

Finding new perspectives in a changing climate

Workplace Pride – The Green Village, 15th of February 2023



Prof. **Andy van den Dobbelsteen**, PhD MSc

TU Delft Sustainability Coordinator & full professor of Climate Design & Sustainability,

Climate change hits us all
without distinction

Extreme weather



Hailstones in Asten [Eindhovens Dagblad/Bert Jansen]



[indebuurt]



[OHRA]

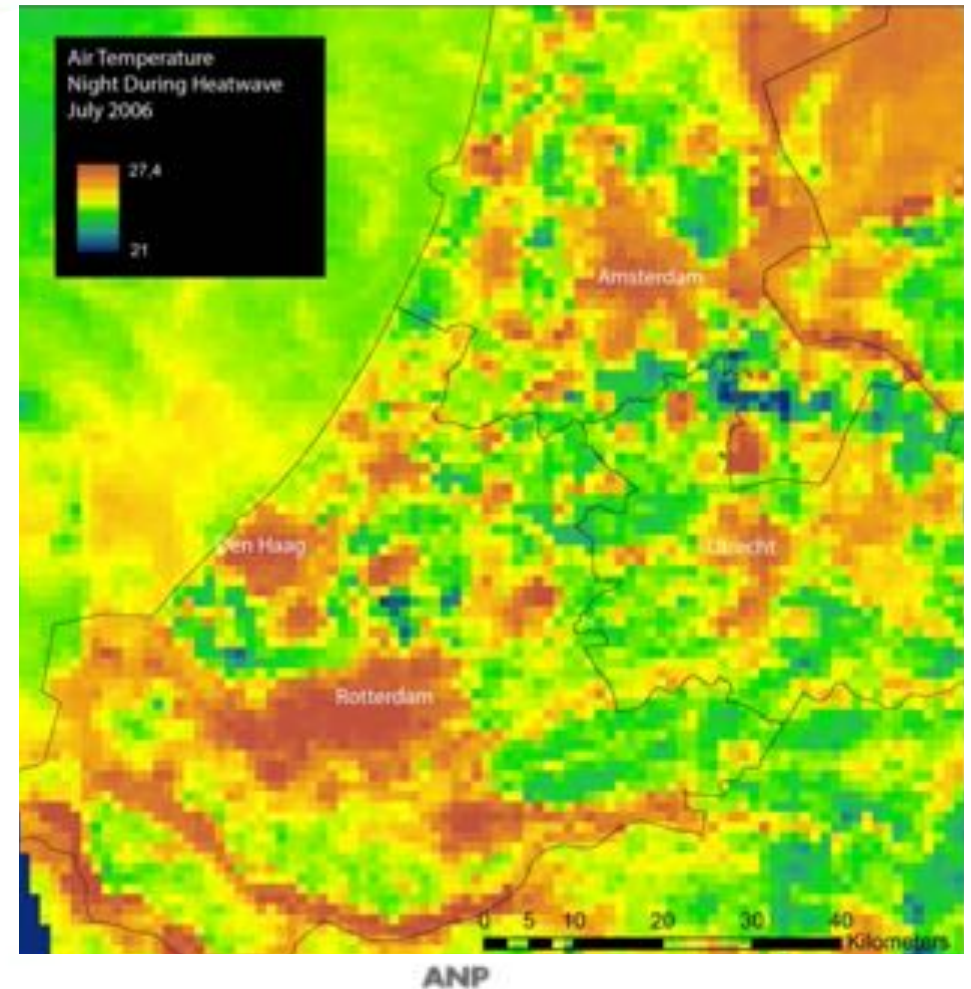
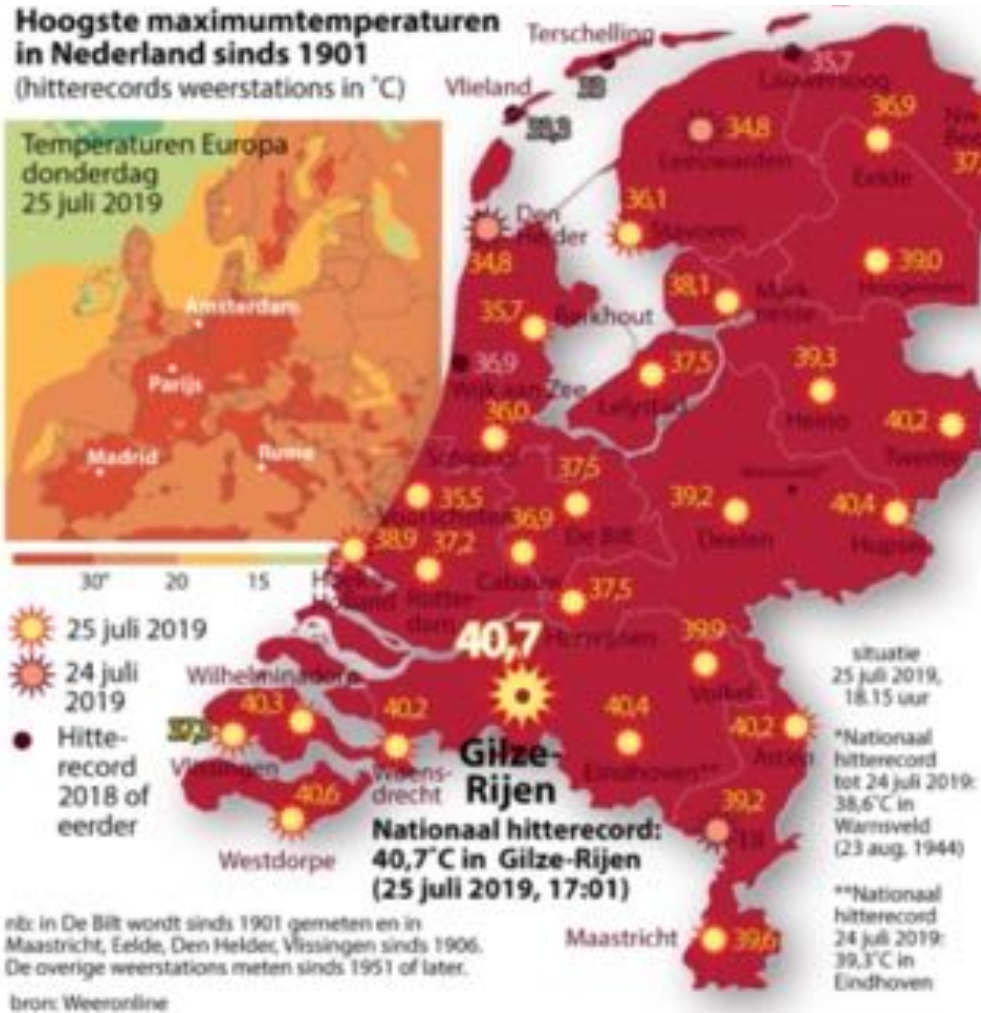
Forest fires



Forest fire in the Algarve, 2018

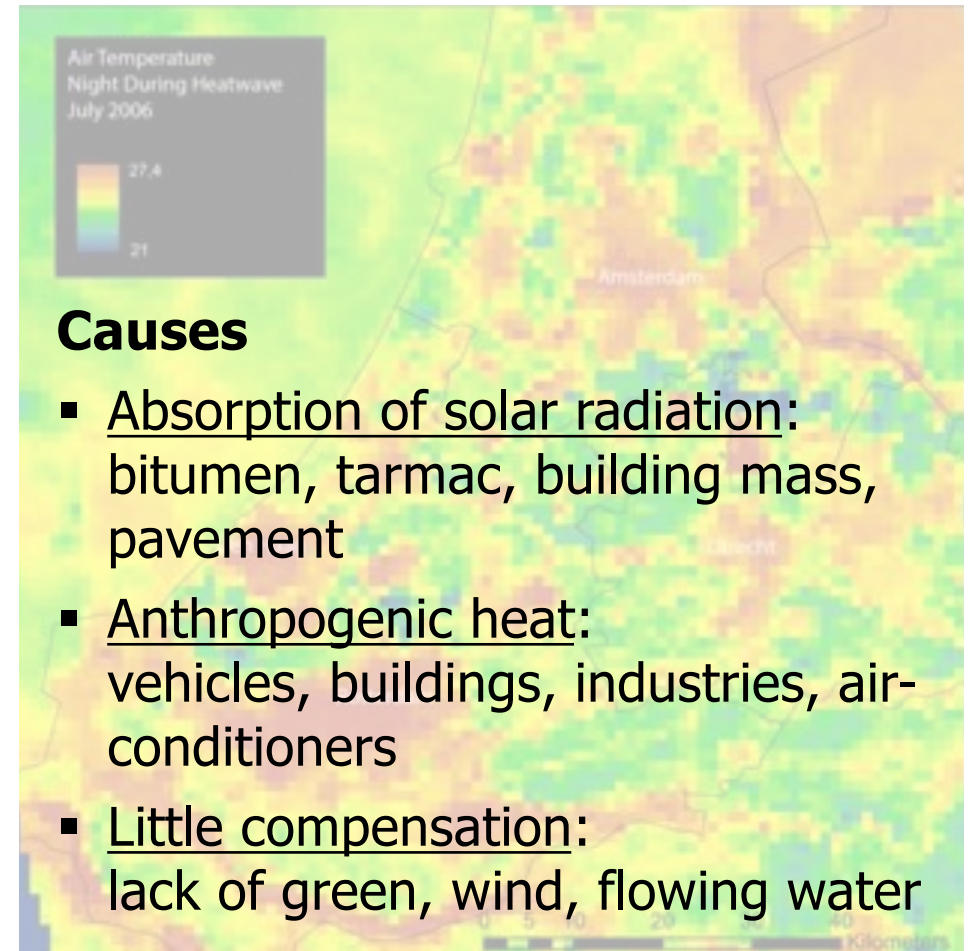
**The
Guardian**

Climate: the new reality, measured **outside the city**



Causes of extreme urban heat

The **urban heat island (UHI) effect** is the phenomenon that urbanised areas are significantly warmer than their rural countryside.



Causes

- Absorption of solar radiation: bitumen, tarmac, building mass, pavement
- Anthropogenic heat: vehicles, buildings, industries, air-conditioners
- Little compensation: lack of green, wind, flowing water



Are you surprised?



Amsterdam roof desert

Bring nature back into the city



Herb roof (Blaauwklakenblok, Amsterdam)



Roof gardens (Chongqing, China)

With many advantages!

Floods



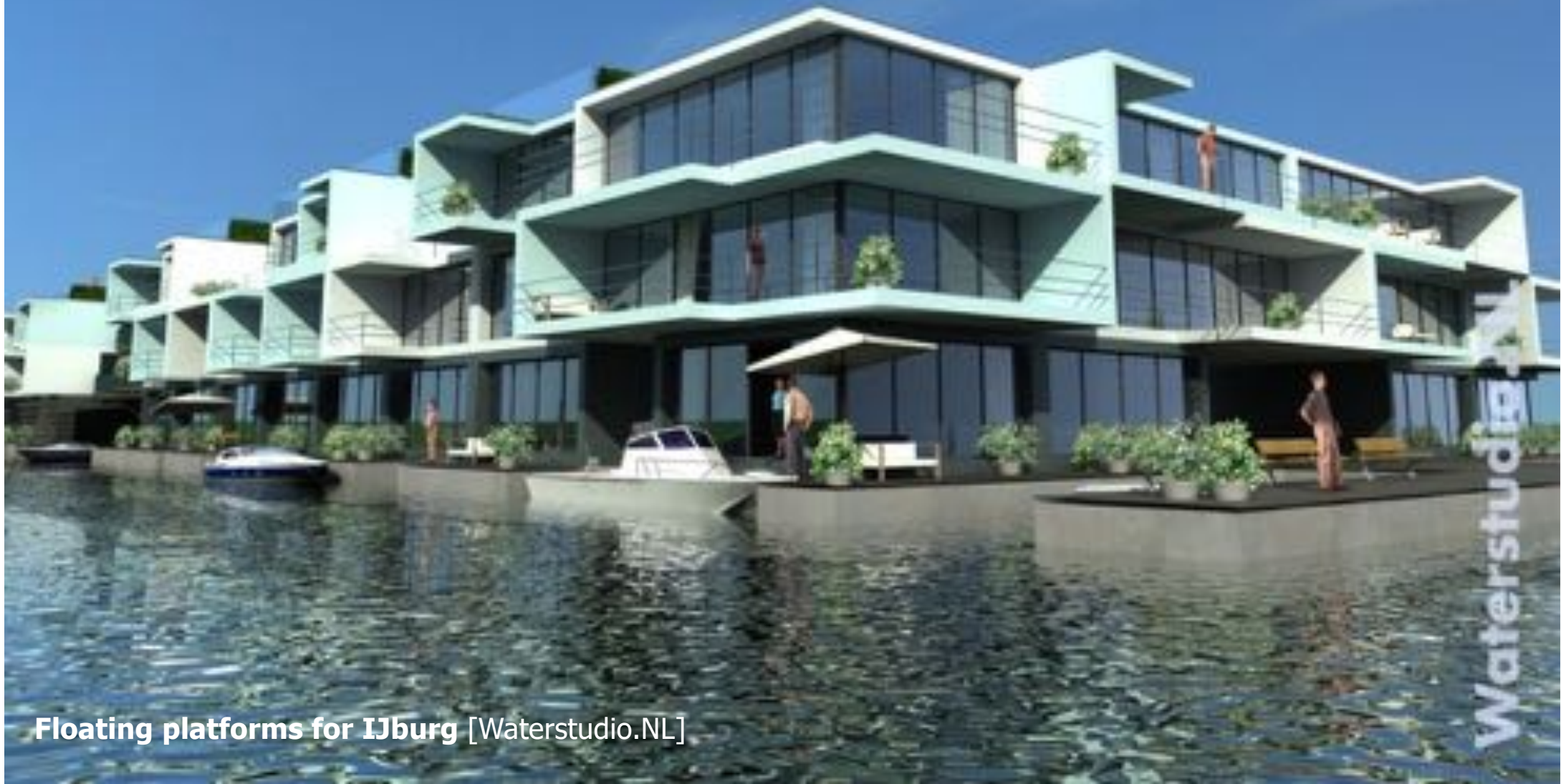
Water surge in the Dutch province of Limburg, 2021 [nu.nl]

