Energy and water

a decentralized approach to an integrated sustainable urban development

Institute of Physics, Berlin-Adlershof

Technial University of Berlin
Institute of Architecture
Dep. of Building Technology and Design

sustainable urban development ?

Urban Climate

- reduced evapotranspiration
- increased thermal radiation
- increased heat, „urban heat island“

Naturalistic Landscape:

- 80% evapotranspiration, 20% groundwater recharge and runoff
- 86% of „consumed“ radiation balance

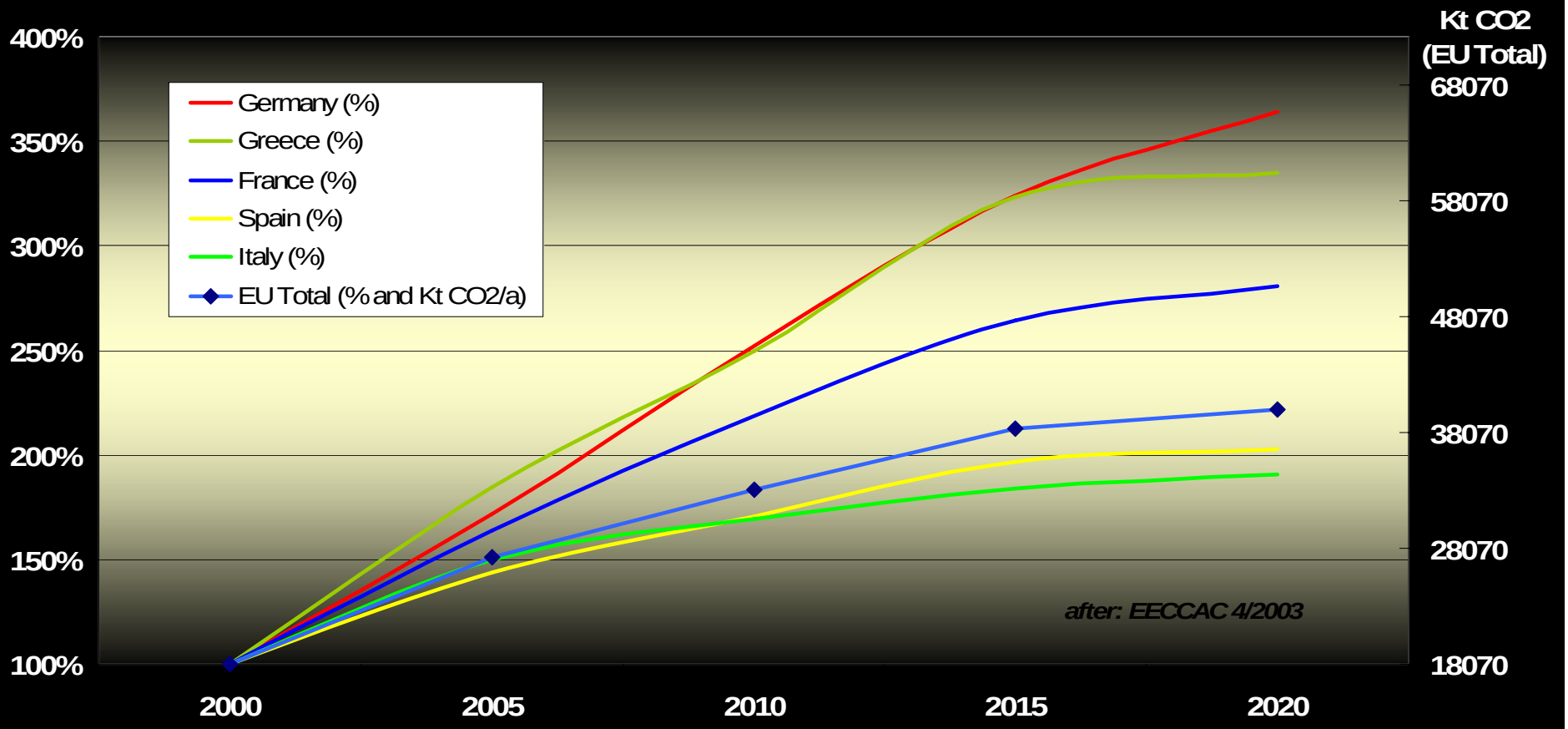
Urban Hydrology

- ***escalated flood risks***
- ***polluted surface waters***

Energy

- ***thermal discomfort inside of buildings***
- ***increased energy consump-tion for climatization***
- ***rise of costs for air conditioning systems***

