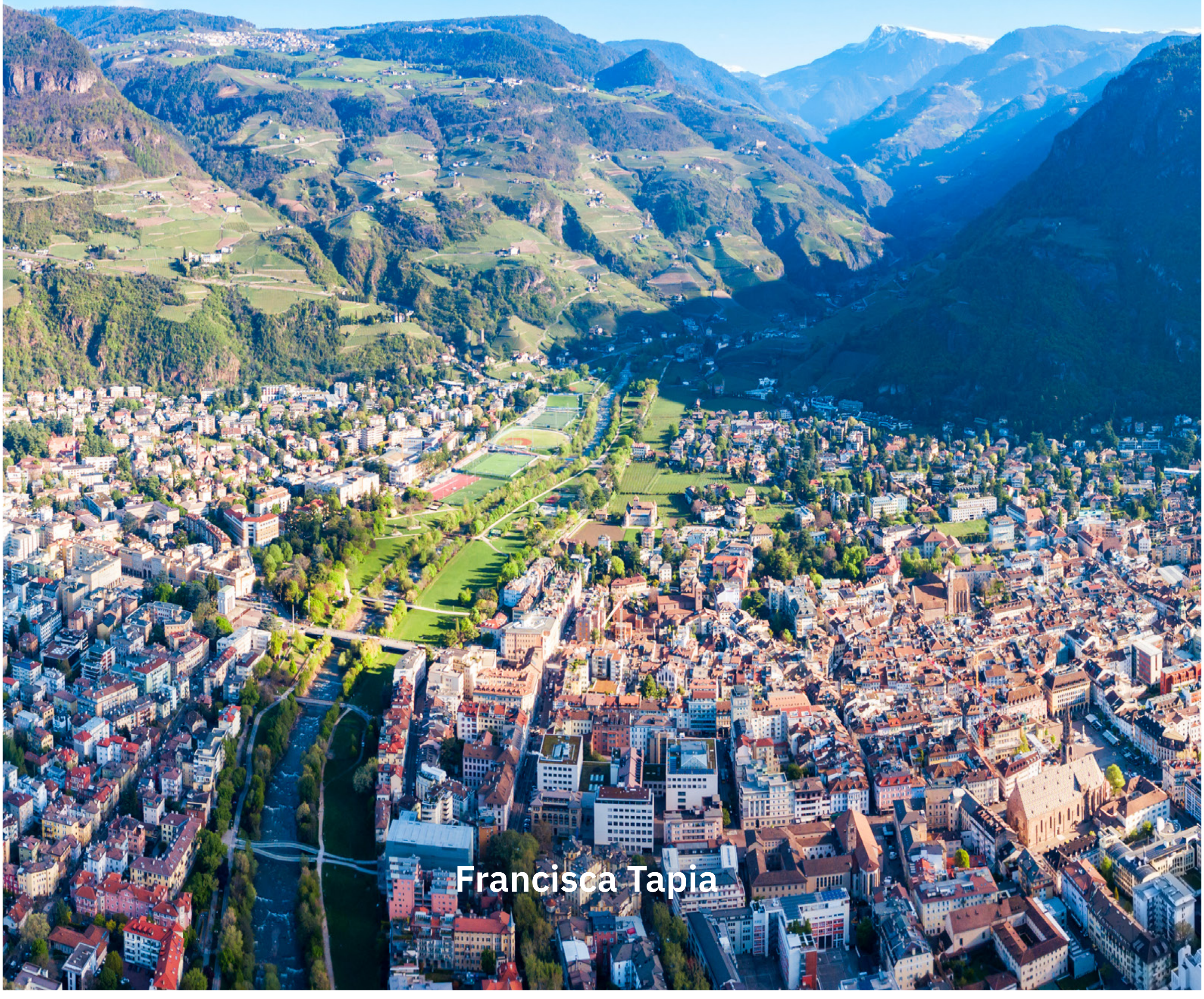
Greening impact on urban-industrial microclimates

Bolzano, Italy



Francisca Tapia

Case study

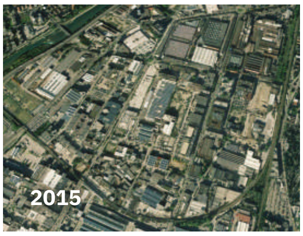
Green infrastructure delivered as a nature-based solutions in an eco-industrial neighbourhood.