Water urbanism



Plan for the Haarlemmermeer [OK Architecten]

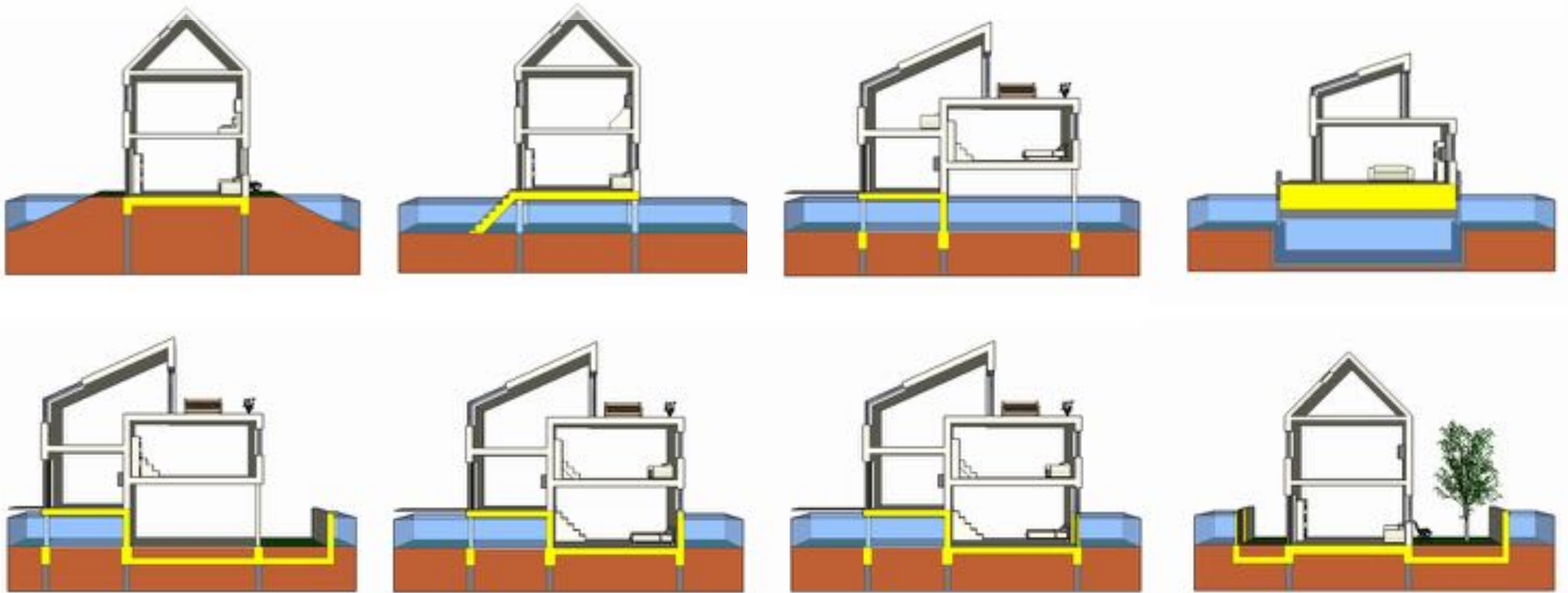
Water architecture



Floating platforms for IJburg [Waterstudio.NL]

A positive take on flooding: flood-proof housing

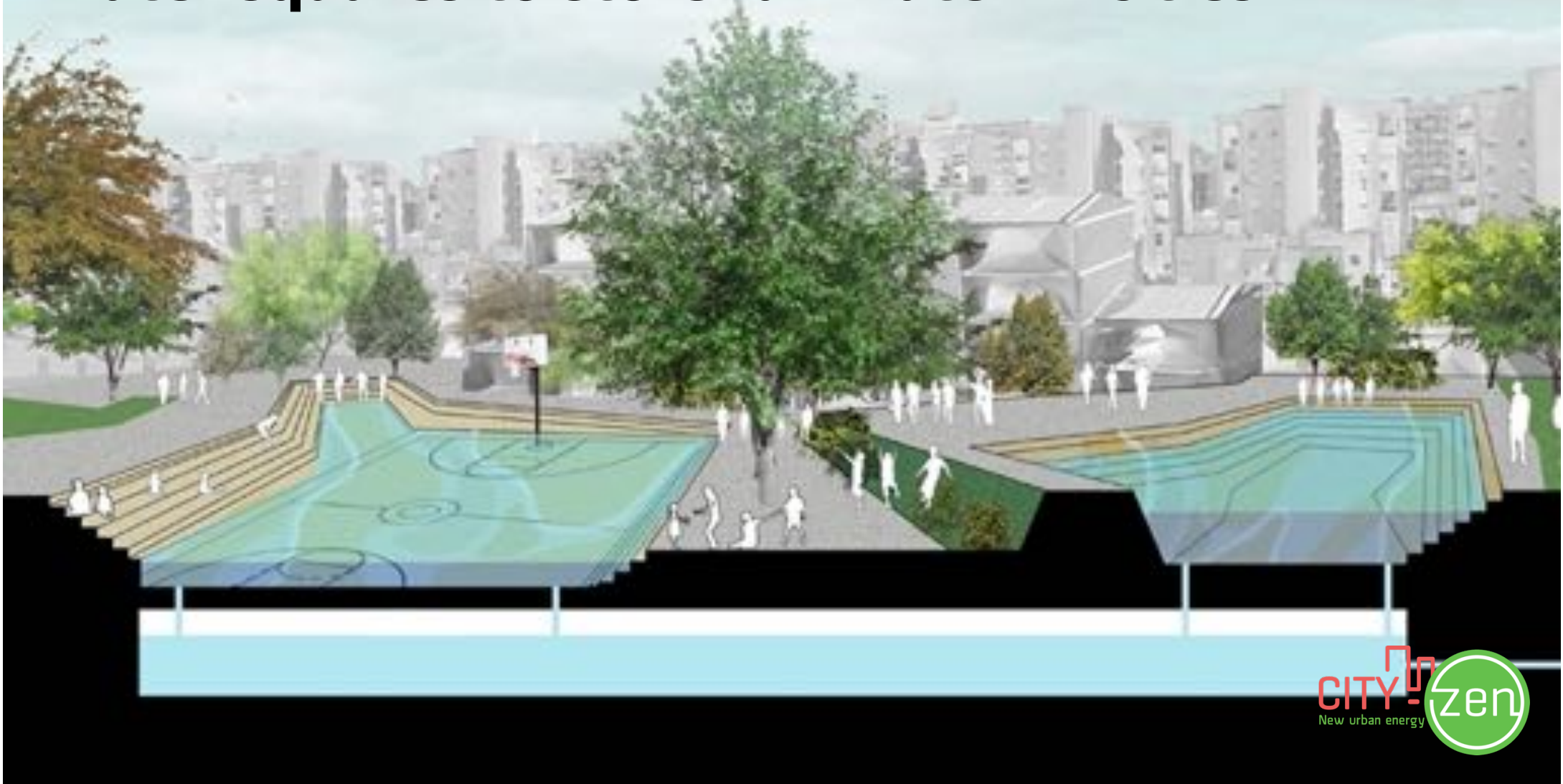
[Dobbelsteen, Lassen, Fremouw 2008]



Green-blue roofs to retain rain water



Water squares to store rainwater in cities

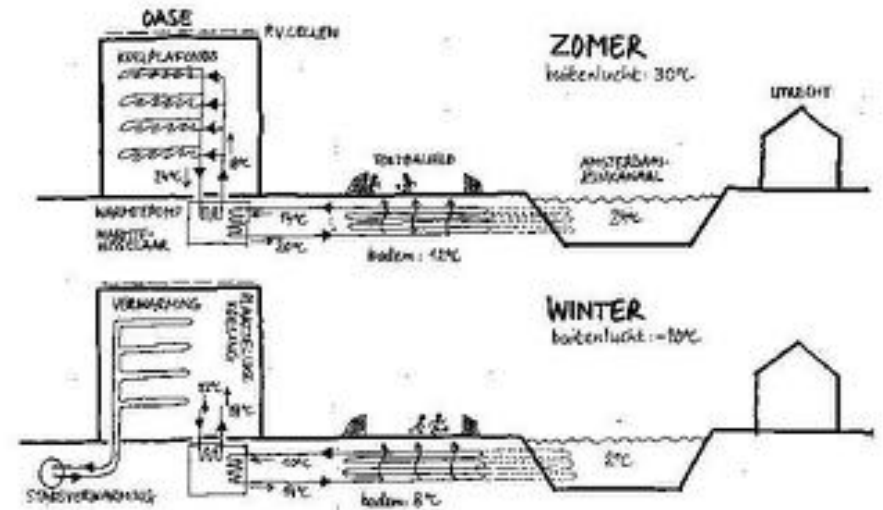
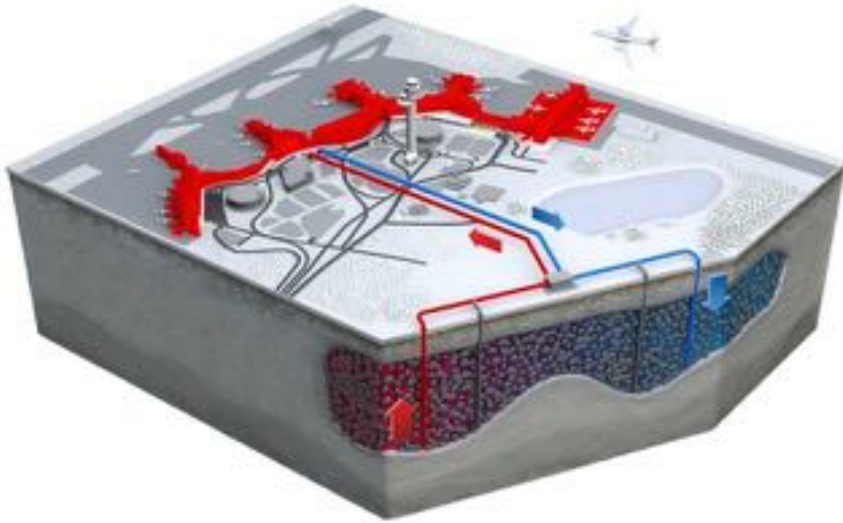


Preparing buildings for a different climate

- **Apply sturdier building envelope details**
- **Capture rainwater and use it**
- **Design safely for floods**
- **Learn from vernacular examples elsewhere**
- **Avoid cooling necessity by bioclimatic design**
- **Use heat pump systems** (for heat and cold)
- **Do not disturb the urban climate**
- **Use more green and contribute to biodiversity**



Active cooling and heating of urban surfaces



This is where **climate adaptation** goes well together with **climate mitigation**

Climate change hits us all.

**But the impact is
not divided equally nor righteously,
not between regions,
not between rich and poor,
not between women and men.**

**Those who are responsible and who have the
means, they should help others – solidarity!**



The Great Sustainability Challenge

Climate adaptive

→ prepare for the new climate

Carbon neutral

→ shift to renewable energy entirely

Circular

→ become part of the circular economy

Adding value

→ contribute to health, happiness and biodiversity

Carbon neutral, asap please
for future generations

Energy slaves (Energieslaven)

Winner of a Gouden Reiger
(Dutch Oscar for commissioned films)

Made for the
Zero-Energy Design
MOOC & ProfEd

Visible on **youtube**



Zero-Energy Design

Winner of the EdX Online Prize (best online course of 2020)



**MOOC open
until September**

**ProfEd starting
October 2023**

ZERO-ENERGY DESIGN
an approach to make your building sustainable

research reduce re-use produce

Start date: April 3, 2019 Course length: 7 weeks Estimated effort: 4 hrs/week Price: FREE*

[Click here to enroll](#)

About this course
Reduction of energy consumption of buildings is an important step in the move towards a sustainable built environment. How can buildings be made net zero-energy, in different climates?