Increase of CO_2 emissions due to cooling in Europe

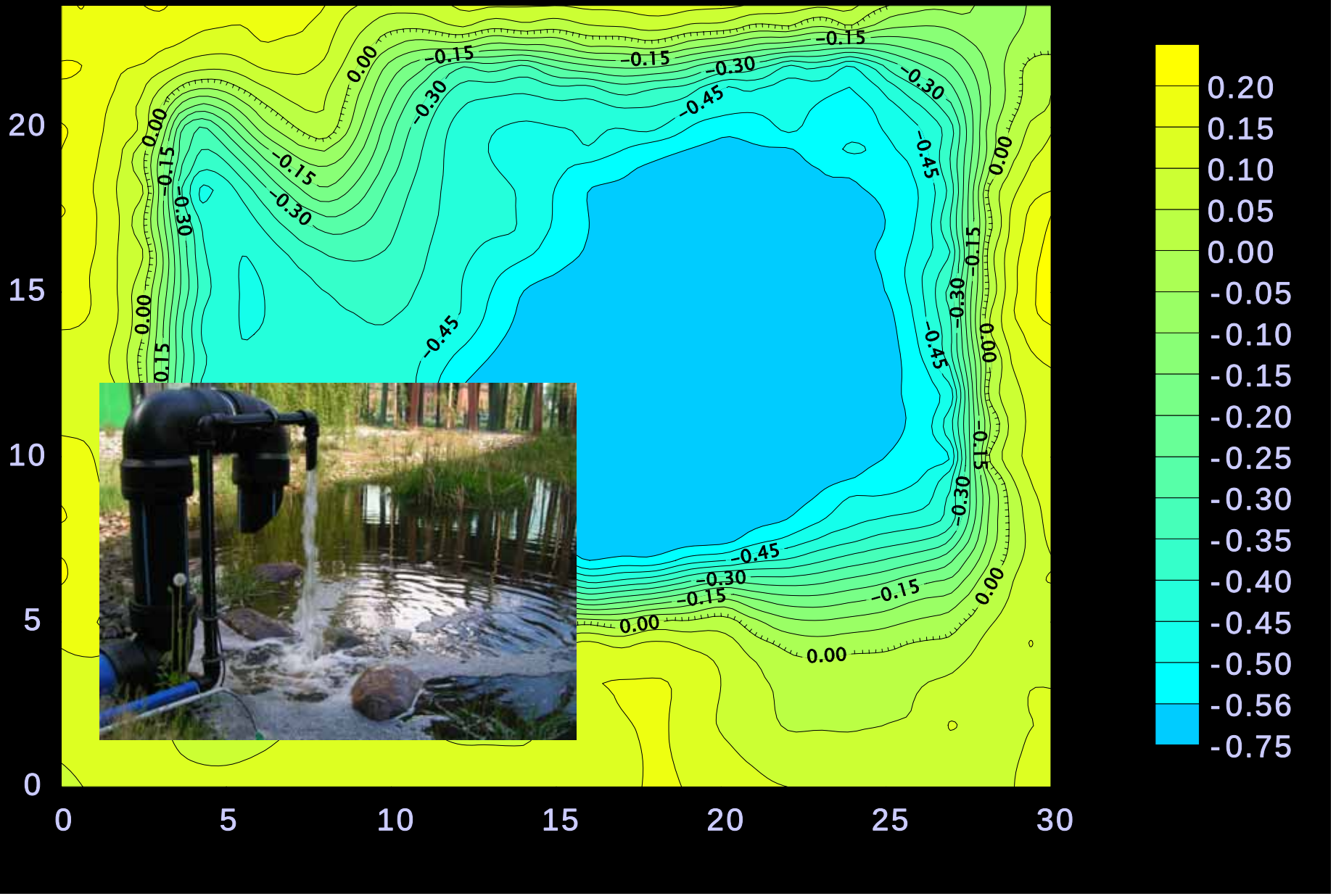


Source: *Energy Efficiency and Certification of Central Air Conditioners (EECCAC)*

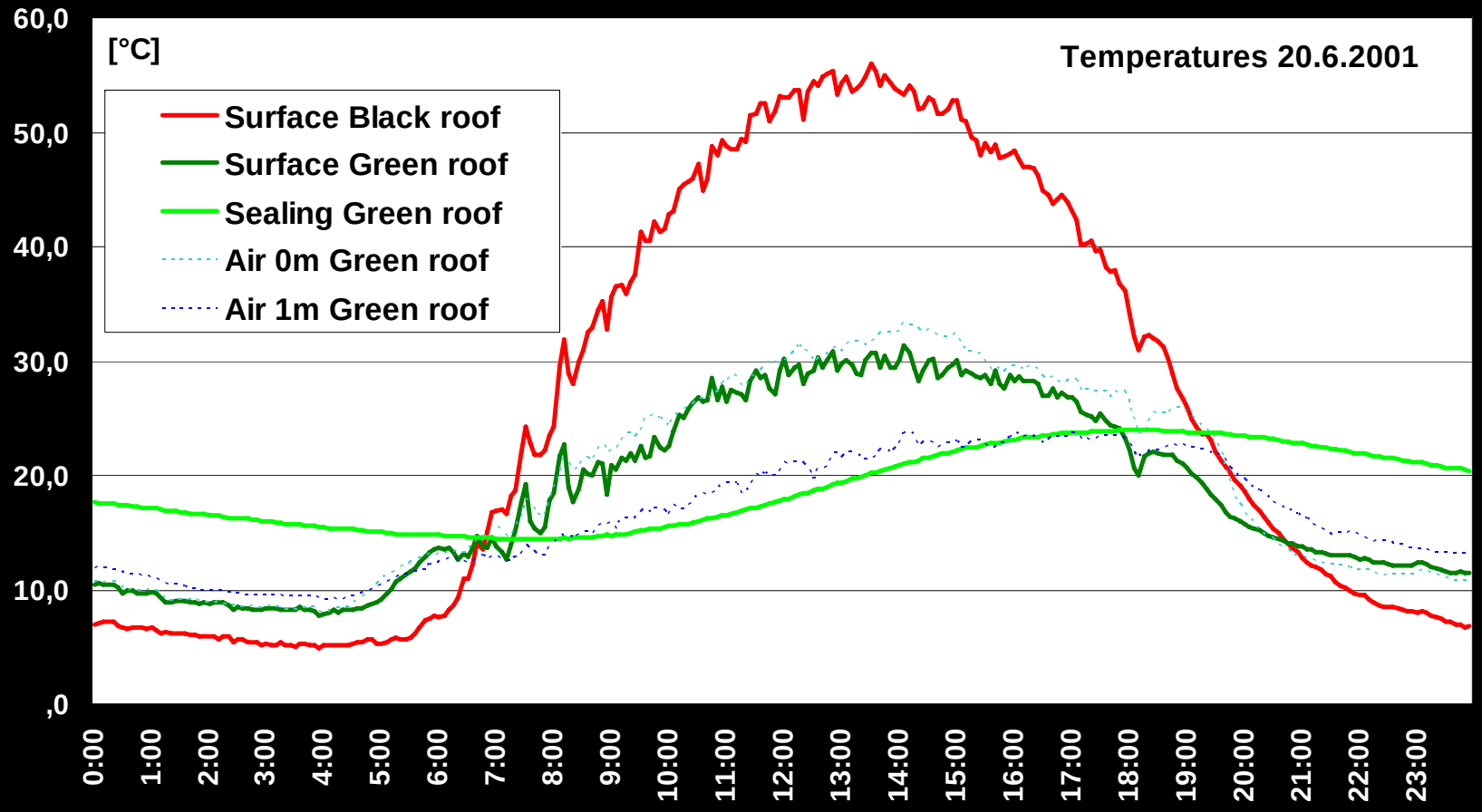
- *Rainwater harvesting for climatization of the building*
- *No rainwater sewerage service (zero release)*
- *Complete runoff management inside of the building complex*
- *Reduction of operating costs*

