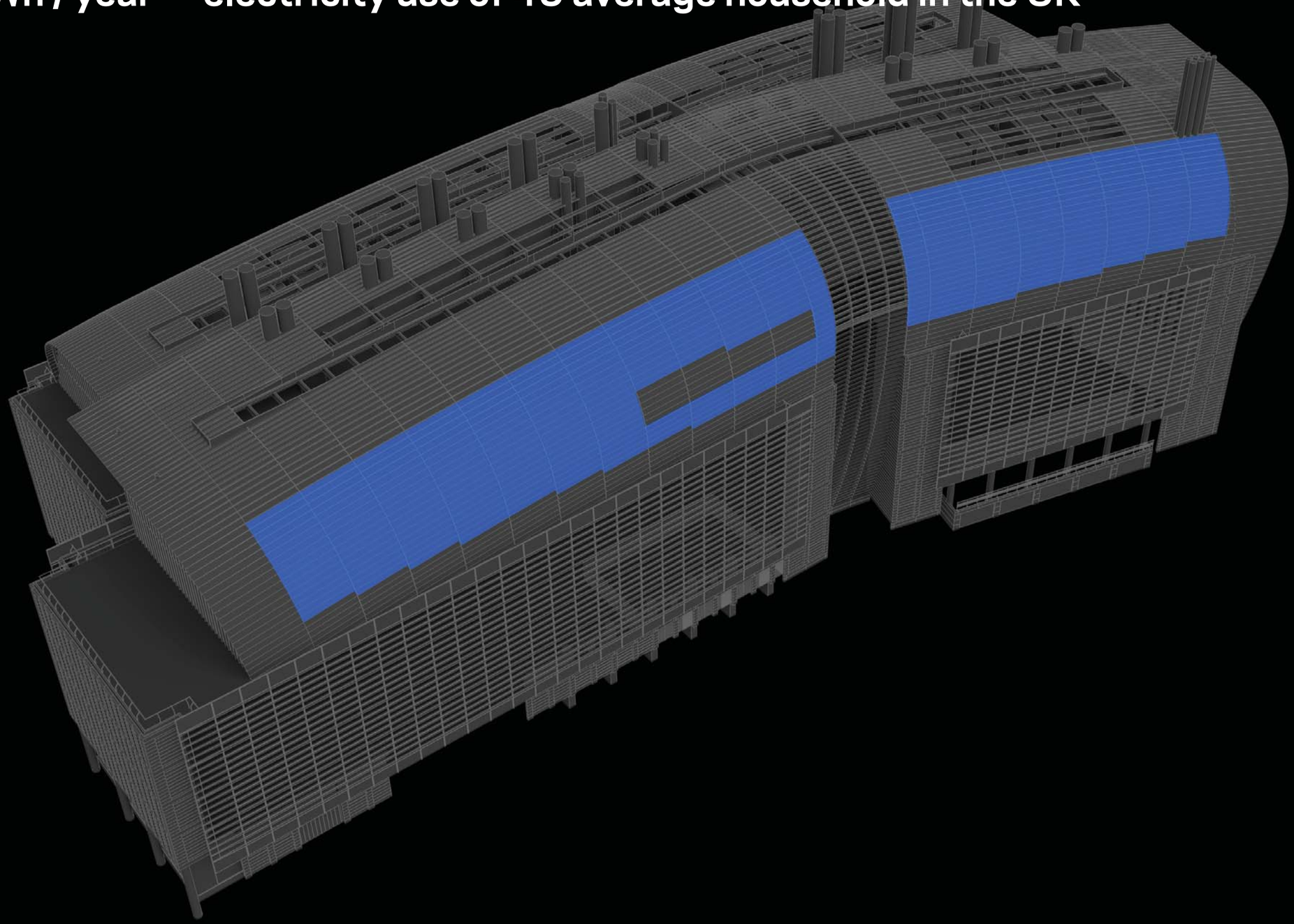
THE FRANCIS CRICK INSTITUTE

9430 PV Louver Panels
1750m3
205 MWh / year = electricity use