This course introduces you to zero-energy design. It will teach you a stepped approach to design a zero-energy climate concept for existing buildings: homes, schools, offices, shops etc. It will demonstrate how an integrated approach, which takes into account both passive measures (such as thermal insulation and sunshading) and active measures (such as heat pumps and photovoltaic panels), can deliver the best results.

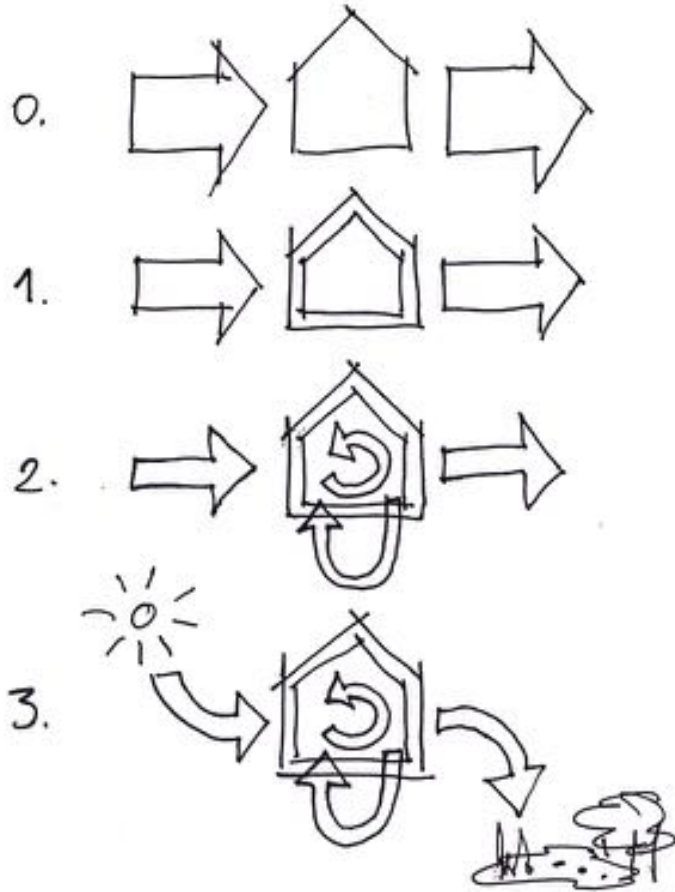
TU Delft

ZERO-ENERGY DESIGN
Andy van den Dobbelsteen

Boom

WEBSITE

Steps toward zero-energy buildings




0 **research:** study the local circumstances

1 **reduce:** reduce the demand
– passive, smart bioclimatic design

2 **reuse:** use residual flows
– waste water, waste material, waste heat/cold
– in closed or connected cycles

3 **produce:** generate renewable energy

Reducing the demand first

- 
- Urban plan ▪ Avoidance of energy users
 - Building orientation ▪ **LED lighting**
 - Building geometry ▪ **Energy-efficient tv**
 - Building layout ▪ **Energy-efficient fridge**
 - Zoning ▪ **Energy-efficient freezer**
 - Compartmentalisation ▪ **Energy-efficient washing machine**
 - Daylight access ▪ **Natural drying**
 - Use regime ▪ **Thermostat taps**
 - Thermal mass ▪ **Thermostat shower**
 - Thermal insulation** ▪ **Smart meters**
 - Insulating glass** ▪ **Kill-button**
 - Sunshading** ▪ **Building management system**

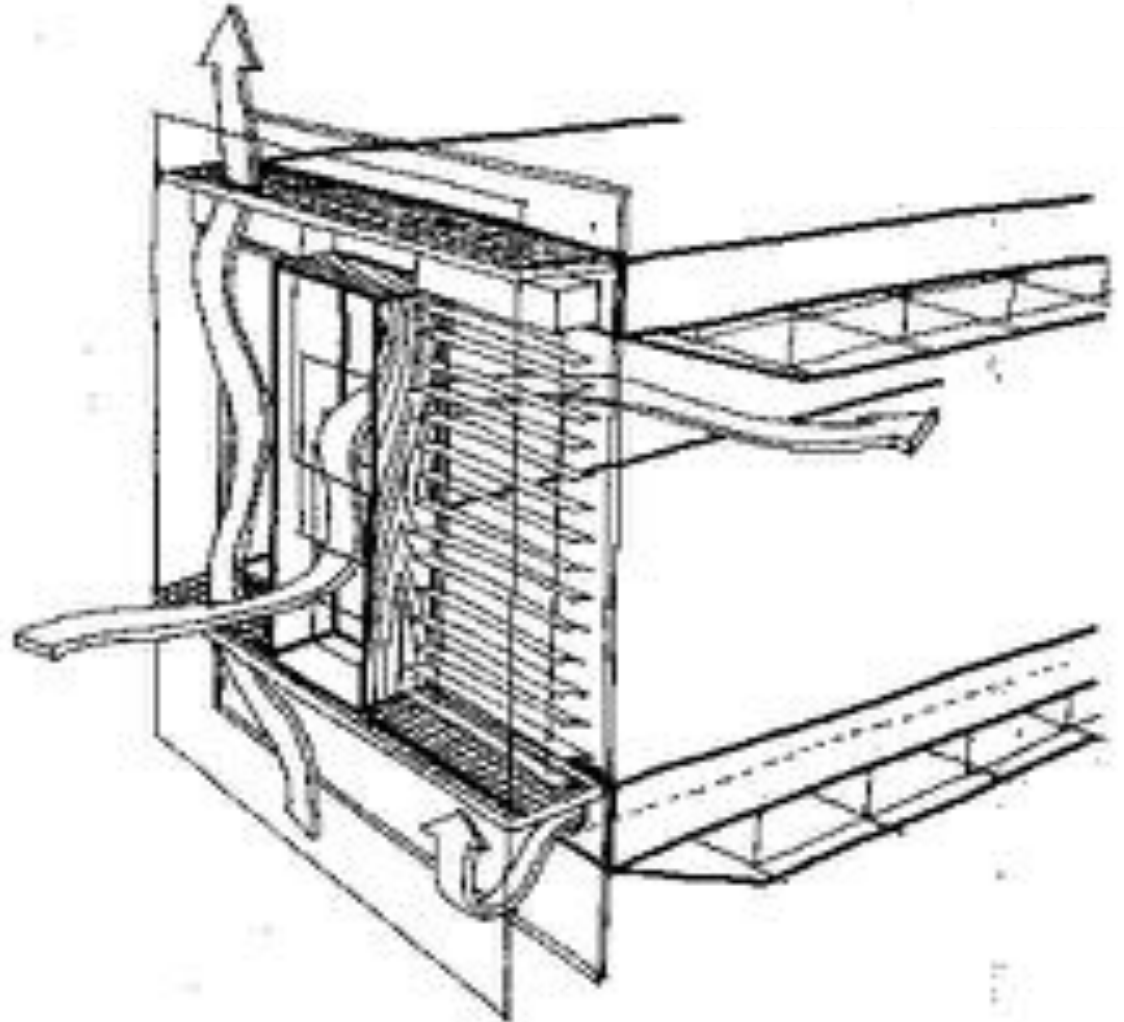
Heat recovery systems in buildings

Exhaust air

- Direct, e.g. via concrete core slabs
- Heat exchanger, air-air
(*heat wheel, cross-flow exchanger*)
- Heat exchanger, air-water
(*direct use or store in the soil*)
- Heat pump, air-water
(*direct use or store in a tank*)

Waste water (tubular exchangers)

- Shower ($\sim 35^{\circ}\text{C}$)
- Sewage ($\sim 25^{\circ}\text{C}$)
- Kitchen sink (varies)

