



## 22.3.2019 Kosice Conference on Landscape Recovery and Rehabilitation

### Rainwater Management: Experience from Berlin

Marco Schmidt  
Technische Universität Berlin/  
Federal Institute for Research on  
Building, Urban Affairs and Spatial  
Development (BBSR)





***Bloc 108 Berlin-Kreuzberg 1983***



***Careful Urban renewal: Bloc "108 Berlin-Kreuzberg" 1986***





**Flood in Germany 2013**



**Flood in Germany 2013:  
Damage 6.300.000.000 €**

**24.7.1342**

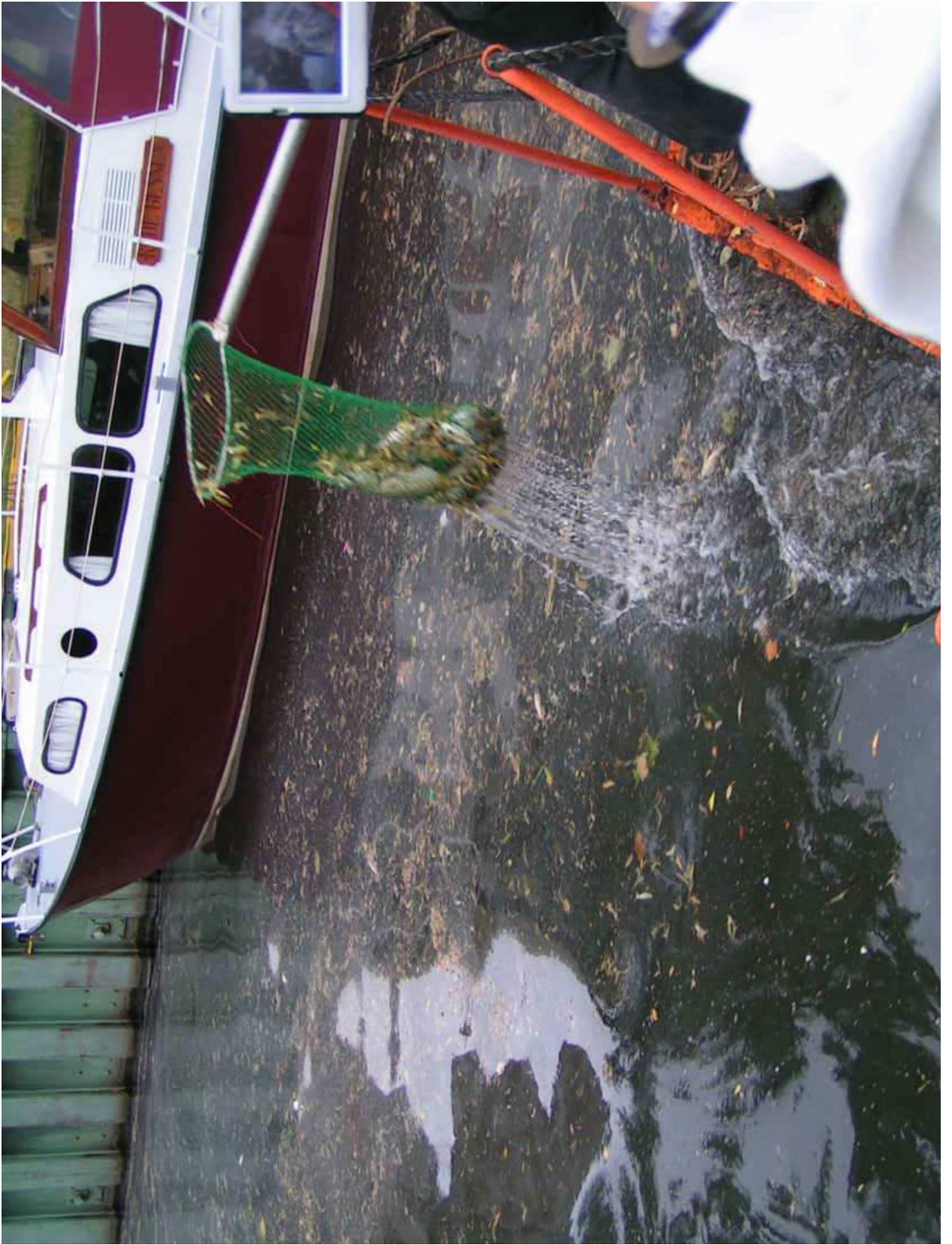


**24.1.1995**



Berlin 2017





# watergy

Water  Energy

[www.watergy.de](http://www.watergy.de)

[www.watergy.eu](http://www.watergy.eu)



**700 kWh/ m<sup>3</sup>** at 45 °C

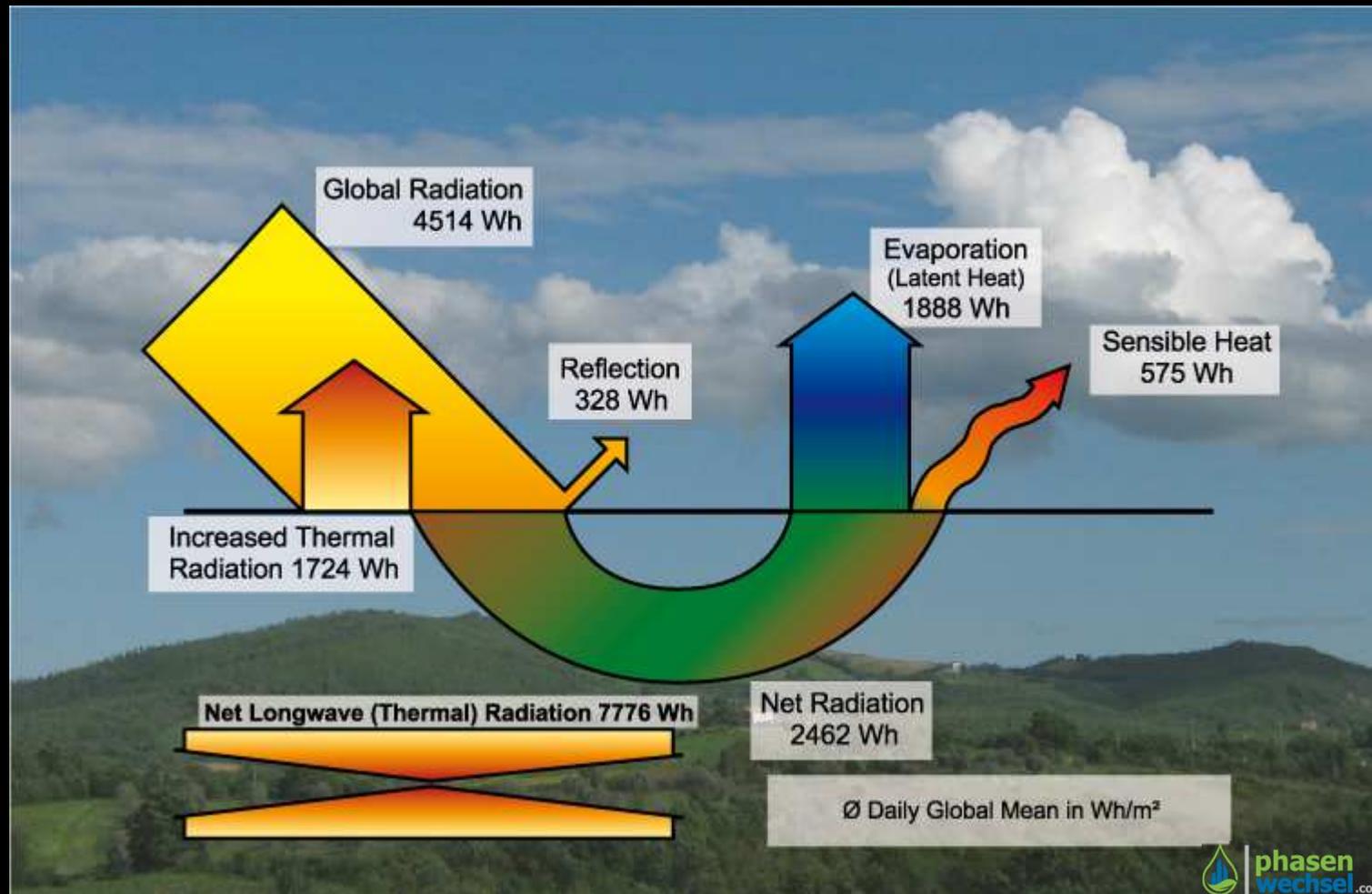
Water heated from 30 to 90°C = 70 kWh/m<sup>3</sup>

**Water** ↔ **Energy**

Phase Change Material (PCM) = 61 kWh/m<sup>3</sup>



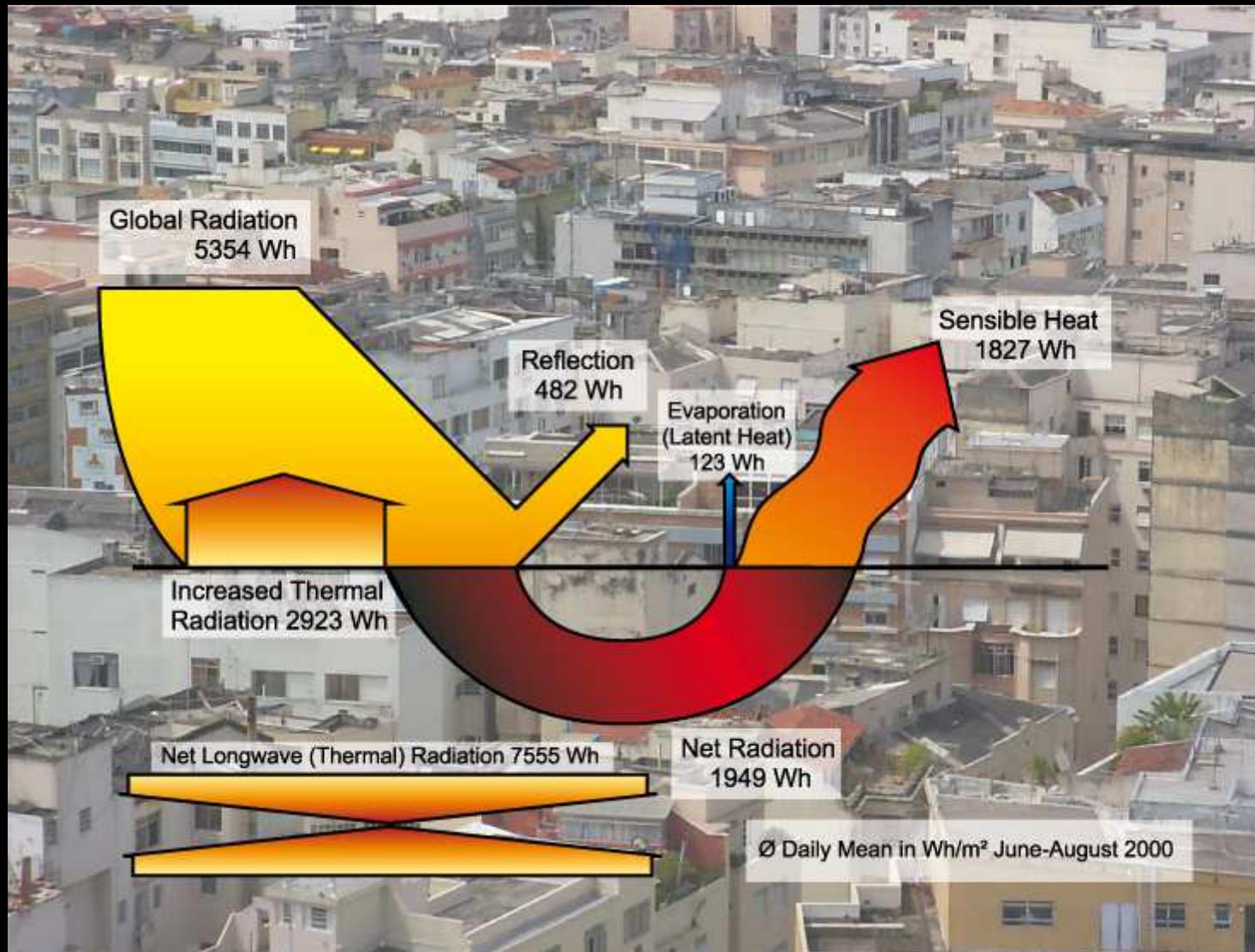
# Global Radiation Balance



Data after [physicalgeography.net](http://physicalgeography.net)

# Urban Radiation Changes

## Example: Asphalt roof Berlin in Summer



**Dramatic reduction in evapo-transpiration on land**  
**Daily loss of *800 km<sup>2</sup>* of vegetation worldwide**

**Daily deforestation rate: *450 km<sup>2</sup>***

**Daily reforestation: *100 km<sup>2</sup>***

**Net loss of forests daily: *350 km<sup>2</sup>***

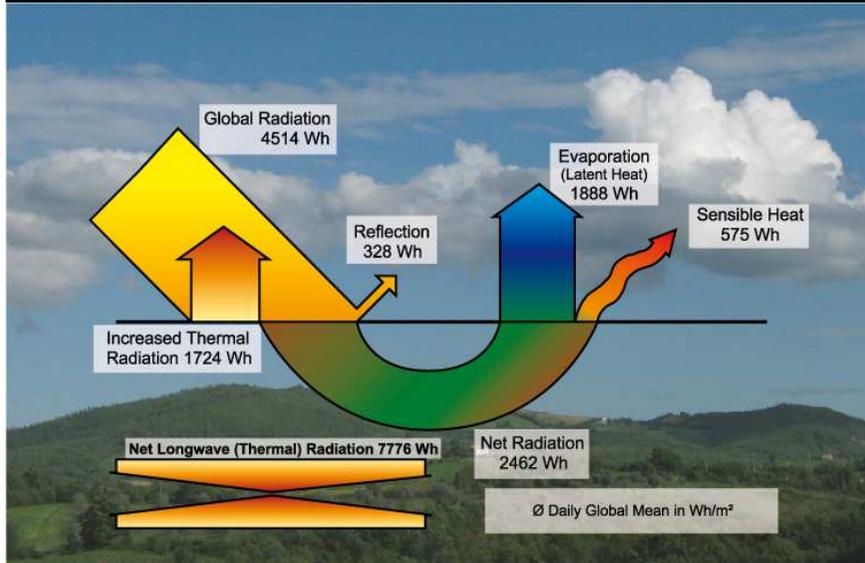
**Daily ongoing global urbanization: *150 km<sup>2</sup>***