Institute of Physics
Humboldt-University Berlin

Rainwater Management in one of the courtyards



Difference in Surface Temperatures Conventional Roof – Green Roof
(Infrared measurements)

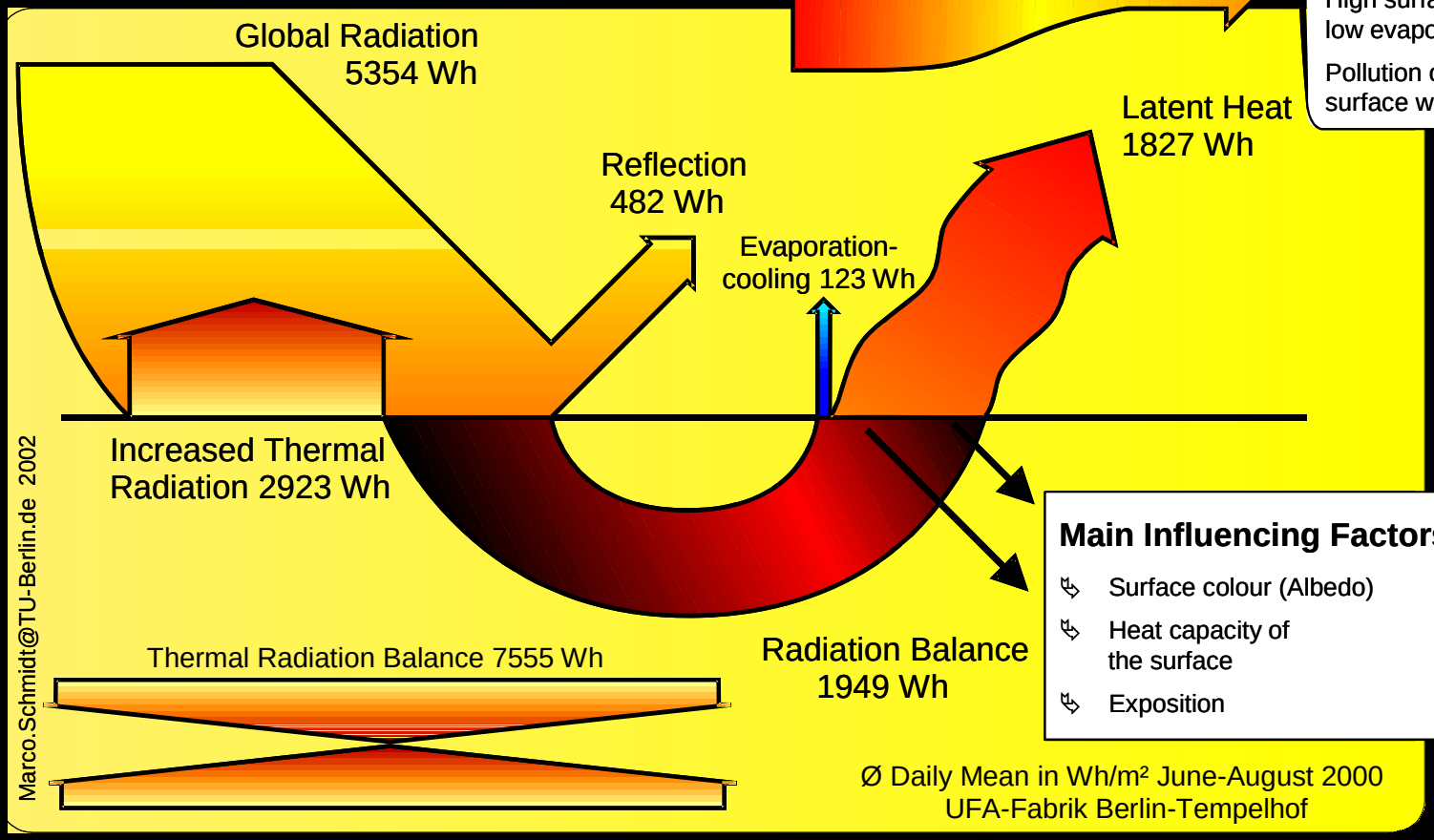


RIO 6 World Climate & Energy Event

Reduced evapotranspiration in urban areas increases thermal radiation and changes up to 95% of the radiation balance to heat