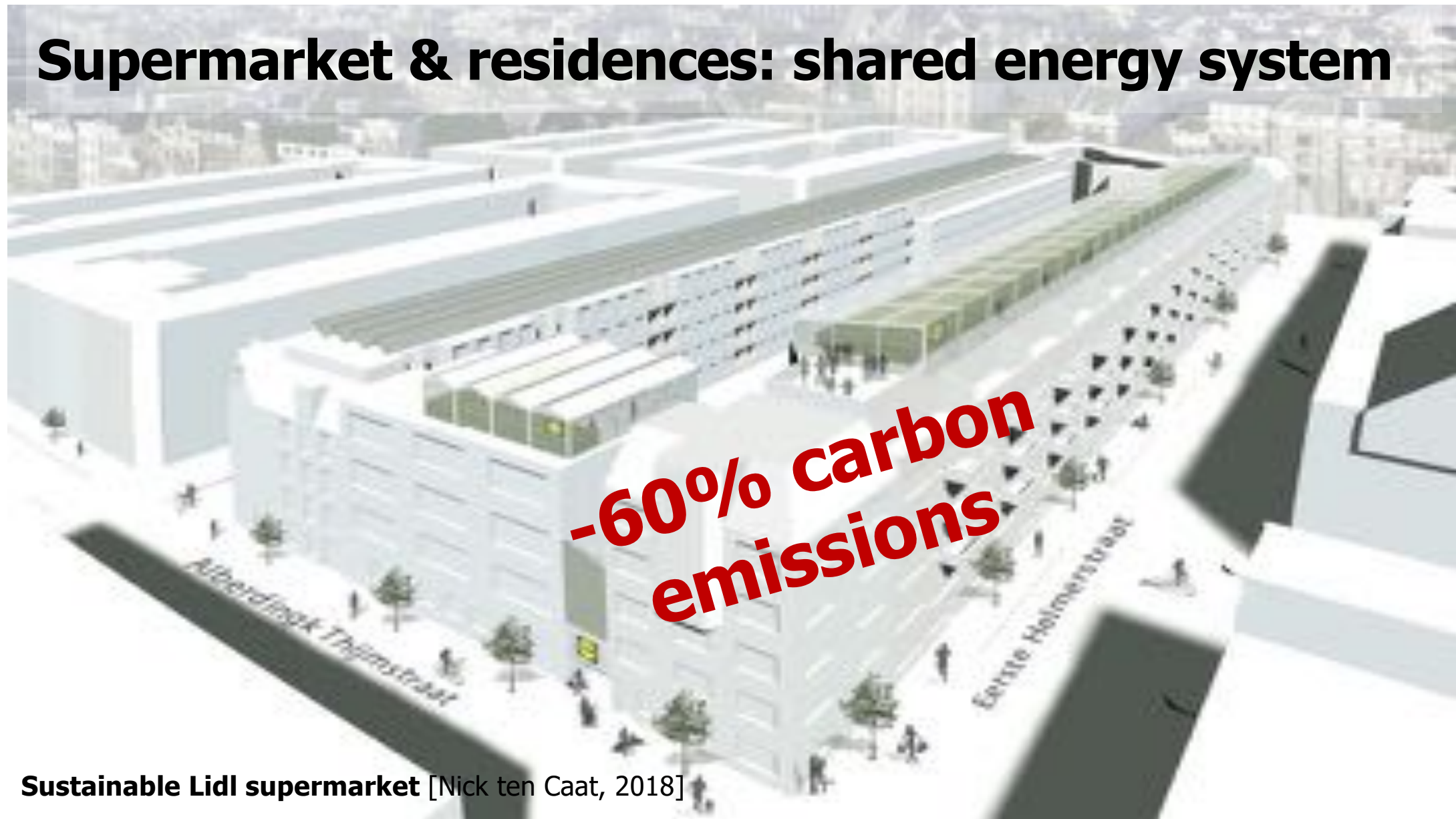


Difference in energy patterns → smart exchange



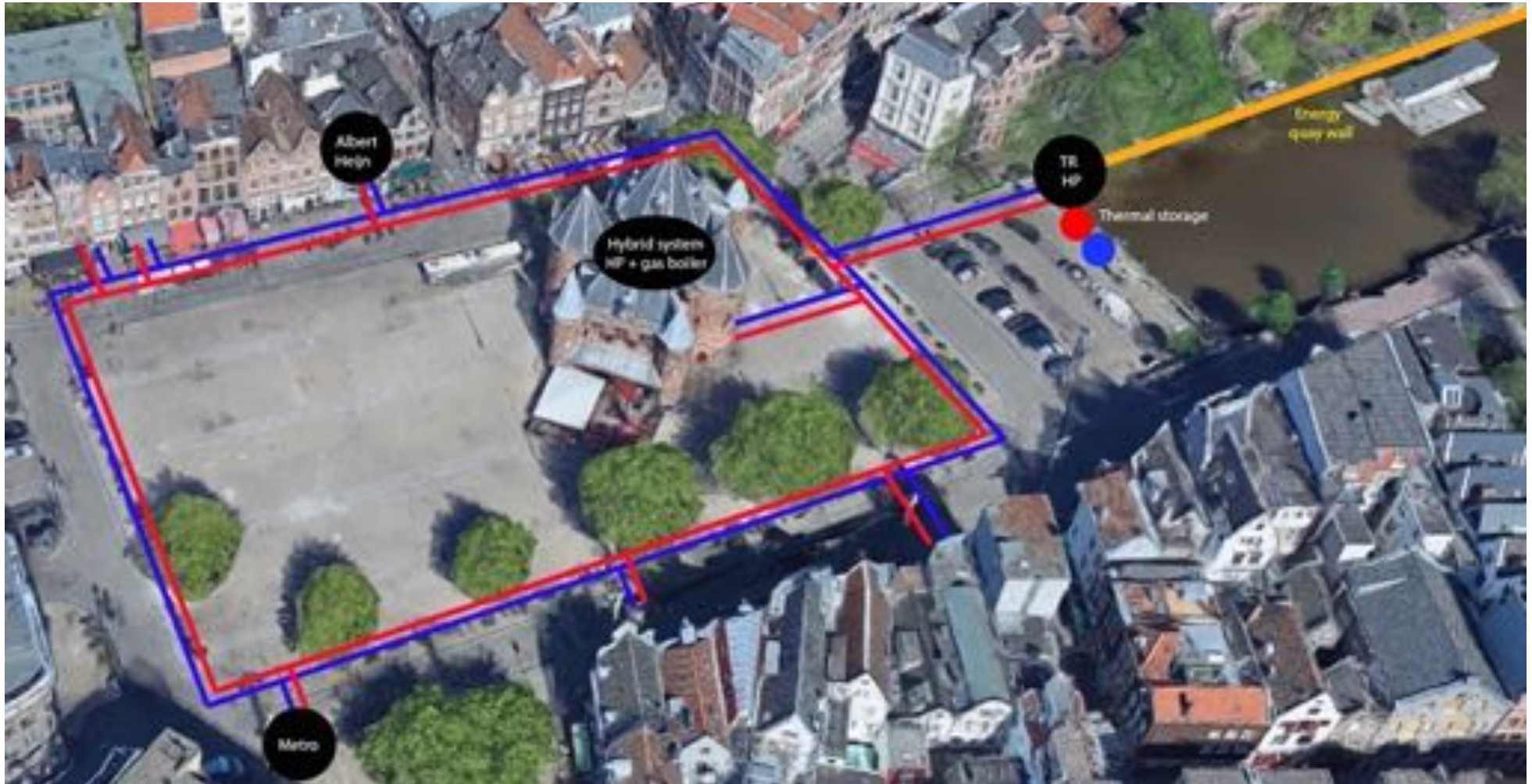
W = heat (warmte); **K = cold** (koude); **E = electricity** (elektriciteit), all **per m²** gross floor area

Supermarket & residences: shared energy system



Sustainable Lidl supermarket [Nick ten Caat, 2018]

LT heat (& cold) network supplied by many sources



Key for sustainability is connecting.

**Connecting between different buildings,
between different organisations,
within neighbourhoods.**

Producing your own (solar) energy



Lidl ZERO, Woerden

Problem: storage of redundant electricity

- **Batteries**
 - Short-term storage, high performance, requires a lot of (rare) material
- **Hydrogen**
 - Seasonal storage, <50% performance from electricity → gas → electricity
 - Special infrastructure, equipment and tanks
- **E-fuels** (turning CO₂ into carbonhydrates with power)
 - Seasonal storage, performance still low
- **Or: supplying your neighbours**
- **Or: designing differently**

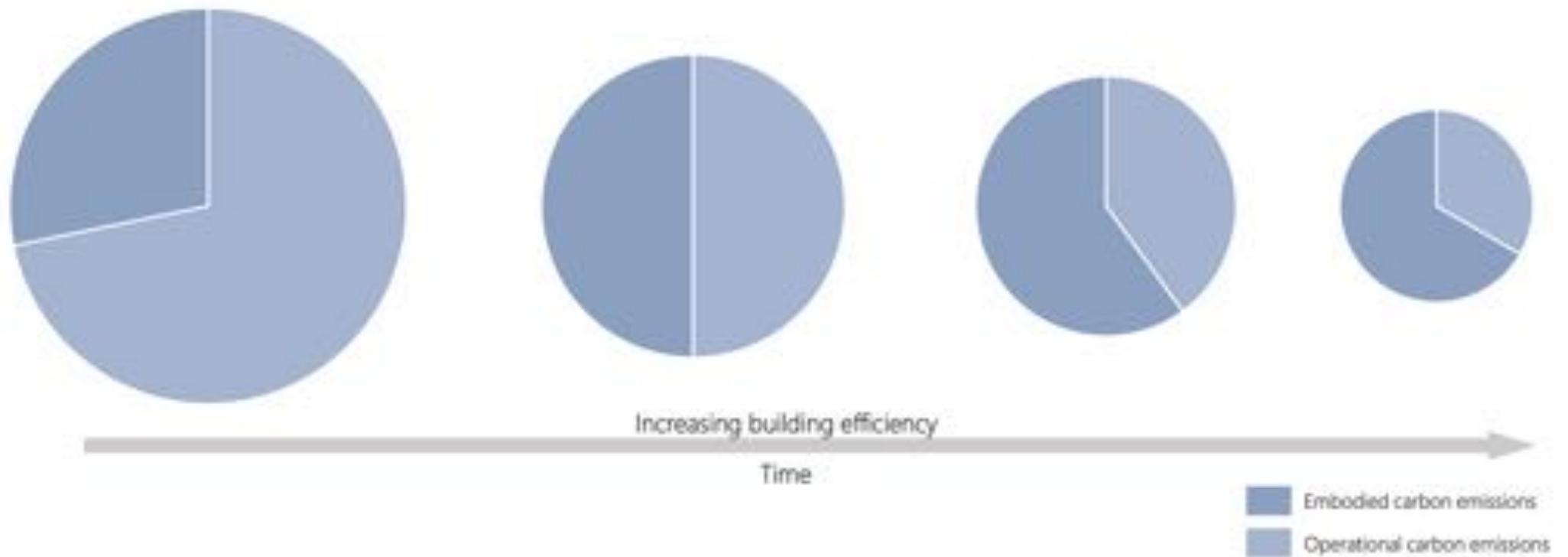
Vertical solar panels: many advantages

- Larger surfaces
- Low sun angles
- Winter produce
- Diurnal spread



Social zero-on-the-meter housing (Best)

Increasing significance of building materials



Working towards circularity
everything is connected

Circular construction

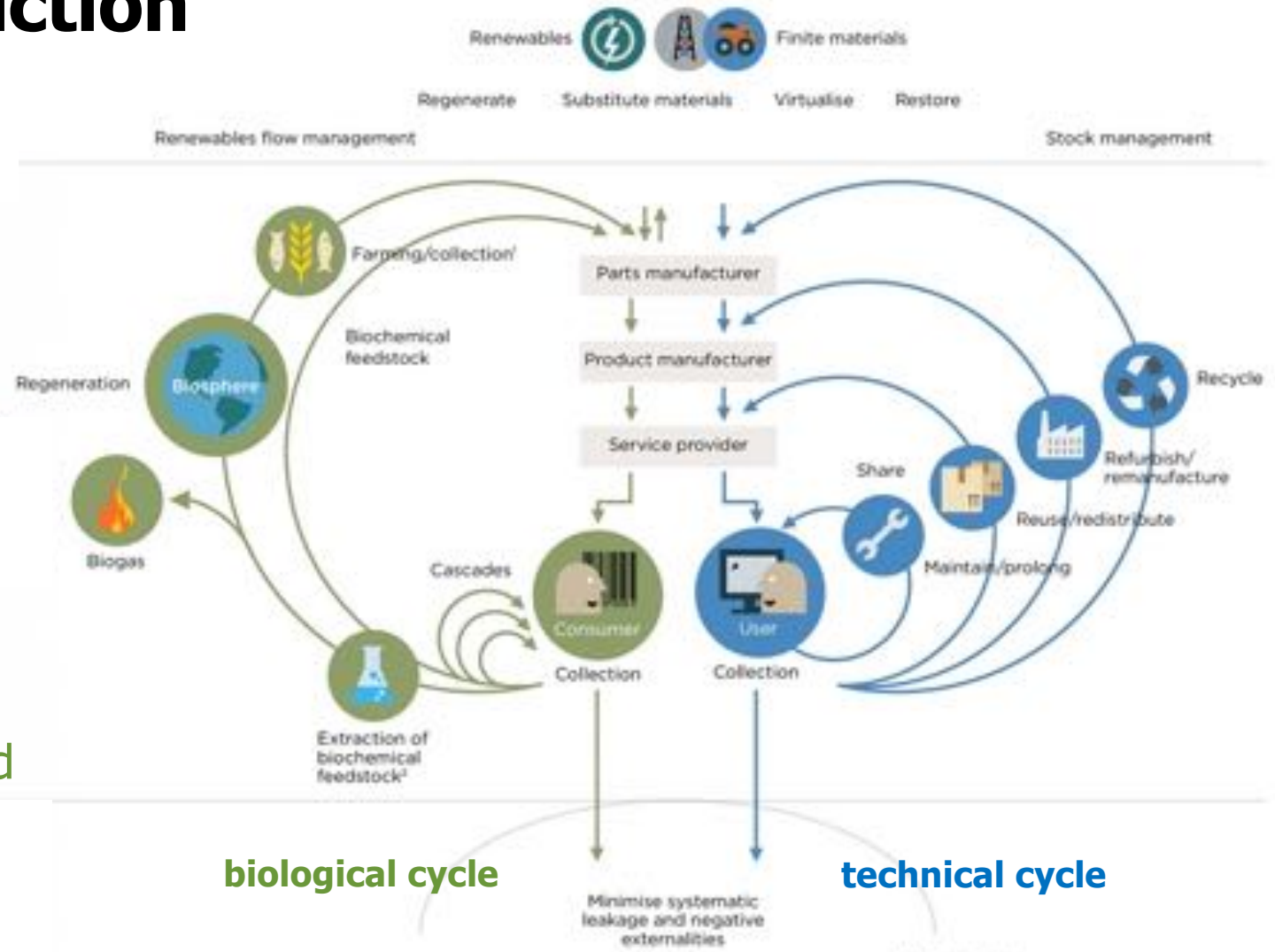
[Ellen MacArthur Foundation]

■ Finite materials

- Prefabricated
- De- and remountable
- Reusable
- Recycleable

■ Renewable materials

- Biobased
- Sustainably maintained
- Cascadeed
- Reusable even better



Circular systems

- **Recovery of all resources from waste**
- **Reprocessing into new products**
- **Retrieve these products afterwards**
[and back to start]

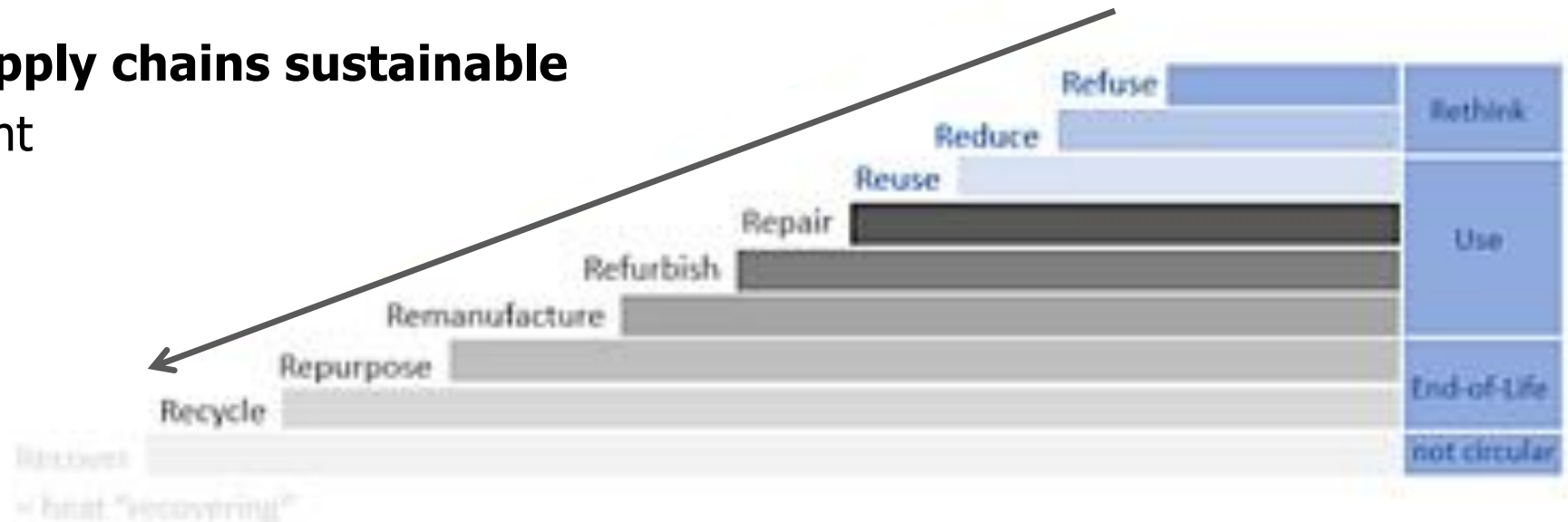
New business models:

- **Product-service systems**
- **Lease products**
- **Deposit/return systems**



Sustainable, circular procurement

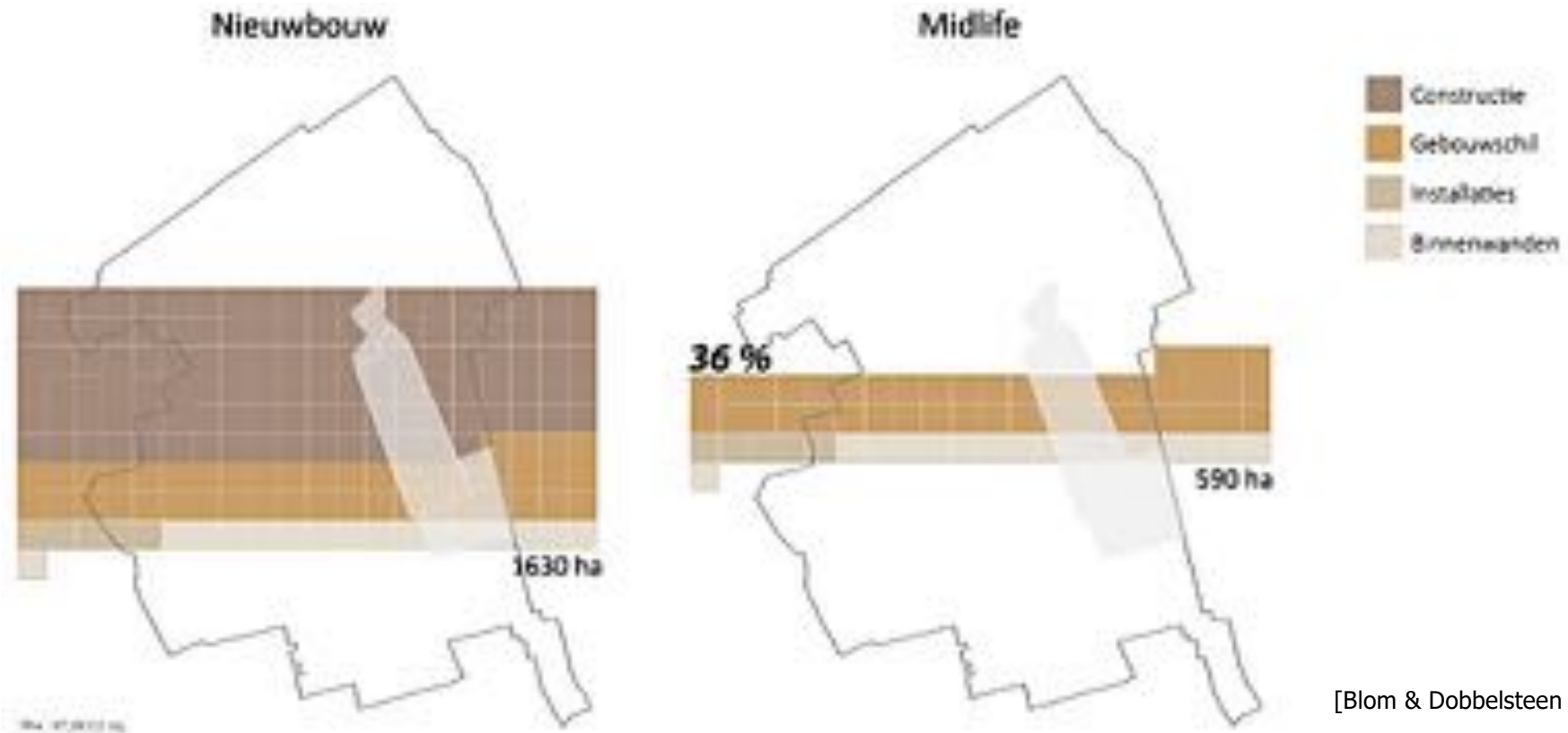
- Use the **R ladder** at all levels
- **Getting supply chains sustainable**
 - Equipment
 - Furniture
 - Products
 - Materials
 - Services



→ Agreements and **circular contracts** with suppliers and partners

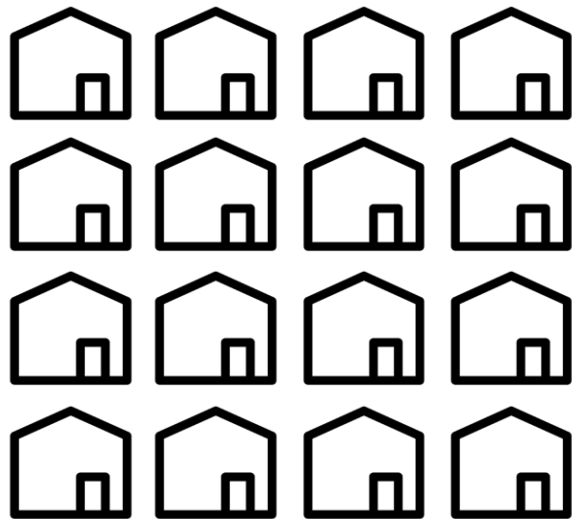
Sustainable new building versus energy renovation

Forest area needed to compensate carbon emissions of the production of materials, projected onto the city of Delft

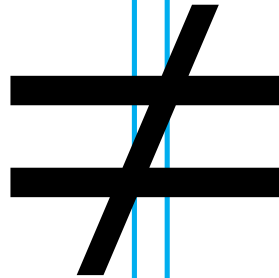


Embodied carbon of building materials is huge → **renovation** is preferred

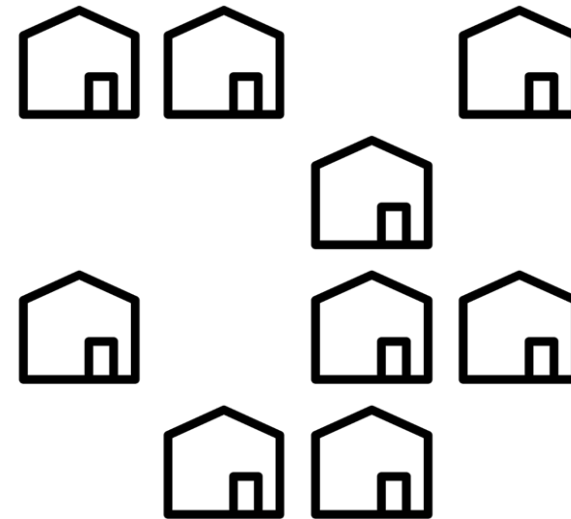
A million extra dwellings



+1 million dwellings by 2030
speed is too low



A million new houses



A lot possible in the existing city
renovation & transformation

Towers





from
**inefficient and vacant
office building**
to
net positive apartments



Biobased circular infill modules

3x circular

Also with
underfloor
heating | cooling
connected to a
heat pump
system



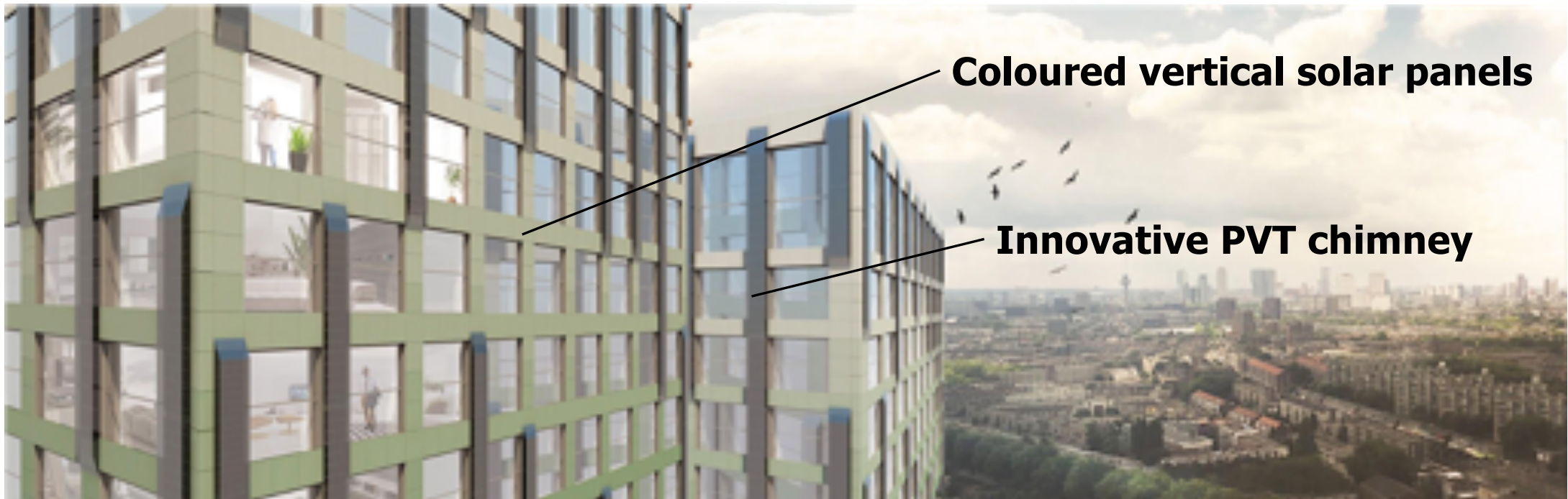
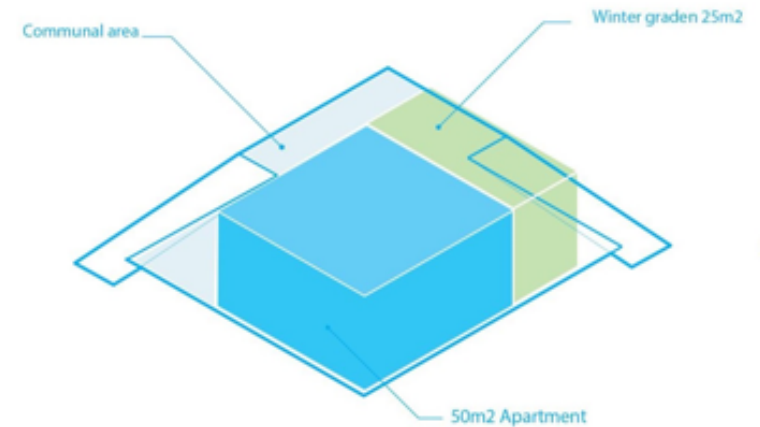
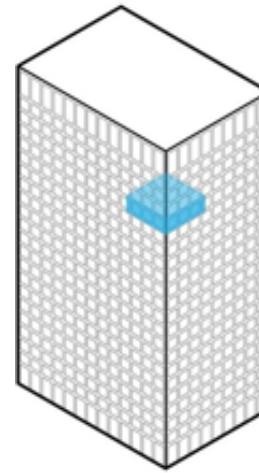
Private garden with green wall

Plants selected for air-purifying capacities;

Air enters pre-cooled/-heated via phase-change materials



The façade as power generator



MOR (Modular Office Renovation)



