From thousands to billions*

Renegerative architecture, a manifesto

*Jonathan Laski et Victoria Burrows, From Thousands to Billions, World Green Building Council, 2017.

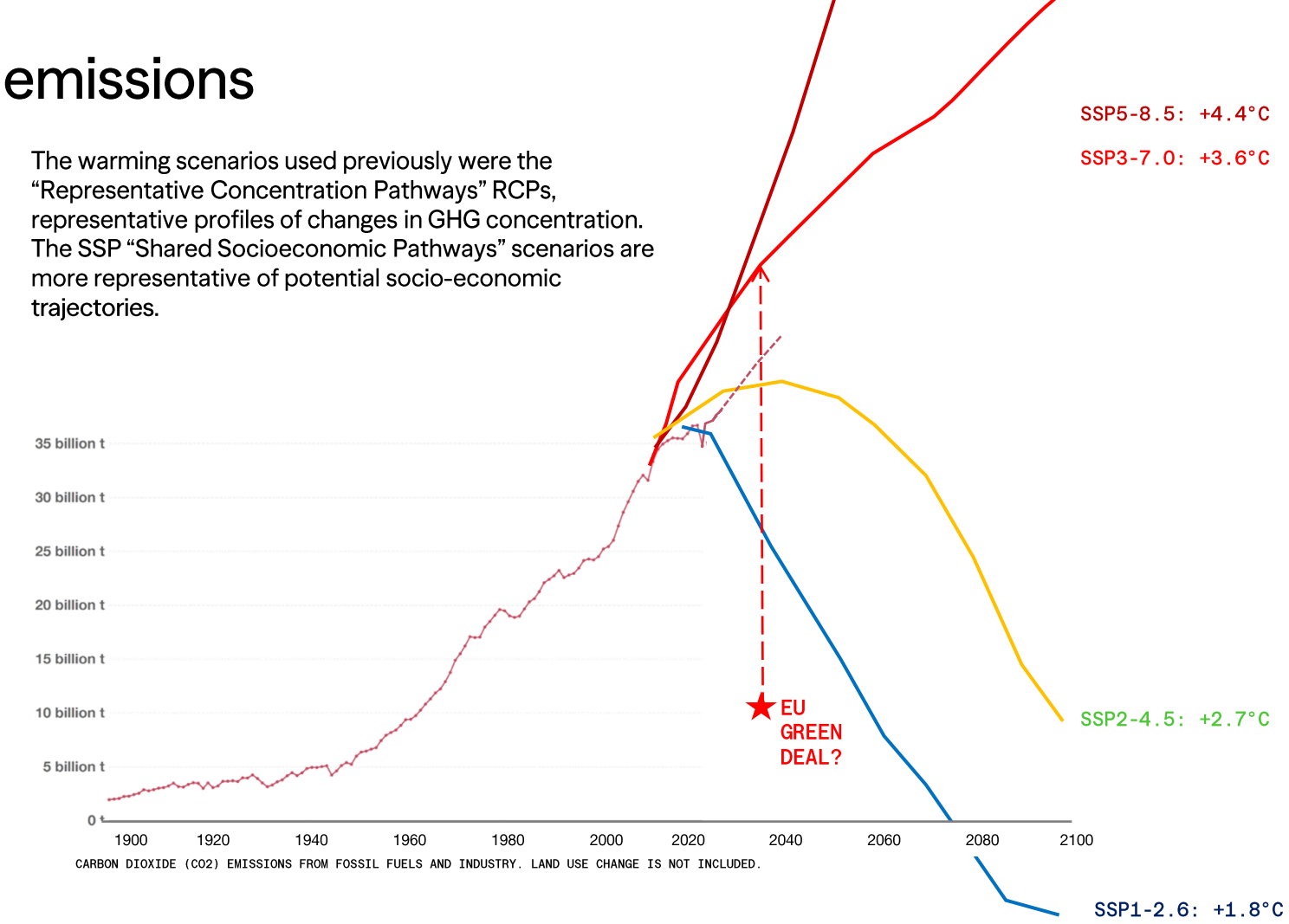
A2M.BE

Marcela Rufino Rocha
Architect team leader
rocha@a2m.be

Who believes we can achieve CO2 neutrality by 2050?

Annual CO2 emissions

The warming scenarios used previously were the “Representative Concentration Pathways” RCPs, representative profiles of changes in GHG concentration. The SSP “Shared Socioeconomic Pathways” scenarios are more representative of potential socio-economic trajectories.

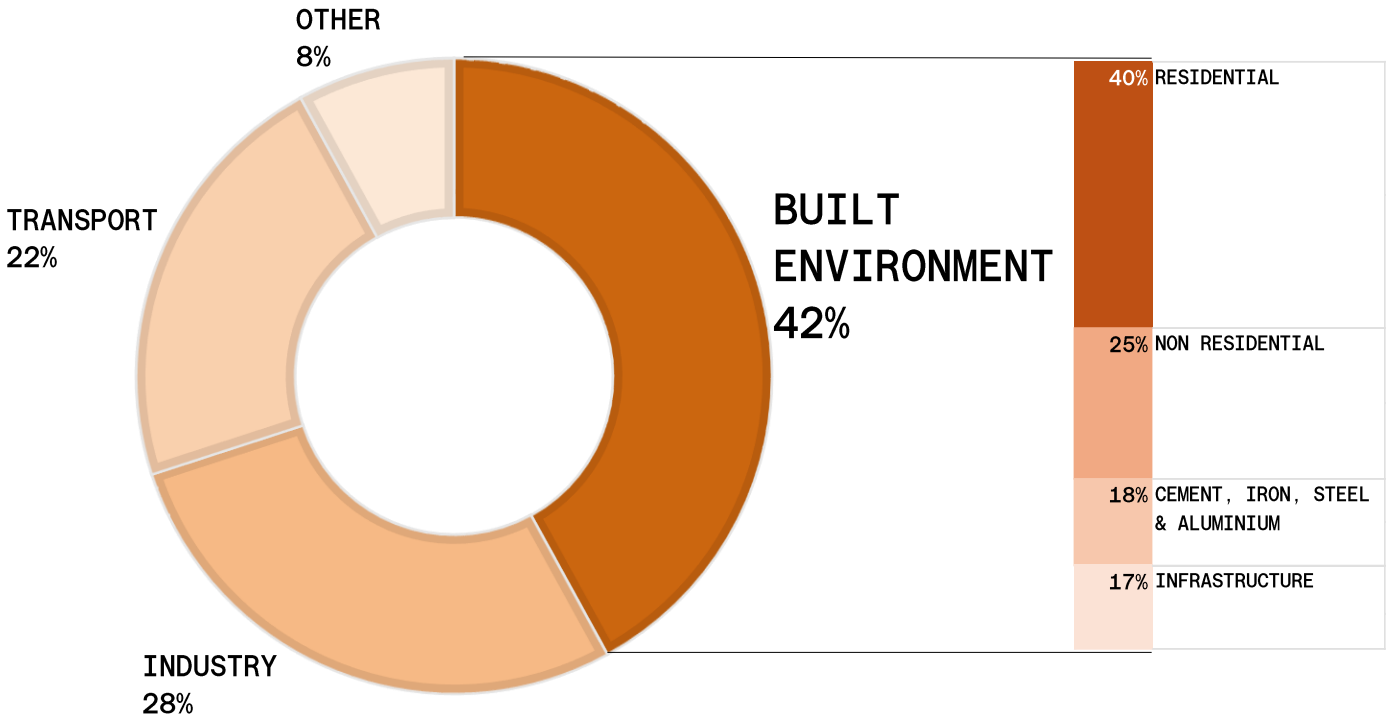


Source: Shift project , Jean-Marc Jancovici
Riahi and al. 2016; Rogelj and al. 2018; IIASA SSP Database; IAMC; Global Carbon Project 2024

Source: Riahi et al. 2016; Rogelj et al. 2018; IIASA SSP Database; IAMC; Global Carbon Project 2024

Source: Global Carbon Project

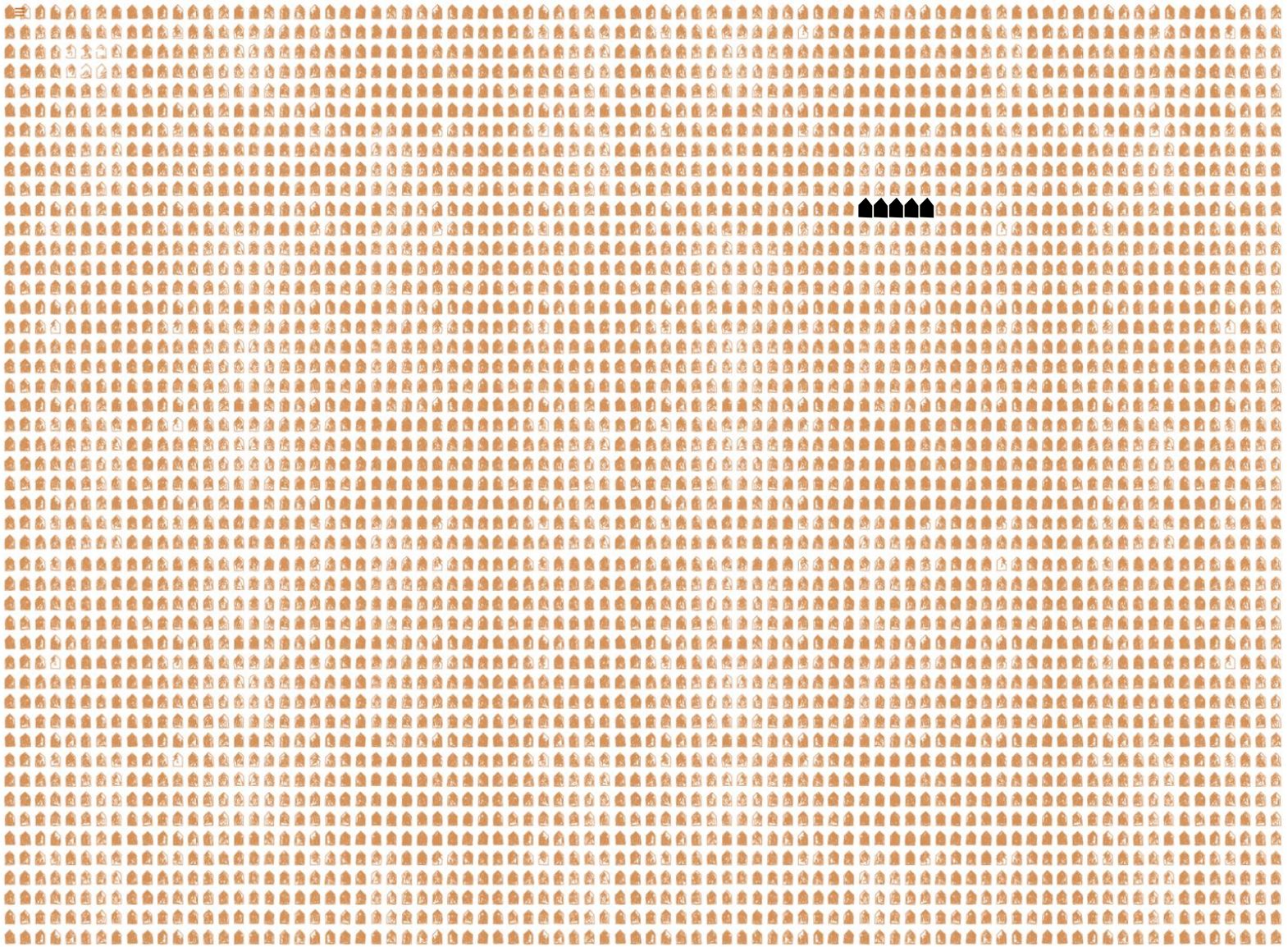
Total annual global CO^2 emissions
Direct & indirect energy & process emissions (36,3 GT)



Source: architecture 2030, IEA (2022), Buildings, IEA, Paris
United Nations Environment Programme. Global Status Report for Buildings and Construction. UNEP, 2022, https://www.unep.org/resources/report/global-status-report-buildings-and-construction.
Architecture 2030. Why the Built Environment?, 2024, https://www.architecture2030.org/why-the-built-environment/.
Selon ces sources, le secteur du bâtiment est responsable de 38 % (UNEP, 2022) à 42 % (Architecture 2030, 2024) des émissions mondiales de CO_2.

Today, about 2-5% of all buildings worldwide are designed by an architectural firm.

Of which only a fraction benefits from a climate engineer's contribution.

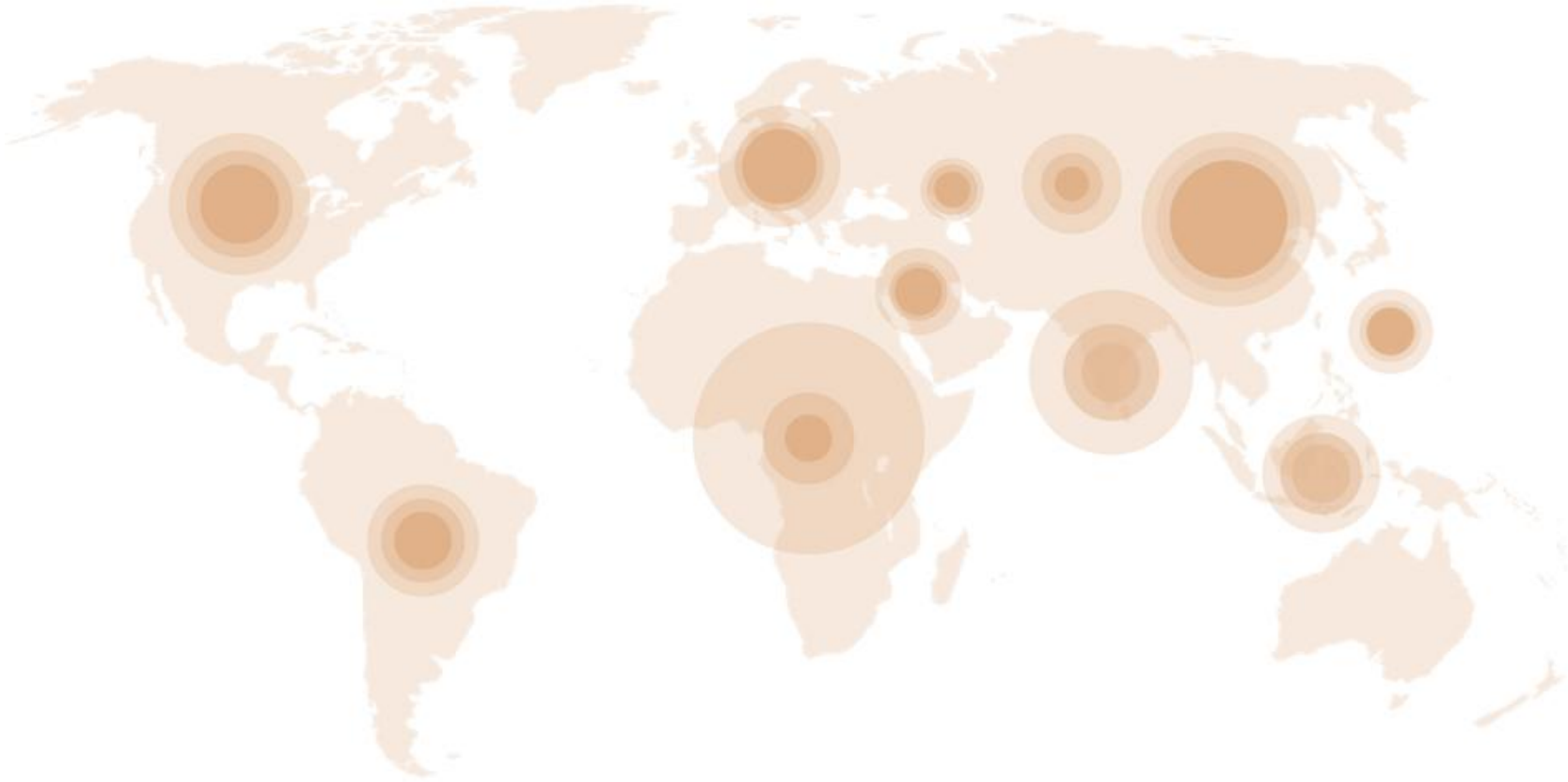


Source: extrait de *Expanding Architecture*, édité par Bryan Bell et Katie Wakeford : « les architectes n'affectent directement qu'environ deux à cinq pour cent de tout ce qui est construit », 2008.