Bitumen roof

Energy balance, daily mean



Disadvantages

- Uncomfortable microclimate
- Low durability of the sealing of the roof
- High surface runoff, low evapotranspiration
- Pollution of the surface waters

Main Influencing Factors:

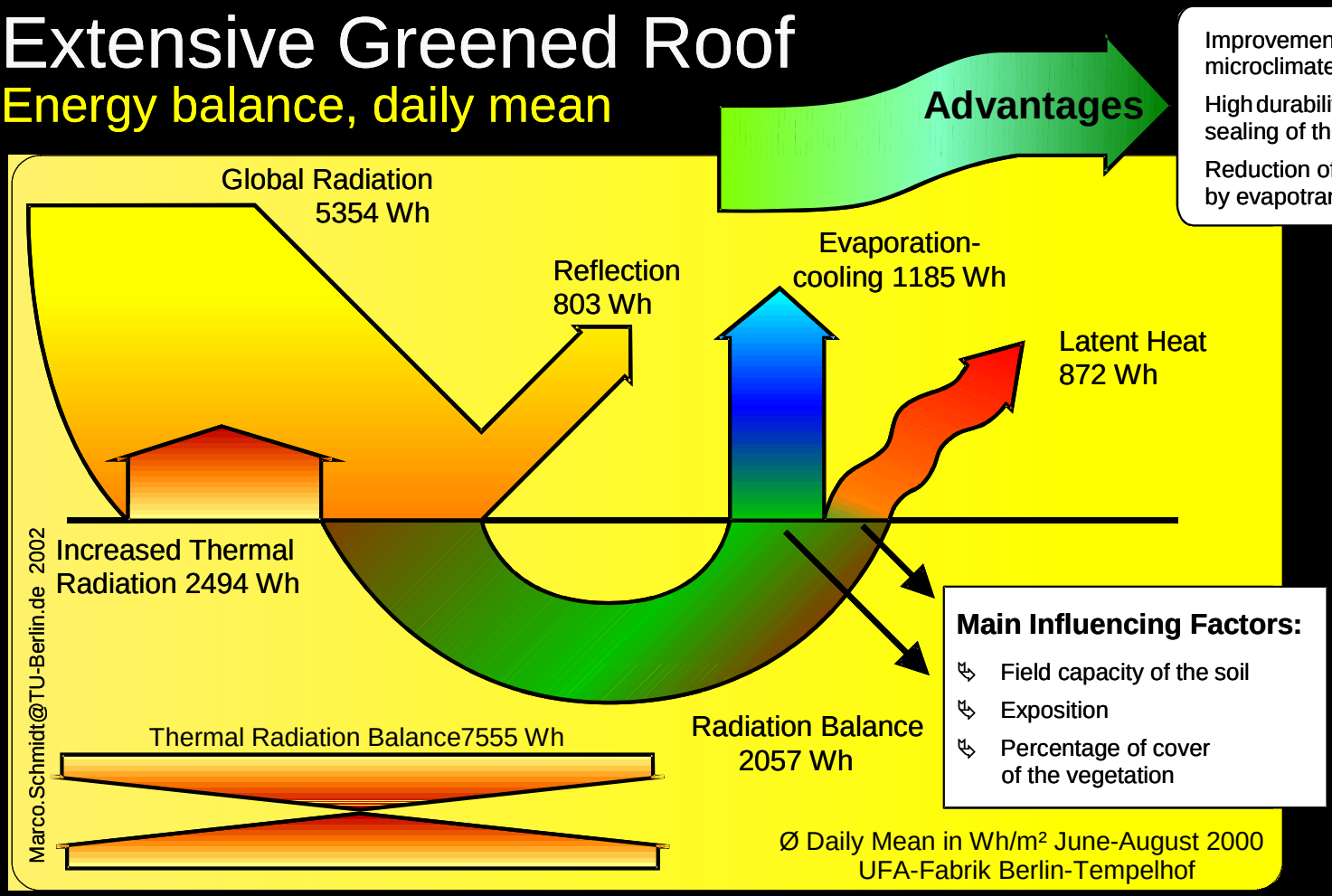
- Surface colour (Albedo)
- Heat capacity of the surface
- Exposition

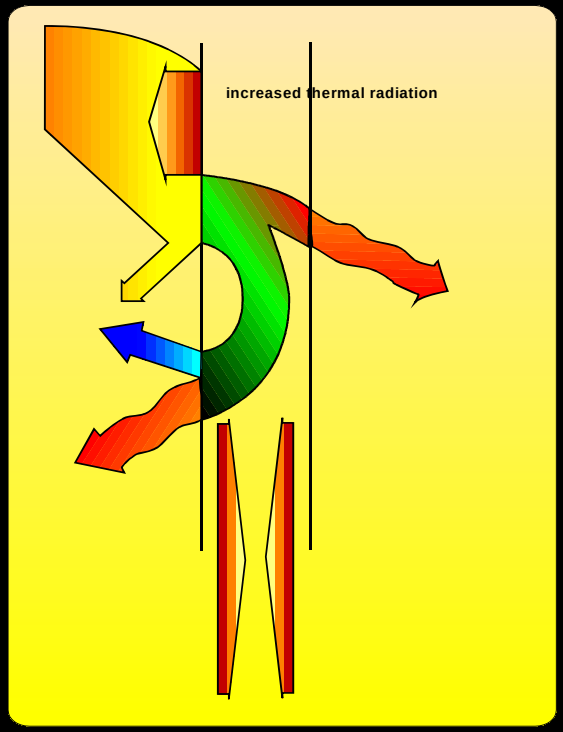
Ø Daily Mean in Wh/m² June-August 2000
UFA-Fabrik Berlin-Tempelhof