Solar Decathlon Europe 2019

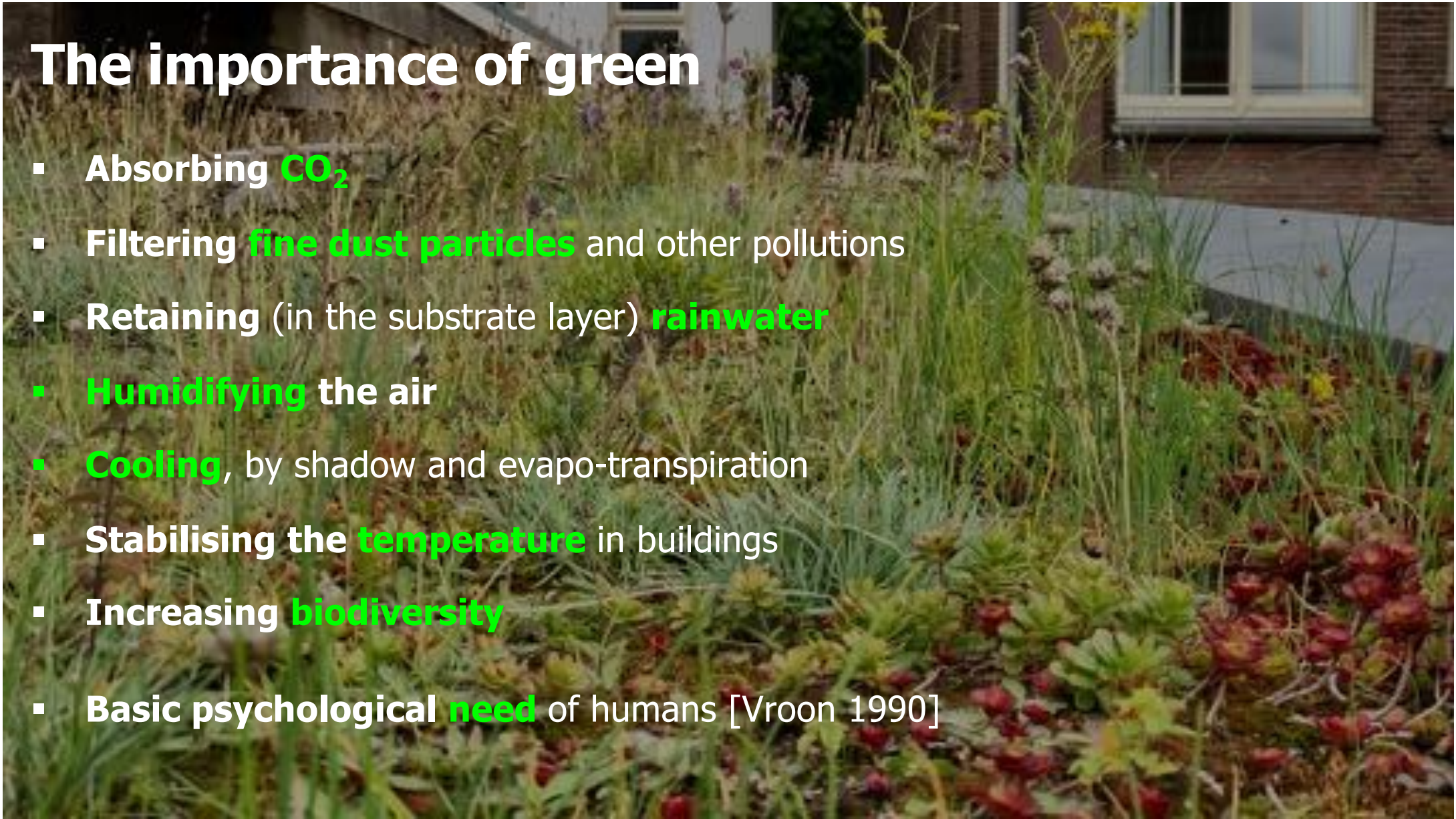
Coffee with Mark



Finding added value
putting emphasis on benefits

The importance of green

- Absorbing **CO₂**
- Filtering **fine dust particles** and other pollutions
- Retaining (in the substrate layer) **rainwater**
- **Humidifying** the air
- **Cooling**, by shadow and evapo-transpiration
- Stabilising the **temperature** in buildings
- Increasing **biodiversity**
- Basic psychological **need** of humans [Vroon 1990]



**Biodiversity is
the life assurance of the planet.**

**The life assurance of mankind
is human diversity.**

Added value of aquathermal heat

- better water quality (algae, bacteria)
- urban cooling in summer
- greater probability of ice in winter



It works!



Gerrit Hiemstra's aquathermal system, Balk 02-03-2021



Andy van den Dobbelsteen

Sustainability Coordinator bij TU Delft

3w • Edited • 1



Vanochtend demonstreerde het warmtepompsysteem van [Gerrit Hiemstra](#) hoe [aquathermie](#) kan worden gebruikt voor het vergroten van de kans op ijs in de Provincie Fryslân: er ligt ijs waar de wisselaar warmte onttrekt, open water op andere plekken.

Zoals Gerrit zelf opmerkt: er spelen andere factoren een rol, zoals het verschil in wat diepte, stroming versus geen stroming, verschil in beschutting, eenden. Maar alle beetjes helpen.

Onderzoek moet uitwijzen hoe groot het effect is op de watertemperatuur, waterkwaliteit en ecologie, mate van stedelijke verkoeling, condities voor ijsvorming en natuurlijk de energieprestatie.

Het gaat om een paar graden afkoeling, dus een koude winterperiode is nog steeds nodig, maar in geval van veel aquathermieprojecten kan de [#Eifstedentocht](#) zo toch ooit weer komen!

Wetterskip Fryslân MEFA GROUP Plushuis Unilever Ivo Pothof Phil Vardon Jakob Haverkamp Frits Kuus Koninklijke Oosterhof Holman Sybrand Frietema de Vries Bram Hulsman Arjan van den Hoogen Lucek Wolthekker Gemeente Noardeast-Fryslân Gemeente Súdwest-Fryslân Gemeente Leeuwarden Gemeente

Coupling sustainability with social-societal issues



Symbiotic
Urban
Movement

**We create the future
by harnessing the past**



Powerplant for the neighbours (reversed parasite)



Making the world more beautiful



SUM (Symbiotic Urban Movement)

Solar Decathlon Europe 2022

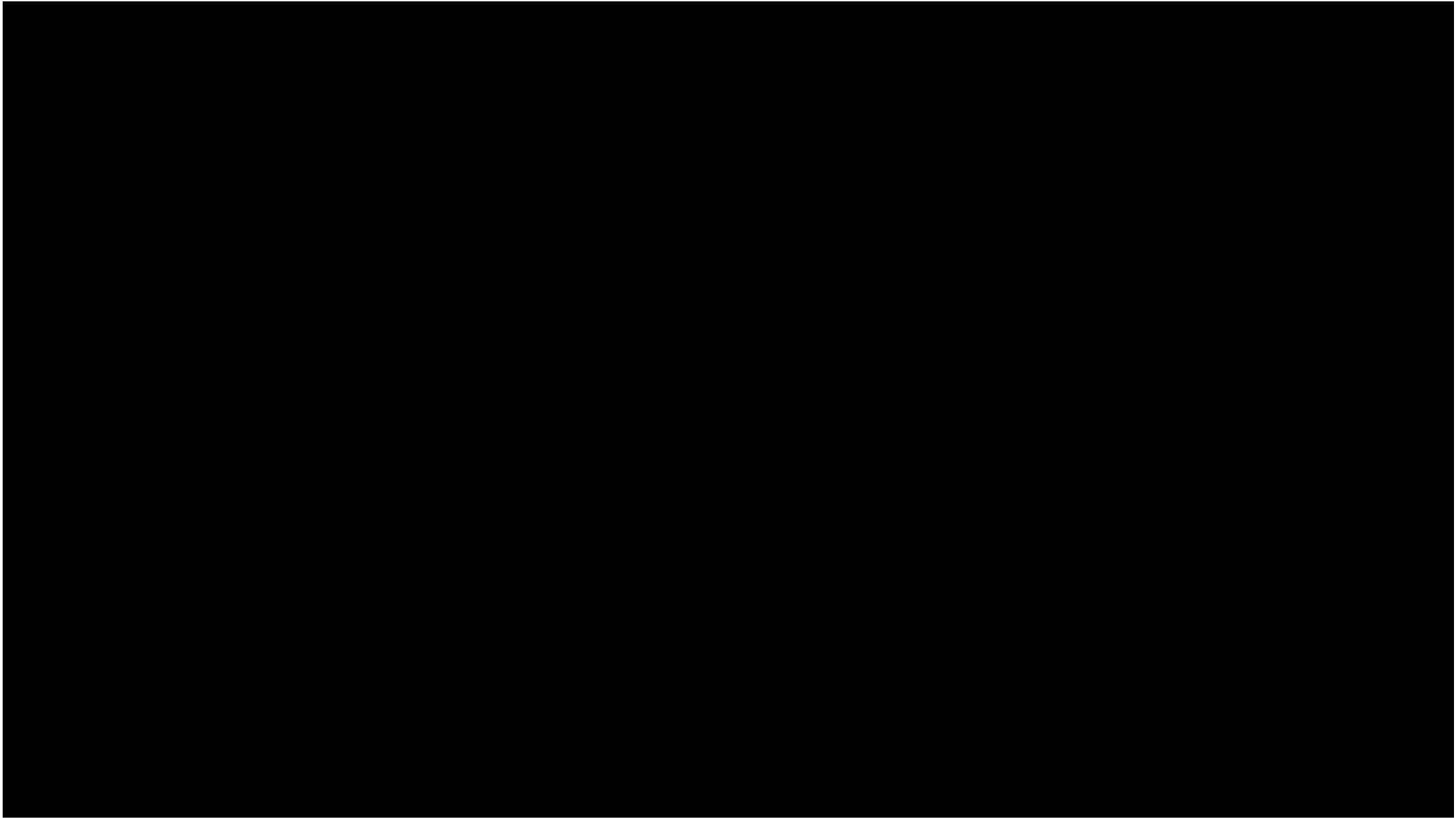


Key for social sustainability is connecting.

**Connecting between all groups in society,
within and without certain groups,
acknowledging differences
and helping each other.**

A large school of fish, possibly sardines, is seen from an underwater perspective, swimming in a circular pattern around a bright, glowing light source in the center. The water is a deep blue, and the fish are silvery and dark, creating a dense, swirling mass. The light source creates a bright, circular glow in the center of the school.

**Stay brave.
Be proud.**



Extra:

**Climate action
on the campus**



TU Delft: practise what we teach & preach

- **Carbon neutral, by 2030**
related to all activities done on and from the campus
- **Circular, by 2030**
referring to all resource and waste flows through the campus
- **Climate-adaptive, by 2030**
dealing with heat, drought, rain, floods, extreme weather
- **Contributing to quality of life**
aiming at biodiversity, safety, health, inclusiveness, happiness
- **Exposing our excellence & sustainability**
accommodating and demonstrating living labs and innovation

Sustainable **TU**Delft
Vision, Ambition and Action Plan
for a Climate University



[2022]

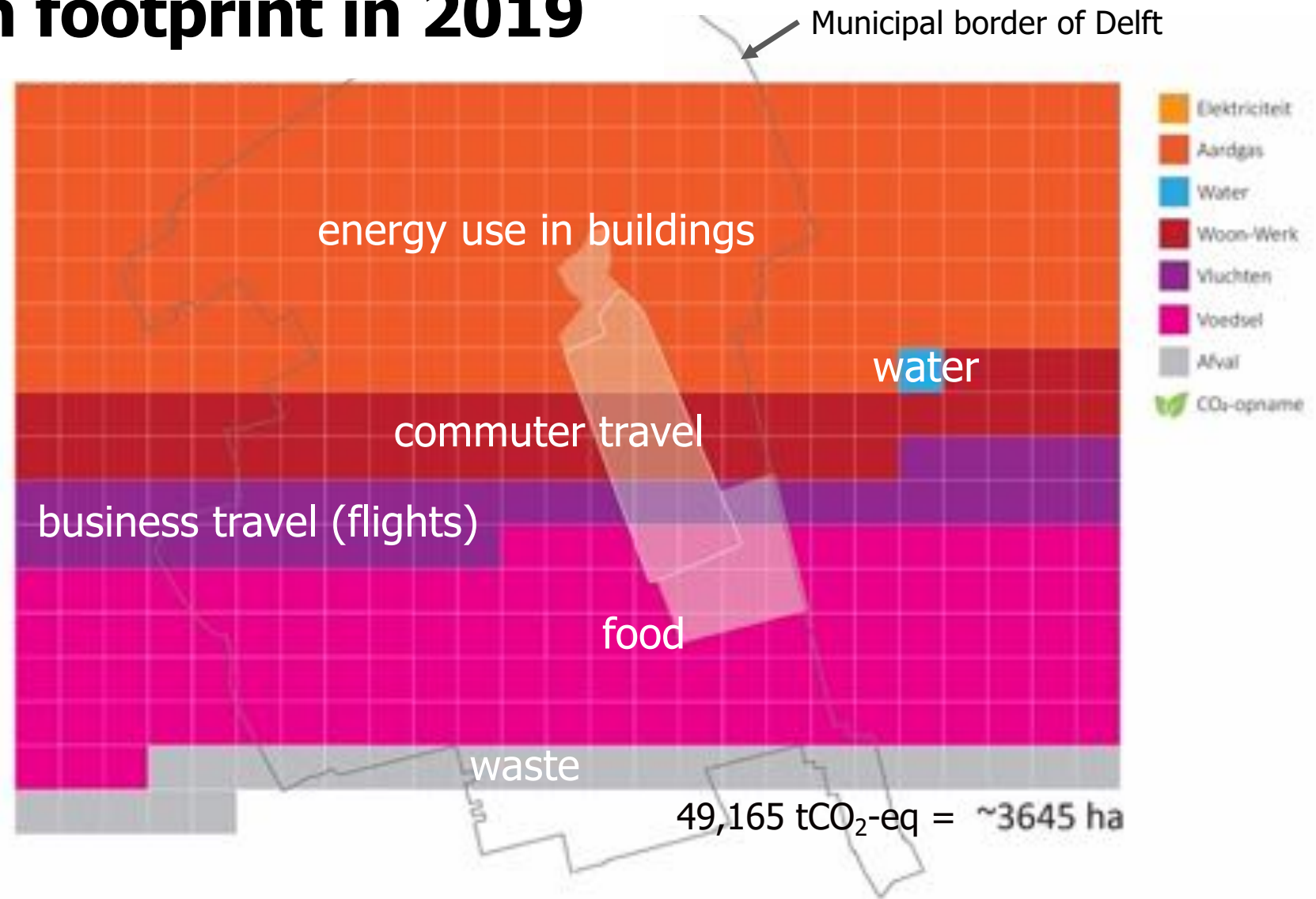
Our carbon footprint in 2019

Forest area required to sequester our greenhouse gas emissions

Procurement still missing

(stationary, furniture, equipment, materials, products, services...)