Source: Transsolar. https://transsolar.com/.

Global building floor area is expected to double by 2060.

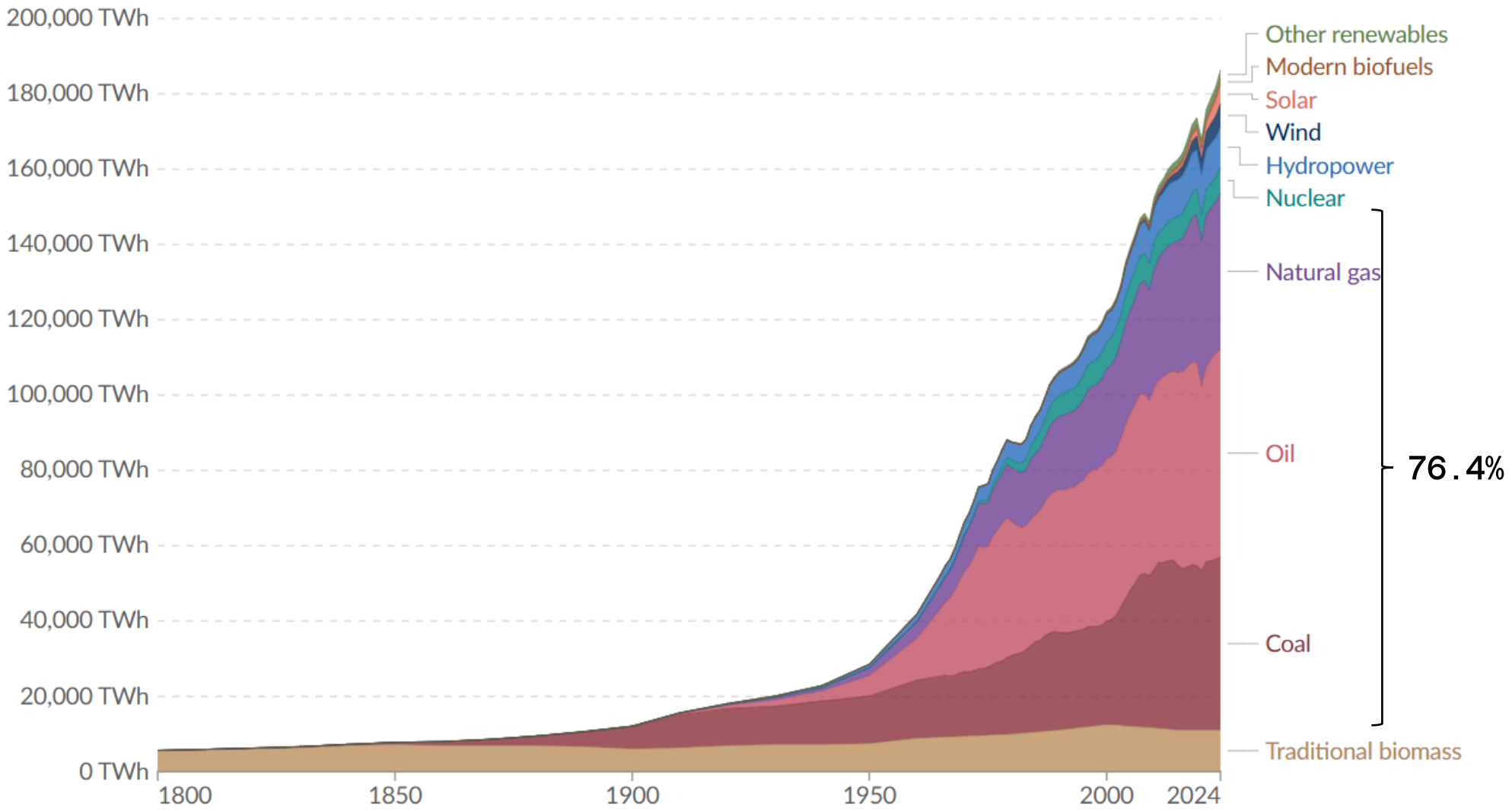
From 2020 to 2060 : + 246 billion m^2 new floor area
(= 1 Entire New York every month for 40 years)
By 2050 : infrastructure = x3!



Source: Architecture 2030, Global ABC, Global Status Report 2017
International Energy Agency: *global building sector CO2 emissions and floor area on the Net Zero Scenario 2020-2050*
United Nation: *Infrastructure*

Who believes the energy transition is actually underway?

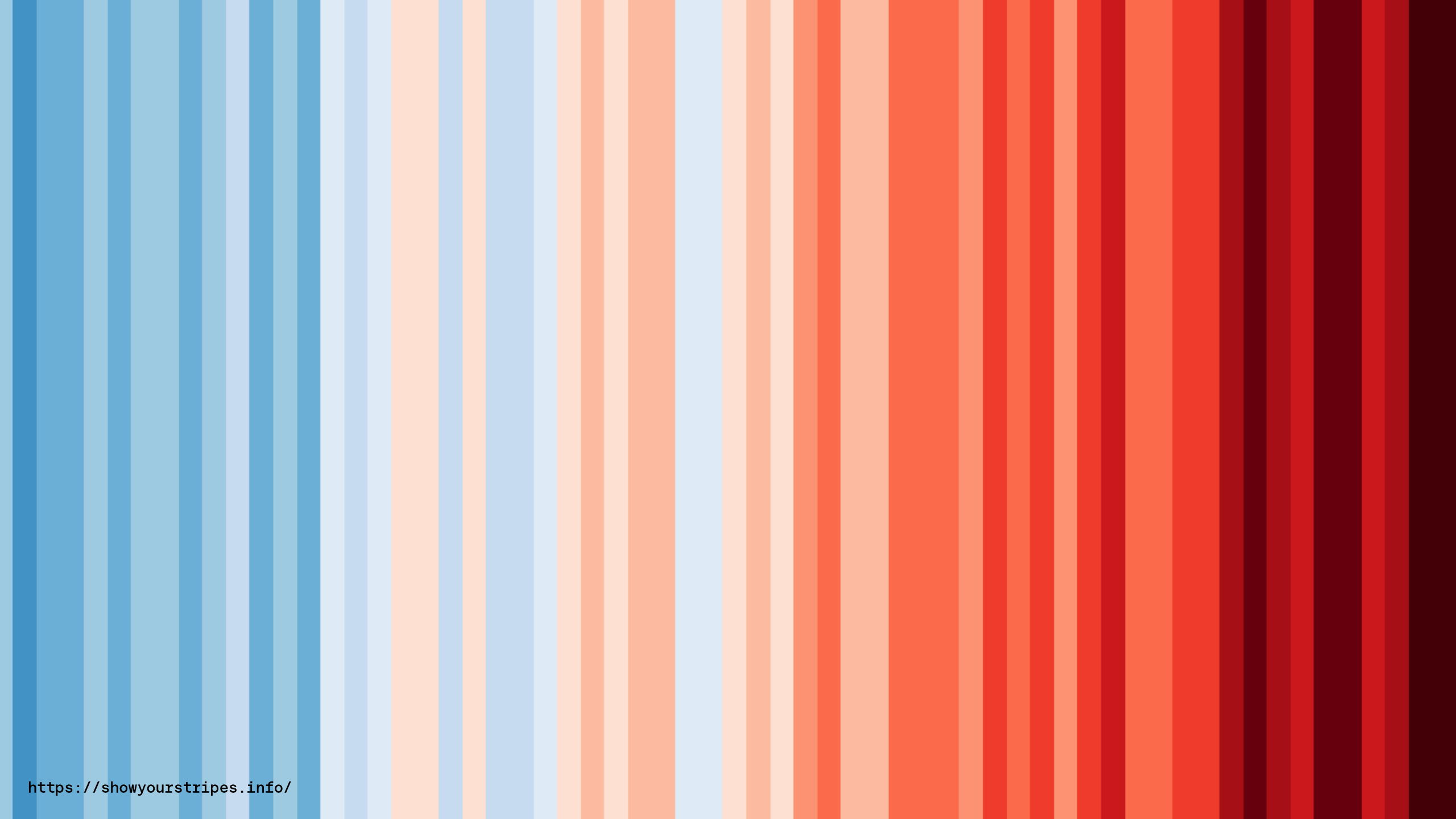
Global primary energy consumption by source

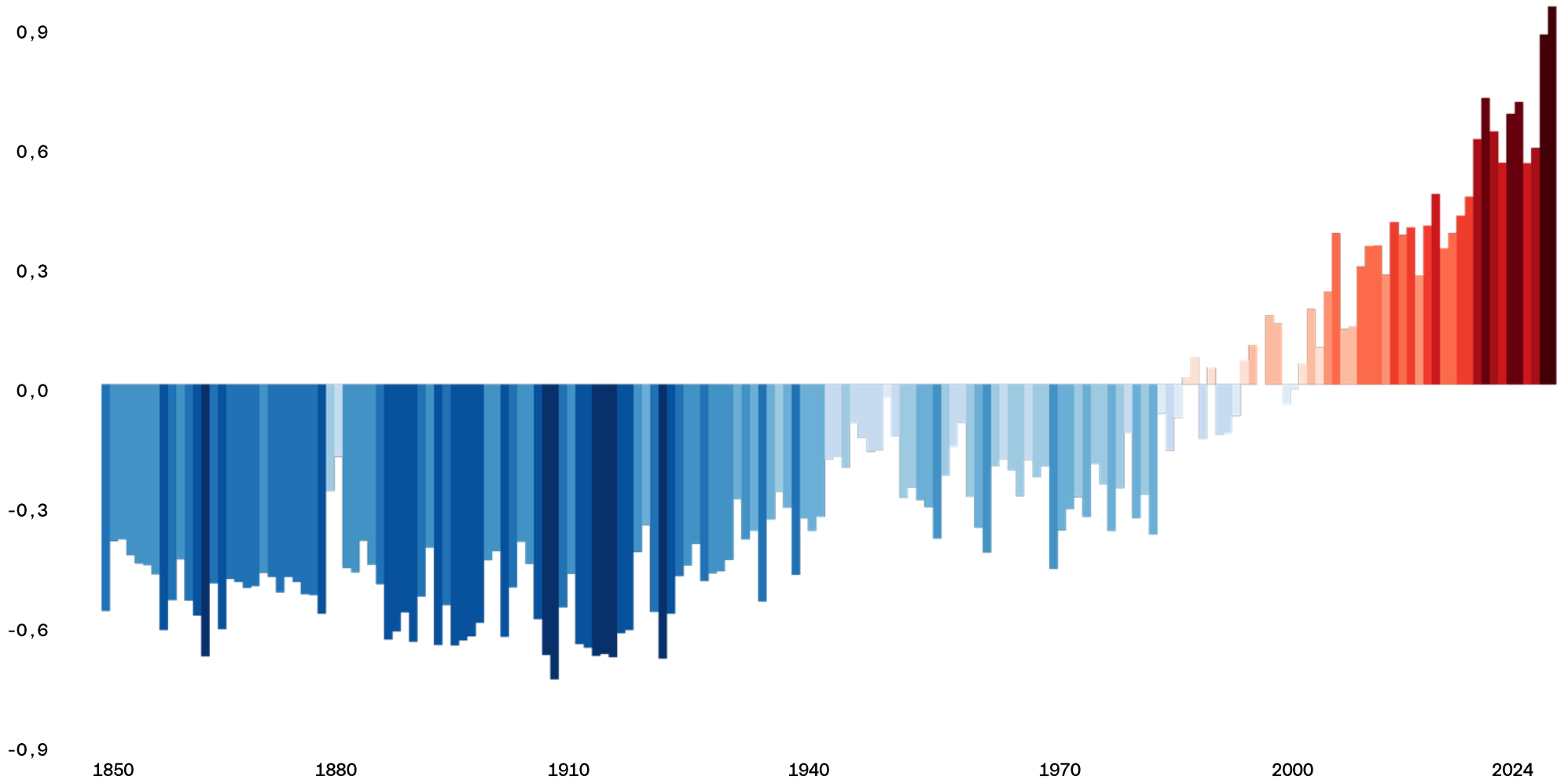


In 2024, 76.4% of energy was fossil fuel. New energy sources have just added up to oil, coal, and gas.

Source: https://ourworldindata.org/global-energy-200-years and Energy Institute - Statistical Review of World Energy (2025); Smil (2017).

Who believes we can still preserve 1,5°C?

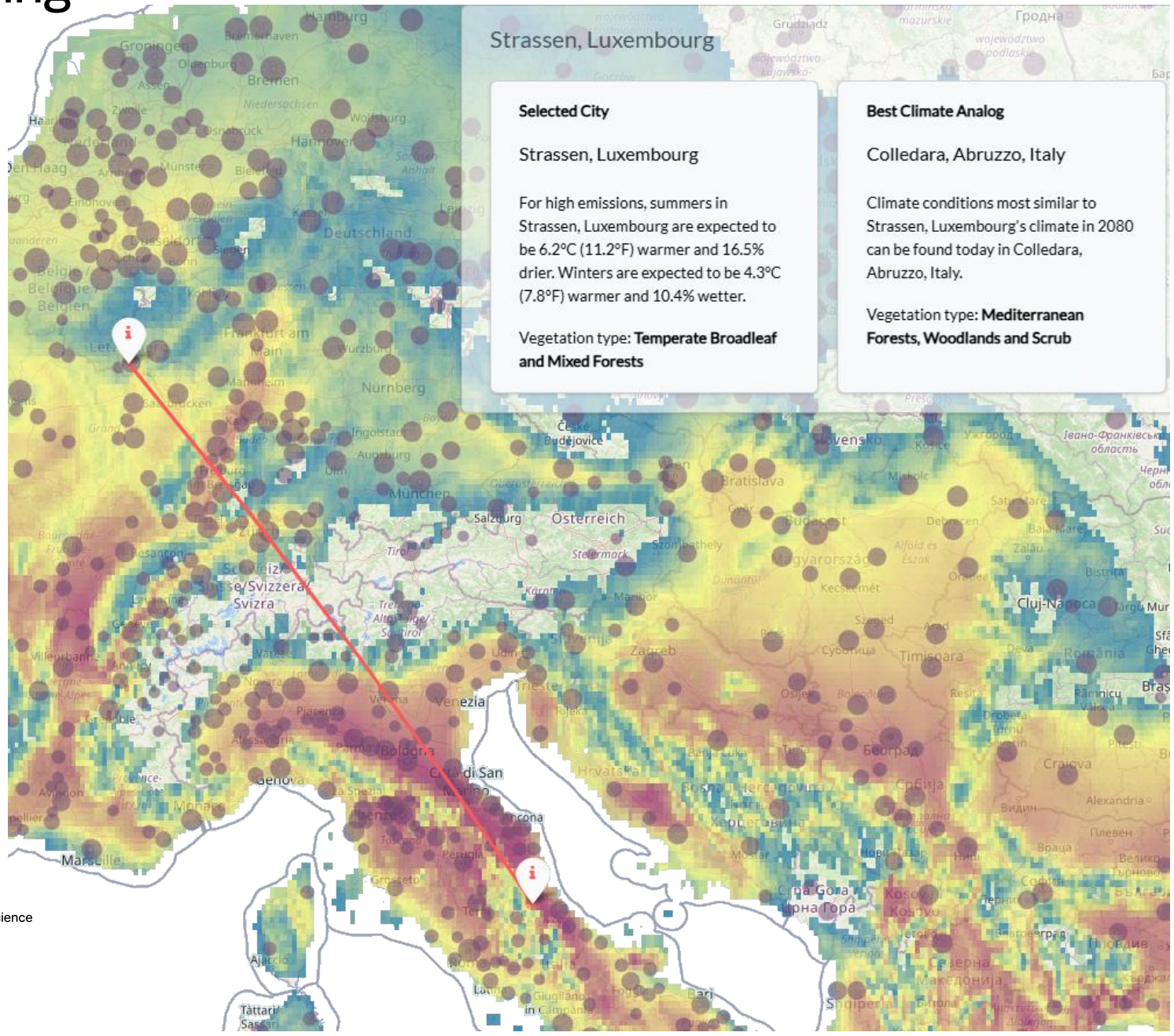

https://showyourstripes.info/



Global temperature change relative to average of 1850-2023 [°C]

https://showyourstripes.info/

...how it's going



SSP5-8.5

(SHARED SOCIO-ECONOMIC PATHWAYS)

University of Maryland Center for Environmental Science

https://fitzlab.shinyapps.io/cityapp/

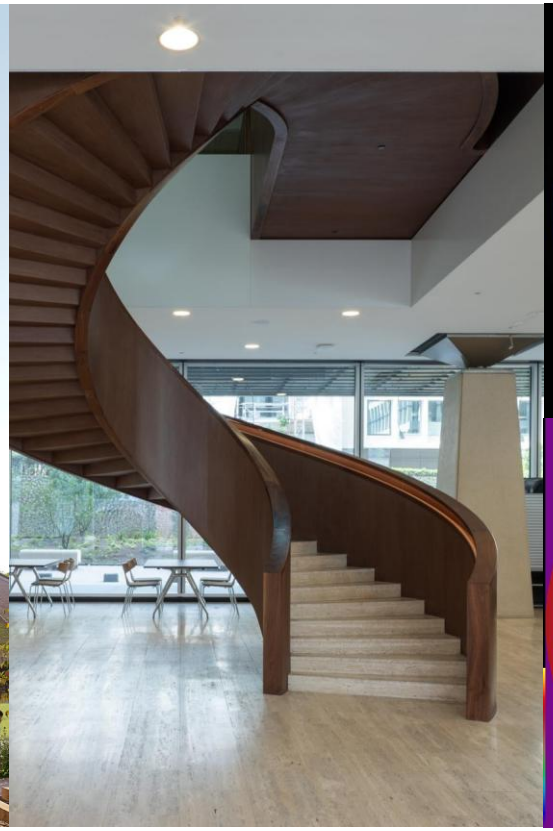
Ok, but how can we act, as architects, developers engineers or builders?