This research implies a set of urban and environmental analyses, focused on the impacts of neighbourhood-scale green roof implementation for air temperature reduction and thermal outdoor comfort in the industrial area in the south of Bolzano in South Tyrol, Italy.


Industrial Neighborhood in Bolzano, Sudtirol, Italy


Industrial Neighborhood in Bolzano, Sudtirol, Italy 2020


2006


2015


2020

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Implementation period: 2019-2020

Numerical and computational fluid dynamic models were conducted with simulations tools as ENVI-met met to carry out microclimate scale analyses through the Universal Thermal Climate Index (UTCI) in the area. The approach is tested in two scenarios: (i) actual scenario of an industrial area with no additions of green practices, (ii) green scenario with green roofs implementation in the neighbourhood. The city of Bolzano was taken as a case study; considered one of the three most sustainable cities in Italy by the annual

study developed by the private entity “Italia Oggi” and Sapienza University of Rome.
The city is developing new proposals for the green and blue infrastructure and guiding old ones according to the new urban plan.

The municipality is building up a new concept of an edible city that emphasizes a vision that is increasingly being imposed on urban scenarios where is the need to share and participate between public and private actors.

Green spaces   Potential infrastructures for green roofs

Building surface   Green surface

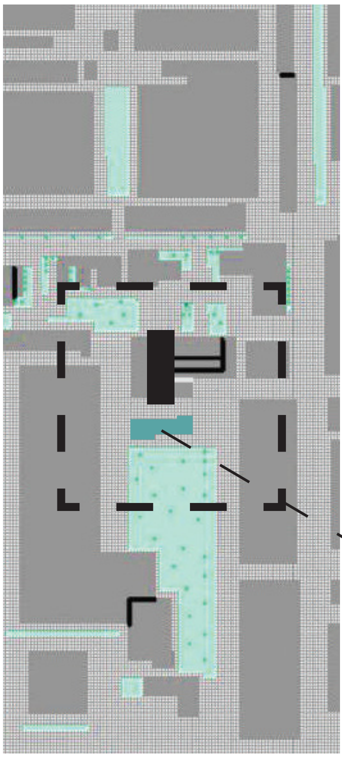
Source: Urban Mobility Plan 2020, Municipality of Bolzano

There are two main goals for the city and private institutions: first, cultivate and harvest involving community and private stakeholders and second, create collective gardens, public gardens, green roofs, and green private areas. For this research, current green projects and future urban planning regulations were analysed at different scales considering their specific purposes and challenges for the development of the city and actual green infrastructure.
The objective of the analysis was the modelling of the urban microclimate, based on the limits imposed by the complexity of several contextual and climatic factors in an industrial area.

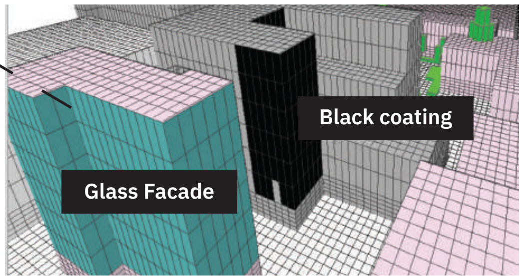
A numerical micro-scale model in ENVI-met v 4.4 was used for carrying out a series of analyses and comparisons. In the actual scenario, the highest temperature in summer conditions during the day is related to asphalt; soil and grass, respectively. These surfaces with relatively high volumetric heat capacity and reduced evapotranspiration due to their impermeability generate higher heat storage and temperatures. The concentration of high thermal capacity buildings, low albedo in urban surfaces and increased urban surface area are factors that guide to enhanced absorption of solar heat that causes the changes in the microclimate analysis.