**Daily global desertification: *300 km<sup>2</sup>***

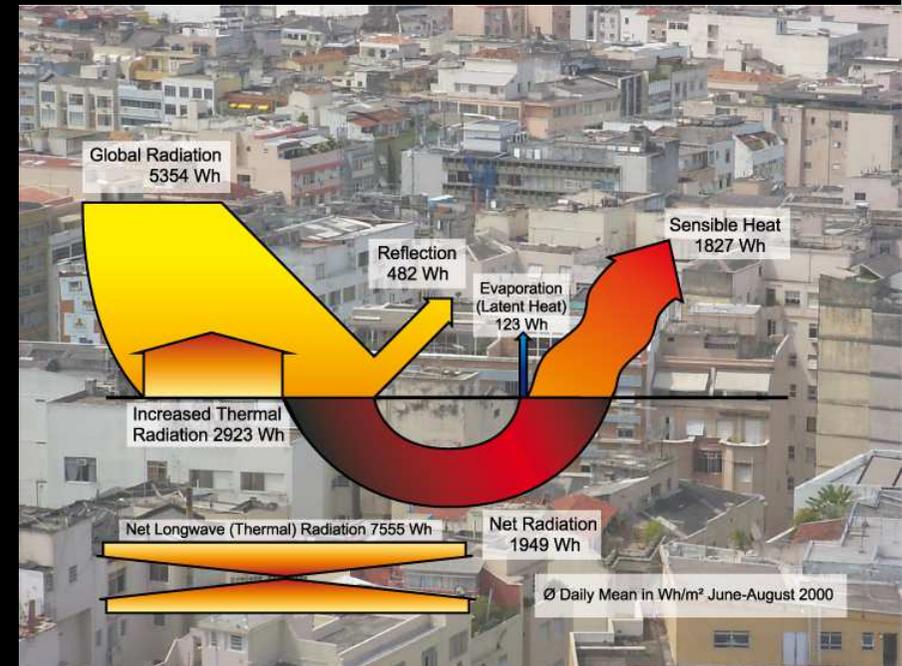
**Size of Berlin: *890 km<sup>2</sup>***



**Germany: 1.000.000 m<sup>2</sup> daily !**



**800 km<sup>2</sup>  
daily !**



# ¿How much of the precipitation is converted to evaporation?

Catchment Berlin/ Brandenburg, Precipitation 580 mm

5 %

50 %

15 %

80 %

??

# ¿How much of the precipitation is converted to evaporation?

Catchment Berlin/ Brandenburg, Precipitation 580 mm

5 %

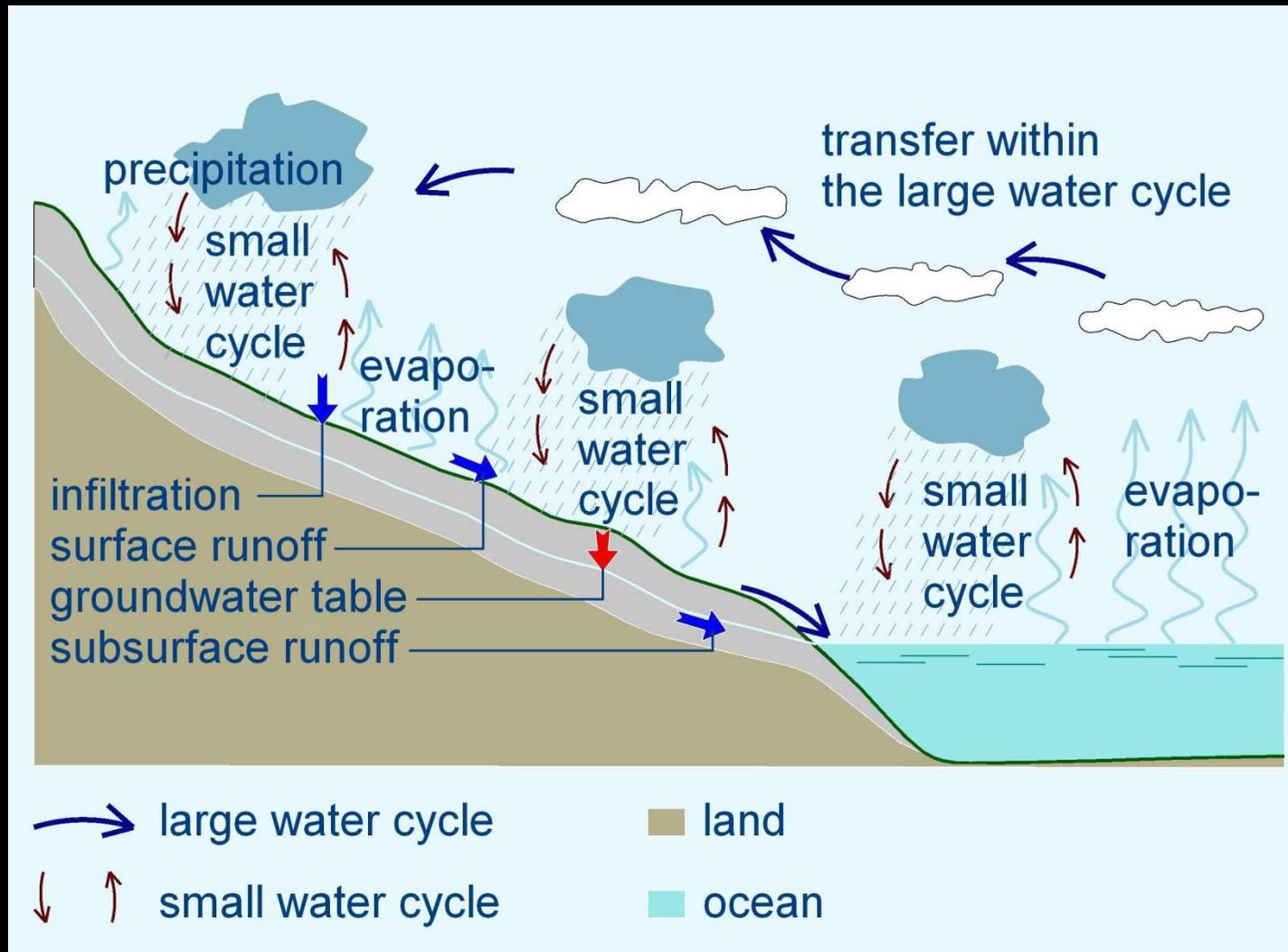
50 %

15 %

80 %

??

# Large and small water cycle





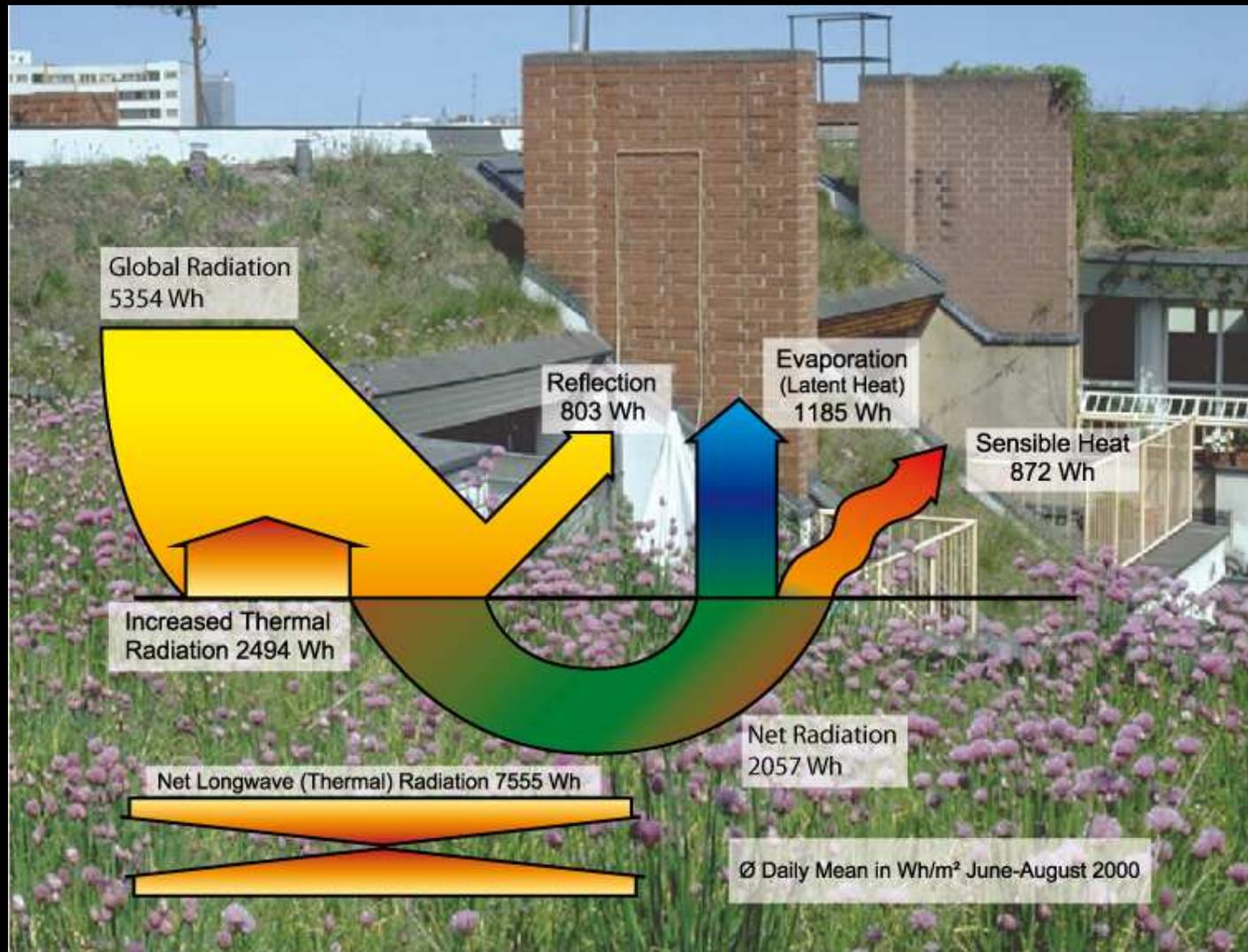
## ***Stormwater management by swale infiltration***