Circularity, reuse, carbon neutrality...
BBCA, HQE, E+C, BEPOS, BiodiverCity, ...
Passive House, BREEAM, LEED, .WELL, DGNB, LCBI,
Living Building Challenge, ...

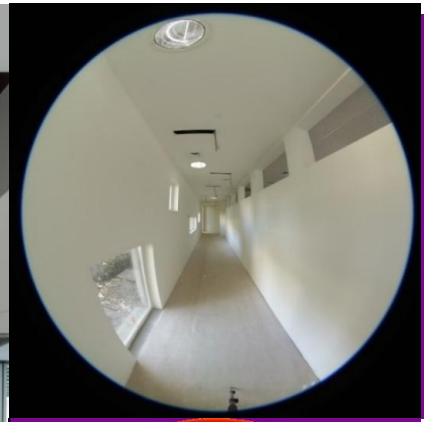
(SERIOUSLY, ARE THERE MORE? YES, A HUNDRED!)

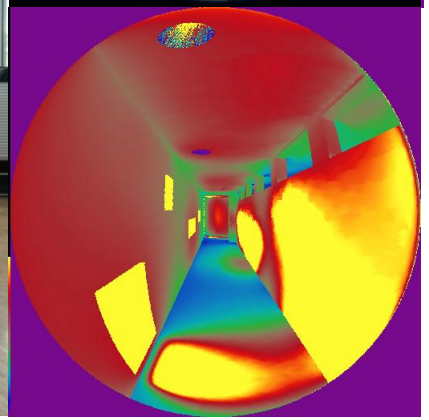
Architecture

Urbanism



Interior architecture





Research



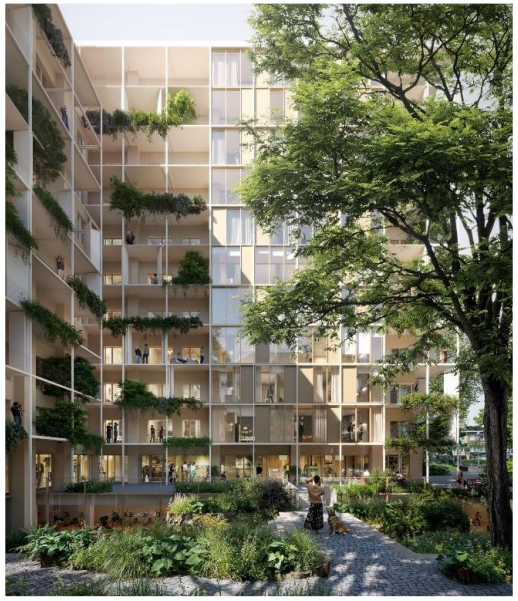
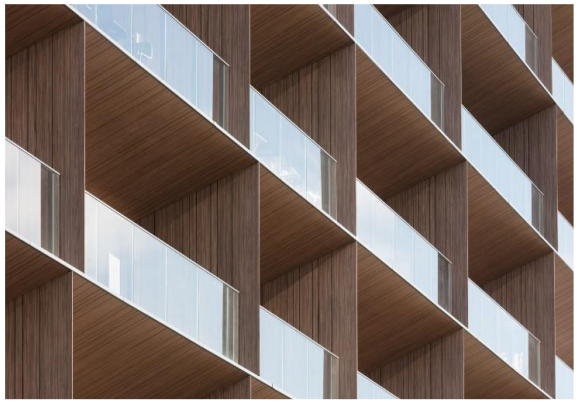




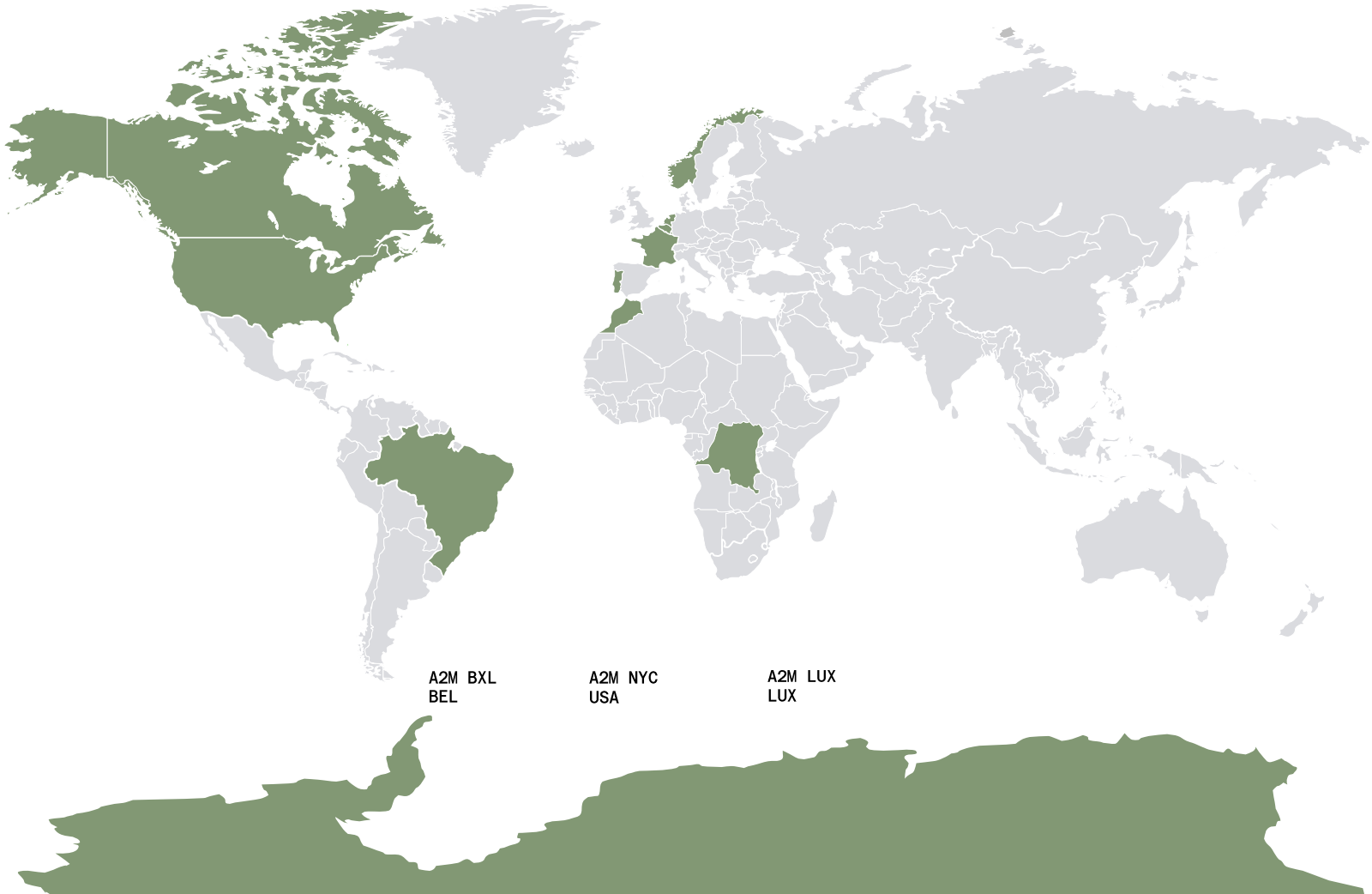




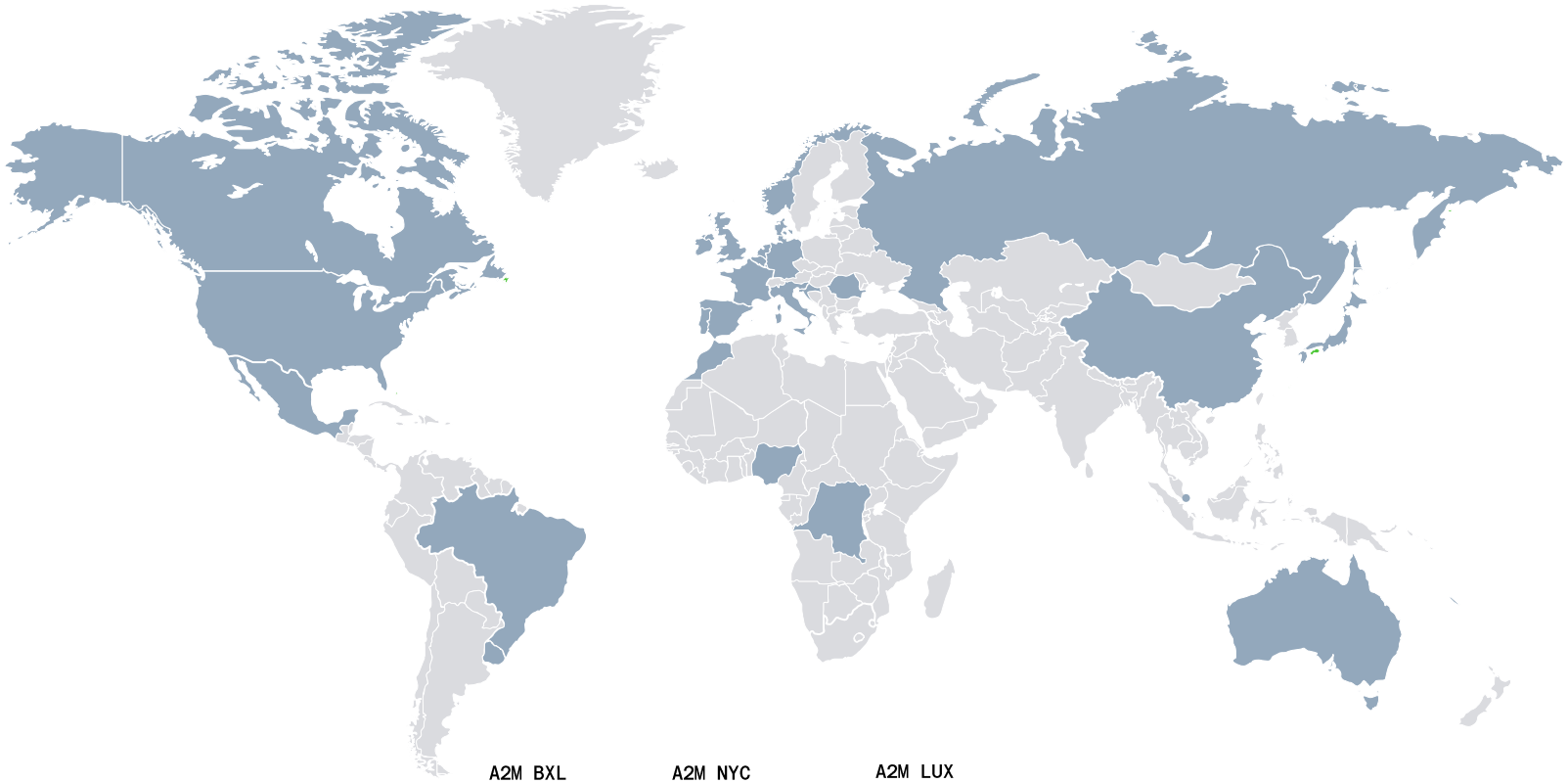



we build

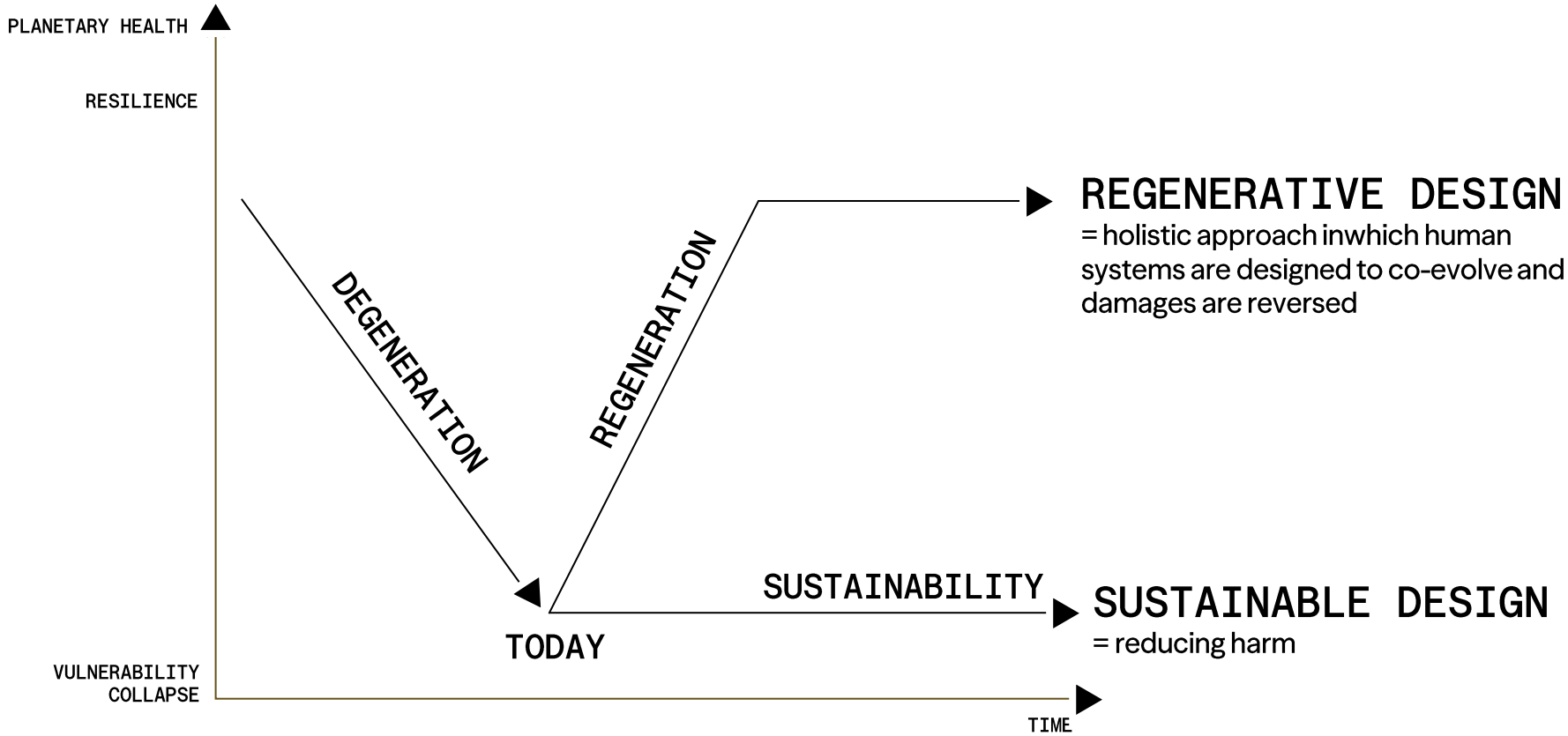


we share



From « less bad to more good »

Can we reverse environmental harm?