of 45 average household in the UK



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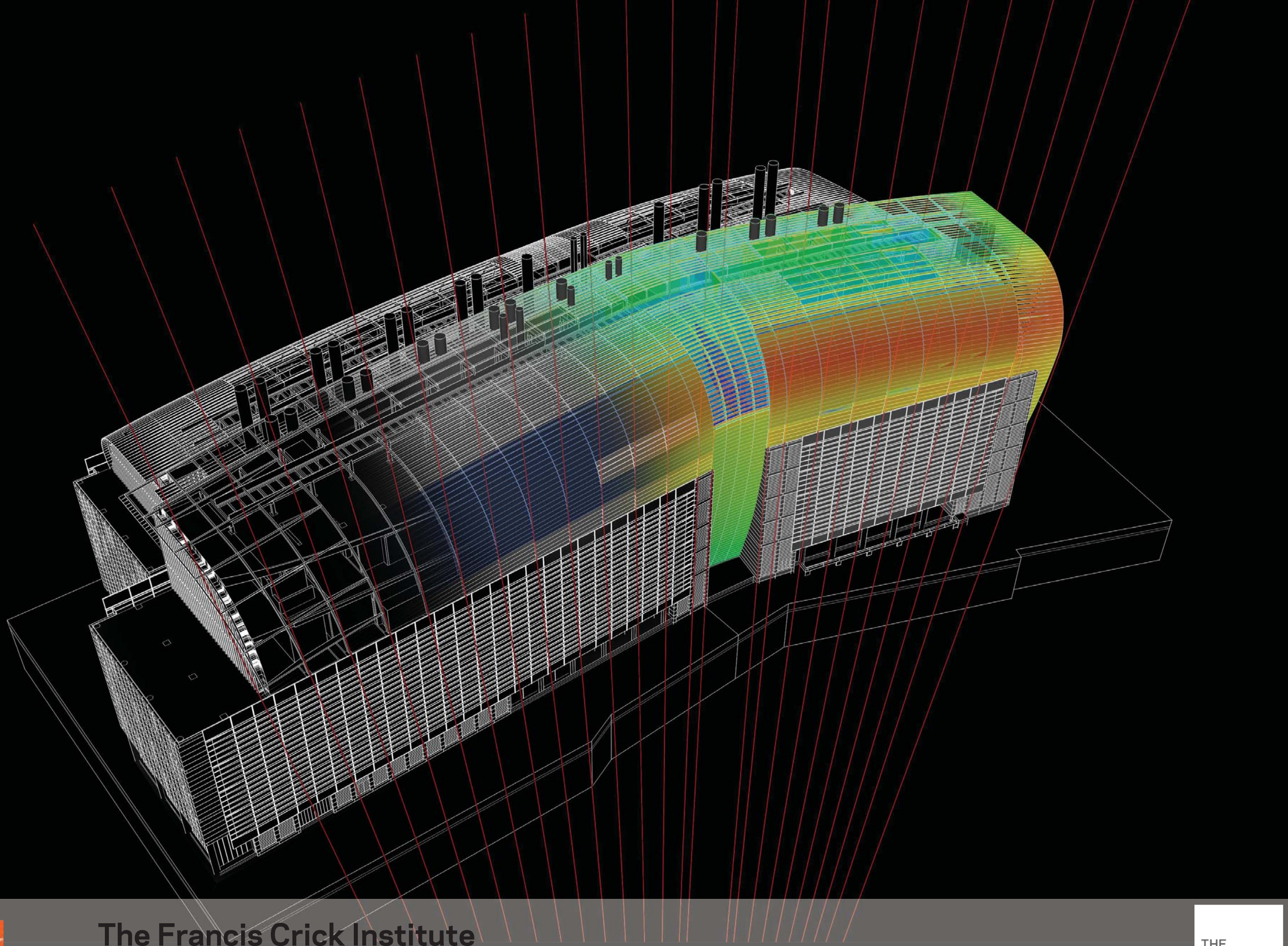