**Increase of infiltration from  
100 l/m<sup>2</sup> to 4000 l/m<sup>2</sup>**

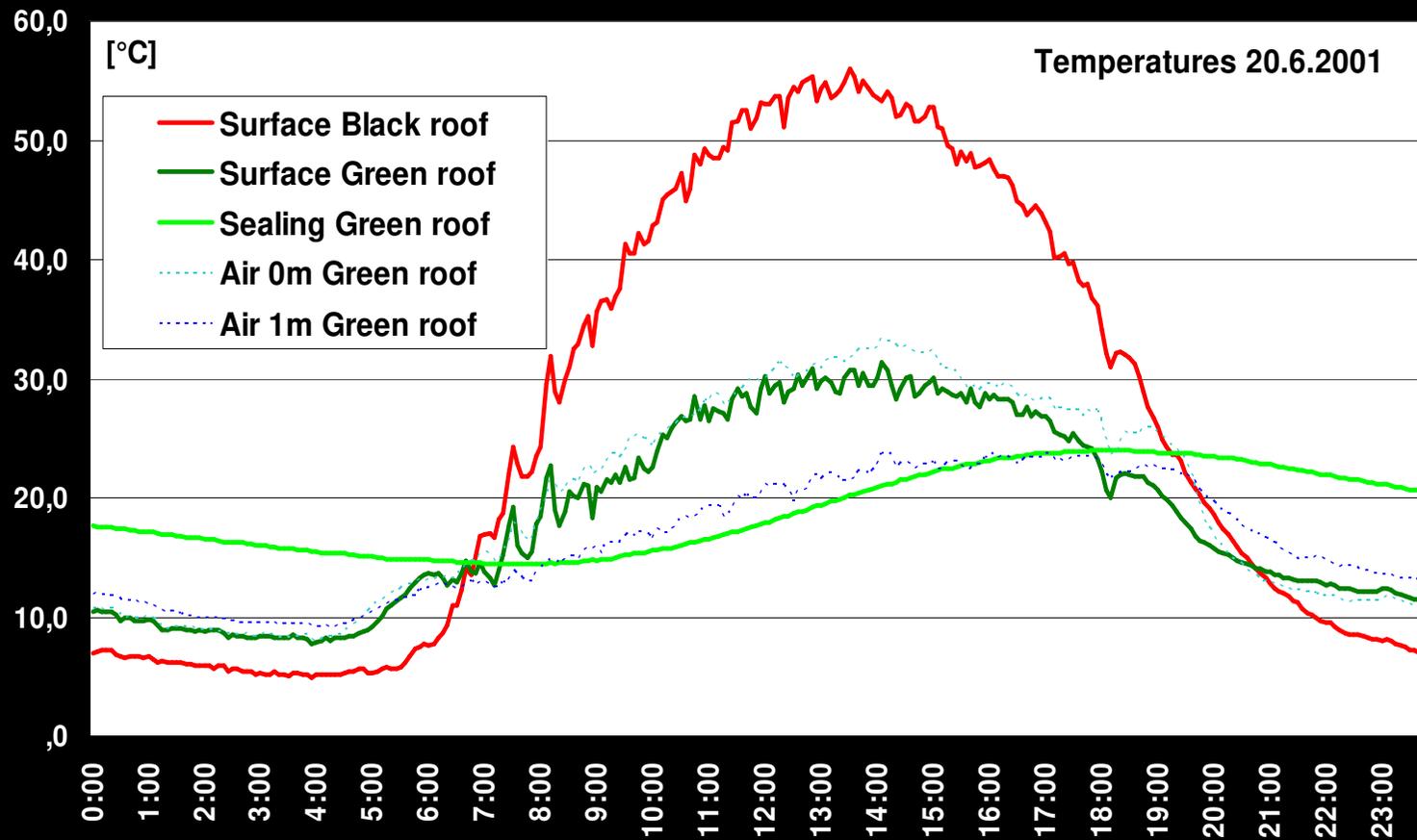
**Not the first priority !**

**Infiltration needs to be  
combined with vegetation  
to increase evaporation !**

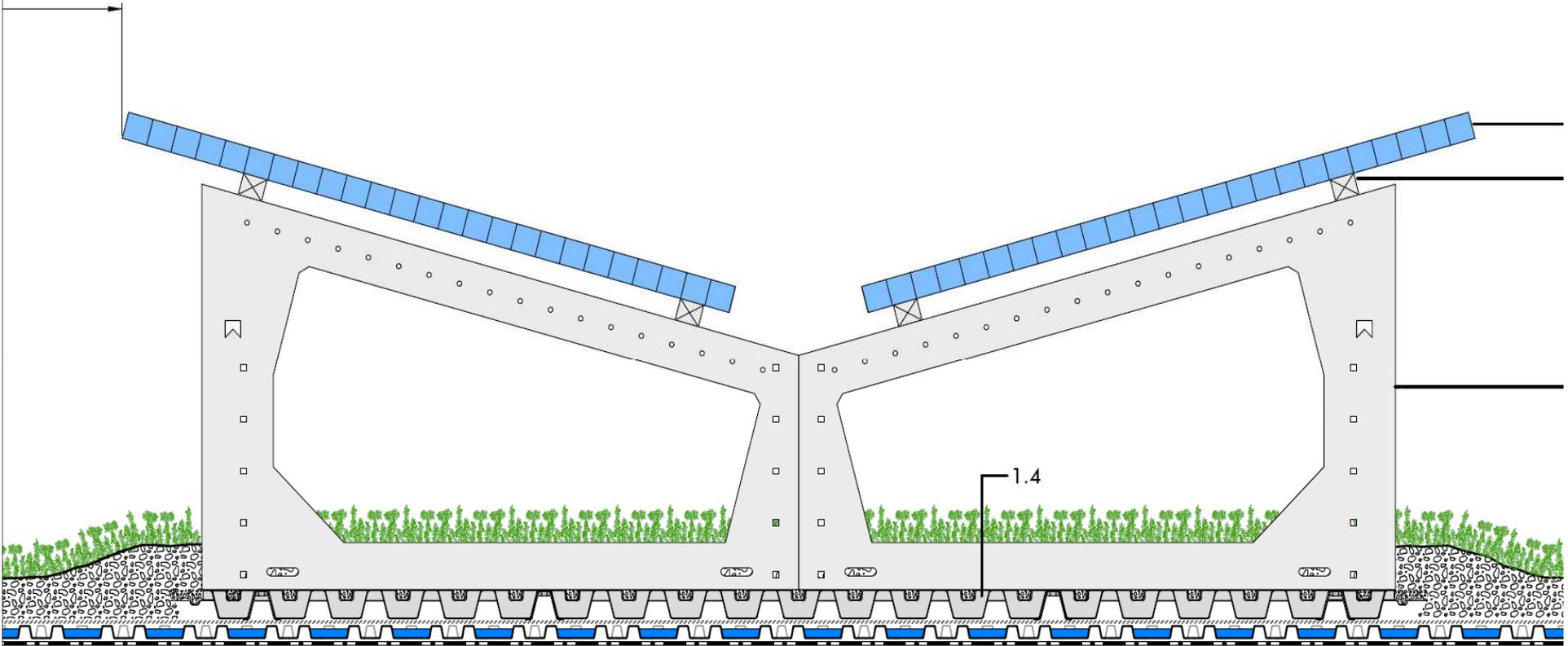
# Green Roof in Summer



# Surface Temperatures Asphalt Roof – Green Roof (Infrared measurements)







**„Butterfly Orientation“ PV East-West**

Figure: Fa. Zinco



**Potsdamer Platz, Berlin City Center**

# Potsdamer Platz Berlin

Requirements by city administration and water supplier:

Maximum drainage into the combined sewer system of less than 1% during stormwater

**Background:** 30-40 times per year overload of combined sewer in Berlin



# Potsdamer Platz, Berlin

**40,000 m<sup>2</sup>** of greened roofs

**2550 m<sup>3</sup>** in 4 tanks for toilet flush and fire fighting

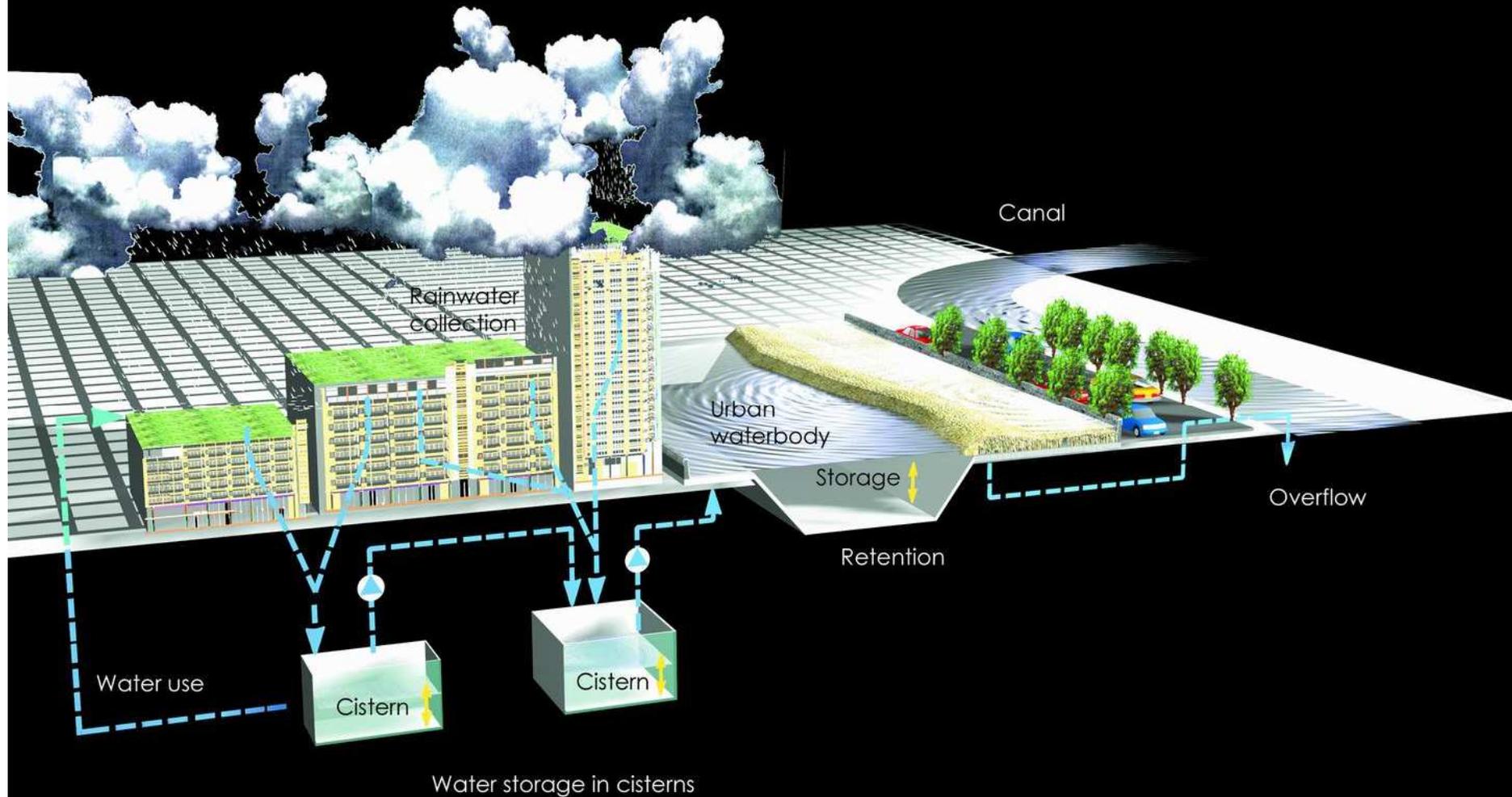
**12.000 m<sup>2</sup>** urban lake, **1200 m<sup>2</sup>** constructed wetland

**3500 m<sup>2</sup>** stormwater retention in lake (30 cm)

**Overall stormwater retention: 125 mm**



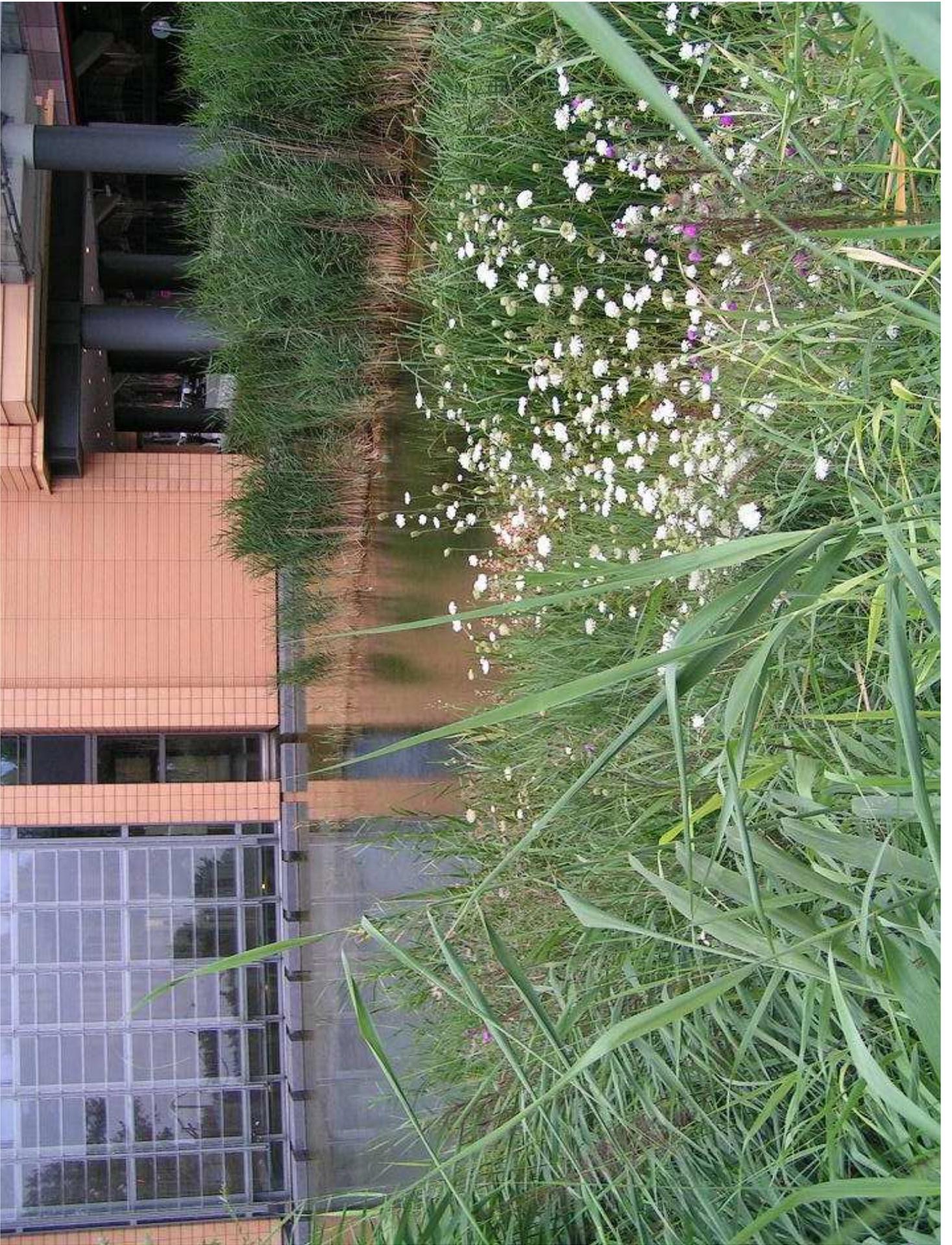
The water system in Berlin's Potsdamer Platz  
Rainwater management



**Architects: Renzo Piano, Kohlbecker u.a.**  
**Landscape Architecture: Krüger/ Möhrle, Daniel Roehr, Berlin**  
**Urban Lake: Atelier Dreiseitl, Überlingen**







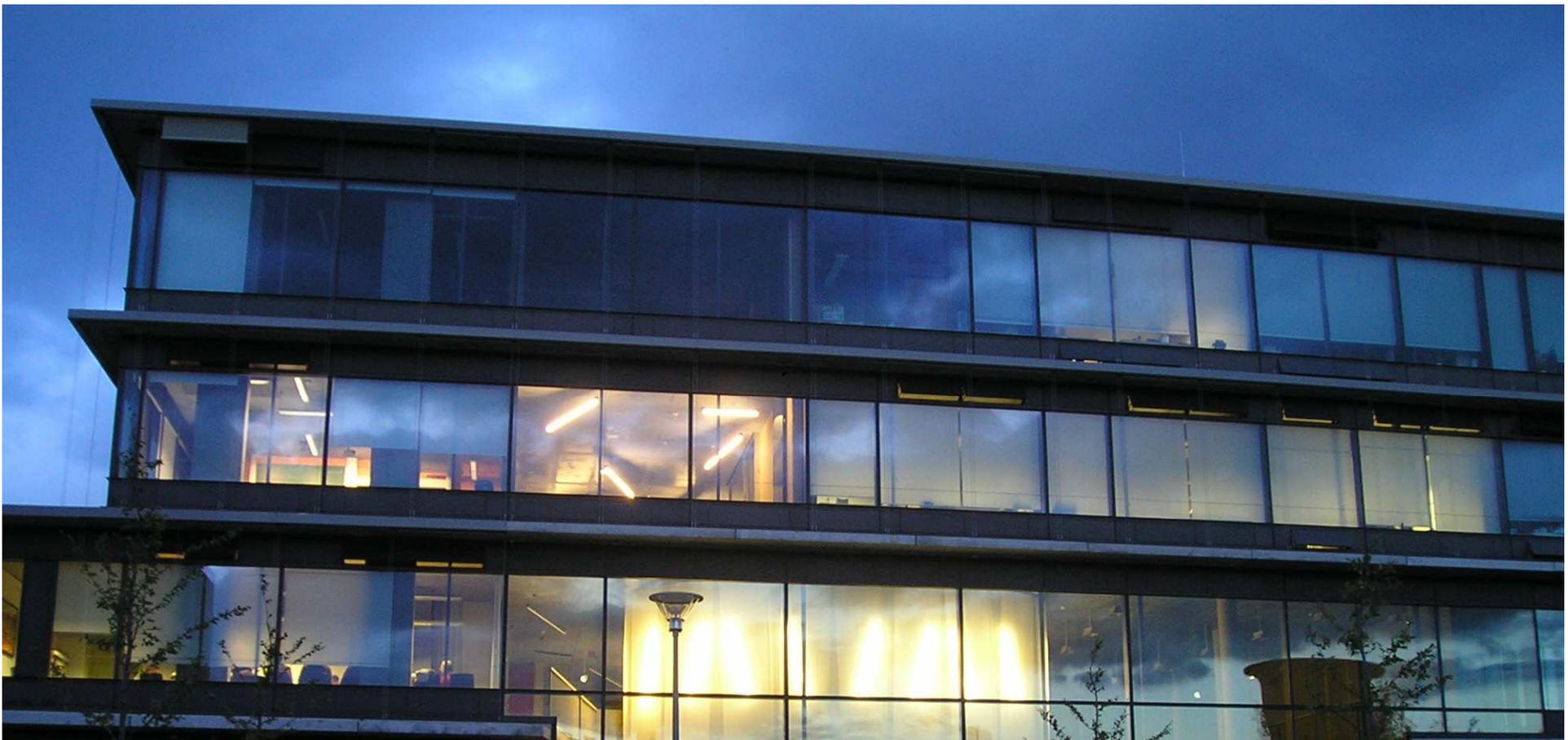
# Influential



- a) Demand by city water administration
- b) Landscape plan/ “Biotope Area Factor” BAF
- c) Berlins “Climate Change Adaptation Plan”
- d) Split in wastewater fee  
(but: not yet used as instrument !)