Upgraded from source: E. Naboni

Regenerative architecture relies on 3 pillars :

design with climate

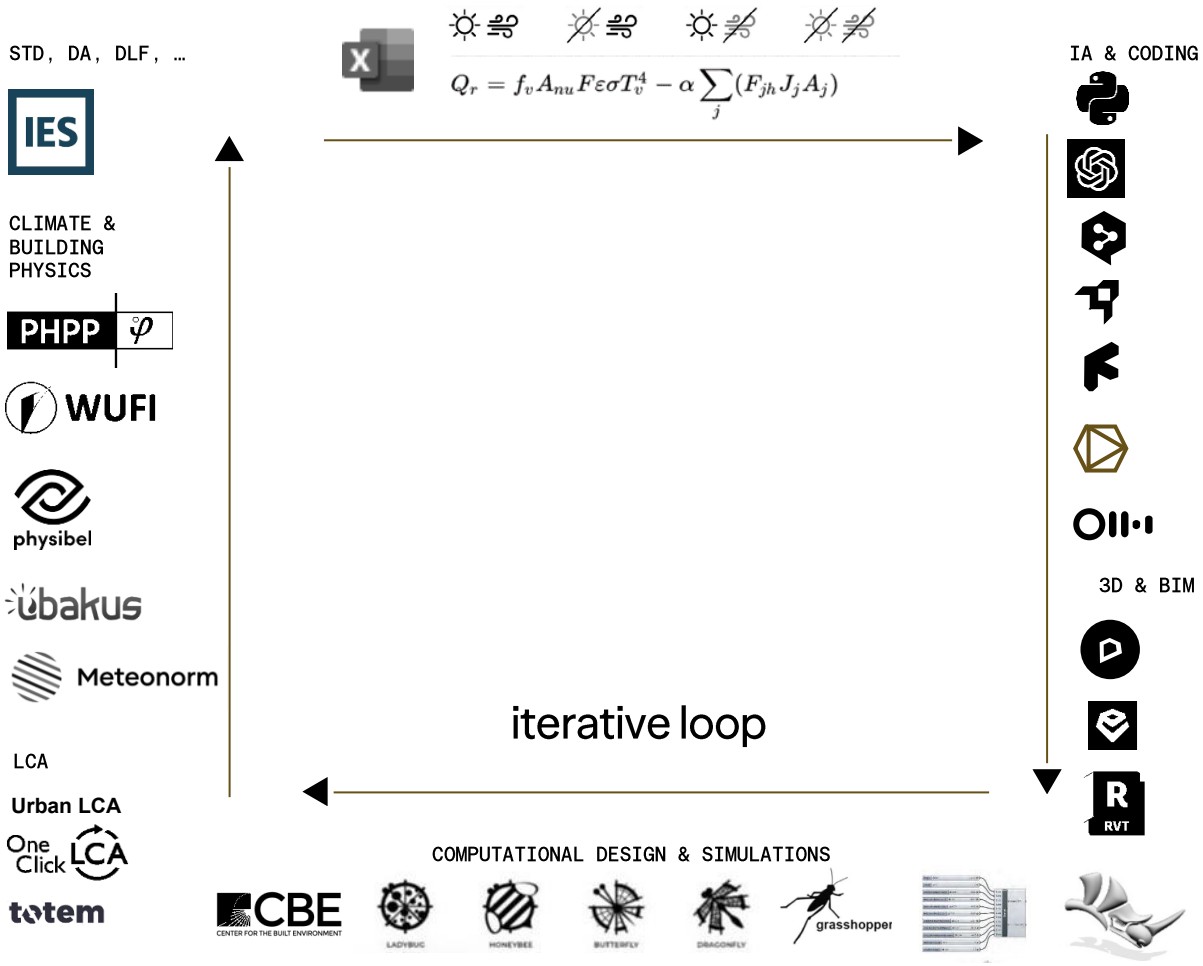
BIOCLIMATIC
MICROCLIMATE
RESILIENCE
EFFICIENCY
RENEWABLES

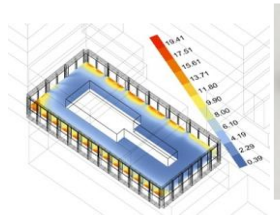
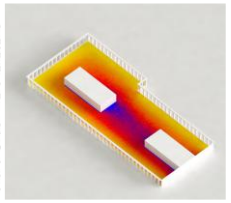
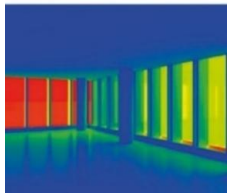
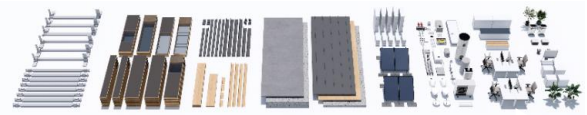
design with nature

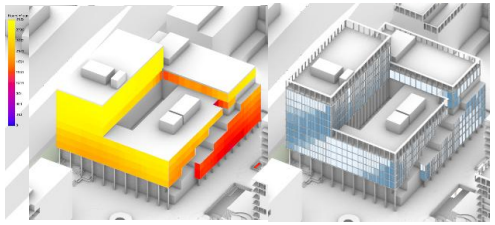
REUSE
CIRCULARITY
MATERIALS
WATER
BIODIVERSITY

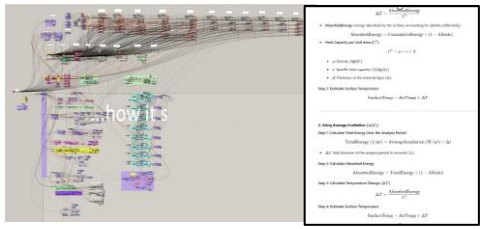
design with people

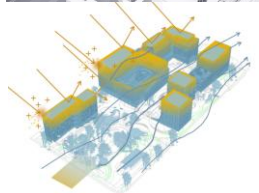
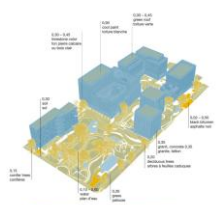
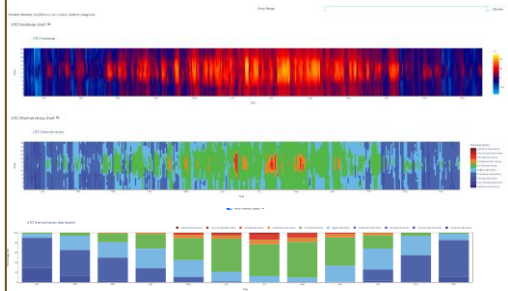
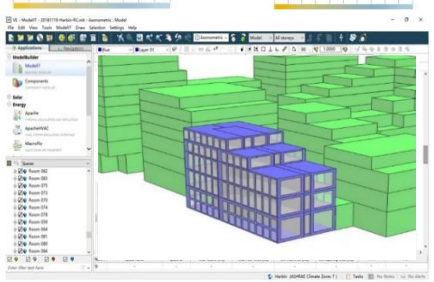
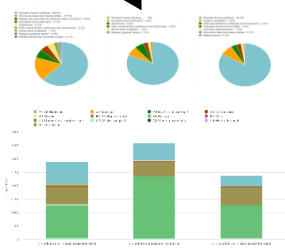
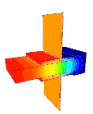
RELEVANCE
CO-CREATION
INCLUSIVITY
COMMUNITY
WELL-BEING

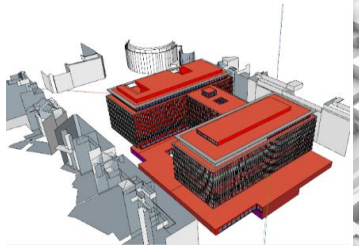
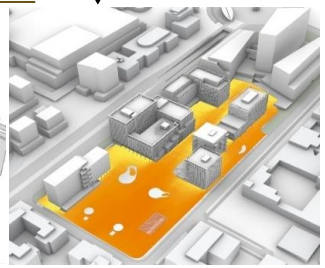

STD, DA, DLF, …
IES
CLIMATE & BUILDING PHYSICS
PHPP
WUFI
physibel
ubakus
Meteonorm
LCA
Urban LCA
One Click LCA
totem
$Q_r = f_v A_{nu} F \varepsilon \sigma T_v^4 - \alpha \sum_j (F_{jh} J_j A_j)$
IA & CODING
3D & BIM
RVT
iterative loop
COMPUTATIONAL DESIGN & SIMULATIONS
CBE
CENTER FOR THE BUILT ENVIRONMENT
grasshopper



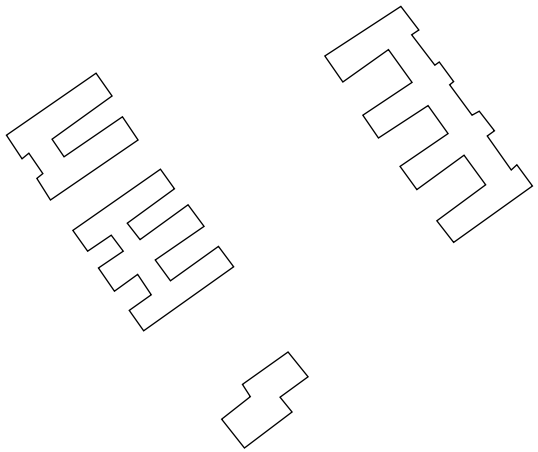



iterative loop

SAO PAULO GVT HQ



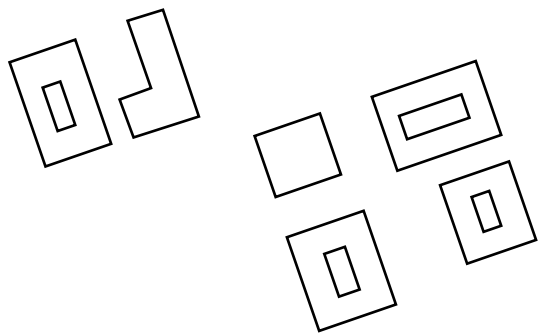
Sao Paulo GVT HQ

From a concrete jungle
to a green climatic district

BRAZIL – SÃO PAULO
COMPETITION
PASSIVE HOUSE, TOWARDS CO2
NEUTRAL, CIRCULAR, BREEAM
OUTSTANDING, WELL PLATINUM,
LEED PLATINUM, FITWEL 3STARS,
REGENERATIVE DESIGN
WITH JAA ARCHITECTS
210 817 M²

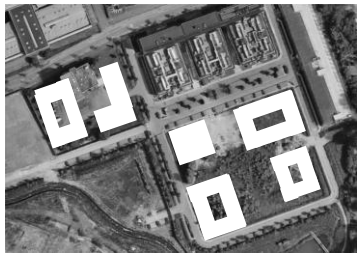
#
Climatic
design
Regenerative

Heal Campus



Heal Campus

from brownfield to greenfield campus

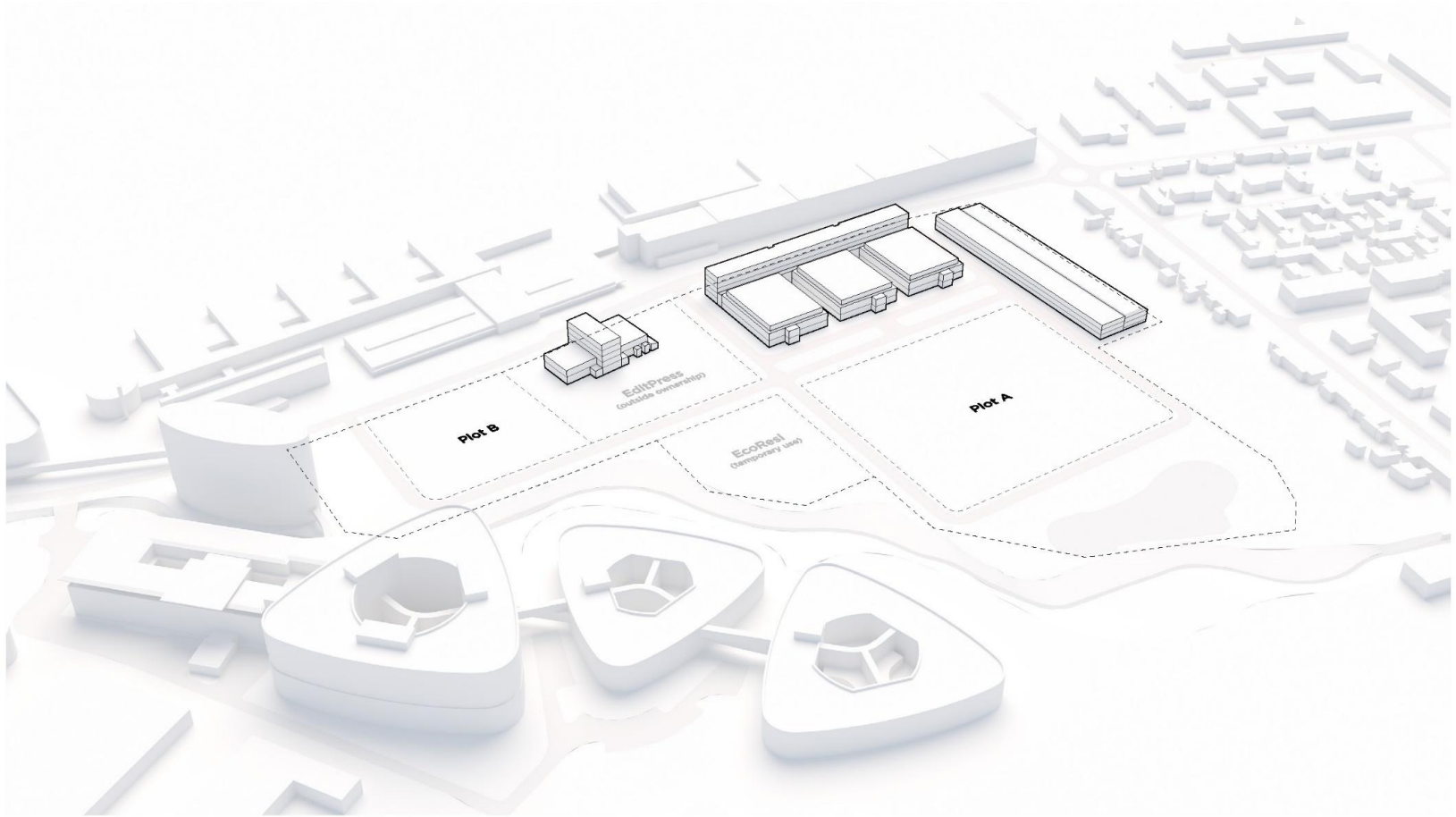


LUXEMBOURG – ESCH SUR ALZETTE
HEAL CAMPUS
HEALTH TECH OFFICE, LABS, FACILITIES, RETAIL, TEMPORARY RESIDENTIAL, REGENERATIVE LANDSCAPE
WITH EFFEKT
83 585 M²

#
Modular
Climatic design
Reuse
Regenerative
Design with nature

un campus régénératif

« a part of nature rather apart from nature »