On a green roof, evapotranspiration reducces thermal radiation and changes up to 65% of the radiation balance to evaporative cooling

Extensive Greened Roof

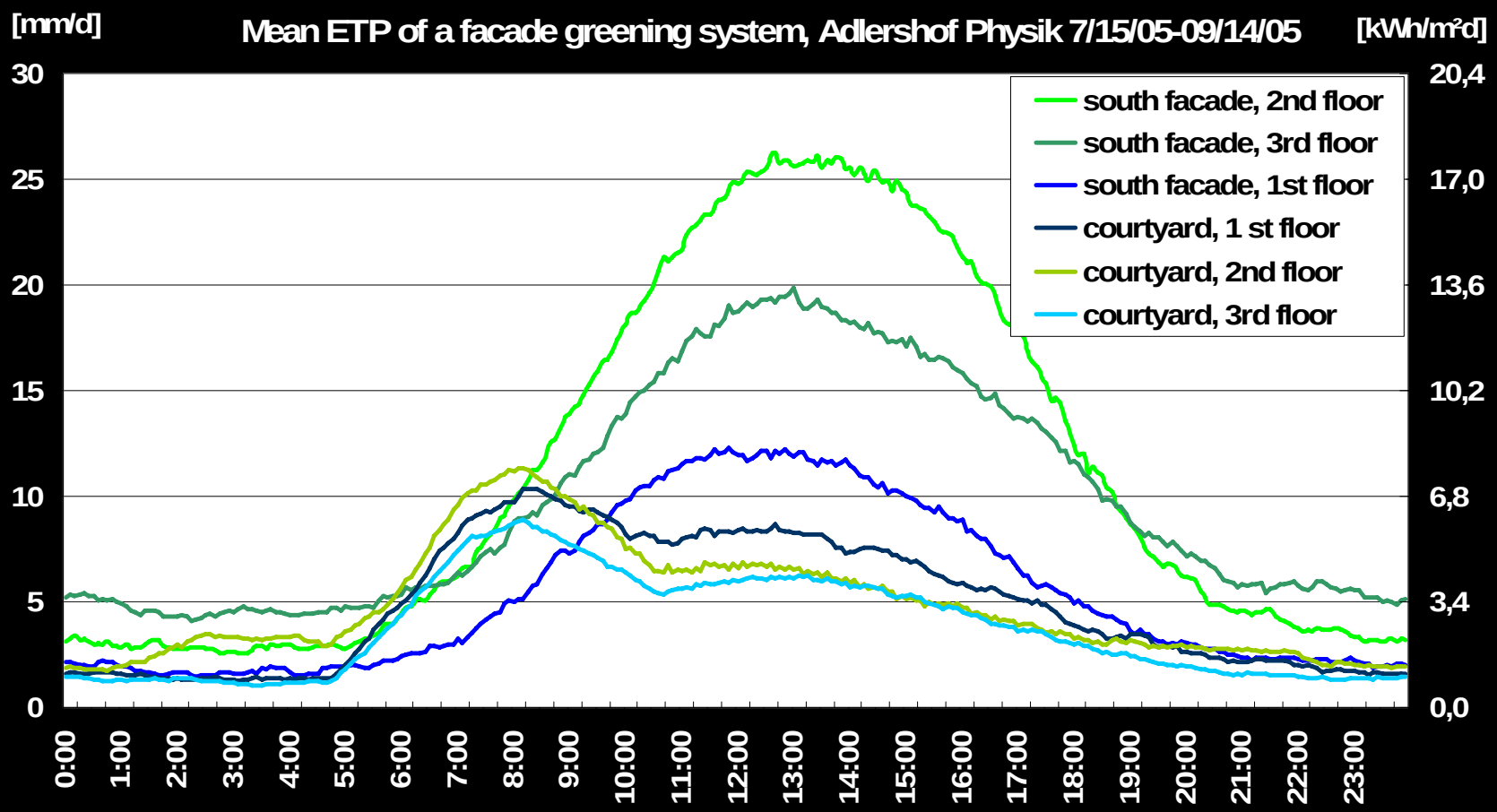
Energy balance, daily mean





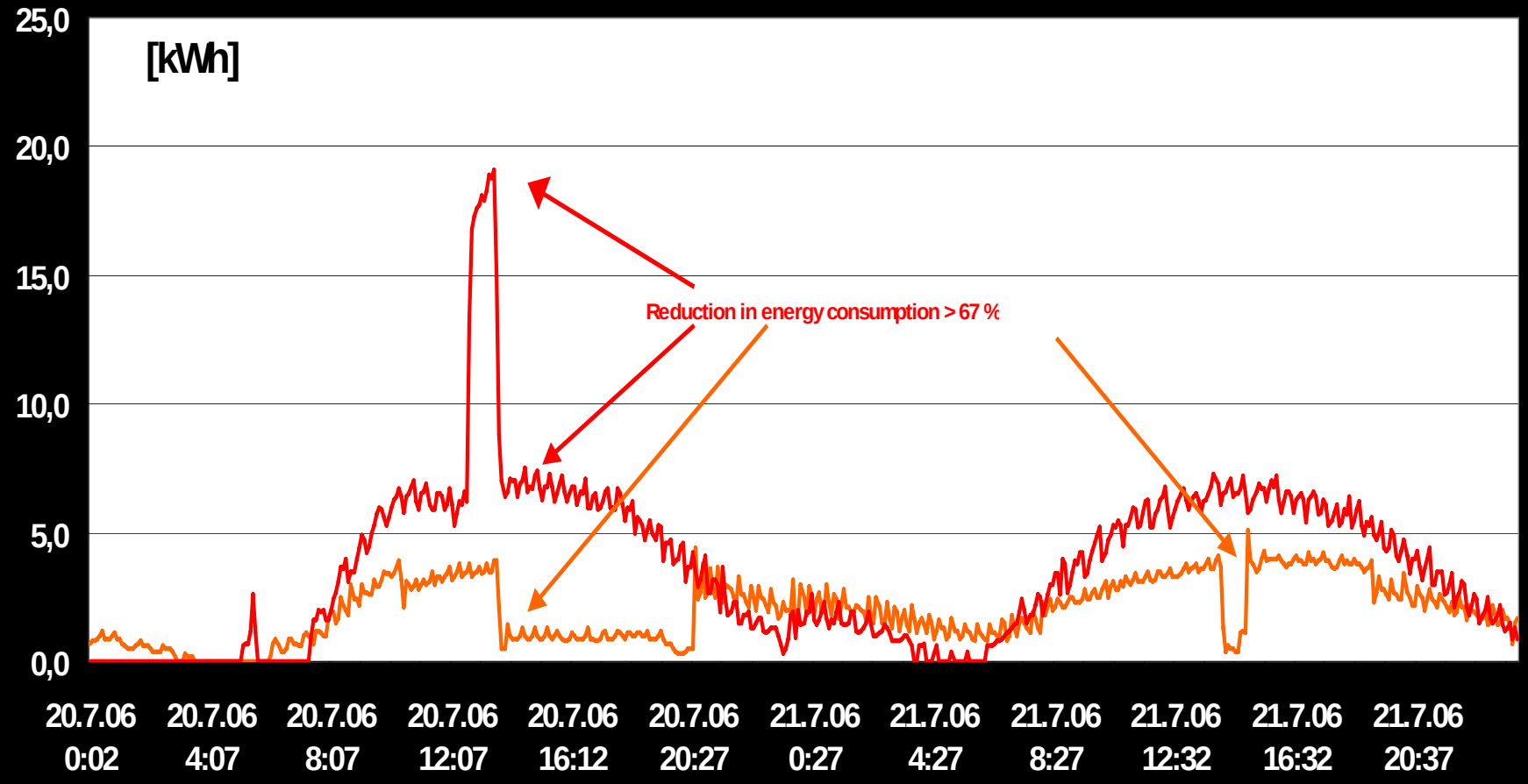
	Institute of Physics Berlin HUB-Adlershof	
Connected Area	Adiabatic cooling systems:	7