## Prices Berlin:

Water	2,17 €/m <sup>3</sup>
Wastewater	2,46 €/m <sup>3</sup>
Rainwater	1,90 €/m <sup>2</sup> a (=3,80 €/m <sup>3</sup> )



**Scientific Monitoring/ Evaluation**  
**2002-2010 Berlin Senate for Urban Development**  
**2011-2013: EnEff Stadt, BMWi via PTJ**  
**2014-2016: INIS, BMBF via PTJ**

**Institute of Physics,  
Humboldt-University Berlin-Adlershof**

# Institute of Physics, Humboldt- University Berlin



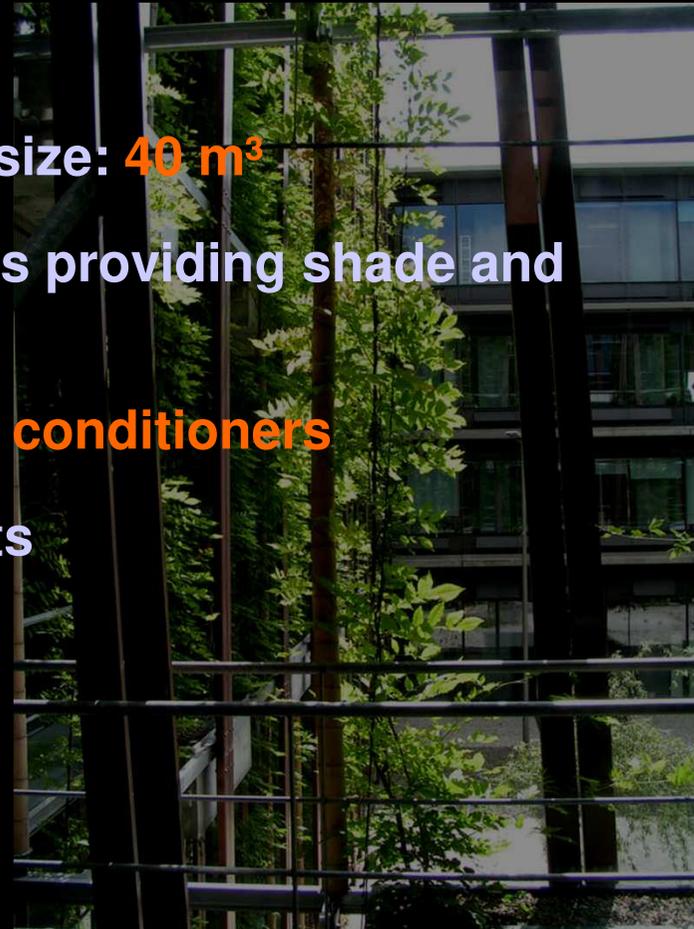
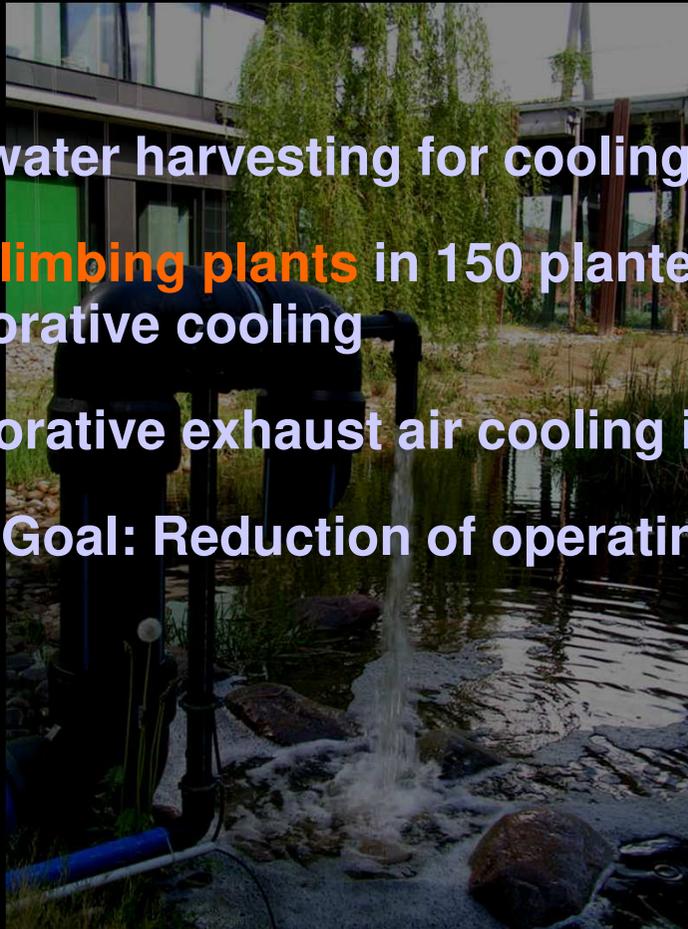
# Institute of Physics, Humboldt- University Berlin

Rainwater harvesting for cooling, tank size: **40 m<sup>3</sup>**

**450 climbing plants** in 150 planter boxes providing shade and evaporative cooling

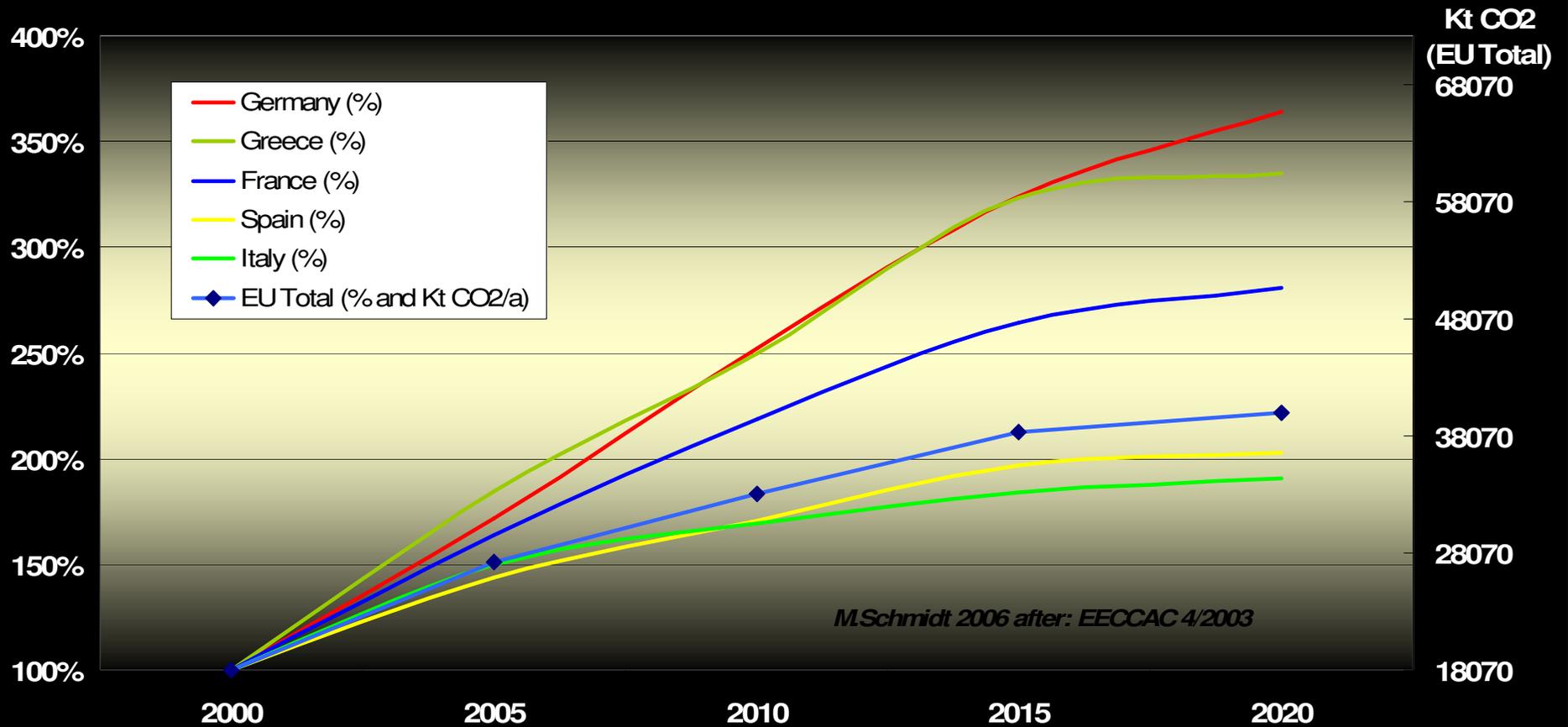
Evaporative exhaust air cooling in **8 air conditioners**

Main Goal: Reduction of operating costs



**Goal: Decrease of energy consumption of buildings by 2020: 50% !!**

**But: Increase of energy consumption for cooling: 260%**



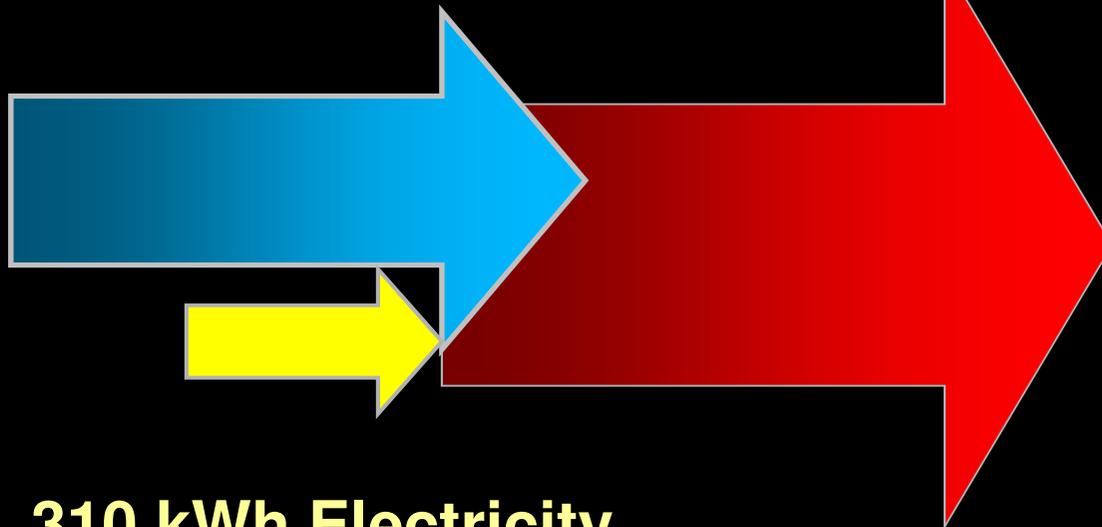
*Source: Energy Efficiency and Certification of Central Air Conditioners (EECCAC) Study for the D.G. Transportation-Energy (DGTREN) of the Commission of the E.U.*

## Reasons for Global Increase in Cooling Demand

- 1: Increase in use of glass**
- 2: Decrease in Heat Capacity, use of light materials**
- 3: Increase in electricity consumption**
- 4: Increase in Urban Heat Island Effect**
- 5: Global Warming**