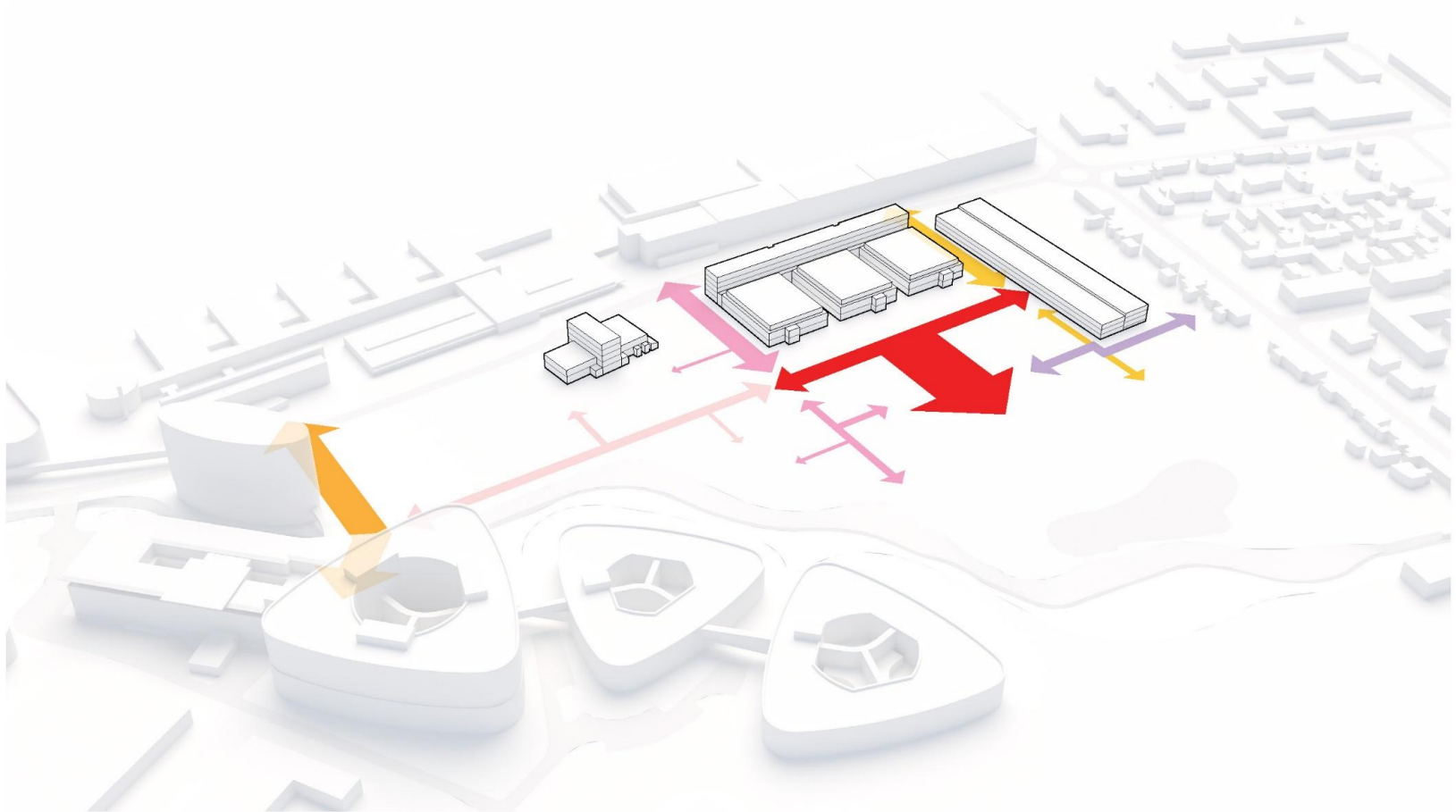
Le site aujourd’hui

The site today consists of an existing infrastructure defining the development plots

Intégrer la nature

Connecting to the ‘wetland’

A key strategy in the masterplan is the integration of nature. Therefore, connecting to, and expanding on the wetland area functions as the basis in the overall layout and urban design. The campus plan setting and experience targets ‘being in nature’.



Infrastructure sociale

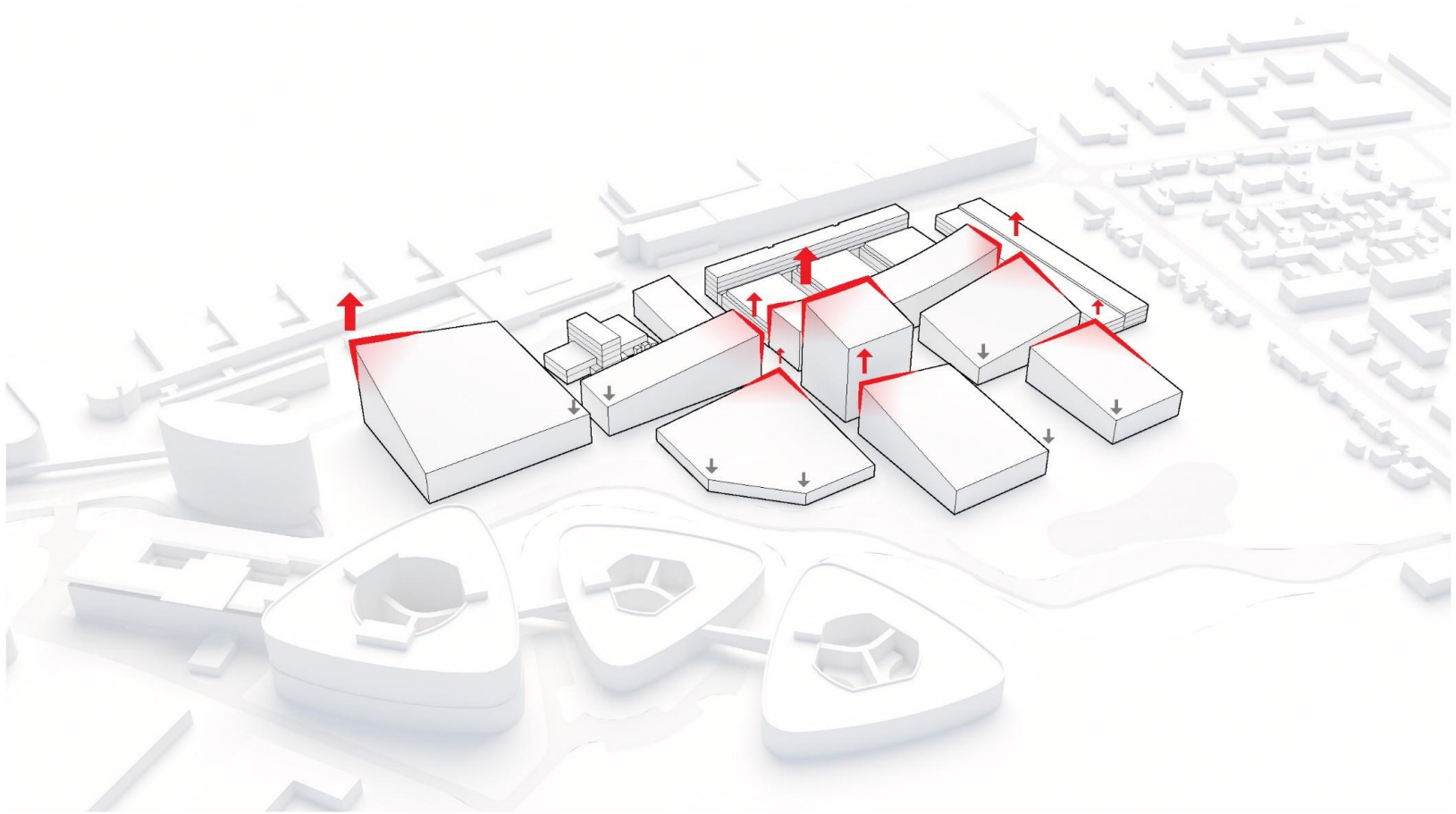
Urban space framework

Cross connections, green and spaces forms a network that connects the campus within and to the surrounding context. This forms the social infrastructure as well as the connecting the individual buildings in the HE:AL campus.

Zones de développements

Connecting to the urban space network

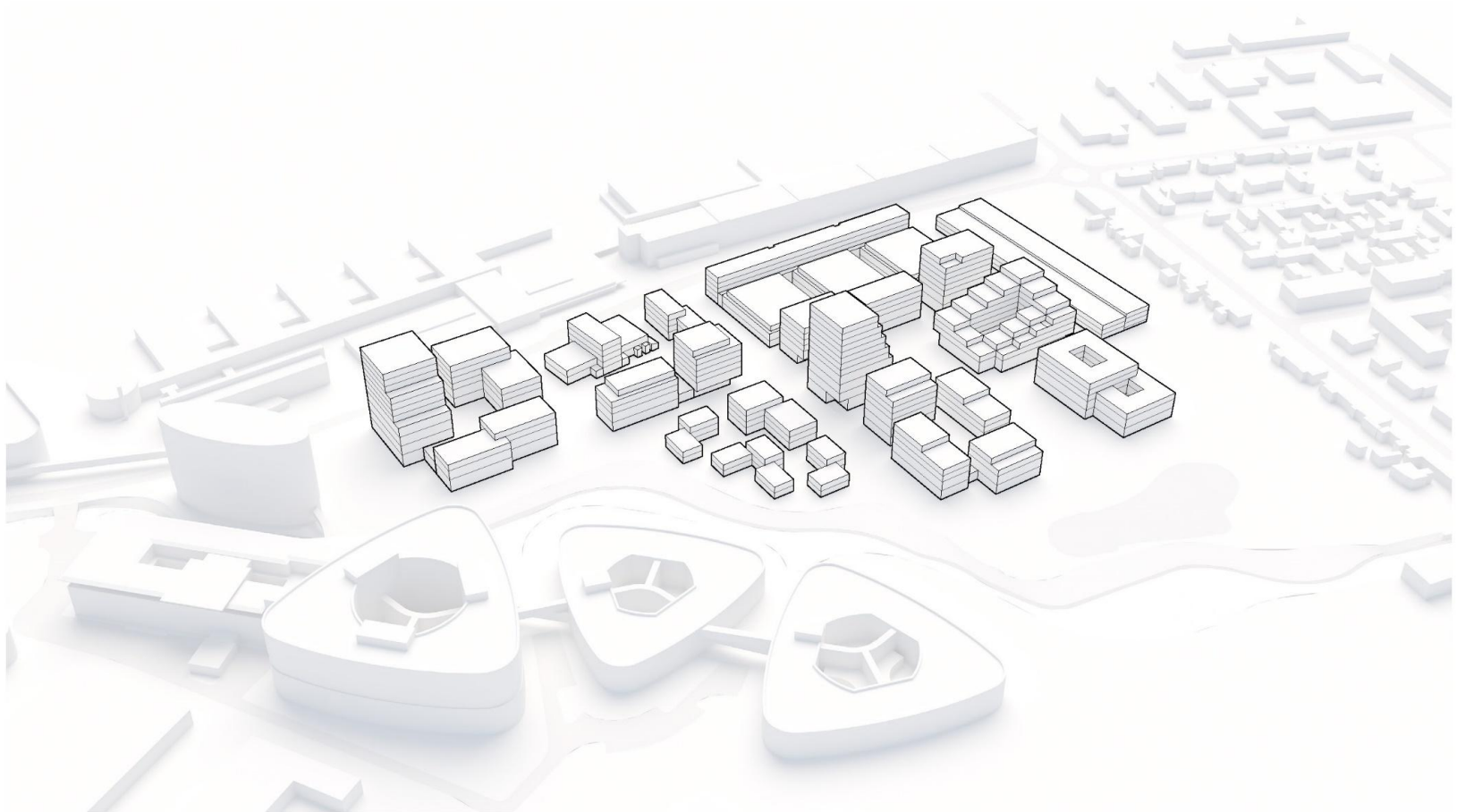
The urban space framework defines the development plots and areas. The development plots results in a building boundaries that allows flexibility for different built structures and a range for different densities. Besides plot A and plot B, a new building area (+A) has been added at the backside of the House of BioHealth, turning it into a front side.



Epannelage des volumes lié au contexte

Massing relates to urban spaces and heights

The massing of the masterplan responds to the surroundings, buildings and neighbors also respecting the flight lines to the hospital. It also responds to the quality of the spaces between the buildings in the campus.



Mise en place de l’architecture

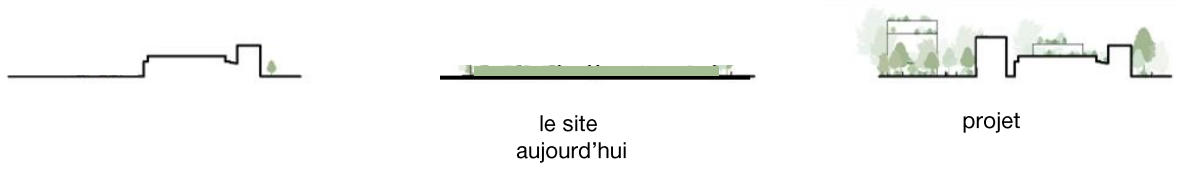
A robust and flexible masterplan

The masterplan accommodates a variety of typologies, creating a diverse campus with easy wayfinding, and varied experiences and identities within the area.

HE:AL Campus

Our proposal is a Masterplan with a clear framework that enhance nature and
a social infrastructure merging the built structure within in the landscape