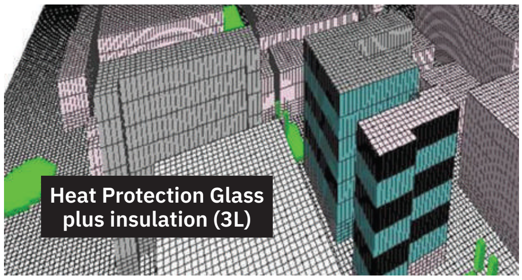
Wall and Roof Materials

Features of artificial building surfaces set in ENVI-met model



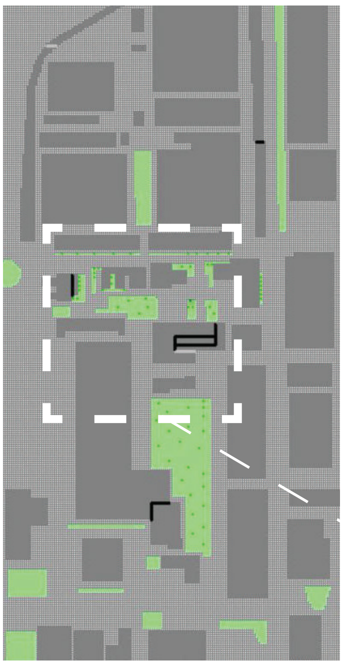
Characteristics	Building					
	Concrete building with metal roof		Brick building		Black Building (New created materials)	
Material type	Concrete hollow block C3	Aluminum AL	Default brick B2	Concrete slab C5	Black Paint + C3	Glass Facade
	facade	roof	facade	roof	facade	facade
Thickness (m)	0.30	0.30	0.30	0.30	0.20	0.30
Absorption	0.70	0.70	0.60	0.70	0.30	0.050
Transmission	0.00	0.00	0.00	0.00	0.00	0.90
Reflection	0.30	0.30	0.40	0.30	0.70	0.050
Emissivity	0.90	0.90	0.90	0.90	0.90	0.90
Specific heat	840	840	650	840	1470	750,00
Thermal Conductivity	0.86	0.90	0.440	0.90	0.20	1.0
Density	930	250	1500	250	1200	2500



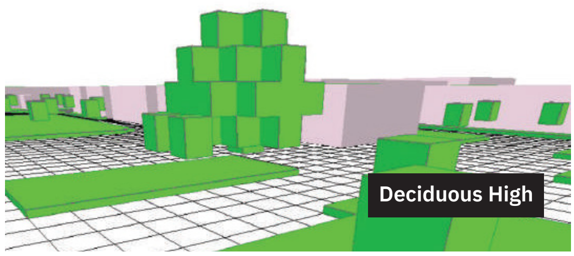


Greening set

Features of artificial greening set in ENVI-met model



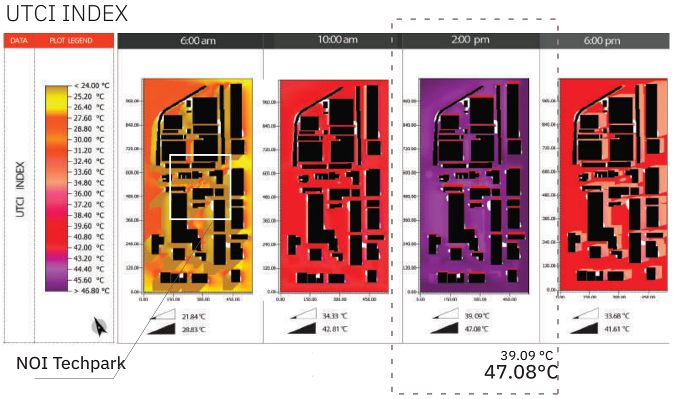
Characteristics		Greening		
Green Type Surface	Grass	Deciduous Tree LAD high		Deciduous Tree LAD low
		Spherical, small Trunk, dense		Spherical, small Trunk, sparse
Allocation	Green spaces	Allocation	Noi Techpark	Streets
Plant Height (m)	0.25	Height (m)	15	5
Albedo	0.20	Width	11	3
Transmittance	0.90	SW albedo	0.18	0.18
Root Zone Depth	0.20	SW transmission	0.30	0.30