# Never use electricity to cool a building !

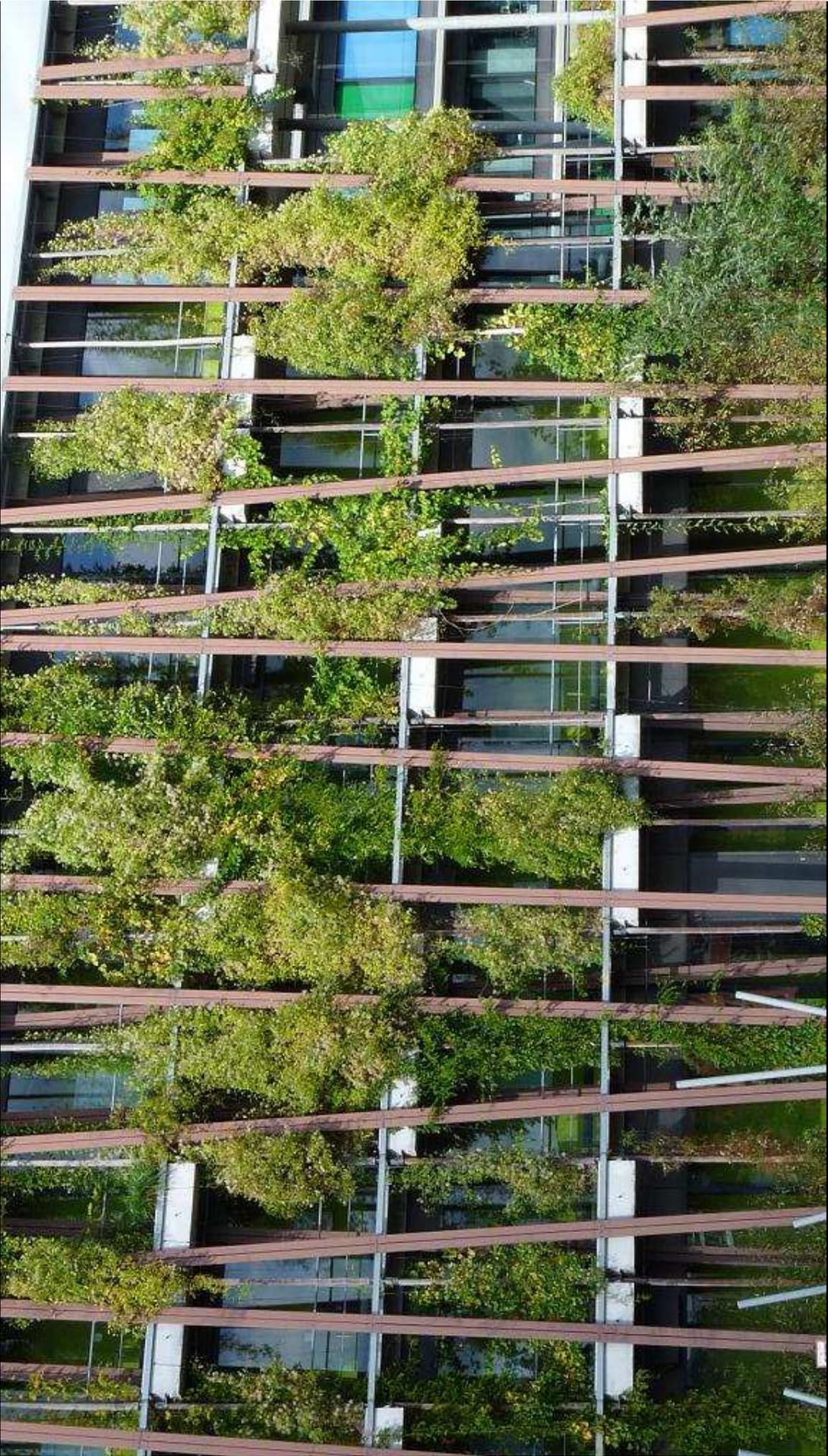
**680 kWh Cold**



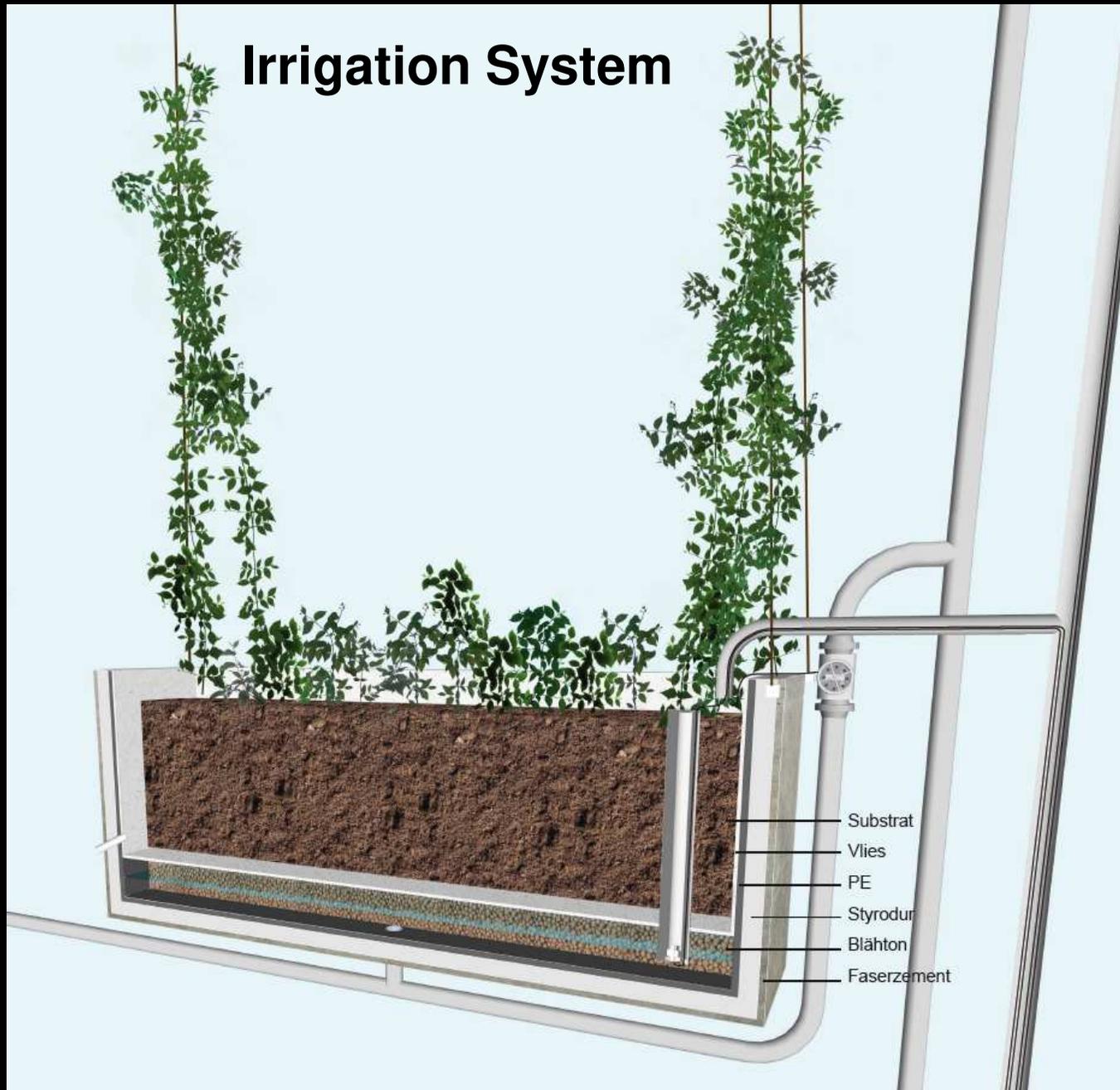
**310 kWh Electricity  
(annual COP 2,2)**



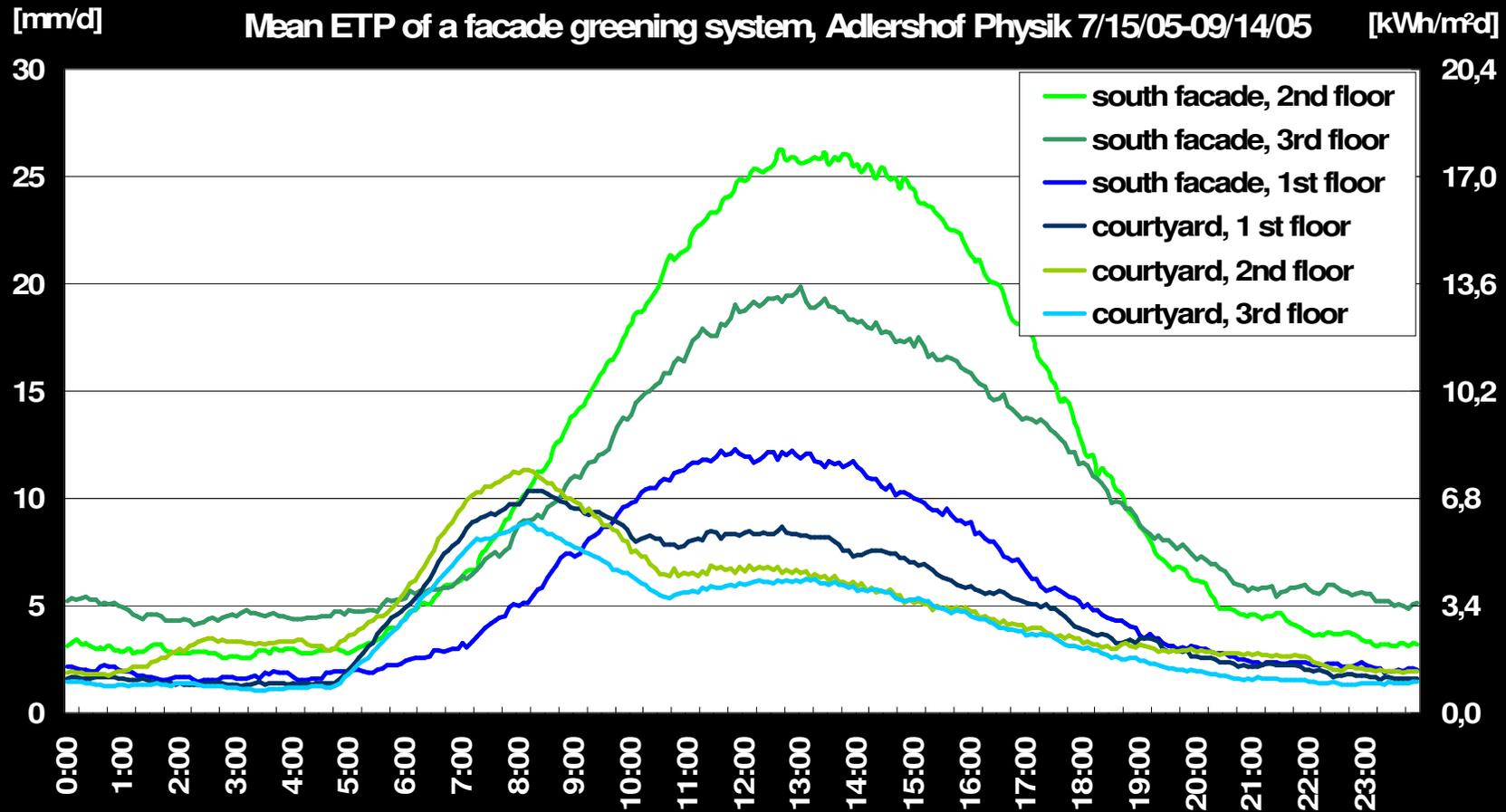
**990 kWh  
Sensible Heat  
Released Outside**