HE:AL Siteplan



le site
aujourd'hui

projet

CBS
0,00

CBS
0,20

CBS
0,59

CBS

habitats

zone artificialisée, imperméable

CBS
0,00

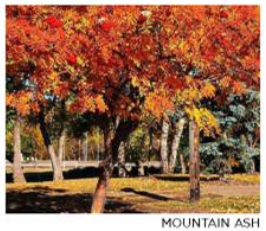
pelouse, prairie, mare, haie…

CBS
0,50

bois, prairies sauvages, massifs arbusifs…

CBS
0,90

BLACK ALDER



MOUNTAIN ASH

WHITE WILOW

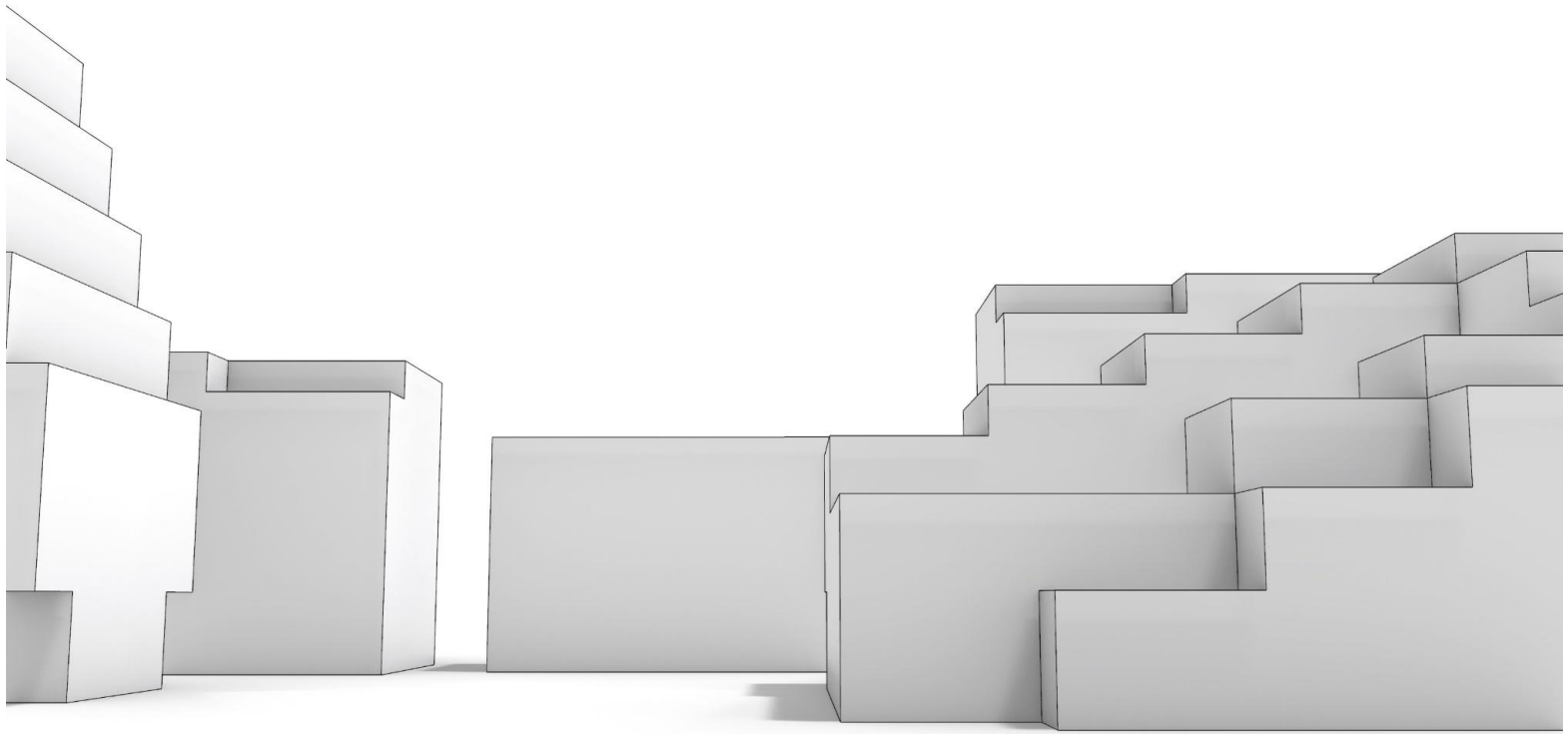
WHITE WILOW

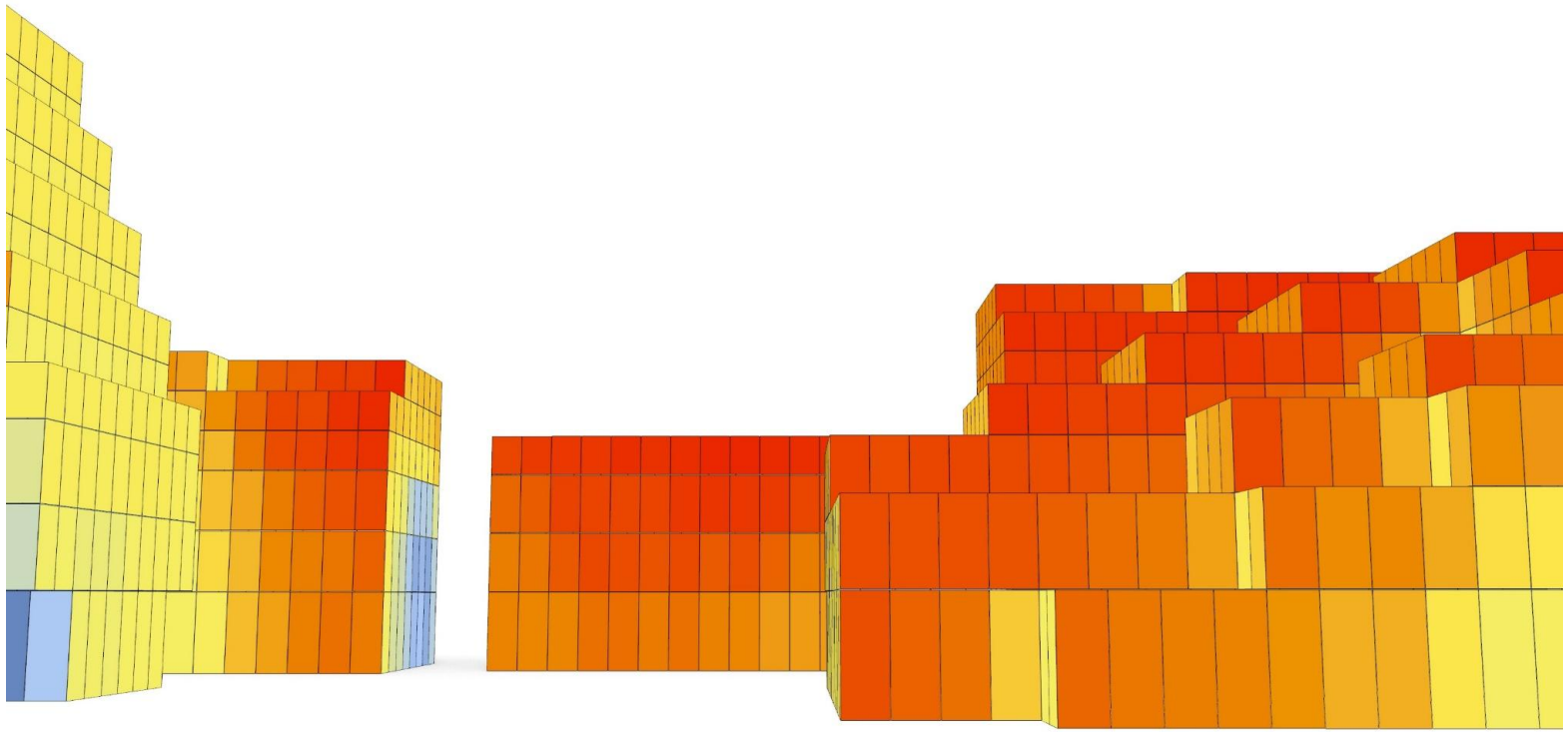
WATER HORSETAIL

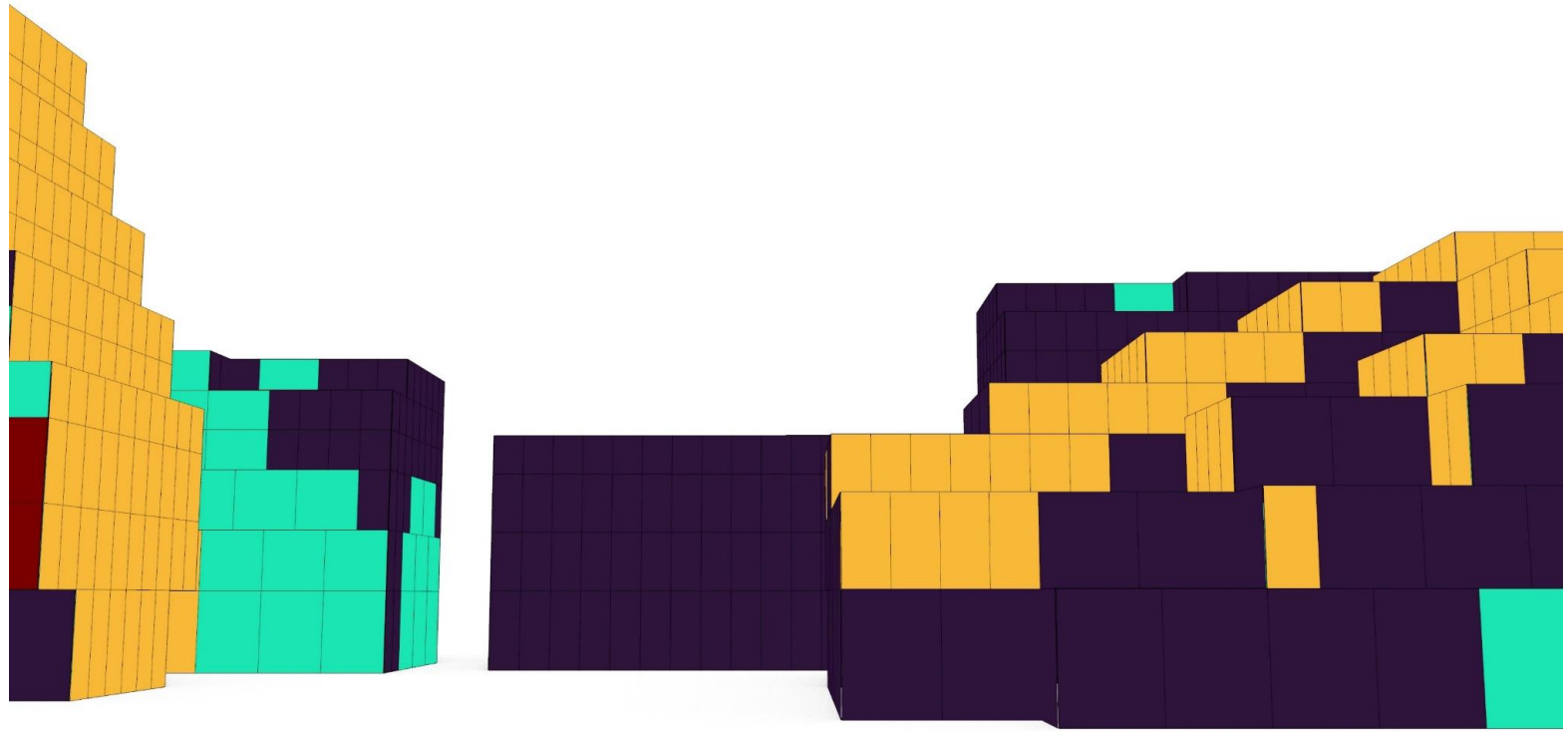
VIBURNUMS

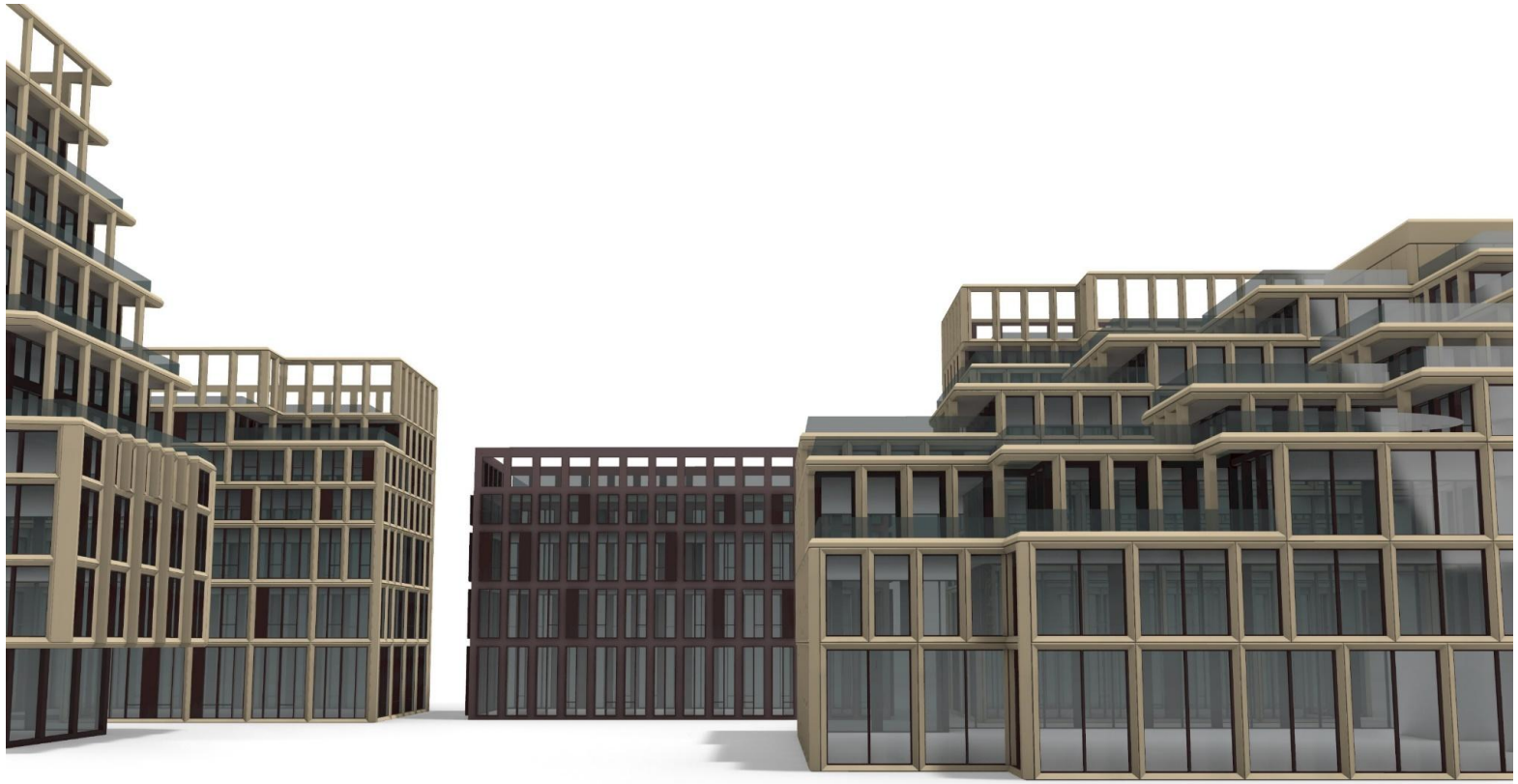
NATIVE WEEDS AND GRASSES

WILD CARROT










HEAL FOOD
FRESH EVERY DAY
HEAL FOOD
FRESH EVERY DAY

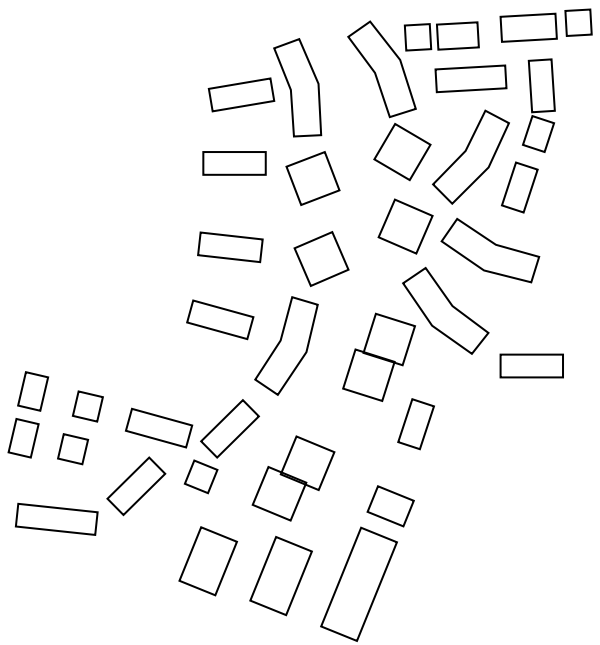

HEAL FOOD
FRESH EVERYDAY

Luxembourg – Esch Sur Alzette

HE:AL Campus
health tech office, labs, facilities, retail,
temporary residential, regenerative
landscape
passive house, CO_2 neutral, circular,
zero energy, modular, regenerative,
BREEAM Oustanding, WELL Platinum