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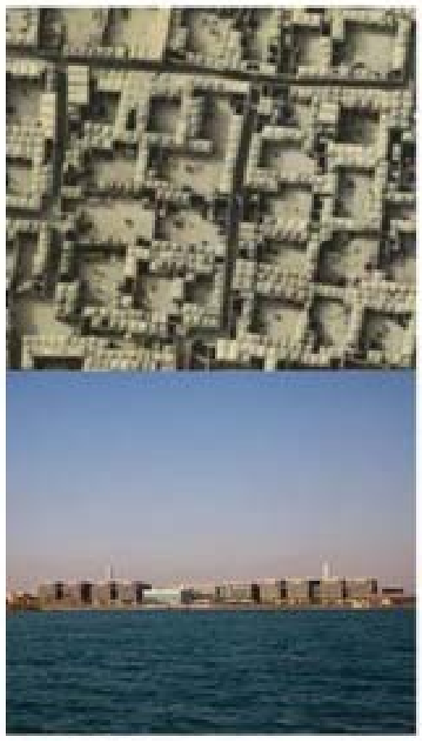
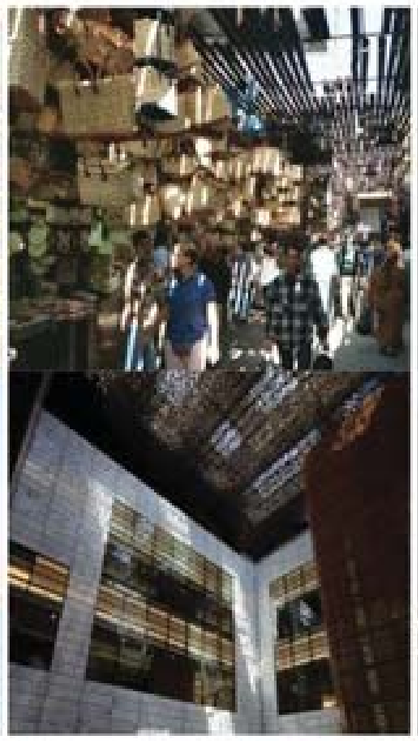
King Abdullah University of Science & Technology (KAUST), Saudi Arabia



- The compactness of the traditional Arabic city.



- The ventilation and dramatic daylight of the souk.

- The ability of the mashrabiya screen to filter the sun and create poetic patterns of shade and shadow.

- Use of courtyards and wind towers in traditional Arabic structures.

- The Bedouin tent's efficiency in sheltering the sun.

- The cultural tendency to occupy the outdoor spaces at night.