	Irrigated planters:	149
	Connected roofs:	4700 m²
	Pond in the courtyard:	225 m²

Mean daily evapotranspiration 7/15/05-09/14/05 correspondent cooling rate: 280 kWh per day



Evaporative cooling in Central Air Conditioners (CAC)

Difference in energy consumption with and without evaporative cooling

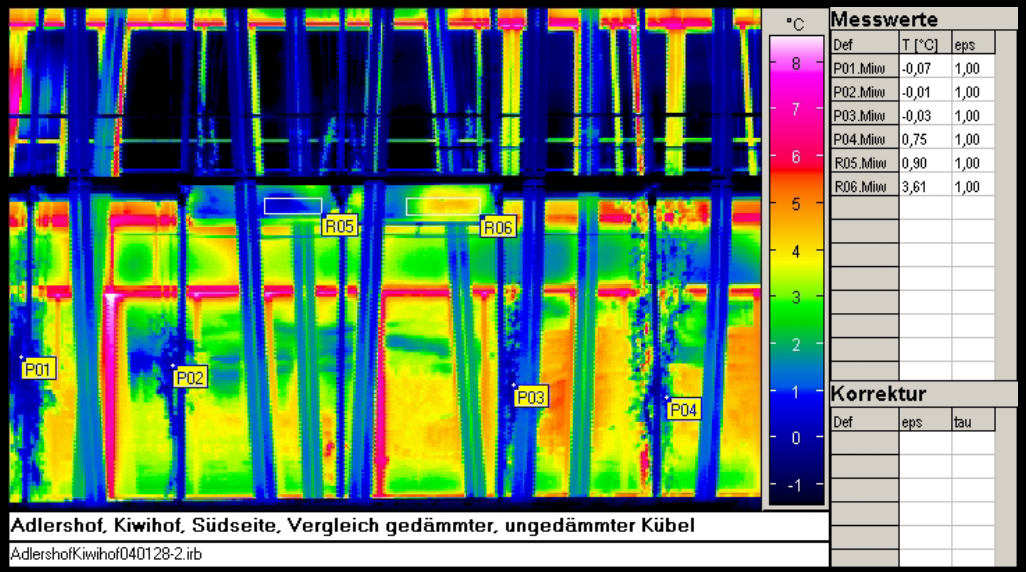


Costs:

	1 J = 1 Ws	kWh
1 g H2O	2450	0,00068
1 Liter	2450000	0,68
1 m³	2450000000	680,6
1,30 €		100,38 €

Rainwater instead of Tap water:

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



Estimated Project data	
Rainwater for adiabatic cooling:	12 % (simulation)
Rainwater for green facades:	26 % (simulation)
Rainwater for irrigated courtyards	6 % (simulation)
Infiltration into the underground	> 35 % (simulation)
Storage capacity:	**40 m³ (9 mm)**
Drinking water supply	**> 30 % (simulation)**

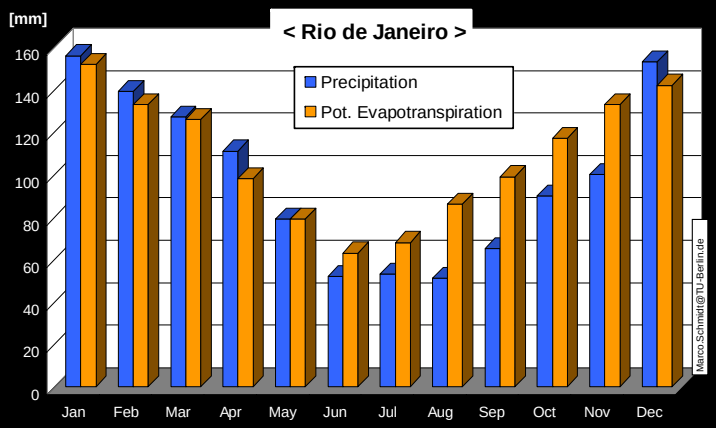
Results

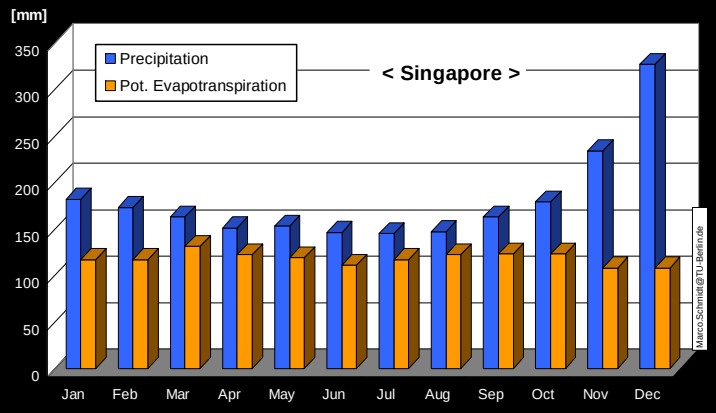
	2005	Simulation	MWh
Used Water	269 m³	1608 m³	
Rainwater	267 m³	864 m³	
Tap water	1,6 m³	744 m³	
Evaporative cooling systems	75,9 m³	536 m³	51,6
Facade greening systems	146,2 m³	1072 m³	99,4
Infiltration	2430 m³	1146 m³	
Precipitation	2700 m³	2700 m³	
Tap water absorption chiller	7488 m³	1415 m³	
Stromverbrauch Druckerhöhung	2,4	0,8 kWh/m³	