83 585 m² / 899 701 ft²

Strassen



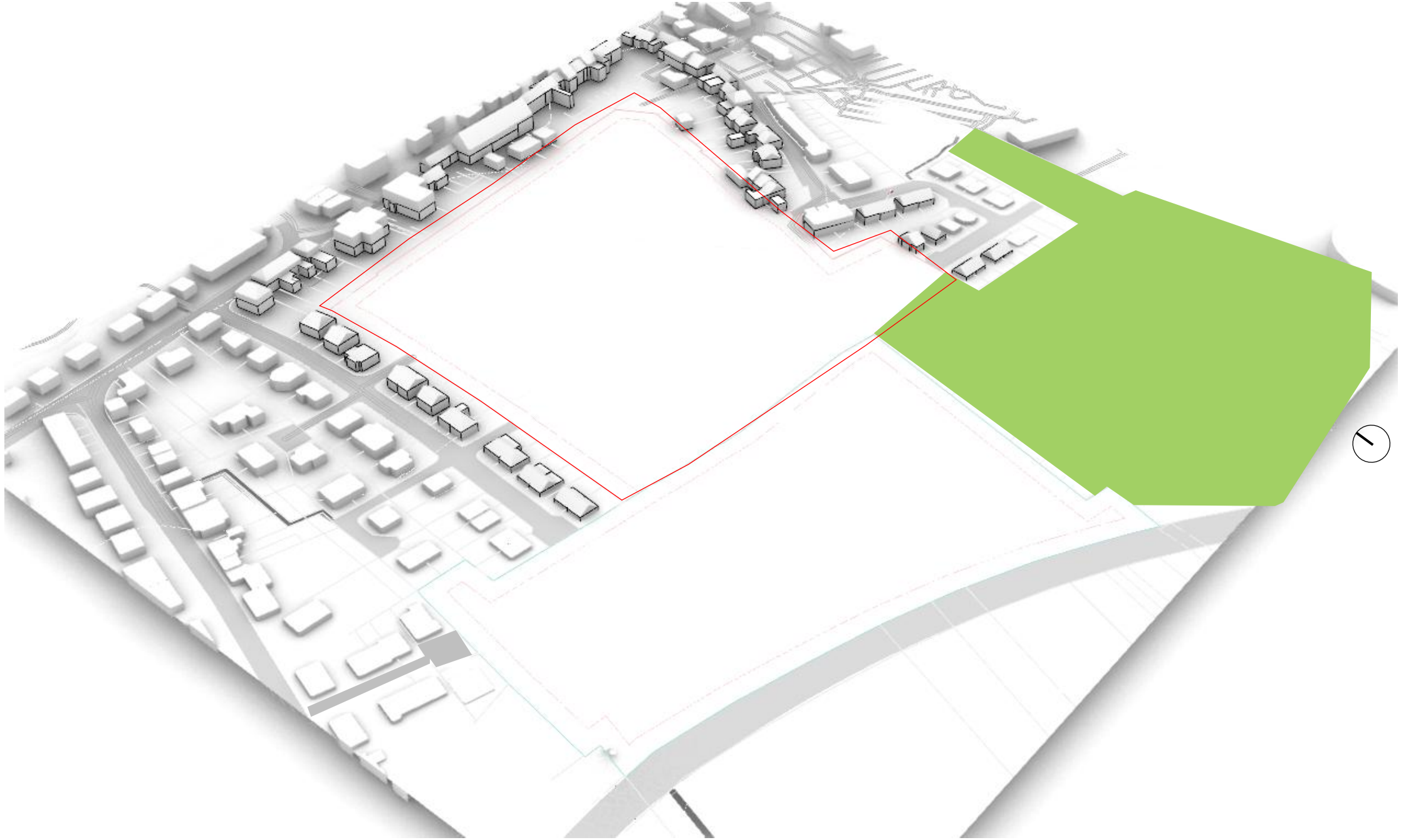
Strassen

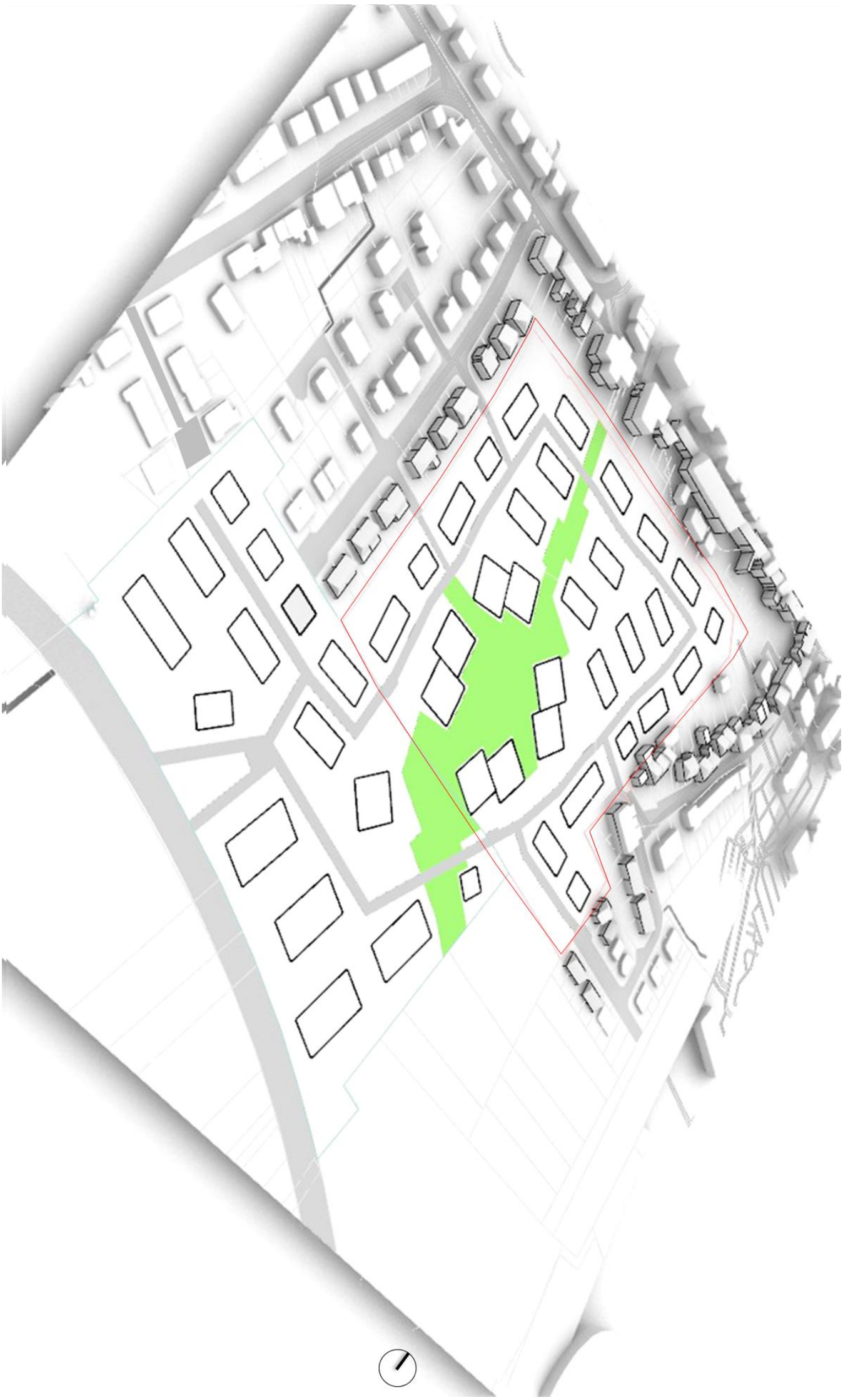
From a landfield to climatic district

LUXEMBOURG – STRASSEN
URBAN PLANNING
RESIDENTIAL, RETAIL
LANDSCAPE
WITH MORENO ARCHITECTURE
ARCHITECTS
66 134 M²

#
Climatic district
Keyline design
Regenerative


landscape before buildings

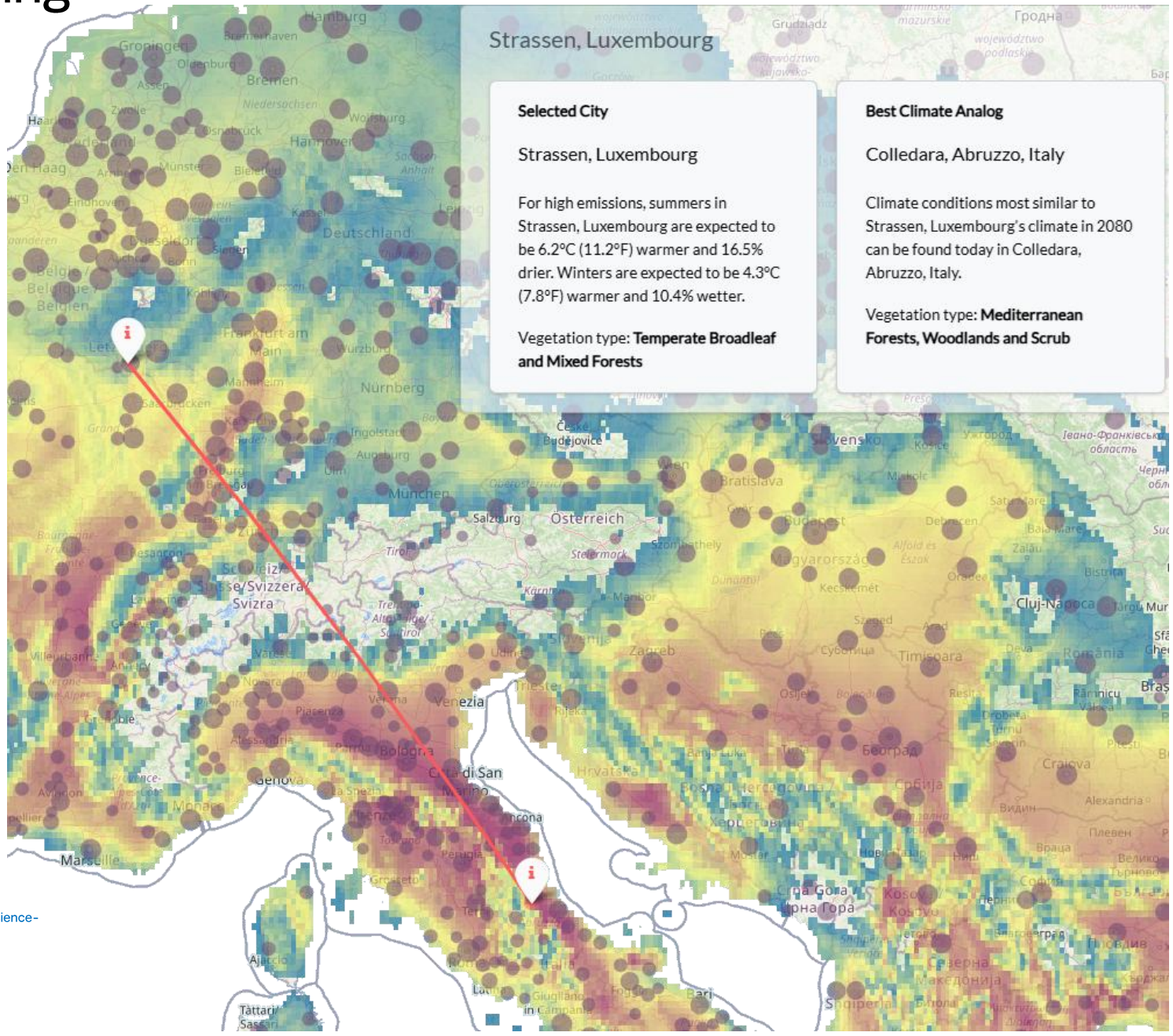




biotopes

Concevoir avec la nature implique de travailler en harmonie avec les flux naturels et de restaurer les interactions entre l'environnement bâti et les écosystèmes dans une contexte climatique connu.

...how it's going



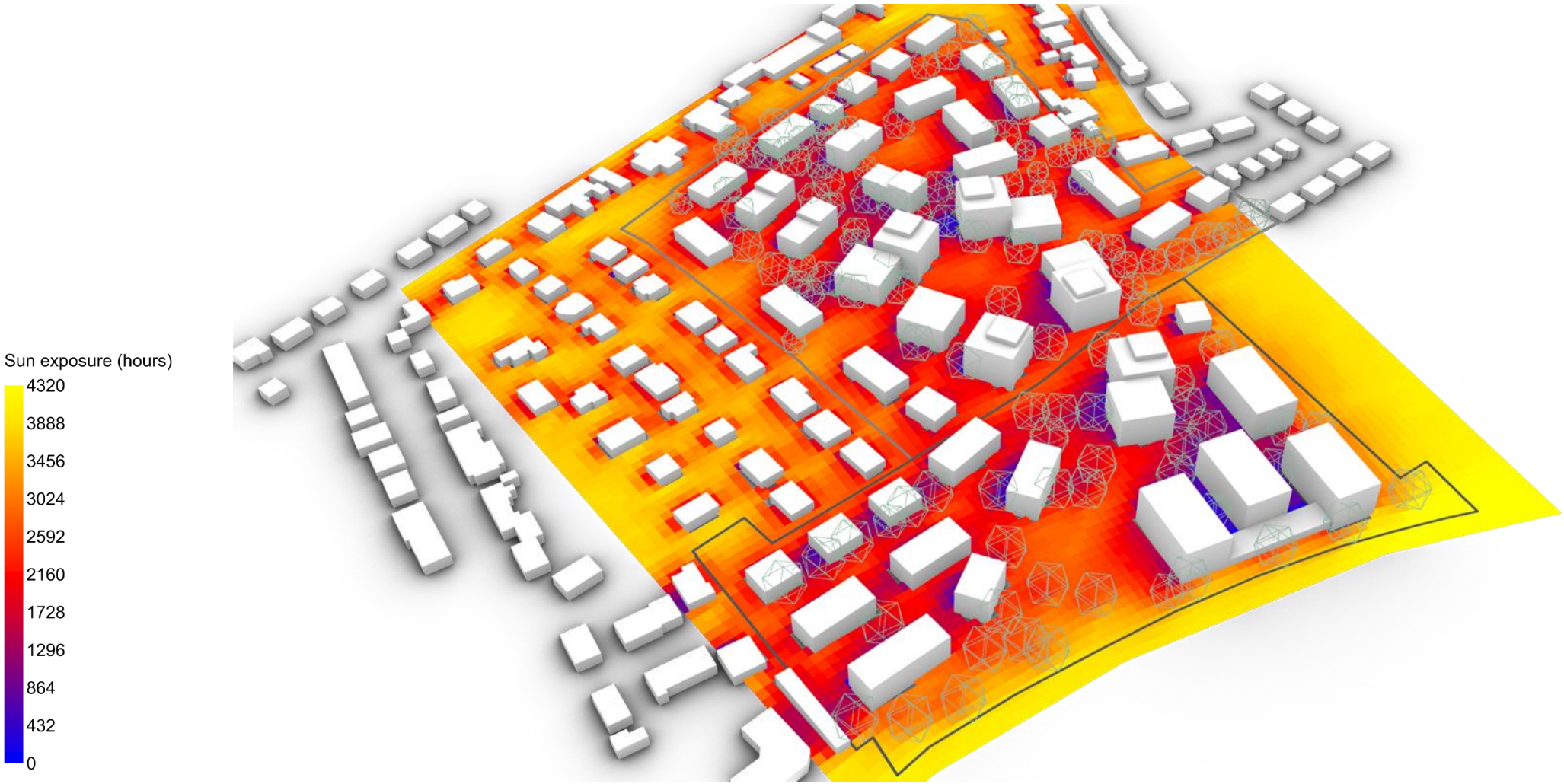
SSP5-8.5
(SHARED SOCIO-ECONOMIC PATHWAYS)

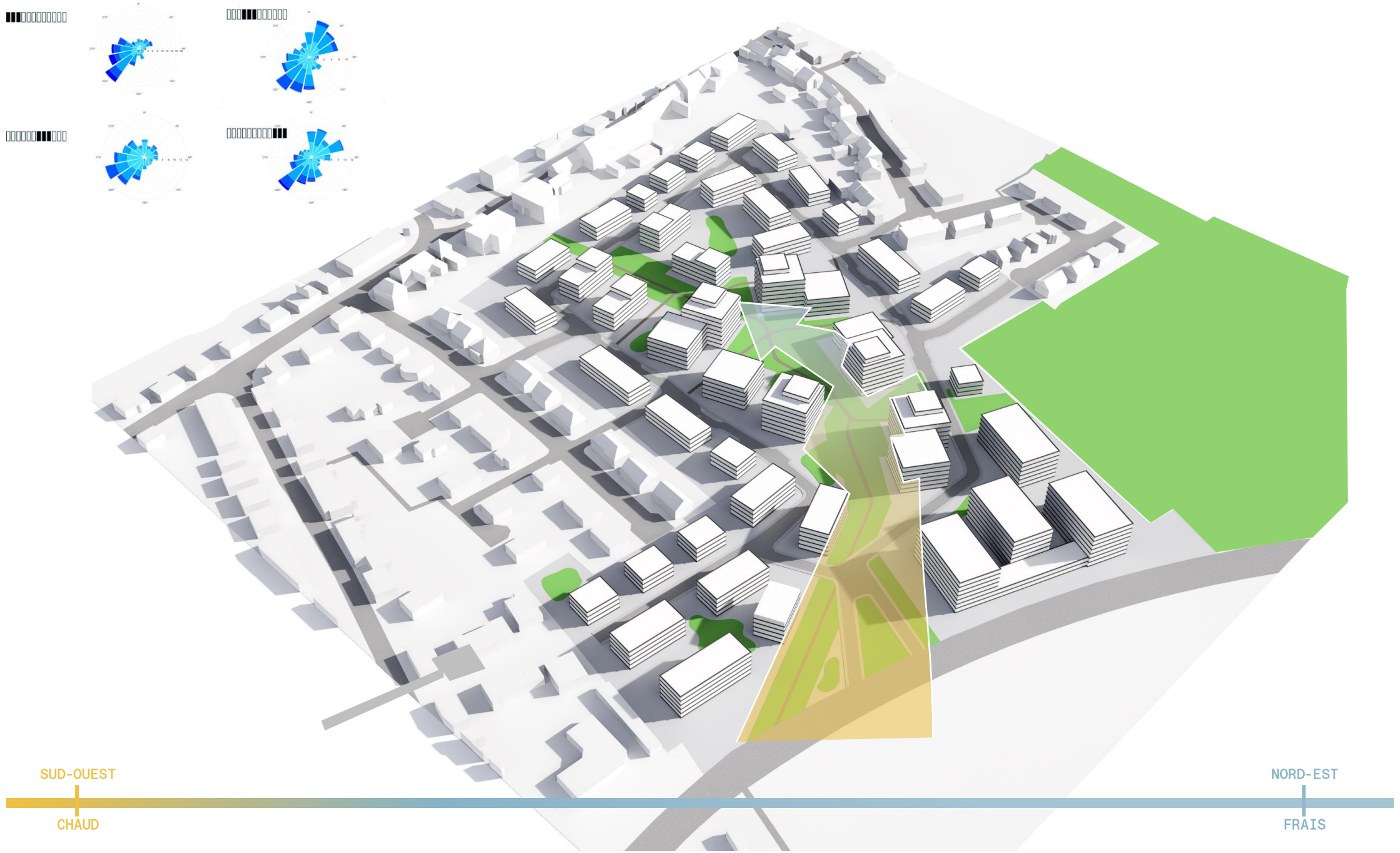
University of Maryland Center for Environmental Science-