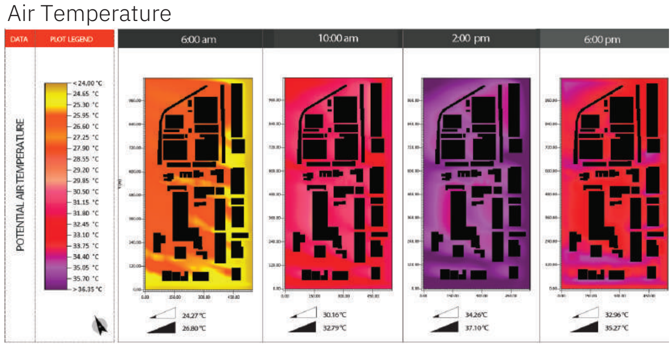
A Actual Scenario : Grey Infrastructure

Summer day: 24th July 2019: 6am-10am-2pm-6pm

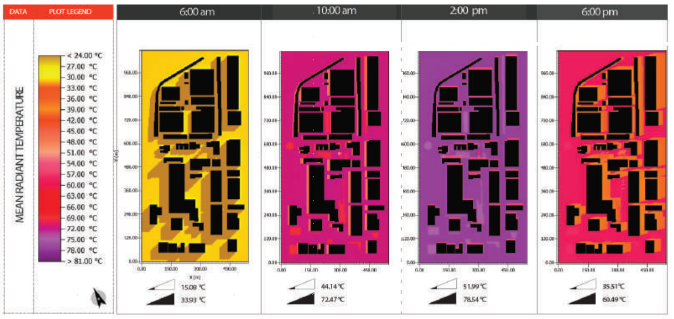
UTCI INDEX



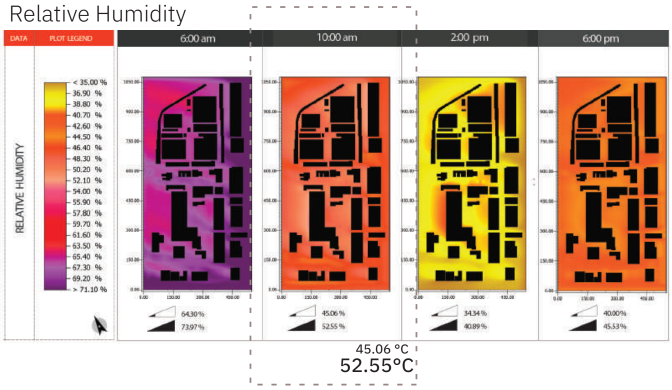
Air Temperature



Mean radiant temperature



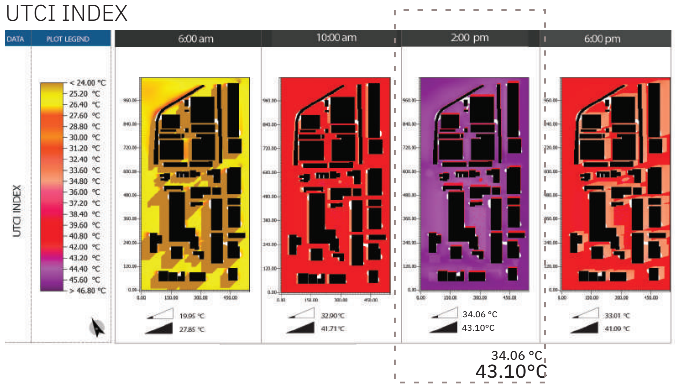
Relative Humidity



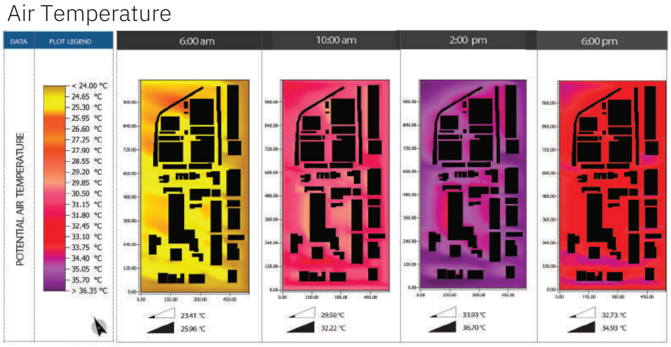
B New Scenario : Grey + Green infrastructure