King Abdullah University of Science & Technology (KAUST), Saudi Arabia

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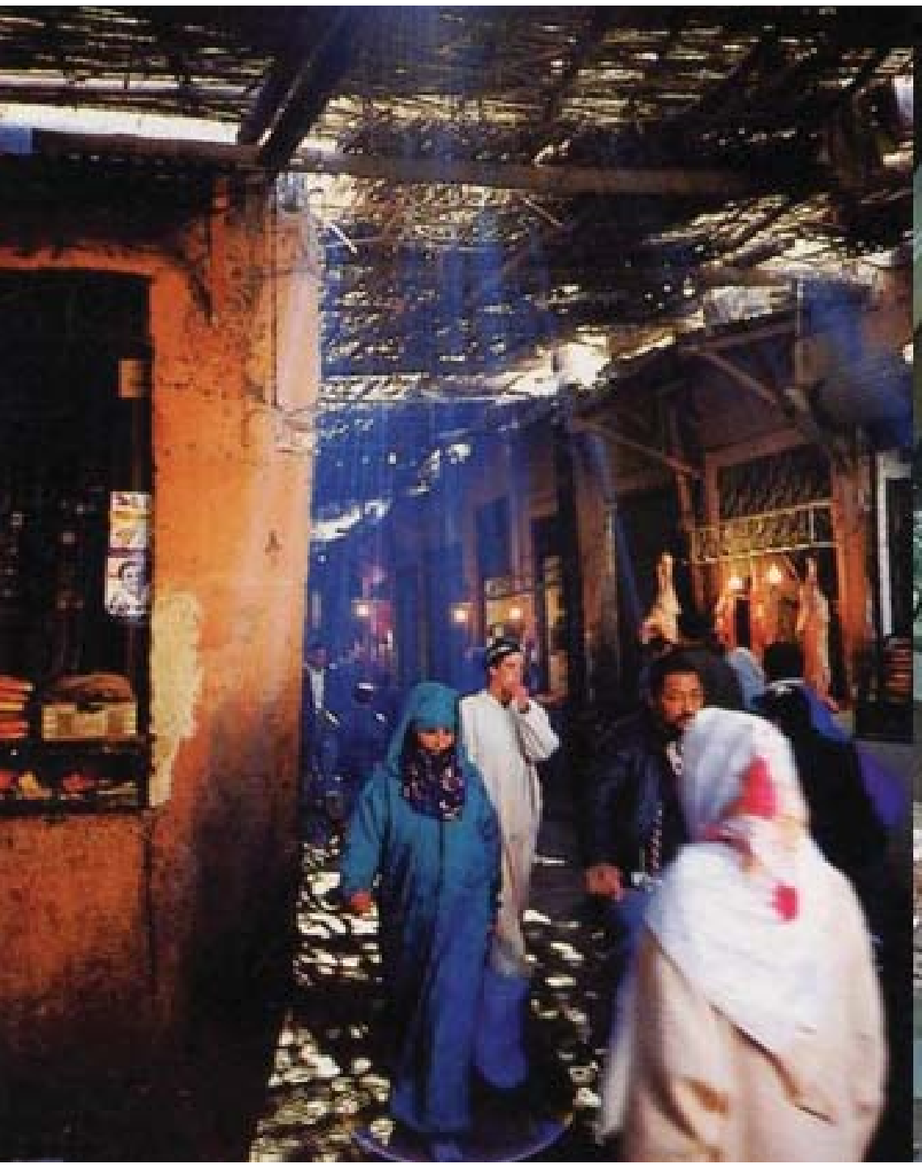
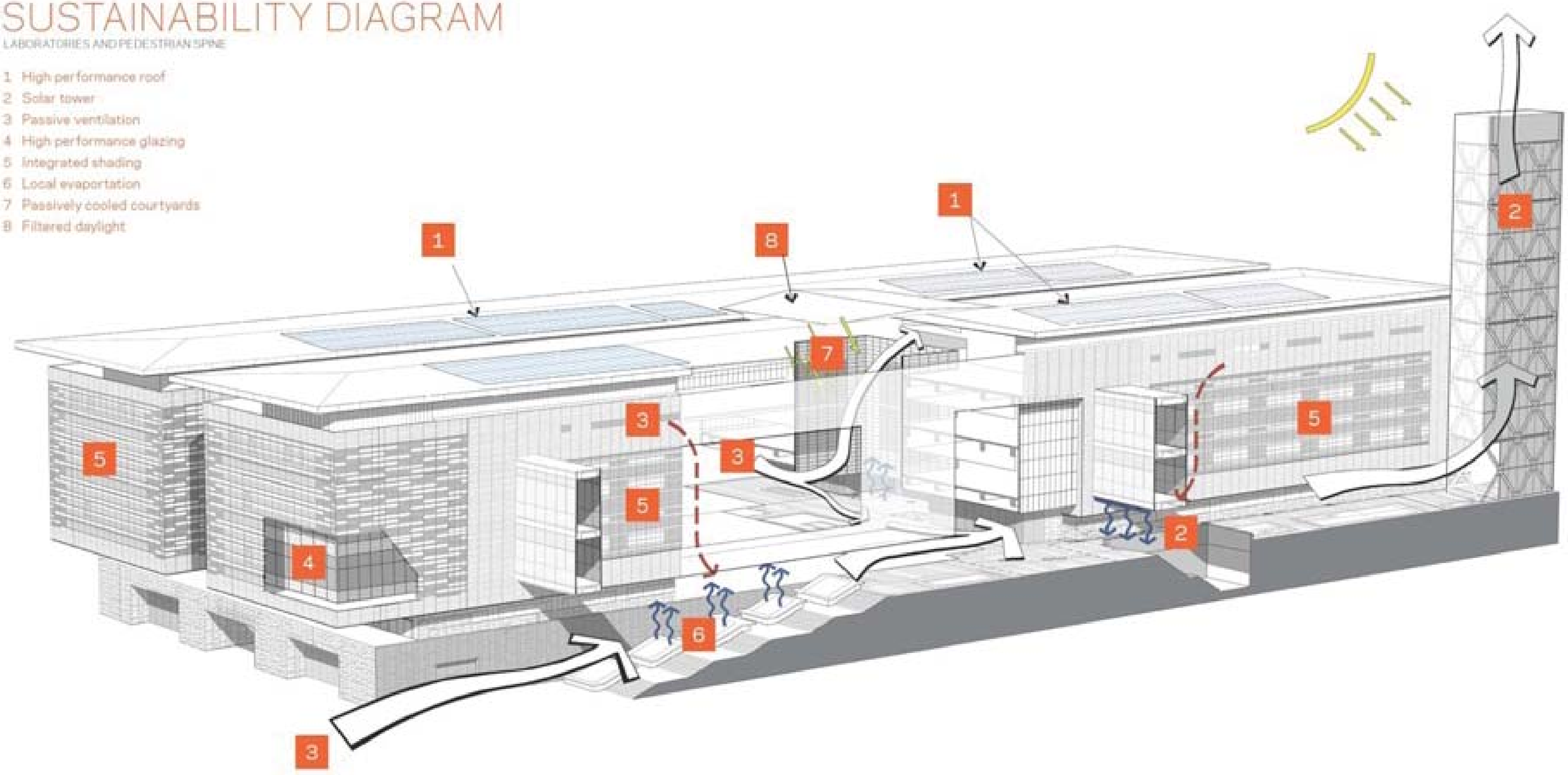