https://fitzlab.shinyapps.io/cityapp/

ensoleillement

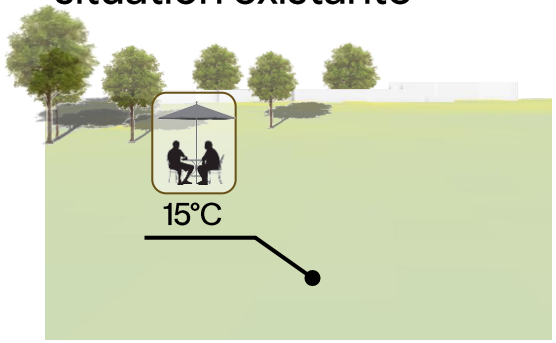
exposition solaire – situation projetée



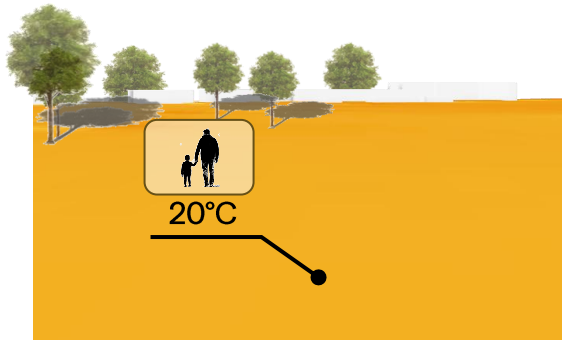

SUD-OUEST
CHAUD
NORD-EST
FRAIS

design with microclimate

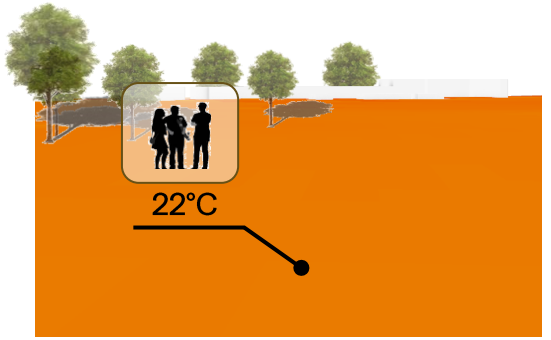
situation existante



UTCI EN 2024

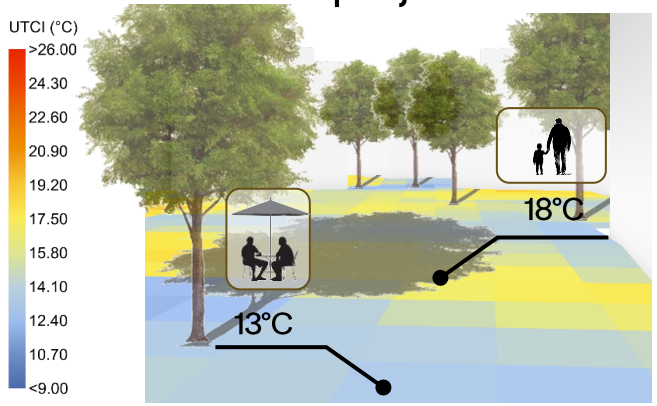


UTCI EN 2050

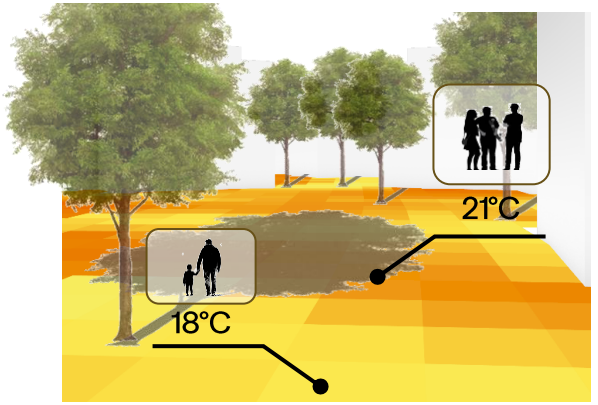


UTCI EN 2080

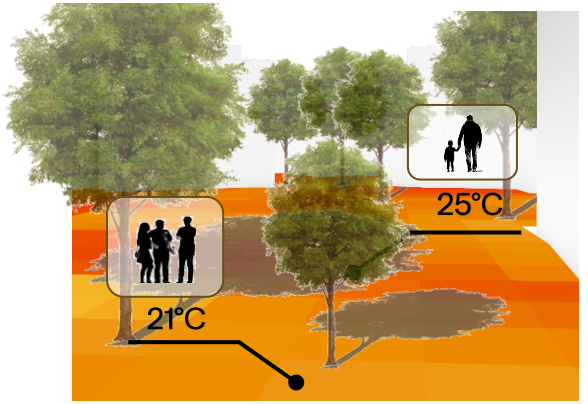
situation projetée



UTCI EN 2024



UTCI EN 2050



UTCI EN 2080

outil de calcul ICU

Alb: calcul de coéfficient global à l'ilot

traduit le facteur de réflexion solaire d'un revêtement

Albédo matériaux de façade > 0.20

j **Albédo moyen à l'ilot > 0.30**

$$Alb_{GLOBAL} = \frac{\Sigma \text{ sur toutes les surfaces (S surface x Alb surface)}}{S \text{ parcelle}}$$

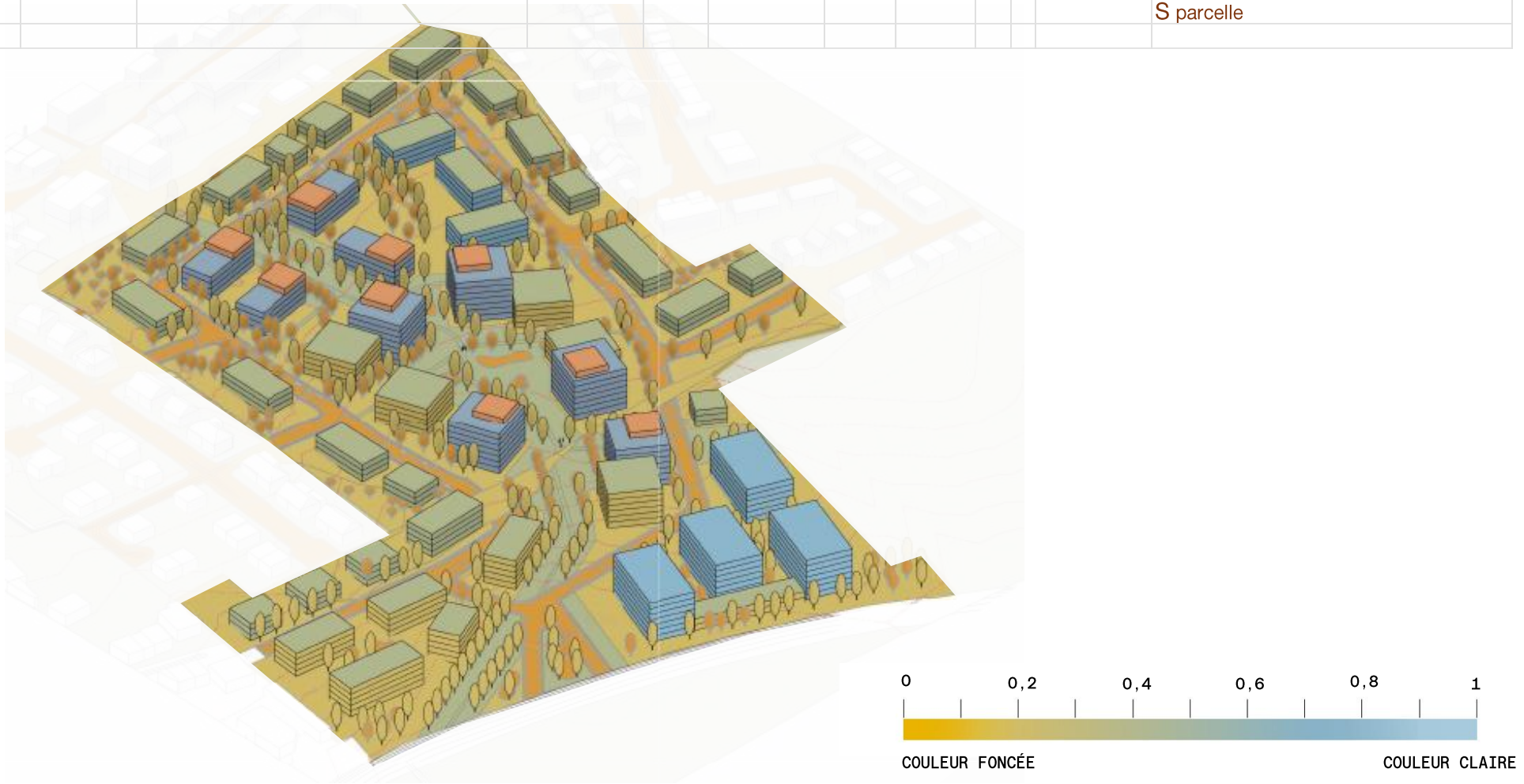
T: coefficient de régulation thermique

potentiel rafraichissant d'une surface grâce à l'évaportranspiration de la végétation et de l'eau

valeur à atteindre: > 0,45

$$T_{GLOBAL} = \frac{\Sigma \text{ sur toutes les surfaces (S surface x T surface)}}{S \text{ parcelle}}$$

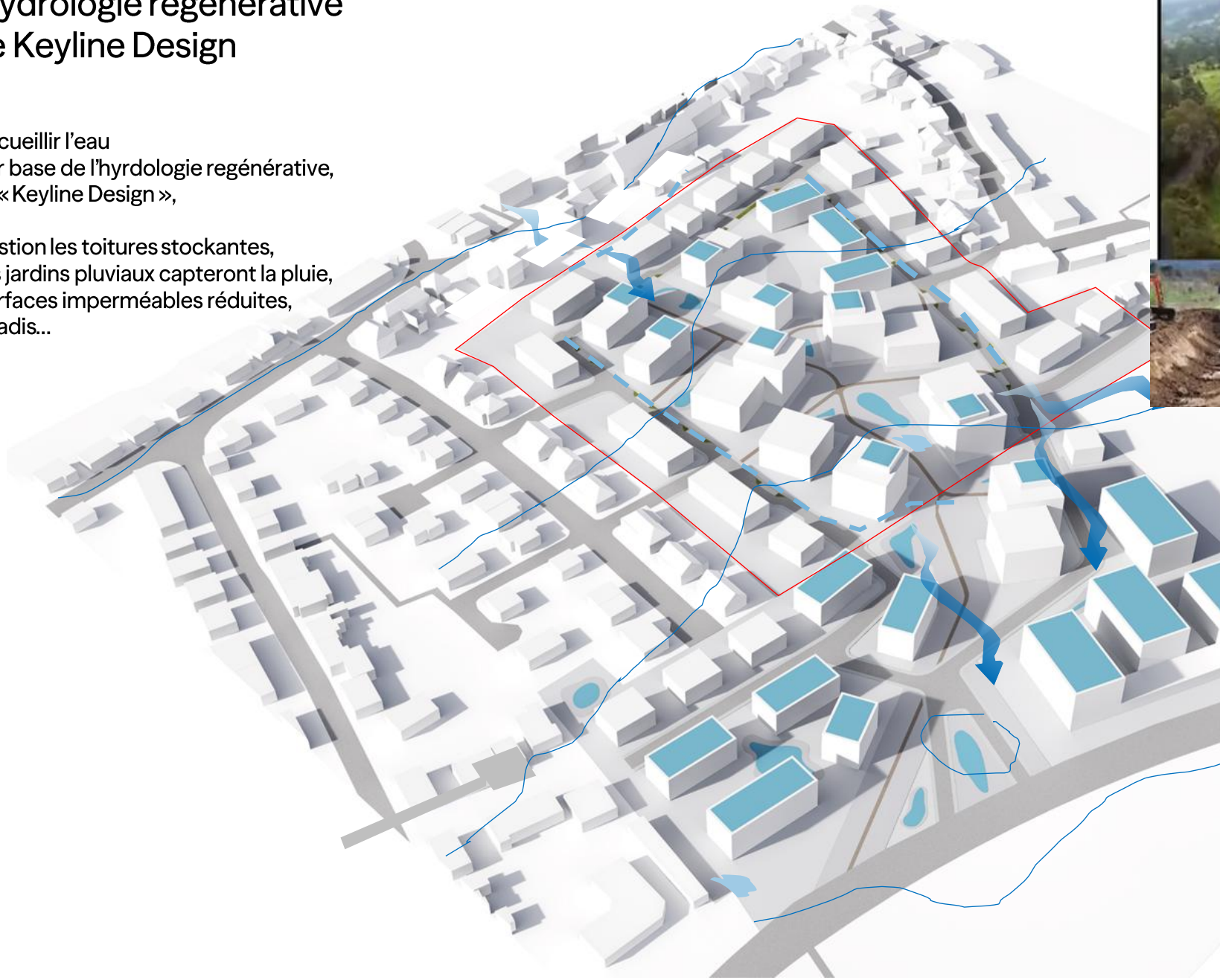
albedos

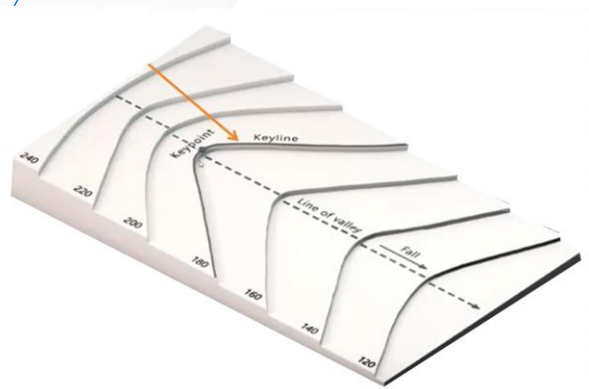


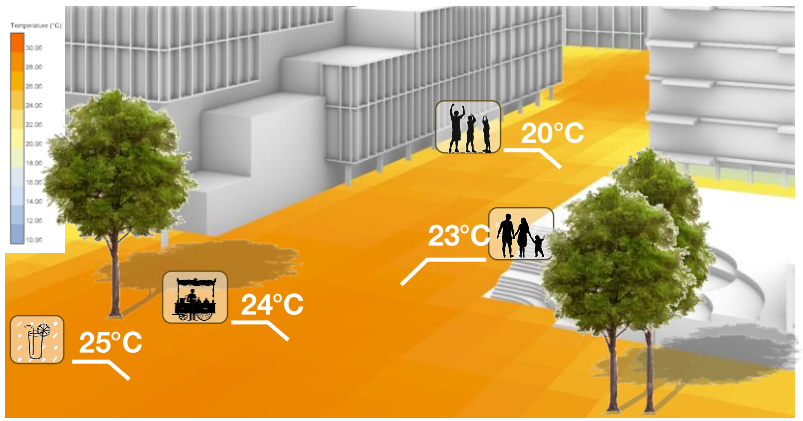
hydrologie regénérative
le Keyline Design

accueillir l'eau
sur base de l'hyrdologie regénérative,
le « Keyline Design »,

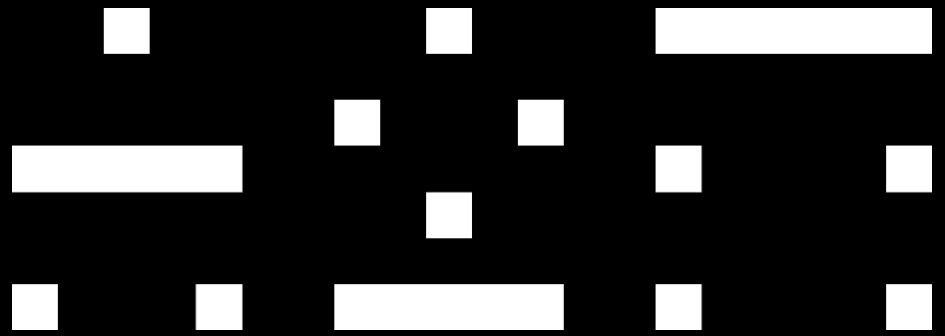
gestion les toitures stockantes,
les jardins pluviaux capteront la pluie,
surfaces imperméables réduites,
Wadis...






Temperature (°C)
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
20°C
23°C
24°C
25°C

What if every project became an act of contamination, of transmission, of environmental reimprinting?



@a2marchitecture
www.a2m.be