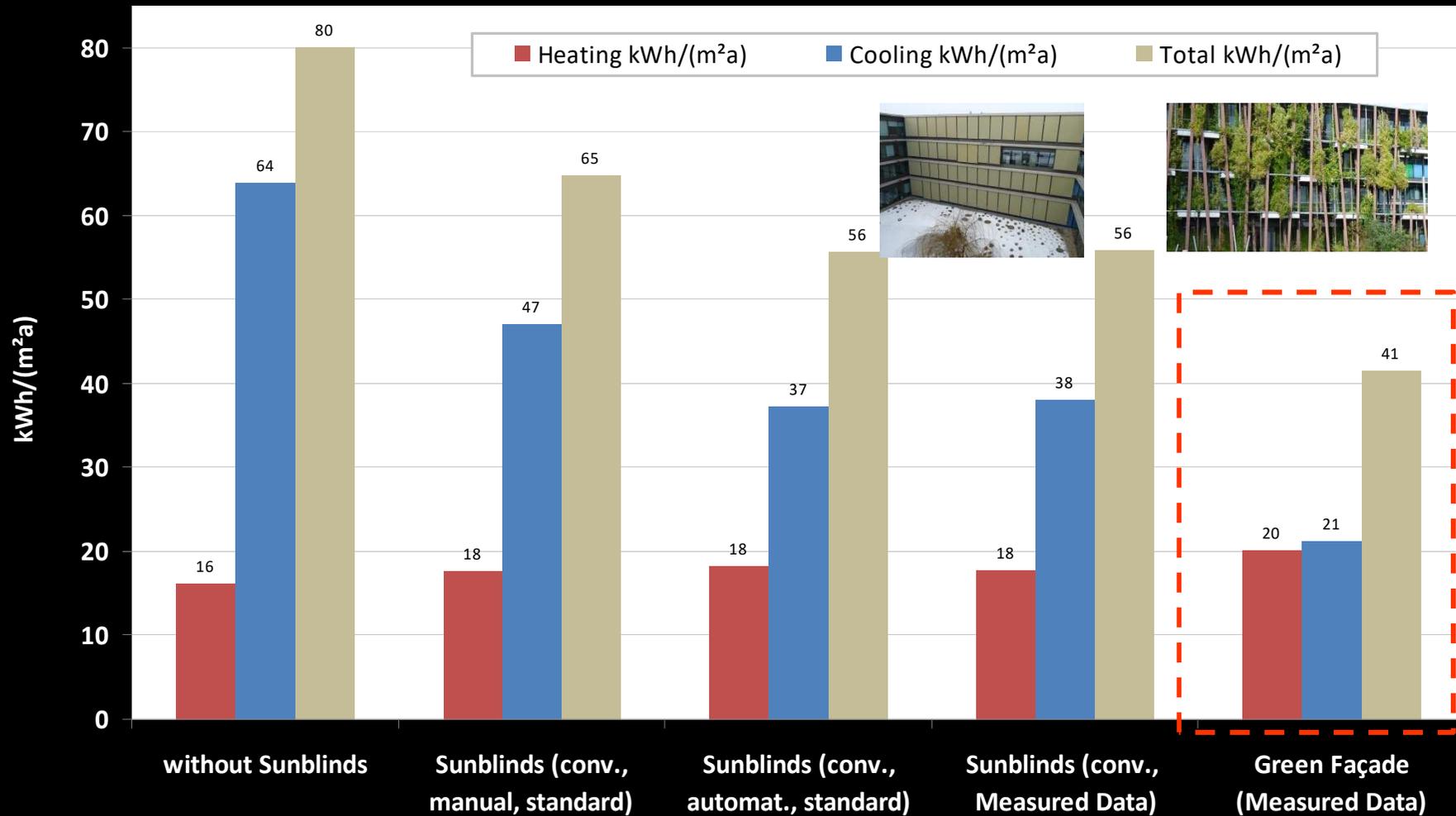
# Irrigation System



# Mean daily evapo-transpiration 15.7.05-14.9.05 corresponding cooling rate: 280 kWh per day per facade



## Primary Energy needed for Heating and Cooling



**Irrigation, maintenance: 1.300 €/a**

**Maintenance: 16.525 €/a**

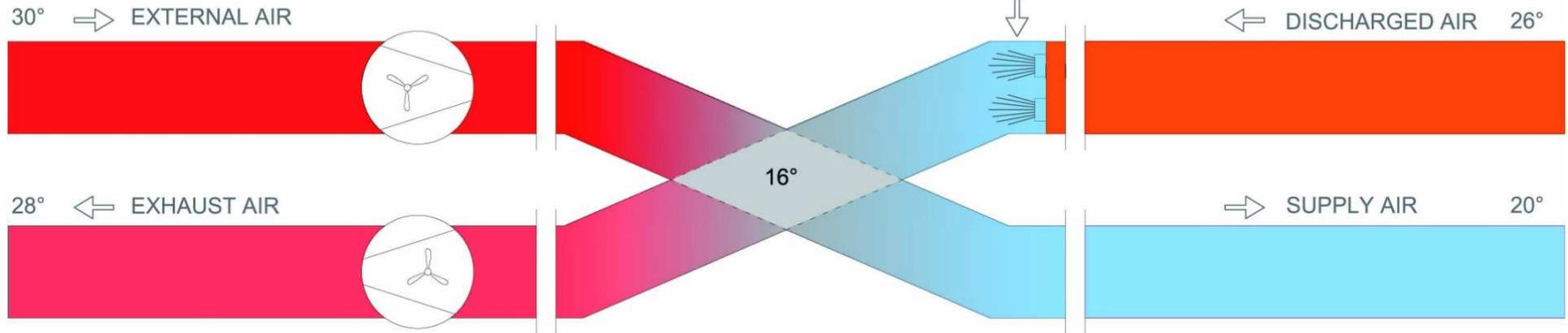


# Win – Win – Win - Win

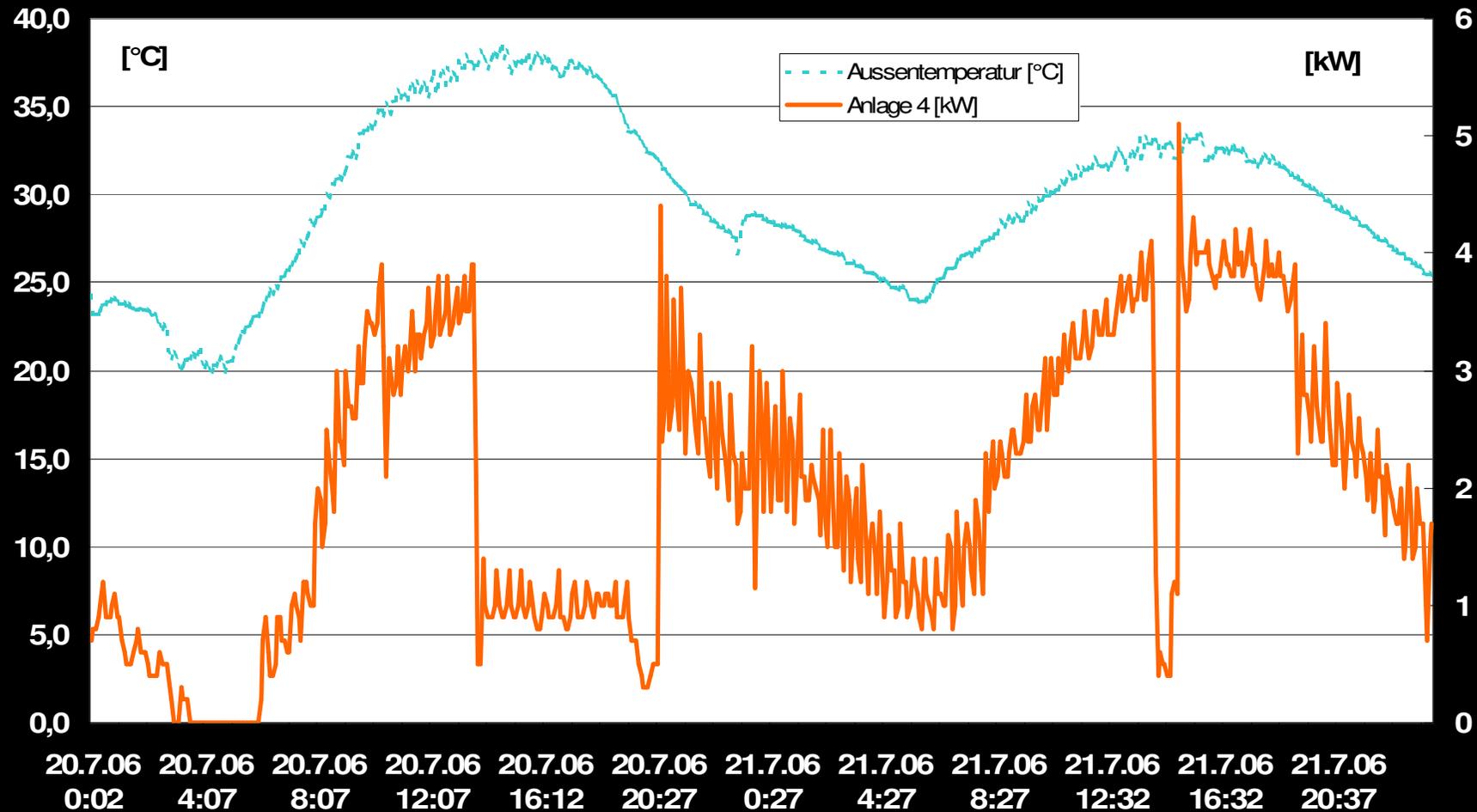
- **Cheaper in investment**
- **Cheaper in operation**
- **Better performance for the building**
- **Better for the environment**

# Evaporative Exhaust Air Cooling

ADIABATIC COOLING OF DISCHARGED AIR



**Difference in conv. energy consumption  
with and without evaporative cooling**  
**hottest day: 38°C => savings 70%**  
**expected annual savings => 90%**



# Costs for Cooling

1 g H<sub>2</sub>O: 2450 J = 2450 Ws a 100 °C

1 m<sup>3</sup> = 2720 MJ = 700 kWh a 45 °C

Adiabatic: 1,06 € (0,185 €/kWh)

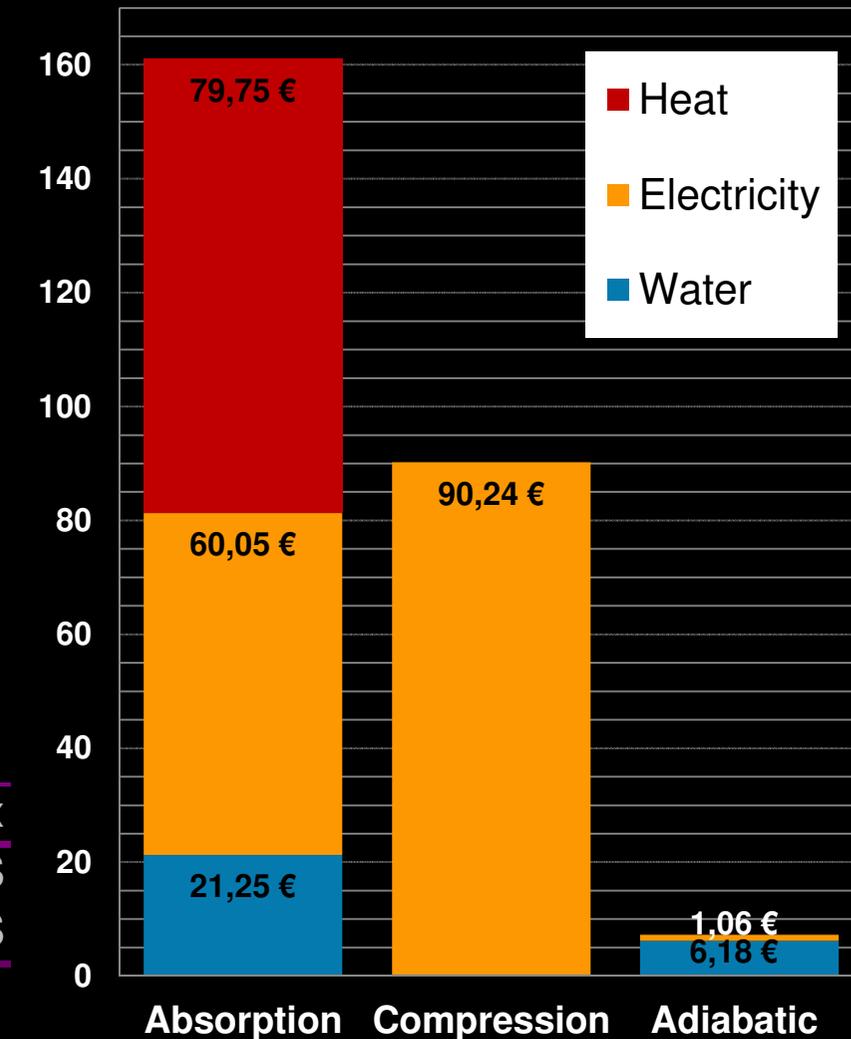
Compression: 90,24 €  
(0,185 €/kWh COP 2,05)

Absorption: 161,04 €  
(0,0376 €/kWh WZ 0,47)

Use rainwater instead of tap water:  
no treatment for lime necessary !

	Conductivity	max
Rainwater	30 µS	1600 µS
Tap water	700 µS	1600 µS

Costs for Cooling  
- 1000 kWh -



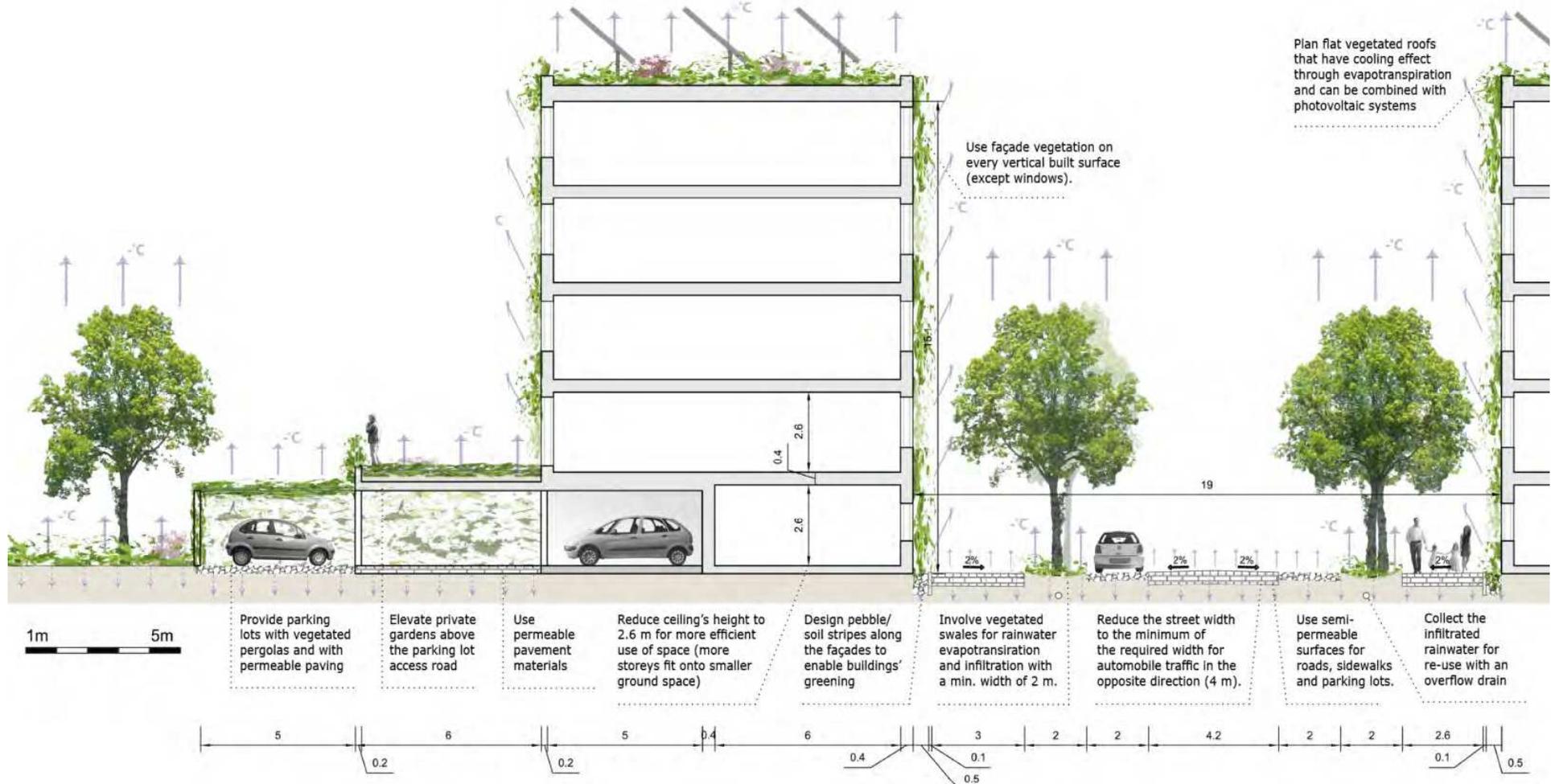
# Win – Win – Win

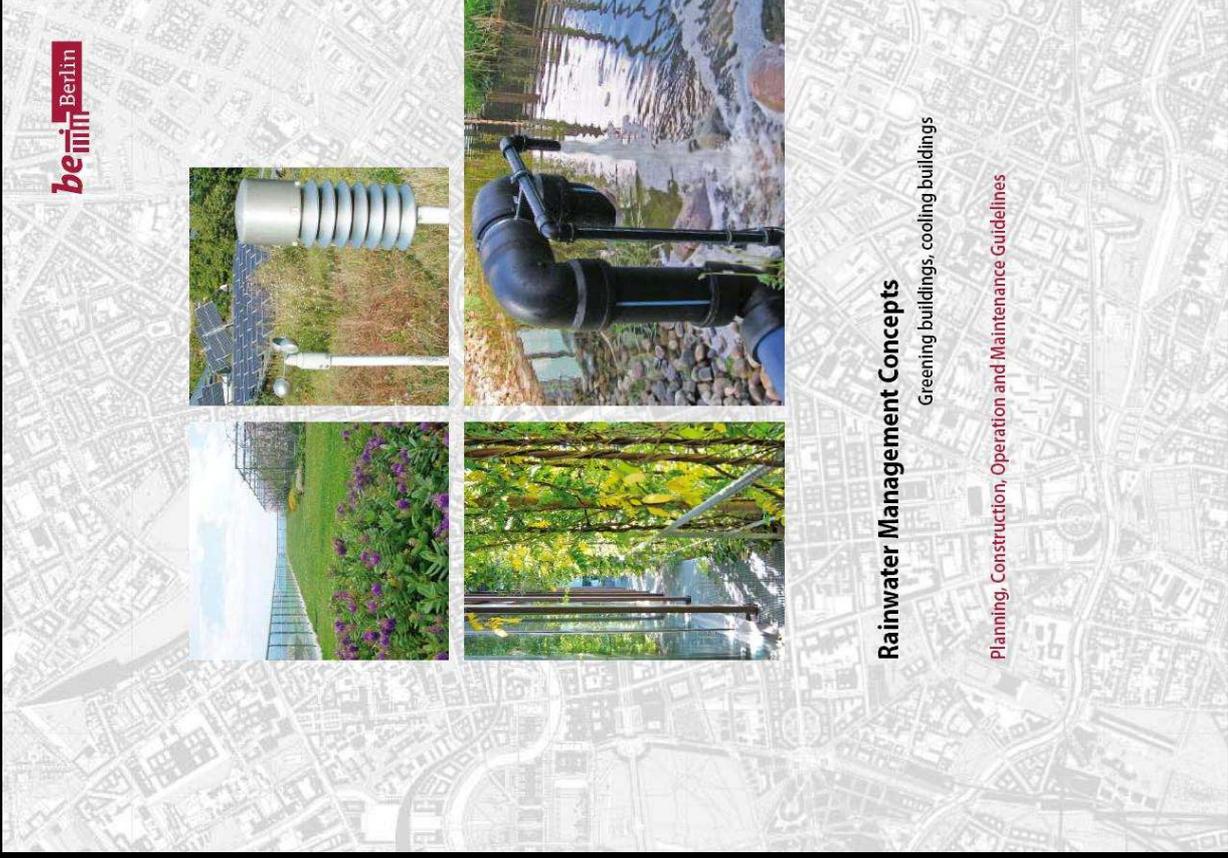
- **Cheaper in investment**
- **Cheaper in operation**
- **Better for the environment**

# Combination of Measures:

## infiltration with the goal of increase of evaporation via vegetation

Masterthesis Jana Milosovicova, TU Berlin





**be**min Berlin

## Rainwater Management Concepts

Greening buildings, cooling buildings

Planning, Construction, Operation and Maintenance Guidelines





.. A David Wrigh... Programm Read Folie 1 Read TU Ber... ALDI TALK Mein ALDI T... Antike Mens... New researc... Pirates: Tide... Fluginforma... Doodle: Me...