King Abdullah University of Science & Technology (KAUST), Saudi Arabia

SUSTAINABILITY DIAGRAM

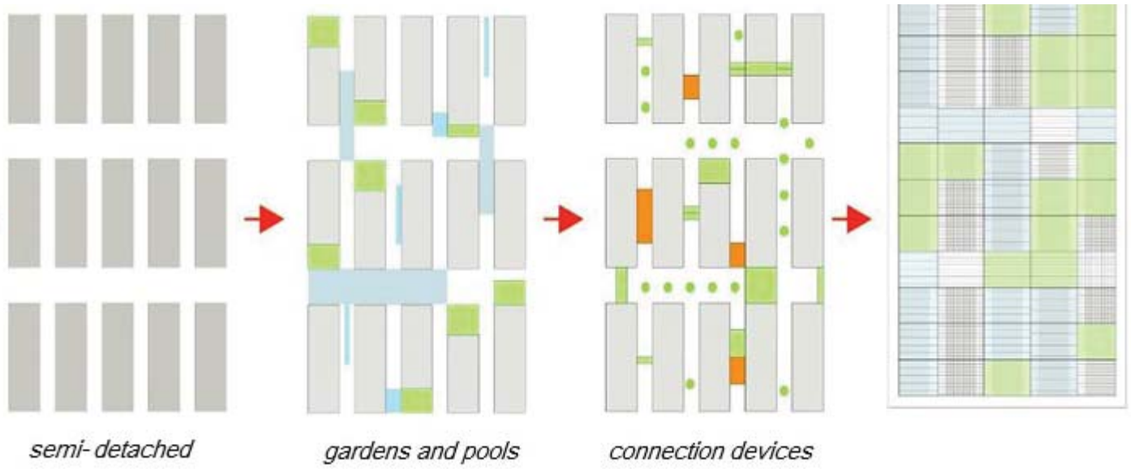
LABORATORIES AND PEDESTRIAN SPINE

1 High performance roof
2 Solar tower
3 Passive ventilation
4 High performance glazing
5 Integrated shading
6 Local evaporation
7 Passively cooled courtyards
8 Filtered daylight



King Abdullah University of Science & Technology (KAUST), Saudi Arabia

Most effective strategies - Passive design/ Compact design / Self shading



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9300 PV Panels
11,600m2
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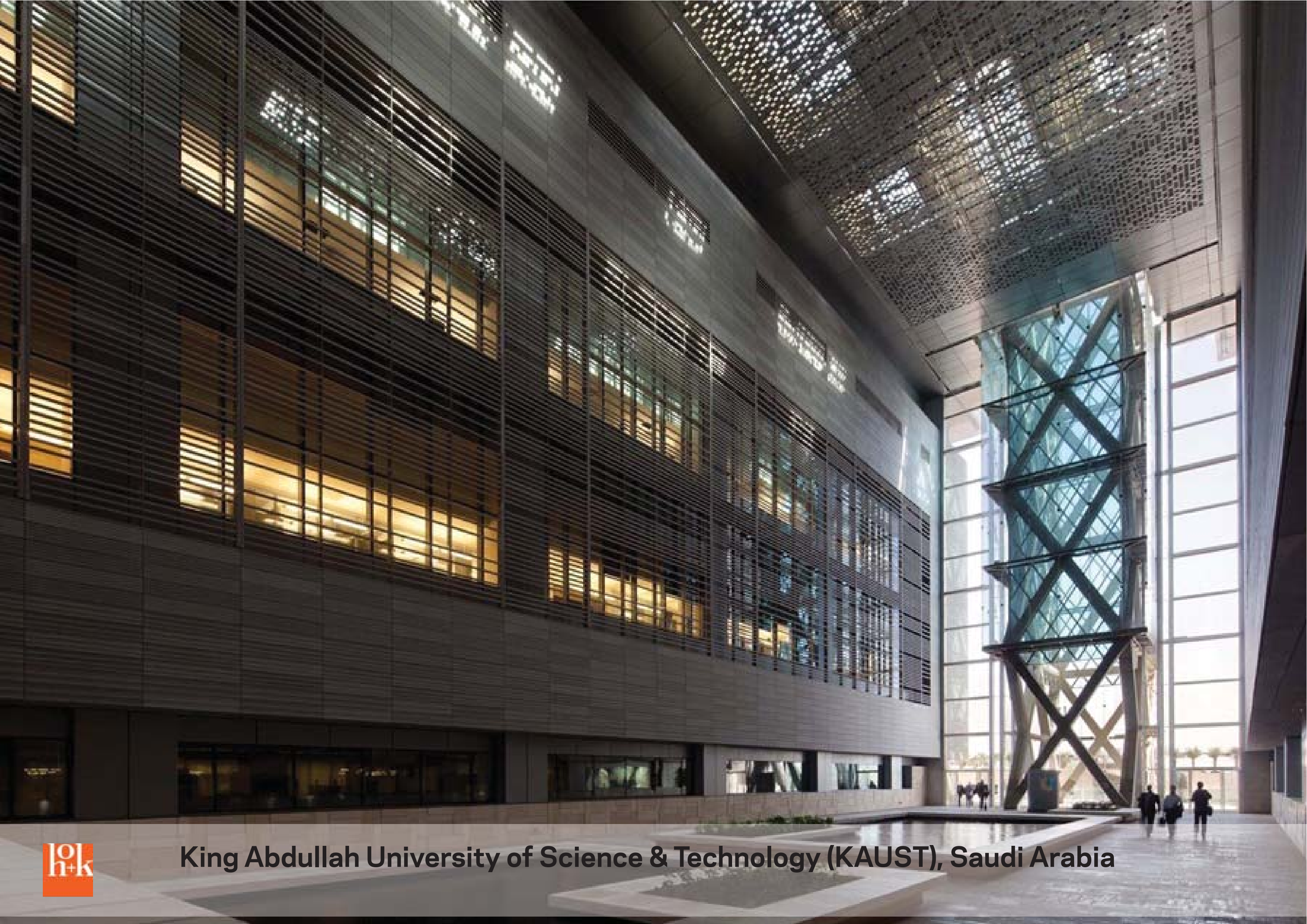