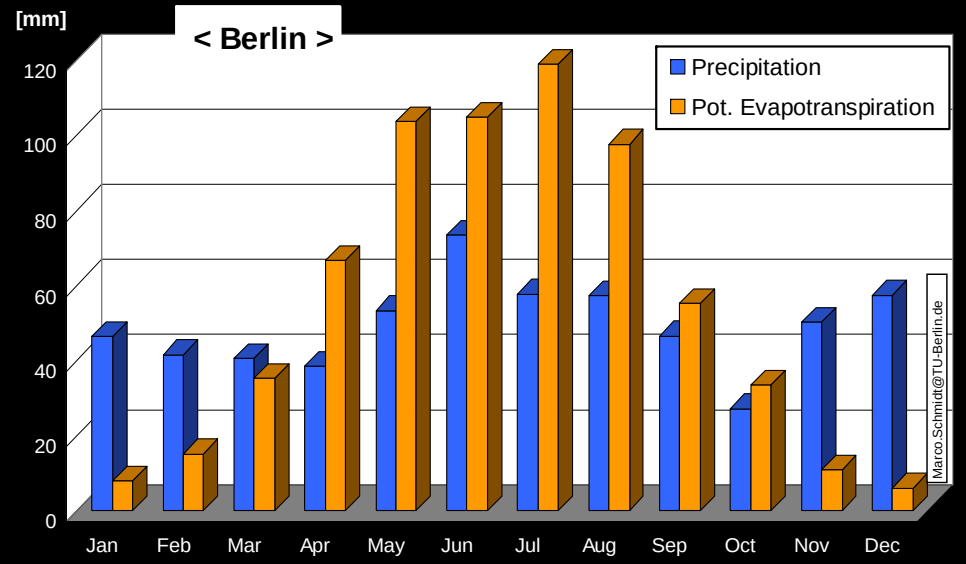
RIO 6 World Climate & Energy Event

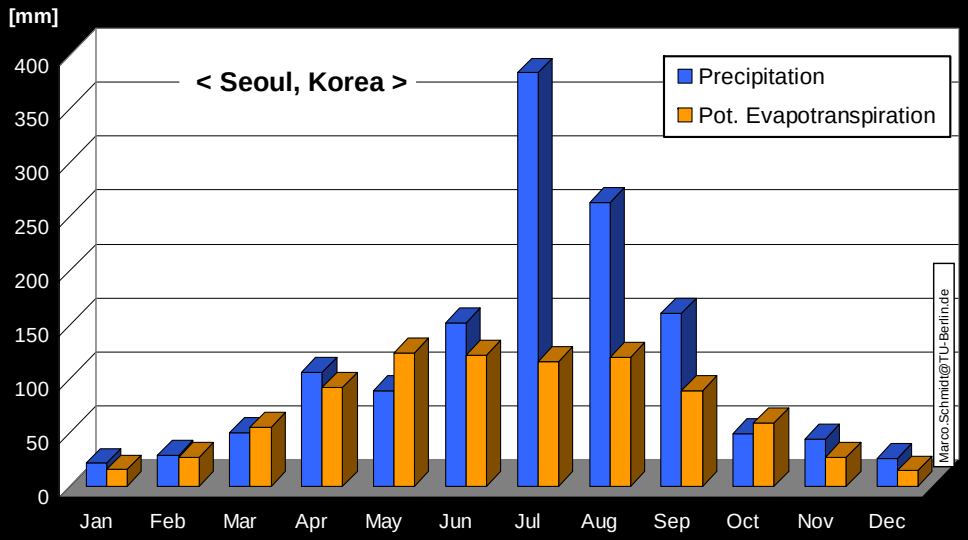
Predicted Results:

- ***Ratio of Precipitation to pot. Evapotranspiration***





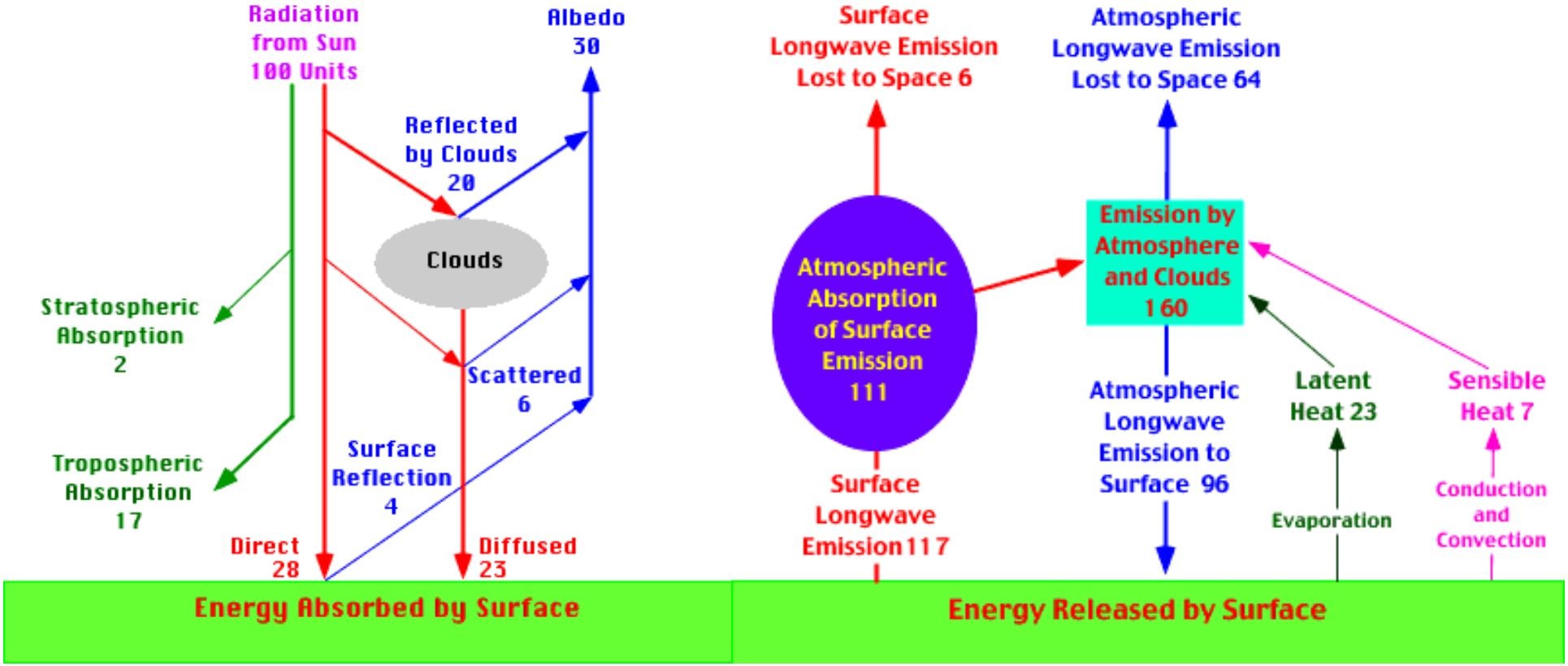




Source of Data: FAO

Radiation

(source: PhysicalGeography.net)



Conclusions

- ***There is an increased need for passive cooling techniques, in Europe as well as in tropical countries***
- ***Rainwater harvesting techniques and stormwater management can be combined with energy saving measures***
- ***The benefit of evapotranspiration in improving indoor climatic conditions and the microclimate around buildings is frequently underestimated***
- ***Legislation:***
  !! New directive of the european parliament on the energy performance of buildings (2002/91/EC) !!

Meet the MDGs:
Improve the conditions of 100 million slum dwellers

Favela Santa Martha, Rio de Janeiro, 12/2003

Thank you for your attention !
Muito obrigado !
Vielen Dank !

http://www.gebaeudekuehlung.de