Science alert

✉ f t 🔍 ☰



KajzrPhotography/Shutterstock

## New Research Suggests Ancient Humans Helped Make the World's Largest Desert

Causing climate change since 6,000 BCE.

***Agadir, Morocco 5/2008***



## Agadir, Morocco 5/2008

Agadir, Morocco today compared to descriptions by ancient Greek geographer Strabo:

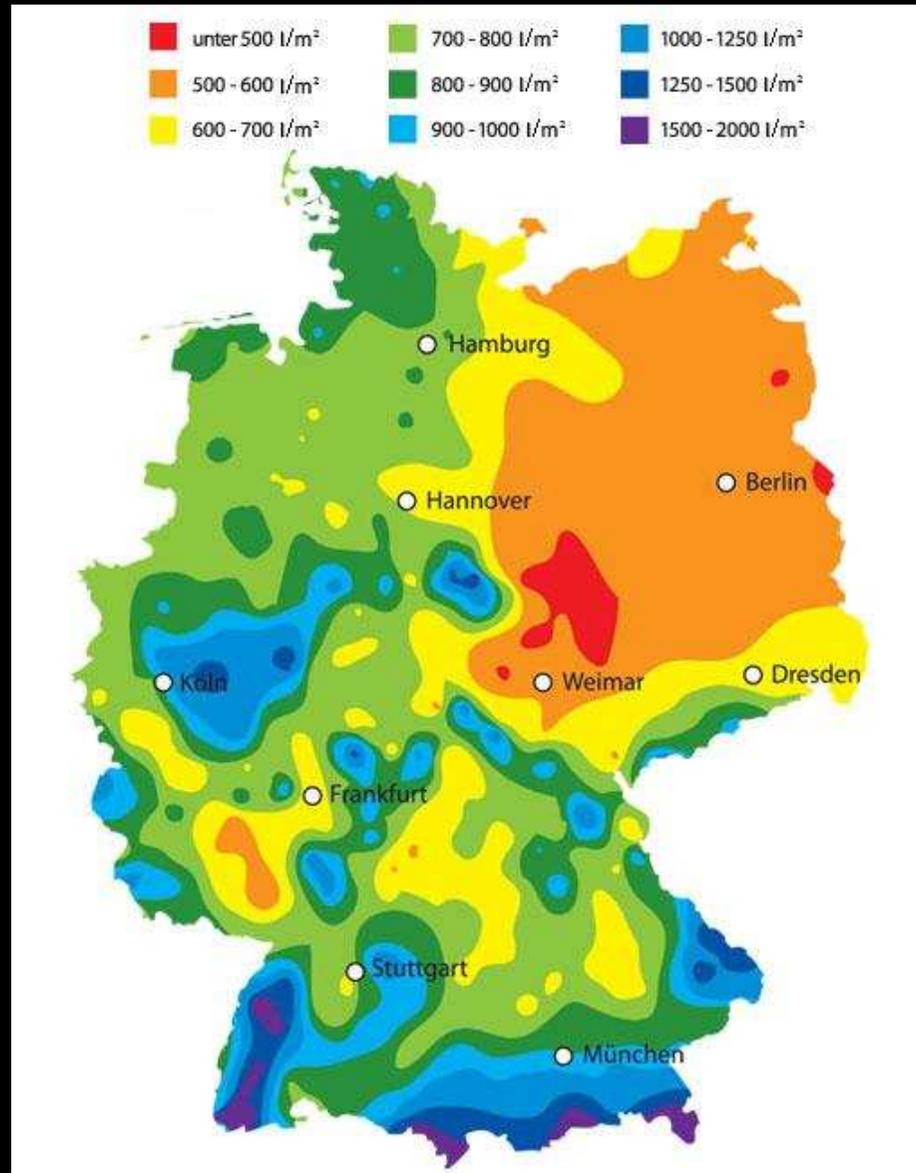
*"all of the [land] between Carthage and the Pillars of Hercules [from Tunis to the Atlantic ocean] is of an extreme fertility."*

Morocco was often singled out as *"one of the most beautiful and fertile countries of the earth"* and was frequently described as *"one of the granaries of Rome"*



**Brandenburg, Germany, 2011 after Harvesting**

# Precipitation Rates Germany



**Dramatic reduction in evapo-transpiration on land**  
**Daily loss of *800 km<sup>2</sup>* of vegetation worldwide**

**Daily deforestation rate: *450 km<sup>2</sup>***

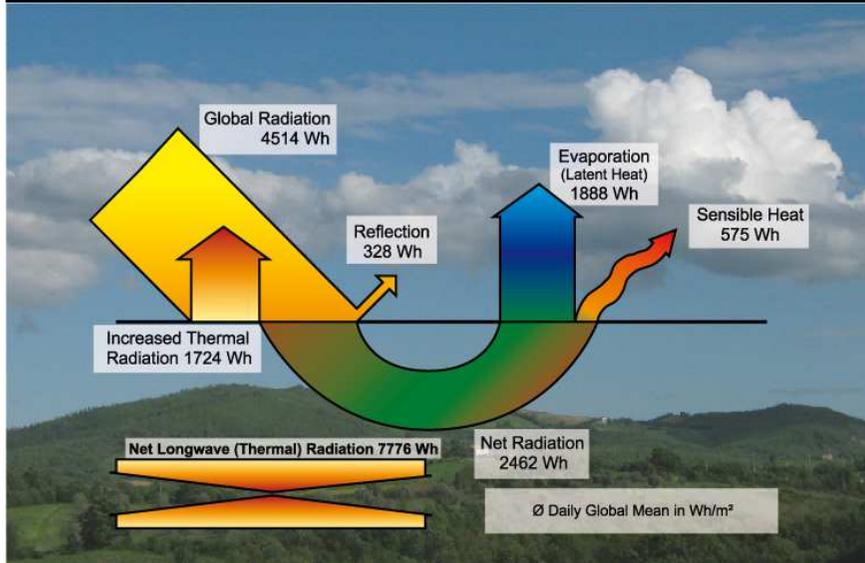
**Daily reforestation: *100 km<sup>2</sup>***

**Net loss of forests daily: *350 km<sup>2</sup>***

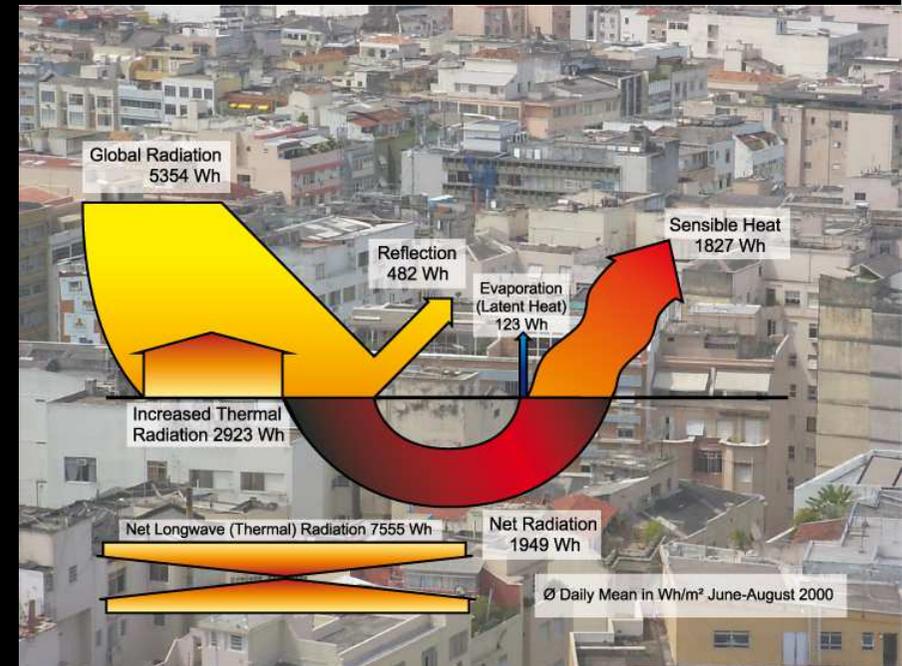
**Daily ongoing global urbanization: *150 km<sup>2</sup>***

**Daily global desertification: *300 km<sup>2</sup>***

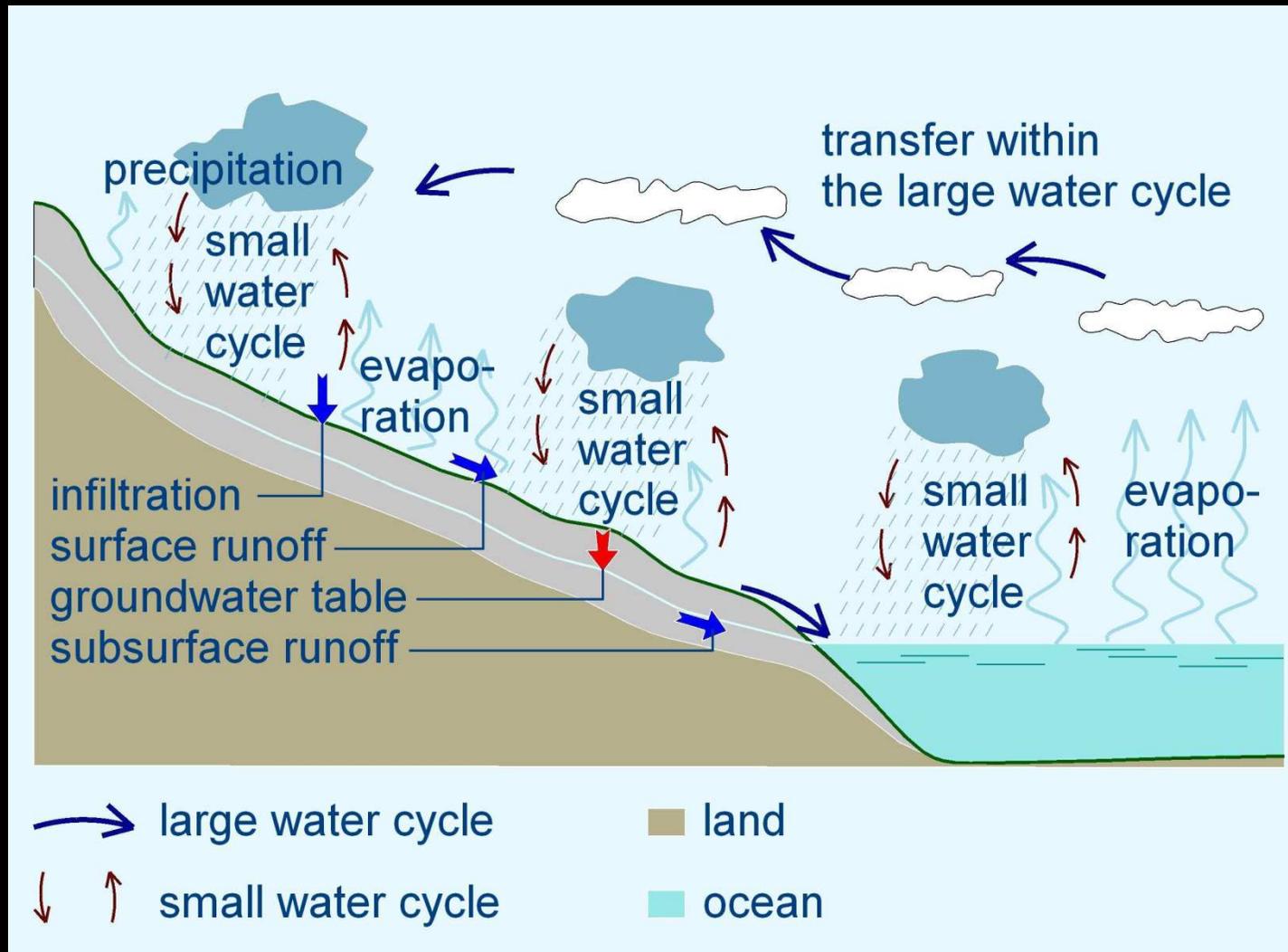
**Size of Berlin: *890 km<sup>2</sup>***