King Abdullah University of Science & Technology (KAUST), Saudi Arabia

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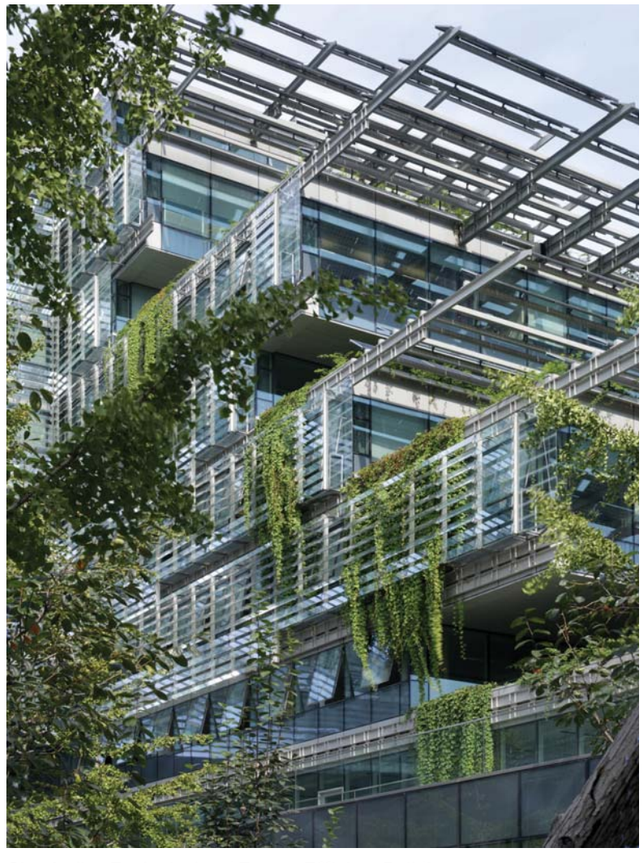
Taichung City Cultural Center , Swallow's Nest
Competition Entry
Taichung, Taiwan
Vincent Callebaut Architectures
BIPVs are applied in the envelope

California Academy of Sciences
Completed 2008
San Francisco, USA
Renzo Piano Building Workshop
BIPVs are applied on the canopy

Ferrer Research & Development Center
Design Development
Barcelona, Spain
William McDonough + Partners
BIPVs are applied on the facade

Novartis Basel Campus
Completed 2009
Basel, Switzerland
Gehry Partners
BIPVs are applied on the roof



Sino-Italian Ecological and Energy Efficient Building
Completed 2006
Beijing, China
Mario Cucinella Architects
BIPVs are applied as partr of the shading devices

Sustainable Buildings: Intelligent & Beautiful?

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