→ **Footprint x2**

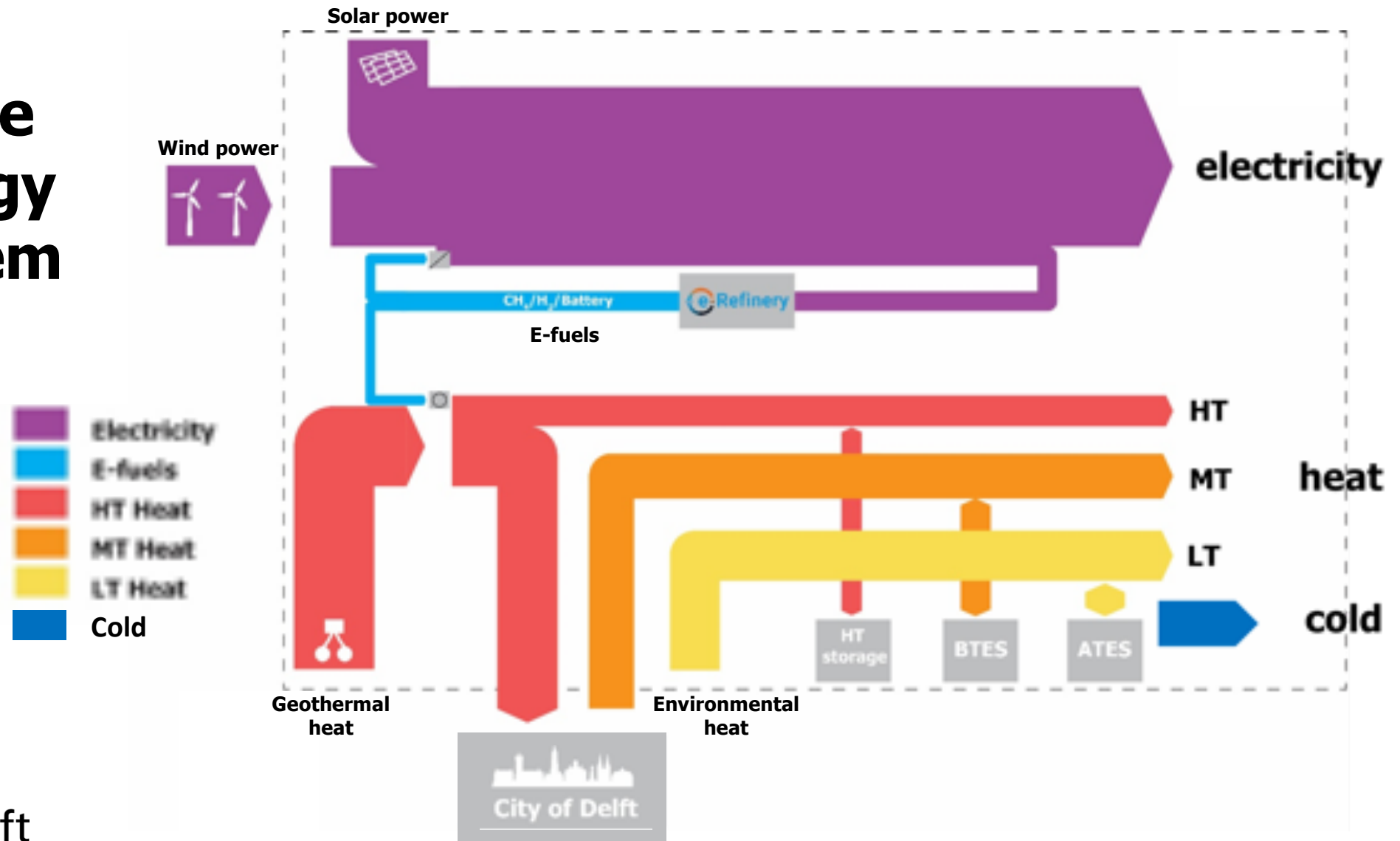


A new financial approach

**Total Cost of Ownership (TCO)
+ € 150/tonne of CO₂-eq = **TCO₂****

- **For all important financial decisions**
- **Selection of partner bids or proposals**
- **Internal carbon tax** (e.g. for travel)
- **Internal price corrections** (e.g. for food)

The future energy system



Prone for 'midlife renovation'

22



34



Applied Sciences (22)
Civil Engineering (23)
3mE (34)
EEMCS (36)