**800 km<sup>2</sup>  
daily !**

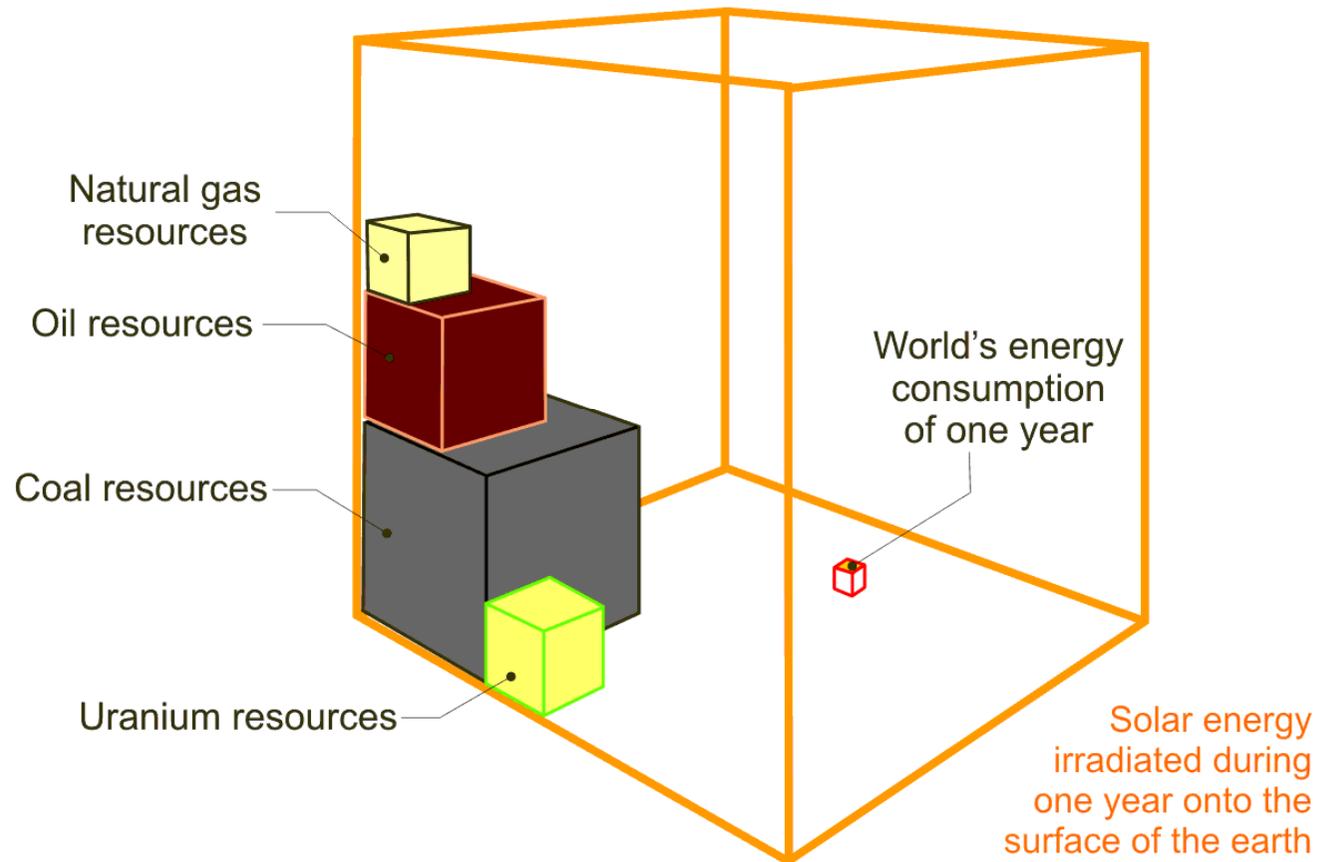


# Large and small water cycle



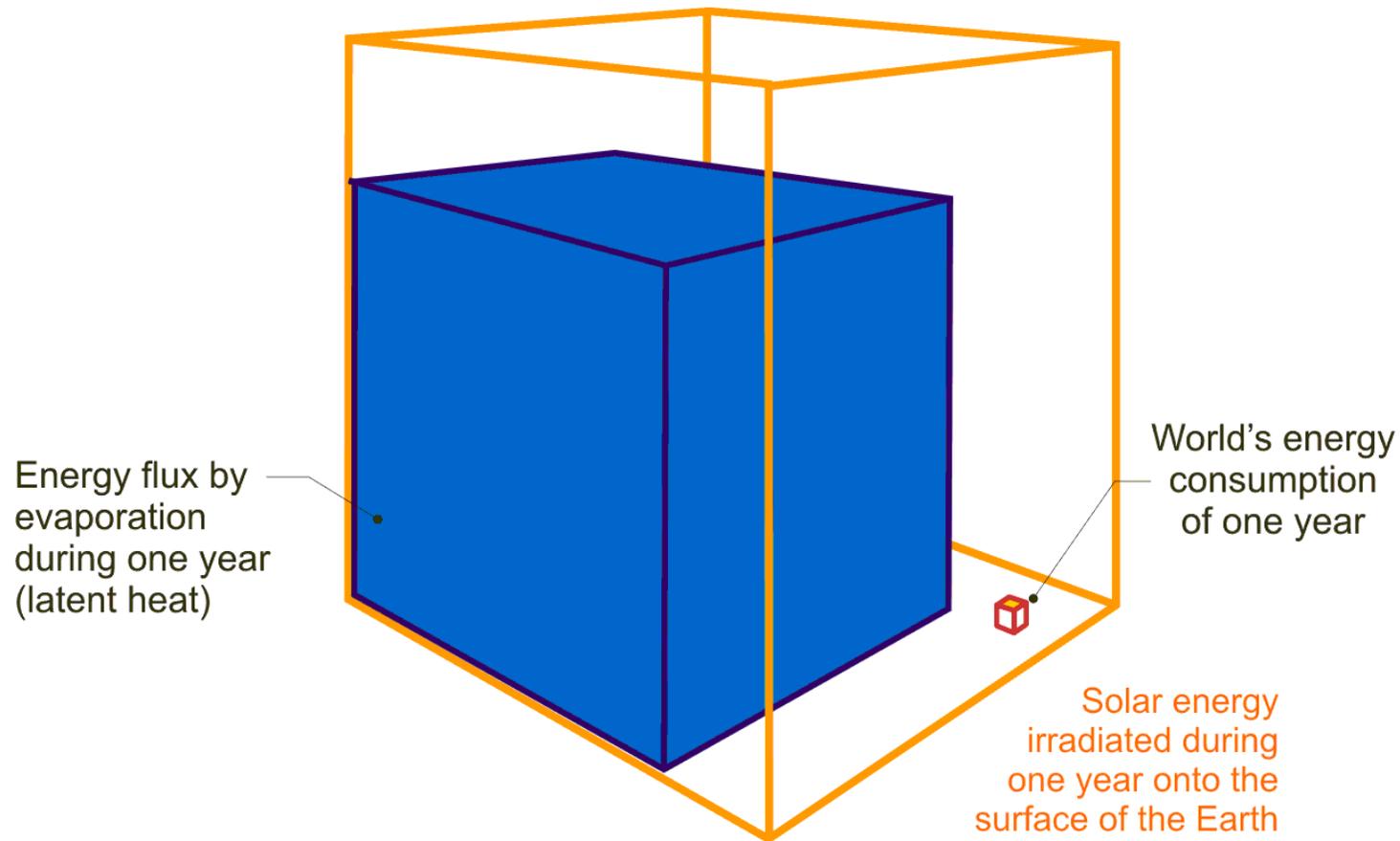
# Global Energy Consumption in Relation to annual Radiation

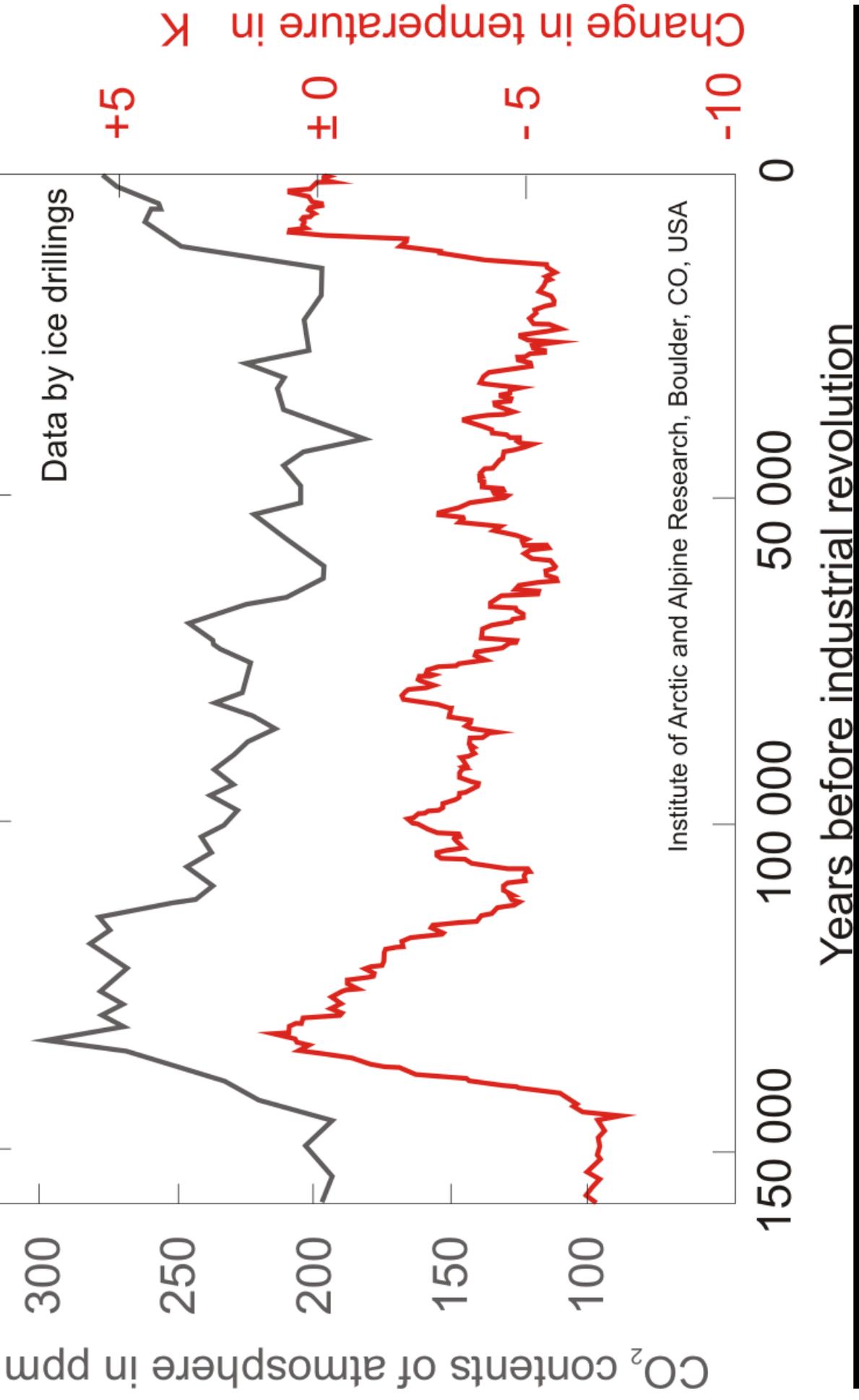
## Consumption and Resources of Energy



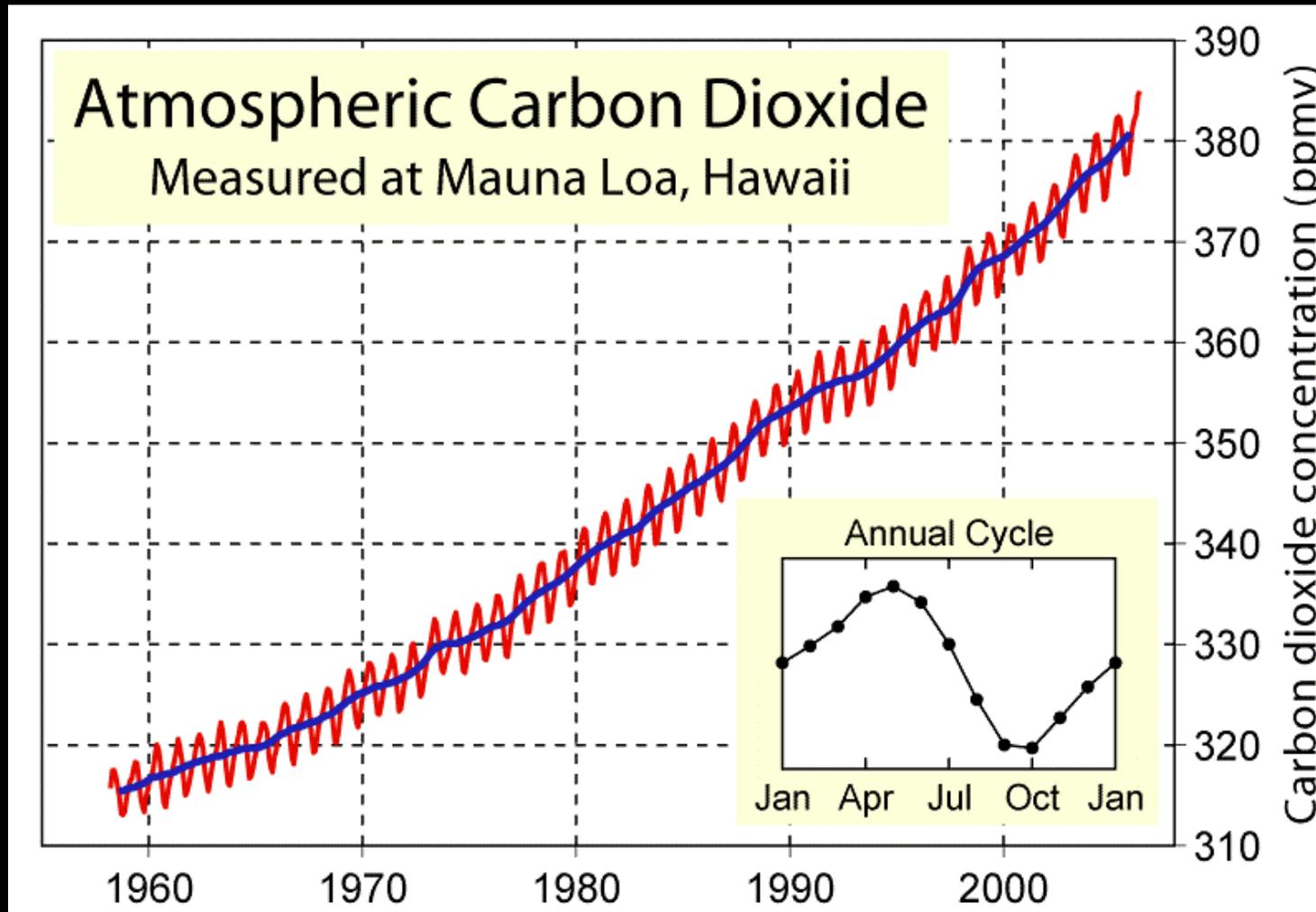
# Annual Evaporation in Relation to Radiation

Global Radiation in Relation of Evaporation (Latent Heat Flux)





## Why does CO<sub>2</sub> correlate with the global temperature ?





## Renewable Biomass ?



**Thank you for your attention !**

**<http://www.gebaeudekuehlung.de>**

**<http://www.rainforclimate.com>**

**<http://www.phasenwechsel.com>**

GEFÖRDERT VOM



Bundesministerium  
für Bildung  
und Forschung



Bundesministerium  
für Wirtschaft  
und Energie



Bundesministerium  
für Umwelt, Naturschutz  
und nukleare Sicherheit