Summer day: 24th July 2019: 6am-10am-2pm-6pm

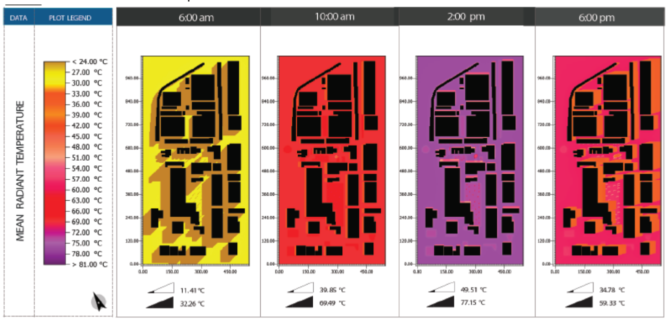
UTCI INDEX



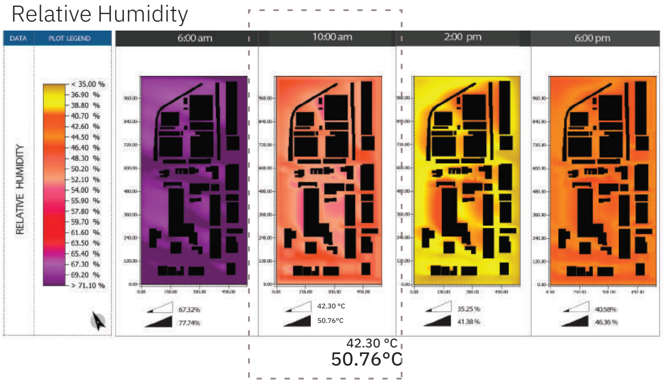
Air Temperature



Mean radiant temperature



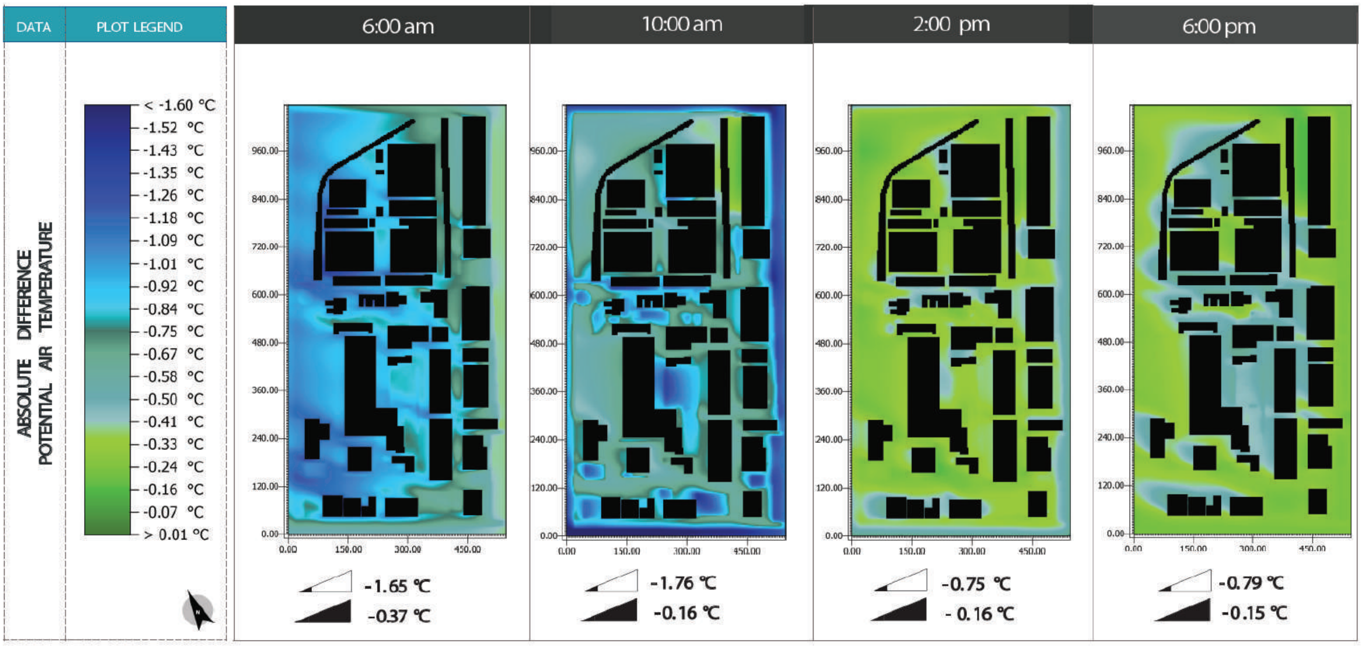
Relative Humidity



ENVI_MET

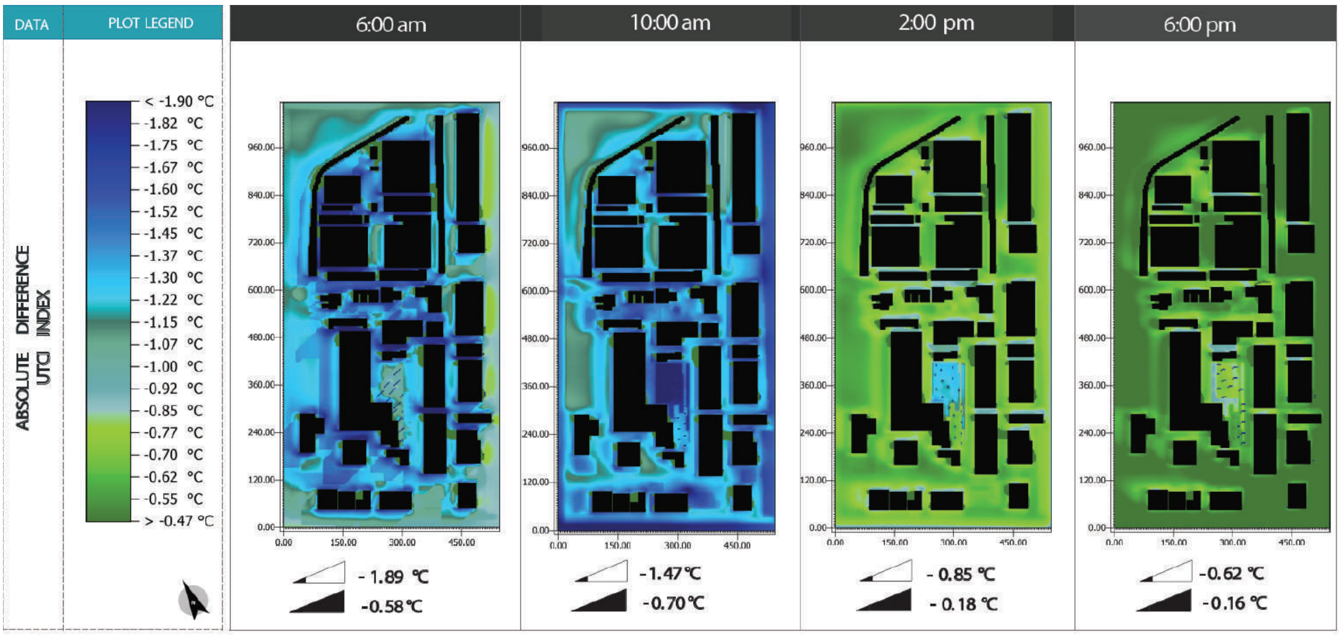
Absolute difference Potential Air Temperature

Summer day: 24th July 2019, 6am-10am-2pm-6pm



Absolute difference UTCI (Universal Thermal Climate Index)

Summer day: 24th July 2019, 6am-10am-2pm-6pm



In the new scenario, the temperatures decrease due to the addition of green spaces and green roofs, especially in the surroundings and in the space behind the black building. Furthermore, during 10:00 am, the ranges decrease by 20% compared to the actual scenario in the common public areas of the simulated buildings. In terms of the Universal Thermal Climate Index (UTCI) for human thermal comfort, temperature differs from 0.20°C to 0.75 °C at the hottest hour of the day. On the other hand, the reduction of 0.80 °C in Potential air temperature (Ta) at 2:00 pm and 0.30 °C in the morning and night hours, demonstrate the relevance of natural and vegetated solutions. The results were analysed to verify the effects of the proposed green design in terms of local climate conditions and human thermal comfort.

Grey Scenario: NOI TECH PARK, Bolzano, Sudtirol, Italy

Green Scenario: NOI TECH PARK, Bolzano, Sudtirol, Italy

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Several factors might influence the effect of vegetation on microclimate and thermal comfort. Lowering the air temperature at the neighbourhood scale could also lead to an evident decrease in the energy consumption of buildings. These effects could be further analysed during the design of future green infrastructures, considering the advantages both on indoor and outdoor thermal comfort. In this way, costs are minimized, and benefits are increased.

Considering summer-overheated areas, as the industrial neighbourhood in Bolzano, green roofs can produce several environmental benefits. Vegetation in roof technologies can also absorb air pollutants such as carbon dioxide and generate oxygen. Green-blue infrastructure is a key component of the quality of outside spaces, especially as industrial areas are considered warmer spots in cities.