23



36

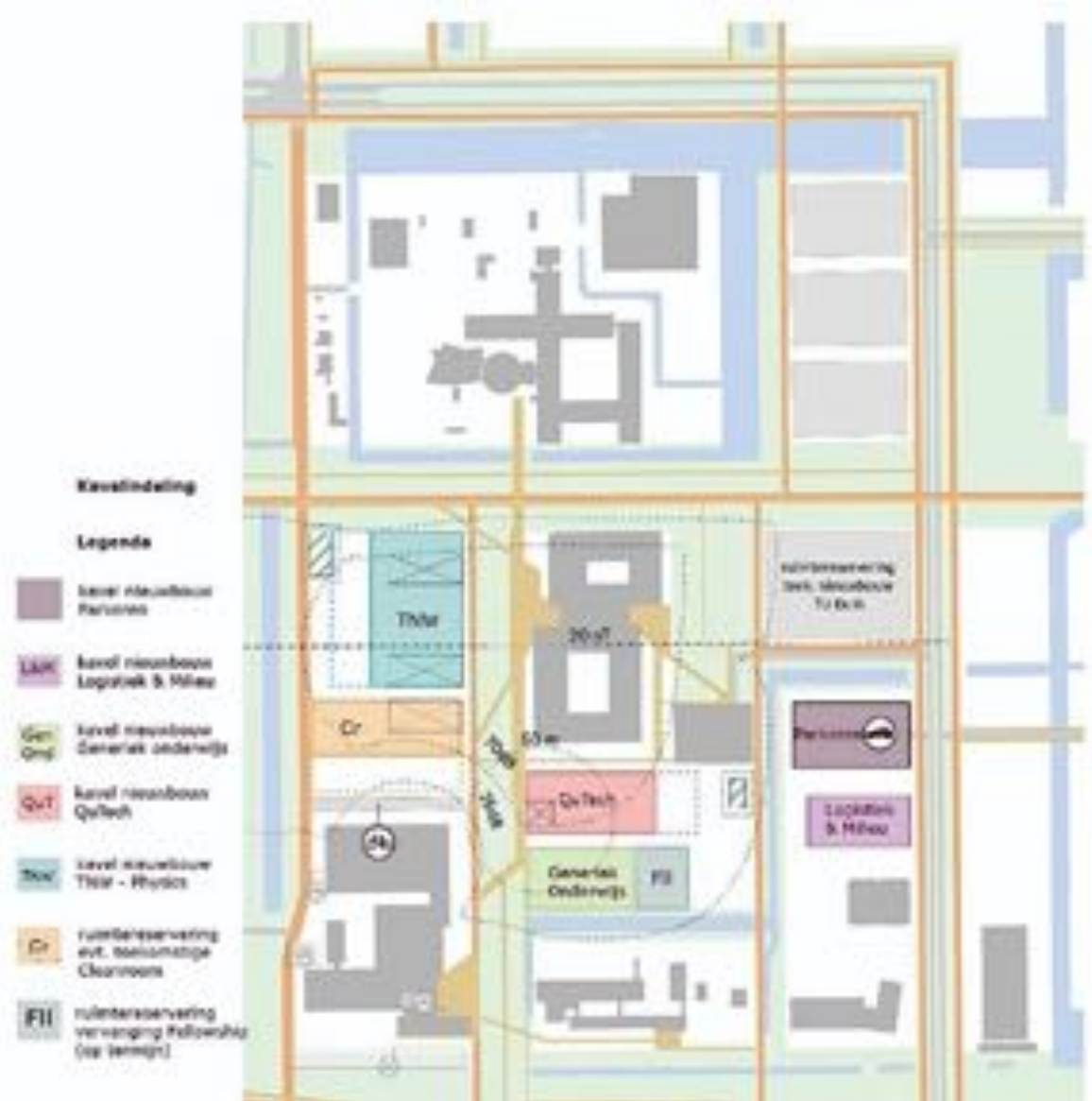


New builds: from energy neutral to energy positive

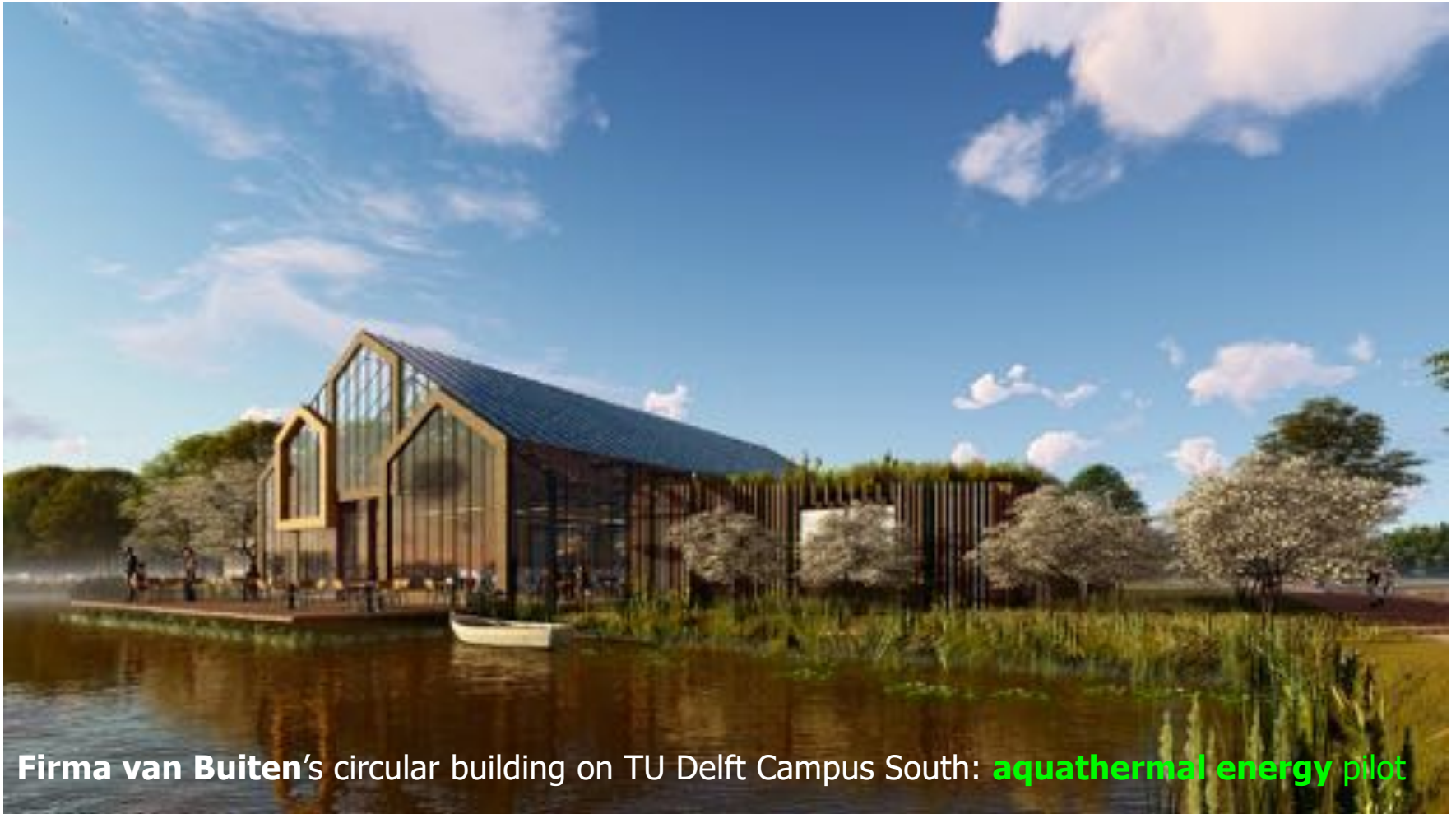


Kluyver Area: super-sustainable new construction site

- Carbon positive
- Circular
- Climate adaptive
- Contributing to liveability

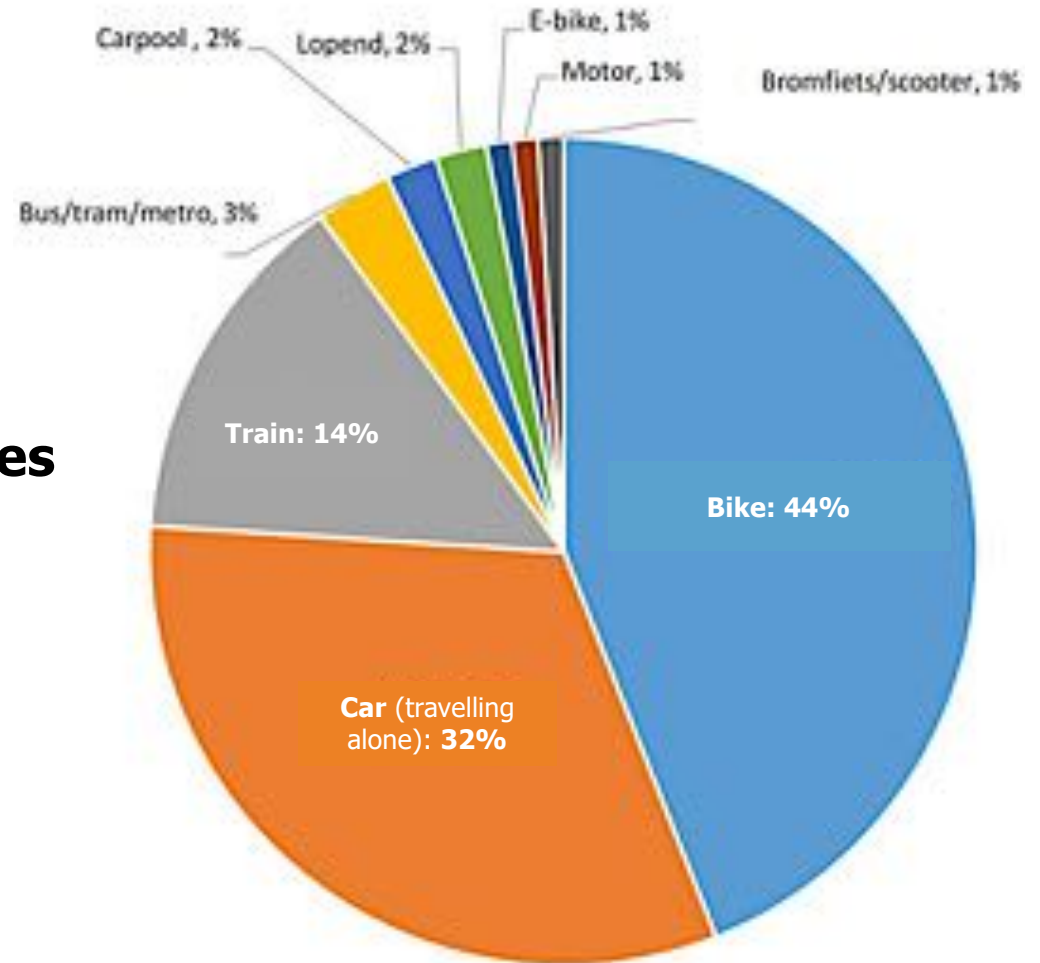


Involving external parties on the campus



Sustainable travel to & from a fossil-free campus

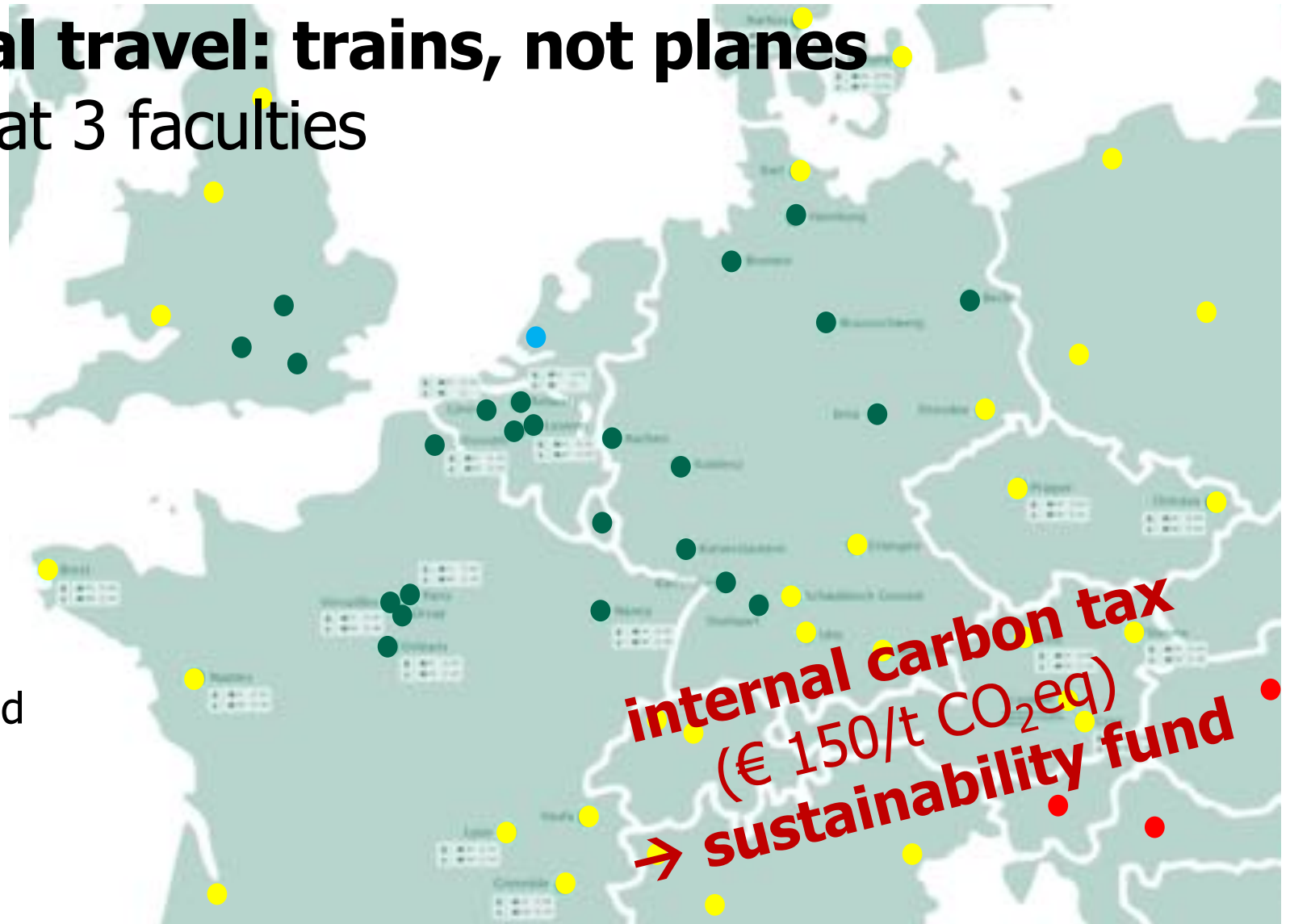
- **Work from home** for a certain time
- **Online/hybrid meetings & conferences**
- **Promote (electric) bikes, public transport and electric (shared) cars**
- **Less parking lots**, more green and blue



International travel: trains, not planes

Pilot projects at 3 faculties

- **Green**
train prescribed
plane prohibited
- **Yellow**
train preferred
plane discouraged
- **Red**
train recommended
plane optional

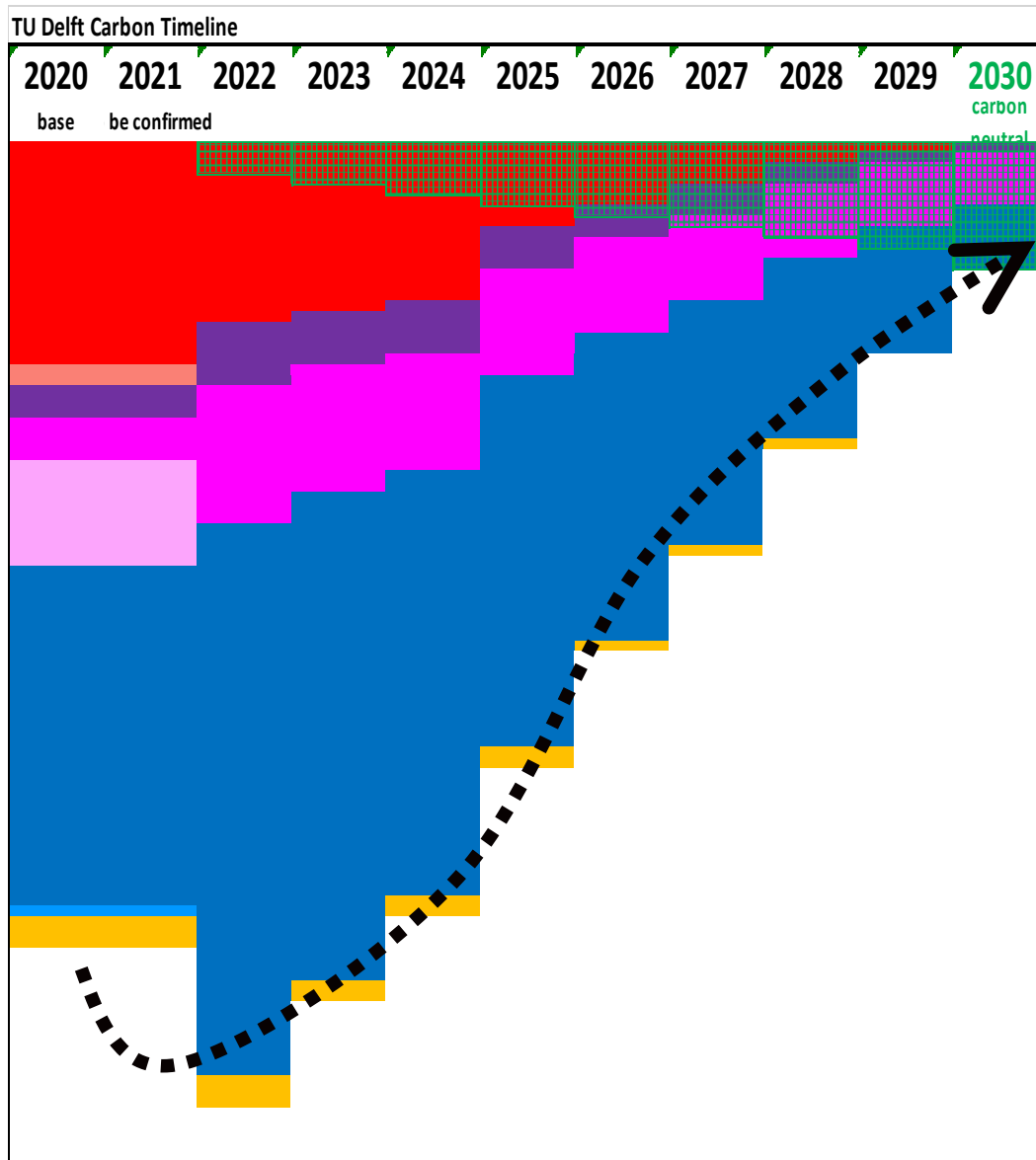


The requirements for food on the campus

- Healthy
- Tasty
- Local
- Seasonal
- More vegan
- Less animal-based
- Animal-friendly
- Organic

Scientific evidence?
→ **EAT Lancet diet**





Towards net zero carbon

- **Carbon price** included in decisions
- Energy system based on **geothermal** energy and **renewable** production
- Energy **retrofit** of existing buildings
- **Supersustainable**, climate-adaptive, circular, nature-inclusive new buildings
- **Circular contracting**, circular procurement & waste management
- **Fossil-free**, emission-free campus
- **Sustainable travel**, or carbon taxed
- **Sustainable food** in restaurants
- Emission compensation by **forestation**

Sustainability at TU Delft

Get involved

EcoCampus

Construction & Renovation

Energy Systems

Climate action on campus

By 2030, TU Delft aims to be operating in a completely sustainable manner. All activities on and from the campus will then be carbon neutral, circular, climate adaptive and contributing to the quality of life for its users and for nature.

Dashboard 2020 baseline

News

